



Solomon Islands Government
**Ministry of Mines, Energy and Rural
Electrification**

**Tina River Hydropower
Development Project (TRHDP)**

Environmental and Social Impact Assessment



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EXECUTIVE SUMMARY

This document is an Environmental and Social Impact Assessment (ESIA) Report for the Tina River Hydropower Development Project (TRHDP), a 15-megawatt hydropower scheme on Guadalcanal, Solomon Islands. More precisely, the Project is located in Malango, Ward 20 of the Guadalcanal Province, 30 km southeast of Honiara. The TRHDP is managed by a dedicated Project Office (TRHDP-PO) under the Solomon Islands Ministry of Mines, Energy and Rural Electrification (MMERE). An Independent Power Producer (IPP) will establish a Special Purpose Company (SPC) to Build, Own, Operate and Transfer (BOOT) the hydropower infrastructure. The IPP will sell electricity to Solomon Power, the state-owned power utility. At the end of the lease, the IPP will transfer the infrastructure to the Solomon Islands Government.

E 1. LOCATION

Tina River is located 30 km South East of Honiara at the upstream end of the Ngalimbiu River Basin in Central Guadalcanal.

Figure E-0-1 – Map of Tina Hydro site in Guadalcanal context



The Project is located in Bahomea, within the Malango Ward (Ward 20) of Guadalcanal Province. The Map at Figure E-2 depicts the dam, reservoir and power station sites in the context of the Black Post Road, Main Highway and Ngalimbiu River.

Figure E-0-2 – Map of Project Location



E 2. THE PROJECT

Currently, power in Guadalcanal is mainly provided by Lungga diesel power plant. The power supply in Honiara is barely adequate to meet demand, especially during periods of peak power consumption. TRHDP will reduce the peak demand requirement on the current diesel system and reduce the requirements for imported diesel. It is also expected to defer the need for further capital expenditure on the diesel generation plant for up to a decade.

Guadalcanal has abundant hydropower potential that could help the country reduce its dependency on diesel fuel, reduce the country's exposure to the uncertainties inherent in world oil markets, and lower the cost of energy production. The price of electricity in Guadalcanal is one of the highest in the Pacific region mainly due to the nearly total reliance on diesel for its power generation. Environmentally, electricity generated from diesel leads to impacts including: greenhouse gas emissions, air pollution and a risk of oil spills during extraction, processing, sea transport and transfer to Honiara (Entura, 2014). Electricity generated by hydropower has the advantage of allowing Solomon Islands to rely on its own renewable resource, and to import substantially smaller amounts of non-renewable diesel.

The Project consists of a 53 meter high Roller Compacted Concrete dam in an uninhabited area of Malango Ward at an elevation of approximately 122 meters above sea level (masl) and roughly 30 river km from the sea. It also incorporates a 3.3 km tunnel to a powerhouse and a tailrace at elevation 73 masl. The reservoir formed by the dam will extend upstream approximately 2.6km and will have a surface area of about 0.28km² at an elevation of 175 masl. The powerhouse will be located 5.4 kilometers downstream from the dam on the left bank of the Tina River, and water will be diverted to the powerhouse from the reservoir through the underground tunnel. Initially, the powerhouse will have 3 turbine/generator units, each with a capacity of 5MW, allowing a maximum discharge of about 18m³/s and a minimum discharge of 2.4m³/s. An environmental flow of 1m³/s will be maintained between the dam and the powerhouse tailrace, a distance of 5.7km.

Figure E-3 shows an illustration of the proposed Project Scheme.

Figure E-0-3 – Project Scheme



Construction activities will last three years, and all construction activities will take place on land acquired for the Project in 2014, known as the “Core Area”, as well as along the Black Post Road. The Tina Core Land Company (TCLC), a joint venture between customary landowners and government, will hold rights to the Core Area, including the access road from the power station to the dam site. This land shall be leased to the IPP.

Table E-0-1 lists the main project components and characteristics of the TRHDP.

Table E-0-1 TRHDP main characteristics (Option 7c) from feasibility study

Project Components	Characteristics
Dam	
Type of dam	Roller Compacted Concrete (RCC)
River Chainage	CH 7km
Height	53m
Base length at river	35m
Base length at crest	200m
Material needed for dam and the two cofferdams	Cement: 5.6 thousand m ³ Fly ash: 9.2 thousand m ³ Aggregate: 160 thousand m ³ Water: 30 thousand m ³ Retarding admix: 0.2-0.4 thousand litres
River level at dam	122masl
Minimum operating level (MOL)	170masl
Normal operating level	172masl
Full supply level (FSL)	175masl
Maximum flood level (MFL)	186.5masl
Spillway	
Release of floods	Up to the 1:10,000 year flood level (3,290m ³ /s)
	The spillway will release flood water in by the by-passed river, on average, 8% of the time (when the inflow is higher than 24m ³ /s)
Width	45m
Height (FSL)	175masl
Reservoir	
River Chainage	CH 7km – CH 4.5km
Number of days for filling	Between 5 and 9 days plus extra time for the minimum environmental flow to be implemented during reservoir impoundment.
Volume at FSL	7Mm ³
Volume at MOL	7.8M ³ +/-
Surface at FSL	30.52ha +/-
Length	2.5km
Power water intake	
Location	162.5masl
Size	3m diameter
Scour outlet	
Location	155masl
Head race tunnel	

Project Components	Characteristics
Internal diameter	3.3m, suitable for flow rates up to 24m ³ /s
Flow rate	24m ³ /s
Length	3.3km
Powerstation	
River Chainage	CH 12.7km
Average net head of powerstation	102m
Turbine floor	72masl
Turbines	3 Francis x 5MW
Operating capacity	15MW, 18m ³ /s
Energy production and taking into account a 1m ³ /s Environmental flow	78.35MWh
Environmental Flow	
Riparian outlet for the environmental flow	162.5masl
Environmental Flow (EF) in bypassed river section	1m ³ /s
Minimal flow downstream of the Powerstation during any overnight (off peak) filling	3.4m ³ /s
Road	
Permanent existing Black Post road unsealed	13.3km
Permanent access road to powerhouse sealed	1.45km
Permanent access road to dam sealed	4.7km
Temporary access road to intake portal unsealed	0.25km
Permanent road to dam base	0.66km
Road to quarries	to be confirmed at detailed design
Transmission line	
Length	23km
Type	33kV double circuit
Project cost	
Full scheme extension of the powerhouse	US\$133.3 Million
Unit cost for the Project	US\$165 to 185/MWh
Diesel energy unit cost (Lungga powerstation)	US\$330 to 400/MWh
River hydrology	
Mean flow at dam	11.5m ³ /s
Tina catchment area	150km ²

Project Components	Characteristics
Catchment area above the dam	125km ²

Chainage is based on distance from the confluence of the Tina River and the Mbeambea River which is (CH 0). The dam is localized at CH 7.

E 3. BASIS FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

To implement the TRHDP, an Environmental and Social Impact Assessment (ESIA) is required by both the Solomon Islands Government (Schedule 2, Section 16 of the *Environment Act 1998*) and the World Bank (Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts). This ESIA was prepared for MMERE in accordance with SIG national requirements, and World Bank performance standards and safeguard policies.

Flora and fauna surveys were carried out, and project-affected communities were consulted extensively through the use of social surveys and mitigation workshops as part of the preparation of the ESIA. In addition, a program of ongoing consultation has been carried out by the TRHDP PO since 2011.

The ESIA examined changes to baseline environmental and social conditions that could potentially result from the construction and operation of the proposed Project. Measures were proposed to avoid, mitigate or compensate impacts. A cumulative impact assessment was also carried out, and an Environmental and Social Management Plan (ESMP) is included in the document. Under the Solomon Islands' *Environment Act*, the developer of a project must submit the project ESIA to the Ministry of Environment, Climate Change, Disaster Management and Meteorology. Consequently, the IPP will prepare the official ESIA for submission based on this ESIA, along with a Construction ESMP and various other management plans meeting the minimum requirements of the Framework ESMP. An Operation ESMP will be submitted to the Ministry prior to commencement of operations.

E 4. ANALYSIS OF ALTERNATIVES

E.3.1 Alternative Energy Sources

The ESIA includes an analysis of alternative means to meet the present and projected energy demand of Guadalcanal. The analysis compared sources on the basis of energy production; economics; reliability and limitations; and environmental and social benefits and constraints. It covered demand-side management, wave and tidal energy, diesel-fueled generation (which, as a continuation of present practice, is also the “no-action alternative”), standard and pumped-storage hydro, solar, wind, geothermal, and gas-fired thermal. The rationale for the selection of the proposed project was that hydropower is a reliable and proven source of renewable energy within the local environment as it has:

- Suitable hydrological conditions;

-
- Project locations with minimal social and manageable environmental impacts;
 - Availability of natural resources (water);
 - Relatively long economic lifetime;
 - Low maintenance costs; and
 - Reliable base load power supply.

E.3.2 Alternative Locations and Configurations

Previous studies had already identified the Tina River as hydrologically the most attractive river on Guadalcanal for hydropower development. Over the course of two phases of feasibility studies, receipt of recommendations from the TRHDP-PO's Dam Safety Panel based on geotechnical conditions, and preparation of the ESIA, seven different possibilities for the location of the dam and configurations of the project were investigated. Two of the options had multiple sub-options so that, in all, ten alternatives were examined. Possible locations ranged from a site near the headwaters in a completely undisturbed reach of the river to a downstream site among riverside settlements. Configurations included building the powerhouse at the toe of the dam and locating it at various distances downstream, entailing tunnels of various lengths.

Location 7c with a dam height of between 35 and 65 m, the preferred option, was chosen based on superior technical, financial, and economic performance, complete avoidance of physical displacement of households, and manageable environmental and social impacts.

E 5. BASELINE CONDITIONS

Information on baseline conditions covers a range of topics and was used to assist project-affected communities, stakeholders and the TRHDP PO to understand the natural and human components of the study areas, from the upstream Tina River catchment to the mouth of the Ngalimbiu River.

E.4.1 Physical Environment

The Ngalimbiu River drains in a northerly direction from some of the highest peaks (2000+ m) on the island of Guadalcanal. The river has two main tributaries, the Tina and Toni rivers. The catchment area of the Tina River is about 150 km² compared to 45 km² for the Toni River. The Tina River contains a diverse fish community and is unaffected by human development in its upper reaches.

The Tina River is a single channel meandering river. It has torrential behaviour with regular flash floods. The texture of its bed includes gravel, cobbles and boulders, and fine and coarse-grained sand. In the higher elevation headwaters of the Tina River, very large boulders are intertwined with logs. The upper Tina River is characterized by sequences of pools and rapids and sharp meanders. Major boulders, some greater than 3 m diameter, have accumulated along the channel bars. These large boulders indicate that intense floods occasionally occur within this reach.

In its middle reach, the river enters steep limestone gorges where its course is more confined and less meandering. At this location most of the river's course is made of rapids. In many

areas, river banks are dominated by rock outcrops. The dam and reservoir site are located in this area.

The river reach downstream of the dam site flows through an area having shallower shoreline slopes, lower gradient, and many meanders. The powerhouse will be located in this area. The density of human settlements also gradually increases with distance downstream to the confluence with the Toni River, where the river becomes the Ngalimbiu River. The Ngalimbiu River flows across a flat coastal plain characterized by denser human settlement, oil palm plantations, and gravel extraction.

Average daily temperatures in Guadalcanal range from 22°C to 31°C throughout the year, with a yearly average of 26.6°C in Honiara. The island has a tropical moist climate with regular rainfall. Rainfall increases with altitude and is higher on the windward coast (South shore). Annual rainfall at both Honiara, and Honiara International Airport is 1972mm, with summer months being the driest. It was estimated that annual rainfall at the dam site exceeds 2500mm per annum, and in excess of 3500mm of total annual rainfall in the headwater reaches of the Tina River.

Guadalcanal is periodically subjected to tropical cyclones that are most likely to occur between November and April, and are associated with extreme rainfall events. The Tina River experiences flash floods almost immediately after heavy rainfall events occur in the upper catchment. Flow and water level can change rapidly during such events.

Soils that cover the steep slopes of the construction area, adjacent to the Tina River, are shallow and unstable. They are comprised of colluvial rock debris. However, in stable areas, soils are deep and leached. A significant number of landslides occur within the Tina River catchment, particularly on the steeper slopes. However, they remain relatively small, and are primarily associated with rockslides along bedding planes. Slope instability is an active and ongoing process within the proposed reservoir area.

The dam site is located in an area of significant seismicity. Along the South Solomon trench, seismicity is predominantly related to subduction tectonics, and large earthquakes are common. Fourteen earthquakes having a magnitude of greater than 7.5, have been recorded since 1900. A Seismic Hazard Assessment for the project was undertaken in 2014.

Alluvial deposits are the predominant riverbed material. Bed load sediment ranges in size from silts and sands in low flow areas, to large boulders in very high flow areas. It is assumed that the depth of alluvium reaches approximately 10 m within the river channel, and up to a depth of 25m in some locations. Alluvial terraces occur adjacent to the current river course and bars. Terraces vary from 1.5m to 5m above the current river level. Bed load sediments are materials likely to be deposited into the storage reservoir

Water quality in the upper Tina River upstream of inhabited areas is good as there are no anthropogenic sources (i.e., no domestic use, no gold panning, etc.) of pollution. Natural peaks in turbidity following flash flood events are considered to be the primary cause of degraded water quality. Air quality is generally excellent in the Project area and there are no air quality non-attainment areas in the vicinity.

Ambient or background noise is consistent with a largely un-mechanised society. Nighttime noise levels typically range from 30dBA to 40dBA, and 40dBA to 50dBA during daytime hours. Occasional spikes up to 75dBA to 80dBA may occur close to villages when chainsaws, petrol powered electrical generators or petrol powered water pumps are in use.

E.4.2 Terrestrial Environment (Flora and Fauna)

A total of 161 plants species were identified during field surveys. Among them 5 species are listed as being vulnerable, and 19 are listed as being threatened. The majority of flora species listed as either threatened or vulnerable are timber species harvested for the local or export trade. The primary habitats of the study area are comprised of forested and non-forested ecosystems, which represent a mix of modified and natural habitats. The level of disturbance increases with distance downstream in the catchment. The upper Tina River catchment, upstream of the dam site, is dominated by highly valued, undisturbed lowland forests, whereas, the area downstream of the dam site near Choro, is dominated by disturbed forests. This is mainly the result of anthropogenic activities (e.g., logging, settlements, gardens, trails, etc.). Disturbed areas such as Black Post Road, and the proposed access road and transmission line corridor, are colonized by invasive plant species. The pristine montane forests found in the upper Tina River catchment will not be directly affected by the Project.

The fauna baseline study has shown that wildlife species thrive in pristine forests of the upper Tina River catchment, but also in the more anthropogenically altered areas in the middle and lower reaches of Tina River. A total of 60 wildlife species were observed by the ESIA team in the study area (which encompasses the project affected area and wider catchment), including 9 amphibian, 5 reptile, 41 bird, and 5 mammal species. This includes 1 endemic amphibian, 1 endemic reptile, and 25 endemic birds. None of the three species listed as endangered or critically endangered (possibly extinct) identified in literature studies (the White-eyed Starling, King Rat and Emperor Rat) are known to be present in the Project affected habitats. The presence of the White-eyed Starling (*Aplornis brunneicapilla*) was not detected in the ESIA and feasibility report baseline studies, which extended several kilometers beyond the extent of project construction and operation activities. While the species does appear to have some reliance on primary forest for nesting, it also regularly feeds in semi- and heavily-degraded areas. It is not always easy to find this species during field surveys, and it appears to have movements which are not yet understood. There is thus potential for the species to use the project area at some point.

The Emperor Rat (*Uromys imperator*) is known from only three specimens collected by Charles Woodford between 1886 and 1888, at Aola, a coastal location on northern Guadalcanal, Solomon Islands (IUCN 2016a). Anecdotal information suggests that the species survived until the 1960s. Recent surveys for native rodents have been conducted at sites between 200m and 1,500m. So far, the Emperor Rat has not been detected, increasing fears it is extinct. Later reports suggest that the species became restricted to mossy montane forest (IUCN 2016a). With respect to the TRHDP, the core area of the Project does not overlap with the mossy montane forest, which is found at higher elevations. Therefore, the Project is unlikely to have any effect on the Emperor Rat, should it still exist on Guadalcanal. The King Rat (*Uromys rex*) is listed as endangered and is endemic to the island of Guadalcanal, Solomon Islands, but is absent from large parts of the island. It has been recorded at elevations of 20 and 600 masl. It is an arboreal species that has been recorded from primary tropical moist forest, including relict patches of native forest. There are few recent records of this species. The most recent recorded captures include a single specimen in 1987 from a relict outlier of tall rainforest in the Poha Valley, approximately 35km west of the Project, and two specimens at Gold Ridge in 1989. An intensive survey of Mount Makarakomburu in 1990 failed to locate the species. Relatively recent records in and near the project area, and some apparent tolerance of the species to forest fragmentation and invasive species, suggest that the King Rat may still persist in higher quality forests of the project area. The absence of records on project surveys should not be taken as evidence of the species' absence, since it is extremely difficult to survey for rare, nocturnal, arboreal rodents.

There are no formal protected areas or proposed protected areas that could be affected by the TRHDP. Informal protection of many small, natural sites called "Tambu" is provided by the local population, which protects these areas in a traditional manner.

E.4.3 Aquatic Environment (Fish, Fisheries and Water Quality)

Current water quality in the Tina River does not appear to be a limiting factor for aquatic life, given the low level of pollution.

The householder survey along Tina River shows that fresh river fish do not feature prominently in people's diets, and that canned tuna is now the main source of fish protein. Despite local people's obvious knowledge of the fish species found in the Tina/Ngalimbiu River, from a livelihoods point of view, that the studies suggest that fishing is now only a minor activity. Fishing activities take place during "fishing trips" in the upper catchment, upstream from Choro. The main mode of fishing is by snorkel diving using a spear gun, and is sometimes carried out at night. Fishing is a significant source of livelihood only at the mouth of the Ngalimbiu River, where semi-commercial fishing occurs using mosquito seine nets, gill nets, and other methods.

Regarding aquatic ecology, 59 species of fish were recorded within the Tina/Ngalimbiu River system, from the upstream catchment area to the mouth of the river.

In Solomon Islands, as with other mountainous islands of the Indo-Pacific Region, Gobioid fishes are the dominant fresh water fauna, and are mainly represented by members of the Gobiidae and Eleotridae families. Baseline fish surveys showed that the Gobioid group was represented by 34 species (25 Gobiidae, 8 Eleotridae and 1 Rhyacichthidae).

Like other tropical islands of the Indo-Pacific Region, all native species encountered in inland fresh water are migratory species with a life cycle that alternates between ocean and river. Two main migration patterns are followed: catadromous and amphidromous. Eels are catadromous fish with adults migrating to the ocean to spawn, and juveniles migrating back

into freshwater systems to grow to maturity. During their upstream migrations, juvenile eels are able to climb to the upper reaches of the Tina River.

Most of the other aquatic species, such as Gobioids *Mesopristes* and prawns, are amphidromous. Spawning occurs in the rivers, and larvae drift passively to the ocean before migrating back as juveniles to the freshwater system where they grow into adults. The factors triggering upstream migration of juveniles are not completely understood. However, it is postulated that flooding, which causes high turbidity, and lunar cycles, play a role for triggering migration in some species. Without mitigation measures, the hydroelectric project will impact fish migration to, and production within, the upper Tina River catchment. Given current limited knowledge of the Tina River's ecology, monitoring during the project will play an important role in understanding whether planned mitigation is effective in ensuring no net loss of fish species and densities in this catchment.

The upper Tina River catchment plays an important role in fish life cycle but not a critical one since:

- fish within Solomon Islands do not show natal stream homing behavior. Rather, juveniles will colonize any rivers to which they can gain access; and
- the mouth of the Ngalimbiu River is more critical to the life cycle of most fish species than upstream areas, as it is the only entry point to all fish that live within the catchment.

Based on current knowledge, the upper Tina River is a highly valued aquatic habitat but not a "critical habitat" for fish species present in Guadalcanal.

E.4.4 Social Environment

The baseline social studies included a review and consolidation of existing information regarding the project area and its various communities, along with an extensive program of community consultations. More than forty-five (45) village communities attended the survey meetings. Attendees included tribal chiefs, village chiefs, men, women, adolescents, and children. Overall, a total of five hundred and eleven (511) people attended the meetings. Valuable data and information was collected during the course of the social field surveys, from the village communities, and also from various stakeholders, including government ministries and provincial offices.

Kinship is the most important basis for community formation and action among the people of the TRHDP area. After kinship, church membership is the next most important basis for local social organisation and action.

The counts made during the social fieldwork put the Bahomea/Tina population at roughly 1800 persons, representing approximately 362 households. Of these, 9 people live in villages in the by-passed river reach between the dam and powerhouse. This includes the villages of Choro, Koropa and Senge. A further 1098 people live in villages likely to be affected by the quantity and quality of the water in the Tina and Ngalimbiu Rivers during and/or after construction. The remaining 693 people live in villages likely to be directly affected by roadworks, the creation of new roads, and by construction traffic.

In the absence of financial capital, local people use a range of livelihood strategies, including a mix of the following:

- traditional garden cultivation and gathering of staple foods for subsistence needs, combined with occasional hunting;

-
- cash-earning activities to raise money to pay for imported food, shop goods, school fees, technology, community obligations, and household needs. Such activities typical include one or several of the following:
 - household-scale cash crop production, with the produce sold in the central market in Honiara (The householder survey indicated that 100% of the households grew crops of some kind for home consumption, while 70% said they grew or collected produce for sale.);
 - small-scale timber milling for local and Honiara markets;
 - local day labouring, for example, in timber milling, garden clearing, house building, and other activities;
 - running a small home-based business, such as home baking, natural materials handicrafts, a local shop-canteen selling small items, vehicle hire, and other activities;
 - full or part time employment for a government agency or large company – typically the Gold Ridge Mining Company (GRMC), GPPOL, Earthmovers Logging Company, QQQ enterprises market gardens; and
 - fishing at the mouth of the Ngalimbiu River.

These strategies mostly rely on having good access to:

- local natural capital such as land, forests, rivers, and forest products;
- household human capital, including traditional and formal skills and knowledge, and labour;
- physical capital in the form of tools, equipment and transport infrastructure; and
- social capital in the form of assistance from neighbours, relatives, and fellow church members.

Important strengths of the residents of the project area are the depth of their traditional knowledge and skills and their ability to live in a largely natural environment and acquire a livelihood from it. The Tina River is an important natural resource and feature in the lives of people of the project area. For example it is:

- the main source of drinking and cooking water for the whole district;
- a source of irrigation water;
- a place to bathe, wash clothes, clean vegetables, and participate in recreational activities, such as swimming;
- a transport corridor;
- a source of food, including fish and crustaceans (although these are a minor part of the residents' diet), and a range of plants found in and around the river and tributary streams;
- a fence and boundary marker (e.g., in some villages pigs are kept on the opposite bank of the river);
- a source of rock, sand and gravel for use in local house building, and for villages in the West Ghaobata area to sell and collect royalty payments; and
- a car wash - in its lowest reaches.

Based on observations made in the villages of the TRHDP area, school attendance appears to be relatively low. The accessibility of health services is a significant issue for communities of the project area. This is particularly problematic in cases of accidents, complications of

childbirth, and child diarrhea and fever. All of the local roads are unsealed, inadequately drained, poorly formed, badly located in some places, and lacking an adequate or durable surface.

E 6. IMPACTS AND MITIGATION MEASURES

E.5.1 Mitigation workshops

Mitigation workshops were held in February 2014 to meet with communities and present information on potential impacts of the Project, along with a first draft of possible mitigation measures. The aim of the workshops was to exchange ideas on these measures and to obtain input on people's issues and concerns, including any grievances, regarding the potential project impacts. Following these workshops, stakeholder issues and concerns were addressed in the impact assessment and mitigation sections of the ESIA. Mitigation measures were adapted to local population needs and aspirations.

Communities affected by dam construction and operation activities, landowners who have customary rights in the project-affected area, and downstream affected communities were present at the mitigation workshops. NGOs and government agencies participated in separate workshops. A total of 442 people attended the workshops.

Figure E-0-4 - Young people discussing the Project's impacts during the village workshops (Antioch (left) and Pachuki (right))



E.5.2 Environmental and Social Impacts and Mitigation

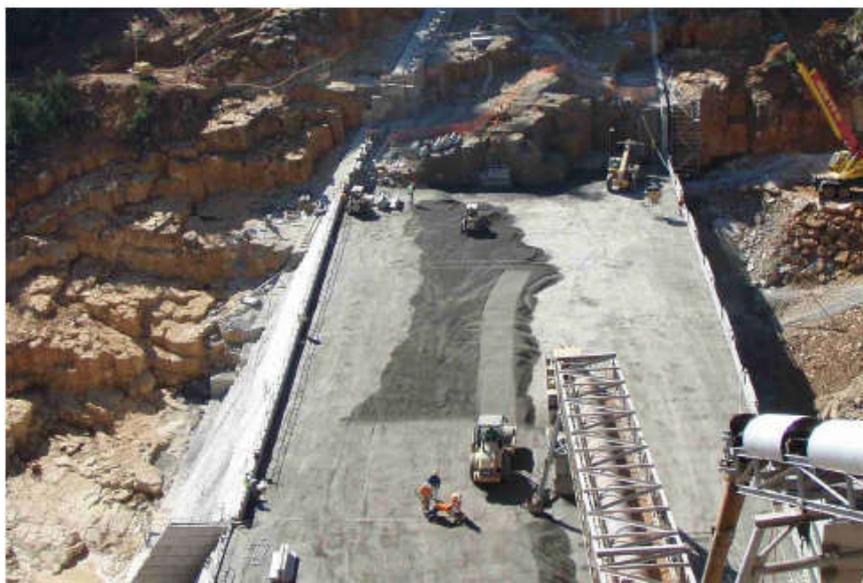
E.5.2.1 Impacts on Physical Environment and Mitigation

Potential physical environmental impacts may include induced seismic activity, local slope instability, soil compaction and erosion, changes in hydrology (surface water and groundwater), changes in sediment transport, temporary impacts on local air quality, and greenhouse gas (GHG) emissions. In turn, impacts on the physical environment may influence the project's viability or sustainability.

A range of mitigation measures have been proposed in the form of management plans and actions to address project construction and operation impacts on the physical environment. These are documented in the Environmental and Social Management Plan contained in Chapter 13. With the application of appropriate mitigation, monitoring and management methods, low to moderate direct and indirect impacts will accrue to the physical environment within the project area.

The Project will have a net GHG reduction potential of 49,500 tCO₂eq per year as a result of reduced use of diesel fuel for power generation. This takes into account potential emissions from the Project during construction, land clearing, and reservoir operation. The Project's net GHG reduction potential for the assumed Project life of 50 years is 2.48 million tCO₂eq.

Figure E-0-5 – Example of RCC Dam Construction



E.5.2.2 Impacts on Flora and Mitigation

Construction activities will necessitate clearing approximately 115.49 ha of natural vegetation in the Core Area, approximately 50 ha of which is disturbed forest and 9.5 ha of which is undisturbed forest, to create an access road and to prepare the reservoir area. Approximately 15 ha each of riparian and cliff vegetation will also be cleared. Measures to mitigate impacts include conducting a pre-construction road alignment survey to delineate environmentally sensitive areas where valued or protected species are to be avoided or, where avoidance is not possible, transplanted where feasible. Changes in road alignment may be necessary based on this survey. Good international industry practice (GIIP) will be implemented by the construction contractor that is responsible for forest clearing to minimize impacts, including maintaining canopy trees where possible. Some natural habitat will be disturbed beyond the road alignment and footprint of other project components, as a result of colonization by invasive species and fragmentation of habitats.

Project operation will necessitate vegetation control under the transmission line. Herbicides will not be used for vegetation clearance, due to the potential toxic effects on amphibians and reptiles, fish and water quality. Instead, manual vegetation control methods will be employed for the Project to maintain the right-of-way.

The presence of the access road will provide local communities in the project area with improved access to harvest forest resources in areas that are currently accessible only by logging roads, including forest resources located in areas upstream of the dam. The access road would be an agent of change in the area if access is not controlled. Land use along the access road may also change with the arrival of new settlers. For this reason, access to the Core Area will be controlled throughout operation.

Improved access could also facilitate increased presence of people in the area around the dam, which could in turn lead to colonization by invasive plant species on areas cleared by, but no longer required for, the Project. Site restoration using native plant species will be undertaken in affected areas to minimise the potential for invasive plant species to become established. A washing station will be used to clean vehicles of soil that may carry the eggs of African Snails.

As part of the financing provided for the Project, SIG will provide funding to an NGO to undertake studies and consultations to determine the feasibility of establishing a protected area in the upper catchment of the Tina River. The NGO will work closely with customary landowners as in Solomon Islands, establishment of a protected area originates with the landowners of the land. No net loss of biodiversity is to be achieved by supporting the protection of the Tina River upper catchment, protecting the remaining natural habitat within the Core Area, rehabilitating impacted habitat post construction and rehabilitating 9.54 ha of existing modified habitat within the Core Area. These measures will be detailed in the Developer's Biodiversity Management Plan and the Post-Construction Rehabilitation and Revegetation Plan.

E.5.2.3 Impacts on Fauna / Fauna Habitat and Mitigation

E.5.2.3.1 Terrestrial Fauna

The TRHDP will be located within the mid-elevation river gorge and downstream catchment areas where human settlements and commercial logging activities have previously contributed to habitat alteration. No critically endangered or endangered species have yet been found within these project-affected areas. Likewise, there do not appear to be any areas associated with key evolutionary processes or globally significant numbers of migratory or congregatory species. Whilst there are restricted range and endemic species, the habitat available within these project-affected areas represents only a small portion of the larger habitat area available to these species adjacent to, and upstream of, the proposed development. Consequently, the areas directly affected by construction and operation of TRHDP are in the vast majority are not considered critical habitat.

The undisturbed montane forest above 400masl in the upper catchment to the south, west and east of the dam site and reservoir qualify as critical habitat because of this ecosystem's limited global distribution and particularly unique assemblages of species. The TRHDP footprint represents a very small proportion of the overall Tina River catchment (<3% of land area), and only directly impacts a very small area of forest which could potentially be considered Critical Habitat. These impacts are not considered significant. To ensure that indirect impacts to Critical Habitat found in the higher elevation area are minimised, measures will be put in place through the Tina Core Land Company who will hold the Core Land to restrict access to the upper Tina River catchment through the Core Land, in effect helping to preserve this area from future resource exploitation. This protection will be furthered by measures in the Biodiversity Management Plan to monitor forest clearing, including illegal logging (eg. logging on sloping land above 400 masl).

Forest clearing in the Core Area is the main activity that will adversely affect terrestrial fauna including less mobile species, such as amphibians and reptiles that are unable to avoid being struck by moving equipment and vehicles. Clearing will disturb fauna and fragment habitats upon which they are dependent. Just over 115 ha of vegetation cover will be permanently removed from the project area. Of that amount, 50 ha has forest cover, but only 9.5 ha can be considered primary forest. Half of the other 40 ha is disturbed secondary forest, and the other half is remnant forest, i.e., secondary forest formed by natural revegetation of cleared areas. The 50 ha represents 0.9% of the total area of non-montane forest and 0.3% of all forest in the catchment. In the context of the assemblage of terrestrial vegetation communities and the wildlife habitats they provide, this permanent loss within the Tina River catchment is not considered to be significant. Approximately 15 ha each of riparian and cliff vegetation will also be cleared. The proposed mitigation measures will help to ensure the direct impacts of vegetation clearing are confined to the 115ha. The developer will prepare a Biodiversity Management Plan (BMP) with the objective of achieving no net loss of biodiversity as a result of natural habitat conversion. The BMP will provide for an offset that will include measures to protect the remaining natural habitat in the Core Area and a program to rehabilitate modified habitat.

Some impacts identified during construction of the Project will continue to affect ecosystems during operation. These impacts are related to the access road. The access road will probably be a low-volume road, with impacts being related less to vehicle-wildlife interactions, and more to ecological modifications brought about by opening of the canopy and increased human presence. Together, these will act as agents of change in the areas adjacent to the road. Whether the access road will be beneficial to reptiles is difficult to assess. Some species, such as snakes, may benefit from openings in the forest canopy created when the road is established, while smaller species might be more vulnerable to feral cats. Grassland birds will be able to colonize areas along the access road. The access road will allow villagers to move into areas that are currently not heavily exploited, putting pressure on wildlife and other natural resources.

Impacts will also arise due to the operation of the dam, including reduction in water recharge of riparian micro-wetlands along Tina River. Conversely the changing water level of the reservoir will open up new aquatic/terrestrial contact zones providing new wetland habitats. These changes will have both positive and negative impacts on amphibians and aquatic insects.

Mitigation measures include controlling access into undeveloped areas as well as specific measures to mitigate impacts on individual species, such as no or low lighting (directed downwards) and fauna underpasses in stream culverts along the access road. Development and implementation of management and monitoring plans that apply good international industry practice (GIIP) will be employed in an effort to reduce the level of disturbance to wildlife.

E.5.2.3.2 Aquatic Fauna

Most impacts to the aquatic ecosystem of the Tina River, including fish and other aquatic organisms, are associated with the physical presence and operation of the dam and power station. Potential impacts during construction are short-term, mainly involving increases in suspended sediment concentrations and turbidity downstream as a result of land clearing and cofferdam installation. Possible spills of fuel, concrete washwater, and other chemicals could also affect water quality. Mitigation and monitoring measures including sediment traps and fuel tank bunding are included in the ESMP to address these impacts.

Beginning with cofferdam installation and continuing throughout the life of the project, flow in the 5.7 km reach of river that is bypassed by the headrace tunnel would be drastically reduced, except in periods of heavy rainfall when water would spill over the dam. Simulation of the hydro operation indicated that floods or freshets would occur on average every 6 weeks, and their average duration would be between 4 to 6 days. Release of an environmental flow of 1 m³/s will be required to avoid damage to the aquatic ecosystem in that reach; this has been determined to be sufficient to preserve the aquatic ecosystem and permit fish movement up and downstream. The 1m³/s EF release at the base of the dam would act as an attraction flow to attract fish into the area for trapping before being hauled over the dam, as described below. It will have the further advantage of ensuring river users along the by-passed section of river (i.e., at Choro, Koropa, Sengue) continue to have access to some water, and that the aquatic ecology of the by-passed stretch of river is supported. Villages located along the bypassed section that depend on the river for drinking will be provided with alternative water supplies.

The dam and reservoir, and to some extent the associated by-passed section of the Tina River, will represent a barrier to the upstream and downstream migration of all native fish species that currently utilise the river system upstream of the dam site. Unless mitigation measures are implemented it is anticipated that most of, if not all, native fishes will disappear from the upstream Tina River catchment. In addition, fish mortality in the powerhouse turbines is a potential impact, as fish become entrained into the power intake of the reservoir and are conveyed to the turbines via the headrace tunnel and penstocks. Mortality of upstream migrating juvenile fish would also occur if they are attracted to the outflow of the powerhouse and then climb into the turbines.

The EF of 1m³/s would be required to enable fish to move up the by-passed section of river to the base of the dam. This EF would be supplemented naturally by up to 1m³/s of additional dry season inflow from the lateral tributaries to the by-passed section of river. Fish density and species richness are likely to be greater with a flow of 1m³/s than with the current median flow of 11.1 m³/s. The estimated fish density at an environmental flow of 1 m³/s is approximately 50 fish per 12 m². This is slightly less than the average of 60.4 fish/12m² observed in the Toni River and considerably higher than the 6.7 fish/12m² observed in the Tina River. Similarly, the estimated number of species per quadrat with an environmental flow of 1m³/s is 2.1 compared to the observation of 2.61 and 1.17 in the Toni and Tina rivers, respectively.

A 1 m³/s flow will provide for fish passage and maintain pool habitat for the pool dwelling species and good riffle habitat for the riffle dwelling species that comprise the majority of fish in the river. In addition, the study suggests there will be an improvement in habitat quality resulting from a reduction in the amount of fine gravel and sand in the river channel.

A minimum of 2.4m³/s will be released to the river from the powerhouse during nighttime hours and those parts of the day when power is not being generated to maintain habitat for aquatic organisms downstream and dampen somewhat the fluctuations in flow between full power generation and reservoir refilling. When combined with the 1m³/s EF release from the dam, this will mean a minimum dry season flow in the river immediately below the powerhouse of 3.4m³/s -- more if small upstream tributaries continue to discharge during the dry season.

An extensive examination of alternative technologies to enable fish migrating upstream to pass the dam led to the conclusion that a combination of a trap-and-haul system at the dam and an EF of 1m³/s from the dam, and a trap-and-haul system at the powerhouse, is considered the only potentially viable system to ensure fish can continue to populate the

upper catchment area. If necessary, this would be further augmented by netting swimming species of fish as they congregate in the mouth of the river or at the base of the dam, for transport and release above the dam. The proposed mitigation would be undertaken using an adaptive environmental management approach in accordance with the EBRD's policy for hydropower projects. This approach would evaluate the effectiveness of the system, and look at other means of ensuring upstream fish passage, in the event that a trap-and-haul system is not successful.

Figure E-0-6 shows a trap system with ramp leading to a holding tank and piped water supply installed at Waitaki Dam, New Zealand. Fish from the trap are to be released in or upstream of the reservoir at a location that will avoid the possibility of fish being entrained by spillway or power station flows. The ramp allows migratory fish to climb to the trap, where they remain until transferred to an upstream location.

Figure E-0-6 – Example of trap system



Installation of fish screens is recommended at the power intake structure to prevent entrainment of eels during their downstream migration. This should be supplemented with periodic releases over the spillway to facilitate movement of adult eels during peak migration conditions. Likewise, a fish barrier or repelling system is recommended for installation in the powerhouse tailrace to prevent mortality of upstream migrating juvenile Syciinids when they enter the turbines. Further, it is recommended that the potential to farm fish within the reservoir be considered if this could be accomplished using species of fish that are native to the Tina River, and which could thrive in a lentic environment. Monitoring of species would need to be done to verify the efficacy of such a program.

Although none of the fish species utilizing the Tina/Ngalimbiu River system will be permanently lost from Solomon Islands if these mitigation measures are not implemented, the loss of viable fish populations from the upper Tina River catchment is an unnecessary impact that can largely be avoided, given the apparent efficacy of mitigation measures that are available.

Fish populations and benthic invertebrates will be monitored upstream and downstream of the dam beginning prior to construction in order to determine actual impacts on fishes and the aquatic ecosystem in this pristine portion of the Tina River and provide a basis for adaptive management if needed. Comparative monitoring will also take place in the Toni River. Aquatic invertebrates will also be monitored downstream, since they are good indicators of long-term impacts on water quality.

E.5.2.4 Social Impacts and Mitigation

The social survey fieldwork covered all of the settled area within the anticipated direct, indirect, infrastructure, and wider impact areas. A high level of participation by the village communities was achieved, with all levels of community members attending focus community workshops and follow up consultations, including adults, youth, women and children.

Several types of social impacts could occur, as a result of the TRHDP. These include:

- direct physical effects on nearby people and households, such as: intrusive noise and vibration, shock waves from blasting, dust and air emissions, soil and groundwater contamination, degraded water quality, and visual intrusion, all of which have the potential to affect health, wellbeing and/or use of local amenities. Physical impacts were identified as a major concern in the vicinity of the dam, tunnel and power house construction (e.g., noise and vibration). This is particularly the case for people living in the villages of Habusi, Managikiki, Namopila, Pachuki and Senge;
- loss of access to the abundant clean fresh water provided by the Tina River during construction and in the low flow river stretch;
- destruction and/or loss of: access to fishing areas on Tina River; food garden areas; hunting areas; plant and related materials; and other important resources; with negative impacts on wellbeing;
- opportunities for improved incomes through employment on project construction and operations, and in new ventures;
- increased risk of disruptions to movement and accidents, given the increase in project-related transport;
- improved road mobility between villages in the project area and between the project area and Honiara;
- threats to indigenous land, natural resources, security, and local culture from intrusion by outsiders;
- potential reduction in gravel extraction over the long term;
- safety issues related to daytime powerhouse flow releases of 24 m³/s, and;
- opportunities for improved quality-of-life, through the provision of replacement services and facilities.

The people and communities most likely to be adversely affected by the project are those living in or utilising areas for their livelihoods, that are close to the proposed project sites.

In addition, people in most riverside communities, especially women, expressed concern about the potential for the failure of the hydropower storage dam and the devastation and loss of life that would occur in the unlikely event that this happened. Members of the indigenous communities expressed anxiety about the potential for social conflict between landowning

groups and with the SIG over land and resource ownership and access rights, royalties, compensation payments, and access to development opportunities and benefits.

To most local people and communities, the Project is seen as offering the opportunity for their villages, churches, and houses to be electrified. Stakeholders believe the construction of the Project will provide opportunities for direct and indirect employment and training in the trades, plant and machinery operation, administration, and security work. The creation of the access roads and the upgrading of the existing Black Post-Tina-Mangakiki Road are seen by local people as a considerable benefit to the community. The TRHDP will be accompanied by a community benefit share fund anticipated to provide non-cash development benefits to the host community. This fund is outlined further in the Community Development Plan.

People in the wider project area believe that the TRHDP may be a good and, perhaps, easy, source of income. This is expected to come from access fees, meeting fees, royalties from use of the river water and construction materials, and rents for use of the land for infrastructure and project sites.

To mitigate potential impacts and enhance benefits the following measures will be implemented:

- Priority be given to job-seekers from the Bahomea and Malango landowning tribes, ahead of other national employment;
- The TRHDP developer and its construction contractors be required to implement a Workers' Code of Conduct covering, at the very least, working hours and conditions, safety, vehicle use, care for the environment, and socially and culturally acceptable behavior in the villages of the project area (see Annex 18 of the Annex report);
- All communities using the river as the main supply source for fresh water will be provided with reliable alternative clean water supply prior to start of construction;
- Road safety concerns on Black Post Road will be addressed by: installing roadside fencing adjacent to village areas, speed controls near residential areas, creation of safe crossing points, bus stop bays, and using best practices for the transport of dangerous goods;
- Use-rights for the storage reservoir and its margins, dam and powerhouse access roads, and other land acquired for the project Core Area will be defined by the Tina Core Land Company (TCLC) together with the Developer as lessee;
- The benefits-sharing program instituted by the SIG and the TRHDP PO will focus on delivering social services, education, training, and improved facilities to host communities. Cash payments and top-down delivery through individual leaders will be avoided and both gender specific programs and gender mainstreaming will be incorporated into the fund design;
- Prior to construction, the TRHDP PO will put in place a protocol for managing cultural heritage. The protocol in the ESIA includes arrangements for avoidance or relocation of cultural or heritage assets, and for compensation where avoidance of assets is not possible or feasible;
- The TRHDP PO acknowledges the effects of project construction and operation on squatters and settlers;
- Consultations will continue with project-affected people and communities, including downstream communities, throughout the life of the Project, using culturally appropriate, inclusive and proven methods and arrangements of stakeholder engagement; and
- Impacts on gravel extraction will be monitored.

E.5.2.5 Land Acquisition and Livelihoods Restoration Plan

World Bank Environmental and Social Safeguard Policies require that where a project undertaken by a Client of the Bank involves land acquisition or restriction of access to sources of livelihood, the relevant Operational Policies (OP) must be followed. In the case of the acquisition of the project land, the relevant policies are OP 4.12 (Involuntary Resettlement) and OP 4.10 (Indigenous Peoples).

A usual consequence of these two safeguards would be the preparation of Resettlement Action Plan and an Indigenous Peoples Plan (IPP). For the TRHDP, the project area was selected to be sufficiently far upstream and sufficiently small that no residential buildings or households will need to be relocated. Therefore, to provide clarity to all stakeholders, the nomenclature for the resettlement action plan was changed to Land Acquisition and Livelihoods Restoration Plan (LALRP) to reflect that land was being acquired, and that the consequent impacts on livelihoods and livelihood assets were assessed and mitigated in accordance with the Safeguards. An IPP was not prepared in accordance with the provision of OP 4.10 that provides that a separate IPP is not required when the overwhelming majority of the project beneficiaries are indigenous peoples, and the elements of an IPP are incorporated into the project design.

A LALRP has been prepared that identifies the actions that have been and will be taken to avoid, minimise, mitigate, or compensate for the adverse livelihoods impacts of the land acquisition and restrictions on land use arising from the Project. The Plan seeks to achieve an equitable and socially and economically sustainable situation for the people whose land is being acquired. This includes ensuring those affected by the acquisition are engaged in its planning and have opportunities to participate in devising and implementing livelihood preservation and restoration. The key points of the plan are:

- Land acquisition was undertaken with the explicit, written consent of the customary landowning tribes;
- Landowning tribes receive payment for full market value of their acquired land including the value of commercial timber;
- Support provided to landowning tribes to establish, manage and invest in a corporation owned by their tribe (co-operative society) including accounting support. The TRHDP PO designed the framework legislation and rules for each society in close consultation with tribes to provide a culturally relevant governance structure;
- To prevent elite capture, and provide sustainable income, through the rules of the co-operative societies, land acquisition payments are divided between future investment, customary obligations, individual payments and administrative costs. Individual payments are made directly to individual bank accounts set up by TRHDP PO for every woman, man and child in each tribe. Payments for children held in trust for school fees until 18;
- Creation of the Tina Core Land Company (TCLC) to hold the Core Area, a joint venture with SIG, with 50% of shares provided (free) to the customary landowning tribes to ensure an ongoing ownership of the land and role in its future use and development;
- Targeted measures for gender equality including presence of women on tribal corporation executive committees; and
- Survey of all assets on project affected land, including gardens and fruit trees, identification of their owners (with or without formal rights to land) and entitlement matrix for compensation and livelihood restoration (see LALRP).

E.5.3 Free Prior Informed Consent (FPIC)

The flow of information from the TRHDP PO to the affected communities appears to have been of a high standard. The TRHDP PO recruited a well-known indigenous media person to develop and document its information sharing and awareness raising activities. The TRHDP PO has made use of a variety of culturally acceptable means for communicating with local communities and stakeholders. Important communications have been, and continue to be, done face-to-face, starting with tribe and village chiefs, and senior women, and then extending out to the wider village communities. Local communications are undertaken by the project's indigenous community relations staff and Community Liaison Assistants (CLAs), and endorsed by community leaders. A wide variety of communications tools have been used to inform the communities and to receive comment and advice in return. Among these are: printed materials, including a project booklet; face-to-face briefings and discussions with groups of community leaders, individuals, community interest groups (e.g., mother's clubs, and church groups) and agency representatives; mobile phone and SMS; presentations using video, photographs, maps, and posters; and site visits. Information briefings to local communities and various groups of stakeholders at key points in the project planning process has been done in local languages, and has been accompanied by the use of audio-visual aids.

Based on the records of the TRHDP PO, discussions with TRHDP PO staff and CLAs, observations, and explicit comments from participants during the 2013 ESIA village community workshops and 2014 mitigation workshops, it appears that:

- There is broad support among local communities for the Project and there is no clear direct opposition to it. A minority of clan leaders and aspirants have objected publically to the land identification and acquisition process undertaken by the Bahomea Land Identification Committee (BLIC) and to the market value valuation of acquired land by the Commissioner of Lands.
- Hydroelectric development is widely seen as the most preferred and least destructive development opportunity for the Tina/Ngalimbiu River catchment (others being gold mining and logging of primary forest);
- community concerns about the project are generally confined to the mitigation of potential impacts and the securing of benefits;
- There has been a comparatively high level of participation of community members of both genders and all ages in the TRHDP PO's activities.
- There is wide-spread understanding of the purpose of the TRHDP, and what it generally involves, although the details of particular hydropower generation options are not well understood, especially by women;
- There is a high degree of trust of the TRHDP PO and the information it has provided, and a sense that local peoples' concerns are being heard and dealt with, even though there is little trust in government, generally;
- There has been considerable discussion within the communities about the Project, including its benefits and potential impacts; and
- SIG acquired the Core Area with the prior, written, negotiated consent of the identified customary land owning tribes (see LALRP).

TRHDP planning to date appears to comply with the requirement of FPIC and, to date, community consent has been achieved at each stage.

E 5.4 Environment Social Management Plan

The Environmental and Social Management Plan allocates responsibilities for implementing each of the identified mitigation measures. The ESMP will form the minimum standards for the Developer's Construction Environment Social Management Plan (CESMP) and Operations Environment Social Management Plan (OESMP). The Ministry of Environment, Climate Change and Disaster Management will review and approve the final CESMP and OESMP, with support from the Project Office.

The ESMP sets out the roles and responsibilities of implementing actors, including their capacity building requirements, together with an implementation schedule.

Monitoring measures include an independent environmental and social safeguard specialist to undertake regular monitoring and auditing to ensure compliance with ESMP measures.

E 7. CUMULATIVE IMPACTS

There are four important sources of disturbance in or near Tina/Ngalimbiu catchment that when combined with the TRHDP could result in cumulative impacts. These include:

- GPPOL's Oil Palm production;
- Potential expansion of mining on the Gold Ridge tenement;
- Artisanal and commercial harvesting of timber; and
- Gravel extraction on the Ngalimbiu River.

As shown in Table E-2, many of the cumulative impacts are related to land tenure issues, water quality issues, loss of biodiversity and economic growth in the area.

Table E-0-2 Summary of cumulative impacts

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Decrease in slope stability, leading to increased soil erosion, and decreased water quality during construction	Low risk of cumulative impacts as long as no clear cutting is allowed nearby Tina River		If new gold mines are exploited in the SPL 194, there is a high risk of cumulative impacts in the Tina/Ngalimbiu River Catchment	Cumulative impacts along the Ngalimbiu River
Disturbance to aquatic habitats and aquatic life during construction	High risk of cumulative impacts if, in the future, clear cutting is practiced nearby Tina River	Aquatic habitat disturbance from drainage of the palm fields in the Ngalimbiu River Catchment		

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Disturbance of water uses during construction				
Colonization by invasive species	Risk of cumulative impacts if additional logging activities take place in the may increase in the upstream area thanks to improved access	Oil Palm has opened the way for plant and wildlife invasive species		
Habitat fragmentation		Oil Palm has transformed some downstream areas into monoculture fields		
Direct habitat and biodiversity loss				
Land Related Issues	Land dispute	Land tenure alienation and land dispute	Land tenure alienation and land dispute	
Employment	Creation of unskilled employment	Creation of unskilled and skilled employment	Creation of unskilled and skilled employment	Creation of unskilled employment
Food security pressure		Increased pressure on food security	Increased pressure on food security	
Challenges to cultural and traditional practices		Added pressure on traditional norms and cultural practices	Added pressure on traditional norms and cultural practices	
Substance abuse and increased criminal activities	Substance abuse and alcohol related abuse among men	Substance abuse and alcohol related abuse among men	Substance abuse and alcohol related abuse among men	
Visual intrusion	Degradation of landscape quality	Degradation of landscape quality	Degradation of landscape quality	Degradation of landscape quality

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Degraded water quality	Suspended solids release due to logging	Herbicides and fertilizers pollution in both water and sediment in Ngalimbiu River	Turbidity, metal and heavy metal pollution in both water and sediment in Matepono River and in the Tina/Ngalimbiu River if SPL 194 is developed	Increase of turbidity in the Ngalimbiu River
Pressures on natural resources availability	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	
Natural hazards and dam safety	Removal of forest upstream of dam, leading to floods, landslides and debris flows that could threaten the dam			

Regarding the probability of occurrence of the cumulative impacts, it should be noted that Gold Ridge Mine has been closed since April 2014 and has been sold to a local consortium that may not have the capacity to reopen it. Resumption of mining activity is not very likely, expansion into the Toni or Tina catchments even less so. There are no known plans for oil palm cultivation to expand in the catchment, and TRHDP will not add to oil palm's most significant potential impacts – water pollution caused by agrochemicals and wastewater discharges. Gravel extraction is also unlikely to expand and may in the long term diminish as the dam traps sediment.

Many constraints limit the implementation of global actions to mitigate cumulative impacts, particularly the lack of capacity of the SIG, the mixed-land tenure system in the area, and the lack of transparency of some local industries. Since TRHDP will be located in the upstream area of the Tina River system, mitigation measures designed for the Project will also address some of the cumulative impact issues. A second phase of cumulative impact assessment will be conducted by the SIG, after which the SIG will prepare a Cumulative Impacts Management Strategy.

E 8. EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The Project will be designed and operated to withstand the various environmental calamities that could affect the project, including seismic events, landslides and debris flows, and severe weather-related events, to ensure the structural integrity of all its components, especially the dam.

Plans relating to dam safety and response to operations related emergency events will be prepared by the Developer. A Construction and Quality Assurance Plan, and an Operations and Maintenance Plan, will be submitted for review and approval prior to Bank Appraisal. An Instrumentation and Emergency Response Plan will be developed during the project design phase, and will be submitted for review and approval prior to project commissioning.

SIG has conducted a Climate Risk Assessment that reached the following conclusions.

- Precipitation changes projected by climate models are distributed fairly uniformly over the year; by 2050 projected changes range between a decrease of 15% and an increase of 15%, on average no significant change.
- Temperatures are projected to increase uniformly over the year. By 2050 the increase will be between 0.5 °C and 2 °C,
- Based on an analysis of multiple climate projections, it is concluded that by 2050 the average basin runoff can vary between 80% (-20%) and 120% (+20%) of the present runoff; by 2090 the range would likely be between 70% and 130% of the present runoff.
- Generated annual energy could vary most likely between -20% and +10% of the energy generated under the baseline hydrological conditions. This range of annual energy generation is reflected in the economic analysis.
- On a global scale, tropical cyclones are likely to show an increase in rainfall rates of the order of 20% within 100 km of the cyclone centre, which could cause for the Tina River basin an increase in extreme flows of 25% to 30%. The operation manual, dam break analysis and emergency preparation plans should take the possibility of extremely high flash flood flows during tropical cyclone conditions into account.

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1. INTRODUCTION

1.1 BACKGROUND

The Tina River Hydropower Development Project (TRHDP or “Project”) is expected to be the first major hydroelectric project in Solomon Islands. Tina River is located 30 km South East of Honiara at the upstream end of the Ngalimbiu River Basin in Central Guadalcanal. Hydropower from Tina River will provide a total annual energy output of 78.35GWh when fully absorbed. The Tina River catchment and proposed transmission line route are situated in the Malango Ward, within Central Guadalcanal District. The Project is managed by a Project Office under the Ministry of Mines, Energy and Rural Electrification (MMERE).

Electricity will be generated by an Independent Power Producer (IPP). An IPP is a private electricity generation company that will sell electricity to the Solomon Islands Electricity Authority (SIEA), the state-owned power utility. The IPP will Build, Own, Operate and Transfer (BOOT) the scheme. It will be the owner of the works during the concession. At the end of the lease, the IPP will transfer the infrastructure to the Solomon Islands Government or SIEA.

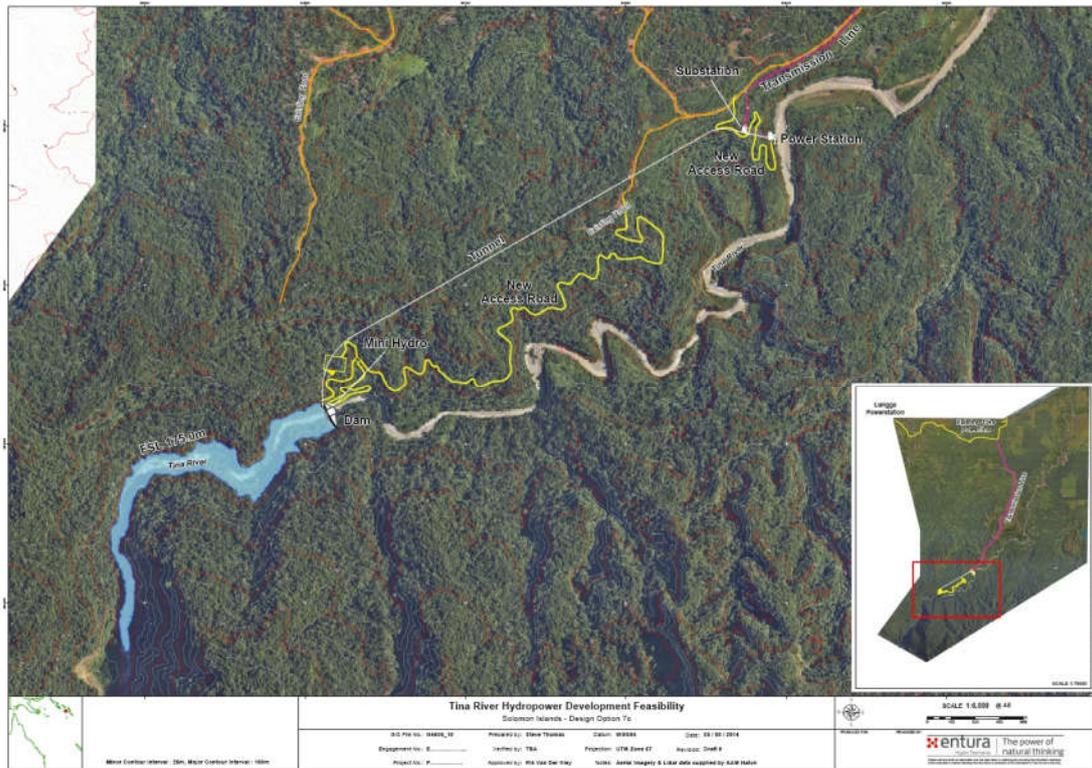
The Project requires an ESIA in accordance with the Solomon Island Government (SIG) *Environment Act (1998)* and World Bank Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.¹ This ESIA is based on the Project Description presented in Entura’s Phase 3 Feasibility Study report dated March 2014. The Phase 3 report identified the preferred project location as “Option 7C” or “Site 7C”.

Option 7C includes a dam located in an uninhabited area approximately 3.5km upstream of the last village situated on the Tina River. The dam will be a Roller Compacted Concrete (RCC) dam. A 15MW (installed capacity) generating station will be located 4.5km downstream of the dam, with a headrace tunnel conveying water from the dam to the powerhouse.

¹ World Bank Performance Standards include the IFC Performance Standards, adopted by the World Bank for use in private sector projects in 2013. See Section 3.

The following photographs (Figures 1-1 through 1-4) show the Scheme Layout, reservoir, dam and powerhouse site, which are all located in the valley.

Figure 1-1 Scheme Layout



Source : Entura 2014

Figure 1-1-2 Approximate location of the reservoir (Tina Valley) looking upstream



Source: BRLi, 2013

1. Figure 1-3 Approximate location of the dam (Tina Valley) looking upstream



Source: BRLi, 2013

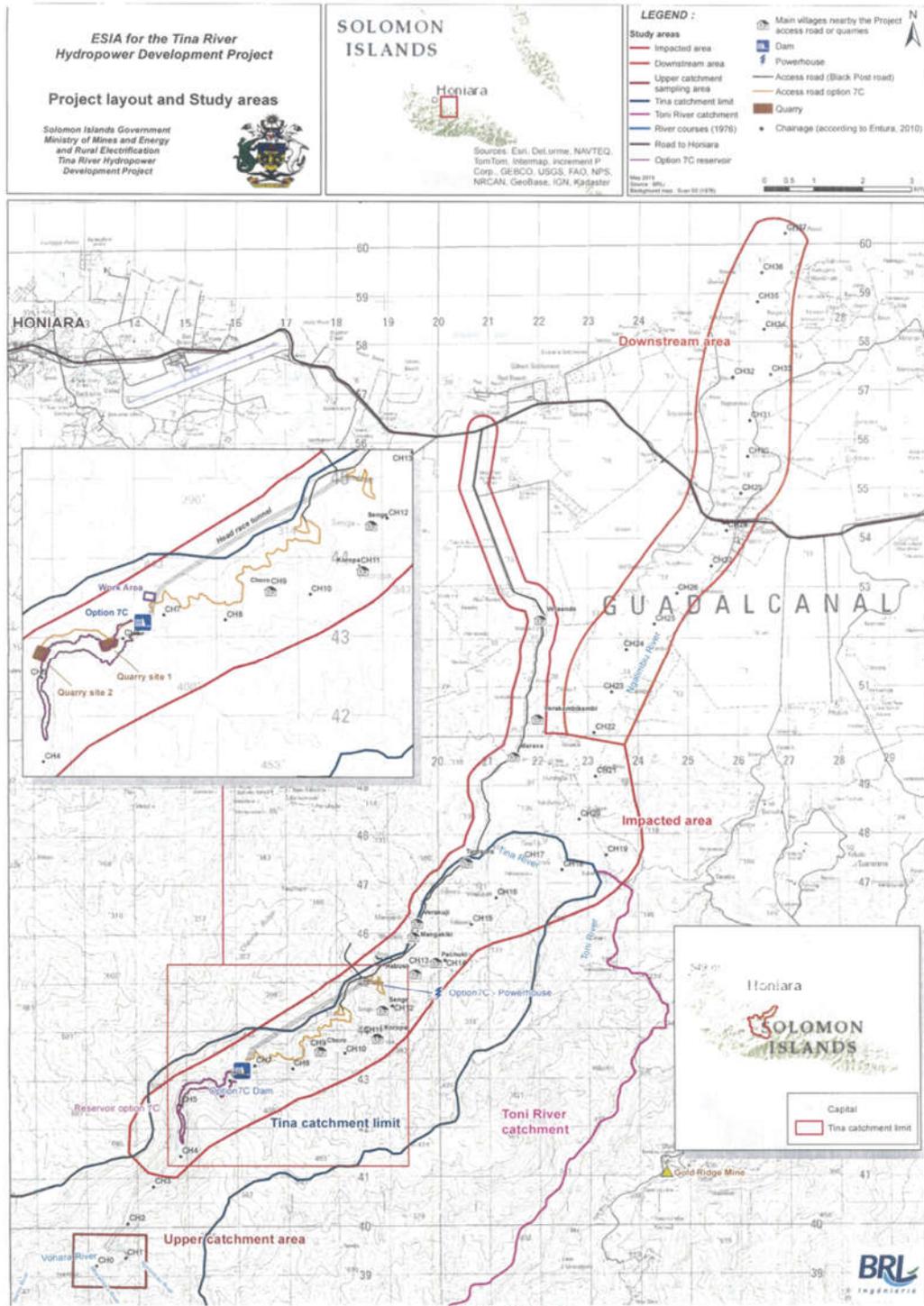
2. *Figure 1-4 Approximate location of the left bank powerhouse looking downstream*



Source: BRLi, 2013

The following map *Figure 1-5: Map of scheme elements and study locations* shows the location of the dam, powerhouse and access road within the Central Guadalcanal region. It also indicates the extent of the Tina catchment, the extent of the project affected area, the downstream area and the location of ESIA study sites both within and outside the affected area.

3. *Figure 1-5: Map of scheme elements and study locations*



1.2 PROJECT PROPONENT

The proponent responsible for developing the Project, is the Government of Solomon Islands, represented by the Ministry of Mines, Energy and Rural Electrification, which has established a TRHDP Project Office (PO) in Honiara, Solomon Islands.

The following contact information applies to the Project:

Entity Responsible for Project Development :	TRHDP Project Office
Address :	Suite 304, Hyundai Mall Mendana Avenue Honiara, Solomon Islands
Principal Contacts for the ESIA :	Mr. Mark France, Project Manager Mark.france@tina-hydro.com Fred Conning, Deputy Project Manager Fred.conning@tina-hydro.com
Project Website :	www.tina-hydro.com

1.3 PARTIES RESPONSIBLE FOR PREPARING THE ESIA

A number of consultants have been involved in preparing the ESIA as follows.

1.3.1 Initial ESIA Preparation

Initial ESIA studies were undertaken, and initial ESIA documents prepared, by BRLi, an engineering company based out of Nimes, France. BRLi was assisted locally by Solomon Environment Services (SES). The initial ESIA report and supporting annexes were submitted in November 2013. The following consultants were responsible for preparing the initial ESIA:

Gilles Pahin – Team leader;

Gerard Fitzgerald – Sociologist;

Lawrence Foanaota – Anthropologist;

Loïc Trébaol – Aquatic ecology and hydrobiology specialist;

Edgar Pollard – Local fauna specialist;

Robson S. Hevalao – Local aquatic ecologist;

Myknee Sirikolo – Local botanist; and

Eric Deneut - Assistant team leader and biologist.

1.3.2 Supplementary Specialty Studies

Based on reviews conducted by environmental and social safeguard policy specialists from the World Bank, and by the environmental and social experts on the TRHDP Panel of Experts, a number of areas were identified that required additional specialist input. The following is a list of the specialist consultants and the studies for which they were responsible:

- Ian Jowett – Supplementary fish and aquatic habitat assessment study for determining minimum environmental flow requirements.
- Gerard Fitzgerald – inputs into TRHDP’s Land Acquisition and Livelihood Restoration Plan for determining compensation and restoration actions related to the land acquired for the project and livelihood assets impacted by this acquisition.

Both the fish and aquatic habitat studies and the Land Acquisition and Livelihood Restoration Plan have been completed.

1.3.3 ESIA Quality Review And Final Edit

The initial ESIA prepared by BLRi was amended to reflect the comments received from various reviewers, include the supplementary information developed by the subject specialists, and to ensure that the ESIA conformed to World Bank Operational Directives, and World Bank Performance Standards.

The current document reflects the compilation of this additional information, along with a quality review and final edit. This activity was performed by:

- TRHDP, Project Office, MMERE
- R. Scott Hanna, Senior ESIA Specialist, Roberschan Environmental.

1.4 PURPOSE OF THE PROJECT

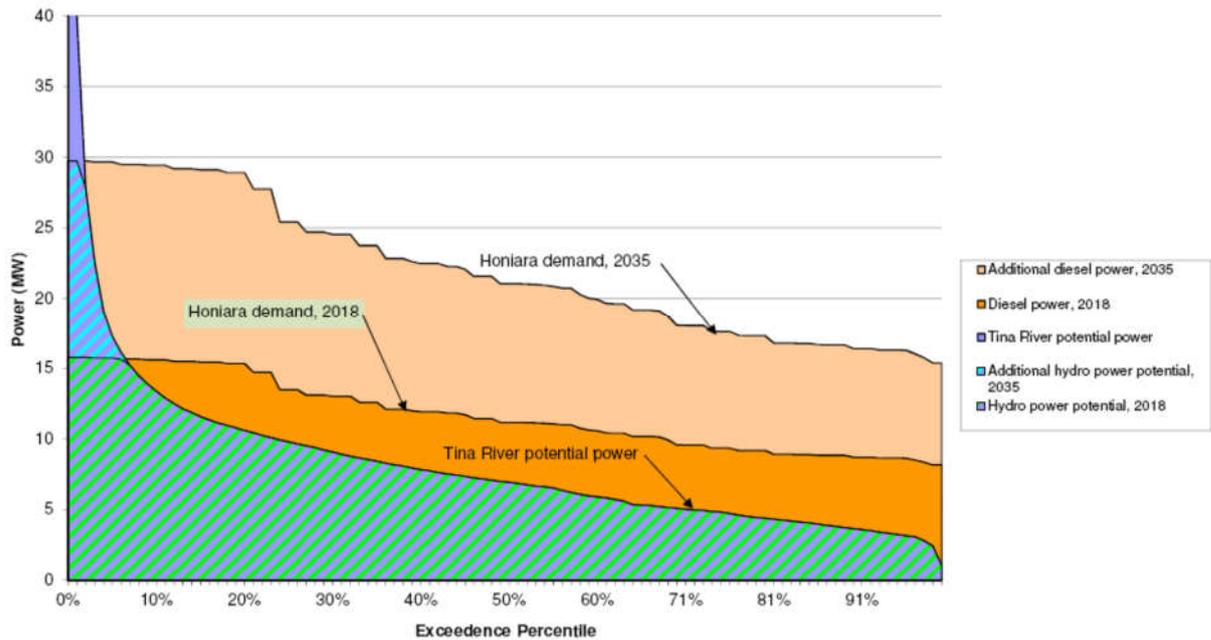
Currently, the Lungga diesel power plant is the main provider of electricity in Guadalcanal. The capital city and key population centre, Honiara, suffers from power shortages, especially during peak demand periods. With increasing population growth and industrialization, Solomon Islands will require an increased supply of reliable power. TRHDP aims to reduce the peak demand requirement from the current diesel system and reduce the need for a backup diesel generating plant. Together, this will defer the need for further investment in Diesel power generation for more than a decade.

The price of electricity in Guadalcanal is amongst the highest in the Pacific region, and is directly the result of having to rely on the importation of costly diesel fuel to generate electricity. Guadalcanal has abundant hydropower potential that could help the country reduce its dependency on oil, reduce uncertainties inherent with world oil markets, and reduce the cost of electricity production.

Electricity generated from diesel leads to environmental impacts such as: greenhouse gas emissions, air pollution and a risk of oil spills during extraction and sea transport to Honiara. Hydropower, as the preferred alternative, has the advantage of allowing Solomon Islands to rely on its own renewable resource to generate electricity rather than importing non-renewable carbon-based resources to generate electricity.

Figures 1-6 and 1-7 show the power demands of Honiara and the power potential of the TRHDP during dry and wet seasons. These two figures illustrate that in both dry and wet seasons, TRHDP will make a significant contribution to power supply in Honiara. Wet year inflows will see the station able to operate at full capacity for most of the time – with unused water being spilled around 40% of the time. In the driest three years on record (i.e. an event with about 10% probability) the station will only rarely be able to utilise all three 5 MW machines.

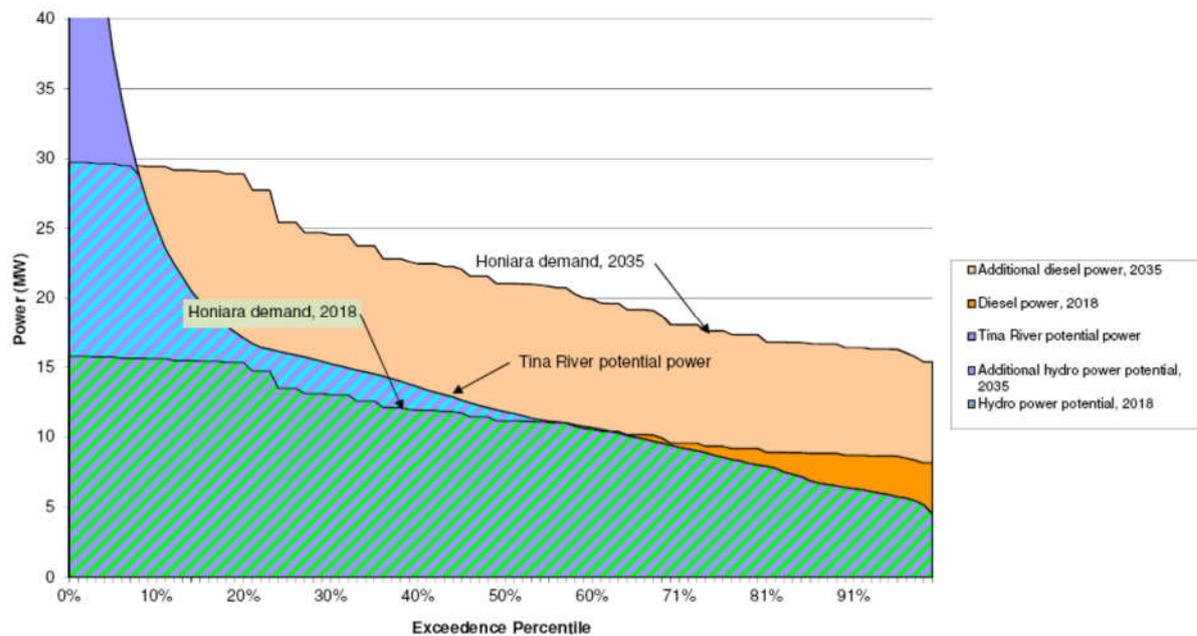
4. Figure 1-6 Power demand and TRHDP power potential during dry seasons



Source: Entura, 2014

In those dry years it is expected that the hydro power station will be used to reduce the need for diesel capacity in the high demand times of the week – between 8 a.m. and 6 p.m. If diesel produced a steady 8MW for the whole of this period of the day, the hydro could produce all of demand which exceeded that base load, in any circumstances modelled. The hydro could also meet all demand above a 6 MW baseload, for all but 4 weeks in the driest year.

5. Figure 1-7 Power demand and potential power from TRHDP during wet seasons



Source: Entura, 2014

In 2014, the unit cost of diesel energy production in Guadalcanal coming from the Lungga power plant was US\$ 330/MWh. The unit cost of diesel energy production is expected to rise to US\$380 to US\$ 422/MWh within 20 years. The unit cost of hydro from the TRHDP is estimated to be US\$ 185/MWh and could decrease to US\$ 165/MWh, which is significantly lower than the unit cost of diesel. As the diesel price increases in future years, the differential will also increase significantly.

1.5 OBJECTIVES OF THE ESIA STUDY

The objectives of the ESIA are to:

- Comply with Solomon Islands legal requirements for the formulation of an Environment Impact Statement under the *Environment Act 1998* since the TRHDP is a prescribed development under schedule 2 (section 16)
- Comply with World Bank/IFC requirements and Performance Standards, including IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts
- Determine the full range of environmental and broad social impacts of the project within the existing environmental, socio-economic and cultural context of the project area to:
- inform the detailed design and implementation stages regarding how to avoid or manage the assessed impacts; and
- achieve development consent through the timely approval of the outcome of the ESIA.
- Provide an analysis of the project area communities and an assessment of the full range of social impacts and benefits of the project within the project area, with particular focus on social impacts associated with IFC PS 7: Indigenous Peoples.
- Assess and discuss impact on natural habitat, gender aspects and cultural heritage as required by the World Bank safeguard policies and IFC Performance Standards.

Analysis of the impacts of Solomon Islands Government's land acquisition on the owners and users of the project land, and compliance with WB OP 4.12 (involuntary resettlement), are addressed separately in the Land Acquisition and Livelihood Restoration Plan.

1.6 ESIA STUDY METHODOLOGY

Preparation of the ESIA has involved several stages, including:

- Identifying the impacted area and study area.
- Identifying and reporting on baseline environmental and social conditions.
- Analysing impacts, and identifying measures to avoid or mitigate impacts, including the use of Mitigation Workshops.
- Reporting on impacts and mitigation.

1.6.1 Area of Influence and Study Area

1.6.1.1 Area of Influence

The Project's Area of Influence (AOI) is defined as the geographical area affected by the Project's construction and operation activities. This area excludes the wider area which may be affected by cumulative impacts. The AOI includes the Direct Impact Area, Upstream Area, Downstream Area and Infrastructure Area.

- **Direct Impact Area (DIA):** The DIA is the direct physical footprint of the project being the land on which all project related infrastructure will be located and all construction will be undertaken. The DIA consists of:
 - **Core Area** – 397 Ha site acquired by SIG in 2014 encompassing all land required for the construction and operation of the dam, reservoir, powerstation, and the portion of the access road from Mangakiki Village to the powerhouse and dam site (also known as Road Lot 2). The Tina Core Land Company (TCLC) will own the Core Area, including the access road. The company is a joint venture between customary landowners and SIG. The map in Figure 1-8 shows the location of the Core Area in red.

NB: The Core Area acquisition in 2014 also included the customary land component of the Infrastructure Corridor, however this area of land acquired for the road and transmission line is defined as part of the Infrastructure Corridor for the purposes of assessing impacts in this ESIA.
 - **Infrastructure Corridor** – Encompassing a 50 metre corridor from Mangakiki Village to the Black Post Turnoff to accommodate the access road and dual 66kV transmission lines, and the transmission line route from Black Post Road to the existing Lunnga Power Station.
- **Upstream Area:** The Upstream Area is the portion of the Tina River Catchment located upstream of the dam and reservoir. Impacts considered in this area include impacts on migratory fish and other aquatic species and impacts of potential reduced access to the hunting and fishing grounds of local communities.

-
- **Downstream Area** : The Downstream Area is the area downstream of the dam to tide-water, (i.e., dam to the confluence with the Toni River, where the Tina and Toni Rivers then become the Ngalimbiu River, and beyond to where the river enters Iron Bottom Sound). The downstream area may be affected by changes in the Tina River flow pattern and water quality. Over the long term, erosion and deposition of materials on the riverbanks may modify the way the river is used for such purposes as household water supply, and exploitation of gravel deposits.
 - **Infrastructure Area** : Infrastructure Area is the geographical area within which people and communities are likely to be affected by the Infrastructure Corridor (modifications to, and use of, the access roads and transmission line corridor). It extends beyond the DIA to include villages or communities that may be impacted by noise, dust, traffic or electricity safety concerns.

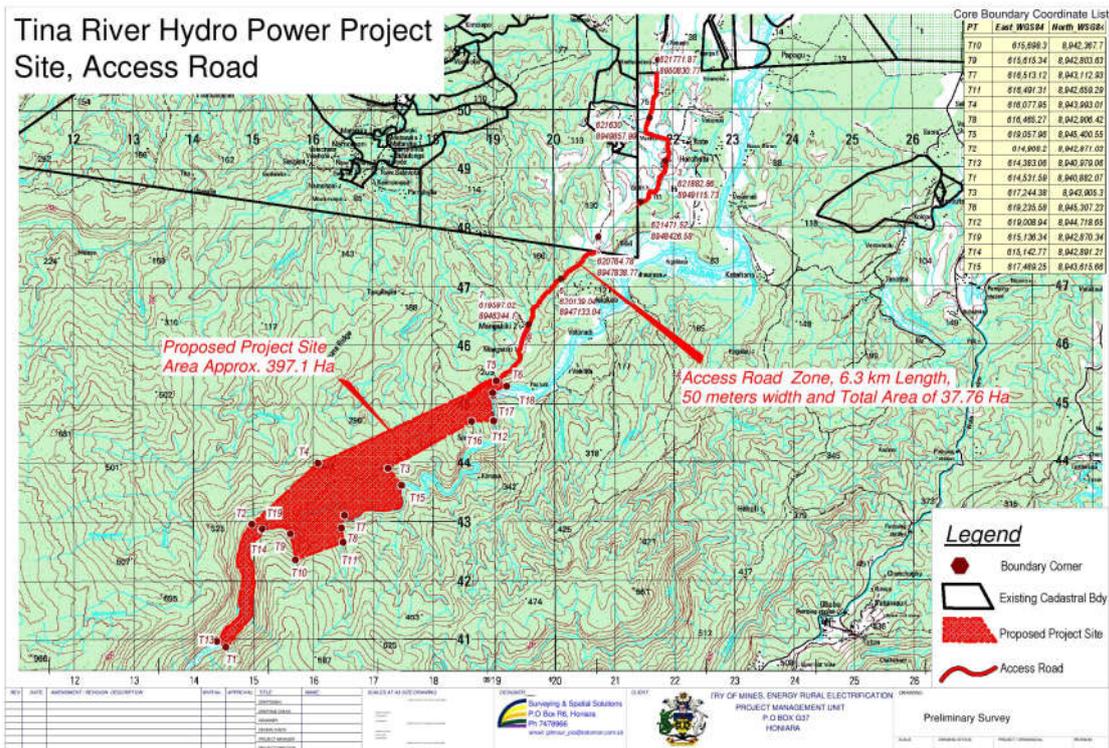
1.6.1.2 Study Area

The study area was selected on the basis of being either part of the Project's Area of Influence or indicative of the wider environmental setting. The study area extends beyond the Project's Area of Influence and is defined as the area in which all potential positive and negative, direct and indirect impacts, including cumulative impacts, may accrue as a result of the project. This includes the entire Tina River and Toni River catchments. It also includes communities that will not be directly affected by the TRHDP, including Behaha and Malango communities, both of which have land interests in the Core Area but are not affected by physical siting of project infrastructure.

For discussion purposes, the Study Area has been broken down into various subunits as follows. The approximate boundary of the Study Area and the subunits described below are shown in the map in Figure 1-5:

- **Area of Influence** - defined above.
- **Toni River Catchment Area** - this area covers the entire Toni River catchment from headwaters to confluence with the Tina River, covering approximately 45km². It was studied as part of the cumulative impact **assessment**, since the Toni River meets the Tina River to form the Ngalimbiu River. Development of mining activities may occur in the Toni River catchment area, since part of the catchment is included in the Gold Ridge Special Prospecting License (SPL 194).
- **Terrestrial Upper Catchment** – The area of terrestrial habitat in the Tina River Catchment above the dam and reservoir.
- **Wider Impact Area (WIA)** – The term used in the Social Impact Assessment (see Section 8.1.2.5) to describe the people and communities in Malango who have ownership rights to land and resources in the Core Area, but who do not reside within the Area of Influence.

Figure 1-8 Core Area and portion of road infrastructure corridor



Source: TRHDP PO, 2014

1.6.2 Identification of Baseline Conditions

The first stage of the ESIA process involved collecting and assembling information on baseline conditions from the study area, and preparing a report that described the current state of the environmental and social components. The baseline included a description of the physical environment, aquatic ecosystem (e.g., fish and aquatic habitat), terrestrial ecosystem (e.g., fauna and flora), and the social environment (e.g., socio-community and socio-cultural aspects and villagers' sources of livelihood). The information was gathered from both extensive on site surveys and review of secondary sources.

The objectives of collecting and assembling baseline information include:

- identifying baseline human and natural environment conditions and the sensitive areas to inform stakeholders and project affected communities;
- Establish the pre- project environmental conditions of the project area so that it can be compared to post project conditions.
- enabling TRHDP to understand the area of influence and its sensitive sites and how these may be affected by project components;
- informing stakeholders and Project affected communities about the ESIA process;
- preparing for the Mitigation Workshops; and
- assessing current policies as a measure of compliance with National, Provincial and IFC/World Bank policies.

-
- Baseline environmental and socio-economic / socio-community information, including information on sensitive areas, was documented in a baseline report.

1.6.2.1 Literature Review

In preparing the ESIA information was obtained from a number of secondary data sources through a literature review process. The following types of data sources were accessed:

- TRHDP Pre-feasibility and Feasibility study reports;
- Other TRHDP project documents and TRHDP website;
- Solomon Island Government publications, including data obtained from various ministries;
- Publications of various South Pacific organisations;
- Scientific journal publications;
- ESIA documents published for other projects in the Solomon Islands;
- World Bank and IFC publications;
- Maps and satellite imagery (e.g., Google);
- Local newspaper articles;
- Information available from various websites (e.g., annual reports for mining companies).

1.6.2.2 Field Studies and Surveys

Secondary data obtained from the literature review was updated and supplemented by primary data collected through field studies and surveys. These included:

Environmental

- Field visits and sampling took place from 05 to 17 August 2013.

Social

- Field surveys were carried out from 29 August to 25 September 2013.

Combined Environmental and Social

- Mitigation workshops - seven workshops with local stakeholders during February 2014 (see Section 1.6.3.1)

1.6.3 Identification of Impacts and Mitigation Measures

The baseline report was reviewed by the Panel of Experts that provided comments that were addressed by carrying out additional analysis during the impact identification stage, and subsequent to this, when the initial ESIA was reviewed.

The following sections summarise the steps followed to identify potential impacts and select mitigation measures:

1.6.3.1 Impact Assessment Methodology

The following steps were used to identify and analyse environmental and social impacts that could potentially accrue as a result of project actions or activities associated with project design and construction, operations and maintenance, and decommissioning and restoration:

- **Define Areas of influence (AOIs)** – identify the area within which a project action or activity could potentially affect a given environmental or social resource or attribute. AOIs differ between attributes.
- **Identify Impact Sources** - identify the project actions or activities (impact sources) likely to affect environmental or social attributes within the AOIs. An impact identification matrix was used for this purpose.
- **Assess Impacts** – assess each impact according to a set of impact criteria, including: duration (temporary vs permanent); reversibility (reversible vs irreversible); extent (site specific vs local vs regional); magnitude or intensity (minor, moderate, major), and probability of occurrence (low, moderate, high).
- **Assess Impact Significance** - assess significance of each identified impact. Impacts can be both positive and negative. Negative or adverse impacts are rated using the criteria of duration, extent, magnitude/intensity (major, moderate or minor); and probability of occurrence.
- **Application of identified mitigation measures** – identify measures to avoid or reduce negative or adverse impacts.
- **Identify Residual Impacts** identify residual effects of the impact after mitigation (significant or not significant).

An impact identification and mitigation matrix was produced. This was used to lead discussions in a series of mitigation workshops. The matrix identified the main impacts and mitigation measures of the TRHDP. The matrix was simplified and used during mitigation workshops to engage local populations and stakeholders, and stimulate discussions.

Seven mitigation workshops were carried out between from 04 to 08 February 2014. The objectives of these workshops included:

- Presenting potential impacts of the Project;
- Discussing possible mitigation and compensation measures with stakeholders and Project Affected People; and
- Obtain input regarding grievances and answer questions.

Table 1-1 identifies mitigation workshop dates, venues, participant groups and number of participants. Additional details on the workshops are provided in Annex 13 of the Annex Report (list of participants) and Annex 12 (minutes of the meetings and lists of grievances and questions).

Table 1-1-1 Mitigation workshops

Date	Venue	Target communities or stakeholders	Number of participants
04 Feb 2014	Heritage park	Ministries and Task force	30 persons
05 Feb 2014	Heritage park	NGOs	14 persons
05 Feb 2014	Tina Village	Communities affected by dam operation	114 persons (including people from surrounding communities such as Antioch and Marava)
06 Feb 2014	Ado	Landowners who have customary rights in the impacted area but that are physically outside of it	60 persons
06 Feb 2014	Mataruka	Landowners who have customary rights in the impacted area but that are physically outside of it	120 persons

Date	Venue	Target communities or stakeholders	Number of participants
08 Feb 2014	GPPOL community building	Downstream affected communities	74 persons
08 Feb 2014	Rate school	Communities affected by dam operation and construction activities	30 persons

1.6.3.2 Environmental Impact Analysis

Impacts on the following valued physical and natural environmental attributes / components were assessed:

- Physical assets
- Small-scale logging, forest and timber milling
- Gravel extraction
- Water supplies, availability and quality
- Livelihoods and key resources
- Natural capital
- Cultural heritage
- Terrestrial flora
- Terrestrial fauna and terrestrial fauna habitats
- Aquatic ecosystems

Impacts accruing as a result of the following were also assessed:

Changes of flow downstream of the dam

1.6.3.3 Social Impact Analysis

Impacts on the following valued social attributes / components were assessed:

- Health, safety and well-being
- Women and vulnerable groups
- Social relations
- Social organisation
- Local customs and way of life
- Employment
- Education and skills
- Ecotourism
- Livelihood strategies
- River and water resource use
- Local financial capital and economic development, royalties, resource rents

Impacts accruing as a result of the following were also assessed:

- Project construction workforce
- Uninvited visitors, job-seekers and settlers

1.6.4 Impact and Mitigation Reporting

The final step in preparing the initial ESIA involved analyzing and describing impacts and issues raised by communities, and proposing measures to avoid, mitigate and compensate for adverse impacts. Impacts are changes that will accrue to both environmental and social attributes as a result of a project's actions or activities. In addition, environmental and social management and monitoring are proposed for construction and operations phases of the Project. The ESIA, as required by the World Bank and IFC, also analyses cumulative impacts (see Chapter 10).

1.6.5 Supplementary Studies and Finalising ESIA

In response to comments received from the World Bank's environmental and social safeguard policy specialists, and from the TRHDP Panel of Experts, two additional technical studies have been undertaken to address outstanding issues and questions. Key pieces of information from the supplementary studies have been incorporated into this ESIA document, and the studies have been appended as annexes. The impact analysis has also been amended based on new relevant information obtained from the supplementary reports, and mitigation measures adjusted appropriately.

The supplementary reports undertaken since the initial draft ESIA was completed for review, and which have now been incorporated into this current document, include:

1. "Report on Engineering Geological Assessment for Proposed 7C Dam Site", prepared by GeoRisk Solution (2014). This study highlights the need for further investigations to answer questions regarding uncertainty associated with geological conditions. The following recommendations for further work were identified by Entura (2014):
 - Storage area: the presence of Karstic limestone in the future storage area needs further study to ensure water tightness and dissolution rate following impoundment of the reservoir. Karstic limestone represents a potential leakage pathway. Additional risks to the reservoir are posed by landslides.
 - Dam site 7C: additional mapping and drillholes are required to characterize the ground conditions upstream and downstream of the dam.
 - Quarry sites: additional mapping and drilling is recommended to better define the suitability of the identified quarry sites. No information is provided for quarry site access roads.
 - Headrace tunnel: a drilling program is required to characterize the rock mass conditions in the tunnel alignment.
 - Powerstation: slope stability and foundation conditions are a concern and field mapping in the vicinity of the proposed powerhouse is required.
 - Access road alignment will require field mapping.
2. "Tina River Hydropower Development – assessment of effects on aquatic ecology and possible mitigation measures", prepared by Ian Jowett of Jowett Consulting Limited (March 2016). This study assesses the effects on the aquatic environment of the proposed project, including:
 - potential effects of environmental flow and fish passage requirements;
 - assessment of minimum environmental flow requirements;
 - hydro peaking;
 - morphological changes resulting from reduced sediment load; and
 - possible mitigation measures.

1.7 STAKEHOLDER ENGAGEMENT AND ESIA DISCLOSURE

The TRHDP PO has been engaged in communication with local communities since 2011 and is involved in an on-going process of community outreach activities, including:

- Development of a stakeholder engagement plan,
- Informative meetings prior to project experts visiting the site (e.g., prior to drilling activities, ESIA surveys, etc.),
- Establishment of Community Liaison Assistant (CLAs) and capacity building to help the PO communicate and identify grievances from the community, as part of the Stakeholder Engagement Plan,
- Community awareness meetings, which inform people about mitigation and entitlements provided by the project (in line with World Bank and ADB policies on resettlement and indigenous peoples),
- Meeting with landowners, community leaders, women, youth, elders, etc.,
- Mitigation workshops.

Since 2011, the TRHDP PO has organized more than 250 outreach activities with communities, summarised in Annex 14.

Key ESIA findings were shared with communities at 15 mitigation workshops over 4 weeks across Ghaobata, Malango and Bahomea, attended by 512 participants, 45% of whom were women. The minutes of these meetings are provided in Annex 12.

In response to the outcomes of the workshops and stakeholder feedback, the ESIA was further revised and disclosed in 2016. Appendix N provides a table of community feedback received during the 2014 ESIA consultations and how that feedback has been incorporated into the revisions of the ESIA and project design.

Following disclosure of the revised ESIA in 2016, TRHDP PO conducted additional ESIA consultations with target communities and key stakeholders in October/November 2016. Table 1-2 identifies consultation workshop dates, venues, and participant groups and Table 1-3 provides a summary of the community feedback and its incorporation in ESIA revision.

Table 1-2 – Stakeholder Consultations for Revised ESIA

Date	Venue	Target communities or stakeholders
20 October 2016	Hyundai Mall, Honiara	Ministry of Environment and NGOs
31 October 2016	Rate Village, Bahomea	Downstream and infrastructure corridor affected communities affected by dam operation and construction activities
1 November 2016	GPPOL community building, Ghaobata	Lower Downstream affected communities

Table 1-3 - Resolution of Community Concerns - ESIA Consultations Oct 2016

Community	Consultation Feedback	Project Outcome
Ngalimbiu Communities	Concerns of reduction in gravel available for commercial extraction	Gravel monitoring by a river geomorphologist provided in the ESMP in section 13.2.2. Drill holes demonstrate areas of deep gravel depth, suggesting sufficient gravel for a significant number of years.
	Dam safety concerns for downstream villages. Dam will 'answer to nature's call'	<p>Dam design complies with dam safety panel requirements. Dam safety panel visited communities in 2012.</p> <p>ESMP section 13.2.2 requires a village level consultation program on modern day dam engineering, construction and operation complemented by community briefings from the World Bank's dam safety panel.</p>
	Concern that environment and safety measures discussed will not be implemented or overseen.	Environment and safety measures to be incorporated into all project agreements. New contractual arrangements section 13.7.3 added to ESMP. Project Finance to include funding for TRHDP-PO and MMERE to provide oversight of SPC and HEC E&S implementation.
Bahomea and Infrastructure Corridor Communities	Concerns of dam safety and question regarding possibility of relocation	<p>Dam design complies with dam safety panel requirements. Dam safety advisory panel (DSAP) visited communities in 2012.</p> <p>ESMP section 13.2.2 requires a village level consultation program on modern day dam engineering, construction and operation complemented by community briefings from the World Bank's dam safety panel.</p> <p>Relocation not advised by DSAP. WB safeguards do not support unnecessary relocation.</p>
	Could the dam be used to provide a water supply for communities and Honiara	Not a component of the current hydropower project.
	Village water supplies to be built before construction starts	Section 13.2.2.6 revised to clarify that all downstream communities whose use is affected by the Project will receive alternative water supplies before construction commences.
	Employment to prioritise host communities. Concerns of influx of people and workers from other islands.	<p>Project related employment to prioritise host communities, ESMP section 13.2.2.2.</p> <p>Requirement incorporated into Implementation Agreement between SIG and SPC.</p>

Community	Consultation Feedback	Project Outcome
	Will downstream fish migration be impacted by the dam once upstream migration measures are implemented	Downstream fish migration predicted to follow freshes and small floods and make use of spillway.
	Electrification for villages	Electrification for priority infrastructure a component of the JSDF Community Benefit Share Pilot, at section 13.5.1.1.
	Important that dust reduction and malaria prevention plans are properly implemented	Air Quality Management and Dust Control Plan and Community Health and Disease Vector Management Plan to be provided by the Developer. Further information on these plans, and details of timeframes and approvals inserted in section 13.4.
	Will there be improvements to education and clinics? Education is priority.	Funding for education and clinics are expected to be key priorities for the Community Benefit Share Fund. Fund priorities to be determined with reference to community consultations as part of fund design and ongoing operations. Discussion of the Benefit Share Fund updated in section 13.5.1.

The TRHDP PO continues to conduct ongoing consultations with communities. In addition, the Ministry of Environment, Climate Change, Disaster Management and Meteorology will undertake further stakeholder consultations in 2017 in accordance with timeframes under the *Environment Act*.

1.8 STRUCTURE OF THE ESIA REPORT

Following the Executive Summary, the ESIA report is divided into the following parts and sections. Additional supporting information is provided in Appendices at the back of this ESIA document, as well as Annexes contained within a separate stand-alone Annex Report.

Part A – Introduction, Project Selection, Rationale and Regulatory Framework

Section 1: Introduction - This chapter provides a general background to the Tina River Hydropower Development Project (TRHDP or the “Project”), its project proponent and purpose. This chapter also briefly describes the objectives and methodology of the ESIA study.

Section 2: Project Description - This chapter describes in detail the project context, access, components, actions and activities of the Project, and its associated project support facilities. It also broadly describes the activities in the project area, the project requirements and the expected implementation schedule.

Section 3: Institutional and Legal Framework - This chapter summarizes the applicable legislative and regulatory context in the Solomon Islands, and notes the World Bank Group's and IFC's requirements including the World Bank's Environmental and Social Safeguards Policies and IFC Performance Standards.

Section 4: Analysis of Alternatives - This section describes the analysis of project alternatives, the reasoning for selecting the preferred option (Option 7c) over other location options on the Tina River, over the "No Project" option, and over other power generation alternatives in the Solomon Islands.

Part B – Baseline Conditions

Section 5: Physical Environmental Baseline - This section describes existing baseline conditions for the physical environment within the project area of influence.

Section 6: Biological Environmental Baseline – Terrestrial - This section describes existing baseline conditions for the terrestrial biological environment (flora and fauna) within the project area of influence.

Section 7: Biological Environmental Baseline – Aquatic - This section describes existing baseline conditions for the aquatic biological environment (flora and fauna) within the project area of influence.

Section 8: Socio-economic / Socio-community Baseline - This section describes existing baseline conditions for the social environment within the project area of influence.

Part C – Impact Assessment and Mitigation

Section 9: Assessment of Impacts on the Physical Environment - This section describes potential environmental impacts that are anticipated to accrue as a result of construction and operation of the TRHDP. It identifies and discusses impacts to the physical environment, and briefly outlines the measures proposed to avoid, minimize, and mitigate potential impacts, following good international industry practice (GIIP) for the hydropower sector.

Section 10: Assessment of Impacts on the Terrestrial Biological Environment - This section describes potential environmental impacts that are anticipated to accrue as a result of construction and operation of the TRHDP. It identifies and discusses impacts to the terrestrial biological environment, and briefly outlines the measures proposed to avoid, minimize, and mitigate potential impacts, following GIIP for the hydropower sector.

Section 11: Assessment of Impacts on the Aquatic Biological Environment - This section describes potential environmental impacts that are anticipated to accrue as a result of construction and operation of the TRHDP. It identifies and discusses impacts to the aquatic biological environment, and briefly outlines the measures proposed to avoid, minimize, and mitigate potential impacts, following GIIP for the hydropower sector.

Section 12: Assessment of Socio-economic / Socio-community Impacts - This section describes the potential social impacts of the TRHDP, and the social impact assessment SIA methodology and constraints of the Social Impact Assessment (SIA). It highlights the communities' perceptions regarding potential adverse social impacts (e.g., impacts on health, safety and well-being), and potential benefits (e.g., electrification, employment, education and skills, ecotourism). This section also briefly outlines the measures proposed to avoid, minimize, and mitigate potential impacts, following GIIP for the hydropower sector.

Part D – Environmental and Social Management

Section 13: Environmental and Socio-economic / Socio-community Management Plan Framework – This section provides the framework for an environmental and social management and monitoring plan framework in accordance with World Bank Operational Policy 4.01 – Annex C. It identifies mitigation measures, monitoring requirements, an implementation schedule and budget, and project context. Detailed commitments and responsibilities are included in a separate stand-alone environmental and social management plan (ESMP).

Part E – Cumulative Impacts Assessment, Natural Hazards and Dam Safety

Section 14: Cumulative Impacts Assessment - As required by the World Bank and IFC, analysis of cumulative impacts is required. Therefore, this section follows the six steps suggested by the IFC for identifying valued environmental and social components (VECs), identifying past, present or reasonably foreseeable projects or activities that in combination with TRHDP could result in cumulative impacts, and recommending measures for addressing these impacts. The TRHDP is assessed for cumulative impacts with mining, oil palm, timber harvesting, and gravel extraction activities. A second phase of cumulative assessment culminating in a Cumulative Impacts Management Strategy will be carried out during project implementation.

Section 15: Effects of the Environment on the Project – This section examines potential natural hazards that alone or in concert could affect components of the project, particularly dam safety.

Part F – Conclusions and References

Section 16: Conclusions – This section summarises the environmental and social impacts that will potentially remain after mitigation measures have been applied (i.e., residual impacts) and identifies whether these residual impacts are significant, or not. An overall conclusion is made regarding the Project.

Section 17: References – This section identifies the secondary data sources used in compiling the ESIA document.

2. PROJECT DESCRIPTION

This chapter describes in detail the project context, access, components, actions and activities of the Project, and its associated project support facilities. It also broadly describes the activities in the project area, the project requirements and the expected implementation schedule.

The Project description is based on Option 7C as defined in the Feasibility Study, dated March 2014.

2.1 PROJECT CONTEXT

2.1.1 Background to Site Selection

The Tina River Hydropower Development Project (TRHDP) is expected to be the first major hydroelectric project in the Solomon Islands. Tina River is located 30 km South East of Honiara at the upstream end of the Ngalimbui River Basin in Malango Ward 20, Central Guadalcanal District. The Tina River catchment and proposed transmission line route are in the Malango Ward within Central Guadalcanal District. During the project feasibility phase, Entura (2010-2014) studied several sites for locating a hydropower facility along the Tina River. The siting options studied by specific study phase included:

- Phase 1 of the Feasibility Study considered a series of 6 options (option 1 to 6) located along the stretch of the Tina River from its confluence with the Mbeambea River (upstream catchment) to its confluence with the Toni River (Entura, 2010).
- Phase 2 studied Option 6. It reached the conclusion that the Option was too technically risky to proceed further. At the time the ESIA work was set to commence, Option 6e was determined to be the best option (Entura, 2012). A further five options (6 b-f) were identified for possible detailed evaluation.
- Phase 3 involved a re-evaluation of Option 6e against a new option, Option 7c. Option 7c emerged from the Phase 3 studies as the preferred option (Entura, 2014).

2.1.2 General Area Description

The Tina River is derived from the joining of three rivers: the Mbeambea, the Voraha and the Njarimbisu rivers. The Tina River catchment area is roughly 150km². The Tina River joins the Toni River, a much smaller river with a catchment of about 45km², to form the Ngalimbiu River, which flows through a coastal plain before discharging into Iron Bottom Sound on Guadalcanal's North coast. This coastal plain is more highly developed than the upstream areas of the catchment, and has more settlements and agriculture activity. At its headwaters, Tina River flows through a very narrow, steeply sided and incised, limestone gorge. In its mid reaches, the slopes gradually become less steep and are dotted with a few human settlements and gardens. A map of the project area is included as Figure 2-1.

The Project area landscape is comprised of volcanic mountains, dissected river ridges in the South and central areas, and low terraces and fertile flood plains toward the North coast. The flora and fauna in Guadalcanal is both rich in diversity and endemism. The project site is dominated by tropical moist forests, and is associated with a majority of low altitude forests, grasslands and mix of habitats. The Tina River upper catchment area is comprised of undisturbed montane forests and aquatic ecosystems.

The majority of the actual inhabitants of the project area are descendants from former settlements located at the base of Mount Popomanaseu, the highest mountain in the Solomon Islands. These inhabitants migrated closer to the North coast plain and Honiara. Most villages are located on the left bank of the Tina River. An unsealed road (Black Post Road) links these settlements with the sealed road to Honiara.

2.2 THE RETAINED OPTION – SITE 7C

2.2.1 Project Description

The project comprises a 53 m high dam located at an elevation of approximately 123 masl, and roughly 30 river km from the sea, a 3.3 km tunnel to a powerhouse and tailrace at elevation 73 masl. The reservoir formed by the dam will extend upstream approximately 2.6 km and will have a surface area of about 0.28 km² at an elevation of 175 masl. The operating range of the reservoir formed by the dam will be 5 m but the reservoir will normally be held about 3 m below the full reservoir level to increase utilisation by storing water during floods and freshes and reducing the number of spill events.

Initially, the powerhouse will have 3 turbine/generator units, each with a capacity of 5MW, allowing a maximum discharge of about 18 m³/s, and a minimum discharge of about 2.4 m³/s.

An environmental flow will be maintained between the dam and powerhouse tailrace. The river distance between the dam and tailrace is 5.4 km.

Table 2-1 shows the Project main components

Table 2-1 Main Project characteristics (Option 7c) as described in the feasibility study

Project Component or Feature	Parameters
Dam	
Type of dam	Roller Compacted Concrete (RCC)
River Chainage	CH 7km
Height	Crest height 53m ; abutment height 64m
Base length at river	35m
Base length at crest	200m
Material needed for dam and the two cofferdams	Cement: 5.6 thousand m ³ Fly ash: 9.2 thousand m ³ Aggregate: 160 thousand m ³ Water: 30 thousand m ³ Retarding admix: 0.2-0.4 thousand litres
River level at dam	122masl
Minimum operating level (MOL)	170masl
Normal operating level	172masl
Full supply level (FSL)	175masl
Maximum flood level (MFL)	186.5masl
Spillway	
Release of floods	Up to the 1:10,000 year flood level (3,290m ³ /s)

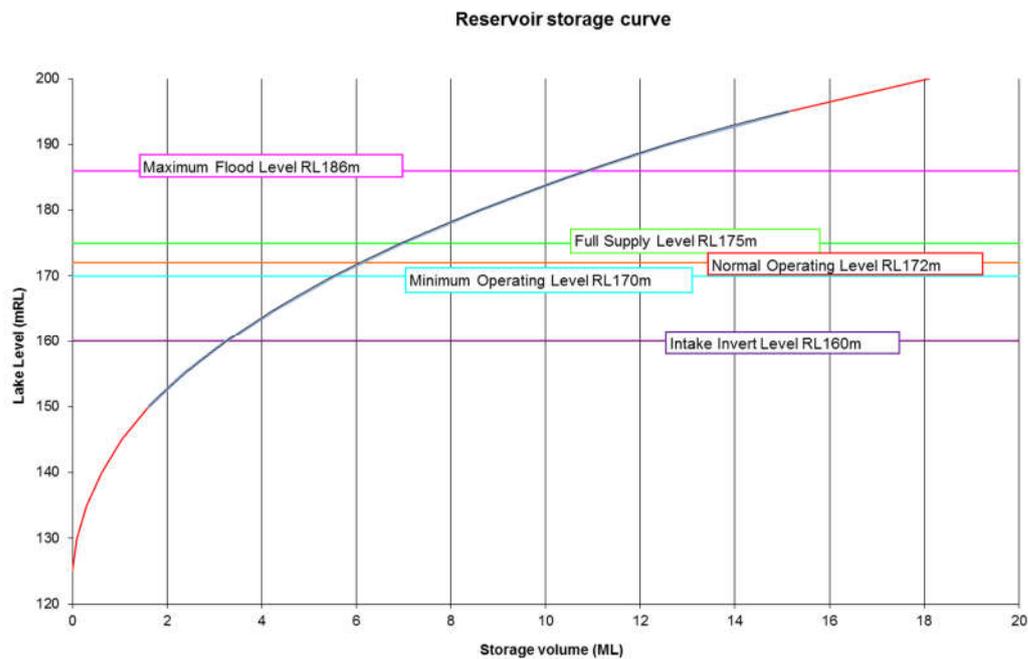
Project Component or Feature	Parameters
	The spillway will release flood water via the by-passed river, on average, 20% of the time (when the inflow is higher than 18m ³ /s)
Width	45m
Height (FSL)	175masl
Reservoir	
River Chainage	CH 7km – CH 4.5km
Number of days for filling	Between 5 and 9 days plus extra time if minimum environmental flow is implemented during reservoir impoundment.
Volume at FSL	7Mm ³
Volume at MOL	7.8M ³ +/-
Surface at FSL	30.52ha +/-
Length	2.5km
Power water intake	
Location	162.5masl
Size	3m diameter
Scour outlet	
Location	155masl
Head race tunnel	
Internal diameter	3.3m, suitable for flow rates up to 24m ³ /s
Flow rate	18m ³ /s
Length	3.3km
Powerhouse	
River Chainage	CH 12.7km
Average net head of powerstation	97m
Turbine floor	72masl
Turbines	3 x Francis of 5MW
Operating capacity	15 MW, at 18m ³ /s
Energy production, taking into account a 1m ³ /s Environmental flow	78.35 GWh per annum
Environmental Flow Outlet Port	
Riparian outlet for the environmental flow	162.5masl
Environmental flow	1m ³ /s

Project Component or Feature	Parameters
Road	
Permanent existing Black Post road unsealed	13.3km
Permanent access road to powerhouse sealed	1.45km
Permanent access road to dam sealed	4.7km
Temporary access road to intake portal unsealed	0.25km
Permanent road to dam base and mini-hydro sealed	0.66 km
Road to quarries	to be determined as part of detailed design
Transmission line	
Length	23km
Type	33kV double circuit
Project Cost	
Full scheme (initial 3 turbines) + Additional turbine (4 th turbine) + extension of the powerhouse	US\$133.3 Million + US\$ 3.4 Millions
Unit cost for the Project	US\$165 -185/MWh
Diesel energy unit cost (Lungga powerstation)	US\$330 - 400/MWh
River hydrology	
Mean flow at dam	11.5m ³ /s
Tina catchment area	150km ²
Catchment area above the dam	125km ²

Chainage is based on distance in kilometres from the confluence of the Tina River and the Mbeambea River, which is (CH 0km). The dam is localized at CH 7km.

The graph in Figure 2-2 illustrates the reservoir storage curve.

Figure 2-2 Reservoir storage curve



Source: Entura, 2014

2.2.2 Site 7c Scheme Construction Activities

According to Entura (2014), the following activities will be included as temporary work:

- Construction of temporary and permanent access roads
- Temporary site office
- Two cofferdams
- Clearing for tunnel portals, pipeline, power house site
- Stripping the main dam foundation
- Clearing vegetation from the reservoir area
- Temporary concrete batch plant
- Temporary pug mill
- Temporary explosive magazine
- Temporary rock crushing mill

The dam construction activities will take place within the Core Area (see Figure 2-1).

2.3 PROJECT COMPONENTS

2.3.1 Dam

2.3.1.1 Choice of Dam

The dam will be a Roller Compacted Concrete (RCC) dam, located in the narrow gorge of the river. The spillway will release flood flows up to the 1:10,000 year flood level (3,290m³/s). The spillway

will release floodwater in by the by-passed river on average 8% of the time (when the flow is higher than 18 m³/s)

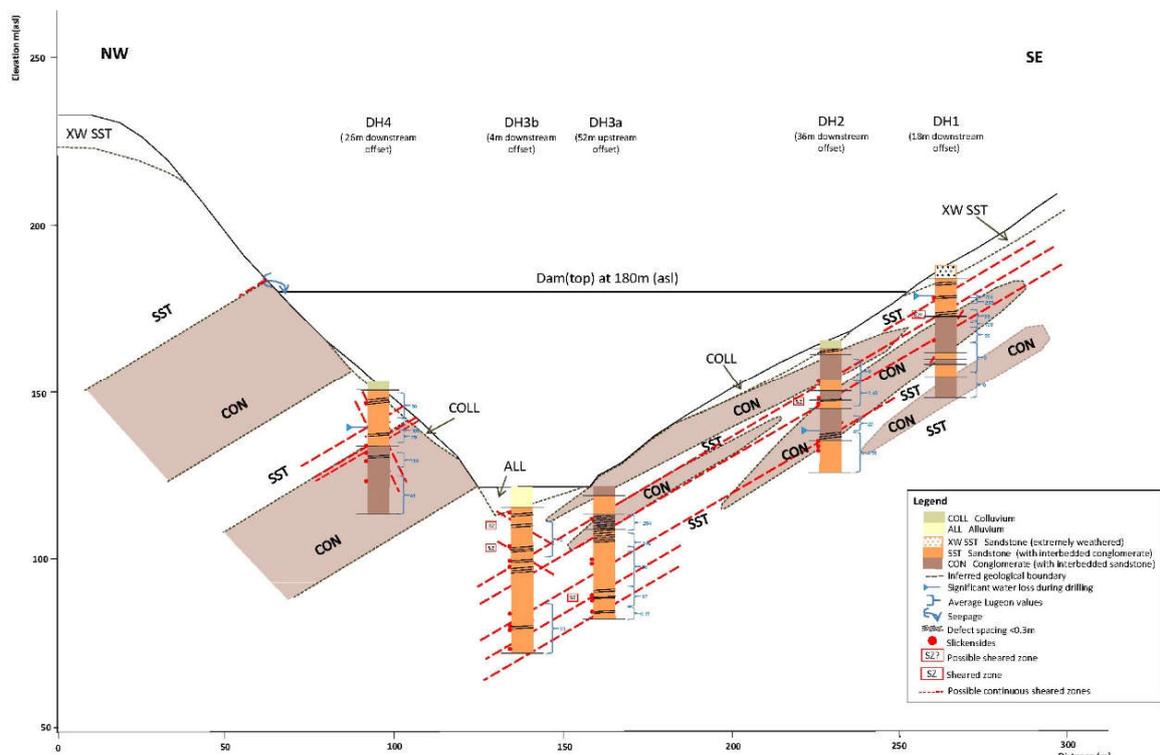
According to Entura (2014), a RCC dam was selected over an embankment dam for the following reasons:

- RCC dams can tolerate over-topping during construction whereas clay core embankment dam will not tolerate over-topping. This is a major element, since flash floods can occur in the Tina River. An embankment dam would need large diameter concrete lined diversion tunnels with high cofferdams to ensure river diversion during flood events. RCC dams require smaller conduit and cofferdam.
- RCC dams can be built with an integral spillway over the dam wall, whereas an embankment dam must have a separate spillway.

An embankment dam would require significant quantities of clay core material, gravel and rock fill. A source of clay was not identified during Entura’s field investigations (Entura, 2014).

Dam height was optimized to maximize energy production. Entura (2014) selected the optimum full supply level to be at RL175. In addition, height is limited to RL175 for stability and water tightness reasons, as above this level there is a risk of leakage through Karst features. The height of the dam spillway crest will be 53 m above the riverbed level (RL 122) with abutments which extend on each side to 64metres to provide dam stability. The dam at Site 7c will have a narrow base (35 m) and steep abutments, resulting in minimum concrete volume for a RCC dam. At crest level the dam will be 200 m wide. A roadway will be located at RL 186.5m. Figure 2-3 illustrates the geology of the dam site.

Figure 2-3 Geology at dam site



Source: GeoRisk Solutions (2014)

2.3.1.2 Construction

The dam will be constructed as a roller compacted concrete (RCC) structure, and require approximately 200,000m³ of roller compacted concrete. The RCC dam, and its two cofferdams, will require an estimated volume of 160,000m³ of aggregate. The construction of the dam and cofferdams will require the following material:

- Cement: 5.6 thousand m³. Cement will be imported from outside the country, due to limited capacity to supply it locally.
- Fly ash (pozzolan): 9.2 thousand m³. This material is required to extend the cement paste, and will be imported from outside the country.
- Aggregate: 160 thousand m³. Aggregate will be sourced locally from quarries and from the river beds as mentioned below.
- Water: 30 thousand m³. Water will most likely be pumped from the Tina River, from a location adjacent to the dam site and RCC batch plant, immediately upstream of the cofferdam.
- Retarding admix: 0.2-0.4 thousand litres. Retarding mix will be sourced from outside the country.

According to Entura (2014), available materials that are close to the dam site at Site 7c include: volcanics, river alluvium, sandstone, conglomerate, calcarenite and limestone. Entura assessed the suitability of these locally available materials as RCC aggregates and concluded that river alluvium and limestone are suitable and calcarenite, sandstone and conglomerate may be suitable but would need additional testing. Finally, volcanic material sources are too distant from the dam site and their exploitation would be costly. Additionally, Entura (2014) identified various criteria to be considered when choosing a quarry site: slope stability, isolation from regular flooding accessibility and location. Ideally, quarry sites will be submerged during reservoir impoundment.

Two locations have been identified as potential material sources:

- Quarry 1: Calcarenite - an estimated 2.5 thousand m³ of material is available. The quarry is located at CH 6.2km to 6.5km.
- Quarry 2: Limestone - an estimated of 1.35 thousand m³ of material is available. Access is more difficult than Quarry 1. This quarry is located at CH 5.4km to 5.5km.

Screening operations for aggregates will occur near the river. At the time the initial ESIA was prepared, the location of stockpiles had not yet been determined. Material from the head race tunnel excavation will be integrated into the crushing operation. One feed mixing plant (pugmill) and concrete batching plants will be required to blend the material and produce the concrete. They will be located in the core construction area.

The RCC will be placed in 300mm layers. It is planned to place two layers a day over a period of about 5 months in the 2nd dry season. Both faces will be grout enriched. Concrete may be delivered to the site using a conveyor as shown in Figure 2-4. Dam construction will start once the cofferdams and diversion conduit and access road are serviceable. Additional concrete work, in the 3rd dry season, will take place for a period of 3 to 4 months.

Construction will start with excavation of the abutments. Abutment stripping will commence at the beginning of the 2nd dry season, when excavation for the foundations of the dam will be carried out in the riverbed. Hydraulic excavators, rear dump haul trucks, air track drills and rock breakers will be used for dam site excavation.

Figure 2-4 Typical RCC dam construction with concrete conveyor



Source: Entura, 2014

Plan, profile and cross section views of the dam, showing its various components, are provided in Figures 2-5, 2-6 and 2-7.

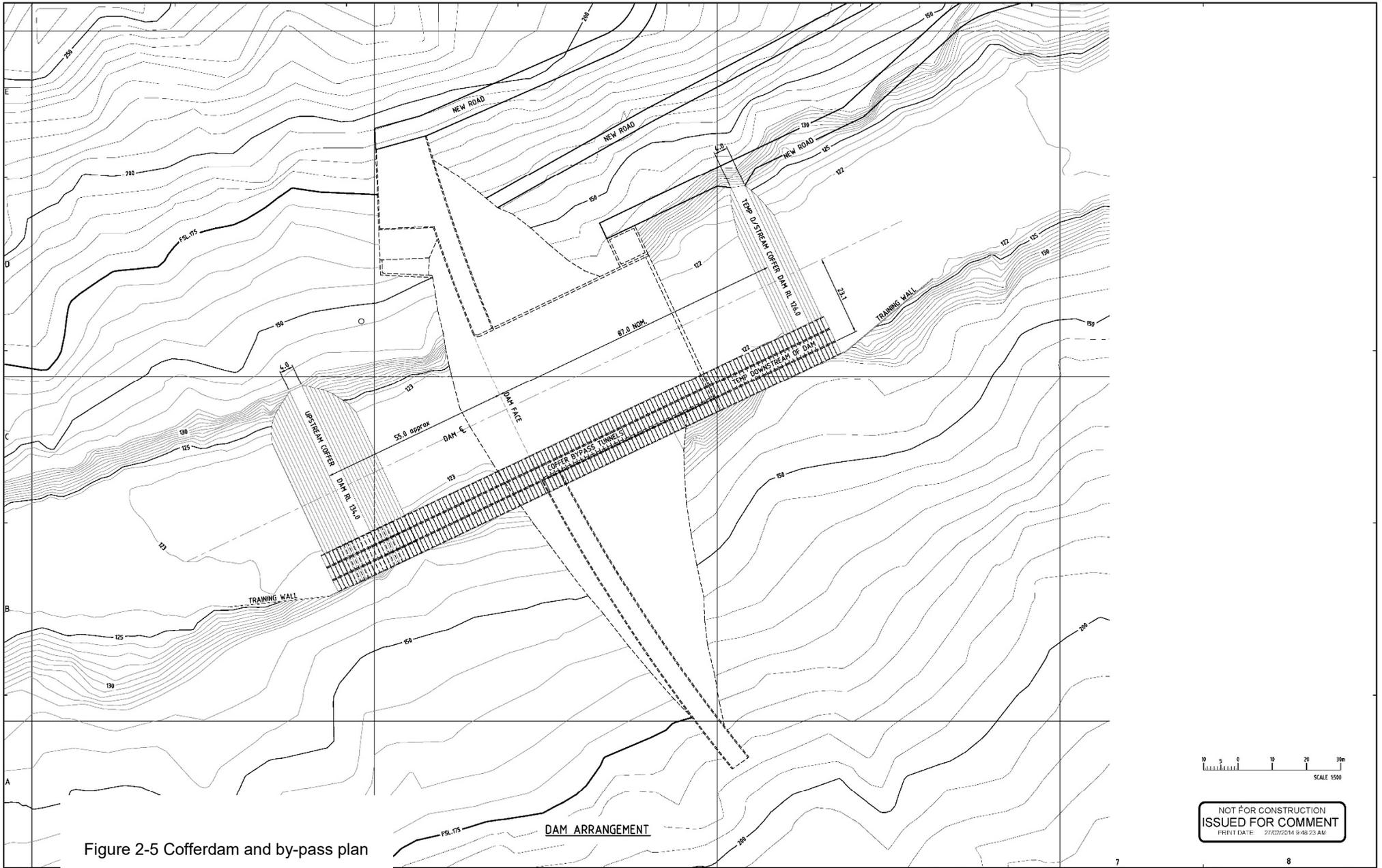
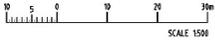


Figure 2-5 Cofferdam and by-pass plan



NOT FOR CONSTRUCTION
ISSUED FOR COMMENT
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ALTERATIONS
NEW ROADS ADDED
UPSTREAM COFFER DAM RAISED
22/02/2014 9:48:23 AM
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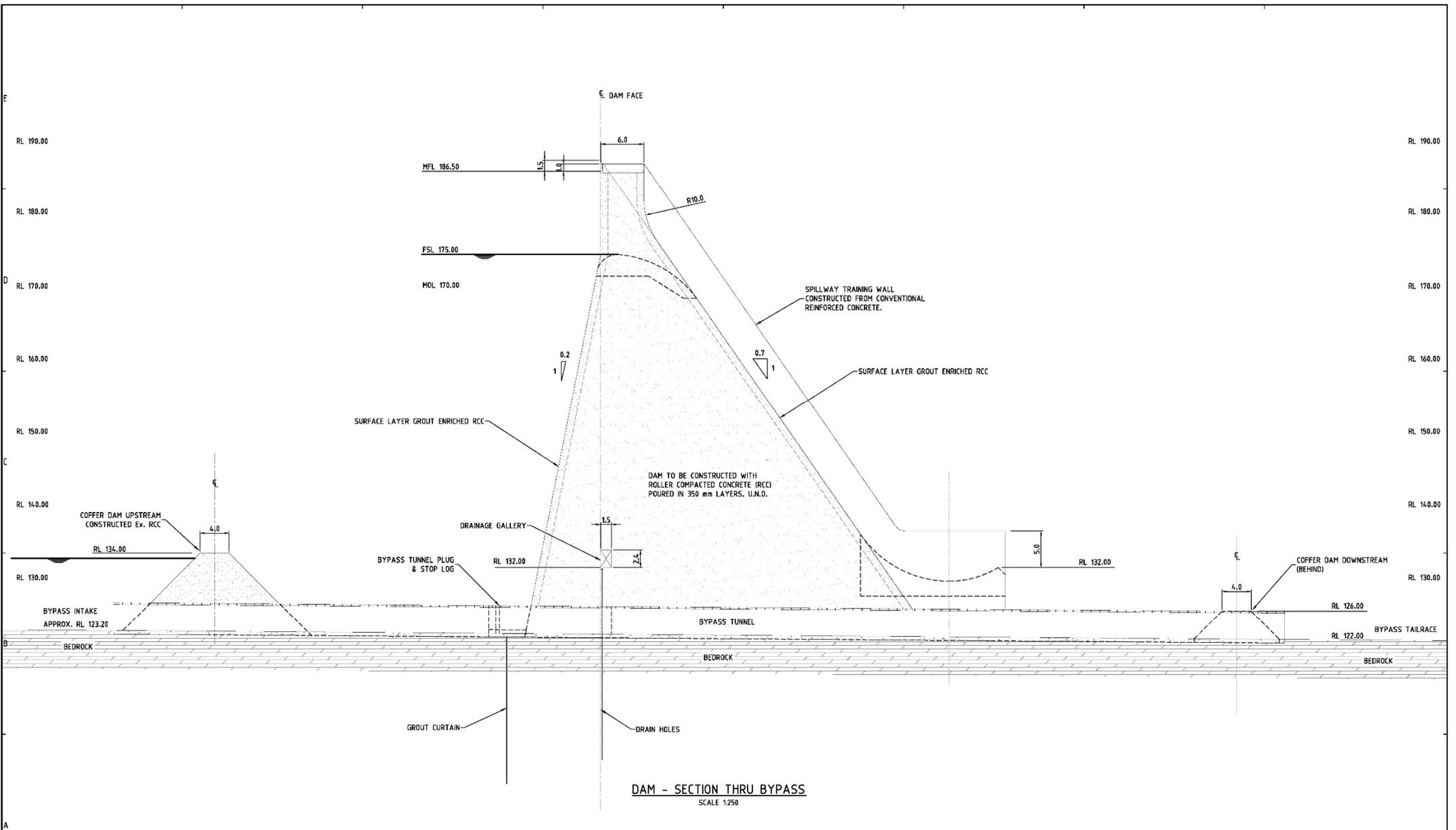
SYMBOLS NOT TO BE USED ON ORIGINAL OR REVISIONS STORED IN PLAN ROOM.

REFERENCE	DESIGN	P. Turnock
	CHECKED	
	DESIGNED	R.V.D.K
	CHECKED	
	APPROVED	
	DATE	
	CLIENT	
	PROJECT	
	NO. OF SHEETS	
	TOTAL SHEETS	

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PROJECT	MINISTRY MINES, ENERGY RURAL ELECTRIFICATION	SCALE	1:400
TITLE	TINA RIVER HYDRO POWER DEVELOPMENT	PROJECT NO.	
	FEASIBILITY STUDY	SHEET	
	SITE 7C, Opt. 1		
	COFFER DAM & BYPASS PLAN		
PROJECT NO.	303416-P3-004	SHEET NO.	02
DATE			



DAM - SECTION THRU BYPASS
SCALE 1:250



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Figure 2-7 Dam section through by-pass tunnel

ALTERATIONS UPSTREAM COFFER DAM RAISED BYPASS TUNNELS & OFF. BYPASS TUNNEL PLUG ADDED 02 P.T. RYDK	SERIALS INDICATED ARE ON ORIGINAL OR REVISIONS STORED IN PLAN ROOM.	REFERENCE	DRAWN: P.Turnock CHECKED: DESIGNED: R.V.D.K. APPROVED: DATE:	 Hydro Tasmania <i>the renewable energy business</i>	CLIENT: MINISTRY MINES, ENERGY RURAL ELECTRIFICATION TITLE: TINA RIVER HYDRO POWER DEVELOPMENT FEASIBILITY STUDY SITE 7C Opt 1 DAM-SECTION THRU BYPASS TUNNEL	SCALE: 1:250 SHEET NO.: DRAWING NO.:														
		07 P.T. RYDK	01 P.T. RYDK		02 P.T. RYDK	03 P.T. RYDK	04 P.T. RYDK	05 P.T. RYDK	06 P.T. RYDK	07 P.T. RYDK	08 P.T. RYDK	09 P.T. RYDK	10 P.T. RYDK	11 P.T. RYDK	12 P.T. RYDK	13 P.T. RYDK	14 P.T. RYDK	15 P.T. RYDK	16 P.T. RYDK	17 P.T. RYDK

2.3.2 Reservoir

The reservoir will have a volume of 7Mm³ at FSL and will extend upstream approximately 2.6 km with a surface area of about 0.28 km². Based on available hydrological data, the reservoir will take between 5 to 9 days to fill to sediment scour outlet (the deepest outlet at 155masl) is reached. An environmental flow will be maintained during reservoir filling,

Once the water level has reached 155masl, the scour outlet could release flow. Implementing a minimum environmental flow during filling will increase the time required to fill the reservoir as shown in the Table 2-2.

Table 2-2 Time required to fill reservoir under varying flow conditions

Inflow (m ³ /s)	Days to fill (to reach 175masl) without minimum environmental flow	Days to fill (to reach 175masl) with 1m ³ /s* environmental flow
3	26.8	Not determined
4	20.1	26.8
5	16.1	20.1
6	13.4	16.1
7	11.5	13.4
8	10.1	11.5
9	8.9	10.1
10	8.1	8.9

* as suggested in Section 12 and Appendix L.

2.3.2.1 Cofferdam and Diversion Conduit

The diversion conduit will be comprised of 3 sets of 150 m long precast culvert units on a concrete base.

A section of the river will be excavated to install the diversion conduit. Excavation will commence from the 3rd month and be completed by the 5th month. Cofferdams will be built commencing in the 5th and 6th months. Both will be RCC structures and, therefore, will require temporary protection from potential river flood waters by pre-coffer dams. These pre-coffer dams will be constructed using material excavated from the diversion conduit excavations. These activities will require hydraulic excavators, rear dump haul trucks and bulldozers.

The diversion of the river will be sized to allow the construction work to continue during the majority of potential river flows.

The diversion will consist of three components: upstream cofferdam, diversion conduit to pass low level floods and downstream cofferdam. These elements will ensure protection from floods during

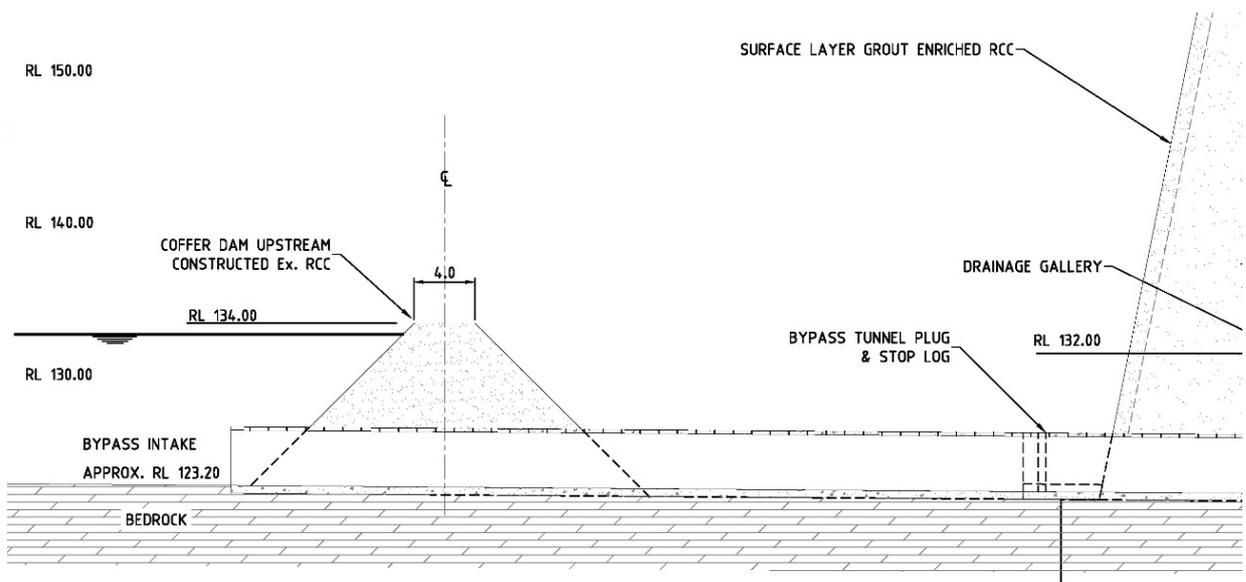
dry-season construction. The RCC dam will tolerate over-topping during the wet-season provided the foundation excavations and high-risk activities have been completed in the dry season.

The diversion will be sized to pass the yearly or 1:2 annual exceedance probability (AEP) flood (up to 360m³/s). An AEP of 2 means that every two years this peak flow could occur, or that every year there is a 50% chance that this peak flow occurs.

The diversion conduit will be 150m long and comprised of three 3.6 x 3.6m rectangular concrete culverts with a capacity of 360m³/s (see Figure 2-5). The Tina River will be diverted through the conduit. Allowing the construction of the main upper stream cofferdam and the downstream cofferdam. Cofferdams will be constructed from RCC. The upstream cofferdam will be set at 134masl, and the downstream cofferdam will be set at 126masl. The upstream cofferdam will be 11 m high and the downstream cofferdam will be 4m high.

Diversion closure will take place once the dam, spillway and intake are completed and will involve installing a gate at the upstream entrance to the conduit. A diversion plug will be installed (as shown in the Figure 2-8) allowing for the installation of an outlet controlled by a valve to ensure 1 m³/s minimum river flow during initial reservoir filling (Note: this outlet is not shown on drawings).

Figure 2-8 Diversion by-pass intake and by-pass plug



Source: Entura (2014)

2.3.3 Power Intake Head Race Tunnel

According to Entura (2014), the underground head-race tunnel construction will be excavated using drill and blast techniques for hard rock, and using road-header equipment for softer and weathered rock. Shotcrete or concrete lining of the headrace will also be required for permanent tunnel support. Construction excavation will be done from both ends to expedite progress. Other temporary services will also be required. This will include power, tunnel ventilation, compressed air and facilities for shotcreting and concreting.

Spoils may be used for road construction, as aggregate base, or for river diversion works downstream of the dam and adjacent to the powerhouse tailrace. The feasibility study did not

provide the quantity of spoil, but BRLi has estimated it to be approximately 24,300m³, based on dimension of infrastructures.

The power intake will be located at 162.5masl and convey water to the power station.

The power intake will be located in the left abutment and will contain trash-racks, isolation gate and a mini-hydro pipe. A flushing outlet (scour outlet at 155masl) will be located upstream of the trash-rack to enable flushing of sediments that have been deposited over time near the intake.

Trash-rack screens will facilitate excluding floating and submerged material from entering the power conduit.

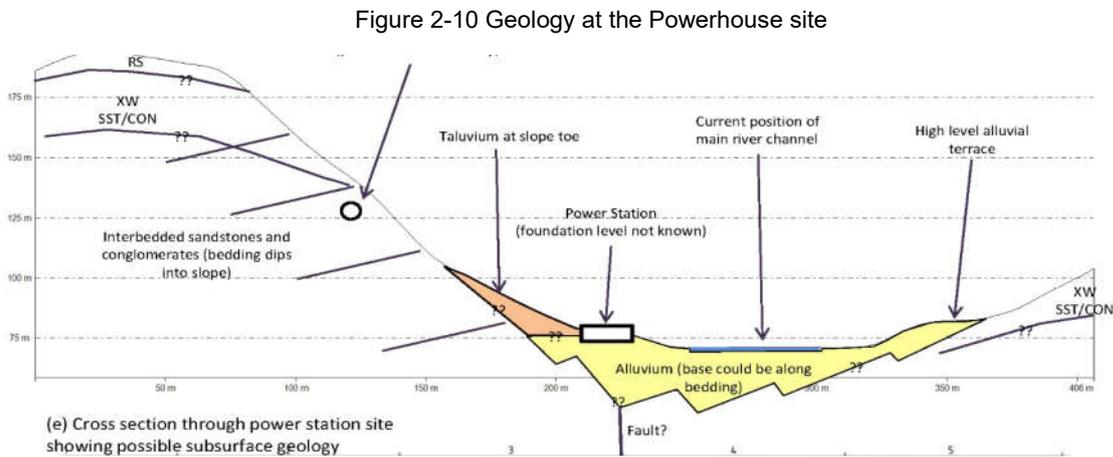
Following the power intake, a 3.3km underground head-race tunnel will convey water to a vertical surge shaft and then via a short power tunnel to the power station. The head-race tunnel will have an internal diameter of 3.3m. The tunnel system will be designed for flow rate up to 24m³/s. The head-race tunnel will be built to ensure a minimum of 20m surficial material remains over the crown. Figure 2-9 illustrates the tunnel system.

2.3.4 Powerhouse

The powerhouse will be built using conventional methods including:

- Foundation excavation and levelling
- Concrete foundations
- Steel superstructure erection
- Steel cladding
- Tailrace excavation

The construction of the power station will require significant site formation and foundation due to the presence of thick taluvial/ landslide debris underlain with alluvial material and due to the proximity of floods coming from the Tina River. Taluvial deposits are angular rocks blocks within fine-grained matrix typically in equal proportion. Figure 2-10 illustrates the geology at the power station site.



Source: GeoRisk Solutions (2014)

The powerhouse will have a concrete substructure and a steel portal frame, and will be protected from a flood event of 1:1000 AEP. The powerhouse will comprise 3 x 5MW Francis turbines (with space to allow for a 4th machine which may be installed later). The building will be 47m long and 13.8 m wide (650m²).

The power station will be operated to maximise power generation, so that during periods of high flow the station will be at full generation for much of the time. However, during low flows in the dry season, the river flow will be considerably less than the maximum generating capacity. During these periods, the station will operate on a daily/weekly cycle, generally following the load demand with maximum generation up to 18 m³/s on weekdays during working hours, then shutting down during the night, as shown in Fig. 9. From an environmental perspective, it would be preferable for the night generation to reduce to minimum machine discharge (2.4 m³/s) rather than zero flow. This will reduce the magnitude of fluctuations in flows, and better meet environmental flow requirements in the Tina River between the tailrace and Toni River confluence.

The powerhouse tailrace will enter the Tina River perpendicular to the river and will be protected from large floods by a concrete wall. A transformer substation occupying 440 m² of land will be located adjacent to the powerhouse. Figure 2-11 illustrates plan, profile and section views of the powerhouse.

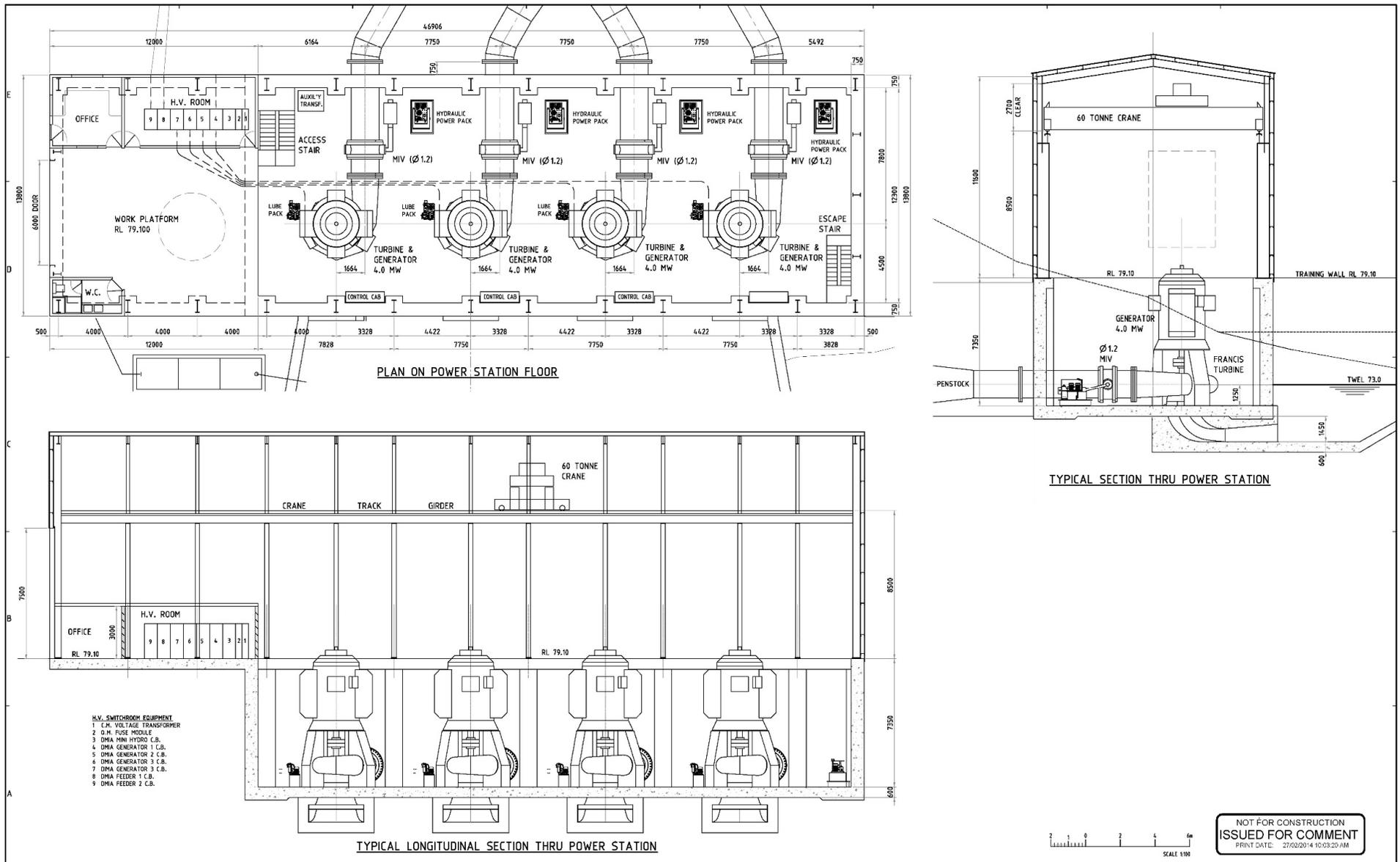


Figure 2-11 Power Station Arrangement

ALTERATIONS 4/16 GENERATOR ADDED 5/17 PENSTOCK ADDED 2/21 PENSTOCK ADDED	REFERENCE DESIGN P.Turnock DESIGN R.V.D.K. DESIGN DESIGN L.C. DRAWN REV.	 the renewable energy business © COPYRIGHT - H.E.C. 2010 BY THE TINA RIVER AND ELECTRICITY TRUST AS A SPECIAL LICENSEE OF THE TINA RIVER AND ELECTRICITY TRUST	01/11 MINISTRY MINES, ENERGY RURAL ELECTRIFICATION 01/12 TINA RIVER HYDRO POWER DEVELOPMENT FEASIBILITY STUDY SITE 7C, Opt. 1 POWER STATION ARRANGEMENT 303416-P3-011	02/11 1/100 100% 100% 02 A1
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2.3.5 Riparian (Environmental Flow) Outlet

The Tina River gradually increases in gradient from its confluence with the Toni River to the head of the proposed reservoir. The average gradient between the Tina/Toni confluence and the power house site is 5.3 m/km, increasing to 9.3 m/km between the power house and dam. The morphology reflects the change in gradient with the substrate size and frequency of swift water habitat increasing with gradient. The river is characterised by runs and riffle, with relatively few rapids/torrents and pools.

Surveys of the river were carried out on 6-9 March 2016 and 11-15 July 2013. During the first survey, the proportion of the different habitat types was measured and cross-sections were identified in each of the habitat types. A large flood that occurred on the second day of the survey removed more than half of the temporary staff gauges that had been installed. This meant that only 3 cross-sections were surveyed in March, one pool, one run and one riffle. Water levels were measured at flows of 8.7 m³/s and 19.7 m³/s and these were used to develop rating curves at each cross-section. The second survey (11-12 July 2013) comprised cross-sections in 2 pools, 5 runs, 5 riffles and 2 rapids; a total of 14 cross-sections. The flow was 9.91 m³/s on the 11 July and 9.66 m³/s on the 12 July. Water level and flow measurements were taken on 15 July and 25 July for rating calibration when the flows were 8.28 m³/s and 5.39 m³/s, respectively.

The selection of an environmental flow depends on the balance between environmental effects and loss of generation and the relative values placed on the environment and generation. The assessment of environmental flow is set out in section 11.3.1.1. Provision of a 1 m³/s environmental flow between the dam and powerhouse should maintain or improve fish and benthic invertebrate densities and total numbers for most species. An environmental flow of 1 m³/s would maintain the riffle habitats that appear to be used by most fish species, although there would be a reduction in habitat for the *Sicyopterus* species, which can live in very swift water. Pools will also be maintained for *Kuhlia* and grunters. Moreover, trapping of sediment in the dam and subsequent coarsening of substrate in the river below the dam will improve habitat for all aquatic species and overall productivity and this improvement with an environmental flow of 1 m³/s should result in fish densities that are similar to that in the Tina and Toni rivers at present.

The environmental flows will be released from the toe of the dam at the left abutment as shown in Figure 2-12.

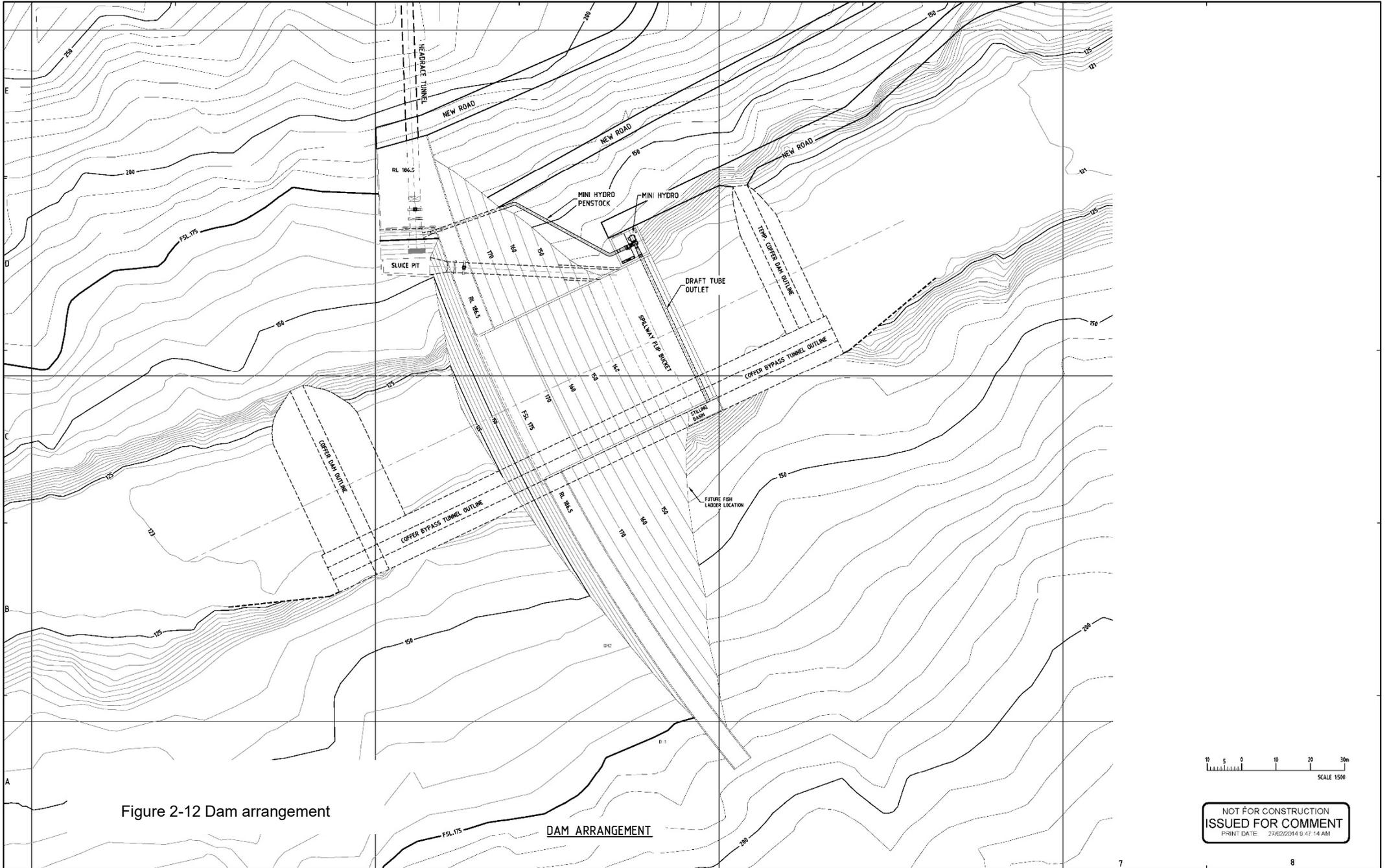
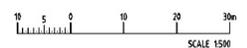


Figure 2-12 Dam arrangement



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ALTERATIONS NEW ROADS ADDED DAM RAISED BYPASS TUNNELS 3 GFB MINI HYDRO AMENDED 02 P.T. RYOK	QUALITIES INDICATED ARE IN GENERAL OF RESPONSES STORED IN PLAN ROOM. 02/19	REFERENCE	DESIGN P.Turnock	 Hydro Tasmania <i>The renewable energy business</i> <small>© COPYRIGHT - H.E.C. 2010</small> <small>NO PART OF THIS DOCUMENT MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE WRITTEN PERMISSION OF HYDRO TASMANIA</small>	CLIENT: MINISTRY MINES, ENERGY RURAL ELECTRIFICATION	SCALE: 1:500
			DESIGNED R.V.D.K.		TITLE: TINA RIVER HYDRO POWER DEVELOPMENT FEASIBILITY STUDY SITE 7C. Opt. 1 DAM ARRANGEMENT	NO. 303416-P3-002

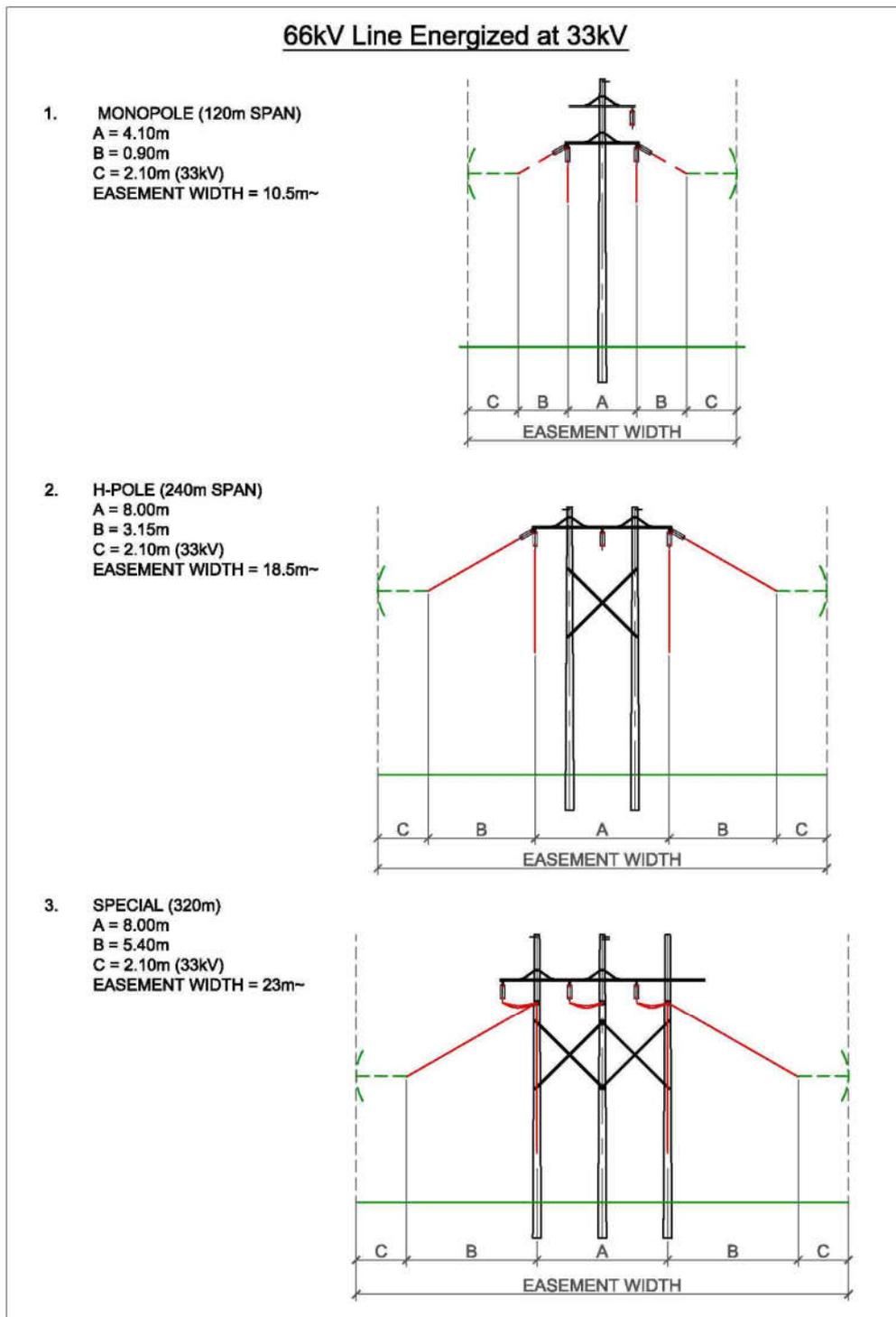
2.3.6 Transmission Line

Two 33kV, 22km long transmission lines, constructed on the access road are proposed to connect the TRHDP substation to the existing SIEA electrical grid at a substation located at the Kukum Highway junction, which in turn, will connect to the Lungga diesel power station. The transmission line will be designed to enable it to be upgraded to 66kV in the future.

The transmission line will be constructed within the purposely acquired road reserve from Black Post to the TRHDP substation above the Power station. The land through which the access road and transmission line are constructed is highly modified, by commercial and casual logging; Oil Palm plantations and relatively intensive settlement. Minor earthwork and complete forest clearing will be required along the right-of-way. The total width of right-of-way for the transmission lines and access road will be up to 50m. Vegetation clearing and control is included in the discussion on access road construction and operation (see Section 13 – ESMP).

Neon 19/3.75 Type AAAC 1120 aluminium alloy conductors will be used to transmit electrical energy. Entura (2014) provided specifications for pole-mounted step-down transformers of 33kV/415V to be located at each village along the access road, to distribute electricity to communities. 2-13 provides examples of the types of transmission towers that may be installed.

Figure 2-13 Examples of transmission line pylons



Source: Entura, 2012

2.3.7 Project Support Facilities

2.3.7.1 Access Roads and Traffic

The main access road will start at the junction between Kukum highway and the existing Black Post gravel road. Black Post Road will provide access to the Project site on most of its current alignment (approximately 10km).

Figures 2-14 and 2-15 are photographs of Black Post Road.

Figure 2-14 Beginning of Black Post Road near Kukum Highway



Figure 2-15 Blackpost Road close to villages



The access road will bifurcate from the existing Black Post Road before reaching Marava. This segment of access road will necessitate about 1.5km of new road construction. Black Post Road stops at Mangakiki. Beyond this point, only an old timber harvesting road is still visible across remnant forests and secondary forests. The dam, powerstation and tunnel sites are currently inaccessible by vehicle. The new section of access road will follow this old timber harvesting road for about 2.6km, and will be extended to the South through an area of secondary and primary forests (see Section 6 – Biological Environment Baseline - Terrestrial) to access the dam site on the left bank of the river.

All roads presented in Table 2-4 will require upgrade/refurbishment to accommodate the passage of construction traffic in both directions. This will involve widening, forest and vegetation clearing, and construction of road subgrade, road base, and roadside drainage (including installation of culverts).

Along the existing Black Post Road (up to Mangakiki), the access road will not require any forest clearing but will be widened. This widening will result in encroachment into disturbed habitat dominated by grassland (see Section 10 – Assessment of Impacts on the Biological (Terrestrial) Environment). Beyond Mangakiki, parts of the access road will be constructed along timber harvesting trails, where forest clearing and earth-work will be required. According to Entura (2014). The presence of steep slopes along this section of road alignment will require significant engineering, including high cuts, high fill embankments and retaining walls.



Figure 2-17 shows a photograph of a section of the timber harvesting trail, as it currently exists, beyond Mangakiki, This section of timber harvesting trail will become part of the right-of-way along which the access road will be constructed. The access road will be routed through areas of forest that will need to be cleared.

Figure 2-16 Timber harvesting trail beyond Mangakiki



Under contract to TRHDP, dam constructors will be responsible for subcontracting a local timber harvesting company to undertake forest-clearing activities if needed. Entura's Feasibility Study (2014) identified two quarry sites both in the reservoir area. However, no access roads were identified to connect to these quarries sites. For the purposes of the ESIA, it has been assumed that these access roads will follow topographic contour lines and use the same design specifications as the other access road(s).

The access road from Mangakiki to the dam site will follow the 160masl to 200masl topographic lines, and will enable traffic to pass in both directions. According to GeoRisk Solutions (2014), the access road at the dam site will follow a tortuous ascent in a tributary valley towards the left bank of the River. The main road (sealed road) to Honiara, also called Kukum Highway, will be used to transport material, equipment and pre-fabricated office trailers to the project site. Table 2-4 identifies the different roads that are required to support project construction and operation.

Table 2-4 Access roads

Road	Type	Length (km)*	Width (m)**
Permanent existing Black Post road	Unsealed	13.3	Approximately 15m (the total right of way is up to 50m to allow room for the two transmission lines)
Permanent access road to powerhouse (extension of Black Post road)	Sealed	1.45	
Permanent access road to dam (extension of Black Post road)	Sealed	4.7	
Temporary access road to intake portal	Unsealed	0.25	Unknown
Permanent road to dam base and mini-hydro	Sealed	0.66	Unknown
Temporary access road to quarries**	Unsealed	1.5	Approximately 15m

* This width includes the right-of-way for the transmission line. Lengths are subject to change when final design is completed.

** It is assumed that access roads will follow topographic contour lines and have the same width as the other access road. It is suggested not to seal this access road to allow vegetation to regrow once material extraction over.

Small landslides occasionally occur along steep sections and may be exacerbated by the construction of the road. Retaining structures, such as gabion walls, or the removal of upslope colluvium may be required to minimize the risk of landslides occurring during construction and operation of the access road. It is anticipated that daily traffic volumes will be comprised of light, medium and heavy vehicles. The anticipated traffic volume between the construction sites and Honiara is estimated to be in the order of 25 to 40 round trips per day. Additional trips for spoils disposal are expected to take place within the Core Area. Most of the heavy vehicles on the road are expected to be associated with the transport of cement, fly ash, rebar, substation transformers, transmission line towers, and electro-mechanical machinery for installation in the powerhouse.

2.3.7.2 Work Areas and Project Offices

The work area will require 130m x 90m (11,700m²) of land. It will need to be cleared of vegetation and levelled. Soils will be removed and stockpiled.

The site for Project offices, stores, work areas such as batch plant, crushing areas and pugmill will be located close to the dam on an area of approximately 11,700m². The fly ash warehouse will be located in this work area. Other supporting infrastructures locations and characteristics were not defined at the time of ESIA writing.

According to Entura (2014), it is likely that explosives will be needed throughout the construction phase, especially during tunnel excavation, stripping of the dam's foundation and quarrying aggregate for concrete and road paving. Explosives will be handled and stored in accordance with local legislation and statutory requirements. Explosive storage facilities will be isolated from the project office and fabrication, equipment storage and maintenance areas,

and will be secured within earth bunds and have sufficient security to prevent theft and misuse.

2.3.7.3 Staff and Workers' Accommodation

The maximum number of staff on site at any one time is estimated to be in the order of 100 during the construction of the dam. During the first construction season, the maximum number of staff will be in the order of 80. Staff will include experienced expat labour and locally sourced semi-skilled and unskilled labour. Accommodation for non-local workers will not be located on site to avoid the presence of non-local workers close to local communities. The housing of non-local workers in Honiara and Lungga will help mitigate adverse impacts on local communities. Employment preference is to be given to Malango and Bahomea communities. It is the responsibility of the Developer to explore accommodation options including in east Honiara, and at Lungga and Henderson, for workers living outside of Malango and Bahomea.

The provision of other utilities on site such as sewage treatment, potable water, electricity and telecommunications is expected to involve minor earthworks.

2.4 BOOT STRUCTURE

The Project aims to mobilize private financing which is expected to be one of the largest investments ever to be made in Solomon Islands. Given that the Project is the first utility-scale hydropower project in the remote island state where all resources need to be imported, the Project's construction cost is relatively high at close to \$140 million.

It is expected that the Project will be developed as a build-own-operate-transfer (BOOT) scheme. The preferred bidder (Korea Water Resources Corporation and Hyundai Engineering consortium) [KW-HEC] has been selected competitively through an open and transparent tender process under the guidance of International Finance Corporation (IFC). K-Water is wholly owned by the Government of South Korea (an SOE) and has extensive experience of investing in, owning and operating Hydro power stations. Hyundai Engineering Company, a subsidiary of Hyundai Corporation, is one of the largest Engineering construction companies in the World. Together KW and HEC have invested in the successful construction and operation of Hydropower projects in Pakistan and Georgia.

Depending upon the structure and sources of project financing, the financing cost and contingencies could add as much as \$60 million to the project cost. The high project cost will put an upward pressure on the power purchase agreement (PPA) tariff, and disincentives SIEA from switching to clean and renewable energy.

Therefore, the Solomon Islands Government (SIG), with the support of IFC and the International Development Association (IDA; World Bank) is seeking concessional funds from the Green Climate Fund (GCF) and other sources in order to reduce the financing cost to strengthen the Project's economic viability and to support SIEA's transition from diesel power to renewable hydropower.

KW-HEC, has been granted an exclusive development right to prepare the project within a period ending on June 30, 2017, by when the PPA should be signed. HEC will be primarily responsible for the Engineering Procurement and Construction (EPC) development; K-Water will be responsible for the Operation and Maintenance contract during the BOOT period. The BOOT concession period is expected to be for a period of 30 years from commissioning,

approximately 34 years from mobilisation. The expected approximately USD140M EPC budget includes nearly USD 2 M for environmental investigations and monitoring; the budget for ongoing maintenance and operation includes nearly USD 1M per annum for training and capacity building. Plans include employment and training for more than 50 locally recruited staff.

The debt-equity ratio is expected to be 75:25. KW-HEC is prepared to collectively hold 51% of the equity (\$26 million) while SIG intends to hold the balance of 49% (\$24 million). As the high cost of equity could be a significant element of project cost, IDA may lend to SIG to hold equity stakes in the Project Company while agreeing to a much lower return than KW-HEC.

The equity investment will be through a Special Purpose Company (SPC) which will hold the development licence; will lease the Core Land from the Tina Core Land Company (a SIG-Landowner JV) for the term of the BOOT; and transfer the project to the Government at the end of the BOOT period.

Concessional debt financing is anticipated from the Economic Development Cooperation Fund (EDCF) of the Korea Exim Bank; Green Climate Fund (GCF); IFC; and IDA. ADB's public sector financing window (Asian Development Fund [ADF]) and commercial window (Private Sector Operations Department [PSOD]) are also considering financing the Project.

2.5 ACTIVITIES ADJACENT TO AND WITHIN THE PROJECT AREA

This section of the ESIA outlines activities within the project area that have had, or continue to have, an influence on the environment and on the local population economy. This section helps to highlight any potential cumulative impacts of other existing or reasonably foreseeable projects or programs (see Section 13). Sources of information regarding the activities in the project area were derived from environmental and social baseline studies undertaken for preparing the initial ESIA, bibliographical sources, and previous project reports (pre-feasibility and feasibility studies). Additional information on each of the activities discussed in the following subsections is provided throughout the ESIA report.

Three main activities occur in areas surrounding the project area: timber harvesting, mining and palm oil extraction. These activities provide sources of income for many people in the area, from royalties, or through employment opportunities. In addition, people's life may be improved with the building of schools, clinics, houses and roads. Nevertheless, despite many benefits on livelihood, health and education, these activities may have caused adverse impacts to accrue to the natural habitat.

2.5.1 Mining in Adjacent Catchment

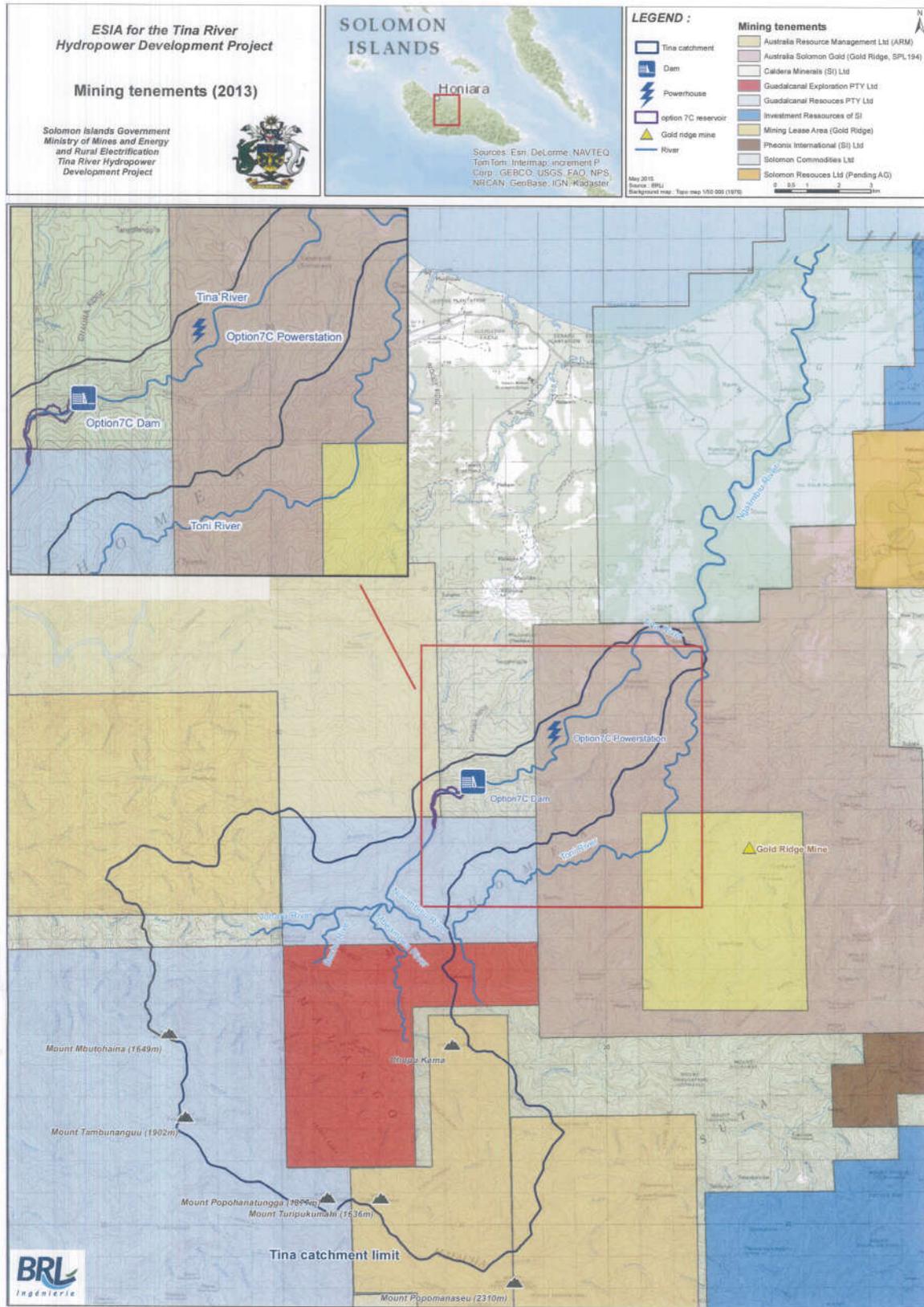
Even though mining activities are much localized, they often lead to groundwater and surface water contamination due to siltation and the release of chemicals used in drilling and mineral processing. There are no gold panning activities on the Tina River or within the Toni River catchment. Chupu Kama, in the Tina River catchment area was prospected in the late 1990s. However, gold assay results were sub-economic (Veronica Webster Pty. Limited, 2012). Prospecting has been carried out in the montane region of Tina River catchment. Today there are no mining activities in the Tina River catchment or in the Toni and Ngalimbiu river catchments. Gold Ridge Mining Limited (GRML) is located in the Tinahulu and Chovohoi

catchments (both rivers are part of the Metapona River catchment). Prospecting tenements have been granted almost everywhere in central Guadalcanal including ten tenements in the Tina catchment as shown Figure 2-15 (obtained from MMERE).

Gold Ridge has been granted a Special Prospecting License (SPL 194 or Vunusa Tenement), which includes an area overlapping both the Toni and Tina river catchments. SPL 194 covers an area of 130km² that surrounds the 30km² Mining Lease (No 1/1997). Gold Ridge was negotiating with landowners for land access some of which are also landowners within the TRHDP area. This SPL covers both the Toni and Tina river catchments, as shown in Figure 2-17.

Gold Ridge operations were suspended in 2014, and the Mining Lease (No 1/1997) has now been cancelled. SPL 194 is expected to expire shortly. Today, local entrepreneurs are looking to reopen the mine. Whether SPL 194 will receive an extension or not is unknown. Notwithstanding, it is assumed that if SPL 194 could be renewed, it would represent a potential worst-case scenario for mining impacts within the catchment.

Figure 2-17 Map of mining tenements



2.5.2 Oil Palm Plantations in Lower Catchment

Oil palm industries can contribute to pollution of rivers and coastal areas from fertilizers (mainly nitrogen based) and pesticides. Pollution can also originate from overflowing mill effluent storage ponds. Surface water pollution is particularly aggravated during floods. Oil palm plantations are located downstream of the project site. However, no information regarding water quality was available at the time the initial ESIA was prepared. Mill storage ponds and nearby water courses are regularly sampled for Biochemical oxygen demand (BOD), pH, Total Suspended Solids (TSS), oil and grease. Some oil palm fields drain into the Ngalimbiu River and others drain into the Metapona River. GPOL has implemented an Integrated Pest Management program that aims to make the use of pesticides more efficient and reduce pollution.

2.5.3 Timber Harvesting in Middle and Upper Catchment

According to WWF (2005) and Pikacha (2008), timber harvesting is the major threat to Solomon Islands forests, as they are exploited faster than their regeneration rates. Timber harvesting causes biodiversity losses, by either killing species or destroying their habitats. It also causes soil erosion, water quality impairment, and may facilitate the establishment of invasive species in remote areas. The opening of the canopy reduces humidity levels near the ground and increases insolation destroying the habitats of many amphibians. Timber harvesting also has adverse impacts on aquatic dependent wildlife. Increased sedimentation, tree felling and frequent collapsing of timber harvesting bridges may obstruct small channels and streams (Polhemus et al., 2008).

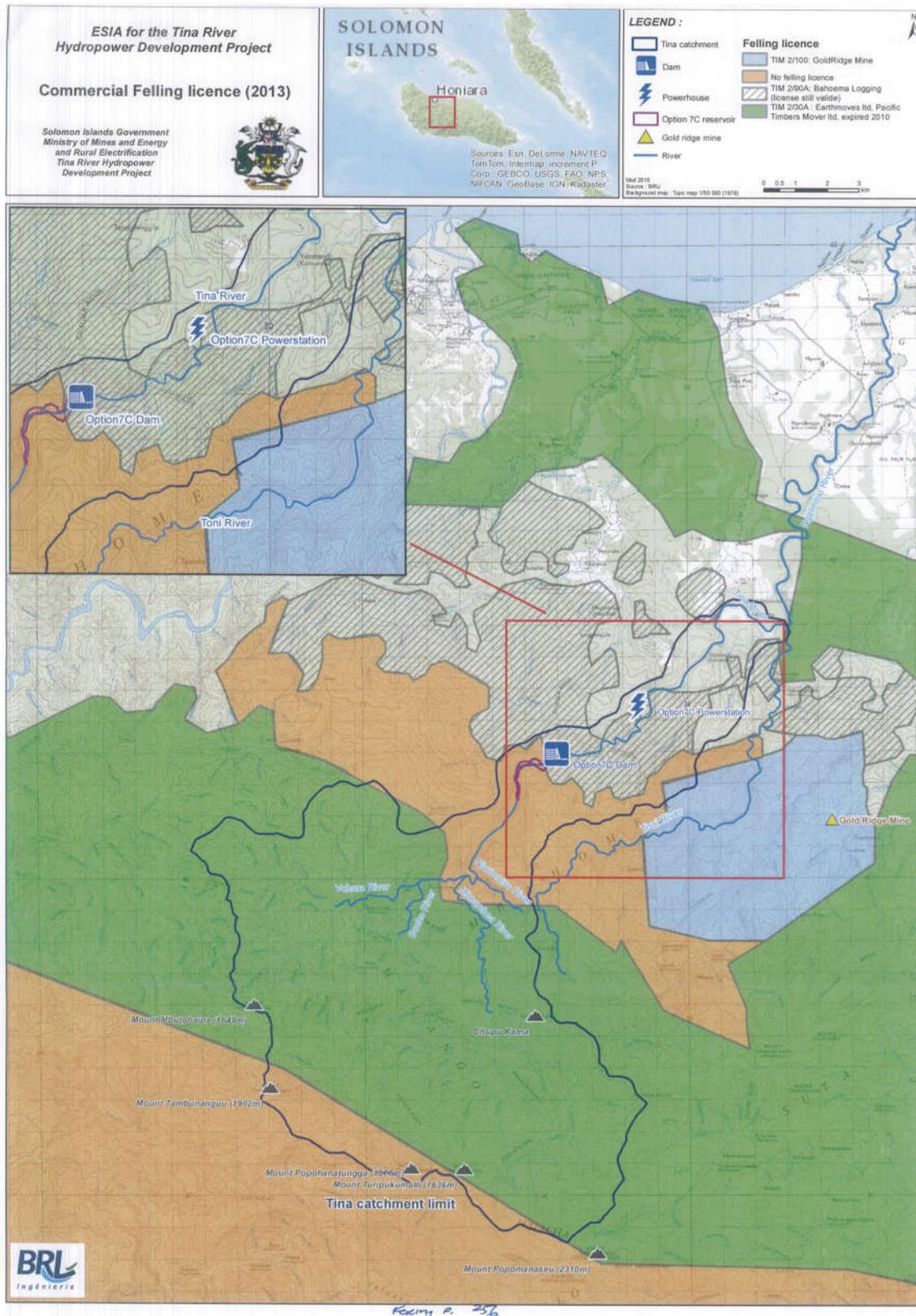
Many areas on the left bank of the Tina River are, or were, being exploited for timber harvesting either commercially (with a timber license) or privately by local villagers. According to national laws, timber harvesting activities are forbidden in areas above 400masl. Based on field visits and the use of Google Earth Imagery, it was possible to observe that most timber harvesting activities were selective timber harvesting, which only involved removing commercially valuable trees. Selective timber harvesting is less damaging to the environment than clear-cutting, since selective timber harvesting has less impact on topsoil erosion. During field visits in August 2013, the sound of chain saws could be heard from Senge to Mangakiki. However, no clear-cut areas were observed. Most timber harvesting activities represent a potential threat to water quality and could increase siltation processes in the reservoir as well as be an initiator of landslides if timber harvesting was to intensify upstream of the dam.

Another problem associated with timber harvesting activities is that no environmental or social impact assessment has been carried out on these activities. It is, therefore, difficult to determine the extent of such activities, or their impacts. License agreements between timber harvesting enterprises and the customary owners of lands are informal and the extent of the exploitation is not precisely known. Officially, according to the Ministry of Forest and Research (2013), there are (or were) three timber licenses within the Tina River catchment, as follows:

- TIM 2/30A : Earthmovers Ltd, Pacific Timber Movers Ltd (Expired in 2010);
- TIM 2/90A: Bahomea Timber harvesting (License is still valid).

Figure 2-18 is a map obtained from MFR that shows the timber harvest licenses recorded as of 2013. It reveals that the majority of the Tina River catchment is is, or was, under a timber license.

Figure 2-18 Timber harvesting licenses (2013)



2.5.4 Gravel Extraction in the Ngalimbiu River

Some private operators have permits to extract gravel from the Ngalimbiu River. Local communities also extract gravel along the Tina River on a much smaller scale (see Section 2.5.5 and Section 13 Cumulative Impact Assessment). Operators pay royalties to landowners of the downstream communities. During both baseline surveys (from July 2013 to September 2013) and mitigation workshops (February 2014), it was impossible to obtain information on the amount of gravel extracted. In theory, a list of the current permit holders should be available from the projects' parent government department but no records are available.

According to a report published by the Pacific Islands Applied Geoscience Commission (SOPAC)² Secretariat (2006), river aggregate deposits are composed largely of igneous rock fragments with lesser limestone constituents. Igneous rock fragments comprise plutonic rocks and slightly lower volcanic rocks. In 2005, extraction covered an estimated 10,000m² on Ngalimbiu River. According to the SOPAC report, there is a need to develop transparent and efficient mechanisms to manage gravel resources.

The main issue concerning gravel extraction associated with constructing the dam is the alteration of sediment continuity downstream and the progressive halt of gravel replenishment.

2.5.5 Local Population Pressures on Natural Resources

The population of the Solomon Islands has increased considerably over the past few decades (Solomon State of Environment, 2008). Increased population leads to increasing pressure on water usage and water pollution; increasing hunting and fishing; and habitat fragmentation due to timber harvesting. The water quality decreases when moving downstream along the Tina River due to sanitation problems (increase in coliform bacteria). Until recently, agricultural activities were limited to gardens that have had minimal impact on the water quality of the Tina River. More details on local population pressures on natural resources are provided in Section 12 – Assessment of Socio-community Impacts, and Section 14 Cumulative Impact Assessment.

2.6 PROJECT PLANNING AND INSTITUTIONAL REQUIREMENTS

2.6.1 Project Planning Impacts

Planning for a project of the scale of TRHDP in this context requires the establishment of constructive relationships with leaders and the project-affected communities. It is important that these relationships are developed and sustained over time. In this regard, consultation

² The Pacific Islands Applied Geoscience Commission (SOPAC) was an inter-governmental regional organisation dedicated to providing services to promote sustainable development in the countries it serves. In 2010, its functions had been transferred to the Secretariat of the Pacific Community (SPC) and the Pacific Regional Environment Programme (SPREP), thus ending SOPAC as a separate entity. Today, SOPAC is a division of the SPC with its main office in Suva, Fiji.

regarding plans for a hydro-electricity scheme on the Tina River began in 2009, and has continued since then.

As outlined earlier, TRHDP planning activities have included community awareness raising and social networking, and consultation with tribal chiefs, local leaders, village communities, and organisations in Bahomea, Malango, and Ghaobata. Through such interactions, the PO has become an important organisation among local communities, and is seen as having the power to shape their future economic and social lives. In terms of institutions, the PO appears to be closer to the Bahomea community and its leaders than any other government agency.

The TRHDP PO's growing involvement in local affairs, and its relationship with local communities, has been facilitated by the establishment of a network of part-time community liaison assistants (CLAs). These assistants provide information and news about the project to their villages, help organise events, and provide support to project planning activities. Furthermore, the project officers appear to make efforts to be accessible to the people of Bahomea, and the Honiara-based PO receives a steady stream of visitors from the area, often seeking assistance with problems. In the context of post-Tension relations with government, the PO and its network of liaison people appear to have been a positive development.

2.6.2 Institutions

As part of its planning, in 2009, the SIG created the Tina River Hydro Landowner Council (LC), an elected body of tribal representatives with which government could negotiate to obtain access to the area, so that project feasibility studies could be carried out. Government made a payment of an Access Fee of SBD 100,000 per member to the 27 clans and sub-clans making up the council, to assist in forging an access agreement. Working with the already established Bahomea HOC and the Malango HOC, the LC also began work on identifying the rightful landowners within the proposed project areas.

Due to representational issues, the apparent proliferation of stakeholders, politicisation of the process, and associated rent seeking, the PO reduced its support for the LC and started working instead with a community consultative group, referred to as the Bahomea Land Identification Committee (BLIC). This is a voluntary group of the most knowledgeable Bahomea elders who wanted the landowner identification process to progress without it becoming politicised or corrupted. There has since been dissatisfaction among some members of the (now defunct) LC, despite the Government's legal endorsement of the current land identification arrangements. At the same time, the HOC was initially supported by the TRHDP PO in resuming its traditional leadership role in customary land and cultural affairs. The TRHDP has, therefore, already had a mixed effect on the institutional situation in the project area³.

During the construction, the developers and contractors will have a strong influence in local communities. Their activities are likely to affect all villages in the Tina area in some way, and there will be more contacts between the communities and the project than at present. The developer should continue to consult directly within affected peoples with the community via

³ Crucially, since the SIA fieldwork and associated consultations, the landowning tribes for the Option 7C Core Area have publicly asserted their rights over decision making over their land, rejected the institutional validity of the Landowner Council, and endorsed the alternative BLIC process (see, for example, Core Land Tribes press release, 24/6/2014)

community liaison committees. The SIG will need to monitor the developer and the contractors in regard to their performance in this area.

Consultation and negotiation will place an increasing burden on community representatives. It is doubtful that the local communities and institutions have the capacity to cope with the amount of work and the complexity of issues arising from the project planning and implementation. Dealing with matters as diverse as compensation for damage to land owner property, cultural heritage protection, benefits sharing and river management, will require that local communities obtain additional capacity, such as affordable, honest, and independent legal advice. Legal advice to land owners is currently available from the Public Solicitor's Office.

2.6.3 Group Formation and Stability

There is no catchment-wide social or political organisation representing those most likely to be affected by the proposed development. The LALRP provides information on the co-operative societies formed to represent landowning groups who are resident of a number of different communities across Malango and Bahomea.

A number of villages want to be able to represent themselves in negotiations with the project and government over compensation and do not want this role to be captured by the HOC or the LC. Some villages have formed their own informal groupings such as the "Up Stream Community" (USC) – involving Valekocha, Komureo, Namopila, Pachuki, Senge and Koropa.

In the downstream Ghaobata villages, where a number of landowner and interest organisations were established to deal with the Gold Ridge mining companies, and the operators of the palm oil plantation, there is also a strong call to have their interests and concerns addressed in a separate organisation. The SIG and PO need to pay more attention to the involvement of the downstream Ghaobata communities in planning decisions.

The desire for separate representation by some communities is understandable, given that there is distrust of landowner trustees and other leaders, and people who have acted previously as agents for timber harvesting companies, etc. The proliferation of groups seeking direct and localised representation in dealings with the project has the potential to increase the risk of internal conflicts or require special attention by the PO and its advisers.

2.7 IMPLEMENTATION SCHEDULE

According to Entura (2014), the Project was estimated to take approximately three years to construct and commission, following award of the prime contract. Major construction would start the third month after the award of the contract.

The following indicative schedule indicates the various phases involved in the construction activities:

- Roads and access (Separate Contract) 340 days starting after Initialling of PPA.
- Contract award: Third Quarter 2017
- Design process; 8 months commencing with Contract award.
- Mobilisation and establishment: 6 months from contract award
- Dam, (including diversion and coffer dams) 22 months starting 6 months after contract award with the establishment of quarries and crushing and stockpiling aggregate.

-
- Intake and head-race tunnel, 22.5 months starting with head-race tunnel and surge tower excavation. (Dual headings, 36 metres per week; 22.5 months); tunnel lining (80m per week; 10 months)
 - Powerhouse construction, 381 days starting after mobilization.

Note: the dam construction will almost certainly constitute the critical path because it is dependent on flow conditions in the river and hence on the pattern of wet/dry seasons. Tunnelling can continue independent of weather once established

2.8 PROJECT OPERATION

Details of power station operation, and utilisation of available water resources in wet and dry seasons will be determined as a result of complex computer modelling. However, the evaluation of available energy from the 29 years of simulated flows, compared with the normal patterns of demand in Honiara, and accepting Solomon Power assessment of load growth, has enabled some calculations to be made.

Wet year inflows will see the station able to operate at full capacity for most of the time – with unused water being spilled around 40% of the time. In the driest three years on record (i.e. an event with about 10% probability) the station will only rarely be able to utilise all three machines.

In those dry years it is expected that the hydropower station will be used to reduce the need for diesel capacity in the high demand times of the week – between 8 a.m. and 6 p.m. If diesel produced a steady 8MW for the whole of this period of the day, the hydro could produce all of demand which exceeded that base load, in any circumstances modelled. The hydro could also meet all demand above a 6 MW baseload, for all but 4 weeks in the driest year.

This modelling assumes that in these relatively rare, dry events, the inflows over-night (apart from the environmental flow) will be used to restore lake levels. Flows during these night time periods would be restricted to the environmental flow plus minimum machine outflow (2.4 m³/s) above the Toni River.

2.9 PROJECT COSTS

The capital cost of the Project is estimated to be US\$133.3million (Entura). This is based on an initial project that consists of 3 turbines, but with space for an optional fourth turbine if demand and hydrology make that viable. An additional 4th turbine, would add another US\$3.4million.

2.10 PROJECT DECOMMISSIONING

It is expected that the TRHDP would have an operating life of 80 to 100 years, and that at the end of this lifespan, it would probably be decommissioned. Decommissioning would involve draining the reservoir, excavating sediments from within the former reservoir, removing the dam, restoring former natural flow regime to the river channel, draining and blocking the power headrace tunnel, removing the penstocks and powerhouse, and removing the

switchyard. The various impacts associated with decommissioning would be examined in a separate ESIA that would be prepared at that time.

3. INSTITUTIONAL AND LEGAL FRAMEWORK

3.1 INSTITUTIONAL FRAMEWORK

This section presents information on the government agencies and NGOs that will most likely play a role in the Project implementation and, where appropriate, discusses their policies, objectives and mission statements as they pertain to TRHDP.

3.1.1 Ministry of Mines, Energy and Rural Electrification (MMERE) and TRHDP Project Office (PO)

The Ministry of Mines, Energy and Rural Electrification (MMERE) is responsible for mining, energy and water resources in the country. It consists of a number of strategic divisions: mines, geology, water resources, and energy divisions, each headed by a director. MMERE's corporate division provides administrative logistical support to all other departments. The administrative head of MMERE is the Permanent Secretary, and the political lead is the Minister. MMERE plays a strategic role in the current development phases of Solomon Islands through the emerging mining sector, the focus on developing sustainable energy supply for the country, and the increasing pressure on water resources.

The Energy Division (ED) is the lead agency directly implementing the Project through the TRHDP PO. The TRHDP PO consists of approximately ten local and expatriate staff, supported by contractors, and includes expertise in engineering, project management, legal, customary land, community relations, public relations, biology and social sciences. As the key government agency responsible for the TRHDP, the PO provides overall coordination and support on matters relating to government policy, land and project implementation and is responsible for meeting the requirements of major donors, such as the World Bank. In the context of the ESIA, the PO plays a critical role in ensuring the information required for the ESIA is provided by other government agencies and stakeholders.

The ED plays an oversight role and ensures that the PO implements the Project according to the directions set by the government. A major constraint faced by the energy division is the limited number of officers available to manage quite a broad range of issues relating to energy in the country. In this context the PO provides dedicated personnel for the Project.

MMERE will also play a key role in overseeing the procurement, engineering design and construction of the access road from the Black Post turnoff to the dam site. Current indications are that the capacity of the MMERE is sufficient to respond to the large-scale TRHDP development with the support of the TRHDP PO and donor agencies. TRHDP PO has engaged an international road specialist to assist with this role.

Through its Policy Goal within MMERE, the Solomon Islands Government Translation and Implementation Framework states that:

“The mineral and energy resources are used in a sustainable, innovative, environmentally conservative and socially acceptable manner that enhances the well being of people and helps toward making Solomon Islands energy efficient”.⁴

⁴NCRA Government Policy Statement

The Solomon Islands National Energy Policy 2014 underpins the role of the ED and outlines the National Government's policies for the planning and management of the energy sector over the next 10 years (2014-2024). to the vision of the Policy is to unlock 'the development potential of Solomon Islands' economic base through a dynamic and effective energy sector'.⁵

The Policy's stated mission is that it:

"Provides the base for appropriate coordination, planning, promotion, development and management, and efficient use of energy resources".⁶

The role of the MMERE and its Energy Division and PO in implementing these policies is, therefore, critical as preparations are made for the TRHDP development.

3.1.2 Solomon Islands Electricity Authority

The *Electricity Act* establishes the Solomon Islands Electricity Authority (SIEA), operating under the brand of Solomon Power, as the central entity to generate electricity in the Solomon Islands. SIEA is in charge of all matters related to electricity production and transmission/distribution, including ensuring standards of safety, efficiency and economy. It also advises the Government on matters related to electricity and can make recommendations as to regulatory instruments. The SIEA is set up as a "corporate body", with independent liability and the capacity to independently enter into contracts⁷.

SIEA consists of a Chairman and four members who, together, form its Board, as well as a general manager, who acts in an ex-officio capacity. The General Manager is appointed by SIEA, whereas, the five members of the Board are all appointed by the Minister of MMERE. SIEA is free to appoint any other members of staff, and is largely self-regulated⁸.

SIEA will play a critical role in the purchase and distribution of power from the Project. SIEA will enter into the Power Purchase Agreement (PPA) with the selected Developer and it is intended that through that agreement SIEA will have contractual rights to enforce the Developer's obligations under the ESIA.

The organisation is going through an institutional reform with support from the World Bank to increase its revenue collection capacity and improve its services.

3.1.3 Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM)

The Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM), has four divisions, each with their own respective directors. The Meteorology division, the Climate Change Division, Disaster Management Division and Environment and Conservation Division.

⁵ Solomon Islands National Energy Policy 2014

⁶ Solomon Islands National Energy Policy Framework

⁷ *Electricity Act*

⁸ Ibid.

The Environment and Conservation Division (ECD) is the key department responsible for assessing, monitoring and mitigating the environmental and social impacts of developments in Solomon Islands. The *Environment Act 1998*, *Wildlife Protection Act 1998*, and the *Protected Areas Act 2010*, together with their respective regulations, guide its mandate. MECDM's Strategic and Corporate Plan 2012-14 identifies five strategic areas (listed below) as core functions of the Ministry.⁹ Within each of these strategic areas, target issues are also identified.

- Strategic Area 1 - Conservation and Management of SIs' Environment
 - Conservation and management of biodiversity
 - Protected areas network
 - Waste management and pollution control
 - Development control
 - Environment Training
- Strategic Area 2 - Climate Change
 - Policy and legislative framework
 - Mitigation strategies
 - Adaptation strategies
 - International representation
- Strategic Area 3 - Meteorology
 - Policy and Legislative review
 - Meteorological Forecasting, operations and monitoring
 - Early Warnings (tsunamis and extreme events)
 - Quality management systems
 - Data & Information management system
 - Research
- Strategic Area 4 - Disaster Management and Risk Reduction
 - Governance and Institutional Framework
 - Operational effectiveness and capacities
 - Public awareness and village disaster risk planning
 - National Disaster Management Office (NDMO) capacity and capability
- Strategic Area 5 - Corporate Services
 - Management Teamwork, direction and coordination
 - Performance management
 - Communication and information flows
 - Staff development and skills upgrading
 - Trainings, selection and recruitments
 - Logistics and asset management
 - Financial Planning and management
 - Corporate planning and reporting

The ECD will play an important role under the *Environment Act* in evaluating the environmental and social impact assessment for the Project, conducting community consultation and issuing the development consent for the Project. The ECD will also play a key role in monitoring the environmental impacts of the Project.

⁹ MECDM Corporate Plan 2012-2014

The increasing number of large scale developments in the country has put a lot of pressure on the division, which has limited capacity in terms of staff and technical ability to assess and monitor environmental and social impacts. While ECD has developed considerable experience addressing the social and environmental issues facing the neighbouring Gold Ridge Mine, ECD would benefit from technical inputs and analysis of water quality and other parameters by third parties. Third party inputs will be incorporated in the final design of the ESMP where relevant.

3.1.4 Ministry of Lands, Housing and Survey (MLHS)

The complex task of administering land lies with the Ministry of Lands, Housing and Survey (MLHS). The key legislation governing the Ministry's mandate is the *Land and Titles Act*.

The Commissioner of Lands is empowered under the *Lands and Titles Act* with the administration of registered land in the country. While customary lands are beyond the Commissioner's jurisdiction, it is the Commissioner's role to acquire and oversee the registration of customary land for development.

With respect to the Project, the Commissioner of Lands had responsibility to oversee the acquisition of the customary land required for the Project under the *Land and Titles Act*. MLHS is also responsible for enacting the subdivisions and transfers of registered land required for the road and transmission line corridor. As the land access components of the Project are managed by SIG, the impact of land acquisition and safeguards relating to this are set out in the Land Acquisition and Livelihoods Restoration Plan.

The Registrar of Titles serves a core function in formally registering land transactions.

The Geographic Operations Group (GOP) provides technical support to other core functions within the MLHS. Surveyors are posted to provinces and are included in the Lands & Survey Provincial Operations Group. With the devolution of the Town & Country Planning Boards to Honiara City Council and the Provinces, physical planners have been re-tasked to provide professional advice and support to these Boards where operational.

The Policy, Management and Regulation Executive Committee provides policy direction to the Ministry, and monitors the achievements of its programs¹⁰. The Administrative Support Services provides administrative services and support to the whole of MLHS. The Human Resource (HR) unit has responsibility for overseeing and supporting human resource development within the Ministry.

The land administration system was inherited from the colonial period, well before independence in 1980, and more than 20 years of poor governance and a lack of funds has diminished the Ministry's capacity. Efforts to support the development of the MLHS have been ongoing since 1999, with support from Ausaid's Solomon Islands Institutional Strengthening of Land Administration Project (SIISLAP), which ran from 1999 to 2007¹¹. MLHS also receives some ongoing support from the Pacific Community (SPC).

¹⁰ Ministry of Lands, Housing and Survey Corporate Plan.

¹¹ *Solomon Islands Institutional Strengthening of Land Administration Project (SIISLAP)*

3.1.5 Ministry of Forestry and Research (MFR)

The Ministry of Forestry and Research (MFR) was created by the Coalition for National Unity and Rural Advancement (CNURA) Government in January 2008.

The MFR undertakes its duties under the framework of the *Forest Resources and Timber Utilisation Act 1969* (FRTU Act).

The FRTU Act, as amended, is the main law governing the use and management of forests in Solomon Islands. Repeated efforts to revise the FRTU Act in recent years have failed to obtain Cabinet approval

The Act assigns responsibility for managing the felling and milling of trees for commercial use to the MFR's Commissioner of Forests.

Section 4 (1) of the FRTU Act establishes that it is an offence to fell trees or remove timber for sale except if it is:

- under and in accordance with the terms and conditions of a valid licence;
- for a purpose declared by notice of the Minister to be exempt from a valid licence; or
- other purposes not applicable to the Project such as use for firewood or under the authorisation granted to a licenced mill.

Section 4(2) of the FRTU Act provides that "any person who fells trees or removes timber from any land shall, until the contrary is proved, be presumed to have felled that tree or removed that timber for the purpose of sale". Whether a timber licence is required for TRHDP will likely depend on whether the timber felled is ultimately sold.

While eight amendments to the FRTU Act have occurred, along with a number of additional regulations, it remains out-dated and principally focused on the role of the MFR in licensing and monitoring the logging industry, including focusing on the allocation of rights and licenses to fell and mill trees. Even in this area, it has significant weaknesses. These include provisions for high levels of discretionary power by forest and tax officials, and limited guidance on levels of license allocation and best practices for timber harvesting.

The FRTU Act covers both forests on registered land and customary land, with any licensee required to have entered into an agreement with the landowner of the plot(s) on which the trees are situated. This requires an agreement of the allocation of timber rights to be obtained from all groups having rights over the land. This process is straightforward on registered lands, but becomes more complex on unregistered customary land where rights holders must first be identified, and then sufficient time allocated for rights to be contested.

With respect to the TRHDP, any trees felled will be within the area of land acquired and registered for the Project. This will reduce the complexity of the timber rights process. If a felling licence is required the registered owner of the land will sign the timber rights agreement for the land and a profit-a-prendre will be registered on the certificate of title. The land valuation conducted as part of the acquisition process outlined in the Land Acquisition and Livelihoods Restoration Plan (LALRP) included an assessment of the commercial timber value of the forests on the acquired land.

A Felling License does not involve any separate environmental permitting processes in addition to the development consent required from the Director of the ECD under the *Environment Act*. In practice many logging operations fail to obtain development consent.

3.1.6 Ministry of Culture and Tourism (MCT)

The primary role of the Ministry of Culture and Tourism (MCT) is to develop, protect and promote Solomon Islands' culture, art and heritage. MCT is an entity that hosts the national museum. Tabu sites and cultural heritage is the responsibility of the National Museum of Solomon Islands.

The National Museum will need to be consulted regarding valuing and undertaking on site assessments if there is proposed disturbance or removal of a tambu site for development purposes.

3.1.7 Ministry of Development Planning and Aid Coordination (MDPAC)

The Ministry of Development Planning and Aid Coordination (MDPAC) was created from the former Department of National Reform and Planning in the mid-2000s. MDPAC is responsible for:

- The preparation and subsequent monitoring of implementation of the National Development Plan. The current plan is the National Development Strategy 2011-20.
- The preparation and formulation of the annual Development Budget Estimates. The SIG prepares two budgets each year, the recurrent budget and the development budget.
- Aid coordination. MDPAC is responsible for coordinating development partner activities and for securing donor funding for new projects/programmes. This is a critical aspect of successful preparation of the annual Development Budget. Aid coordination also includes frequent liaison with aid donor representatives and for the organisation of high level talks with some development partners.

MDPAC is the lead coordinating agency for donor-funded projects and, therefore, is a key stakeholder. The Ministry has shown considerable competence in managing and coordinating donors in the country and has been and will be involved in the TRHDP in this regard.

3.1.8 Ministry of Infrastructure and Development (MID)

The Ministry of Infrastructure and Development (MID), Department of Infrastructure (DI) plays a key role in the public administration of Solomon Islands, and is responsible for roads, wharves, airstrips and government workshop facilities. In the past twenty years, the government and donors have invested a little more than one billion Solomon dollars in transport infrastructure throughout the country. The country's internal problems, including inadequate funding, reduced DI's capacity for ongoing and systematic infrastructure maintenance. Consequently, much of that infrastructure is now in need of complete reconstruction. DI's mission is to enhance the prosperity, wellbeing and participation of the community by providing an integrated, efficient and affordable infrastructure and transport system; supported by ethical, professional, proficient and valued staff.¹²

The work of DI focuses on the sustainability of rural and urban livelihoods¹³. Its scope includes:

- Provide quality advice to support the Government's reforms and priority activities

¹² Ministry of Infrastructure and Development Corporate Plan

¹³ *ibid*

-
- Implement major reforms in line with Government policy
 - Offer individuals and industry in various parts of the country a satisfactory and safe transport system at affordable cost
 - Ensure compliance and a regulatory framework that delivers safe, reliable and efficient transport services
 - Ensure that financial resources are targeted to best achieve Solomon Island's transport system needs
 - Communicate the benefits of transport reforms
 - Effectively plan the upgrade and rehabilitation of infrastructure, government housing stock, fleet, plant and machinery
 - Effectively provide transport planning that supports other sectors in the economy through an integrated approach, targeting Economic Growth Centers and vital social infrastructures
 - Promote development of a professional, technical, proficient, able, capable and dedicated workforce
 - Ensure and provide opportunities for more private sector participation.¹⁴

3.1.9 Guadalcanal Provincial Government

Guadalcanal Province is divided into 21 Electoral Wards. Elections are held every 4 years for the 21 Members of the Provincial Assembly. The Premier is the political head of the Province and also presides over the Provincial Executive. The Speaker presides over the Provincial Assembly meetings. The Provincial Assembly is the highest law-making body in the Province. It enacts and passes ordinances for the proper conduct, welfare and livelihood of Guadalcanal citizens.¹⁵

Currently, there are 10 Executive Members or Provincial Ministers including the Premier. Similar to the national government, each Minister is responsible for a certain portfolio. The portfolios are as follows:

1. Office of the Premier, including Finance & Education
2. Ministry of Planning and Economic Development/Deputy Premier
3. Ministry of Natural Resources
4. Ministry of Reconciliation and Rehabilitation
5. Ministry of Health, Medical and Social Services
6. Ministry of Agriculture & Lands
7. Ministry of Geana Regional Affairs
8. Ministry of Tasimauri Regional Affairs

¹⁴ ibid

¹⁵ Guadalcanal Province - Reform and Rural Regional Development and Empowerment Policy Framework (2011-2015)

9. Ministry of Tasimate Regional Affairs

The administrative head of the Province is the Provincial Secretary who coordinates all administrative and management units in the Province. The incumbent is seconded from the Public Service on a fixed-term appointment. In this regard, the Provincial Secretary and other seconded officers have a dual responsibility. While they are responsible to their supervisor at the national level, they are also required to equally fulfil their duties to the Province.

Guadalcanal Province has been mandated by an Act of parliament to perform three different functions in the provision of services to the people, including “legislative matters, provincial services and statutory functions”. However, some of the statutory functions have not been transferred from the national to the provincial government at the time the ESIA was prepared.

Regarding legislative matters, Guadalcanal Province has been responsible for the following: facilitating the marketing of products; collecting land taxes to raise revenue; forming the Guadalcanal Town and Country Planning Board; providing water to some rural villages; and establishing corporate bodies for the provision of provincial services, including some economic activities. The provincial minister responsible for natural resources has been vested with certain powers to facilitate some forestry operations under the Devolution Order No. 1 of the *Forestry Resources and Timber Utilisation Act 1970*. As well, the police have been collecting revenues from commercial vehicles under the *Traffic Act*.

Provincial governments, under Schedule 3 of the *Provincial Government Act 1997* (PG Act), have been given responsibility for minor local matters such as the licensing of local businesses, bars, hotels, markets, fire protection and waste disposal. They have not been empowered with control over the delivery of services for the people.

With respect to the Project, the Guadalcanal Provincial Government’s newly constituted Town and Country Planning Board will have a role in granting planning consent for the Project under the *Town and Country Planning Act*. This consent is separate to the development consent to be issued by the ECD of MECDMM under the *Environment Act*.

The Province will also have a key role in issuing business licenses for the developer and other sub-contractors under the *Guadalcanal Province Business and Hawkers Licence Ordinance*.

The Provincial Government may also have a role in the application of ministerial powers under the *River Waters Act* under a devolution order. This will require confirmation in consultation with SIG.

3.1.10 Ministry of Agriculture and Livestock Development (MAL)

Established in the 1950’s the Ministry of Agriculture and Livestock Development (MAL) is one of the oldest ministries, and has played a key role in the development of the country. Its levels of capacity have, however, shifted significantly over time, with staff numbers reducing from over 400 in the late 1990’s to 169 in 2007 (GoSI 2007, MAL 2007). Over 80% of the country’s population still relies on subsistence agriculture as a key element of its livelihood strategy. Improvement of small-scale agricultural production is a key goal for national growth.

The MAL is currently subdivided into four departments, each with its own director:

- The Livestock and Quarantine Department – Aim is to formulate and regulate policies; provide livestock development and extension services in the provinces; breed and distribute livestock and disseminate information; and conduct research into indigenous animal species.

-
- Extensions and Training Department - The department's staff is supposed to work directly with villagers in rural areas. Around 100 extension staff are planned for the provinces, mostly men, with up to 10 in each province, except Western Province and Malaita, which will have 20 each. In many cases, the majority of staff are based in the provincial capital.
 - Research Department - In the past this department, which is based at Dodo Creek, played a major role in the delivery of services, both directly to farmers via on-farm field trials and demonstration plots at its field stations, and via technical support to the Extensions and Training Division. With the destruction of the research station and the displacement of research staff, the department is unable to function effectively.
 - Planning and Management Department - This department includes the land use-planning unit. It had a general role in coordinating the activity and policy of the other MAL departments.

Whilst MAL has no direct inputs in the Project, development activities to compensate for impacts on livelihoods could be agriculturally based and therefore their inputs in any such initiatives will be important. Land based compensation measures are discussed in the Land Acquisition and Livelihood Restoration Plan.

3.1.11 Ministry of Finance and Treasury (MFT)

The Ministry of Finance and Treasury (MoFT) is responsible for facilitating the provision of sound advice on monetary, budget and fiscal policy to the Solomon Islands Government. The mission of the Ministry is to provide leadership to the Solomon Islands community in financial matters and deliver high quality, professional financial and economic services to the Minister of MFT, the SIG, other ministries, and the wider community.¹⁶

MoFT's services include statistics and economic management to support government decision-making processes and the implementation of good governance practice.¹⁷ Core tasks of the Ministry include financial reporting, revenue collection, border protection, government payments, preparing and managing the annual recurrent budget and advising the Government on a range of financial policies including economic reforms.¹⁸

To achieve its mission, MoFT delivers services through its divisions and units:

- The Customs and Excise Division
- The Inland Revenue Division
- The Budget Unit
- The Economic Reform Unit
- The Debt Management Unit
- Statistics,
- Internal Audit,
- Corporate Services¹⁹

¹⁶ Ministry of Finance Corporate Plan

¹⁷ *ibid*

¹⁸ *ibid*

¹⁹ *ibid*

MoFT has been very active in structuring and sourcing the financing for the Project. It will continue to perform functions on behalf of the Government through the Implementation Agreement with the Developer and possibly also through an equity shares and/or on-lending arrangement to the Project Company.

3.1.12 Public Solicitors Office

The Public Solicitors Office provides legal assistance and representation and comprises of three key units:

- The Criminal Unit;
- The Family Protection Unit; and
- The Landowner's Advocacy and Legal Support Unit (LALSU).

LALSU provides free legal advice sessions and formal representation to landowners and communities across the country relating to land use and ownership, with an emphasis on logging, mining, protected areas and large scale developments. LALSU also conducts regular legal awareness trips to each province, runs test cases and is active in advocating for policy and law reform impacting on customary land owners. LALSU works closely with NGOs in the environment space and has strong relationships with the Ministry of Environment, Climate Change and Disaster Management.

With respect to the Project, LALSU has provided a series of awareness sessions on legal rights to communities in the Project area. LALSU has also provided assistance to identified landowning tribes in the compulsory acquisition process. This is discussed in further detail in the Land Acquisition and Livelihood Restoration Plan.

3.1.13 Civil Society / Non-government Organisations (NGOs)

There is a range of civil society groups and non-government organisations (NGOs) that are likely to play important roles in the development of the TRHDP. The involvement of civil society groups will be important in the review of the ESIA, in particular, the implementation of mitigation measures adopted in the environment management plan. The role of many of the civil society groups in the country can be described as geographically constrained, or, on a national level, sporadic and reactive when issues arise. Often, this is the result of the perception that political interference dominates major development projects and programs in the country.

Table 3-2 includes a list of civil society groups / NGOs that may become involved in the project at some stage.

Table 3-1 Key NGOs

Civil Society/NGO	Focus area	Potential involvement
Transparency Solomon Islands (TSI)	Transparency and Governance in Solomon Islands	Benefit distribution and the nature of agreements between communities, landowners and investor
Solomon Islands Development Trust (SIDT)	Rural development	Community projects and development
The Nature Conservancy	Environmental conservation and promotion of protected areas	Advocacy with respect to environmental impacts
Live and Learn Environment Education (LLEE)	Environment Education	Education and awareness on the potential environmental impact on livelihoods for communities and on gender inclusion and leadership
Red Cross	Social and health issues and advocacy	Advocacy and training on health issues and opportunities from the Project
National Council of Women (NCW) and Guadalcanal Provincial Council of Women	Advocate women's rights and gender equality	Ensuring gender issues are fully addressed and that issues affecting women are taken into account.
World Wide Fund for Nature (WWF)	Environmental advocacy and promotion of protected areas	Environmental and conservation advocacy

3.1.14 Key Stakeholders

There are a number of other stakeholders that will play direct and indirect roles in the TRHDP. These stakeholders are important for the reasons indicated in Table 3-3, and are described throughout the report.

Table 3-2 Key stakeholders

Stakeholder/Organization	Importance to Project	Key focus areas/Lessons learned
Gold Ridge Mining Ltd (GRML)	Close proximity to the Tina Hydro Project. Many villagers worked or received royalties from GRML when operational.	<ul style="list-style-type: none"> ▪ landownership issues ▪ benefit distribution ▪ lessons learned from addressing environment and social issues
Guadalcanal Plains Palm Oil Ltd (GPPOL)	Close proximity to the Tina Hydro Project. Many villagers work for GPPOL or receive royalties.	<ul style="list-style-type: none"> ▪ land issues ▪ benefit distribution ▪ dispute settlement ▪ community engagement. ▪ addressing environment and social issues
World Bank /DFAT/Green Climate Fund/EDCF/IDA/ADB	Main or potential funding agencies	<ul style="list-style-type: none"> ▪ World Bank Environment and Social Safeguards ▪ World Bank (WB) Performance Standards ▪ ADB Safeguard Policy Statement (2009)
Financial Institutions including Pan Oceanic Bank and ANZ	Management of financial benefits for landowners from the project including establishing bank accounts for individuals and trust accounts for minors	<ul style="list-style-type: none"> ▪ financial services to landowning groups and compensation recipients ▪ financial literacy to communities

3.2 ACTS, REGULATIONS AND ORDINANCES

This section describes the acts, regulations and ordinances that are relevant to the Project and helps to describe what is required prior to the implementation of TRHDP. This section also presents requirements from national and provincial legislation to ensure the compliance and will assist in the development of mitigation measures in the course of the ESIA.

Table 3-4 presents a summary of the Solomon Islands regulatory regime (see Annex 10 for a more complete analysis).

Table 3-3 Solomon Islands Acts and Regulations

Name of Act or regulation	Implication for the Project
<i>Constitution of Solomon Islands</i>	The Constitution provides additional safeguards for the compulsory acquisition of customary land.

Name of Act or regulation	Implication for the Project
<i>Solomon Islands National Energy Policy 2014</i>	The Policy outlines the National Government's policies for the planning and management of the energy sector over the next 10 years.
<i>Agriculture Quarantine Act 1982</i>	An Order of the Minister may prohibit or regulate the importation or landing of: (a) animals and animal products; (b) plants; (c) earth; and (d) other things by, or by means of, which it appears to the Minister that any disease or pest might be introduced.
<i>Environment Act 1998 and Environment Regulation 2008</i>	<p>The TRHDP is a prescribed development under schedule 2 (section 16) of the <i>Environment Act 1998</i> and, therefore, requires the preparation and submission of an Environment Impact Statement (EIS) through the Environment and Social Impact Assessment (ESIA) Process.</p> <p>The scope of the <i>Environment Act</i> and its Environment Regulations encompass a number of processes, and procedures, and the establishment of an institution, to regulate them. The following key issues are addressed by the legislation:</p> <ul style="list-style-type: none"> ▪ Provides the guiding principles and definition for environmental management. ▪ Establishes the Environment and Conservation Division as a key institution responsible for managing environmental issues in the country. ▪ Sets out the procedures for undertaking and approving Environmental and Social Impact Assessments. ▪ Develops requirements for robust stakeholder engagement processes through public consultation as part of assessment and decision making process. ▪ Requires the formulation of appropriate environmental and social safeguards as part of the environment and social impact assessment process (section 31) ▪ Requires environmental monitoring of the development (section 31) ▪ Establishes the Environment Advisory Committee as the appeal body where the Developer or any person may, within 30 days of the publication of the Director's decision, appeal against the Director's decision concerning the issuing of development consent.

Name of Act or regulation	Implication for the Project
<p><i>Fisheries Management Act 2015</i></p>	<p>The Act is concerned with the conservation, management and development of fisheries and marine resources. The Act provides a regime for licensing commercial fishing as well as for establishing fisheries management plans that can cover commercial and non commercial fishing.</p> <p>The Act may become relevant to any future use of the reservoir for commercial fishing, whether as a livelihood development project for communities or otherwise. It would also be relevant if any fisheries management plan were applied to the Tina River.</p>
<p><i>Forest Resources and Timber Utilization Act 1969</i></p>	<p>The Act requires a felling licence to be obtained to fell any trees for the purposes of sale. Whilst the intention of law is not to cover vegetation removal for construction or other purposes, there is a possibility that a “felling license” could be required for the project if any commercially valuable trees felled are later sold, whether by the developer or landowners. Further consultations will be undertaken with the Ministry of Forestry based on the amount of vegetation to be removed during the construction phase of the Project.</p>
<p><i>Labour Act 1996</i></p>	<p>This Act makes provisions for the protection of workers and their rights. It establishes the Office of the Commissioner of Labour to address all labour related issues. The legislation broadly covers the roles and powers of the office, identifies the commissioner as the relevant administrative body, and outlines specific guidance on minimum wages and hours of work for all workers in the country.</p> <p>It also makes provision for the manner in which contracts for employment are made for both national and foreign workers.</p> <p>The provisions of both the <i>Labour Act</i> and the <i>Immigration Act</i> will be important during the construction phase.</p>

Name of Act or regulation	Implication for the Project
<i>Land and Titles Act</i>	<p>The <i>Land and Titles Act</i> establishes the procedure for the registration and acquisition of customary land.</p> <p>The Project's Core Land was acquired through the compulsorily acquisition process set out in Division 2, Part V of the Act. The acquisition included all of the customary land needed for the construction and operation of the project including part of the access road.</p> <p>The process used was a 'compulsory' process under the legislation, with acquisition contingent on first obtaining the consent of all identified landowning tribes. This consent was obtained through the negotiation of a written 'process agreement'.</p> <p>The <i>Land and Titles Act</i> also establishes the procedure for the subdivision and voluntary sale of registered land, relevant to the Project's acquisition of the registered land required for the access road and transmission line corridors.</p> <p>The <i>Lands and Titles Act</i> also made provision for preservation orders to be applied to land of "historic, architectural, traditional, artistic, archaeological, botanical or religious interest", and permits the establishment of nature reserves.</p>
<i>Customary Land Records Act</i>	<p>The Act provides a process for the formal identification and recording of customary land ownership and boundaries.</p> <p>Although the <i>Customary Land Records Act</i> is technically in force, the administrative bodies required to administer the Act have not been established. The Act has been piloted informally but never technically used.</p> <p>For this reason, the Project cannot make use of the Act. However, an informal process for recording customary land was undertaken by a land identification committee. The provisions of the <i>Land and Titles Act</i> were used to formally register the land required for the Project.</p>

Name of Act or regulation	Implication for the Project
<i>Mines and Minerals Act</i>	<p>The Act sets out procedures the licence prospecting for, and the extraction of, minerals.</p> <p>The Act will be relevant to the extraction of building materials from the site for use in project construction.</p> <p>The Act requires that the extraction of gravel for use as a building material must have a “Building Materials Permit” (BMP). The BMP is not transferable and royalties must be paid at the prescribed rate per cubic meter for all building materials extracted. However, similar to many of the laws in the Solomon Islands, the Minister can issue an exemption to the building materials permit: building materials for building or road construction for the personal use of the landowner or occupier, or for sale not exceeding a prescribed amount, may be mined without a “Building Materials Permit”. The extraction of materials for the TRHDP could require seeking an appropriate permit from MMERE for quarry development to occur. However, the Minister has powers to issue exemptions where a national project, such as TRHDP, is involved.</p>
<i>National Parks 1954</i>	<p>The Minister can make a proclamation declaring certain areas to be a National Park and purchase or acquire any land for such purpose.</p> <p>This Act is outdated and lacks provisions to empower customary landowners to make decisions about their resources. In practice, the Act has been replaced by the <i>Protected Areas Act</i> although not formally repealed.</p>

Name of Act or regulation	Implication for the Project
<p><i>Protected Areas Act 2010</i></p>	<p>The Act sets out the process for landowners to formally protect their land. Once protected, land cannot be used for commercial logging or mining, and other uses of the land will be subject to the terms of the management plan established for the land.</p> <p>For an area to become a Protected Area (PA), a community or organization shall prepare an application to the Director of Environment for their site to be declared. The application shall include a PA management plan and scientific studies to show that the area is of significance to biological diversity and to the community in terms of natural resources. The application will also include an estimated budget for the PA, and evidence of agreement by all customary landowners, as well as a map showing the boundary and size of the site. The director, upon receiving the application, will review the application and make recommendations to the Minister. The Minister shall consider whether:</p> <ul style="list-style-type: none"> (a) Conservation objectives of the proposed PA are identified and are in accordance with sound conservation practices; (b) Boundaries of the area are accurately identified, or otherwise demarcated and surveyed; (c) Consent and approval are obtained from persons having rights or interests in the area; (d) Appropriate conservation, protection or management plan is developed for the area, to ensure that the conservation objectives of the protected area will be achieved. <p>The Protected Areas Committee has been established and the country's first Protected Area was declared in 2016.</p>

Name of Act or regulation	Implication for the Project
<p><i>Provincial Government Act 1997</i></p>	<p>Schedule 3 of the <i>Provincial Government Act 1997</i> provides a list of activities for which the provinces have responsibility, and have the power to pass ordinances;</p> <ul style="list-style-type: none"> ▪ Trade and Industry - Local licensing of professions, trades and businesses, local marketing. ▪ Cultural and Environment Matters - Protection of wildlife, coastal and lagoon shipping, ▪ Agriculture and Fishing - Protection, improvement and maintenance of fresh-water and reef fisheries. ▪ Land and Land Use - Codification and amendment of existing customary law about land. Registration of customary rights in respect of land including customary fishing rights. Physical planning except within a local planning area ▪ Local Matters - Waste disposal ▪ Rivers and Water - Control and use of river waters, pollution of water ▪ Corporate or Statutory Bodies - Establishment of corporate or statutory bodies for provincial services including economic activity. (Provincial services include "Conservation of the Environment" and "Fishing"). <p>The Guadalcanal Province Wildlife Management Area Ordinance 1990 (GPWMAO) applies to the protection of wildlife. This ordinance applies to TRHDP to ensure that wildlife impacts are understood.</p> <p>Other requirements include a business license during construction and approval under the provincial Town and Country Planning Board.</p>
<p><i>River Waters Act 1964</i></p>	<p>The <i>River Waters Act 1964</i> states that it is an offence to interfere with a river, except in accordance with the terms and conditions of a permit.</p> <p>The Act applies to the section of the river called Ngalibiu (referred to as part of the Ngalimbiu River). A permit will, therefore, be sought from the Minister for MMERE before constructions works proceed.</p> <p>The process for applying for a permit involves submitting details of the proposed construction and diversion that will occur, including maps of the location in which construction will occur. The conditions for issuing a permit include a study of the current use of the river and the potential impact of the proposed interference on the river. In granting any permit, the Minister shall have regard to the existing use of water and shall safeguard such existing use of water as far as it appears to be practicable and consistent with the provisions and purposes of this Act. A practical application would be to submit the ESIA and proposed development plan for a permit to be issued. The law does not provide a timeframe for the permit to be issued.</p>

Name of Act or regulation	Implication for the Project
<i>River Waters Ordinance 1969</i>	Provides measures for watershed control in relation to rivers and regulates the use of designated river water through permit applications.
<i>Public Health Ordinance 1970</i>	This Ordinance authorises inspections to be conducted for the regulation of water pollution.
<i>Solomon Islands Water Authority Act 1992</i>	The Solomon Islands Water Authority (SIWA) is established under this Act and is currently charged with providing the proper management and development of urban water resources and services, and sewerage services in the Solomon Islands.
<i>Safety at Work Act 1982</i>	The legislation codifies the duties of employers to their employees and others responsible for ensuring the safety of workers in various work environments, in particular, safety of workers in dangerous and risky conditions. It provides for the civil and criminal liability of employers who are negligent regarding the safety of their workers.
<i>Town and Country Planning Act 1980</i>	<p>The Act requires developments on registered land to obtain planning consent from the relevant provincial Town and Country Planning Board.</p> <p>The Guadalcanal Board has recently been re-established.</p> <p>The TRHDP will require consent under this Act.</p>
<i>Wild Birds Protection Act 1914</i>	This Act was repealed by the <i>Wildlife Protection and Management Act</i> .
<i>Wildlife Protection and Management Act 1998</i>	<p>The legislation primarily protects wildlife by limiting the import of potentially harmful species, preventing the export of listed protected species and requiring a permit (for scientific research) for others. Schedule I lists the species that are prohibited to export, and Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required.</p> <p>The Act also empowers the Minister to make an order to approve a management programme which can include measures for the breeding or study of certain species, and the setting aside of reserved areas for their protection. There are no known orders currently in place.</p>

Name of Act or regulation	Implication for the Project
<i>Environmental Health Act 1980 and Environmental Health (Public Health Act 1970) Regulations</i>	In the case of the TRHDP, the Guadalcanal provincial health authority has a duty to take necessary and reasonably practicable measures to enforce the law and request that, at all time, the Project site be in a clean and sanitary condition.
<i>Electricity Act</i>	<p>The <i>Electricity Act</i> sets out in very wide terms the functions and duties of the Solomon Islands Electricity Authority (SIEA). The SIEA (trading as Solomon Power) is generally in charge of all matters related to electricity production and transmission/distribution in Solomon Islands, including ensuring standards of safety, efficiency and economy. It also advises the Government on matters related to electricity and can make recommendations as to regulatory instruments.</p> <p>Relevant to the Project, the Electricity Act empowers SIEA to enter into contracts for the purposes of signing the Power Purchase Agreement. The Act also establishes a licencing regime for an electricity producer and the developer will require a licence under this Act.</p>
<i>Guadalcanal Historic Places Ordinance 1985</i>	This Ordinance provides a means of legally protecting sacred, traditional and archaeological sites. No such sites are present in the Project study areas.

3.3 INTERNATIONAL ENVIRONMENTAL AND SOCIAL TREATIES

Table 3-5 presents and describes international environmental and social treaties signed and ratified by the Solomon Islands, and the relationship between the Project and these treaties is analysed.

Table 3-4 Treaties observed by the Solomon Islands

Multilateral Environment Agreement	Status	Purpose/Aim	Agency Responsible	Relevance to TRHDP
Regional Multilateral Environment Agreements				
Pollution Protocol for Dumping	Ratified 10/9/98	Prevention of pollution of the South Pacific region by dumping.	Marine Div/MECDM	NA

Multilateral Environment Agreement	Status	Purpose/Aim	Agency Responsible	Relevance to TRHDP
Pollution Protocol for Emergencies	Ratified 10/9/98	Cooperation in combating pollution emergencies in the South Pacific region.	Marine Div/MECDM Project: National Pollution Prevention Plan	NA
Natural Resources & Environment of South Pacific Region (SPREP Convention)	Ratified 10/9/98	Protection of natural resources and environment of the South Pacific Region in terms of management and development of the marine and coastal environment in the South Pacific Region.	MECDM	This is relevant for the Project and the ESIA should address the related issues. This a pacific agreement for the management of natural resources and biodiversity
Waigani Convention on Hazardous & Radioactive Wastes 1995	Ratified 7/10/1998	Bans the importation of hazardous and radioactive wastes into Forum Island countries and to control the trans-boundary movement and management of hazardous wastes within the South Pacific region.	MECDM	Any import of hazardous material will require permits to be issued by MECDM. This is a regional version of the Basel Convention.
International Multilateral Environment Agreements				
Chemicals, Wastes and Pollution				
Liability for Oil Pollution Damage	Ratified	Strict liability of ship owner for pollution damage to a coastal state within a certain amount.	Marine Div	NA
Marine Pollution Convention (London)	Ratified	Prevention of marine pollution by dumping of wastes and other matter.	MECDM/Foreign Affairs	NA
United Nations Convention to Combat Desertification (UNCCD)	Acceded 16/4/1999	Agreement to combat desertification and mitigate the effects of drought in countries experiencing drought or desertification.	MAL/MECDM Project: National Action Plan on Land Degradation and Drought	NA

Multilateral Environment Agreement	Status	Purpose/Aim	Agency Responsible	Relevance to TRHDP
POPs Convention (Stockholm)	Acceded 28.7/2004	Protection of human health and environment from persistent organic pollutants (POPs).	MECDM/Environmental Health Div. Project: National Implementation Plan	NA as no POP chemicals will be used during construction.
Biodiversity				
CITES	Instrument of ratification being prepared	Regulations and restriction of trade in wild animals and plants through a certification system of imports and exports.	MECDM	Unlikely to be applicable as applies to import or export of relevant species
World Heritage Convention (UNESCO)	Acceded 10/6/1992	Protection of sites of Outstanding Universal Values. Solomon Islands currently has East Rennell Island as a World Heritage site. ²⁰ Mt. Popomanaseu is on the Tentative list of the UNESCO	National Museum/ MECDM	NA, however, Mount Popomanaseu is at the upper reaches of the Tina Catchment
UN Convention on Biological Diversity (UNCBD)	Ratified 3/10/1995	Conserve biological diversity through the sustainable use of its components and the fair and equitable sharing of the benefits arising out of utilizing genetic resources.	MECDM Project: NCSA; National Biodiversity Strategy and Action Plan; International Waters Program; 3rd National Report	Relevant since the ESIA also aims at protecting species
Cartegena Protocol to the UNCBD	Acceded – 26/10/2004	Protection of human health and the genetic diversity. ²¹	MECDM	NA

²⁰ World Heritage Convention

²¹ Cartagena Protocol to the UNCBD

Multilateral Environment Agreement	Status	Purpose/Aim	Agency Responsible	Relevance to TRHDP
Coral Triangle Initiative (CTI) Agreement		Protection and conservation of marine resources within the coral triangle region.		NA
Cultural and Natural Heritage				
World Cultural and Natural Heritage Convention	Acceded in 1992	Protection and management of cultural and natural heritage	National Museum under the Ministry of Home Affairs	Applicable since cultural heritage is valued by local communities
Climate Change Related				
United Nations Framework Convention on Climate Change (UNFCCC)	Ratified – 28/12/1994	Set an overall framework for intergovernmental efforts to tackle the challenges posed by climate change.	MECDM	This is relevant since the Project will reduce the use of fossil fuel for electricity production.
Kyoto Protocol	Ratified – 13/03/2003	Reduce greenhouse gases especially carbon dioxide for the 39 industrial/ developed countries by an average of 5.2% by 2012.	MECDM	NA- emissions from the construction of the Project are limited in time
Montreal Protocol	Acceded - 17/06/1993	Allows phase out of substances that deplete the ozone layer according to a fixed schedule.	Energy Division	NA
Vienna Convention for the Protection of the Ozone Layer	Acceded – 17/06/1993	-Protection of the ozone layer through intergovernmental cooperation on research. -observation of ozone layer - monitoring of CFC		NA

3.4 WORLD BANK GROUP REQUIREMENTS

To date, the World Bank has provided significant project funds to the Project. The Bank has also proposed that it may provide a partial risk guarantee, as well as concessional and grant financing, towards construction costs. Therefore, the Project must comply with several social

and environmental principles. These principles are reflected in the WB Operational Policies, and the WB Performance Standards.

The WB Operational Policies apply to public sector projects and will apply to the land acquisition and livelihood restoration undertaken by the SIG.

The eight Performance Standards, initially developed by the IFC in 2006 and amended in 2012, were adopted by the World Bank in 2013 as the World Bank *Performance Standards for Projects Supported by the Private Sector* (“WB Performance Standards”). They are to be applied where the Bank provides support for projects (or components thereof) that are designed, owned, constructed and/or operated by a Private Entity, in lieu of the World Bank’s Operational Policies. The developer, the Special Purpose Company (SPC) managed by K-Water as a private sector entity, will abide by WB Performance Standards, all of which, except for PS5 on land acquisition and resettlement, apply to the dam and power plant.

The following sections identify the World Bank Operational Policies and World Bank Performance Standards that will apply to the Project.

The developer/contractor will be responsible for developing an environmental and social management system (ESMS) and for identifying, assessing and managing environmental and social risks and impacts associated with the Private Sector Activity, all in accordance with the WB Performance Standards.

3.4.1 WB Operational Policies

While a private sector agent is taking the lead role in management of environmental and most social impacts, TRHDP-PO, within MMERE, retains the responsibility for land acquisition, livelihood restoration, and benefit sharing, all of which have particular significance to indigenous communities.

World Bank OP 4.12 and OP 4.10 thus apply as safeguards relating to Indigenous Peoples (IP) that are managed in the land acquisition plan (LALRP). WB PS 7 is applicable to the dam and power plant because the Developer must abide by any IP-related mitigation, monitoring, hiring, community engagement, etc. all of which involve IPs.

It is proposed that Solomon Power will construct the transmission line between the powerhouse / switchyard and the main tie-in point at Lungga Generating Station for which WB Operational Policies will apply. Solomon Power as a state owned enterprise is classified as a public sector agency according to OP 4.03 criteria.

The access road, between the Black Post turnoff and Mengakiki, will be upgraded by the Ministry of Mines, Energy and Rural Electrification (MMERE), in part using funding provided by Australian DFAT for which WB Operational Policies will apply.

3.4.1.1 Applicable Operational Policies

Those components of the Project relating to the transmission line and the access road to Mengakiki will be undertaken in accordance with the following applicable World Bank Environmental and Social Safeguard Policies:

- OP4.01 – Environmental Assessment
- OP4.04 – Natural Habitats
- OP4.36 – Forests
- OP4.10 – Indigenous Peoples
- OP4.11 – Physical Cultural Resources

OP 4.01: Environmental Assessment

OP 4.01 (Environment Assessment) sets out the general policies and principles for environmental and social protection and requirements for assessment of impacts and implementation plans and measures to mitigate or manage impacts.

OP 4.01 requires that an assessment evaluate a project's potential environmental risks and impacts in its area of influence; examine project alternatives; identify ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and include the process of mitigating and managing adverse environmental impacts throughout project implementation.

The requirements of OP 4.01 for the access road are addressed as part of this ESIA.

OP 4.04: Natural Habitats

OP 4.04 supports the protection, maintenance, and rehabilitation of natural habitats, and a precautionary approach to natural resource management. It provides that the Bank does not support projects that involve the significant conversion or degradation of critical natural habitats unless there are no feasible alternatives for the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs.

The requirements of OP 4.04 for the access road and transmission line are incorporated into this ESIA. No critical natural habitats are identified as affected by the access road.

OP4.10: Indigenous Peoples

OP 4.10 Indigenous Peoples (Amended 2013) is triggered where a project affects Indigenous Peoples. The vast majority of the people benefiting from and affected by the Project are assessed to be Indigenous Peoples. The Policy will apply to the SIG's acquisition of land for the Project, as well as the SIG's upgrade and construction of the access road and Solomon Power's construction of the transmission line. The Policy requires that SIG engage in free, prior and informed consultation resulting in broad community support. It also requires that SIG avoid potentially adverse effects on Indigenous People and where avoidance is not feasible, minimize, mitigate or compensate such effects. Compensation and benefits must be culturally appropriate and gender and inter-generationally inclusive.

Clause 12 of the Policy indicates that "when Indigenous Peoples are the sole or the overwhelming majority of direct project beneficiaries, the elements of an Indigenous Peoples Plan (IPP) should be included in the overall project design, and a separate IPP is not required." Based on this clause, since the vast majority of citizens of the Solomon Islands are members of one or more Indigenous Peoples, and the entirety of the communities in the project Area of Influence are comprised of members of one or more Indigenous Peoples. Rather, the Social Impact Assessment prepared for the whole project, as part of the overall ESIA, fulfills the needs of what would otherwise be an IPP, and the project design fully accounts for the interest of Indigenous Peoples within the project-affected area. Measures to minimize, mitigate and compensate for land acquisition impacts, and the SIG's process of free, prior and informed consent, are set out in the Land Acquisition and Livelihood Restoration Plan.

OP4.12: Involuntary Resettlement

The World Bank's policy on involuntary resettlement "is triggered" in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects (World Bank, 2014).

In the case of the TRHDP as it is currently conceived, the Policy is triggered because:

- the proposed project will require the taking of customarily owned land for the dam site, hydro storage reservoir, power station, access roads, quarries and borrow sites, and for power transmission infrastructure, and;
- the taking of such land implies a loss of assets for some, and/or a loss of income sources or means of livelihood.

It is not anticipated that the construction or operation of the TRHDP will result in the loss of residence or shelter of any members of local communities or require any of them to move to another location. While there have been calls during community consultations by some people for their villages to relocate, the project is being designed to avoid relocating and resettling any existing households or communities and, accordingly, will not require any relocations for it to proceed safely.

Avoidance of displacement is consistent with the Bank's policies on the protection of indigenous peoples; nevertheless, compliance with OP 4.12 requires the preparation of a Resettlement Action Plan or a Livelihood Restoration Plan for loss of livelihood.

This plan has been prepared as a separate document, the Land Acquisition and Livelihood Restoration Plan. As the SIG is responsible for land acquisition, the plan is prepared with respect to World Bank OP 4.12.

3.4.1.2 OP4.37: Dam Safety

WB Performance Standard 4 will apply to the Project with respect to dam safety. However, OP 4.37 has been used to guide the actions necessary for Performance Standard compliance.

The World Bank's policy on dam safety "is triggered" when the construction of a new dam is proposed. The policy prescribes that the dam be designed and its construction supervised by experienced and competent professionals. It also requires that project adopt and implement certain dam safety measures for the design, bid tendering, construction, operation, and maintenance of the dam and associated works. (World Bank, 2013).

If TRHDP were a Government project, the Policy would be triggered because the proposed TRHDP dam at a height of 53m qualifies as a large (>15m high) dam.

Under the Policy the project proponent is required to engage technical specialists to investigate the site and design the dam, supervise new or remedial construction, advise on initial reservoir filling and start-up operations, and perform inspections and safety assessments. The qualifications of the professionals (e.g., engineers, geologists, or hydrologists) employed by the borrower must be adequate to the complexity of the particular dam.

Project information relevant to dam safety, including: cost estimates; construction schedules; procurement procedures; technical assistance arrangements; environmental assessments; plans for construction supervision and quality assurance, instrumentation, operation and

maintenance, and emergency preparedness are to be prepared, along with any other action plans relating to dam safety.

3.4.2 WB Performance Standards

WB Performance Standards (PS) will guide all actions and activities of the Project from design and construction through operations and maintenance, to decommissioning and rehabilitation / restoration of the site. The PS will guide the Project to identify impacts and to avoid, mitigate and manage them in an environmentally and socially acceptable way.

The term “client” is used throughout the Performance Standards broadly to refer to the party responsible for implementing and operating the Project that is being financed, or the recipient of the financing, depending on the project structure and type of financing. In the case of TRHDP, the client is the developer of TRHDP.

The term “consultant” refers to the company that is responsible for preparing the ESIA.

TRHDP has delegated the consultant to prepare the ESIA to describe the baseline environmental and social conditions, identify impacts, and propose mitigation measures in accordance with national, World Bank and other IFI standards.

The following sub-sections present the WB PS that apply to the ESIA and highlight what needs to be implemented to comply with the PS.

3.4.2.1 Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts

The requirements of PS1 are presented in Table 3-6

Table 3-5 PS 1 requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	To conduct a process of Environmental and Social Impact Assessment (ESIA) and maintain an effective Environmental and Social Management System (ESMS).	This ESIA includes an Environmental and Social Management Plan
R.2	The client will establish an overarching policy defining the environmental and social objectives and principles that guide the project to achieve sound environmental and social performance	The client will implement such policy based on the ESIA

#	Requirements	How will the Project implementation process comply with requirements
R.3	The client will establish and maintain a process for identifying the environmental and social risks and impacts of the project	<p>ESIA identifies and describes risks and impacts.</p> <p>As required, the ESIA studies the areas likely to be affected directly or indirectly by the Project, studies associated facilities (access roads, camps, quarries, etc.) and cumulative impacts.</p> <p>Monitoring measures will be implemented to enable verification of impact predictions and mitigation measures.</p>
R.4	The client will establish management programs (such as environmental and social action plans) to describe mitigation and performance improvement measures and actions that address the identified environmental and social risks and impacts of the project	The ESIA includes a list of action plans annexed in the ESMP. These plans will be further developed by the developer as it finalises the detailed design.
R.5	The client, in collaboration with appropriate and relevant third parties, will establish, maintain, and strengthen as necessary an organizational structure that defines roles, responsibilities, and authority to implement the ESMS.	The final ESMP will assess the responsible actor's capacity to implement environmental and social measures. Capacity building measures to strengthen staff are proposed. The ESMP also assesses the need for external experts to assist the responsible actor in implementing measures.
R.6	The ESMS will establish and maintain an emergency preparedness and response system so that the client, in collaboration with appropriate and relevant third parties, will be prepared to respond to accidental and emergency situations associated with the project in a manner appropriate to prevent and mitigate any harm to people and/or the environment.	To respond to accidents and emergency situations, and to comply with World Bank Operational Policy OP 4.37 Safety of Dams, several reports will be produced that address seismic monitoring of the dam, instrumentation, construction supervision, reservoir loading and flood prediction, emergency preparedness and response, etc., prior to commencement of construction. In addition, the ESMP outlines some safety measures.

#	Requirements	How will the Project implementation process comply with requirements
R.7	The client will establish procedures to monitor and measure the effectiveness of the management program, as well as compliance with any related legal and/or contractual obligations and regulatory requirements.	The ESMS defines a monitoring program for the developer to implement, identifying all monitoring activities, and roles and responsibilities for monitoring and reporting. The developer will also conduct internal audits to ensure measures are implemented. Results will be documented and the monitoring program will be part of the review cycle. The monitoring program will define corrective measures in situations where goals are not achieved.
R.8	The client will develop and implement a Stakeholder Engagement Plan that is scaled to the project risks and impacts and development stage, and tailored to the characteristics and interests of the Affected Communities.	A final Stakeholder Engagement Plan (SEP) will be developed. Some amendments are proposed in the ESMP.

3.4.2.2 Performance Standard 2: Labour and Working Conditions

The scope of application of this Performance Standard depends on the type of employment relationship between the client and workers. It applies to workers directly engaged by the client (direct workers), workers engaged through third parties to perform work related to core business processes of the project for a substantial duration (contracted workers), as well as workers engaged by the client's primary suppliers (supply chain workers).

Since the need for human resources will be concentrated in the construction phase, most employment will be temporary and, therefore, some requirements of PS2 do not apply. In the case of the Project construction, workers will be contracted. Even though only part of PS2 applies for contracted workers, all requirements are presented for the construction contractor to implement. The client, in turn, will have to audit the construction contractor for compliance and will have to ensure that specific requirements are part of tender documents.

The requirements of PS2 are presented in Table 3-7.

Table 3-6 PS 2 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	The construction contractor/client will adopt and implement human resources policies and procedures appropriate to its size and workforce that set out its approach to managing workers. The construction contractor/client will provide workers with documented information regarding working conditions and a written contract.	Through call for tender process, the TRHDP PO will ensure that the developer has a written human resources policy.

#	Requirements	How will the Project implementation process comply with requirements
R.2	The construction contractor will provide reasonable working conditions and terms of employment.	The developer shall develop a health and safety plan, which will be audited by TRHDP PO.
R.3	In countries where national law recognizes workers' rights to form and to join workers' organizations of their choosing, without interference, and to bargain collectively, the construction contractor will comply with national law.	This measure will be presented in the ESMP and will be included in any contracts between the developer and its contractor(s).
R.4	The construction contractor will not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The construction contractor will base the employment relationship on the principle of equal opportunity and fair treatment, and will not discriminate with respect to any aspects of the employment relationship.	This measure will be presented in the ESMP and will be included in any contracts between the developer and its contractor(s).
R.5	The construction contractor will provide a grievance mechanism for workers (and their organizations, where they exist) to raise workplace concerns.	The Stakeholder Engagement Plan applies to the developer. Its contract will include specific measures regarding workers' conditions.
R.6	The construction contractor will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with them.	This measure is presented in the ESMP and will be included in any contracts between the developer and its contractor(s).
R.7	The construction contractor will not employ forced labor.	This measure is presented in the ESMP and will be included in any contracts between the developer and its contractor(s).
R.8	The developer will provide a safe and healthy work environment, taking into account inherent risks in its particular sector and specific classes of hazards in the client's work areas, including physical, chemical, biological, and radiological hazards, and specific threats to women.	The developer will develop a health and safety plan, which will be audited by TRHDP PO

#	Requirements	How will the Project implementation process comply with requirements
R.9	With respect to contracted workers, the developer will take commercially reasonable efforts to ascertain that the third parties who engage these workers are reputable and legitimate enterprises and have an appropriate ESMS.	Through the call for tender process, the developer will ensure that construction contractors put the ESMP into effect.

3.4.2.3 Performance Standard 3: Resource Efficiency and Pollution Prevention

The requirements of PS3 are presented in Table 3-8.

Table 3-7 PS 3 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	During the project life-cycle, the client will consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment.	The ESIA and ESMP address all impacts and define pollution prevention measures.
R.2	The client will implement technically and financially feasible and cost effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs, with a focus on areas that are considered core business activities.	<p>The ESIA/ESMP addresses water quality impairment issues during construction activities and proposes efficiency measures.</p> <p>The ESIA/ESMP ensures that specific measures are developed to help the client integrate them in the call for tender documents.</p> <p>The client will include an environmental expert on its staff to ensure that processes are efficient (water, energy, etc.)</p>
R.3	The client will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release.	The ESIA/ESMP addresses pollutant release issues during construction activities and proposes measures to avoid, mitigate, and control release of pollutants.

#	Requirements	How will the Project implementation process comply with requirements
R.4	The client will avoid the generation of hazardous and non-hazardous waste materials. Where waste generation cannot be avoided, the client will reduce the generation of waste, and recover and reuse waste, in a manner that is safe for human health and the environment.	<p>The ESIA/ESMP addresses waste issues during construction activities and proposes measures to avoid release, and reduce, reuse, and recover all types of waste.</p> <p>The construction contractor will use subcontractors that are reputable and legitimate enterprises licensed by the relevant government regulatory agencies and obtain chain of custody documentation for wastes transferred to the final destination. This condition will be included in contracts between the client and its contractor(s).</p>
R.5	Hazardous materials are sometimes used as raw material, or produced as product, by the project. The client will avoid or, when avoidance is not possible, minimize and control the release of hazardous materials.	<p>The client will include conditions regarding use of hazardous materials in call for tender and in contracts.</p> <p>This measure will be presented in the ESMP and will be included in contracts between the client and its contractor(s).</p>

3.4.2.4 Performance Standard 4: Community Health, Safety, and Security

The requirements of PS4 are presented in Table 3-9.

Table 3-8 PS 4 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	The client will evaluate the risks and impacts to the health and safety of the Affected Communities during the project life-cycle and will establish preventive and control measures consistent with Good International Industry Practice (GIIP).	The developer will develop a health and safety plan. A warning system will be developed as part of the Operations Plan to address the peak hour water releases (i.e., sudden releases from 2m ³ /s to flow of 24m ³ /s).

#	Requirements	How will the Project implementation process comply with requirements
R.2	The client will design, construct, operate, and decommission the structural elements or components of the project in accordance with GIIP, taking into consideration safety risks to third parties or Affected Communities.	The developer will engage one or more external experts with relevant and recognized experience in similar projects, separate from those responsible for the design and construction, to conduct a review as early as possible in project development and throughout the stages of project design, construction, operation, and decommissioning
R.3	The client will avoid or minimize the potential for community exposure to hazardous materials and substances that may be released by the project.	The developer will develop a health and safety plan, and hazardous materials management plan as part of the developer's final ESMP.
R.4	The project's direct impacts on priority ecosystem services may result in adverse health and safety risks and impacts to Affected Communities, the client will identify those risks and potential impacts on priority ecosystem services that may be exacerbated by climate change.	The ESIA identifies the extent to which the Project affects ecosystem services that contribute to impacts on the health of local communities.
R.5	The client will avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases, and communicable diseases that could result from project activities, taking into consideration differentiated exposure to, and higher sensitivity of, vulnerable groups.	The ESIA identifies the extent to which Project construction and operation impact the health of local communities.
R.6	The client will assist and collaborate with the Affected Communities, local government agencies, and other relevant parties, in their preparations to respond effectively to emergency situations, especially when their participation and collaboration is necessary to respond to such emergency situations.	To respond to accident and emergency situations, and to comply with World Bank Operational Policy OP 4.37 Safety of Dams, several reports shall be produced to address seismic monitoring of the dam, construction supervision, reservoir loading and flood prediction, emergency preparedness and response, etc., prior to commencement of construction. These studies will be carried out in close collaboration with project affected communities

#	Requirements	How will the Project implementation process comply with requirements
R.7	<p>When the client retains direct or contracted workers to provide security to safeguard its personnel and property, it will assess risks posed by its security arrangements to those within and outside the project site.</p> <p>The client will make reasonable inquiries to ensure that those providing security are not implicated in past abuses; will train them adequately in the use of force, and appropriate conduct toward workers and Affected Communities; and require them to act within the applicable law.</p>	<p>The ESMP addresses such issues to ensure that local communities are safe.</p>

3.4.2.5 Performance Standard 5: Land Acquisition and Involuntary Resettlement

Option 7C will not necessitate any physical resettlement. It will, however, necessitate land acquisition for the construction area. Land acquisition will be done in compliance with World Bank safeguard policies OP 4.12 on Involuntary Resettlement rather than PS5 since the process is carried out by SIG, which is a public agency.

A land acquisition process was carried out by the TRHDP PO to secure land from its customary tenure. The customary land acquired is referred to as the Core Land (also the Core Area). A memo summarizing the land acquisition process that was prepared at the time the ESIA was being developed, is included as Annex 20 in the Annex Report.

3.4.2.6 Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

The requirements of PS6 are presented in Table 3-10.

Table 3-9 PS 6 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	The risks and impacts identification process should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. The client should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented.	The ESIA/ESMP addresses such issues. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services will be implemented. The ESIA presents the baseline conditions of natural habitats within the Project areas and describes their services.
R.2	For the protection and conservation of biodiversity, the mitigation hierarchy includes biodiversity offsets, which may be considered only after appropriate avoidance, minimization, and restoration measures have been applied.	The ESIA/ESMP has studied possible ways to offset impacts on natural habitats.
R.3	The client will conduct a systematic review to identify priority ecosystem services: (i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities; and/or (ii) those services on which the project is directly dependent for its operations	The ESIA/ESMP addresses such issues. Section 4.2 identifies and describes environmental components that play a role for local population (sources of livelihood), Tambu sites, etc.
R.4	Where a client is purchasing primary production, systems, verification practices will be adopted as part of the client's ESMS to evaluate its primary suppliers	The ESMP develops measures to ensure that suppliers of natural resources (quarry, etc.) will be evaluated regarding their compliance with measures.

3.4.2.7 Performance Standard 7: Indigenous Peoples

The WB Performance Standard (and accompanying procedure) on indigenous peoples is triggered because the peoples and communities likely to be directly or indirectly affected by the construction, and/or operation of TRHDP, can be considered indigenous people according to the Standard. Performance Standard 7 uses the term indigenous people in a generic sense to refer to 'a distinct, social and cultural group possessing the following characteristics in varying degrees:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; or
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside (WB, 2012).'

The baseline sections of the ESIA identify several groups or communities resident within, or in close proximity to, the proposed project area that could be potentially affected by the project, including:

- Indigenous Teha/Malango-speaking people of the Bahomea district who customarily own and occupy the 'Core Area' for the project;
- Indigenous Malango people of Malango district, some of whom are customary 'shareholders' or users of the Core Area;
- 'Settler' Guale people in the Bahomea district, who are largely indigenous *Talise*-speaking people from the Weather Coast of Guadalcanal and do not have customary ownership rights in the project area, though have been granted usufruct rights to certain areas by Bahomea customary owners;
- Indigenous coastal *Lengo*-speaking Ghaobata people of the Guadalcanal Plains who have ownership rights over the land and resources of the lower part of the Ngalimbiu catchment, and the adjacent coastal area, and;
- 'Squatter' peoples of various origins and language groups, who are living on 'unoccupied' government/alienated land in the northern part of the project area, without the formal approval of the local indigenous customary tribes, and people who are living and working on the LQQ and GPPOL agricultural estates on the Guadalcanal Plains. These people are Indigenous to other parts of the Solomon Islands or other islands of the Pacific, such as the Gilbertese from Kiribati.

Based on the interpretation of the World Bank (World Bank's Lead Social Development Specialist, and the World Bank's Lead Safeguards Specialist for the project), for the purposes of the social impacts assessment and social standard compliance, all the groups resident in the project area are considered Indigenous Solomon Islanders since they all have the defining characteristics mentioned above.

As noted elsewhere in the ESIA, compliance with this policy requires that TRHDP preparation include a social impact assessment (see Section 12), the scale of which needs to be proportional to "the nature and scale of the proposed project's potential effects on the indigenous peoples and a process of free, prior, and informed consent (FPIC) with the affected indigenous communities, to ascertain whether there is 'broad community support' for the Project, or not.

This means that the project must also: involve the development of measures to avoid, minimise and/or mitigate adverse impacts; that the design and provision of benefits and mitigation measures include the consideration of options preferred by the affected indigenous peoples; and that the social and economic benefits for indigenous people are culturally appropriate and gender and generationally inclusive.

Other requirements of WB PS 7 mean that the ESIA must also review the extent to which the project planning has considered:

- Free, prior and informed consent;
- Achievement of broad community support;
- Actions that are taken to achieve the legal recognition of customary rights to lands that are traditionally owned, or customarily used or occupied, and for such land acquisition; and
- Management of the commercial development, if any, of cultural resources.

The requirements of PS7 are presented in Table 3-11

Table 3-10 PS 7 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	The client will identify, through an environmental and social risks and impacts assessment process, all communities of Indigenous Peoples within the project area of influence who may be affected by the project, as well as the nature and degree of the expected direct and indirect economic, social, cultural (including cultural heritage), and environmental impacts on them.	The ESIA achieves this requirement.
R.2	Adverse impacts on Affected Communities of Indigenous Peoples should be avoided where possible. Where alternatives have been explored and adverse impacts are unavoidable, the client will minimize, restore, and/or compensate for these impacts in a culturally appropriate manner commensurate with the nature and scale of such impacts and the vulnerability of the Affected Communities of Indigenous Peoples.	Development of measures is carried out during the ESIA with the full participation of indigenous population to ensure that their opinions are taken into account and to minimize impacts on them.

#	Requirements	How will the Project implementation process comply with requirements
R.3	The client will undertake an engagement process with the Affected Communities of Indigenous Peoples	The client's stakeholder engagement plan will be a dynamic document. Local population concerns and grievances will be gathered throughout the lifespan of the Project. Answers will be formulated to ensure ongoing communication.
R.4	The client will obtain the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples in the circumstances.	Mitigation Workshops prepared the way for the FPIC by presenting local populations with information on the various components and impacts of the Project. Social Surveys has also prepared the way for FPIC and results are presented in Section 7 and annexes included in the Annex Report. The assessment of FPIC is presented in the social baseline section
R.5	The client will consider feasible alternative project designs to avoid the relocation of Indigenous Peoples from communally held lands	The new Project layout, based on Option 7C, avoids any relocation of people. Section 4 (Analysis of Alternatives) of the ESIA studies alternatives, presents each alternative, its strengths and weaknesses, and the reasons for the selection of the preferred option.
R.6	Where a project may significantly impact on critical cultural heritage that is essential to the identity and/or cultural, ceremonial, or spiritual aspects of Indigenous Peoples lives, priority will be given to the avoidance of such impacts. Where significant project impacts on critical cultural heritage are unavoidable, the client will obtain the FPIC of the Affected Communities of Indigenous Peoples.	Section 7.2 focuses on gathering information on cultural heritage in the Project areas from interviews with the local population. It identifies cultural sites that will be affected by the reservoir impoundment or road upgrades. During the mitigation workshops, measures were discussed with local populations, to ensure that their opinions regarding the fate of cultural sites, were taken into account and that compensation will be paid for any losses incurred. The ESMP includes a Cultural Heritage Management Plan.
R.7	The client and the Affected Communities of Indigenous Peoples will identify mitigation measures in alignment with the mitigation hierarchy as well as opportunities for culturally appropriate and sustainable development benefits.	Development of measures are carried out during the ESIA with the full participation of local populations to ensure that their opinions are taken into account (during mitigation workshops).

#	Requirements	How will the Project implementation process comply with requirements
R.8	The nature of the project, the project context and the vulnerability of the Affected Communities of Indigenous Peoples will determine how these communities should benefit from the project. Identified opportunities should aim to address the goals and preferences of the Indigenous Peoples, including improving their standard of living and livelihoods in a culturally appropriate manner, and to foster the long-term sustainability of the natural resources on which they depend.	Development of measures, including measures to ensure safeguarding of livelihoods, are carried out in the ESIA and Land Acquisition and Livelihood Restoration Plan with the full participation of local population. Measures to ensure long-term benefits for local population were proposed.
R.9	The client will prepare a plan that, together with the documents prepared by the responsible government agency, will address the relevant requirements of this Performance Standard	Requirements for an IPP incorporated into Social Impact Assessment of overall ESIA. Specific measures for restoring the livelihoods of indigenous peoples with respect to land acquisition are covered in the Land Acquisition and Livelihood Restoration Plan. This plan is prepared under OP4.12 but has also been drafted to meet FPIC requirements of PS7.

3.4.2.8 Performance Standard 8: Cultural Heritage

The requirements for PS8 are presented in Table 3-12

Table 3-11 PS 8 Requirements

#	Requirements	How will the Project implementation process comply with requirements
R.1	In addition to complying with applicable law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage, the client will identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented.	Chapter 8 presents information on cultural heritage in the Project areas from interviews with local population.

#	Requirements	How will the Project implementation process comply with requirements
R.2	The environmental and social risks and impacts identification process should determine whether the proposed location of a project is in areas where cultural heritage is expected to be found, either during construction or operations. In such cases, as part of the client's ESMS, the client will develop provisions for managing chance finds through a chance find procedure.	Chapter 8 presents information on cultural heritage in the Project areas from interviews with local population. Cultural sites that will be impacted by the reservoir impoundment have been identified. During the mitigation workshops, measures were discussed with local populations to ensure that their opinions regarding the fate of cultural sites were taken into account. The ESMP includes measures regarding chance find procedures.
R.3	The client will consult with the Affected Communities to identify cultural heritage of importance, and to incorporate into the client's decision-making process the views of the Affected Communities on such cultural heritage.	The Cultural heritage protocol of the ESMP details this requirement.
R.4	Where the client's project site contains cultural heritage or prevents access to previously accessible cultural heritage sites, the client will, based on consultations, allow continued access to the cultural site, or will provide an alternative access route.	The ESIA has studied project alternatives to ensure minimization of impacts on cultural sites
R.5	Where the client has encountered tangible cultural heritage that is replicable, where avoidance is not feasible, the client will implement restoration measures. Where restoration in situ is not possible, restore the functionality of the cultural heritage, in a different location.	As presented in Chapter 8, no replicable cultural heritage sites were identified. Mainly "non-physical" cultural heritage sites (Tambu sites) may be potentially affected.
R.6	Removal of non-replicable cultural heritage is subject to conditions: there are no technically or financially feasible alternatives to removal; The overall benefits of the project conclusively outweigh the anticipated cultural heritage loss from removal; and any removal of cultural heritage is conducted using the best available technique.	As presented in Chapter 8, no replicable cultural heritage sites were identified. Mainly non-removable "non physical" cultural heritage sites may be potentially affected. Compensation for losses of cultural heritage sites are described in the ESMP and Land Acquisition and Livelihood Restoration Plan.

#	Requirements	How will the Project implementation process comply with requirements
R.7	The client should not remove, significantly alter, or damage critical cultural heritage. In exceptional circumstances when impacts on critical cultural heritage are unavoidable, the client will use a process of Informed Consultation and Participation (ICP) of the Affected Communities.	As presented in Chapter 8, no critical cultural heritage sites were identified. Most sites are locally valued by population. Consultation with population regarding cultural places (Tambu sites) has been an ongoing process.

3.5 ASIAN DEVELOPMENT BANK REQUIREMENTS

3.5.1 Safeguard Policy Overview

The Asian Development Bank (ADB) is one of the development partners for this project and therefore the requirements set out in the Safeguard Policy Statement 2009 (SPS) also apply.²² The goal of the SPS is to promote the sustainability of project outcomes by protecting the environment and people from any potential adverse impacts of the project.

The objectives of the SPS are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The SPS contains three safeguard requirements; SR1: environment, SR2: involuntary resettlement, and, SR3: indigenous peoples. Each of the safeguard requirements comprises an objective, scope and triggers, and a set of policy principles that must be met. Each of the safeguard requirements follows a due diligence process of screening, categorization, scoping, consultation, impact assessment, management, and monitoring and reporting. Documentation of the due diligence is subject to disclosure as per the requirements of the Public Communications Policy 2011.

ADB will not finance projects that do not comply with the SPS and the host country's social and environmental laws and regulations, including those laws implementing host country obligations under international law. The SPS also contains a prohibited activities list identifying specific activities that ADB will not finance.

As per SR1, the project has been screened as category A i.e. its potential adverse environmental impacts are likely to be significant, irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. In terms of level of environmental assessment, for category A projects, an environmental impact assessment is required. This ESIA has been prepared to meet the requirements of World Bank and ADB as per their respective safeguard policies, as well as national laws of Solomon Islands. The ESIA identifies the various components of the project, makes an assessment of the potential adverse environmental impacts and identifies the measures required to mitigate or minimise them and summarises these in the environmental and social management plan

²² ADB 2009, Safeguard Policy Statement (Manila, Philippines)

(ESMP). As per the requirements of World Bank and ADB, the draft ESIA has been formally disclosed at least 120 days before consideration of their respective Boards.²³

A separate report, the Land Acquisition and Livelihood Restoration Plan, identifies and addresses social safeguard impacts and how the project meets the requirements of SR2 and SR3.

3.5.2 Requirements for Natural and Critical Habitat

Policy principle 8 of SR1 requires that the borrower/client assesses the significance of project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process. The assessment is required to focus on the major threats to biodiversity, which include destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner. The borrower/client needs to identify in the ESIA the measures required to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.

Natural Habitat

The SPS specification is that areas of natural habitat will not be converted or degraded unless all of a number of conditions are met (see below), and the key requirement for mitigation measures is they are to be designed to achieve no net loss of biodiversity.

The three conditions are: (i) no alternatives are available; (ii) a comprehensive analysis demonstrates that the overall benefits from the project will substantially outweigh the project costs, including environmental costs; and (iii) any conversion or degradation is appropriately mitigated.

Critical Habitat

Critical habitat includes areas with high biodiversity value and require special attention. Critical habitat is defined as comprising several characteristics including: (i) habitat of significance to critically endangered or endangered species; (ii) habitat of significance to endemic and/or restricted range species; (iii) habitat supporting globally significant numbers of migratory species or congregatory species; (iv) areas associated with key evolutionary processes; and (v) areas with unique assemblages of species or that provide key ecosystem services, and areas having biodiversity of significant social, economic or cultural importance to local communities in its definition. Endangered and critically endangered species are as defined in IUCN Red List or any national legislation.

Projects will not be implemented in areas of critical habitat unless additional thresholds are met. It is incumbent on the borrower/client to demonstrate the conditions can be met. Three thresholds that must be met include:

- (i) there are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function;
- (ii) the project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem is compromised; and
- (iii) any lesser impacts are mitigated in accordance with SPS para. 27 (i.e. mitigation measures will be designed to achieve at least no net loss of biodiversity).

²³ Disclosure for the World Bank was August 2016 and January 2017 and disclosure for the ADB was June 2017.

When a project involves activities in a critical habitat, the borrower/client must retain qualified and experienced external consultants to assist in conducting the assessment.

4. ANALYSIS OF ALTERNATIVES

4.1 BACKGROUND

This section examines alternative ways that the objective of providing a more reliable source of electricity to Guadalcanal can be met, including potential alternative technologies to hydropower, and alternative ways of delivering a hydropower scheme. This section is based on the feasibility reports prepared by Entura for various phases of project development, between 2010 and 2014, as well as supplementary investigations undertaken since then.

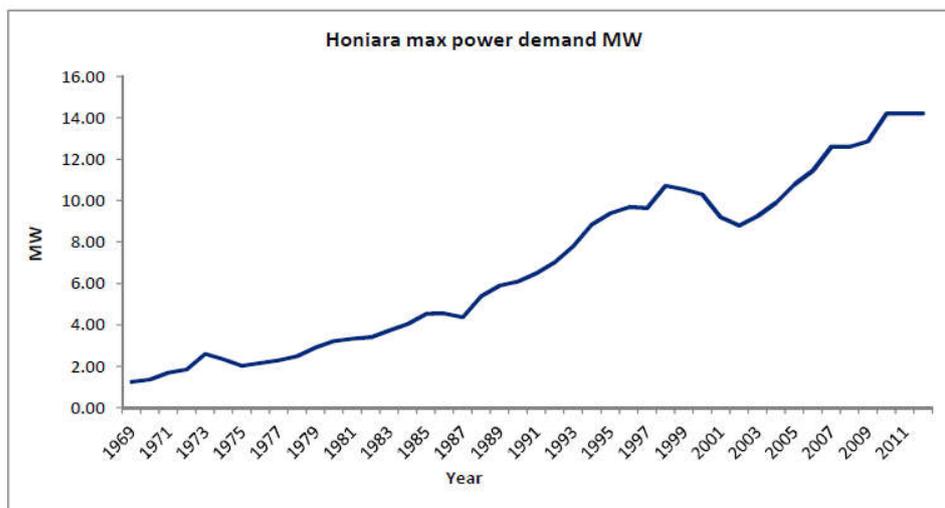
4.2 ENERGY DEMAND AND SUPPLY

4.2.1 Current and Future Energy Demand

Demand growth forecast studies have recently been undertaken by Deb Chattopadhyay for “Solomon Islands Sustainable Energy Project (SISEP)”, commissioned by the World Bank as well as part of the “Energy Contract Modelling” (2014 JACOBS). The figure below is taken from the SISEP report showing demand growth for low, medium and high demand growth scenarios.

According to JACOBS, the historical annual maximum power demand for the Honiara electricity network dating from 1969 to 2012 is shown in Figure 4-1. The stagnation of demand growth since 2009 is thought to be a consequence of load shedding due to insufficient generation capacity (i.e. consumers are less inclined to buy and use electrical apparatus / appliances when the supply of electricity is unreliable).

Figure 4-1 Honiara historical maximum power demand

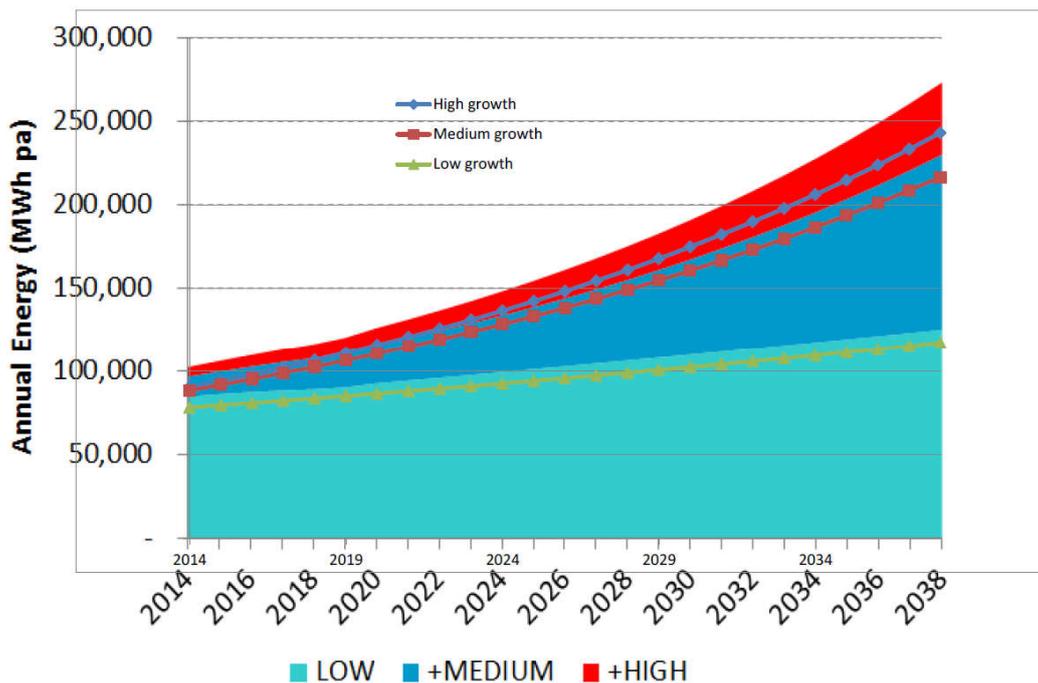


SISEP estimated new generation capacity requirements as 7 MW over the 25 next years for the Low demand growth scenario and an additional requirement for the High demand growth scenario as 25 MW.

The realization of High Demand growth scenario for the Honiara grid here depends on major new and uncertain loads coming on board — Gold Ridge, Tenaru, Mamara, Doma. If these loads do not eventuate the least cost generation plan changes (see Figure 4-2).

The SISEP assumed growth rates for the Honiara grid are conservative in that they do not envisage a significant expansion of the grid’s geographic reach along the north coast of Guadalcanal. If such an expansion were to take place, as part of a national electrification strategy, demand would be higher, possibly requiring additional generation capacity.

Figure 4-2 Honiara Energy Growth Scenarios

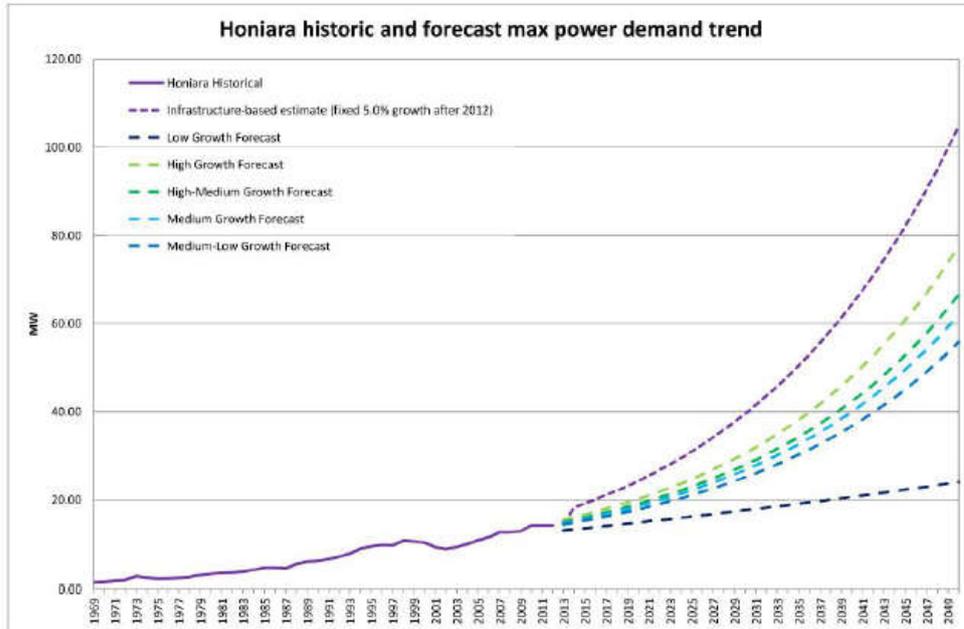


Solomon Power in 2015 predicts the annual growth in demand for energy from the Honiara grid to be 2.5% (compounding on the 2014 base year energy production of 77.6 GWh). This is similar to the SISEP report Low-Growth scenario shown in the figure above.

Solomon Power developed a 5 year demand forecast as part of the recently completed planning study.

Figure 4-3 below shows the extrapolated to demand forecast to 2050 combined with the historical demand records.

Figure 4-3 Combined Historical and Demand forecast to 2050 based on extrapolation of the 5 year forecast



4.2.2 Energy Supply

The Lungga diesel power plant is the main provider of electricity in Guadalcanal. The capital city and key population centre, Honiara, suffers from power shortages, especially during peak demand periods.

4.3 IDENTIFICATION OF POTENTIAL ALTERNATIVES TO THE PROJECT

4.3.1 Screening of Alternatives

Alternatives to the project were divided into four categories for the purpose of initial screening. These include:

1. Energy resources barred from development ;
2. Emerging energy resources;
3. Demand side management (DSM); and
4. Available Energy Resources.

Alternatives to the Project were screened to determine their respective regulatory, technical and financial viability. Only those technologies that made it through the initial screening were further assessed against economic, environmental and social criteria.

4.3.2 Energy Resources Barred from Development

No legislation is barring energy resources from development in Solomon Islands.

4.3.3 Emerging Energy Resources

Wave power is the transport of energy by wind waves, and the capture of that energy to do useful work – for example, electricity generation, water desalination, or the pumping of water (into reservoirs). A machine able to exploit wave power is generally known as a wave energy converter (WEC). Wave power is distinct from the diurnal flux of tidal power and the steady gyre of ocean currents. Wave-power generation is not currently a widely employed commercial technology (the first experimental wave farm was opened in Portugal in 2008).

Tidal power, also called tidal energy, is a form of hydropower that converts the energy obtained from tides into useful forms of power, mainly electricity. Tidal power has potential for future electricity generation but is currently not widely used. Among sources of renewable energy, tidal power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus constricting its total availability. However, recent technological developments and improvements in design and turbine technology indicate that the total availability of tidal power may be much higher than previously assumed, and that economic and environmental costs may be brought down to competitive levels in the future.

Because the technologies for producing power from these resources are still in their early stages and not sufficiently well developed to be employed in the Solomon Islands environment and, therefore, would not provide a reliable source of energy for Guadalcanal, they have been ruled out as alternatives to the Project.

4.3.4 Demand Side Management (DSM)

According to Wikipedia²⁴, Demand Side Management, or DSM “is the modification of consumer demand for energy through various methods such as financial incentives and behavioural change through education.” DSM was considered, but quickly ruled out for Guadalcanal. This is because electricity costs are already very high and most consumers, having relatively low incomes and, therefore, being price sensitive, are already limiting their use of electricity. Most rural areas are not provided with electricity from the grid, so DSM has no bearing on their use, or not, of electricity produced by Solomon Power.

²⁴ https://en.wikipedia.org/wiki/Energy_demand_management

4.3.5 Available Energy Resources

Available energy resources include those for which technologies are sufficiently evolved to provide reasonably reliable generation and transmission and which might be available to Guadalcanal. They include: hydropower, pumped storage, solar, wind, geothermal, gas fired thermal, and transmission of electricity from adjacent islands, where surplus electricity might be available. A portfolio of different energy resources (e.g., combination of solar, wind, geothermal resources) was also considered, as was the status quo diesel generation.

4.3.5.1 Status Quo – Diesel Generator at Lungga

Sticking with the status quo is effectively choosing the “No Project” alternative.

Grid-connected electricity is generated and supplied in Solomon Islands by Solomon Power (SolPower) which is a state-owned electricity utility. SolPower provides electricity to the national capital (Honiara) and eight provincial centres (Auki, Buala, Gizo, Kirakira, Lata, Malu’u, Noro-Munda, and Tulagi). Installed generation capacity in Honiara is 26 megawatts (MW) with a peak load of 14.3 MW and combined installed capacity in the provincial centres is 4 MW.

The demand for electricity in 2015 in Honiara peaked at 14,425 Kilowatts compared with a figure of 14,100 Kilowatts in 2014.

Figure 4-4 below shows the demand growth for Honiara from 2001 to 2015 (Source: Solomon Power annual Report 2015)

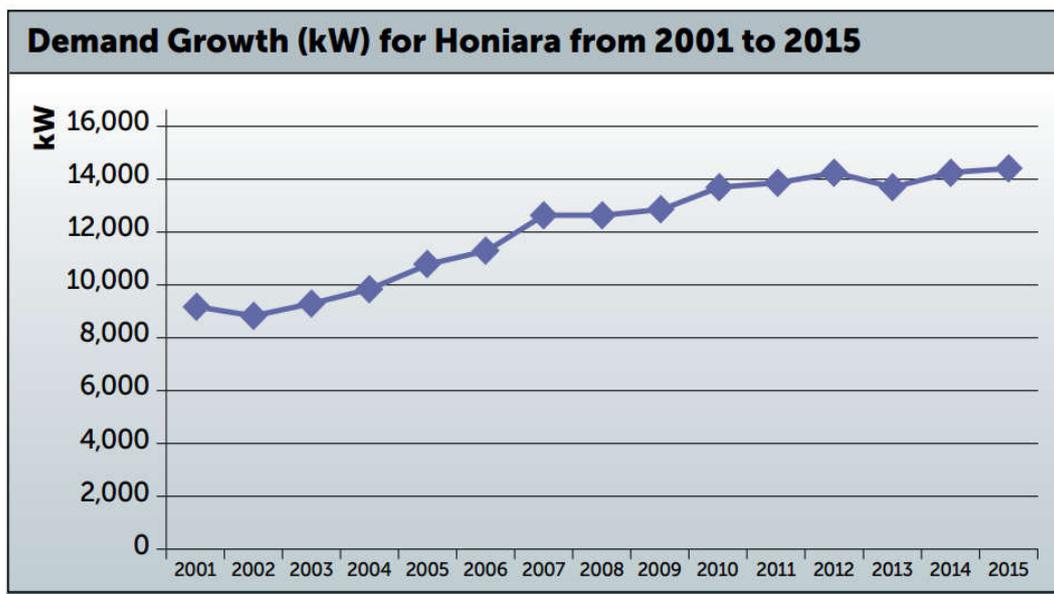


Figure 4-4 Honiara Electricity Demand Growth Solomon Power Annual Report 2015

Lungga and Honiara Solomon Power operations produced a total of 77.91Gwh (89.70%) whilst Solomon Power's provincial outstations (Buala, Taro, Auki, Gizo, Noro, Kirakira, Lata, Munda, and Tulagi), Solomon Tropical Products as an Independent Power Producer (IPP) (coconut oil) at Ranadi, and the Ranadi Solar Plant at Solomon Power head office together produced 8.91Gwh (10.3%). There was no energy bought by Solomon Power from its PPA with Soltuna in Noro during the year.

Diesel generation consume fossil fuels and in the long term are not considered a sustainable form of electricity generation. Diesel fuel is a relatively expensive, non-renewable energy source and highly dependent on market price and price changes.

Disadvantages of Diesel power generation:

- High operational cost
- High maintenance and lubrication cost
- Diesel unit capacity is limited
- Diesel generation is a net producer of the greenhouse gas carbon dioxide
- Air pollutant emissions
- Noise emissions
- Diesel plants are limited when it comes to supplying overloads continuously
- Diesel power plants are not economical where diesel has to be imported
- Limited life of a diesel power plant (usually 2 to 5 years)

4.3.5.2 Hydropower

Prior to identifying the Tina River as the site of a potential hydropower project, two hydropower schemes were studied for other sites in Guadalcanal. These were the Lungga Hydroelectric Project, and the Komarindi hydropower Project. Little is known about the characteristics of the Lungga Hydroelectric Project.

The Komarindi hydropower project was studied by Tonkin and Taylor (1993), who completed prefeasibility and feasibility studies, geotechnical investigations, detailed design, and an Environmental and Social Impact Assessment. If constructed, the project would have included a river intake, a tunnel to a penstock connecting to a powerhouse, and a tailrace / outlet back into the river.

The map in Figure 6-1 identifies the respective project areas for the proposed Komarindi, Lungga and Tina hydropower project.

- Komarindi hydro potential was identified "G-SI-7 Komarindi" with a hydro potential of 6.6MW.
- Lungga hydro potential was identified "G-SI-4 Lungga" with a hydro potential of 21MW.
- Tina hydro potential was identified "G-SI-21 Ngalimbiu" with a hydro potential of 17.7MW.

According to the World Bank, “the previous studies highlighted the unsuitability of the Lungga and Komarindi sites. The Lungga and Komarindi schemes failed to proceed for a variety of reasons, including inappropriate scale (both schemes) and poor site selection for the dam wall (Lungga)”. Investigations of the Lungga Gorge, as a site for potential Hydro development, were carried out in the 1980s. After initial optimism and development of a costly road to the proposed construction site, the project was abandoned because of the presence of geological conditions which made the site unsafe for development.

In addition, ‘The Solomon Islands, Guadalcanal Renewable Development Concept Study’ (World Bank Project Power Mission, February 2006) studied the hydropower potential of three catchments on Guadalcanal: the Ngalimbiu site on the Tina River; the Nuhu site on the Mbalasuna River; and the Choha site on the Ngheunaha and Kolokumaha Rivers. The study concluded the Ngalimbui site on the Tina River as having the greatest hydropower potential, and the other sites were dropped (Entura, 2012). The present TRHDP is located upstream of the Ngalimbui Site, and has a hydropower potential of 20MW.

Figure 4-5 shows all catchments and rivers that were, at one point, studied for potential hydropower development in Guadalcanal.

As with other forms of economic activity, hydropower projects can have both a positive and a negative environmental and social impact, because the construction of a dam and power plant, along with the impounding of a reservoir, creates certain social and physical changes.

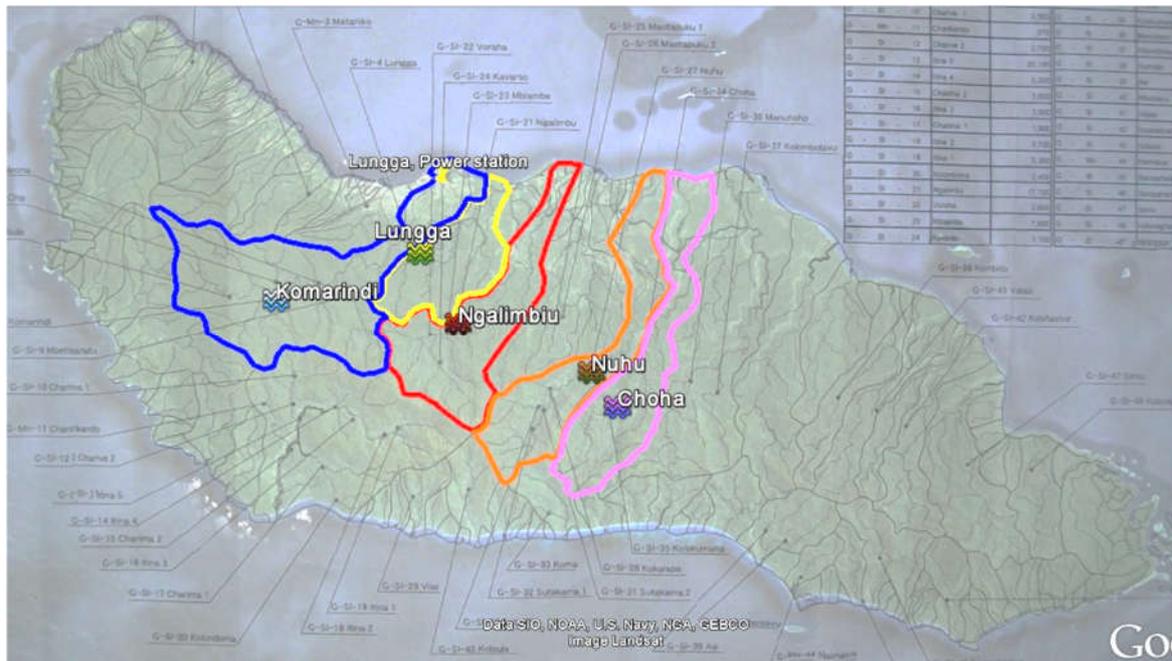
Advantages of hydropower

- Elimination of fuel costs;
- Comparably higher economic lifetime (than diesel generators, for instance);
- Low operation and maintenance (O&M) cost due to a high degree of automation;
- No direct emission of greenhouse gases or air pollutants.
- Potential for multipurpose usage (i.e. irrigation and water supply, fishery);
- River flow and flood regulation;
- Generation of renewable energy.

Disadvantages of Hydropower

- Construction of hydropower projects could introduce local imbalances to ecosystems, landscapes and river flow;
- Impoundment can potentially lead to thermal and chemical changes within the immediate reservoir areas, with possible downstream impacts.
- Sedimentation, deposition, and nutrient enrichment in the reservoir can lead to increased development of aquatic flora (plankton, benthic algae, rooted and floating macrophytes) which in turn, under certain conditions, can reduce the dissolved oxygen content in the water and cause mortality of fish and other aquatic life;
- Construction of hydropower plants in general is expensive (although having low operation & maintenance costs).

Figure 4-5 Studied catchments for hydropower development in Guadalcanal



Source: Photograph provided by MMERE offices and adapted with Google Earth

4.3.5.3 Pumped Storage

Pumped storage facilities use the height difference between two natural bodies of water or artificial reservoirs. At times of low electrical demand (night times), excess generation capacity is used to pump water into a higher reservoir. During times of higher demand (morning, mid-day and late afternoon), water is released back into the lower reservoir through a turbine, generating electricity. Reversible turbine/generator installations can be utilized to act as pump and turbine (usually a Francis turbine design).

A pumped storage system can be economical because it flattens out load variations on the power grid. Capital costs for purpose-built pumped storage are relatively high.

In summary, pumped storage depends on either:

1. Having a “must run” source of energy such as nuclear or geothermal which has excess capacity at low demand periods and can therefore pump the water to storage at little or no additional cost (other than the capital to establish the storage and hydro facility).; or
2. At least a peak demand price which greatly exceeds the off peak price (i.e. an essential part of the peak generation mix that has a variable cost which exceeds the cost of the pumped storage).

In Honiara, neither of these conditions applies. The pumped facility would cost more than Tina River Hydro per MW to build and more than the diesel generation cost to operate. In addition, there are no identified areas where any suitable hydro storage can be established.

4.3.5.4 Solar

A photovoltaic power station, also known as a solar park, is a large-scale photovoltaic system (PV system) designed for the supply of power into the electricity grid. They are differentiated from most building-mounted and other decentralised solar power applications because they supply power at the utility level, rather than to a local user or users. They are sometimes also referred to as solar farms or solar ranches, especially when sited in agricultural areas. The generic expression utility-scale solar is sometimes used to describe this type of project.

The land area required for a desired power output, varies depending on the location and on the efficiency of the solar modules, the slope of the site and the type of mounting used. Fixed tilt solar arrays using typical modules of about 15% efficiency on horizontal sites, need about 1 hectare/MW in the tropics and this figure rises to over 2 hectares in northern Europe.

Grid connection

The availability, locality and capacity of the connection to the grid is a major consideration in planning a new solar park, and can be a significant contributor to the cost. Most stations are sited within a few kilometres of a suitable grid connection point. This network needs to be capable of absorbing the output of the solar park when operating at its maximum capacity. The project developer will normally have to absorb the cost of providing power lines to this point and making the connection, often also any costs associated with upgrading the grid so it can accommodate the output from the plant.

Operation and maintenance

Once the solar park has been commissioned, the owner usually enters into a contract with a suitable third party to undertake operation and maintenance (O&M). In many cases this may be fulfilled by the original EPC contractor.

Solar plants' reliable solid-state systems require minimal maintenance, compared to rotating machinery for example. A major aspect of the O&M contract will be continuous monitoring of the performance of the plant and all of its primary subsystems, which is normally undertaken remotely. This enables performance to be compared with the anticipated output under the climatic conditions actually experienced. It also provides data to enable the scheduling of both corrective and preventive maintenance. A small number of large solar farms use a separate inverter or maximizer for each solar panel, which provide individual performance data that can be monitored. For other solar farms, thermal imaging is a tool that is used to identify non-performing panels for replacement.

Power delivery

A solar park's income derives from the sales of electricity to the grid, and so its output is metered in real-time with readings of its energy output provided, typically on a half-hourly basis, for balancing and settlement within the electricity market. Income is affected by the reliability of equipment within the plant and also by the availability of the grid network to which it is exporting. Some connection contracts allow the transmission system operator to constrain the output of a solar park, for example at times of low demand or high availability of other generators. Some countries make statutory provision for priority access to the grid for renewable generators

Advantages of Solar Power

Solar energy is a resource that is not only sustainable for energy consumption, it is indefinitely renewable. Solar power can be used to generate electricity, it is also used in relatively simple technology to heat water (solar water heaters).

Solar panels usually require little maintenance. After installation and optimization they are very reliable due to the fact that they actively create electricity in just a few millimetres of material and, unless installed with variable tilt mountings, do not require any type of mechanical parts that can fail. Solar panels are also a silent producer of energy, a necessity if dealing with sensitive neighbourhoods.

Disadvantages of Solar Power

The primary disadvantage of solar power is that it cannot be generated during the night. The power generated is also reduced during times of cloud cover (although energy is still produced on a cloudy day). Advances are being made in battery technology to permit overnight storage, but utility-scale applications are still rare.

Solar panel energy output is maximized when the panel is directly facing the sun. This means that panels in a fixed location will see a reduced energy production when the sun is not at an optimal angle. Many large scale solar "farms" combat this problem by having the panels on towers (above left) that can track the sun to keep the panel at optimal angles throughout the day.

A further disadvantage is the relatively large area required to develop commercial solar farms. For instance, Royalla Solar Farm (Canberra AU) comprises of 83,000 PV panels which are occupying 50 hectares at 20 MW installed capacity. The Royalla Solar Farm is a solar only facility and therefore generating power only during daytime hours.

Even today's most efficient solar cells only convert just over 20% of the sun's rays to electricity. Besides their low conversion efficiency, solar panels can be a substantial initial investment.

4.3.5.5 Wind

Economic wind generators require wind speed of 16 km/h (10 mph) or greater. An ideal location would have a near constant flow of non-turbulent wind throughout the year, with a minimum likelihood of sudden powerful bursts of wind. An important factor of turbine siting is also access to local demand or transmission capacity.

Advantages

- A clean fuel source. Wind energy doesn't pollute the air like power plants that rely on combustion of fossil fuels, such as coal or natural gas. Wind turbines don't produce atmospheric emissions that cause acid rain or greenhouse gases.
- Wind is a domestic source of energy.
- It's sustainable. Wind is actually a form of solar energy. Winds are caused by the heating of the atmosphere by the sun, the rotation of the Earth, and the Earth's surface irregularities. For as long as the sun shines and the wind blows, the energy produced can be harnessed to send power across the grid.

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- Wind power is cost-effective. It is one of the lowest-priced renewable energy technologies available today, costing between four and six cents per kilowatt-hour, depending upon the wind resource and the particular project's financing.
 - Wind turbines can be built on existing farms or ranches. This greatly benefits the economy in rural areas, where most of the best wind sites are found.

Disadvantages

- Wind power must still compete with conventional generation sources on a cost basis. Depending on how energetic a wind site is, the wind farm might not be cost competitive. Even though the cost of wind power has decreased dramatically in the past 10 years, the technology requires usually higher initial investments.
- Good wind sites are often located in remote locations, far from cities where the electricity is needed. Transmission lines must be built to bring the electricity from the wind farm to the city.
- Wind resource development might not be the most profitable use of the land. Wind farms on land suitable for wind-turbine generation must compete with alternative forms of development for the land that might be more highly valued by the owners.
- Turbines cause noise and aesthetic impact. Although wind power plants have relatively little impact on the environment compared to conventional power plants, concern exists over the noise produced by the turbine blades and visual impacts to the landscape.
- Turbine blades can harm local wildlife. Birds and bats have been killed by flying into spinning turbine blades. These problems can be somewhat reduced through technological development and proper site selection.

To ascertain whether there is a commercial wind resource in useable locations within Solomon Islands would require at least 2 years of meteorological data monitoring prior to construction of a wind farm. A previous attempt to carry out such monitoring with meteorological measuring masts provided by donor funding failed to capture data from the installed equipment due to inadequate funding, and eventually the installed equipment was adapted for other purposes by the local communities.

4.3.5.6 Geothermal

Initial investigations were conducted into a possible geothermal resource on Savo Island, 40 km from Honiara. However, due to financial constraints, no drilling has been undertaken and the potential resource remains unproven. In 2015, Geodynamics, the majority shareholder of the geothermal venture, announced that it did not intend to incur any further significant expenditure on the project due to 'market conditions'.²⁵ No further activities have been undertaken. High transmission costs from Savo Island to Honiara are a disadvantage of the site, with 16 km of undersea cabling required to the closest point on Guadalcanal, some 60 km from Honiara, depths of Iron Bottom Sound near Savo of 600-1350 metres, and Solomon Power's preference for dual transmission lines to provide for n-1 redundancy.

²⁵ Geodynamics Annual Report 2015. See also 'Geodynamics puts expenditure on hold for Pacific Geothermal Projects', *Think Geoenergy*, 16 October 2015: <http://www.thinkgeoenergy.com/geodynamics-puts-expenditure-on-hold-for-pacific-geothermal-projects/>. Accessed 10 December 2016.

4.3.5.7 Gas Fired Thermal

A gas fired power station is a power station which burns fossil fuel to produce electricity. Central station fossil-fuel power plants are designed on a large scale for continuous operation. In many countries, such plants provide most of the electrical energy used. Fossil-fuel power stations have machinery to convert the heat energy of combustion into mechanical energy, which then operates an electrical generator. The prime mover may be a steam turbine, a gas turbine or, in small plants, a reciprocating internal combustion engine. All plants use the energy extracted from expanding gas, either steam or combustion gases. Heavy fuel oil and other liquid fuels besides diesel could also be used in a thermal plant, but because any fossil fuels would have to be imported and gas is less expensive, only gas is being considered here.

Advantages

- **Economy:** Natural gas is cheaper compared to other fossil fuels and cheaper than electricity when used for supplying home appliances. Natural gas appliances are also cheaper compared to electrical ones.
- **Environment:** It does not pollute the ground or the underground water because its by-products are in gaseous form. Another important fact is that natural gas burns without releasing any particulate material or sulphur dioxide. It also emits 45% less carbon dioxide than coal and 30% less than oil per unit of electricity produced.
- **Transportation:** Transportation is made via sea (tankers) and land (pipelines and small tanks). This fact allows natural gas to be easily transferred from power plants to residential areas surrounding residential areas.
- **Multi-uses:** Natural gas is a multi-use fuel. It is used inside the house for cooking, heating, drying, etc. It can be used for generating electric power, powering vehicles (by substituting for diesel and gasoline), producing plastics, paints, fertilizers, and many more uses.
- **Availability:** It is abundant and almost worldwide available.
- **Conversion to Hydrogen Fuel:** It is currently the cheapest fossil fuel source for producing hydrogen.

Disadvantages

- **Flammable:** Natural gas leaks can be proven to be extremely dangerous. Such leaks may be the cause of fire or explosions. The gas itself is an asphyxiant. The main risk comes from the fact that it is naturally odourless and cannot be detected by smell, unless an odorant has been added to the gas mixture. In the case of an underground leak, the odorant may gradually become weaker and the gas may go undetected.
- **Environmental Impact:** When natural gas burns, carbon dioxide, monoxide, and oxides of nitrogen s are emitted in the atmosphere contributing to air pollution and the greenhouse effect. Although it is cleaner than other fossil fuels (oil, coal, etc.) as far as combustion by-products are concerned, natural gas leaks are significant contributors to climate change since methane, its main constituent, has 21 times the global warming potential of carbon dioxide.
- **Processing:** In order to use it as a fuel, constituents other than methane have to be extracted. The processing results in several by-products: hydrocarbons (ethane, propane, etc.), sulphur, water vapour, carbon dioxide, and even helium and nitrogen.
- **Non-Renewable:** It is a finite source of energy and cannot be considered a long-term solution to our energy supply problem.

-
- Installation: The whole pipe installation may be very expensive to construct since long pipes, specialized tanks, and separate plumbing systems need to be used. Pipe leakage may also be very expensive to detect and fix.
 - Efficiency in Transportation: When natural gas is used as a fuel in cars, the mileage is lower than gasoline.
 - Economics: In addition to the gas fired thermal generating station itself, an onshore compressed gas storage facility and dedicated deep sea terminal to receive LNG or CPG shipments site infrastructure are required.
 - Conversion to Hydrogen Fuel: A drawback in producing hydrogen from natural gas is that efficiency drops to almost 50% compared to the original chemical energy.

4.3.5.8 Transmission of Electricity from Other Islands

Transmission of electricity from one of the other islands within the Solomon Islands archipelago, and from neighbouring island countries like Papua New Guinea (e.g., Bougainville) and Vanuatu, were quickly dismissed on the basis that all of these islands are currently in short supply of cheap electricity and, therefore, do not have surplus energy to sell. More importantly, even if surplus electricity were available for purchase, the great distances involved to connect Guadalcanal using an undersea transmission cable of sufficient capacity to overcome line losses, would cost orders of magnitude more than the next best alternative. Therefore, this option was given no further consideration.

4.3.5.9 Portfolio of Available Energy Resources

Consideration was given to combining the most promising available energy resources – solar, wind and geothermal – into a portfolio of energy generation against which the hydropower option was compared.

A significant percentage of total capacity being provided by hydropower would be favourable to the potential to add other more intermittent energy sources (such as solar, wind or tidal) to provide a portfolio of available energy sources because of the particular characteristics of hydropower generation. The hydro generators are able to provide ancillary services (frequency control, voltage control), spinning reserve and maintenance capacity to the networked generators.

The hydro turbines are able to start or increase output virtually instantaneously, and to maintain the key power quality characteristics of the network (voltage and frequency) even as other elements of the network fluctuate in their production.

A certain percentage of hydropower in the network is an essential feature that will allow for significant penetration to the network of either wind or solar generation. Thus a station like Tina Hydro could be a catalyst to support further construction of solar farms.

4.3.5.10 Preferred Project Alternative

Table 4-1 compares the various available energy project alternatives on the basis of: energy production; economics; reliability and limitations; and environmental and social benefits and constraints. Based on a comparative review of the various available energy resources, the best alternative was determined to be that of a hydropower project located on the Tina River. The rationale for this selection is as follows:

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- Hydropower is a reliable and proven source of renewable energy within local environments such as Solomon Islands
 - Suitable hydrological conditions
 - Project locations with minimal social and manageable environmental impact
 - Availability of natural resource (water)
 - Relatively long economic lifetime
 - Low maintenance cost
 - Reliable base load power supply

When compared with the status quo or no-project alternative, if the hydropower alternative is not constructed, Honiara would probably continue to experience frequent power outages, as is the case today. Lungga power station would need to be upgraded, or additional diesel plants would need to be constructed to provide electricity during peak hours. Unlike electricity generated from hydro, electricity generated from diesel can contribute to environmental impacts in the form of greenhouse gas emissions, air pollution, risks of oil spills during production, sea transport and transfer. Another advantage of hydropower over diesel is that it allows the Solomon Islands to move toward energy self-reliance, using its own renewable resources, rather than importing non-renewable sources of energy. From an economic perspective, the unit cost of hydro is significantly lower than the unit cost of diesel. As diesel prices increase, this gap will become more significant. Therefore, not implementing the hydropower alternative would have economic consequences for SIG.

According to the TRHDP PO, there is provision in the transmission design for rural electrification, which will include 33kV/415V pole mounted transformers at each of the villages situated along the Tina Village road. Therefore, not implementing the hydropower project would potentially result in the loss of opportunity for rural electrification.

From an employment perspective, more jobs will be created during construction than for any other alternative energy project. Therefore, not developing the hydropower project would eliminate the opportunity for local communities to earn salaries, and gain experience and skills in construction work. Wages paid to construction workers typically represent the single largest social benefit during the construction phase of a dam. In the case of the TRHDP, it is the intention of the PO to engage as many workers as possible from the local communities during the construction phase.

Table 4-1 Comparative summary of energy resource projects

	Status Quo (Lungga Diesel)/No Project	Hydro Project on Tina River	Solar	Wind	Geothermal	Gas Fired Thermal	Transmission from Another Island	Portfolio of Energy Resource Alternatives
Energy Production	71.91 GWh (2015)	78.35 GWh pa	Dependent on size (range 1 to 2.5 ha/MW)	1 average onshore wind turbine (2.5–3 MW capacity) can produce more than 6 GWh pa given suitable average wind speeds	Depending on available energy stored within geological unit	Approx. 8,000,000 m ³ gas / 81 GWh pa	Not feasible due to lack of suitable energy production facility on other islands	Combination of Hydro + Solar considered feasible to meeting increasing future demand (refer to hydro and solar columns)
Reliability & Limitations	Frequent outages experienced during times of peak energy demand	Reliable power generation option, immediately available energy, long project lifetime	Generation mainly during sunshine hours, difficult to store energy on large scale, suitable in combination with other power generation sources	Dependent on site selection, high initial investment cost	Low operation and maintenance cost once established, potential to run out of steam thus high initial investigation costs, extremely long lead time to install/repair undersea cables	Reliable technology, high efficiency (up to 60%),		
Economics	High cost due to import of diesel and lubricants, high operation and maintenance cost	High initial investment, low operation and maintenance cost	Medium to high initial investment, low operation and maintenance cost, current technology warranty of 25 years, average of 1% per annum of reduction in output	Due to storage limitations for energy, wind farms typically complement hydro power very well. Suitable sites for wind farms are required to operate economically, which may result in high transmission costs	Potentially available geothermal energy at Savo island (unproven), approx. 11MW, thus additional energy source required to meet demand; High initial investment, high transmission cost (undersea cable + transmission line), finite energy source	High cost due to import of natural gas and lubricants, high operation and maintenance cost, added cost for site and storage handling and infrastructure (storage, port facility, etc.)		
Environmental Benefits / Constraints	Fossil fuel, noise, priority air contaminants and GHG emissions, dependency on imported fossil fuels, potential spills	Inundation of land due to reservoir impoundment, requirement to manage reduced river flows between dam and powerhouse tailrace; potential barrier to migration of some fish species; lower net GHG emissions; no air pollutant emissions from operations	Relative large areas of land required for establishment (approx. 1 MW/2.5ha, depending on angle to sun), operation of solar plants has low environmental impacts	Large site required for establishment of wind park, but land can continue to be used for some agricultural purposes. Noise and aesthetic pollution. Bird and bat mortality.	Potential to release poisonous or otherwise harmful gases such as hydrogen sulphide. Potential water pollution from brines,	Fossil fuel, noise, priority air contaminants and GHG emissions, dependency on imported fossil fuels		

	Status Quo (Lunga Diesel)/No Project	Hydro Project on Tina River	Solar	Wind	Geothermal	Gas Fired Thermal	Transmission from Another Island	Portfolio of Energy Resource Alternatives
Social Benefits / Constraints	Local employment opportunities, constraints on locally available skilled maintenance/engineering	Local employment opportunities, constraints on locally available skilled maintenance/engineering	Local employment opportunities, constraints on locally available skilled maintenance/engineering	Local employment opportunities, constraints on locally available skilled maintenance/engineering	Local employment opportunities, constraints on locally available skilled maintenance/engineering	Local employment opportunities, constraints on locally available skilled maintenance/engineering		

4.4 ALTERNATIVE LOCATIONS AND CONFIGURATIONS FOR THE PREFERRED PROJECT - THRDP

4.4.1 History of Project Refinement

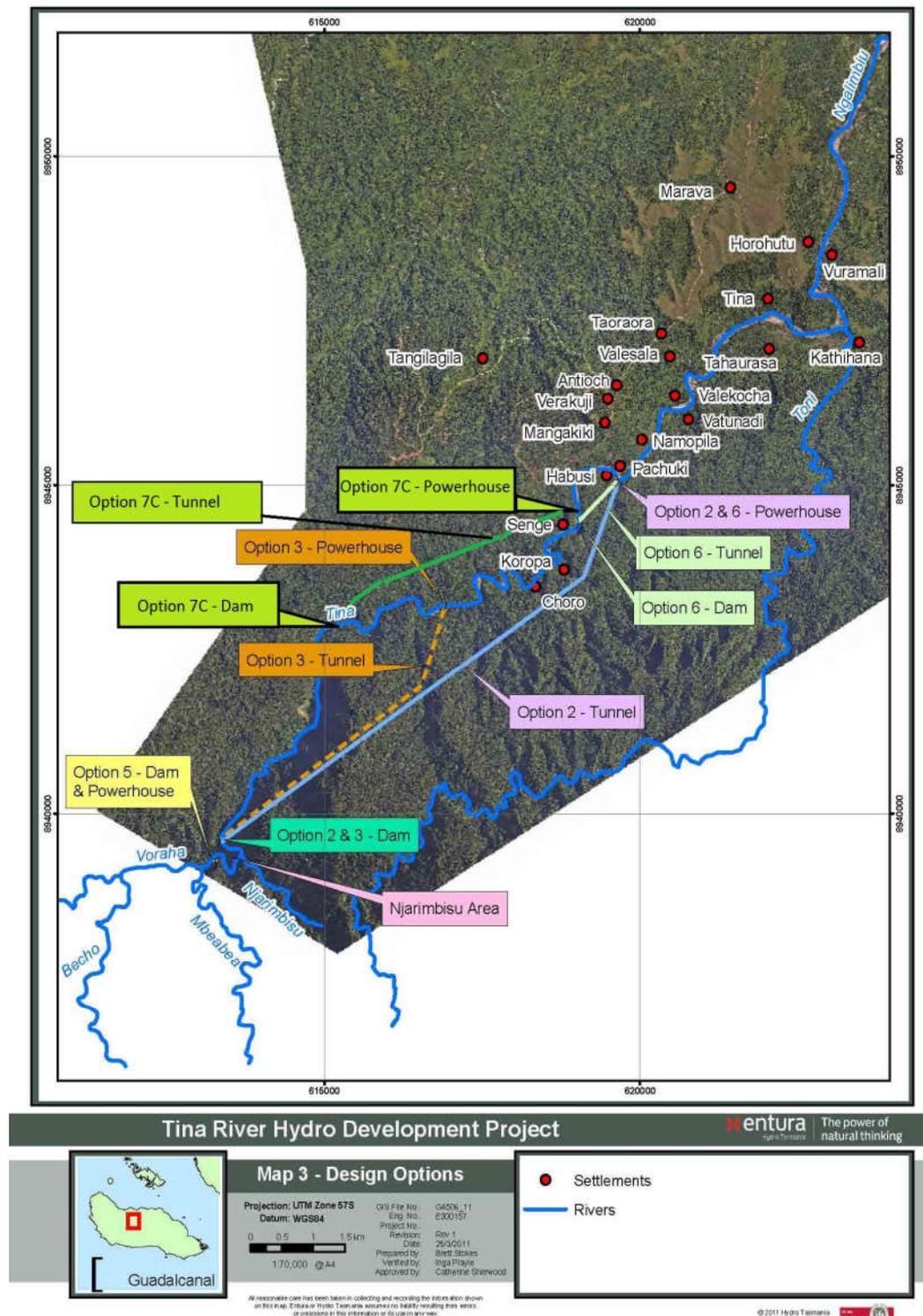
Entura (2010 to 2014) studied several options along the Tina River with the objective of locating the best site to optimize power generation capacity. Options were evaluated based on economic, technical and environmental and social criteria. The key criteria used to select the single best option were financial / economic viability and geological integrity.

Entura carried out a three-phased program to select the preferred site for a hydropower project, as follows (see Figure 4-6):

Phase 1 report studied a series of dams along the stretch of river from the Mbeambea River / Tina River confluence (upstream catchment) to the Toni River / Tina River confluence (Entura, 2010):

- Site 1: Dam located on the Tina River upstream of Njarimbisu and upstream of Mbeambea geological fault, and a powerhouse located upstream of Habusi village. Option 1 was considered not technically viable because of the high geological risk associated with the long tunnel. Option 1 was eventually dropped due to high environmental sensitivities of the upper catchment region.
- Site 2: Dam located on the Tina River downstream of Njarimbisu tributary and upstream of the Mbeambea geological fault, and a powerhouse located upstream of Pachuki, connected by a tunnel of approximately 8.6 km. Option 2 was eventually dropped due to high environmental sensitivities of the upper catchment region.
- Site 3: Dam located on the Tina River downstream of Njarimbisu tributary. Power station located upstream of Koropa, connected by a tunnel of approximately 5.5 km. Option 3 was eventually dropped due to high environmental sensitivities of the upper catchment region.
- Site 4: Dam located on the Tina River upstream of Njarimbisu tributary at the Mbeambea geological fault, and a powerhouse located at the downstream end of Njarimbisu. Option 4 was considered not technically viable because of extremely difficult access and unsuitable geology at the dam site.
- Site 5: Dam located on the Tina River upstream of Njarimbisu tributary and Mbeambea geological fault, and a powerhouse located at the toe-of-dam. Option 5 was eventually dropped due to high environmental sensitivities of the upper catchment region.
- Site 6: Dam located on the Tina River downstream of Senghe, and a powerhouse located upstream of Pachuki connected by a short tunnel. This option was selected for phase 2 report.

Figure 4-6 Sites investigated for the TRHDP



Phase 2 report (Entura, 2012) dropped the Site 6 (also called 6a) option, due to geological risks, and studied several further locations for siting a dam-powerhouse, from Site 6a to Site 6f. Two options were retained for further evaluation (Sites 6e and 6f) by GeoRisk Solutions (2012). The other options were eventually dropped due to potential adverse geological conditions. At the time the ESIA commenced, the Site 6e option was favoured.

Phase 3 report by Entura (2014) evaluated two sub-options for Site 6e, as well as a new site, referred to as Site 7c, for which three sub-options were evaluated.

- Site 6e: Option 1: RCC dam at chainage 11.3km, left bank pipeline to powerhouse at ch11.5km, dam height ranges from 35m to 75m above existing riverbed level (toe of dam solution)
- Site 6e: Option 2: RCC dam at chainage 11.3km, right bank tunnel to powerhouse at ch13.3km, dam height ranges from 35m to 75m above existing riverbed level (mid tunnel solution).
- Site 7c: Option 1: RCC dam at chainage 7km, left bank tunnel to powerhouse at ch12.7km, dam height ranges from 35m to 65m above existing riverbed level (long tunnel solution).
- Site 7c: Option 2: RCC dam at chainage 7km, right bank pipeline to powerhouse at ch7.3km, dam height ranges from 45m to 85m above existing riverbed level (toe of dam solution)
- Site 7c: Option 3: RCC dam at chainage 7km, left bank tunnel to powerhouse at ch8.9km, dam height ranges from 35m to 75m above existing riverbed level (mid tunnel solution)

In its Phase 3 report, Entura (2014) concluded that Site 7c Option 1 had superior economic, social and technical value when compared to Site 6e. A comparative environmental and social alternative analysis was made of Site 6e and Site 7c, the results of which are provided in the following subsection. Site 7c Option 1 is the Project assessed by this ESIA.

4.4.2 Final Selection of the Preferred Project Site and Layout

Table 4-2 presents an analysis of alternatives from Entura's 2014 Phase 3 report, based on social, environmental, technical and economic criteria.

The Phase 2 and Phase 3 feasibility studies by Entura (2014), had selected several options along Tina River, the selection of options was mainly based on geophysical criteria used to select a site that offers stable geological conditions, as well as economic performance in terms of return on investment, and electricity production. In the following analysis, emphasis was placed on environmental and social criteria to complement the technical analysis done by Entura.

Options that were favoured, were those that were best able to address environmental, social or technical/financial criteria, or combination of criteria.

Criteria were selected based on their relevance, and do not necessarily reflect the various existing baseline sections. For example, criteria such as "reptiles and amphibians" or "birds" are not dealt with since they represent a level of detail that was not available at the time the overview level of analysis of alternatives was undertaken.

Table 4-2 summarises the results of the evaluation of the two Site 6e and three Site 7c alternatives for the Project. Chainage distances are based on Entura (2010) Phase 1 work, with CH 0km being the confluence of the Mbeambea and the Voraha, and CH 18.7km being the downstream Tina River / Toni River confluence.

Table 4-2 Comparison of siting options

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
Location (Chainage in km)	Dam: 11.3 Powerhouse: 11.5 Reservoir: 11.3 - 7 Toe of dam option (no by-passed river reach)	Dam: 11.3 Powerhouse: 13.3 Reservoir: 11.3 - 7 Mid tunnel option (mid by-passed river reach)	Dam: 7 Powerhouse: 12.7 Reservoir: 7 – 4.5 Long tunnel option (long by-passed river reach)	Dam: 7 Powerhouse: 7.3 Reservoir: 7 – 4.5 Toe of dam option (no by-passed river reach)	Dam: 7 Powerhouse: 8.9 Reservoir: 7 – 4.5 Mid tunnel option (mid by-passed river reach)
Catchment size (150 km ²)	Upstream of dam: 135 km ² Downstream of dam: 15 km ²		Upstream of dam: 125 km ² Downstream of dam: 25 km ²		
Social and cultural					
Number of people/villages to relocate and land acquisition	For this criteria, the best option would be the one that involves the least number of inhabitants to resettle and the smallest Core Area to acquire (to alienate from customary land ownership)				
	Choro (CH 9km), ~4 inhabitants to be resettled due to the reservoir Senghe (CH 11.5km), ~16 inhabitants to be resettled due to the powerstation Koropa (CH 11 km), ~19 inhabitants to be resettled due to quarries Habuchi (CH 13.3 km), ~33 inhabitants, no foreseen physical resettlement Pachuki (CH 13.8 km), ~65 inhabitants, no foreseen physical resettlement	Choro (CH 9km): no foreseen physical resettlement Senghe (CH 11.5km): no foreseen physical resettlement Koropa (CH 11 km): no foreseen physical resettlement Habuchi (CH 13.3 km): no foreseen physical resettlement Pachuki (CH 13.8 km): no foreseen physical resettlement Villages along the access road: no foreseen physical resettlement			

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3	
	Villages along the access road: no foreseen physical resettlement					
	Since this option will physically relocate people, some of their sources of livelihood will also be affected such as garden and river uses. However, this option would require a relatively small Core Area because the powerhouse would be at the toe of the dam	Since this option will physically relocate people, some of their sources of livelihood will also be affected such as garden and river uses. In addition, the Core Area to be acquired would include the powerhouse 2 Km downstream of the dam	Although this option does not necessitate relocation of people, the Core Area to be acquired would be relatively large to include the powerhouse 5.7 Km downstream	In terms of livelihood, this option would probably be the best since it would not require any resettlement of people and it would require a relatively small Core Area because the powerhouse would be at the toe of the dam	Although this option does not necessitate relocation of people, the Core Area to be acquired would need to include the powerhouse 1.9 Km downstream	
				Best Options		
Sacred sites and cultural heritage	For this criterion, the best option would be the one that would affect the least number of sacred sites or safeguards the most important ones.					
	Each community has numbers of cultural heritage sites (tambu site); most of their localizations are unknown to outsiders, therefore all options have to be considered equally good for this criteria. However, the sacred site identified as "Tulahi" would be unaffected by 7c and it has been excluded from Land Acquisition					
			Best option			
Infrastructure, school, clinic, churches to displace	None of the options affect infrastructure or buildings					
River uses	For this criterion, the best option would be the one that would affect the fewest villages along the Tina River (and the fewest river users), and affect the shortest river section.					

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
	Fishing is carried out along the length of the Tina River, though nowadays it is focused on the river holes and pools in the upper catchment, upstream of Choro and as far as the Mbicho and Mbeambea rivers. All options will modify river use around Choro-Koropa because of the presence of either the reservoir or the by-passed river reach. River uses will evolve due to the presence of a reservoir creating new opportunities such as sustainable, non-commercial fisheries. At the reservoir location, local topography and distance from villages will determine whether the reservoir will be easily accessible for new uses or not.				
	This option will modify river use due to the presence of a reservoir	This option will modify river use due to the presence of a reservoir, in addition to the 2 km affected river reach with modified flow between the dam and powerhouse that would potentially affect Koropa, Senghe, Habusi and Pachuki villages.	The 5.7 km affected river reach with modified flow will pass through Choro, Koropa and Senghe potentially affecting river uses.	This option will not affect river uses outside of the infrastructure rights-of-way since it is located outside any human settlement and has no by-passed river reach with modified flow.	The 1.9 km affected river reach, with modified flow, will not pass through any villages.
	Local topography around Site 6e is less steep, and the reservoir will be easily accessible for pedestrians, access to the reservoir will, therefore, most likely be easier, allowing for local people to develop new uses of the reservoir		Steep gorge around site 7c will restrain access to the reservoir (especially during day-time low water level). In addition, being located approximately 5 km upstream from Mangakiki, access for pedestrians will be more difficult.		
	Best option in terms of potential for developing new opportunities around the reservoir			Best option in terms of limitation of actual river uses	
Natural resources use (on a livelihood perspective)	For this criterion, the best option would be the one that would be located the farthest away from villages and valuable natural resources, thereby limiting impacts on natural resources (timber, game wildlife, etc.)				
	These options will affect natural resource uses by the local population since they are close to Choro, Senghe and Koropa. Hunting and timber products will be affected locally.		Natural resources close to Option 7C dam and the reservoir are poorly utilized by local population as the site is difficult to access and is located upstream from villages.		

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3	
			Regardless of the location of the powerhouse, any of Options 1, 2, 3 have the same low impact on actual natural resources use.			
			Best option			
Local population wellbeing and safety	For this criteria, the best option would be the one that would be located the farthest away from villages (including access road).					
	Regardless of the option, the access road through villages would be the same, according to TRHDP PO, the final road alignment is being designed to limit disturbances and ensure the safety of villagers.					
	All options will necessitate heavy machinery and truck traffic during construction, so villages nearby the access road will be disturbed. Villagers will be at risk of collisions with trucks and will be subjected to noise and vibration from passing trucks. Health and safety precaution will be developed.					
	Noises and vibration from dam construction could affect some nearby villages		Noise and vibration from dam construction will probably not affect villagers thanks to the site's remote location			
	The powerhouse is relatively far from settlements. This helps reducing flow related safety hazards (since the powerhouse outlets release flows after a night's storage (sudden flows))	The powerhouse is the closest of all options to settlements, this could lead to flow related safety hazards (since the powerhouse outlets release flows after a night's storage (sudden flows))	The powerhouse is close to settlements, this could lead to flow related safety hazards (since the powerhouse outlets release flows after a night's storage (sudden flows))	The powerhouse is the farthest of all, this significantly reduces flow related safety hazards (since the powerhouse outlets release flows after a night's storage (sudden flows))	The powerhouse is relatively far from some settlements, this helps reducing flow related safety hazards (since the powerhouse outlets release flows after a night's storage (sudden flows))	
				Best option		
Effect on downstream communities due to modified flow and water quality	Regarding water quality impairment during construction and modified flow, any options will have the same effects on communities downstream of the dam. There is a slight difference between Sites 6e and 7c, that benefits 7c: the size of the reservoir and the volume of usable storage is less for 7c than with 6e, thus limiting the ability to hold back and manage flows.					

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
	Regardless of the option, supply of potable water to affected communities will be necessary during construction, and during the first years of post-impoundment reservoir filling.				
Gender aspects	There is no difference between options regarding gender aspects.				
Best option based on socio cultural criteria				Site 7c- Option 2 is the best option based on social criteria	
Environment					
Plant and wildlife habitat during construction	For this criteria, the best option would be the one that would necessitate the smallest surface of natural habitat to be cleared and the option that is located the farthest away from primary forests, as upstream area are more intact and would require longer access roads				
	With a toe-of-dam powerhouse and a location closer to the existing access road (Black Post Road), the access road will encroach on limited area of habitats. Moreover, the site is located closer to anthropogenically altered areas, which limits the losses of forested areas.	The site is located closer to anthropogenically altered areas and closer to the existing access road (Black Post Road), which limits the losses of forested areas. However, the powerhouse, located away from the dam, would lead to greater impact on habitats.	Due to the great distance between the dam and powerhouse, this option will necessitate more forest clearing than any other options, especially for access roads, leading to greater negative impacts on wildlife (collision, disturbances, noise, vibration, etc.).	Due to a toe-of-dam powerhouse, disturbed areas will be limited	Due to the distance between the dam and powerhouse, this option will necessitate forest clearing for access roads leading to greater negative impacts on wildlife.
	Best option				
Plant and wildlife habitat during reservoir impoundment	For this criteria, the best option would be the one that inundates the smallest volume of habitat (in m ³)				
	At reservoir full supply level, 25.2 x 10 ⁶ m ³ of habitat would be inundated		At reservoir full supply level, 7.0 x 10 ⁶ m ³ of habitat would be inundated		
			Best option		

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3	
Long term changes to habitat	For this criteria, the best option would be the one that would lead to the least long term pressure on natural resources and the least habitat fragmentation. This criteria is important since it deals with long terms effects.					
	Being located closer to already disturbed areas, with shorter access roads, these options will better preserve upstream natural resources from increased pressure.		<p>These options are located at the edge of a pristine area with undisturbed forests which can shelter more wildlife than disturbed or remnant forests, especially mammals and birds (wildlife surveys have shown that mammals and bird diversity is higher in pristine habitats of the study area).</p> <p>As determined from plant surveys, undisturbed forests located upstream also shelter more vulnerable or threatened plant species than downstream areas. The access road that will lead to the dam will probably be used by local populations to access remote areas. This will inevitably increase hunting and logging pressure on wildlife in pristine areas, and potentially attract new settlers into these areas. Habitat fragmentation is also more pronounced with Site 7c.</p>			
	These options are the best ones					
Fish	For this criteria, the best option would be the one that would lead to the smallest affected length of the Tina River and that would limit aquatic habitat fragmentation. The further upstream a dam is, and the shorter the by-passed section is, the less the fragmentation of aquatic habitat will be. This criteria does not weight much since the habitat gain from one location to the other is rather small (10 km ²).					
	Unless a fish pass is installed, the dam will block the migration of fishes, regardless of the option					
	With a toe-of-dam powerhouse, there will be no reduced flow reach on the Tina River, thus reducing negative impacts on the length of affected river	This option has a 2 km by-passed river reach with reduced flow	This option has a 5.7 km by-passed river reach with reduced flow	With a toe-of-dam powerhouse, there will be no reduced flow reach on the Tina River, thus reducing negative impacts on the length of affected river	This option has a 1.9 km by-passed river reach with reduced flow	
	Being located the farthest downstream, these options lead to greater aquatic habitat fragmentation		Being located the farthest upstream, these options lead to less aquatic habitat fragmentation			

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
				Best option	
Endemic species	Wildlife surveys and data obtained from the literature have shown that endemism is common in the Solomon Islands. However, regardless of the location, endemic species could be affected to the same extent.				
Downstream water quality for aquatic life	All options will lead to water quality impairment during construction especially turbidity (suspended solid). Diminished water quality could disturb aquatic life				
Sediment continuity	For this criterion, the best option would be the scheme that leaves the largest river bank volume unaffected, allowing for more natural erosion/deposition processes to take place. The difference between sites is, however, small given the small difference in affected (upstream) catchment size, regardless of the site. This criteria does not provide much weight in the assessment, since the gain between one location and the other is rather small (10 km ²).				
	Being located the farthest downstream, more sediment will be trapped by the dam. Trap efficiency of the Tina River catchment is 750 tons/km ² /year (Entura, 2014). Therefore, this site will trap 101,250 tons per year of sediment (mostly bed load).		This site will trap 93,750 tons per year of sediment (mostly bed load).		
			Best option		
Amount of spoils	For this criterion, the best option would be the one that generates the least amount of spoils (topsoil during road construction and subsoil during tunnel excavation).				
	With a dam and powerhouse located close to the existing Black Post Road, and with a toe of dam scheme, this option will generate the least amount of spoils	The dam and powerhouse are located close to the existing Black Post Road. However, tunnel excavation will generate spoils	With a dam and powerhouse located far from the existing black post road, and with the longest tunnel of all options, this scheme will generate the greatest amount of spoils	The dam and powerhouse are located far from the existing Black Post Road. Therefore, a great amount of topsoil will be excavated for road construction	With a dam and powerhouse located far from the existing Black Post Road, and with the tunnel, this scheme will generate a large amount of spoils

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
	Best option				
Protected area	There are no protected areas				
Risk of cumulative impact	During construction, all options may result in cumulative water quality impacts with Gold Ridge Mine potential extension project in the Toni River catchment (also called SPL 194), with Oil palm industry drainage discharged, and with logging activities.				
Best option based on environmental criteria	Site 6e – Option 1 is the best option based on environmental criteria				
Technical and Financial*					
Net Present Value (\$US) (based on 15m ³ /s flow)	\$25m – 38m (35m dam – 75m dam)	\$53m – 57m (35m dam – 65m dam)	\$90 – 103m (35m dam – 65m dam)	\$28 – 47m (45m dam – 85m dam)	\$55 – 69m (35m dam – 75m dam)
			Best option		
Unit cost of energy (\$US/MWH) (based on 15m ³ /s flow)	\$ 222 – 314 (35m dam – 75m dam)	\$ 189 – 285 (35m dam – 65m dam)	\$158 – 193 (35m dam – 65m dam)	\$ 218 – 312 (45m dam – 85m dam)	\$ 186 – 248 (35m dam – 75m dam)
			Best option		
Annual energy (GWh/a) (based on 15m ³ /s flow)	26 – 57	38 – 69	59 – 82	34 – 65	39 – 70
			Best option		
Geological features	At the time the Phase 3 report was prepared, some elements of geology were still to be confirmed. Preliminary comparison was made between Site 6e- Option 2 and Site 7c – option 2.				
Best option based on technical and financial criteria			Site 7c – Option 1 is the best option based on technical and financial criteria		

Criteria	Site 6e- Option 1	Site 6e- Option 2	Site 7c- Option 1	Site 7c- Option 2	Site 7c- Option 3
Overall conclusion	Preliminary Project optimization (optimization of dam height and position, tunnel size and route, powerstation size and location, etc.) has lead TRHDP PO to select Site 7c with its superior economic performance. The site was also trending to fewer social impacts, especially in terms of resettlement.				

*this only present a few relevant technical and financial criteria, for the full scope please read the Phase 3 report

4.4.3 Evaluation of Selected Ancillary Facilities for Preferred Alternative 7C

4.4.3.1 Fish Passage

4.4.3.1.1 Comparison of Select Ancillary Works and Construction Methods for Preferred Project

The following comparisons have been made for some of the key elements of ancillary facilities or construction methods with a view to selecting alternatives offering the best value for money, while at the same time lessening potential direct and indirect environmental and social impacts.

4.4.3.1.2 Comparison of Fish Pass Options

Hydropower dams present a barrier to upstream migrating fish and, as a result, can reduce the number of fish species and their numbers in upstream areas. Consideration was, therefore, given to methods for enabling fish to move past the dam and access upstream areas of the Tina River watershed. These included:

- ▶ Fish pass structures – these are of two basic designs depending on whether the fish that would use them are free swimming or climbing species, both of which are found in the Tina River. Free-swimming fish require fish pass structures (e.g., fish ladders) with sufficient water depth and reduced velocities to enable fish to freely swim up and over a dam. They are generally comprised of inclined ramps with pool/weir or baffle elements to moderate flow velocities and maintain water depth. Climbing fish may also use pool/weir fishways, but some will require fish pass structures comprised of ramps with wetted rough surfaces (e.g., carpet or roughened concrete) up which they can pass. For both types of fishway, sufficient flow of water is required at the base of the structures to attract fish to enter and continue upwards through the fishway.
- ▶ Trap and haul facilities – these consist of an area of attraction water into which fish are either attracted to climb the roughened surface of a wetted ramp to enter a tank in which they are trapped (e.g., for climbing species), or swim via a short pool/weir structure into a tank where they are trapped by a screened cage with a one-way entry. The fish are then brailed or pumped out of the trap into a tanker truck, which is then driven to a location upstream of the dam where the fish are released. Alternatively, swimming species can be netted where they congregate in the attraction waters at the base of the dam or powerhouse tailrace, transferred into tanks, then transported upstream of the dam.

Consideration has been given to include two forms of trap-and-haul. An engineered trap-and-haul system to accommodate climbing fish species, plus, a system involving netting and hauling for swimming species, as part of an adaptive management approach to monitor their migrations and congregations with a view to designing an effective but inexpensive engineered structure, should the results of monitoring support this. Each type of system will need to be monitored during operation to determine whether changes to design or operation are required to ensure fish passage over the dam.

Table 4-3 presents the pros and cons of the two approaches for moving fish upstream past the dam.

Based on this analysis, the trap-and-haul facility was selected as the preferred means of ensuring upstream fish passage for the TRHDP, as it offers potentially greater effectiveness, better opportunity for adaptive management, lower capital cost, and provides ongoing social benefits in the form of employment to operators of the facility.

Table 4-3 Pros and Cons of two primary means of fish passage

	Facilities			
	Fish Pass Structures (i.e., pool/weir/baffle fish ladders for swimmers and friction ramp fishways for climbers)		Trap and Haul Facilities for both swimmers and climbers	
Parameter	Pros	Cons	Pros	Cons
Effectiveness (environmental)	<ul style="list-style-type: none"> - operates with minimal human intervention - effective at moving species for which it is designed up and over dam 	<ul style="list-style-type: none"> - requires potentially significant volume of water to be effective - a given design of fishway may not serve all species due to different swimming capabilities in the case of free swimming fish - considerable research may be needed to design fishways for target fish species - not effective for climbing fish attracted into tailrace 	<ul style="list-style-type: none"> - trap-and-haul facilities are capable of moving multiple species of fish, if properly designed - relative simplicity of trap-and-haul systems facilitates use at multiple locations - facilities are effective for moving both free swimming and climbing species of fish 	<ul style="list-style-type: none"> - will require that trap-and-haul facilities be installed at least at two locations – at dam site, and at tailrace - requires that ongoing monitoring be undertaken such that trapping and hauling fish be carried out on time and not miss periods when schooling fish are congregating at trap locations
Compatibility with Adaptive Management	<ul style="list-style-type: none"> - it may be possible to adapt fishway operations to multiple species that might use the fishway at different times of the year by adjusting fishway flows 	<ul style="list-style-type: none"> - costs of changing fishway designs once constructed, or having to add additional fishways of a different design as an adaptive management technique can be very costly and would require additional research to justify - changing operating flow parameters of fishways can have a significant cost on a project especially if this 	<ul style="list-style-type: none"> - relatively easy to change design and operation of trap-and-haul to suit different species and different migration patterns and timing - can add an additional trap and haul system at the mouth of the Ngalimbiu River when certain species school for upstream migration, if this is later 	<ul style="list-style-type: none"> - minimal when compared to fishway structure

	Facilities			
	Fish Pass Structures (i.e., pool/weir/baffle fish ladders for swimmers and friction ramp fishways for climbers)		Trap and Haul Facilities for both swimmers and climbers	
Parameter	Pros	Cons	Pros	Cons
		removes flow from power generation	determined to be advantageous	
Capital Cost	- issue of capital cost is less of an issue if multiple species can be served by the same fishway design	- high cost relative to trap-and-haul system, especially since two systems, one for free swimmers, the other for climbers, would likely be required	- relatively low capital cost	
Operating and Maintenance Costs (direct and indirect), including social costs	- relatively low if fishway design and operation does not have to be altered	- potentially high cost to ongoing project operations if monitoring determines that adaptive management requires retrofitting fishway, or additional flows that take away from power production	- provides steady employment for a small number of persons within the local community	- ongoing costs of labour, and fuel, maintenance and eventually replacement costs of the tanker truck

4.4.3.2 Quarries and Borrow Sites

Based on the Feasibility Study carried out by Entura, the quarry / borrow sites selected are the closest to the proposed location of the concrete batch plant and are within the Core Area, the land that has been acquired for the project. No other suitable quarry / borrow sites are located within the Core Area. If additional stone is required, it will be purchased from commercial suppliers.

4.4.3.3 Access Roads

The parameters for siting access roads included: using existing permanent alignments that could be upgraded for project purposes, and serve local villages as improved roadways during and after construction; avoiding relocating houses and villages; and, where roads did not exist, use former logging roads providing they could be developed as stable access roads, or routes along ridge-tops that could provide stable roadways. Based on these criteria, the main access road was chosen as it follows the existing alignment from the highway to Managakiki Village with a diversion to minimise physical and economic displacement. From Managakiki to the powerhouse and damsite, the road alignment chosen provides for optimum stability.

4.4.3.4 Drilling and Blasting

A variety of drilling methods were examined, including the use of pneumatic and hydraulic drills. Hydraulic drills were chosen due to their lower noise profile.

Standard blasting methods were chosen since, for the most part, blasting will occur 2 or more kilometres from the nearest settlements. Notwithstanding, for safety purposes, blasting mats will be employed to minimise the spread of shot rock from the blasts.

4.4.4 Conclusions

Under the proposed Site 7c Option for the TRHDP, no villages or households in the Tina River Valley will need to be physically resettled. There will be some loss of resources in the upper catchment, especially fishing and forest materials, due to creation of the reservoir, access road clearing, and in the “low-flow” section of the river between dam and powerhouse. The latter is of central importance to the people living at Choro, Koropa, and Senghe, and to those engaged in timber milling alongside the river.

Development of Site 7c will generate significantly fewer social impacts on local communities than the other options previously advanced and assessed (Site 6a and Site 6e). Site 7c is, therefore, a significant improvement from a social and cultural point of view. The main issue, loss of clean fresh water supplies for all riverside communities located downstream during the project’s construction, will need to be addressed by the Project.

In terms of environmental impacts, development of Site 7c will generate greater disturbance in the long term due to the presence of a 5.7 km by-passed stretch of river, which will be affected by reduced night-time flows, and the presence of an upgraded all-season road that passes close to undisturbed forested areas along the reservoir. This access road can be a strong agent of change, as new settlers could arrive, placing additional pressure on natural resources. To mitigate the potential impact of the access road, the original core land owners have been included in the process by the establishment of a core land company which will make decisions with respect to the use and access of the core

land, including the access road to the dam. Further mitigation will be the closure of the dam access road for public traffic except operation and maintenance vehicles. A minimum environmental flow will be a requirement for dam operation to mitigate environmental impacts in the low-flow section, and the project's monitoring program will provide information to allow the effectiveness of the flow to be evaluated and appropriate adjustments to be made.

To mitigate impacts on upstream fish passage, a trap and haul system is proposed, combined with an adaptive management approach to monitor and adjust the scheme.

Of the two options that made it to final review, Site 6e and Site 7c, Site 7c is the superior option from both a technical and economic perspective, with the best NPV, best unit cost of energy and best annual energy production.

Based on more favourable expected technical and economic outcomes, fewer social impacts, and environmental impacts that, while not as favourable, should be manageable, Site 7c was chosen as the preferred project alternative to carry forward for a full environmental land social impact assessment.

5. PHYSICAL ENVIRONMENT BASELINE

5.1 INTRODUCTION

This section describes the existing baseline physical environmental conditions within the project-affected area. Biological environmental baseline conditions are discussed in Section 6 (Terrestrial) and Section 7 (Aquatic).

The information on the environmental baseline is based on detailed on-site environmental studies and field-surveys carried out by the ESIA team from August to September 2013, for the purposes of preparing the initial ESIA. Additional, supplementary studies were conducted in the field to address follow-up review comments. The regional information on the study areas is based on a review of secondary literature, supported by field studies, interpretation of available topographic imagery, and review of the Environmental Scoping Report (Entura, 6 June 2012) and the Feasibility Study Report Phase 2 (Entura, June 2012).

The objective of the environmental baseline was to assess the present state of the environmental conditions in the project area, and to provide a basis for evaluating environmental impacts and issues related to project design and construction, operations and maintenance, and decommissioning and rehabilitation.

The description of the physical environment is based on secondary and primary data sources, including the report entitled "Engineering Geological Assessment of Tina River Hydro Project, Guadalcanal, Solomon Islands" (GeoRisk Solutions, 2012); Entura's feasibility study (2014); and site visits made by the ESIA team involved in preparing the initial ESIA.

5.2 TOPOGRAPHY AND GEOMORPHOLOGY

The Ngalimbiu River is a large river draining in a northerly direction from some of the highest peaks (2000+ m) on the island of Guadalcanal. The river has two main tributaries, the Tina and Toni rivers. The Tina River catchment is more than three times larger than the Toni River. The catchment area of the Tina River is about 150 km² compared to 45 km² for the Toni River. The Tina River contains a diverse fish community and is unaffected by human development in its upper reaches. The gradient of the river increases with distance upstream (Table 5-1). Downstream of the Tina/Toni confluence the gradient is 2.3 m/km. This increases to about 5 m/km between the Tina/Toni confluence and the powerhouse site. Upstream of this the gradient continues to increase and is an average of about 9.3 m/km through the reach between the dam and powerhouse, and is steep (19 m/km) between the dam and the head of the proposed reservoir.

Table 5-1 Distance, elevation and gradient of key sections of the Tina River

Location	Distance from sea (km)	Elevation (m amsl)	Gradient (m/km)
Estuary	0	0	0.0
Tina/Toni confluence	19	43	2.3
Powerhouse site	24.7	73	5.2
Dam site	30.1	123	9.3
Proposed reservoir reach	32.7	172	18.8

The changes in gradient with distance upstream are reflected in the substrate and morphology. In the lower reaches downstream of the Tina/Toni confluence, the river is relatively wide and the substrate is dominated by sand and gravel. The bars and braiding are evidence of bedload movement during floods. From the Tina/Toni confluence to approximately 1 km upstream of Tina Village the river gradient is low, and the river unconfined with a substrate comprised of cobble, gravel and sand. The aquatic habitat comprises mainly wide runs and riffles. Upstream of this, the river becomes steeper and more confined and boulders are present, as well as cobbles, gravel and sand. The runs and riffles are generally narrower, with occasional rapids and places where the river splits into two channels. There are also pools which form where the river flows against a bedrock bank and changes direction. Upstream of the powerhouse site, the river becomes even more confined and steeper (50 m in 5.4 km).

Some villages (e.g., Mangakiki and Marava) are located on flat, low elevation ridges, connected by Black Post Road. The elevation of this road ranges from 23masl at Kukum Highway junction, to 235masl at its terminus at Mangakiki village, a distance of 12km. Black Post Road grades are less than 10%, with the average grade around 2%. Other villages (e.g., Koropa, Choro, Sengue, Habusi, Pachuki, etc.) are situated along the edge of the Tina River. These villages are separated from one another by steeply sloped ridges. The Ngalimbiu River runs through flat coastal plains, where human settlements are more numerous.

The dam site is located in a narrow valley comprised of steep slopes and narrow ridge crests. The valley sides at the site of the dam abutments are very steep (30° to 45° slope), and rise to the ridgeline that crests at approximately 200masl.

5.3 GEOLOGY AND SOILS

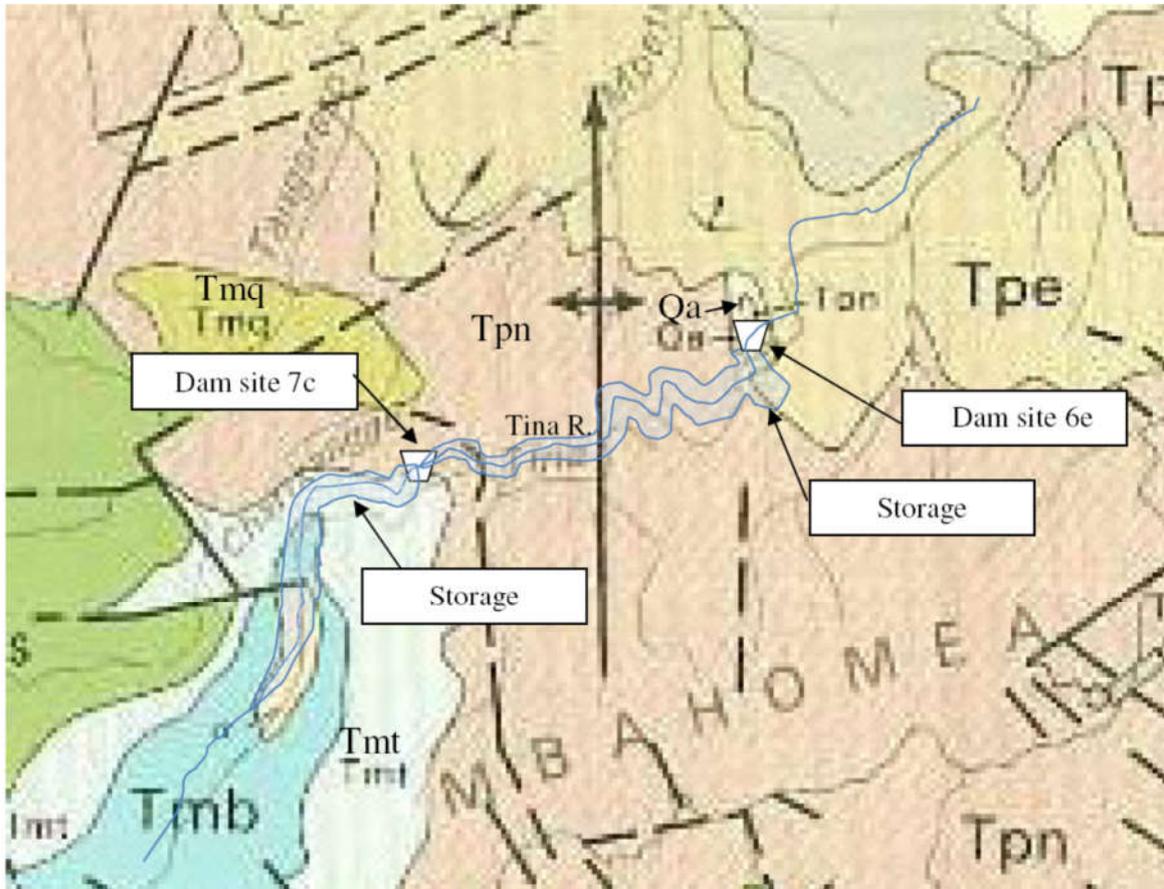
The Tina River is located within five key lithological units, as follows (Entura, 2014):

- Conglomerate (Tpn: Lower and Upper Toni Conglomerate members)
- Limestone (Tmb: Mbetilonga Limestone)
- Sandstone (Tpe: Mbetivatu Sandstone)
- Calcarenite (Tmt: Tina Calcarenite)

- Suta Volcanics

Figure 5-1 includes a map of the local geology found within the Project area. Dam site 7c is the relevant site.

Figure 5-1 Local Geology



Source: Entura (2014)

In addition to these formations, faults and karst are present in the project area. The presence of karst means that sandstone and conglomerate beds have a significant, soluble calcareous content. Entura (2014) considered it most likely that karst features are relatively minor and unlikely to lead to significant geotechnical concern. The proposed Site 7c location for the dam lies within the Toni Conglomerate Formation. This site is composed mostly of sandstone beds, interbedded with conglomerate beds (Entura, 2014). The majority of the proposed reservoir area lies within limestone, overlain by calcarenite. The proposed headrace tunnel and powerhouse are also located within the Toni Conglomerate.

Soils that cover the steep slopes of the construction area, adjacent to the Tina River, are shallow and unstable. They are comprised of colluvial rock debris. However, in stable areas, soils are deep and leached. Based on field observations, topsoils close to the proposed access road that will connect to the dam site are primarily composed of organic red-brown clay loam, or clay silt, with underlying weathered sandstone. Organic matter is primarily restricted to the first 10cm of the topsoil. These soils possess moderate to high fertility, resulting in rapid regeneration of vegetation following disturbance, as long as the topsoil remains undisturbed. Conversely, weathered soils observed in disturbed forested areas often become lateritic, are poor in nutrients, and do not facilitate rapid plant regeneration.

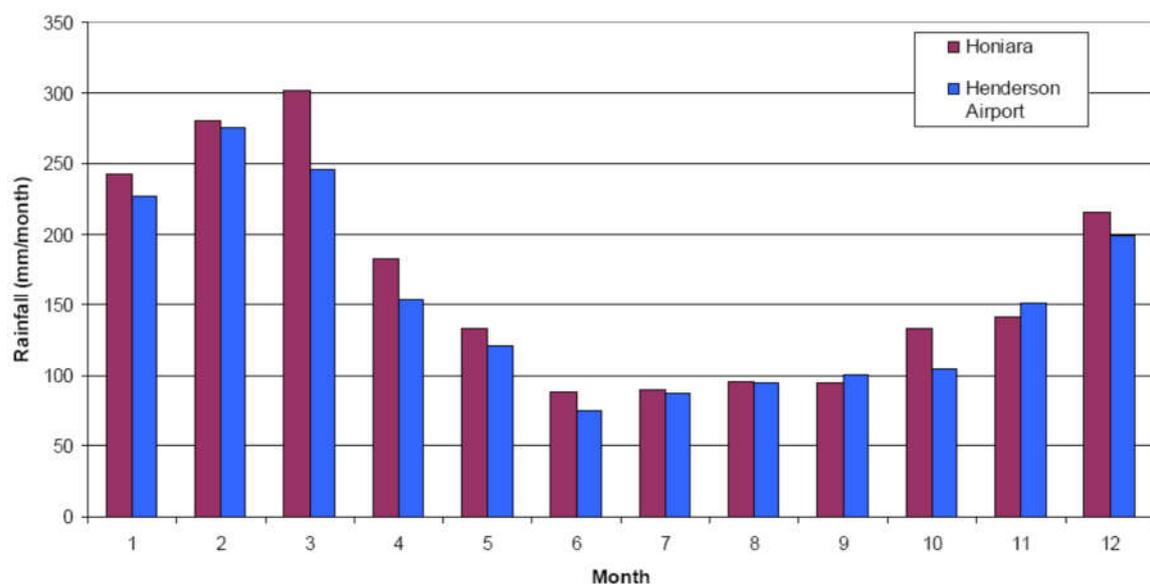
Along Black Post Road, soils are sandy and have low organic matter content, which does not allow for rapid regeneration. In the Solomon Islands, surface soil horizons are usually rich in organic-matter, while underlying mineral horizons contribute poorly to plant growth (SOPAC, 2007). In Guadalcanal, most soils are acidic (pH 3 to 5) (SOPAC, 2007).

5.4 CLIMATE AND METEOROLOGY

Average daily temperatures in Guadalcanal range from 22°C to 31°C throughout the year, with a yearly average of 26.6°C in Honiara. The island has a tropical moist climate with regular rainfall. Rainfall increases with altitude and is higher on the windward coast (South shore). Annual rainfall at both Honiara, and Honiara International Airport (also known as Henderson Airport), is 1972mm, with summer months being the driest. Figure 5-2 (Entura, 2013) shows the trend in rainfall.

Historic rainfall records for Tina River do not exist. However, based on modeling undertaken by Entura (2012), it was estimated that annual rainfall at the dam site exceeds 2500mm. The same model predicts in excess of 3500mm of total annual rainfall in the headwater reaches of the Tina River.

Figure 5-2 Average monthly rainfall at Honiara and Henderson Airport



Month 1 is January

In Guadalcanal, cyclones are most likely to occur between November and April, and are associated with extreme rainfall events.

In May 1986, cyclone Namu contributed 1200mm of rainfall over a period of a few days, causing rivers to overflow their banks. Water depth at the project site was said to be 7m. The Ngalimbiu River depth reached 7.2m, with a peak discharge of 2,460 m³/s (Baines & Danitofea, 1987). The extreme rainfall associated with Cyclone Namu contributed to major floods, mudflows and landslides that, in combination, transported logs down the rivers destroying villages and the bridge spanning the Ngalimbiu River.

The floods and mudflows precipitated by Cyclone Namu reshaped the course of the Tina River, and deposited highly fertile silt. The deposited silt has improved soil fertility for the communities that plant crops, and has permitted sustained intense market gardening.

An analysis of a map of sediment deposit patterns from Baines & Danitofea (1987) shows that following Cyclone Namu, communities downstream from Habusi received up to 50cm of deposited sediments. Sediment plumes at the mouth of the Ngalimbiu River mouth extended almost one kilometer offshore.

Meteorological events are important element in people's lives, as they have influenced decisions to move from one location to another. People that currently reside in the project area were originally from the upper Tina River catchment area. Landslides, floods such as those caused by Cyclone Namu, and heavy rains were often mentioned during social surveys, as reasons for moving to downstream areas where the effects of these events are less severe. Heavy rain often brings floods that destroy gardens along Ngalimbiu River. Fear of extreme meteorological events is still very strong among villagers.

5.5 LANDSLIDES, ROCKSLIDES AND SEISMICITY

5.5.1 Landslides and Rockslides

A significant number of landslides occur within the Tina River catchment, particularly on the steeper slopes. However, they remain relatively small, and are primarily associated with rockslides along bedding planes. Slope instability is an active and ongoing process within the proposed reservoir area (Entura, 2014).

A rockslide of 2Mm³ to 3Mm³ volume is visible at the upstream end of the proposed reservoir. A historic rockslide of 0.3Mm³, caused by an earthquake, blocked the Tina River in the proposed reservoir area creating a 20m high dam. One year later, the natural dam failed, and caused one causality downstream (anecdotal).

Other slope failures are located in the upstream end of the proposed reservoir, in Suta Volcanics. Large-scale landslides are unlikely to directly affect the dam.

5.5.2 Seismicity

The damsite is located in an area of significant seismicity (GeoRisk Solutions, 2012).

The U.S. Geological Survey (USGS) notes that along the South Solomon trench, the seismicity is predominantly related to subduction tectonics, and large earthquakes are common. Fourteen earthquakes having a magnitude of greater than 7.5, have been recorded since 1900. On 01 April 2007, an inter-plate megathrust earthquake of a magnitude of 8.1 occurred at the western end of the trench, that generated a tsunami that killed at least 40 people. This was the third megathrust event associated with this subduction zone in the past century; the other two having occurred in 1939 and 1977 (GeoRisk Solutions, 2012).

GeoRisk Solutions (2012) recommended that a site-specific seismic hazard evaluation be undertaken for the Project. This evaluation was undertaken by the Seismology Research Centre in February and October 2014. The evaluation employed probabilistic seismic hazard assessment (PSHA) using an earthquake recurrence model that considered the seismicity and geology of the area.

Peak Ground Acceleration (PGA), a measure of the amplitude of the earthquake motion, has been calculated for the TRHDP as being 0.286 *g*, based on an earthquake of Richter magnitude ML 4 or greater, and 0.273*g*, based on earthquakes of Richter magnitude ML 5 or greater. This is based on a return period of 475 years, with a 10% chance of exceedance in 50 years, and assumes a Vs30 value of 1000m/s.

During feasibility studies, a pseudo-static seismic stability analysis was undertaken to assess the potential damage caused by the earthquake and a post-earthquake analysis was undertaken to assess the stability of the dam after earthquake events. Conclusions of this evaluation will assist in the final design of the dam.

5.6 RIVER (FLUVIAL) GEOMORPHOLOGY

The Tina River is a single channel meandering river. It has a torrential behavior with regular flash floods. The texture of its bed includes gravel, cobbles and boulders, and fine and coarse-grained sand. In the higher elevation headwaters of the Tina River, very large boulders are intertwined with logs, attesting to the power of its water velocity during floods. Along its banks, some areas have large fluvial deposits.

The River flows through three main geological areas:

- Volcanics, upstream of the Study area and upstream of the Njarimbisu bend area;
- Limestone from the Njarimbisu to the middle reaches of of the Tina River;
- Sandstone, where the Tina River flows through villages upstream of the Toni River.

The following sections describe the Tina River from its upper catchment to its mouth. Figures 5-3 through 5-8 uses Google Earth imagery to identify morphological features of the River. In addition, Annex 1: Description of the Aquatic Survey Stations (see Annex Report) describes the river's morphology at each fish sampling station.

5.6.1 Upper Catchment Area

Figure 5-3 presents an aerial view of the Tina River headwaters (270masl), which are comprised of the junction of two main rivers: Vohara River (1) and Mbeambea River (2) and a minor tributary: Njarimbisu River (3). Becho River (4), a tributary of the Vohara is located further upstream.

This section is characterized by sequences of pools and rapids and sharp meanders. Major boulders, some greater than 3 m diameter, have accumulated along the channel bars. These large boulders indicate that intense floods occasionally occur within this reach. Boulder clasts are predominantly volcanic in origin.

This reach of the Tina River flows along a north-south orientated thrust fault (GeoRisk Solutions, 2012).

Figure 5-3 Tina River headwaters



Source: Google Earth, 2014

5.6.2 Tina River Gorge

The Tina River enters steep limestone gorges (Figure 5-4) where its course is more confined and less meandering. At this location most of the river's course is made of rapids. In many areas, river banks are dominated by rock outcrops. This area is the site of a major historic landslide (1) of around 200,000m³. The dam and reservoir site are located in this area (2). At the dam site, the river lies at an altitude of approximately 122masl.

Figure 5-4 Tina River Gorge with dam site (Site 7c) and reservoir

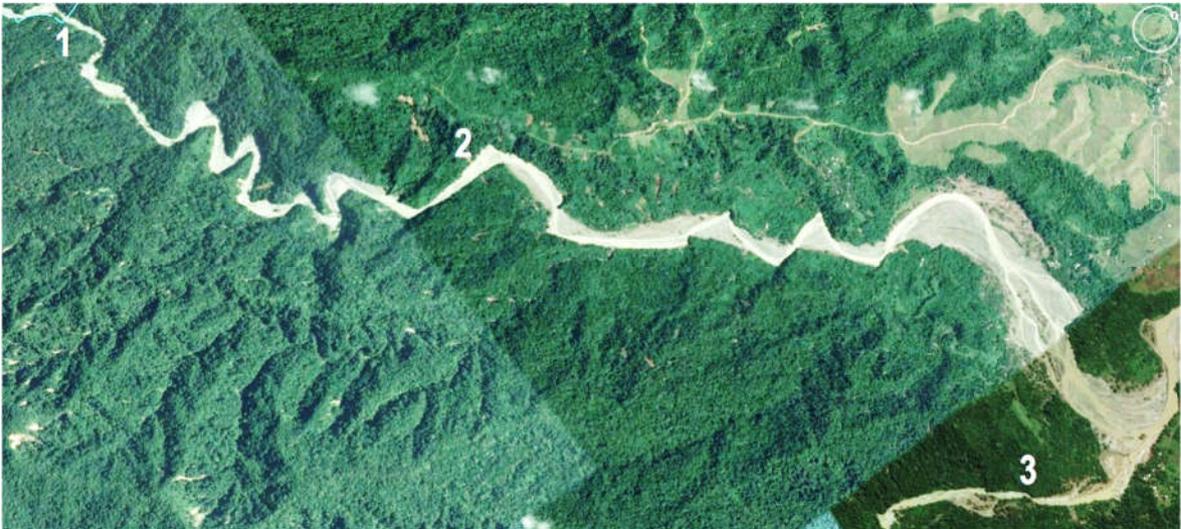


Source: Google Earth, 2014

5.6.3 Meandering River Toward the Plain

Figure 5-5 illustrates the river reach downstream of the dam site (1), the river gradually flows through an area having shallower slopes and many meanders. The powerhouse (2) will be located in this area. The density of human settlements also gradually increases as the river flows through villages, until it is joined by the Toni River (3).

Figure 5-5 Tina River between damsite (7c) and Toni River confluence



Source: Google Earth, 2014

Figures 5-6 and 5-7 illustrate the sharp meander bends, channel braiding, and other deposition-erosion features associated with intense flash floods that have the capacity to rapidly shape the river. The inside curves of the meander bends show large point bars of alluvial deposits comprised of cobbles and boulders, while the outside curves show marked cut banks in sandstone. In this area, both size and position of meanders have changed throughout time, and sometimes quickly as a result of weather related events, such as Cyclone Namu. One example of rapid river channel migration is the behaviour of the Tina River (3) at “Tina’s old meander (1)” adjacent to Tina Village (2) where the channel quickly shifted from a straight line channel to a large meander channel before its junction with Toni River (4). The following example shows the evolution of the Tina River channel within one year.

Figure 5-6 Tina River before channel shifted



Source: Google Earth, 2013

Figure 5-7 Tina River after channel shifted



Source: Google Earth, 2014

The riverbed and the adjacent terrace are comprised of rounded cobbles and boulders, predominately less than 0.5m in diameter, within a matrix of silty sand.

5.6.4 Tina and Toni River Confluence: Ngalimbiu River

Figure 5-8 illustrates the flat coastal plain, located downstream of the confluence of the Toni and Tina rivers, where they give rise to the Ngalimbiu River. The Ngalimbiu River flows across an area characterized by denser human settlement, and other anthropogenic human activities, such as gravel extraction. Drainage from agricultural lands, such as oil palm plantations, enters the river. During Cyclone Namu, sediments from the Ngalimbiu River extended across this coastal plain in a path more than 6km wide (Baines & Danitofea, 1987). The Ngalimbiu River also shows intense deposition-erosion processes at work, as illustrated by sharp meanders and fluvial deposits.

At the confluence of the Tina and Toni rivers, the elevation is approximately 40masl.

A small delta has formed at the mouth of the Ngalimbiu River where it enters the Solomon Sea at Lasa Point (close to Tenaru Bay).

Figure 5-8 Ngalimbiu River flood plain



Source: Google Earth, 2014

5.7 RIVER HYDROLOGY

The Tina River catchment covers an area of approximately 150km². Upstream of the dam site, the catchment covers an area of about 125km².

The Tina River is comprised of three rivers: the Mbeambea, the Voraha and the Njarimbisu rivers. The Tina River's catchment area is delineated by: Chupu Kama to the East; Mount Mbutohaina (1649m) to the West; and a chain of mountains to the South, including Mount Tambunanguu (1902m), Mount Popohanatungga (1877m), and Mount Turipukumahi (1636m). Mount Popomanaseu (2310m), the highest mountain of the Solomon Islands, is located just outside of the Tina River catchment.

The Tina River meets the Toni River 17.8km downstream from the Tina River's headwaters. The Toni River is a much smaller river with a catchment of approximately 45km², and a flow roughly 1/3 that of the Tina River.

To model the flow of the Tina River, a river level and rainfall gauging site was installed upstream of the proposed dam site. Another rainfall-gauging site was installed in the upper catchment at Chupu Kama. Hourly rainfall data has been collected since mid-June 2010. River water levels and flows were collected until April 2014 when equipment was destroyed by flooding. The levels and flows have been obtained to allow development of a rating curve for the site (Entura, 2014).

According to Entura (2014), the lack of long-term rainfall data within the upper Tina River catchment is a major constraint to estimating the catchment rainfall and flow at the proposed dam site.

Two years of additional data have been acquired and this has allowed Entura to develop a hydrological model and synthesise a long-term flow data series for the Tina River. One of the conclusions from the additional data and the long-term (29 years) flow analysis is a reduction of the fully absorbed energy of the scheme from 84.7 Gwh to 80.6 Gwh.

5.7.1 Duration Curves of Specific Yield

According to Entura (2014), the duration curves of specific yield for the Tina River is 0.097m³/s/km², which means that, on average, when moving downstream, for every additional km² of Tina River catchment, the yield increases by 0.097m³/s.

5.7.2 Average Flow

Flow data were taken from the Feasibility Study prepared by Entura (2014). Tina River gauging station is located in the upper catchment area between the confluences of the Tina River and the Voraha and Mbeambea rivers (see location at A3 in Figure 5-3). Flow data has been collected by automatic gauging and telemetry from 15 June 2010 to April 2014. Plans are underway to reinstate the gauging station.

According to Entura (2014), the average monthly flow at dam, estimated from extended records, was 11.5 m³/s. This flow was used in the estimating energy production for the TRHDP scheme.

Using available data from the gauging station upstream of the proposed dam site, for the period 15 June 2010 to 21 September 2013, the average flow at dam site in the wet season (December first to March 31) was estimated to be 19.40 m³/s, and the average flow at dam site in the dry season (April 1 to November 30), was estimated to be 12.72 m³/s. This data shows that the average flow appears higher than the average flow obtained from the extended records.

Table 5-2 shows the average flow on a monthly basis, based on the same data. January shows abnormally low values. Although the wet season, this could be the result of abnormally dry conditions that occurred in January 2011, 2012 and 2013. Alternatively, this may have been the result of an error in recording measurements at the gauging station. There is considerable variation around the average flow, as illustrated by the figures in the minimum and maximum columns.

Table 5-2 Monthly flow at damsite (15 June 2010 to 21 September 2013)

Months	Average monthly flow at dam site (m ³ /s)	Minimum recorded (m ³ /s)	Maximum recorded (m ³ /s)
January	13.87	5.97	120.94
February	21.48	4.96	342.38
March	21.94	6.55	233.54
April	18.23	5.04	141.84
May	14.27	4.53	201.50
June	8.69	3.83	185.64
July	10.55	3.42	222.93
August	10.81	3.01	234.85
September	11.62	2.85	220.06
October	12.90	3.91	176.93
November	17.12	3.26	445.62
December	20.46	4.83	298.33

The Phase 3 addendum report based on the 29 years of river flow modelling shows a dry season flow (between June and September) of 7.5 m³/s with increasing flow in September and a wet season flow up to 20 m³/s occurring in December to January. This is shown in Figure 5-9 below.

Figure 5-9 Seasonal river flows

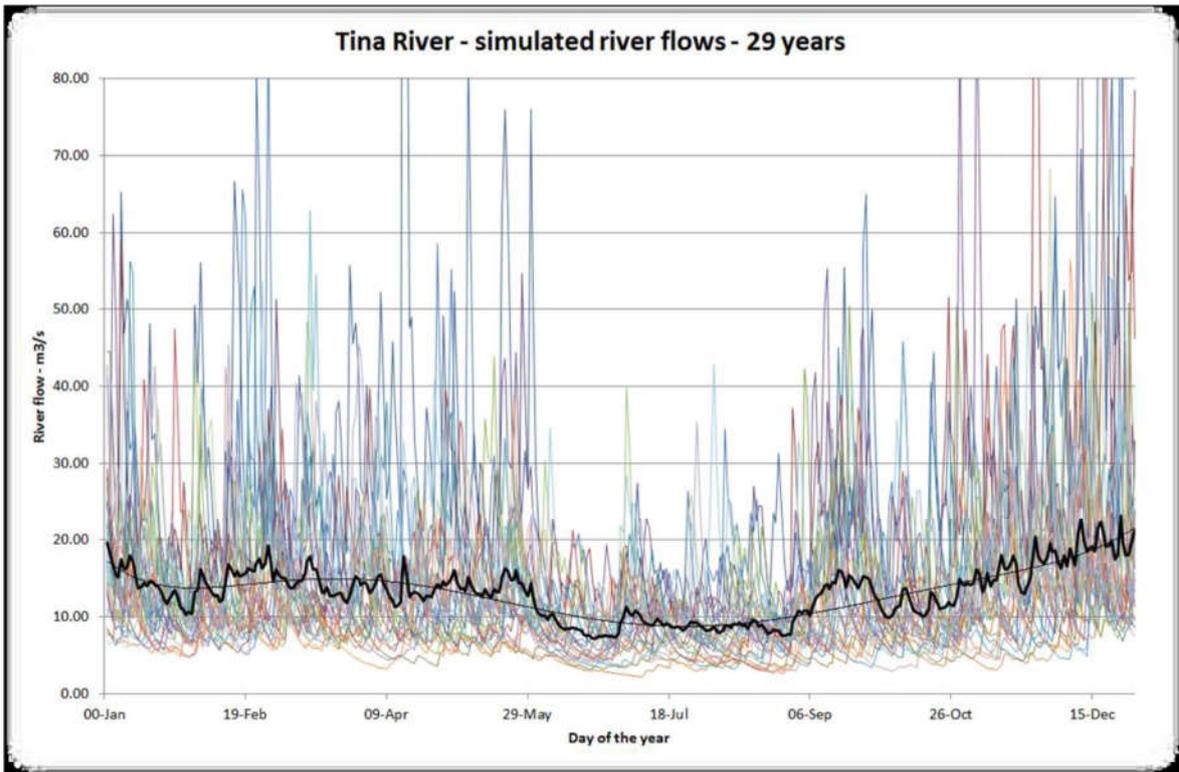


Table 5-3 identifies flow percentiles of long-term estimated flow at the dam site. Flow percentiles provide precise information about occurrences of flows.

Table 5-3 Flow percentiles for long-term estimated flow at damsite

Flow Percentile	Average daily flow transposed to dam site (m ³ /s)
10	5.1
25	8.0
50	11.8
75	17.0
90	25.4

Source: Entura (2014)

Table 5-3 is interpreted as follow:

- On an annual basis, average daily flow is less than 5.1m³/s, 10% of the time. This also means that for 90% of the time, flow is greater than 5.1m³/s.
- On an annual basis, average daily flow is less than 25.4m³/s, 90% of the time. This also means that for 10% of the time, flow is greater than 25.4m³/s.

5.7.3 Flow Difference Between Toni River and Tina River

A rapid comparison (Table 5-4) of flows between the Tina River and Toni River was made during the rainy season to quantify the flow input of the Toni River on the Ngalimbiu River. The following table shows that the Toni River has a flow roughly 1/3 that of the Tina River. At approximately 45km², the Toni River catchment covers an area approximately 1/3 that of the Tina River catchment, which covers roughly 150km².

Table 5-4 Comparison of flows between Tina and Toni rivers

Station	Location	Date	Width (m)	Water level (m) at different locations	Water Velocity (s) for 20 m	Water Velocity (m/s)	Estimated flow (m ³ /s)
A5B	Tina River (before its confluence with Toni)	11/02/14	46.40	0.28	35	0.57	28.99
				0.28	20	1	
				1.10	11	1.82	
A6B	Toni River (before its confluence with Tina)	11/02/14	19	0.50	42	0.48	7.16

5.7.4 Flood Frequency

The Tina River flood frequency curve is derived from the Lungga River flood frequency curve, as measured at Lungga Bridge. The Lungga frequency curve, with up to 1:200 Annual Exceedance Probability (AEP), was scaled to the Tina River catchment using catchment area and rainfall scaling.

The maximum observed flow over a period of three years in the Tina River is 445m³/s, which is close to the 1:5 AEP event. This means that, statically, this AEP event could take place every 5 years, or that there is a 1 in 5 chance that it will occur every year). Figure 5-10 and Table 5-5 show the preliminary estimate of flood frequency curve at the dam site.

Figure 5-10 Preliminary estimate of flood frequency curve at damsite

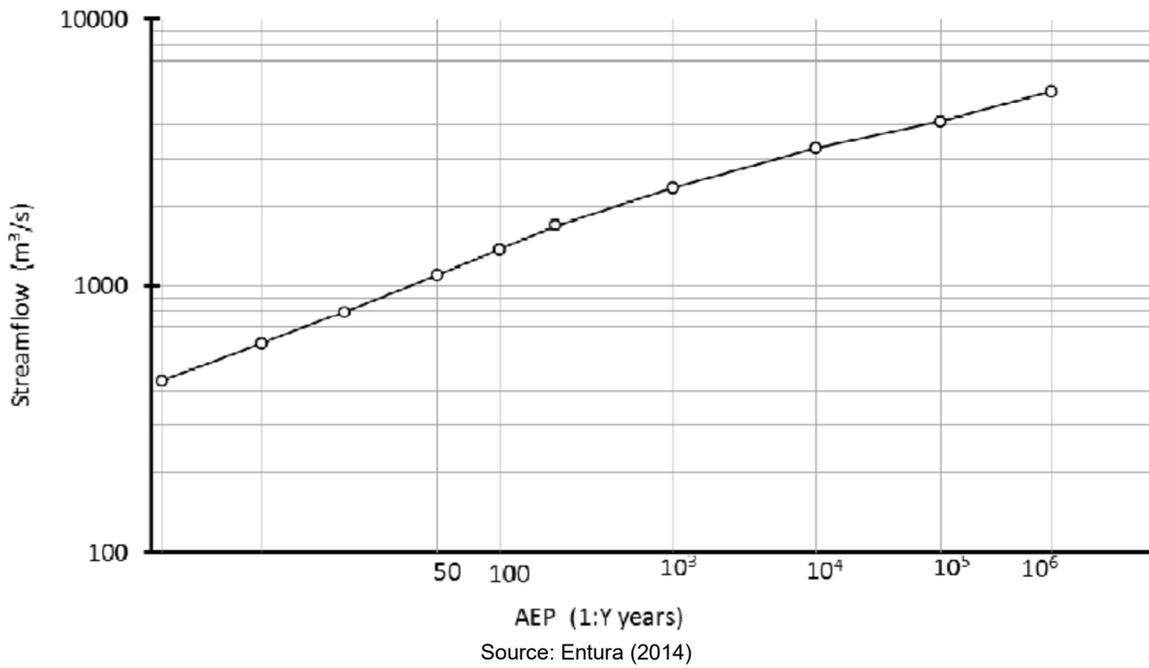


Table 5-5 Preliminary peak inflow estimates for Tina River damsite

AEP (1 : Year)	Peak Flow (m³/s)
1.01	60
2	245
5	460
10	610
20	800
50	1100
100	1375
200	1690
1,000	2340
10,000	3290
100,000	4140
1,000,000	5050

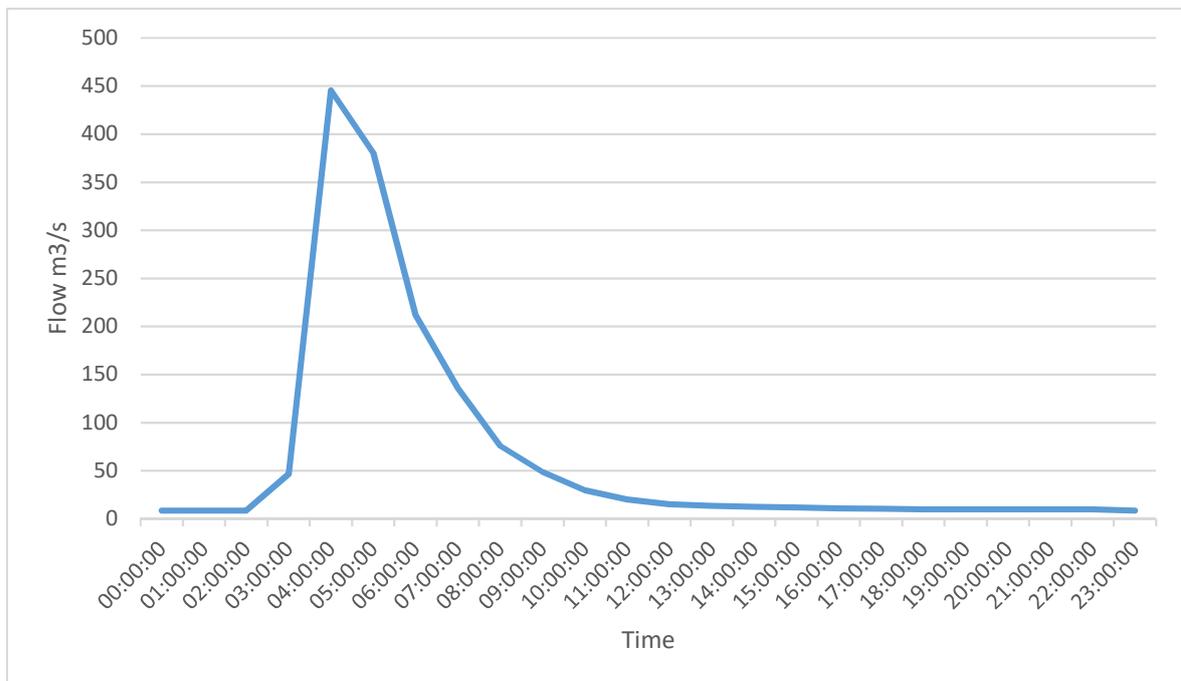
Source: Entura (2014)

The spillway has been designed to pass a Maximum Flood Level of an AEP equals to 1:10,000, which is 3,290 m³/s. In comparison, according to Entura, 2014 Cyclone Namu was approximately a 1:50 event, meaning that, statistically, it can occur once every 50 years, or that it has a 1 in 50 chance of occurring every year. This compares to data provided in Baines & Daitofea (1987), which indicated that cyclone Namu had a peak discharge at the Ngalimbiu River mouth of 2,460 m³/s, meaning that it was a 1:1,000 event.

5.7.5 Flash Floods

The Tina River experiences flash floods almost immediately after heavy rainfall events occur in the upper catchment. Flow and water level can change rapidly during such events. Heavy rainfalls in the upper catchment are visible from afar, and people use this visual cue as a warning of an impending flash flood. On 11 November 2010, a spectacular flood occurred that increased the flow from 8.7m³/s to 445.65m³/s in only four hours (see graph in Figure 5-11).

Figure 5-11 Example of a significant flash flood that occurred on 11 November 2010



Data based on Tina River gauging station

In area where the Tina River runs through gorges, water can quickly rise up to 2 meters in elevation. Whereas, elsewhere these flash floods briefly inundate riparian areas and replenish wetlands.

A dam at 7C can become a means of controlling flash flood for the downstream communities. The Hydro powerstation will have accessories to monitor flow installed and this can be used to advise the downstream communities about possible flooding and the level of flooding can be more easily determined. The downstream communities can access this information to take appropriate actions if required. The downstream communities should not experience any significant changes to the current flooding characteristics as the volume of water flowing down the Tina river after the power station will not be impacted after the power station.

5.7.6 Tina River Tributaries in the Reduced Flow Reach

A number of small, seasonal tributaries enter the Tina River between the dam and powerhouse sites (i.e., “reduced flow reach”). These streams are valuable aquatic resources that will need to be protected during road construction.

These small left and right bank tributaries cover an area of 1,042ha (+/- 10 km²). Given the specific yield of 0,097m³/s/km², calculated for the watershed upstream of the dam, with its higher elevation and rainfall, the run-off supply from the smaller tributaries entering the reduced flow reach is estimated to be less than 0.97m³/s (~1m³/s) on average. Hence, this represents only a small proportion of Tina River flow. Table 5-6 identifies the length of the tributaries that enter the reduced flow reach.

Table 5-6 Left and right bank tributary streams

Small left bank tributaries of Tina River	Length of the tributary (m)
Vurahairauha	1149
Vurapokola	1088
Valemalamala	362
Choro	250
Hainalovo	511
Senge	314
Nembo	607
Small right bank tributaries of Tina River	
Kaka'uha	3044
Jarikela	757
Puaka	3760
Valebou	3113
Valepohopoho	509
Mbabakoechir	273
Aho	406
Chongo	853
Chanbaulo	446
Pihu	645
Koeropa	705
Lotulotu	583

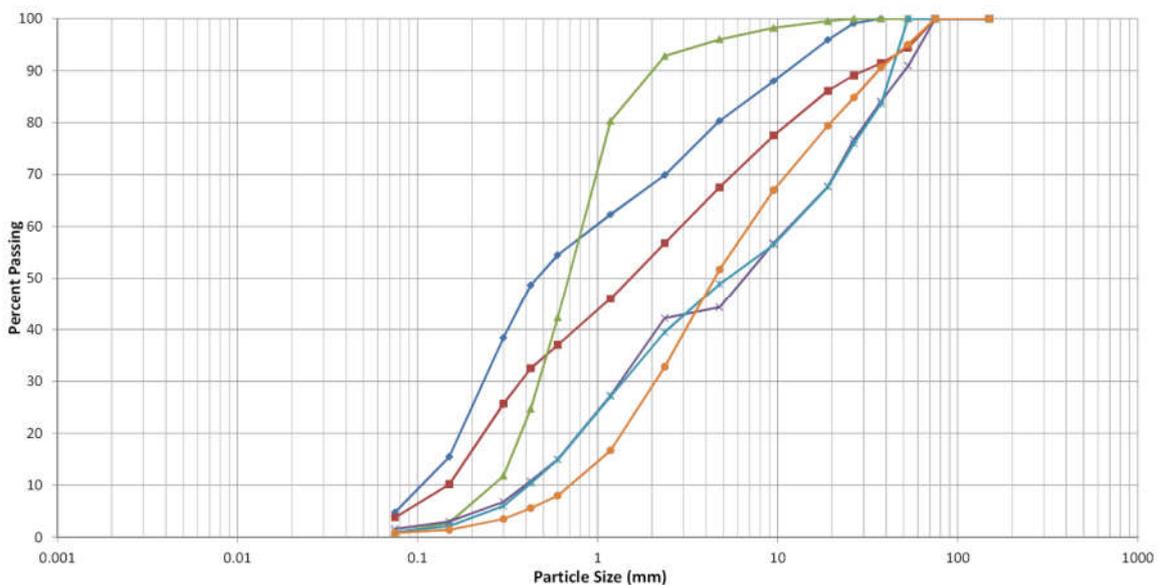
5.8 RIVER SEDIMENT TRANSPORT

According to Entura (2014), alluvial deposits are the predominant river-bed material. It is assumed that the depth of alluvium reaches approximately 10 m within the river channel. Although, alluvium deposits within the Option 6 area extended to a depth of 25m. Alluvial terraces occur adjacent to the current river course and bars. Terraces vary from 1.5m to 5m above the current river level. They are comprised of cobbles and boulders, predominately less than 50cm in diameter, with a matrix of silty sand. At some locations, large boulders up to 3m in diameter are found, indicating that intense floods occasionally occur.

Bed load sediment ranges in size from silts and sands in low flow area, to large boulders in very high flow areas. Bed load sediments are materials likely to be deposited into the storage reservoir because of reduced water velocity, and will accumulate over time in the dead storage zone of the reservoir and are, therefore, unlikely to be transported downstream. In addition to bed load, additional material may be transported into the reservoir from landslides, and from surficial materials eroded from the land as a result of upstream logging and construction activities.

According to Entura (2014), bed load sediments deposited in the Tina riverbed and alluvial bars range from 0.1mm to 100mm in size, as shown in Figure 5-12 (sample taken in the vicinity of Site 7c).

Figure 5-12 Particle size distribution of bed load sediment and alluvial bars in the Tina River



Source: Entura (2014)

By opposition to bed load sediments, suspended sediment are material transported by the river that remain in suspension even when water velocity is reduced. These materials are likely to be transported downstream through the headrace tunnel and turbines. Sand, silt and clay make up suspended sediments. Based on field surveys by Entura (2014), total suspended solids in Tina waters range from 8mg/L to 157mg/L.

Based on trap efficiency for the suspended sediment of 50% and 100% for bed load, Entura (2014) has estimated that the amount of material (both suspended sediment and bed load) that will be trapped would be of 750t/km²/year (93,750 tons per year or 45,000m³) would be deposited in the reservoir. It would therefore take about 65 years until the reservoir fills to the intake invert level at 162.5masl.

Despite the dam acting as a barrier for sedimentation transport to the downstream areas, the over topping of the dam during flooding will continue to carry sediments from tributaries downstream of the dam and this will continue to supply sediments to the downstream communities which will allow them to continue with their livelihood activities such as gardening on fertile land along the river bank.

5.9 AIR QUALITY

Air quality is generally excellent in the Project area and there are no air quality non-attainment areas in the vicinity. Construction activities can be sources of dust pollution during wind events in the general region.

Impacts: There would be short-term dust impacts during excavation work although this would be limited to fugitive dust emissions and emissions from machinery and vehicles used and dust control would be followed during construction. There would be no negative long-term adverse impacts on air quality due to operation and maintenance of the hydropower facilities. As with other hydropower projects, there would be an offset of emissions of carbon dioxide and other green house gases.

5.10 WATER QUALITY

5.10.1 General Water Quality

Tables 5-7 and 5-8 include water quality results for both dry and rainy seasons, respectively. The locations of water quality sampling stations are set out in Table 5-9, at the end of this section. Dry season water sampling was carried out in July and August 2013 and rainy season sampling was carried out in February 2014.

Generally speaking, the water quality in the upper Tina River, upstream of inhabited areas, is assumed to be good owing to there being no anthropogenic sources (i.e., no domestic use, no gold panning, etc.) of pollution. Natural peaks in turbidity following flash flood events are considered to be the primary cause of degraded water quality. Current water quality in the Tina River does not appear to be a limiting factor for aquatic life, given this low level of pollution.

Table 5-7 Dry season surface water quality monitoring results

Water course			Upper Tina				Middle Tina.			Upper Ngalimbiu			Lower Ngalimbiu		Ngalimbiu Mouth				
Station Code			A1	A2	A2b	A3	A4	A5	NA	A6	A7	NA	A8	A9	A10a	A10b	A10c	A10d	A10e
Rivers & location			Becho-Voraha river	Mbembea riv.	Tina river pool.	Tina river gauging stat.	Tina river. Koropa	Tina river. Sengue	Valekocha	Toni river. Kathihana	Ngalimbiu riv. Horohutu	Ngalimbiu riv. Birao	Ngalimbiu riv. Bridge	Ngalimbiu riv. Saele	Ngalimbiu riv. Upp. right bank	Ngalimbiu riv. Lower	Ngalimbiu riv. Upstream	Ngalimbiu riv. mouth	Ngalimbiu riv. Downstream
			PK																
Parameters	Norms	Reference	38.1	37.96		37.14	28.29	27.69		19.81	16.12		7.76	2.62	0	0	0	0	0
pH	6.5-8.5	ADWG	8.1	8	7.9	8.2	-	-	-	8	8.5	-	8	8.3	7.9	7.8	-	-	-
Turbidity (NTU)	<5 NTU	WHO	0.61	1.07	0.48	0.98	-	-	-	9.77	6.87	-	5.09	9.66	12	12.8	-	-	-
Cond.(µS/cm)	20-250 (uS/cm)	ANZECC*	166.3	135.7	270.8	154.7	-	-	-	243.8	173.7	-	186.3	215.2	191.7	319.4	212.6	218	242.3
NO2 (mg/l)	<3.0mg/L	WHO	0.042	0.041	0.012	0.042	-	-	-	0.039	0.046	-	0.045	0.011	0.049	0.046	-	-	-
PO4 (mg/l)			1.4	1.3	1.3	1.2	-	-	-	1.4	1.1	-	1.5	1.6	1.8	1.9	-	-	-
Total phosphorus (mg/l)	<0.01 mg/l	ANZECC*	0.5	0.4	0.4	0.4	-	-	-	0.4	0.4	-	0.5	0.5	0.6	0.6	-	-	-
E.coli (MPN)	0 MPN	WHO	-	-	-	-	-	-	7.5	12.4	-	42.9	-	129	-	-	-	-	-
Total Coliform (MPN)	<10 MPN	WHO	-	-	-	-	-	-	16.4	94.5	-	>200.5	-	>200.5	-	-	-	-	-

* Norms for Rivers in tropical Australia

ADWG: Australian Drinking Water Guidelines; WHO: World Health Organization

Stations A10C, A10 D and A10E are not mapped, they were taken in the river mouth at the shore line about 20m upstream inland and about 20m downstream in the river outflow outside of the shoreline. The conductivity measurements clearly show that, at the time of the observation, there was no estuarine effect: the freshwater flows directly to the sea. No salinity gradient inland. This was confirmed by the presence of fresh water helophytes and can toad tadpoles at the river mouth.

Table 5-8 Rainy season surface water quality sampling results

			Tina Village. gravel filtered water	Tina village	Toni River	Ngalimbiu after junction of Toni and Tina	Ngalimbiu Bridge	Saele village	Saele. gravel filtered water	River Mouth	River Mouth
			Water course								
			Tina	Tina	Toni	Ngalimbiu	Ngalimbiu	Ngalimbiu	Ngalimbiu	Ngalimbiu	Ngalimbiu
			Sample Code								
			A5B	A5B	A6B	A6C	A8	A9	A9B	A10A	A10B
			Date								
			11-Feb-14	11-Feb-14	11-Feb-14	11-Feb-14	10-Feb-14	10-Feb-14	10-Feb-14	10-Feb-14	10-Feb-14
			PK								
Parameters	Norms	Reference	18.90	18.90	17.97	17.37	7.76	2.62	3.35	0	0
pH	6.5-8.5	ADWG	-	6.82	7.89	7.08	7.36	7.35	6.6	7.91	6.62
Turbidity (NTU)	<5 NTU	WHO	-	16.1	2.54	15.5	8.69	14.6	2.34	15.3	18.4
Conductivity (uS/cm)	20-250 (uS/cm)	ANZECC*	-	155.2	239.3	166.8	191.9	195.2	488.5	190.8	995.1
TDS (ppm)	<600mg/L	ADWG	-	97.4	153.4	105.3	121.7	124	321.8	120.8	676.6
Nitrate (NO3) in mg/L	<50mg/L	WHO	-	0.9	1	0.9	0.9	0.8	1.1	1	0.7
Nitrite (NO2-N) in mg/L	<3.0mg/L	WHO	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.016	0.019
Nitrogen Ammonia (NH3-N) in mg/L	<0.01 mg/l	ANZECC*	-	<0.06	<0.06	<0.06	0.1	0.2	0.1	0.3	0.2
Dissolve oxygen (ppm) (in situ)	>6 ppm	ANZECC	-	6.69-7.13	6.54-6.68	7.20-7.24	6.00-6.06	6.28-6.43	-	5.71-5.84	5.69-5.69
T° (in situ)			-	24.5-25.0	28.4-29.4	26.4-27.2	31.2-32.0	29.3-30.5	-	26.9-27.4	28.3-27.7
<i>E.coli</i> (MPN)	0 MPN	WHO	8.6	10.9	75.4	18.1	14.8	12.2	20.3	6.3	6.3
Total Coliform (MPN)	<10 MPN	WHO	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	>2419.6	461.1	>2419.6	>2419.6

* Norms for River in tropical Australia

ADWG: Australian Drinking Water Guidelines; WHO: World Health Organization

Table 5-9 Table of location of water quality sampling sites

Station	Area	River	Location	Chainage*	WQ sample
A1	Upper catchment	Bicho-Voraha Riv.	confluence	CH -1km	X
A2	Upper catchment	Mbembea River	confluence	CH -1km	X
A3	Upper Tina	Tina River	Gauging st	CH 1km	X
7C	Middle Tina	Tina River	Dam	CH 7km	
A4	Middle Tina	Tina River	Koropa	CH 11km	
A5	Middle Tina	Tina River	Sengue	CH 11.5km	
A6	Upper Ngalimbiu	Toni River	Horohutu	CH 19km	X
A7	Upper Ngalimbiu	Ngalimbiu Riv.	Kathihana	CH 20km	X
A8	Lower Ngalimbiu	Ngalimbiu Riv.	Ngalimbiu	CH 28km	X
A9	Lower Ngalimbiu	Ngalimbiu Riv..	Saele	CH 34km	X
A10a	Mouth area	Old Ng. mouth	Komporo	CH 36 km	X
A10b	Mouth area	New Ng. mouth	Komporo	CH 37 km	X

* Based on Entura Phase 1 chainage, starting at Tina River between the upstream confluence of the Mbeamea and the Voraha (chainage 0km)

For further details on the location of the water quality sampling sites see Section 7.3.3.

5.10.2 Specific Water Quality Parameters

5.10.2.1 Turbidity

During the dry season water quality sampling (August 2013), the water was very clear in the vicinity of the gauging station (turbidity of 1 NTU or less). In the Toni River, a high turbidity (9.7 NTU) was observed on a rainy day. In the Ngalimbiu section (Horohutu to Saele), turbidity values were significantly higher, ranging from 5NTU to 9NTU (5NTU is considered as noticeable when observing). The maximum turbidity (12NTU) was observed at the mouth of the River.

During the rainy season water quality sampling (February 2014), the water was less clear than it had been at the same location during the dry season water quality sampling. In all river stations, turbidity was higher than the World Health Organisation's (WHO) recommended norm of 5NTU for drinking water. At the time the rainy season sampling was conducted, frequent heavy high rainfall events were generating silt and soil laden runoff originating from within the large catchment area.

Turbidity in downstream reaches of the Tina River (16.1NTU) was higher than in the downstream reaches of the Toni River (2.52NTU). As would be expected by these NTU levels, visually, the Toni River was also much clearer than the Tina River. The difference between the water clarity in the two rivers could be explained by the fact that Toni River catchment does not extend to the same higher elevations as the Tina River catchment.

In Guadalcanal, rainfall is directly related to altitude, the higher the altitude, then the higher the amount of rainfall. In addition, The Toni River catchment is much smaller than the Tina River catchment. During the dry season water quality survey, according to laboratory results, the mouth of the river was less turbid than at other stations. During the rainy season water quality survey, the river mouth appeared more turbid. This difference could be explained by the slower currents in the vicinity of the river mouth, where the water is also deeper, versus the stronger currents observed at the upstream sampling stations (Tina, Toni and Ngalimbiu).

People residing next to the rivers extract water from small holes dug into the river gravels adjacent to the shore, to obtain water that has been filtered through the sand, before drinking it. Water sampled from a hole dug into the gravel showed reduced turbidity (2.34NTU), compared to water taken directly from an adjacent location in the river (14.6NTU).

The increase in turbidity in the Ngalimbiu River is likely the result of both anthropogenic (high population with increasing water usage, and agricultural drainage in the coastal plain), and natural causes (increase of primary productivity in the lower reach of the river due to the degradation of organic matter from the upper reach, "spiral effect").

The level of turbidity observed indicates good quality of water for aquatic life.

5.10.2.2 pH

During the dry season, the water had a slightly basic pH (7.8 to 8.2) with no particular variation along the river. During the wet season, the water had a pH that ranged from 6.6 to 7.89.

The observed pH levels indicate good water quality for aquatic life.

5.10.2.3 Conductivity

During the dry season, conductivity readings on the upper Tina River were relatively low (136 $\mu\text{S}/\text{cm}$ to 155 $\mu\text{S}/\text{cm}$), compared to isolated pools, where readings were roughly double (271 $\mu\text{S}/\text{cm}$). Conductivity appeared to increase slightly in the Ngalimbiu River (173 $\mu\text{S}/\text{cm}$ to 215 $\mu\text{S}/\text{cm}$) for the same reasons that dry season turbidity was higher in this reach.

At the mouth of the river, conductivity readings (191 $\mu\text{S}/\text{cm}$ to 242 $\mu\text{S}/\text{cm}$) were not significantly higher (319 $\mu\text{S}/\text{cm}$) than in the Ngalimbiu reach, even at the point where freshwater was pushing the ocean outwards. No salinity gradient was observed during the survey (i.e., no brackish water estuary). During flood tides, ocean waters can intrude upstream as a salt wedge beneath the freshwater for a distance of roughly 500m.

During the rainy season, the river mouth shows a significant increase in conductivity (995.1 $\mu\text{S}/\text{cm}$) when compared to the upstream river reaches (155.2 $\mu\text{S}/\text{cm}$ to 239.3 $\mu\text{S}/\text{cm}$). Total Dissolved Solids (TDS) exhibited the same trend as conductivity.

5.10.2.4 Other parameters

Regarding nutrients (nitrate, phosphate), during both the rainy and dry seasons, nutrient concentrations were found in low concentrations in the upper Tina River, and were slightly elevated in the Ngalimbiu reach.

Nutrients are more a concern for drinking water quality for humans, than for aquatic life.

5.10.2.5 Faecal Coliform Bacteria Levels

During dry season, the level of faecal coliform contamination was low in the upper Ngalimbiu reach and in the Toni River, where few riparian settlements occur. Faecal coliform levels increased within the lower reaches, especially downstream of Ngalimbiu village.

During the rainy season, the level of total coliform contamination was high in all sampled stations. Total coliform indicates the presence of coliform derived from both vegetative, and human and animal sources. The presence of *Escherichia Coli* (E. Coli) bacteria indicates faecal contamination from human or animal origin. Sample results exceeded WHO standards but, surprisingly, remained lower than during the dry season. These results were counter-intuitive, as it would have been expected that, due to heavy rains and the volume of runoff from nearby villages, higher levels of E. Coli would have occurred during the rainy season.

5.10.2.6 Water Temperature

Water temperatures were obtained using a Hanna HI 9146 dissolved oxygen and temperature meter. River water temperatures increase in a downstream directly from higher elevation to lower elevation. At the river mouth water temperatures decrease, somewhat, due to the moderating influence of the ocean. During the rainy season, water temperatures ranged from 24.5°C in the Tina River to 32.0°C in the Ngalimbiu River.

Anthropogenic processes have no influence on water temperatures in the sampled rivers.

5.10.2.7 Dissolved oxygen

Dissolved Oxygen (DO) measurements were made using a Hanna HI 9146 dissolved oxygen and temperature meter. Sampling was conducted during the rainy season, at depths of 20cm and 40cm, to obtain a range of results. Along the Tina, Toni and Ngalimbiu rivers, DO ranged from 6.00mg/L to 7.24mg/L, levels that are considered good aquatic life. At the mouth of river, DO decrease to between 5.71mg/L and 5.84mg/L, indicating poorer conditions for aquatic life. According to ANZECC, DO levels below 6mg/L result in conditions that are stressful for aquatic organisms. No DO measurements were obtained during the dry season.

The source of DO is aquatic plants that expel oxygen into the water during photosynthesis, or from the atmosphere through turbulent mixing (entrainment) and diffusion. In the river system, DO comes from entrainment and atmospheric diffusion rather than from aquatic plants, since high water velocities and frequent flash flooding does not facilitate the establishment of aquatic plants. DO is affected negatively by the amount of soil and vegetation debris (organic matter) that enters the river system, both of which consume oxygen through adsorption and decomposition. The presence of fast moving water over rapids and riffles positively affects the amount of oxygen that diffuses into water. Temperature also influences DO, with the higher the temperature the lower the oxygen content of the water. Warm, slow moving water, as observed at the mouth of the river, negatively influences oxygen content.

Erosion caused by human activities, such as agriculture or forest clearing, runoff that occurs during the rainy season, and natural landslide events, all contribute to reducing DO levels in the river, thereby affecting aquatic life. However, notwithstanding the negative effects on DO, floodwaters rich in organic material from the Tina River's large catchment area are valuable for some aquatic species.

5.10.2.8 Dissolved Metal Concentrations at Ngalimbiu River Bridge (2006)

Water quality at the Ngalimbiu River Bridge has been monitored by Golder Associates (August 2006, November 2006, March 2007 and September 2007) as part of a water quality baseline survey. The Ngalimbiu site was used as a reference site for the Matepono River, which is effected by mine activities. Results were obtained from the Gold Ridge Mine Environmental Audit report (Golder Associates 2008).

The report focuses on metal concentrations in surface water, and includes analyses for aluminium, copper, arsenic, cadmium, manganese, nickel, lead and zinc. Concentrations of dissolved metals were below the ANZECC trigger thresholds for drinking water with the following exceptions: Aluminum (August 2006 and September 2007), Copper and Cadmium (August 2006), Zinc (September 2007).

5.10.2.9 Pesticides Associated with Oil Palm Cultivation

Pesticides, including Glyphosate CT, Basta, 2-4-D Amine, Ally (Metsulfuron Methyl), Kamba 500 selective herbicide (present as the dimethylamine salt), and Gramoxone Tropical (Paraquat), are most likely present in the Ngalimbiu River, since they are used by the oil palm industry in the area. Since 2011, Paraquat is no longer used (New Britain Palm Oil Limited, 2011) but is most likely still present in the sediments of the Ngalimbiu River.

No water quality data were available for these parameters, and it is suspected that they have never been analysed in the Ngalimbiu River. National laboratories do not have the capabilities to analyse pesticides.

5.10.3 Water Quality Study Limitations

The three main study limitations regarding water quality sampling are:

- Limited capacity of the Solomon Islands Water Authority (SIWA) laboratory;
- Lack of national laboratories with the capability to analyze heavy metals and pesticides; and
- Sampling was undertaken as unique events, rather than as recurring events over a period of time.

The quality of analyses by SIWA Laboratory could not be verified, since blank samples needed for quality control, were lost by the laboratory.

The river system is highly variable, with sudden flash floods rapidly changing turbidity, dissolved oxygen, temperature and Total Suspended Solids (TSS). With the exception of logging, the Tina and Toni rivers are not affected by other anthropogenic disturbances, (e.g., no gold panning, no other major sources of TSS, no agriculture activities, etc.). Therefore, heavy metal and pesticide pollution are not likely to affect the Tina River system. It is, however, likely that the Ngalimbiu River, downstream of the Tina River, is affected by pollution resulting from drainage of oil palm plantations that use fertilizers and pesticides. National laboratories do not have the capability to analyze these sources of pollution. To establish a benchmark for aquatic organisms and the aquatic environment, it is recommended that a program of water, sediment and fish tissue sampling for heavy metal and pesticide toxicity be implemented for the river system, prior to construction of TRHDP (as presented in Section 6). Samples could be sent to Brisbane, Australia.

5.11 AMBIENT NOISE LEVELS

5.11.1 Ambient Noise – Baseline

Ambient noise monitoring was not undertaken for the TRHDP. This is because the Project will be located in a rural setting in which ambient or background noise is consistent with a largely un-mechanised society. Night time noise levels for undeveloped rural settings typically range from 30dBA to 40dBA, and 40dBA to 50dBA during day time hours. Occasional spikes up to 75dBA to 80dBA may occur close to villages when chainsaws, petrol powered electrical generators or petrol powered water pumps are in use.

5.11.2 Noise Emissions – Construction and Operation

Impact Identification and Rating

During project construction, noise levels will increase considerably at the dam site and powerhouse site over a period of up to three years. However, as the dam site is approximately 2km from the nearest village, only minimal impacts will accrue to local inhabitants as a result of dam construction. Noise disturbance from powerhouse construction will affect Habusi village, which is located across the river and approximately 400m away from the site.

Noise levels will also increase close to villages during the period that access road improvements are underway. This noise disturbance will be transient, extending over a matter of days or weeks, as the road construction progresses. Transient noise levels will also increase within villages located along the access road as a result of truck / vehicle movements, which are estimated at almost 10 transits per hour during the daytime construction period (7:00am to 5:00pm). Heavy truck movements will also generate vibrations that may affect any buildings located in close proximity to the road.

Overall, noise impacts will be significant adjacent to the dam. However, as there are no villages within 2km of the dam site, the effects on villages will be low-moderate. Noise impacts from access road construction and operation, and powerhouse construction will be moderate during the daytime construction period, and low during nighttime.

During project operation, noise disturbance will be minimal and primarily related to occasional vehicle movements to/from the dam and/or powerhouse.

Typical noise levels associated with machinery used to construct a hydropower project are included in Table 5-10.

Typical levels of noise disturbance are shown in Figures 5-13 and 5-14.

Table 5-10 Equipment Noise Emission Levels

Equipment Description	Impact Device?	Actual Average dBA Measured L _{max} @ 50 feet or Spec (where actual not available)
All Other Equipment > 5 HP	No	85 (spec)
Auger Drill Rig	No	84
Backhoe	No	78
Bar Bender	No	80 (spec)
Blasting	Yes	94 (spec)
Boring Jack Power Unit	No	83
Chain Saw	No	84
Clam Shovel (dropping)	Yes	87
Compactor (ground)	No	83
Compressor (air)	No	78
Concrete Batch Plant	No	83 (spec)
Concrete Mixer Truck	No	79
Concrete Pump Truck	No	81
Concrete Saw	No	90
Crane	No	81
Dozer	No	82
Drill Rig Truck	No	79
Drum Mixer	No	80
Dump Truck	No	76
Excavator	No	81
Flat Bed Truck	No	74
Front End Loader	No	79
Generator	No	81
Generator (<25KVA, VMS Signs)	No	73
Gradall	No	83
Grader	No	85 (spec)

Equipment Description	Impact Device?	Actual Average dBA Measured L _{max} @ 50 feet or Spec (where actual not available)
Grapple (on backhoe)	No	87
Horizontal Boring Hydraulic Jack	No	82
Hydra Break Ram	Yes	90 (spec)
Impact Pile Driver	Yes	101
Jackhammer	Yes	89
Man Lift	No	75
Mounted Impact Hammer (hoe ram)	Yes	90
Pavement Scarifier	No	90
Paver	No	77
Pickup Truck	No	75
Pneumatic Tools	No	85
Pumps	No	81
Refrigerator Unit	No	73
Rivit Buster/Chipping Gun	Yes	79
Rock Drill	No	81
Roller	No	80
Sand Blasting (single nozzle)	No	96
Scraper	No	84
Sheers (on backhoe)	No	96
Slurry Plant	No	78
Slurry Trenching Machine	No	80
Soil Mix Drill Rig	No	80 (spec)
Tractor	No	84 (spec)
Vacuum Excavator (Vac-Truck)	No	85
Vacuum Street Sweeper	No	82
Ventilation Fan	No	79
Vibrating Hopper	No	87
Vibratory Concrete Mixer	No	80
Vibratory Pile Driver	No	101
Warning Horn	No	83
Welder/Torch	No	74

Source: US Federal Highway Authority - Construction Noise Handbook

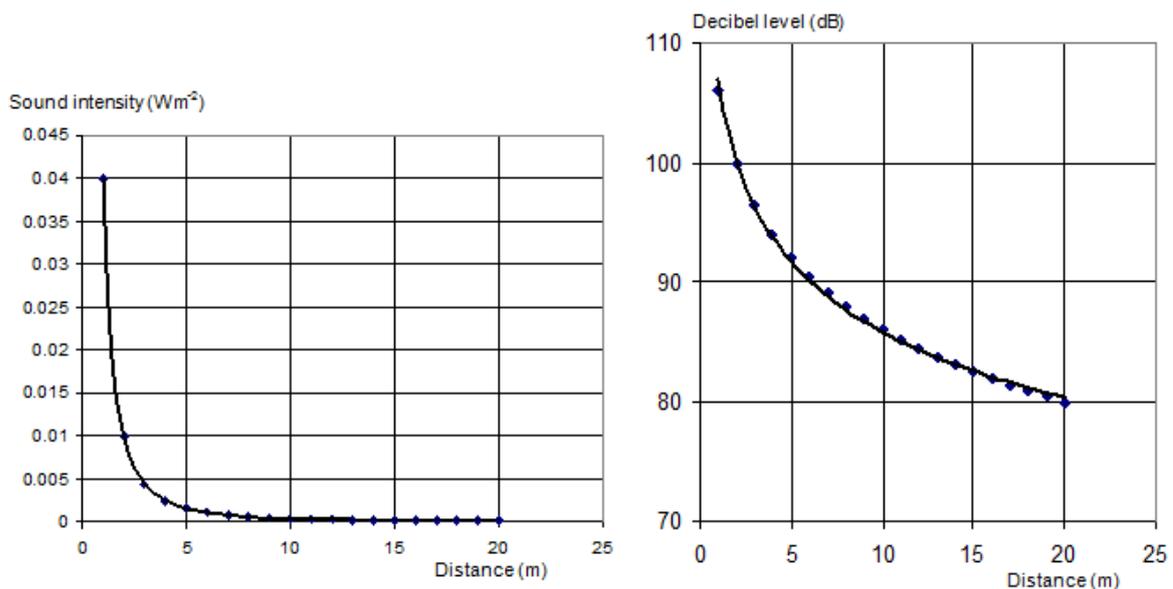
(https://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm)

For each generic type of equipment listed in Table 5-10, the following information is provided:

- an indication as to whether or not the equipment is an impact device;
- the acoustical usage factor to assume for modelling purposes;
- the measured "Actual" emission level, or the specification "Spec" limit for each piece of equipment (where actual not available) expressed as an Lmax level in dBA at 50 feet
- Data obtained from a number of construction projects over the period beginning in the 1970s through 2006

Sound intensity decreases by the inverse square of the distance.

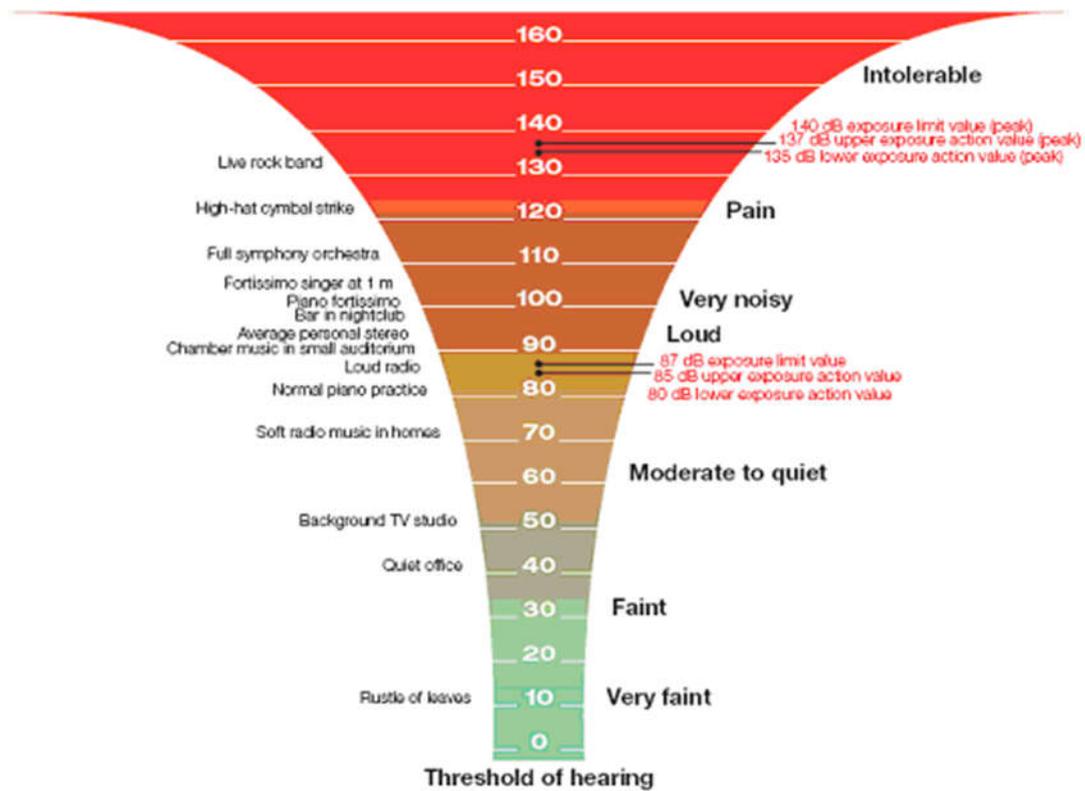
Figure 5-13 Variation of sound level intensity and the decibel level with distance from the source of sound (decibel level of 80 dB at 200 m)



Source: http://www.schoolphysics.co.uk/age16-19/Sound/text/Sound_levels_and_distance/index.html

http://www.schoolphysics.co.uk/age16-19/Sound/text/Sound_levels_and_distance/index.html

Figure 5-14 Noise disturbance levels



Source: Sound Advice. <http://www.soundadvice.info/thewholestory/san1.htm>

Mitigation Measures

Noise emissions and vibration effects will be mitigated through best practice, including:

- Restricting construction in areas close to villages (access road and transmission lines, powerhouse) to the period 7:00am to 5:00pm;
- Restricting blasting at the dam site or other locations that require blasting to the period 7:00am to 5:00pm;
- Restricting movement of heavy vehicles through villages to the period 7:00am to 5:00pm;
- Requiring that all mobile and stationary equipment be equipped with fully functioning noise mufflers and baffles.

Residual effects and their significance

By implementing best practices to control noise emissions, including restricting construction work adjacent to villages to daytime hours, noise impacts will be moderate during daytime hours, and low during night time hours and, therefore, are considered to be not significant.

<http://www.soundadvice.info/thewholestory/san1.htm>

6. BASELINE BIOLOGICAL ENVIRONMENT - TERRESTRIAL

6.1 INTRODUCTION

This section presents baseline information on the fauna and flora found within the study area.

According to UNESCO (2013), no other areas of comparable size support more unique bird species than the Solomon Archipelago. Solomon Islands has about 4500 species of plants and is recognized as being rich in plant diversity, and endemism (MECM, 2008). Solomon Islands supports breeding populations of 47 endemic bird species. The country has 4 Endemic Bird Areas (EBAs), one of which is located on Guadalcanal. An EBA is an area of less than 50,000km² that encompasses breeding range for two or more restricted-range land birds (Bird Life International, 2013).

Solomon Islands and Guadalcanal are rich in biodiversity and endemism, not only for birds, amphibians, reptiles and mammals, but also invertebrates. The degree of variation in bird species between islands is very marked. Guadalcanal is home to many small mammals mostly bats, rats and possums, some of which are rare (MECM, 2008). As it is the case with other islands that make up Solomon Islands, Guadalcanal's interior mountain species have been poorly studied, and much more scientific information is needed (MECM, 2008; McCoy, 2008). The mountains of Guadalcanal reach elevations up to 2,310 meters, and are uninhabited by humans. They provide pristine wildlife habitats.

6.2 METHODOLOGY

Field surveys to inventory fauna were undertaken by Edgar Pollard, an expert on fauna of the Solomon Islands. Field surveys to inventory flora were carried out by Myknee Sirikolo, an expert on the flora of Solomon Islands. Eric Deneut, biologist and assistant team leader, provided additional observations and discussion concerning terrestrial fauna. Field visits and sampling were carried out from 5 to 17 August 2013. A total of 24 flora stations and 22 fauna stations were studied for the purpose of characterizing the environmental baseline.

Sampling locations were selected to reflect potentially project-affected areas. Prior to conducting the field visits, the location of fauna and flora stations was presented to the TRHDP PO and fauna and flora experts, for discussion and approval. To enable experts to precisely locate each station and to facilitate the process of data gathering in the field, special field maps were prepared using BaseCamp (Garmin). These maps were then printed on waterproof sheets. An example of one of these field maps is included in Annex 9 of the Annex Report. Maps used in recording aquatic environment data show the exact location of each sampling station. Three categories of sampling area were selected:

- Upper Stream sampling area - a typical upper stream area within undisturbed lowland forest (primary forest).
- Middle Tina River sampling area - a large area that represents the main location of potential impact generating activities (e.g., access road, powerhouse, tunnel, and dam).

-
- Transmission line sampling area - these stations represent the future location of the transmission line. All sampling stations were located along the road that connecting to Tina River village (Black Post Road). This will be the access road used by trucks and machinery to connect to the construction site.

6.3 TERRESTRIAL FLORA

6.3.1 Survey Locations and Methodology

The upper catchment of the Tina River provides important terrestrial habitat, consisting of areas of Montane forest spread across the high peaks of Guadalcanal (see Figure 6-1). The ESIA team accessed this upper catchment to sample flora and fauna, using a helicopter. However, due to issues of limited access and availability of scientific data, many questions remain regarding the flora and fauna assemblages in the upper catchment's montane forest. Notwithstanding, the ecosystem of this area will not be directly affected by the Project.

Fauna and flora surveys were carried out at specific survey sites across the project area of influence as shown in Figure 6-1, and further described in Appendix A. Flora species at each station were identified within circular plots having a radius of 10m to 20m from their centre point (see Annex 8 in the Annex Report for a list of identified plant species). In some cases, the radius was increased to reflect the need to sample the diversity of plant species. Although the flora survey was undertaken at one specific time, timing of the surveys is irrelevant since species were identified regardless as to whether they were flowering at the time of the survey, or not. Survey results also confirmed the presence of plants and wildlife that were identified from previous studies.

To ensure that no major rare or protected plant communities will be affected as a result of construction activities, a ground level reconnaissance survey will be done at the time the final road and transmission line alignments are identified, with the purpose of identifying potential threatened or vulnerable plant species that would need to be avoided. This reconnaissance survey would serve as the baseline for monitoring the construction of the access road to ensure that no threatened or vulnerable flora is destroyed.

A constraint for undertaking the flora survey was the lack of site-specific information on the Project area.

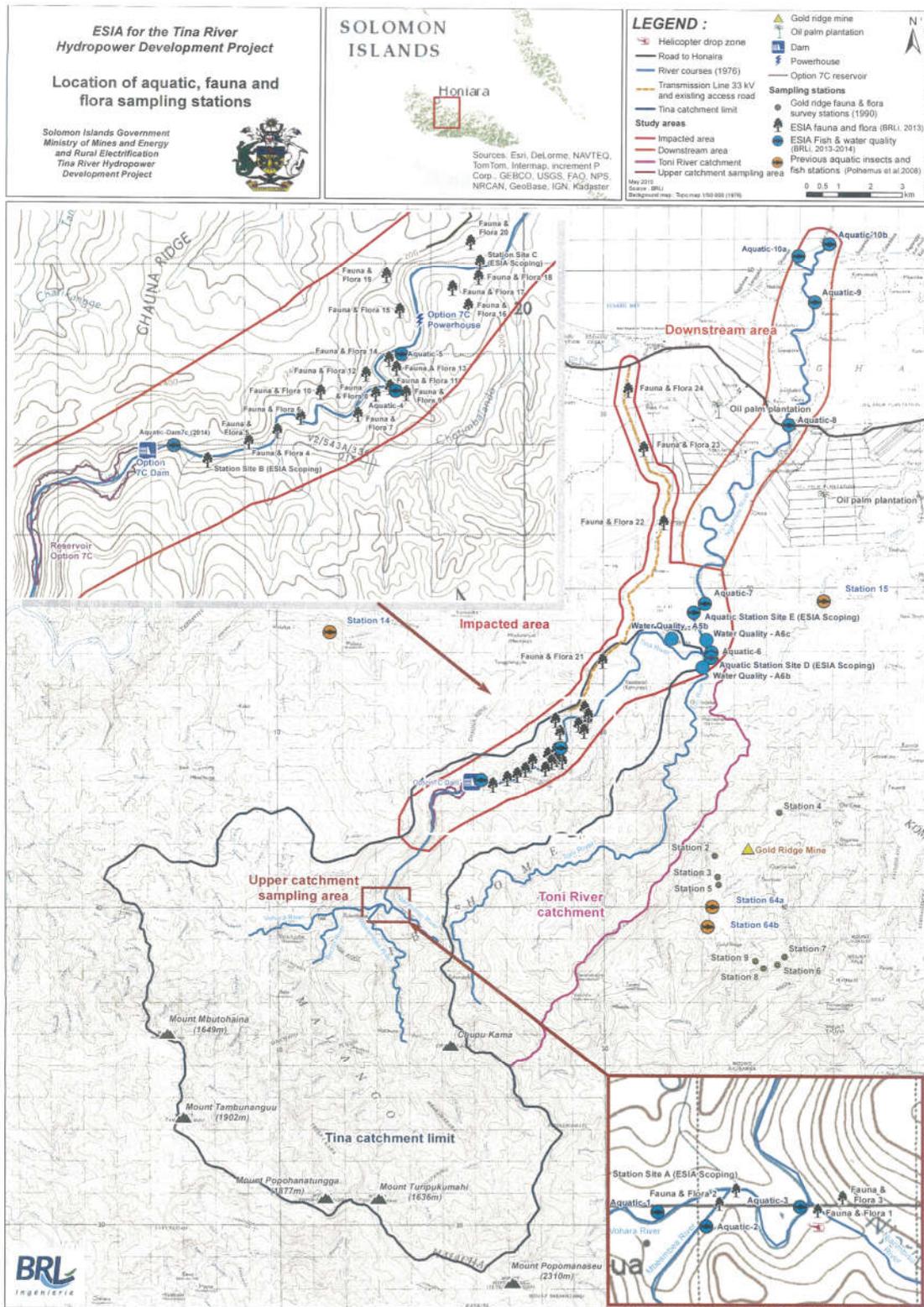
6.3.2 Flora Survey Results

From the flora survey, the floral expert identified a total of 159 plant species. Among the species identified, 5 are listed as vulnerable, and 19 are listed as threatened. A total of 66 species of trees, fern trees and palm trees were identified. They are classified in the "tree stratum". Many species are regrowth and secondary trees species and are, therefore, good indicators of past disturbances, whether from natural events (e.g., cyclones; landslides) or anthropogenic activities (e.g., timber harvest). At least 23 identified tree species are of commercial timber value. A total of 36 shrubs and vines, and a total of 57 herbaceous plants were identified.

The ESIA flora baseline survey was supplemented by information obtained from the Feasibility Study rapid flora assessment, which had identified 23 additional species of plants, including: 2 trees, 3 palms, 4 shrubs (including bamboo) and 14 orchids (herbaceous plants). Many plants are used by local communities as medicinal plants, as a source of building materials, and for food.

Disturbed areas such as Black Post road, and the proposed access road and transmission line corridor, are colonized by invasive plant species. The level of disturbance increases from upstream to the downstream in the catchment. Disturbance is the result of human activity, mainly logging and human settlements (garden, houses, etc.)

Figure 6-1 Biological sample sites



6.3.3 Species of Concern

Three categories of habitat disturbance were defined according to their level of disturbance: weakly disturbed habitats, moderately disturbed habitats and highly disturbed habitats. According to the flora survey, the highly disturbed areas, such as the areas around the Black Post Road, have fewer species of concern (see Table 6-1 and Figure 6-2) (see Annex 8 in the Annex Report for the list of floral species, including species of concern).

Table 6-1 Number of flora species of concern

	Stations	Number of species of concern	Percentage of species of concern
Increasing level of disturbances	Fauna&Flora2	5	36
	Fauna&Flora1	5	17
	Fauna&Flora3	5	28
	Fauna&Flora7	5	15
	Fauna&Flora6	2	11
	Fauna&Flora5	4	18
	Fauna&Flora4	3	13
	Fauna&Flora14	5	33
	Fauna&Flora10	4	17
	Fauna&Flora19	2	10
	Fauna&Flora12	11	48
	Fauna&Flora15	4	29
	Fauna&Flora13	3	12
	Fauna&Flora9	3	13
	Fauna&Flora11	1	10
	Fauna&Flora8	2	11
	Fauna&Flora18	0	0
	Fauna&Flora17	5	23
	Fauna&Flora16	1	7
	Fauna&Flora20	0	0
	Fauna&Flora21	5	19
	Fauna&Flora22	0	0
	Fauna&Flora23	0	0
	Fauna&Flora24	0	0

Figure 6-2 Number and percentage of flora species of concern

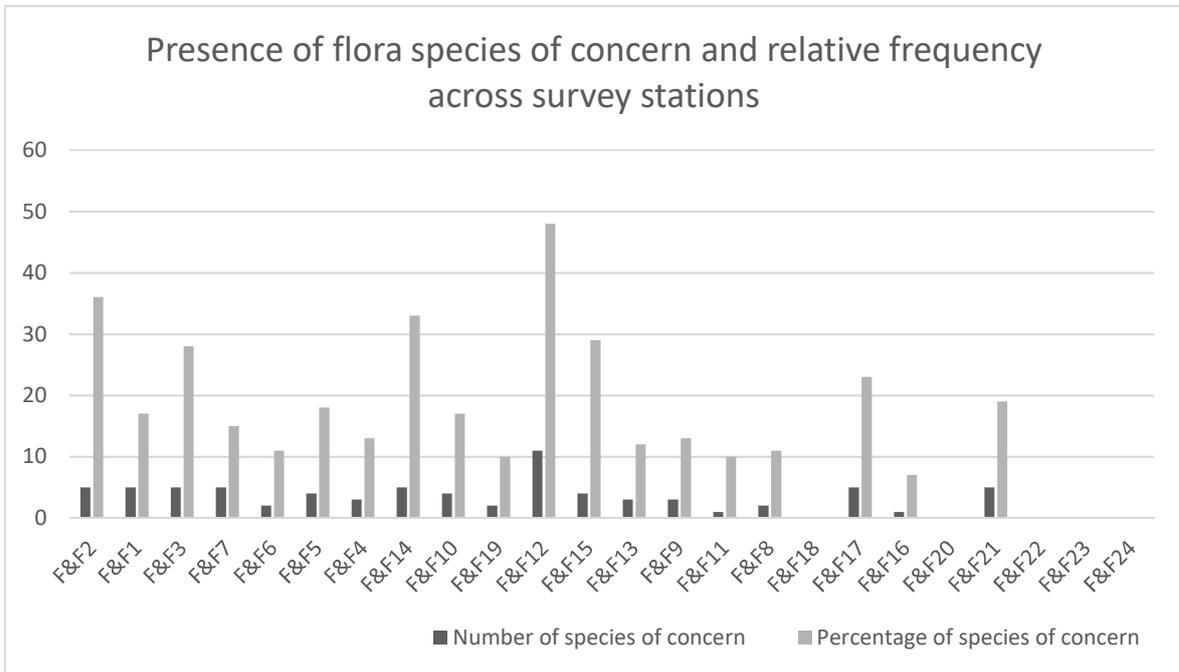


Table 6-2 identifies the threatened and vulnerable flora found within the study area (i.e. core area plus areas adjacent to the access road and transmission line). The majority of flora species listed as either threatened or vulnerable are timber species harvested for the local or export trade. Most of the area downstream of the dam has been affected by commercial timber harvesting, village settlements and gardens. With the exception of approximately 100m of access road, the road alignment from the powerhouse to the intersection with Black Post Road, and all of the transmission line, will be located within existing highly modified habitat.

Table 6-2 Threatened and vulnerable species of flora

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
Lowland forest, open vegetation, secondary regrowth along transmission line corridor – Station #1	Canarium indicum	Ngali, Canarium nut	Planted, Few Trees	Threatened	Planted food nut tree, also used for timber
“	Intsia bijuga	Kwila, Iron wood	Few Trees	Threatened	High value timber species
“	Pometia pinnata	Pometia, Taun	Few Trees	Threatened	High value timber species
“	Vitex cofassus	Vitex, Vasa	Few Trees	Threatened	High value timber species
“	Alstonia scholaris □	Alstonia, Milky Pine	Few Trees	Threatened	Export timber species
Lowland forest on ridge-tops along access road corridor – Station #1	Pometia pinnata	Pometia, Taun	Few Trees	Threatened	High value timber species
“	Canarium indicum	Ngali, Canarium nut	Planted, Few Trees	Threatened	Planted food nut tree, also used for timber
Lowland forest on ridge-tops along access road corridor – Station #2	Calophyllum peekelii	Calophyllum	Uncommon	Threatened	Export timber species
“	Syzygium onesima	Syzygium	Uncommon	Threatened	Shrub species
“	Syzygium tierneyana	Syzygium	Uncommon	Threatened	Shrub species
“	Syzygium myriadena	Syzygium	Uncommon	Threatened	Shrub species
“	Canarium salomonense	Small □ Ngali nut, Canarium	Uncommon	Threatened	Planted food nut tree, also used for timber
“	Pometia pinnata	Pometia, Taun	Uncommon	Threatened	High value timber species
“	Intsia bijuga □	Kwila, Iron wood	Uncommon	Threatened	High value timber species

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
"	<i>Calanthe longifolia</i> □	Terrestrial Orchid	Uncommon	Threatened	
"	<i>Calophyllum paludosum</i>	Calophyllum	Rare, Uncommon	Vulnerable	Export timber species
"	<i>Pterocarpus indicus</i>	Rose wood	Uncommon	Threatened	High value timber species
Lowland forest on ridge-tops along access road corridor – Station #3	<i>Cycas seemannii</i>	Cycad	Rare, Uncommon	Vulnerable	
"	<i>Pterocarpus indicus</i>	Rose wood	Uncommon	Threatened	
"	<i>Calophyllum peekelii</i>	Calophyllum	Common	Threatened	Export timber species
"	<i>Pometia pinnata</i>	Pometia, Taun	Uncommon	Threatened	High value timber species
Lowland Forest - Power Plant – Station #2	<i>Calophyllum peekelii</i> □	Calophyllum	Common	Threatened	Export timber species
"	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
"	<i>Syzygium onesima</i>	Syzygium	Common	Threatened	
"	<i>Canarium salomonense</i>	Small Ngali nut, Canarium	Uncommon	Threatened	Planted food nut tree, also used for timber
"	<i>Vitex cofassus</i> □	Vitex, Vasa	Uncommon	Threatened	High value timber species
Lowland forest - Secondary regrowth and riparian vegetation – Reservoir Station #1	<i>Vitex cofassus</i> □	Vitex, Vasa	Uncommon	Threatened	High value timber species
"	<i>Pometia pinnata</i>	Pometia, Taun	Uncommon	Threatened	High value timber species

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
"	<i>Drymophloeus salomonense</i>	Drymophloeus	Uncommon	Threatened	Palm
"	<i>Calophyllum peekelii</i> □	Calophyllum	Uncommon	Threatened	Export timber species
"	<i>Elaeocarpus sphaericus</i> ^[1] _[SEP]	Elaeocarpus	Uncommon	Threatened	
Lowland forest overlapping secondary vegetation (old garden and village site) – Reservoir Station #2	<i>Pometia pinnata</i> □	Pometia, Taun	Common	Threatened	High value timber species
"	<i>Canarium indicum</i>	Ngali nut, Canarium	Uncommon	Threatened	Planted food nut tree, also used for timber
Lowland forest - Secondary regrowth on a very steep slope – Reservoir Station #3	<i>Pometia pinnata</i> □	Pometia, Taun	Common	Threatened	High value timber species
"	<i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened	Timber species
"	<i>Terminalia brassii</i> ^[1] _[SEP]	Brown □ Terminalia Swamp Oak □	Uncommon	Threatened	Export timber species
"	<i>Alstonia scholaris</i> ^[1] _[SEP]	Alstonia, Milky Pine □	Common	Threatened	Export timber species
Lowland forest - Riparian vegetation – Reservoir Station #4	<i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened	
"	<i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Uncommon	Threatened	Export timber species

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
“	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
Riparian Vegetation – Dam Station #1	<i>Pometia pinnata</i> □	Pometia, Taun	Common	Threatened	High value timber species
“	<i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened	
“	<i>Nastus obtusus</i> □	Bamboo	Uncommon	Vulnerable	
Secondary Lowland Forest – Dam Station #2	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
“	<i>Palaquium firmum</i>	Pencil Cedar	Uncommon	Threatened	Export timber species
“	<i>Calophyllum peekelii</i>	Calophyllum	Uncommon	Threatened	Export timber species
Old Garden Area – Secondary Forest – Dam Station #3	<i>Pometia pinnata</i> □	Pometia, Taun	Common	Threatened	High value timber species
Lowland forest and Riparian Vegetation on very steep cliff substrate – Dam Station #4	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
“	<i>Terminalia brassii</i> □	Brown Terminalia, Swamp Oak	Common	Threatened	
Lowland forest - Secondary Vegetation	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
Uphill forest - Riparian vegetation on Very Steep Cliff Substrate – Cliff Station #1	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
"	<i>Cycas seemannii</i>	Cycad	Uncommon	Vulnerable	
"	<i>Pandanus</i> sp? □	Pandanus	Uncommon	Threatened	
"	<i>Pholidota</i> sp? □	Orchid □	Uncommon	Vulnerable	
"	<i>Spathoglottis plicata</i> □	Ground Orchid	Common	Vulnerable	
Uphill forest - Riparian vegetation on Very Steep Cliff Substrate – Cliff Station #2	<i>Terminalia brassii</i> □	Brown Terminalia, Swamp Oak	Common	Threatened	
"	<i>Pometia pinnata</i> □	Pometia, Taun	Common	Threatened	High value timber species
"	<i>Pterocarpus indicus</i> ^(L) _(SEP)	Rose wood	Common	Threatened	
"	<i>Elaeocarpus sphaericus</i> ^(L) _(SEP)	Elaeocarpus	Common	Threatened	
Lowland - Riparian vegetation – Upstream Station #1	<i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened	High value timber species
"	<i>Terminalia brassii</i> □	Brown Terminalia, Swamp Oak	Common	Threatened	
"	<i>Crinum asiaticum</i> □	Crinum, Lilly	Uncommon	Threatened	
"	<i>Pterocarpus indicus</i>	Rosewood	Common	Threatened	
"	<i>Calophyllum peekelii</i>	Calophyllum	Common	Threatened	Export timber species

Location	Species	Common Name	Distribution Status within Study Area	Protection Status	Comments
Lowland - Riparian vegetation – Upstream Station #2	Paraserianthis falcata □	Albizia	Common	Threatened	
“	Pometia pinnata □ □	Pometia, Taun	Common	Threatened	High value timber species
“	Vitex cofassus	Vitex, Vasa □	Common	Threatened	High value timber species
“	Calophyllum peekelii ¹¹ SEP	Calophyllum	Common	Threatened	Export timber species
“	Alstonia scholaris ¹¹ SEP	Alstonia, Milky Pine	Uncommon	Threatened	Export timber species
Lowland - Riparian vegetation – Upstream Station #3	Terminalia brassii	Brown Terminalia, Swamp Oak	Common	Threatened	
“	Calophyllum peekelii	Calophyllum	Common	Threatened	Export timber species
“	Pterocarpus indicus	Rose wood	Common	Threatened	
“	Pometia pinnata	Pometia, Taun	Common	Threatened	
“	Paraserianthis falcata □	Albizia	Uncommon	Threatened	

6.3.4 Plant Diversity and Protected Area Status

The project area lies outside any formally recognized protected areas. However, there are nearby areas that are considered to be of great landscape and biodiversity value, and are either protected or could be considered for protection. Despite its great biodiversity and landscape richness, the Solomon Islands has one of the poorest records for forest protection in the world, with only 0.28% of its terrestrial territory included in protected areas (WWF, 2005).

6.3.4.1 World Heritage Site

Guadalcanal does not have any World Heritage sites. However, one site, the Tropical Rainforest Heritage of Solomon Islands, is on its Tentative List (UNESCO, 2013). This site is comprised of four areas that, together, cover approximately 1500km²:

- Mt. Popomanaseu region of Guadalcanal Province;
- Bauro Highlands of Makira-Ulawa Province;
- Mt. Maetambe region of Choiseul Province; and
- Central caldera forests of Kolombangara of Western Province.

Mt Popomanaseu region includes the nearby forest catchment and lowland valleys of the Itina River, which flows towards the windward coast. It partially overlaps the Tina River Catchment. The lowland riverine forests and montane forests, which make up this site, are intact. According to UNESCO, this site offers the best chance of conserving representative, distinctive and unique biodiversity. This area has outstanding biodiversity and a high proportion of endemic plants and wildlife (up to 75% of known species are endemic). The proposed area supports the largest contiguous area of montane forests in the country. Due to limited surveys, it is suspected that many of its species have not yet been identified. Endemic means that a species is only found in a restricted area, such as Guadalcanal. The area is customary land and any formal or informal protection would require the support of the local landowning tribes.

Unfortunately, the Sutakiki River headwaters of the Mt. Popomanaseu area are currently being prospected for gold, copper and zinc (Veronica Webster Pty. Limited, 2012).

6.3.4.2 National Park

Queen Elizabeth National Park is the only National Park in Guadalcanal Province. It covers an area of 1093 ha, and is located approximately 5km South of Honiara, along the Lungga River between the Matanikau River, Kolaa Ridge and Mount Austen. The British High Commissioner declared the area as a National Park in 1953. The local population disputed the government's right to use the land, and cleared vegetation to make way for farming instead. By the time money was allocated to rangers to protect the Park, squatters and farmers had already cleared much of the rainforest of Mount Austen. Today the National Park is highly degraded (Tedder, 2008). The National Park does not share any boundaries with the Project, or the Tina River catchment.

6.3.4.3 Areas with Informal Protection

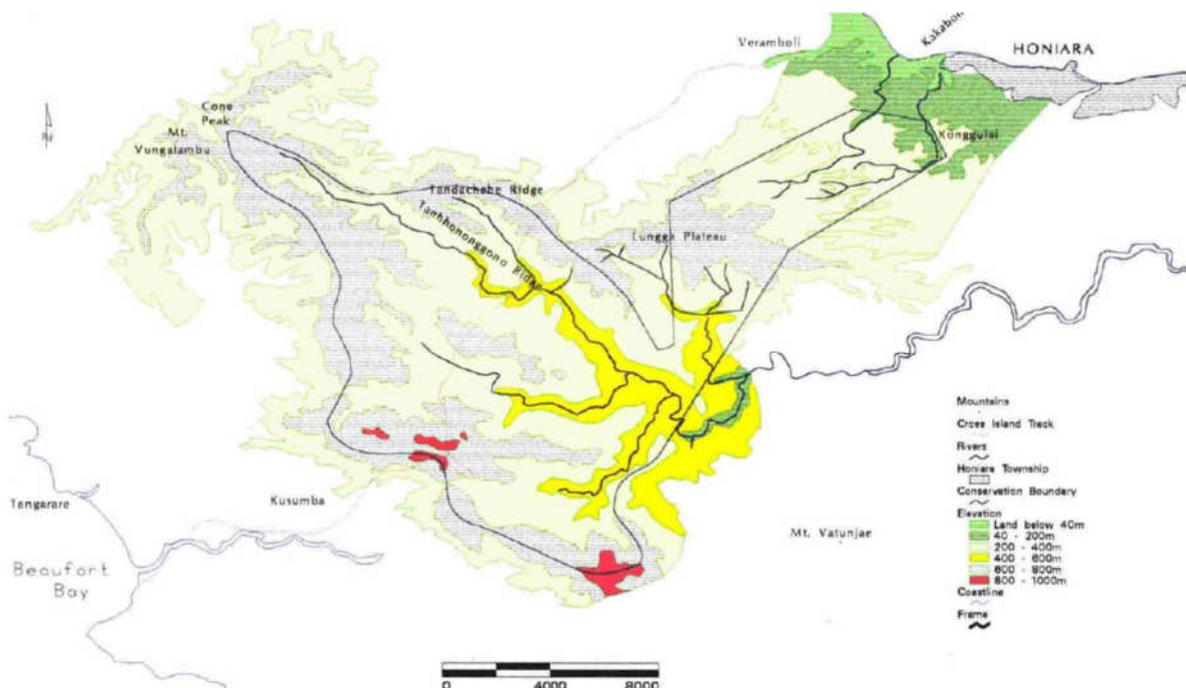
Informal protection of many small, natural sites is afforded by the local population, which protects these areas in a traditional manner. These sites are named “tambu” (for more information see Section 8). However, with modernization, traditional sacred beliefs associated with these sites have been eroded, and their protection is, therefore, threatened.

Komarindi Conservation Catchment Area (KCCA), located 30km west of the Project’s Core Area, is a vast informally protected area, managed under customary estates. It was established as a Wildlife Sanctuary in the early 1990s, and covers an area of 19,300 ha. A community-based ecotourism development program functioned from 1997 to 1999 but was terminated due to ethnic unrest. Support for the conservation project came principally from the (then) Solomon Islands Department of Forests, Environment and Conservation (DFEC), the South Pacific Biodiversity Conservation Programme (SPBCP), and the South Pacific Regional Environment Programme (SPREP) (SPREP, 2013).

The KCCA was designed in conjunction with the Komarindi Hydroelectric Power Project, and was supposed to be integrated with the hydropower scheme, which was never implemented (SPREP, 2013). The parallel development of the KCCA ecotourism program and the Komarindi hydroelectric scheme was supposed to provide an opportunity for SIG to implement a locally-managed, integrated conservation and hydropower project, and to achieve economic and social benefits for the local landowners and the wider community, while conserving the natural environment and cultural heritage (SPREP, 1996).

Since the late 1990s, the KCCAP has ceased to function and there are no longer any ecotourism activities. Figure 6-4 shows the boundaries of the KCCA.

Figure 6-3 The former KCCA boundaries



Source: SPREP, 1996

6.3.5 Conclusions on Flora

The tropical forests from PNG, along with the forests of the Solomon Islands, represent the largest block of tropical rainforests in the Asia-Pacific region, and are part of the three great rainforests of the planet (WWF, 2005). As shown in Table 6-3, forests have high ecological values, and play an important role for people's livelihoods, providing sources of timber, medicinal plants, food and wood fuel.

The forests of Guadalcanal, especially the lowland forests such as those of the Project site, are threatened by logging, which is considered an important source of income for the country. According to FAO (2009), deforestation is a result of an increased population on the island, and is influenced by a high demand for agricultural land, new settlements, and timber.

The study area encompasses the Core Area around the Tina River, as well as the access and transmission line corridors, which traverse primarily grassland and plantation areas. The primary habitats of the study area are comprised of forested and non-forested ecosystems, which represent a mix of modified and natural habitats. The Tina River catchment upstream of the dam site, is dominated by highly valued, undisturbed lowland forest and, in its upper portion, undisturbed montane forest, whereas, the area downstream of the dam site near Choro, is dominated by disturbed forests. This is mainly the result of anthropogenic activities (e.g., logging, settlements, garden, trails, etc.). However, even though the forests are disturbed, they still show rich plant diversity, which is a factor of rapid vegetation regeneration due to a tropical humid climate and fertile soils. Indeed, disturbed forests are quickly recolonized by various second growth species of trees, shrubs and herbaceous plants. The Tina River catchment is primarily dominated by forests, with some grassland areas on its northern side. The mid-river catchment is dominated by lowland forests, whereas, the upper catchment is dominated by montane forests.

Table 6-3 Summary of habitat ecological values

Habitat Units	Location Relative to Project Components	Ecological value
Grassland	Transmission line and access road	Moderate
Undisturbed forest (primary lowland forest)	Reservoir and dam abutments	High
Undisturbed forest, montane forest	No interaction	High
Disturbed forest (secondary lowland forest)	Transmission line, access road, reservoir and dam abutments	Moderate
Remnant forest (secondary forest colonized by pioneer species)	Transmission line, access road, reservoir and dam abutments	Moderate
Riparian	Dam, reservoir and reaches downstream of dam	High
Cliffs	Dam and reservoir	High

Habitat Units	Location Relative to Project Components	Ecological value
Garden	Transmission line and access road	Low
Fallow brush land	Transmission line and access road	Low
Oil palm	Transmission line and access road	Low
Settlements	Adjacent to transmission line, access road and reaches downstream of dam	Low

The Project footprint, including areas of inundation during operation, access and construction activity, will affect parts of the study area which are largely disturbed forest and modified grassland with extensive and ongoing anthropogenic change.

6.4 TERRESTRIAL FAUNA

6.4.1 Methodology

Visual and auditory encounter surveys (diurnal and nocturnal), plot counts and mist netting, were used to identify terrestrial vertebrate, birds, reptiles, amphibians, and mammals. Informal interviews were carried out with villagers to determine the presence of important species. Point counts involved visual and auditory surveying from a set location (sampling station) for a duration of 20 minutes. Binoculars were used for the visual surveys. All faunal species (amphibians, birds, mammals and reptiles) observed (seen or heard) during the sampling period, were recorded. Sampling effort was the same for each station, with approximately 30 minutes per station. Mist netting involved the placement of 8 mist nets (15m x 2m, 20mm mesh size) at sampling stations to capture and record birds and mammals. Nets were placed in forested areas, and also in locations adjacent to waterways. Informal interviews with local populations were carried out to obtain local knowledge about important fauna, habitats, and associated use of fauna by local communities. These informal interviews resulted in the recording of local knowledge.

'Potential Presence' of each species in the Tina River study area was based on a review of the following available literature, and on species observations made in close proximity to the study site:

- TRHDP ESIA Scoping Study (Entura, 2011);
- Birds of Melanesia (Dutson 2011);
- Guadalcanal Island Bird Checklist (Tarburton 2007);
- Frogs of the SI (Pikacha et al. 2008);
- Reptiles of the Solomon Islands (McCoy 2006); and
- Gold Ridge Report (Ross Mining N. L. 1997) since Gold ridge mines are located nearby the Project site.

6.4.2 Terrestrial Fauna Survey Results

6.4.2.1 Invasive and Feral Species

Feral animals such as cats and rats, introduced species such as cane toads, invasive plants (e.g., *Merremia peltata*), and introduced trees (e.g., paper mulberry) are widely distributed in the study area. Feral cats are a major threat to many vertebrate species, such as ground nesting birds, and introduced rats compete with native rats and prey on fledgling birds and eggs (Pikacha, 2008). Cane toads have a devastating effect on the population of indigenous frogs (Pikacha, 2008), as they are aggressive predators of native frog species. Moreover, eggs and tadpoles are poisonous and affect native tadpoles that eat them (IUCN, 2014). These species were observed by the ESIA team as far upstream as the upper Tina River catchment area.

The Giant African Snail was introduced into Solomon Islands, most likely by foreign logging machinery contaminated with soil containing eggs and juvenile snails. It competes with native species and damages food crops. During mitigation workshops, it was mentioned that the Giant African Snail had already reached Veraande village (along Black Post Road) and is a concern for villagers.

Insects such as the fire ants (*Wasmannia auropunctata*) are also a concern. Pathways created by logging roads have allowed this aggressive ant species that affects native insect biota to colonize new sites.

6.4.2.2 Game Species

Some species in the area are opportunistically hunted for food. According to social surveys on food eaten by households in the Project area (see Annex 6 of the Annex Report), except for wild pigs, game species were not declared as a significant part of people's diet. The harvesting pressure on game species around villages is unknown. However, people from surveyed villages sometimes go to the upper Tina River catchment on hunting trips.

6.4.2.3 Amphibians

Amphibians are sensitive animals, and are often seen as good indicators of ecosystem health. This is due to their dependence on certain moisture regimes and their sensitivity to pollutants, as they are able to 'breathe' through their skin. Therefore, amphibians require moist environments that are relatively pollutant free. Along the Tina River, flash floods bring water to riverine wetlands, these riverine wetlands are valuable habitats for amphibians. Heavy rainfalls in the project areas also bring moisture to forested areas. Amphibians are not highly mobile and, therefore, any changes to their habitat could lead to impacts on species. See Appendix B for a listing of amphibian species by family, including scientific and common names.

A total of 9 amphibian species were observed from a total of 13 potential species²⁶ from 4 families. This represents 64% of all amphibian species expected to occur within the Project study areas. None of the amphibian species is endemic to Guadalcanal or the Tina River catchment.

²⁶ The term 'potential species' is defined as species that were found in the vicinity by previous studies and have a likelihood of being present, even if they were not observed in the course of this study.

Three native frog species deserve particular mention and are discussed below along with their relative vulnerability to the project.

Solomon Island's Treefrog (*Litoria lutea*) - This frog is deemed ecologically important because of its vulnerability based on the IUCN Red List assessment (IUCN, 2013). It is a rare forest frog in the Solomon Islands, and little information about it is available (Pikacha *et al.*, 2008). It inhabits the upland forest habitats and was observed there during the ESIA field investigations. The Project would have minimal, if any, impacts on this species as it will not impact upland forest habitats.

Giant Webbed Frog (*Discodeles Cornufer guppyi*) - This frog is deemed ecologically important because of its dependence on the river system and is usually found along smaller rivers and streams (Pikacha *et al.*, 2008). It is the largest frog in the Solomon Islands, and members of local communities report eating it. This species belongs to the riparian habitat. It was observed only in the upper catchment in small streams²⁷.

San Cristobal Treefrog (*Hylarana Papurana krefftii*) – This frog is deemed ecologically important because of its dependence on the river system. It is an aquatic breeder that lays eggs in pools of water (Pikacha *et al.* 2008). It is the only Solomon Islands frog that has a tadpole stage, as opposed to direct development evident in the Ceratobatrachidae frogs (Figure 6-5). The species is found in the riparian habitats. Possible impacts of the Project on this species include loss of its wetland habitats for feeding. The creation of a dam may increase habitats for breeding.

Figure 6-4 San Cristobal Treefrog tadpoles and eggs



Figure 6-6 is a photo of two species of frogs found within the study area.

²⁷ Personal Communication with Pikacha 2016.

Figure 6-5 Weber's Wrinkled Ground Frog (left) and Solomon Islands Eyelash Frog (right)



Source: Edgard Pollard 2013

6.4.2.4 Insects

Species of damselfly (Odonata spp.), including *Neurothemis stigmatizans*, *Neurothemis terminata* and *Xiphiagrion cyanomelas* were commonly observed along the Tina River, and its adjacent micro-wetlands. The life cycles for these species are closely linked to the Tina River and riparian habitats, since they spend much of their life cycles as benthic organisms. Flash floods can occasionally convey water to small branches of the river allowing the Odonata to breed and reproduce there.

Photographs of four species of damselflies are shown in Figure 6-7

Figure 6-6 Odonata species observed during field surveys



Neurothemis stigmatizans (left) and *Neurothemis terminata* (right)



Xiphiagrion cyanomelas (left) and Odonate imago (juvenile) (right)

Many spiders were observed along the Tina River, including Spiny orb-weavers of the genus *Gasteracantha* and spiders of the genus *Argiope*.

6.4.2.5 Reptiles

Reptiles are important animals of the forest and provide a large proportion of faunal biomass, thus playing an important role in the food web of the ecosystem. Reptiles are ectotherms and require heat from the sun. Their body heat is regulated externally, similar to amphibians. Therefore, they can also be susceptible to changes in micro-habitats. Due to their size, reptiles are not considered to be very mobile species, and changes to their environment often lead to impacts, such as interactions with road vehicles, with damaging consequences to the reptile. Appendix C lists reptile species by family, including scientific and common names.

A total of 5 reptile species were observed from a total of 23 potential species representing 5 families. This is about 22% of all reptile species expected to occur within in the general study area. The ESIA team has observed evidence of salt-water crocodiles (*Crocodylus porosus*) in the mouth of the Ngalimbiu River. According to villagers, adjacent wetlands are used by the crocodiles.

The relative importance of 5 of the reptile species expected to occur within the general study area and their relative vulnerability to the project are discussed below.

Guadalcanal Bow-fingered Gecko (*Cyrtodactylus biordinis*) - This gecko is deemed ecologically important because it is a Guadalcanal island endemic (McCoy, 2006). It is commonly found on smaller trees and within tree hollows where it lays its eggs. In forested habitats it feeds on insects, especially moths. It is not considered as threatened. However, it will be affected by construction activities, such as forest clearing.

Solomon's Bent-toed Gecko (*Cyrtodactylus salomonensis*) - This species has been listed on the IUCN Red List (IUCN, 2013) as Near Threatened. It is also an endemic species that thrives in forested habitat up to 400masl, where it lives in the forest canopy. Its population is currently listed as static. It is a strictly arboreal species found in larger trees. In Solomon Islands, it is threatened by logging activities and the illegal pet trade. The TRHDP will overlap with the lower elevation range of this species, but not its upper elevation range. Given the relatively small footprint of the Project relative to the extensive area of available forested habitat upstream of the dam, the impacts accruing to this species as a result of the Project are expected to be minimal.

Prehensile-tailed Skink (*Corucia zebrata*) - This skink is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013). It is endemic to the Solomon Islands (McCoy, 2006) and is classed as Near Threatened on the IUCN Red List (IUCN, 2013). It is also opportunistically hunted for food. This species is probably the largest skink in the world and prefers large trees with dense foliage in forest habitats. It has a vegetarian diet and feeds on vine leaves, vines, fruits and flowers. It may be threatened by habitat loss and so may be affected by project related construction activities, such as forest clearing.

Schmidt's Crocodile Skink (*Tribolonotus schmidtii*) - This skink is deemed ecologically important because it is a Guadalcanal island endemic (McCoy, 2006). It is relatively common and prefers moist areas under fallen and rotting timber in forest habitats, where it feeds on insects. It is not threatened. However, it will be affected by construction activities, such as forest clearing.

Solomons Ground Boa (*Candoia paulsoni*) - This common snake is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013). It occurs in a wide variety of habitats, from forests to gardens, and feeds on frogs, skinks and smaller snakes. It is not threatened. However, it will be affected by construction activities such as forest clearing and, being a snake, probable persecution by workers.

Figure 6-8 includes photos of two different species of skinks that occur within the study area.

Figure 6-7 Pacific Black Skink (left) and Solomons Blue-tailed Skink (right)



Source : Edgard Pollard 2013

6.4.2.6 Avifauna (Birds)

There are a wide variety of birds that occupy different ecological niches, in various habitats, from grasslands to waterways to upland forests. Birds play an important ecological role in the dispersal of plant seeds, the control of insects and the pollination of plants, amongst other things. Specialist birds that occupy very narrow niches are very good environmental indicators as their disappearance indicates a degraded habitat. Appendix D lists bird species by family, including scientific and common names, along with their CITES or IUCN (Red List) status, and endemism, and their relative vulnerability.

A total of 41 bird species, representing 28 families, were observed out of a total of 67 potential species previously recorded. This is around 61% of all birds expected to occur in the general study area.

Of the species of birds that potentially occur within the study area, one species – the White-eyed Starling (*Aplornis brunneicapilla*) -- is listed as endangered on IUCN's Red List (IUCN, 2013). As a result of this status, it is deemed ecologically important. Although not listed as a Guadalcanal endemic, it is identified as a Solomon Islands endemic (Dutson, 2011), where it is found in forested habitats, feeding on insects, flowers and fruits. It is threatened by habitat loss and human predation. The ESIA and feasibility report baseline studies did not detect presence of this species in the study area, which extends several kilometers beyond the extent of project construction and operation activities. While the species does appear to have some reliance on primary forest for nesting (in colonies in trees with high epiphyte cover), it also regularly feeds in semi- and heavily-degraded areas, where small fruit trees provide abundant food.²⁸ Even when present, it is not always easy to find this species during field surveys, and it appears to have seasonal or interannual movements which are not yet understood.²⁹ There is thus potential for the species to use the project area, for example on a seasonal or periodic basis in response to fruit availability.

An additional seven species of birds (see Table 6-4) that could potentially occur within the study area, are listed as vulnerable or near threatened. Of these, only four species were observed during field investigations. These four species are discussed below:

Solomon Sea-Eagle (*Haliaeetus sanfordi*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013) and its vulnerability based on the IUCN Red List assessment (IUCN 2013). It is also important as being endemic to Solomon Islands (Dutson, 2011). It feeds mainly on pigeons, doves, fish, possums and lizards. The eagle is wide ranging, from coast to upland forests, and is found throughout the entire study area. Although it is considered to be rare, it was observed at sampling site #5 on the proposed transmission line corridor, and above the proposed dam site at upstream sampling station #1. The Project will likely have only minimal impact on it, given that the project footprint is small in relation to its wide-ranging territory, and parts of the range it inhabits will not be affected by project construction.

Guadalcanal's Rail (*Hypotaenidia woodfordi*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011) and is classified as being Near Threatened on IUCN's Red List (IUCN, 2013). It is opportunistically hunted by inhabitants of local communities as a source of food. During the ESIA field studies, it was observed at sampling stations #1 and #3 along the proposed transmission line corridor, where the forest habitat has already been significantly modified. The impacts of the hydropower project on this rare rail should be minimal because the project is not expected to have significant impacts on the thicket and grassland habitat where it occurs.

²⁸ Guy Dutson, *in litt.* 2017; Chris Filardi, pers. comm. 2017

²⁹ Chris Filardi, pers. comm. 2017

Red-knobbed imperial pigeon (*Ducula rubricera rufiglia*) – This bird is deemed ecologically important because it is listed as Near Threatened on IUCN's Red List (IUCN, 2013) due to rates of deforestation largely associated with development of oil palm plantations. It is found on nearly all forested islands in Solomon Islands and inhabits lowland rainforest up to 1,200m on Guadalcanal. Although it is still common where extensive forest remains, it is much rarer in degraded habitats. Its population is suspected to have declined rapidly in recent years due to ongoing clearance of lowland forest, at least in parts of its range. During the ESIA field studies, this species was observed at multiple sampling stations throughout the study area. Owing to the relatively small footprint of the hydropower project, the widespread distribution of this species within the study area, and its wider distribution in unaffected rainforest areas at elevations well above the TRHDP, the Project is unlikely to have only minimal potential impact on this species of bird.

Crested Cuckoo-Dove (*Reinwardtoena crassirostris*) – This bird is deemed ecologically important because it is listed as Near Threatened by IUCN's Red List (IUCN, 2013), primarily as a result of removal of lowland forests. It is a large pigeon endemic to Bougainville (Papua New Guinea) and Solomon Islands, where it occurs at relatively low densities that suggest the total population is small. It may be declining rapidly in the lowlands, although the hill populations are probably declining very slowly. Within the study area, it was observed on the right bank of the river, which is an area that has been previously logged and has secondary forest regrowth. Given that the Project footprint is primarily in areas where populations have already been affected (i.e., close to village settlements and where commercial tree harvesting has already occurred), it is unlikely to have an effect on this species. Further, the Project will not materially affect hilly, forested areas outside the Tina River Gorge, where populations of this species are considered to be less threatened.

Table 6-4 Near to threatened and vulnerable bird species

Scientific name	Common name	IUCN category	Population trend	Observed in ESIA Extended ³⁰
<i>Haliaeetus sandfordi</i>	Solomon sea eagle	Vulnerable	Declining	Yes – Station TL5; Upp1
<i>Hypotaenidia woodfordi</i>	Guadalcanal rail	Near threatened	Declining	Yes – TL1, TL3
<i>Ducula rubricera rufigila</i>	Red-knobbed imperial pigeon	Near threatened	Declining	Yes – multiple stations and reports
<i>Reinwardtoena crassirostris</i>	Crested cuckoo dove	Near threatened	Declining	Yes - Tun
<i>Chamosyna margarethae</i>	Duchess lorikeet	Near threatened	Declining	No
<i>Edolisoma holopolium</i>	Solomon cicadabird	Near threatened	Declining	No
<i>Monarchus b. barbatus</i>	Solomon's monarch	Near threatened	Declining	Yes – Res3, Dam2

³⁰ The extended ESIA includes the ESIA survey stations, the scoping study by Entura in 2011, and recorded local knowledge

Figure 6-9 includes photos of two different species of Monarch that occur within the study area.

Figure 6-8 Solomons Monarch (left) and Chestnut-bellied Monarch (right)



Source: Edgar Pollard, 2013

6.4.2.7 Mammals

Guadalcanal is home to some of the most cryptic and rare mammals in the Pacific, including flying foxes and giant native rats. Appendix E lists mammal species by family, including scientific and common names.

A total of 5 mammal species were observed out of a total of 14 potential species from 4 families. This is roughly 36 percent of all mammals that are expected to occur within the general study area. The 5 species were the Island Tube nosed Fruit Bat (*Nyctimene major*), the Rousette Bat (*Rousettus Amplexicaudatus*), the Fawn Leaf nosed Bat (*Hipposideros cervinus*) the Solomon's Flying Fox (*Pteropus rayneri*) and the Wild Pig (*Sus scrofa*).

Of the 14 potential mammal species, the relative importance of the 5 most ecologically significant and their relative vulnerability to the project are discussed below.

Solomon's Flying Fox (*Pteropus rayneri*) - This bat is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013) and its classification as Near Threatened by the IUCN's Red List (IUCN 2013), and because it is endemic to the Solomon Islands. It is opportunistically hunted as a food resource by inhabitants of local communities. This large bat is found over a wide variety of habitats, though it uses forests for roosting, especially large trees and caves, and for foraging for fruits. It is threatened by habitat loss and hunting. Forest clearing and removal of big trees for access roads will likely affect the species.

Island Flying Fox (*Pteropus admiralatum*) - This bat is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013). Like the Solomon's Flying Fox, it is also opportunistically hunted as a food resource by inhabitants of local communities. This large bat is found in forest habitats, where it feeds on wild and cultivated fruits. It is threatened by habitat loss and hunting. Forest clearing and removal of big trees to construct access roads will affect the species.

Emperor Rat (*Uromys imperator*) - This species is known from only three specimens collected by Charles Woodford between 1886 and 1888, at Aola, a coastal location on northern Guadalcanal, Solomon Islands (IUCN 2016a).

Listed as Critically Endangered (Possibly Extinct) because it has not been recorded with certainty since three specimens were collected between 1886 and 1888. Anecdotal information suggests that the species survived until the 1960s. This species is quite possibly extinct, however, Guadalcanal has not been adequately surveyed (Lavery 2013). Should this species still exist, it is almost certain to be very few in number.

It seems as though this was a largely terrestrial species that was at one point found throughout much of Guadalcanal, including the dry northern lowlands and areas close to the coast. Later reports suggest that the species became restricted to mossy montane forest (IUCN 2016a).

Recent surveys for native rodents have been conducted at sites between 200m and 1,500m altitude across Solomon Islands using baited camera traps. So far, the emperor rat has not been detected, increasing fears it is extinct. According to Tyrone Lavery of the University of Queensland (Lavery, 2016),

. . . camera traps used to carry out the surveys have provided some alarming data on densities of feral cats present in the archipelago. These data support long-held suspicions that predation by cats has been the main cause of extinction for Solomon Island mammals and ground dwelling birds such as the Makira moorhen.

With respect to the TRHDP, the core area of the Project does not overlap with the mossy montane forest, which is found at higher elevations. Therefore, the Project is unlikely to have any effect on the Emperor Rat, should it still exist on Guadalcanal.

King Rat (*Uromys rex*) - This species is endemic to the island of Guadalcanal, Solomon Islands, but is absent from large parts of the island. It has been recorded at elevations of 20 and 600 masl. It is an arboreal species that has been recorded from primary tropical moist forest, including relict patches of native forest. It is listed as Endangered because its area of occupancy is probably less than 500 km², its distribution is fragmented, and the extent of its forest habitat is declining.

There are few recent records of this species. The most recent recorded captures include a single specimen in 1987 from a relict outlier of tall rainforest in the Poha Valley, approximately 35km west of the Project, and two specimens at Gold Ridge in 1989. An intensive survey of Mount Makarakomburu in 1990 failed to locate the species. Interviews with local inhabitants conducted by Roger James (pers. comm. in IUCN 2016b) suggest that the species may occur elsewhere on the island. However, no specimens have been captured that would confirm this anecdotal information.

Relatively recent records in and near the project area, and some apparent tolerance of the species to forest fragmentation and invasive species, suggest that the King Rat may still persist in the higher quality forests of the project area. The absence of records on project surveys should not be taken as evidence of the species' absence, since it is extremely difficult to survey for rare, nocturnal, arboreal rodents.

Northern Common Cuscus (*Phalanger orientalis*) - Cuscus are the only marsupial mammal in the Solomon Islands. Northern Common Cuscus has a good tolerance to degraded forested areas (IUCN, 2013). It feeds on fruits, leaves and seeds, and dwells in *Ficus* trees. Cuscus forage in the high canopy but will also feed in gardens. Cuscus require shade, moderate temperature and humidity (Pikacha, 2008). The species is nocturnal and sleeps in hollow trees. They mate and give birth only once a year between June and October. They will be affected by project related forest clearing. Figure 6-10 shows an exposed Cuscus following forest clearing.

Figure 6-9 Exposed Cuscus after forest clearing



Source: Pikacha, 2008

Figure 6-11 includes photos of two different species of bats that occur within the study area.

Figure 6-10 Fawn Leaf-nosed Bat (left) and Rousette Bat (right)



6.4.3 Conclusions Based on Fauna Surveys

Valued species occupy ecological niches that can be simplified in four categories:

- Grassland species – which require openings and limited tree cover;
- Forest interior species – which require high canopy coverage and dense vegetation, and do not tolerate openings and dryer environments;
- Disturbed forest and forest edge species – for most of the time these are ubiquitous species, that can occupy a range of ecosystem types;
- Riparian species – which need to be close to rivers and wetlands.

Table 6-5 shows the ecological niche of each valued species.

Table 6-5 Ecological niches occupied by valued species found within the study area

Valued species	Grassland	Forest interior	Disturbed forest and forest edge	Riparian
Amphibians				x
Giant Webbed Frog				
Solomon Island's Treefrog		X		
San Cristobal Treefrog				x
Reptiles				
Guadalcanal Bow-fingered Gecko		X		
Solomons Bent-toed Gecko		X		
Prehensile-tailed Skink		X		
Schmidt's Crocodile Skink		X		
Solomon Ground Boa		X	X	
Birds				
Nankeen Night Heron				x
Little Pied Cormorant				x
Pacific Black Duck				x
Brahminy Kite	X	X	X	x
Pacific Baza	X		X	
Variable Goshawk	X		X	
Meyer's Goshawk	X		X	
Solomon Sea-Eagle	X	X	X	x
Red-backed Button-Quail	x			
Guadalcanal Rail	x			
Common Sandpiper				x
Yellow-bibbed Fruit-Dove		X		
Ducorp's Cockatoo		X	X	
Cardinal Lory		X	X	
Coconut Lorikeet		X	X	
Yellow-bibbed Lory		X	X	
Duchess Lorikeet			X	
Finsch's Pigmy Parrot		X	X	
Eclectus Parrot	x	X	X	
Song Parrot	x	X	X	
Guadalcanal Boobook		X	X	
Blyth's Hornbill		X	X	

Valued species	Grassland	Forest interior	Disturbed forest and forest edge	Riparian
Common (River) Kingfisher				x
Variable Dwarf Kingfisher				x
Cockerell's Fantail		X		
Rufous Fantail		X	X	
Golden Whistler		X	X	
Midget Flowerpecker		X	X	
Black-headed Myzomela		X	X	
Brown-winged Starling	x		X	
White-eyed Starling		X	X	
Mammals				
Solomon's Flying Fox		X	X	
Island Flying Fox		X	X	
King Rat		x (mostly upland forest)		
Emperor Rat		x (upland forest)		

6.5 WILDLIFE HABITAT VALUE DELINEATION

This section describes the value of the general habitat types for terrestrial wildlife (highly valued, moderately valued, weakly valued) in all study areas. This section also defines what are considered to be the important habitats found within the study area from a strictly biological point of view. These include areas: with protected species colonies; with endemic species, with migratory species; and with endangered species. Natural habitats include grassland, riparian and forests.

6.5.1 Natural habitat and critical natural habitat

Forests provide high ecological values, as they play an important role as wildlife habitat, and provide livelihood for inhabitants of local communities who selectively harvest timber, obtain medicinal plants, and hunt and forage for food (fruits, nuts, wild game), fuel and non-wood products. The forests of Guadalcanal, especially lowland forests, are threatened by logging which provides an important source of income for the country. However, according to FAO (2009), deforestation is also a result of increasing population in the islands that fuels demand for rising agricultural activities, new settlements, and timber harvesting.

After the tropical forests of PNG, the forests of the Solomon Islands comprise the largest block of tropical rainforest in the Asia Pacific region, and are one of the three great rainforests of the planet (WWF, 2005).

Appendix F contains information on the types of natural habitat found within the Tina River

catchment, the characteristics of each habitat type (vegetation assemblage, elevation, etc.), the ecological value of each type of habitat, and provides photographs to illustrate how the habitat typically appears. The map in Figure 6-12 illustrates the different habitats and land use of the study area.

The World Bank considers conservation of natural habitats, particularly Critical Natural Habitats, as essential for long-term sustainable development and supports projects that apply a precautionary approach to natural resource management.

Natural Habitats are defined as areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.³¹

Critical Habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered or Endangered species; (ii) habitat of significant importance to endemic and/or restricted range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened or unique ecosystems; and/or (v) areas associated with key evolutionary processes.³² The World Bank does not support projects that involve significant conversion or degradation of natural habitat unless :

- No other viable alternatives within the region exist for development of the project on modified habitat;³³
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and
- Any conversion is mitigated according to the mitigation hierarchy.

In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible.³⁴

The World Bank does not support projects in areas of critical habitat unless:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the project management program.

³¹ World Bank Performance Standard 6

³² Ibid.

³³ Performance Standard 6 defines modified habitats as areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological function. Note that a modified habitat may also be a critical habitat if it meets any of the criteria in the critical habitat definition above.

³⁴ Performance Standard 6

Where a project is able to meet all of those requirements, the mitigation strategy must be described in a Biodiversity Action Plan and must be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.³⁵

For the purpose of habitat analysis, the study area has been divided into three sub-regions based on elevation: the higher elevation area of the upper Tina River catchment (above 400 masl) which lies to the south, and is dominated by undisturbed montane forests; the mid-elevation river gorge area which is dominated by lowland forests modified by extensive logging and semi-commercial timber operations, as well as gardens and habitation clearings; and the lower elevation area which is dominated by grassland and plantations within the downstream (northern) Tina River catchment. The degree of anthropogenic modification increases markedly with decreasing altitude, with a large proportion of the Project area comprising modified habitats.

The TRHDP will be located within the mid-elevation river gorge and downstream catchment areas where human settlements and commercial logging activities have previously contributed to habitat alteration. No critically endangered or endangered terrestrial or aquatic species have been found within these project-affected areas. Likewise, the area does not support any areas associated with key evolutionary processes or globally significant numbers of migratory or congregatory species. Whilst there are restricted-range and endemic species, the habitat available within these project-affected areas represents only a small portion of larger habitat area available to these species adjacent to, and upstream of, the proposed development.

Except for the upper catchment area, most habitats in the vicinity of the project site are not in a pristine state, having been used and degraded, to a certain extent, by human activity including clearing land to establish settlements and gardens, and commercial and artisanal logging.

The undisturbed montane forest above 400masl in the upper catchment to the south and east of the dam site and reservoir, and remaining areas of undisturbed lowland forest below 400 masl, qualify as critical habitat because of this ecosystem's limited global distribution and particularly unique assemblages of species.

The TRHDP footprint represents a very small proportion of the overall Tina River catchment (<3% of land area) and only directly impacts a very small area of natural forest which could potentially be considered Critical Habitat. These impacts are not considered significant.

A range of measures will be implemented to mitigate against impacts on natural habitat, indirect impacts to the Critical Habitat, to provide for no net loss of biodiversity, and to achieve net gains of those biodiversity values for which the potential critical habitat was designated.

The Project will take a series of steps to protect the upper Tina River catchment. Immediate protection measures will include actions of the TCLC and Project Company to restrict access to vehicles (including commercial logging machinery) to the upper catchment through the Core Area, to monitor changes in forest coverage in the upper catchment, to monitor logging truck activity on existing logging roads, and to support SIG to enforce seldom used statutory restrictions on logging at elevations above 400 masl (which if enforced would represent the vast majority of the upper catchment).

³⁵ Ibid.

This protection work will be furthered by Project Office funding for an NGO to facilitate consultations with customary landowners to seek support for the creation of a protected area in the upper catchment and to conduct mapping and forestry studies, towards preparation of a management plan. The NGO will work closely with customary landowners as in Solomon Islands, establishment of a protected area should originate with the customary landowners of the land.

In addition to upper catchment offset activities, the Project Company will implement measures including a post construction rehabilitation plan for disturbed areas, and an offset within the Core Area which will include measures to protect the remaining natural habitat in the Core Area, and to rehabilitate an area of modified habitat within the Core Area of at least 9.5 ha. These measures will be set out in the Biodiversity Management Plan.

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Figure 6-11 Study area habitat types and land use

**ESIA for the Tina River
Hydropower Development Project**

Habitats

Solomon Islands Government
Ministry of Mines and Energy
and Rural Electrification
Tina River Hydropower
Development Project

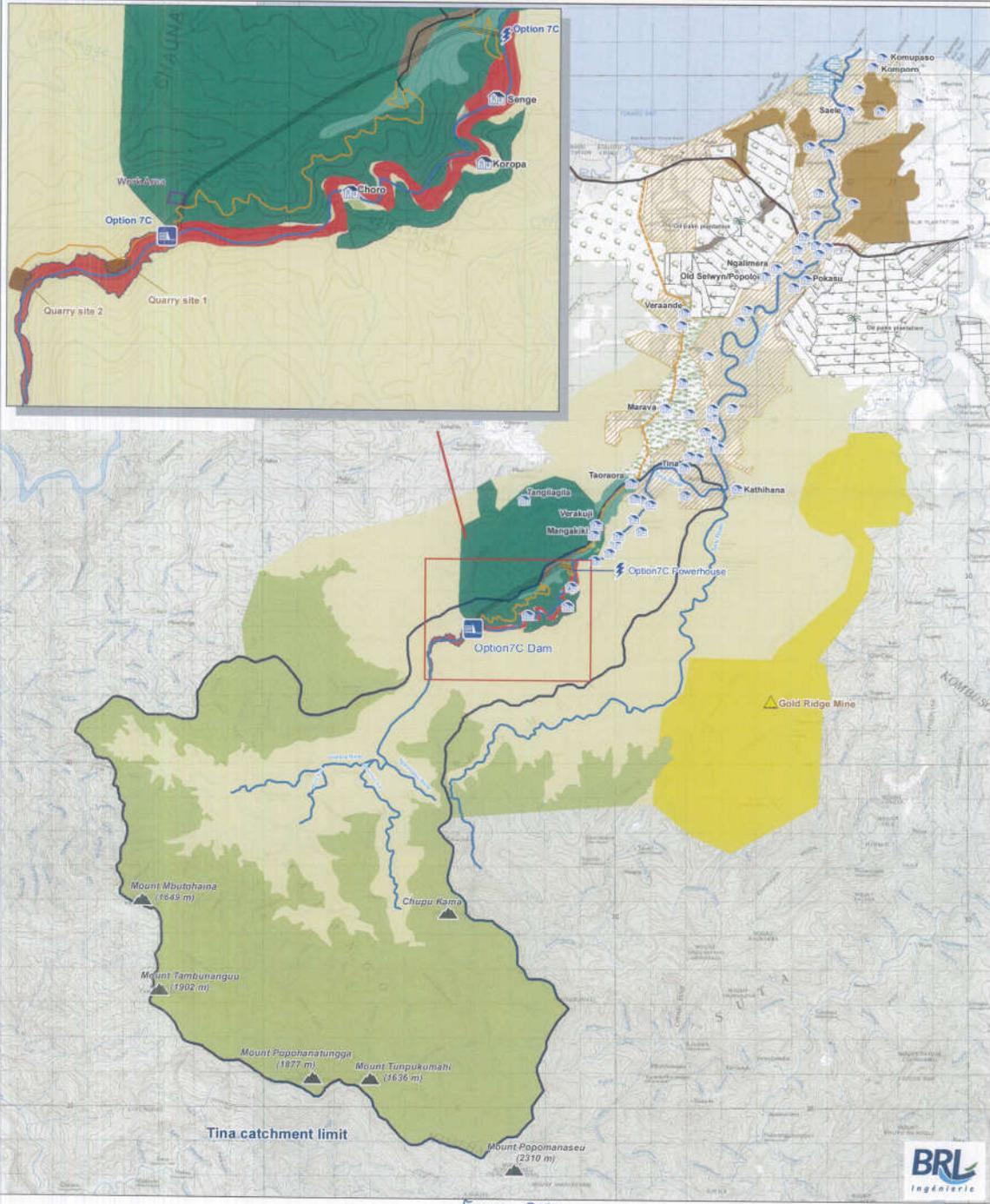


LEGEND :

- Villages / Settlements
- Road to Honiara
- River courses (1976)
- Transmission Line 33 kV and existing access road
- Gold Ridge Mine
- Quarry
- Dam
- Powerhouse
- Option 7C reservoir
- Tina catchment limit
- Old logging road
- Access Road 7C
- Tunnel option 7C

- Habitats**
- Riparian
 - Cliff
 - Farming
 - Oil Palm
 - Garden
 - Grassland
 - Mixed
 - Remnant Forest
 - Fallow Brushland
 - Disturbed Forest
 - Undisturbed forest
 - Montane forest
 - Wetlands

May 2015
Source: BPL
Background map: Topo map 1:50 000 (1976)



6.5.2 Discussion on Wildlife and Wildlife Habitat

The ESIA team observed a general trend of habitat degradation from upstream areas to downstream areas. Human settlement increases in a downstream direction, and land use shifts from forested areas to remnant forests and grasslands. Disturbed forests were observed in all of the study area, but the level of disruption was low in Choro. The upper catchment area, inland and up-elevation from the project site, remains covered by pristine forest.

Except for birds, the impacts of habitat degradation is not noticeable when observing the number of species. This could be attributed to some species being able to thrive in modified habitats that are close to settlements. Regarding endemic species (except for birds), their abundance does not decrease with habitat degradation. Most of the areas covered by the project are utilized by endemic wildlife species.

Table 6-6 classifies three types of modified habitat: weakly disturbed, moderately disturbed and highly disturbed. As shown in the table, the number of species observed in each habitat type, during the period when field surveys were conducted (August, 2013), did not decrease with habitat disturbance, except for birds, which seem to prefer undisturbed areas.

Table 6-6 Number of species observed by habitat quality

	Weakly disturbed												Moderately disturbed					Highly disturbed				
	Upper Stream		Middle Tina River sampling area										Middle Tina River sampling area					Transmission line sampling area				
	F&F2	F&F1	F&F7	F&F6	F&F5	F&F4	F&F14	F&F10	F&F13	F&F9	F&F11	F&F8	F&F19	F&F12	F&F18	F&F17	F&F16	F&F24	F&F23	F&F22	F&F21	F&F20
Amphibian	0	4	1	4	4	2	0	0	0	4	1	0	0	0	0	0	0	1	0	0	0	0
Birds	9	12	5	8	17	7	3	4	0	11	1	7	3	4	4	2	5	2	0	8	6	4
Reptiles	1	2	0	0	0	1	0	0	2	2	0	0	3	0	1	1	0	1	0	0	1	2
Mammals	0	0	0	1	5	2	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0

Table 6-7 Number of endemic species observed by habitat quality

	Weakly disturbed												Moderately disturbed					Highly disturbed				
	Upper Stream		Middle Tina River sampling area										Middle Tina River sampling area					Transmission line sampling area				
	F&F2	F&F1	F&F7	F&F6	F&F5	F&F4	F&F14	F&F10	F&F13	F&F9	F&F11	F&F8	F&F19	F&F12	F&F18	F&F17	F&F16	F&F24	F&F23	F&F22	F&F21	F&F20
Amphibian	0	3	0	3	2	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
Birds	5	10	5	8	13	4	3	3	0	10	1	4	3	4	4	2	5	1	0	3	4	4
Reptiles	1	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1
Mammals	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

6.5.3 Conclusions on Wildlife Habitat

The fauna baseline study has shown that wildlife species thrive in the undisturbed forest of the upper Tina River catchment, upstream of the Project, but also in the more anthropogenically modified areas in the lower reaches of the Tina River, in which the Project is located. The ESIA team observed a total of 60 species of wildlife within the study area, including: 9 species of amphibians; 5 species of reptiles; 41 species of birds; and 5 species of mammals. Approximately 45% of the species are endemic, including: 1 species of amphibian; 1 species of reptile; and 25 species of birds;. The extent of potential impacts of the TRHDP on these fauna, and proposed measures to mitigate impacts to them, are addressed in Section 10.

7. BIOLOGICAL ENVIRONMENT BASELINE - AQUATIC

7.1 METHODOLOGY

Various methods were used to characterise the baseline aquatic environmental conditions within the study area, including:

- ▶ a review of existing information (literature & previous studies);
- ▶ a field survey of the Tina river system undertaken from 30 July to 06 August 2013, which encompassed water quality sampling, observations on fish and river system, and interviews with local fishermen and other river users. Field surveys were carried out by Loïc Trébaol, with the assistance of Robson S. Hevalao;
- ▶ a second fish and water quality survey carried out by Robson S. Hevalao in February 2014, the results of which are compiled in this ESIA report. In addition to the dry season stations, this additional survey included sampling at the proposed dam site (Site 7C); and
- ▶ a supplementary study of environmental flow requirements and associated habitat suitability for migratory fish, prepared by Jowett Consulting in March and July 2016 in association with Robson S. Hevalao and David Boseto. The methodology and result of this study are summarised in Section 7.5.6.

7.2 LITERATURE REVIEW

The following sources of available information were used to obtain an understanding of, and describe, the baseline freshwater ecology in the study area.

7.2.1 Fresh and Brackish Water Fishes in Guadalcanal, by Gray (1974)

This small publication records 36 fish species collected from roughly twelve sampling stations located in estuarine environments of Guadalcanal, mostly on the North coast, West of Honiara, and two stations on the South coast at Lauvi lagoon. It provides a representation of each species and a description of some ecological features.

Most species are marine forms entering into estuaries. Ten species are identified as being likely to occur in inland reaches of the rivers (*Anguilla marmorata*, *Kuhlia marginata*, *Mesopritus argenteus*, some Eleotridae and some pipefish), and represent only one component of freshwater biodiversity. Gobiidae, the predominant family in the inland river reaches of the Solomon Islands, was not described in the study.

7.2.2 Aquatic Ecology Surveys for the Gold Ridge Project (Since 1990)

In support of the Gold Ridge Project, extensive baseline studies and water quality and aquatic ecology monitoring has been undertaken from 1990 to the present.

The information collected is particularly useful for characterizing the baseline conditions of the TRHDP study area, as the Matepono River watershed is directly adjacent to the Tina/Ngalimbiu watershed and, therefore, shares a number of environmental features. Additional data were collected from the Tina/Ngalimbiu watershed, especially at Ngalimbiu River Bridge, to use as control data.

The different sets of data include:

Initial field studies by AMOCO/ARIMCO (1990)

In 1990, two studies were undertaken regarding the feasibility of discharging treated tailings fines into the river. These included:

- ▶ “Hydrology, meteorology and water quality” (Scott Technical instruments, Aug 1990); and
- ▶ “*Aquatic flora & fauna study*” (Dr D. Fannings, Sept-Oct 1990) in which 14 survey stations were sampled, including 8 stations on the Matepono River system, 1 station at Ngalimbiu River bridge, and 6 stations on other adjacent watersheds. Several species of prawns (dominant taxa in the samples), a variety of fish species, and a few species of frogs, were collected. Most species were unidentified due to a lack of information at that time regarding freshwater ecology in the SI.

The concentration of arsenic, mercury and cadmium in fish flesh was determined for each location. The results showed highly significant, naturally occurring levels of contamination, especially for arsenic (at, or greater than, 1 mg/kg).

The discussion of aquatic ecology biota in the initial Gold Ridge EIS (Ross Mining N. L., 1996) was based on these field results.

Water quality samples (1989 to 1995)

- ▶ The Gold Ridge EIS report (Tables 3-13 and 3-14) refers to a compilation of water quality samples from 6 stations on the Matepono River system (1989-1992), with an additional sampling station added in 1995.

Additional aquatic fauna surveys (2003 & 2006)

- ▶ At the reopening of the Gold Ridge mine, following a period of political unrest, two additional aquatic fauna surveys were undertaken at 8 sample stations, including: 7 stations on the Matepono River system; and 1 station at Ngalimbiu River bridge. The methodology and main results are described in the Environmental Performance Report 2009 by Golder Associates (pp 99-100).
- ▶ A first survey by Golder Associates (Dec 2003) showed good fish and crustacean abundance in the river system. Analyses of heavy metal concentrations in fish/prawn flesh (As, Cu, Cd, Zn, Hg) showed evidence of increased arsenic (As) levels, resulting from bioaccumulation downstream of the mine site. The arsenic concentrations were below levels considered detrimental for human consumption.
- ▶ A second survey by Hydrobiology Pty Ltd (July 2006), using electrofishing and dip net methods of capture, was undertaken to collect additional specimens for tissues analysis.
- ▶ Gold Ridge’s 2009 Environmental Performance Report includes a table with 32 species of fish recorded in Matepono River system and 45 species of fish recorded at Ngalimbiu River Bridge (see Annex 2 of the Annex Report).

7.2.2.1 Survey of Freshwater Biota in Solomon Islands, by Polhemus Et Al. (2004-2005)

For the first time in the Solomon Islands, a scientific survey of Solomon archipelago freshwater biota was undertaken during 2004 and 2005, by staff from Bishop Museum Hawaii, and four other research organizations with long-standing interests in Melanesia.

Altogether, 70 stations were sampled with a focus on freshwater fish and aquatic insects. The insect taxa included: Heteroptera (aquatic true bugs), Odonata (damselflies), Coleoptera (whirligig beetles, Gyroniidae) and Diptera (Simuliidae).

Fish were sampled at 31 stations, on 10 islands. Sampling stations ranged in elevation from sea level to 460masl. Four stations were located on Guadalcanal (see following table), with two of them near the Gold Ridge facilities. Table 7-1 identifies the location of the four sampling stations that were located on Guadalcanal.

Fish survey techniques consisted of underwater observations using mask and snorkel at each site, as well as selective capture of specimens using small hand nets. Digital photographs were taken of most species, either in situ within their habitats, or with the captured specimen in a small field aquarium.

The results were compiled in the report “*Freshwater biota of the Solomon Islands; analysis of richness, endemism and threats*” (Polhemus *et al.*, 2008). Altogether, 52 species of fish were recorded in Solomon Islands, with 13 of these recorded from the Guadalcanal sampling stations.

Table 7-1 Location of fish sampling stations on Guadalcanal, Nov 2004 and Jul 2005 (Polhemus *et al.*, 2008)

Stat n°	Date	River	Location	GPS location	Elevation (m)
14	21/11 /05	Tenaru riv.	At Tenaru falls, 12 km SE of Honiara	9°31'01,0"S 160°00'59,5"E	40
15	27/11 /05	Tina Hulu riv.	Above Gold Ridge road bridge, at Bemuta village	9°31'26,8"S 160°09'20,3"	35
50	28/07 /05	Lungga riv.	At mouth of gorge, near proposed dam site, SW of Mt Austen	9°23'44.3"S 159°50'47.6"E	25
64	03/08 /05	Charebuma riv.	Above Gold Ridge mine	9°35'39.8"S 160°07'28.6"E	290-460

7.2.2.2 Survey of Freshwater Fishes on Tetepare Island (2006)

A very comprehensive freshwater fish survey was undertaken in September 2006 by Jenkins, A.P and Boseto, D., on Tetepare Island, Western Province. The area was considered at the time as being the “*largest unlogged and uninhabited lowland rain-forest island in the South Pacific*”. Fifteen 150 m sections were sampled from four rivers and 2 lakes for fresh water fishes and water quality, with 797 specimens being captured by different means.

Though taking place in the Western Province, this comprehensive scientific study is an important reference, as it provides a precise description of the fish assemblage in the fresh waters of Solomon Islands.

7.2.2.3 Survey of the Tina River System, by Entura (2010)

An ESIA scoping study of the TRHPD was prepared by Entura (2010). The study included a rapid ecological assessment survey of the Tina River system, that was undertaken from 10 to 12 September 2010 by Pacific Horizons Consultancy Group.

Observations on aquatic habitats and fish biodiversity were limited to the proposed dam and reservoir area, as it was then defined, with 3 sampling stations located at Habusi, Toni River and Horohutu, respectively, corresponding to Stations C, D and E, respectively. In addition, bacteriological quality was measured at stations C and E.

These first results on aquatic ecology in the project area (see Annex E of the ESIA scoping study) raised some environmental concerns about baseline data, and impacts of the project on aquatic ecosystems.

A total of 20 fish species were recorded, 12 of these based on visual observation.

7.3 FISH AND AQUATIC ENVIRONMENT SURVEY

7.3.1 Delineation of the Aquatic Ecology Study Area

The aquatic ecology study area covers the whole river system, upstream and downstream of the dam/reservoir sites, from the upper catchment to the river mouth. Delineation of the study area is based on the likely area of influence of the project, as follows:

- ▶ upstream of the reservoir area, the fish and crustacean assemblage is likely to be affected, with the hydroelectric facilities being a barrier to the migration of amphihaline species.
- ▶ within the reservoir area, a major change will occur to aquatic ecosystem, which will be transformed from rheophilic to lentic conditions.
- ▶ downstream of the dam site, changes in water quality, flow and sediment transport patterns are likely to impact aquatic ecology in Tina/Ngalimbiu River down to the river mouth.

7.3.2 Organization of Field Survey

The first aquatic ecology survey was undertaken between 30 July and 06 August 2013 by the local and international BRLi experts in aquatic ecology, who were assisted by local guides.

The schedule was optimized to take advantage of the availability of transportation to and within the study area (e.g., by helicopter and automobile), and meteorological conditions (e.g., rainfall events, flash floods)

The field survey of upstream the reservoir area, in the vicinity of the hydrometric gauging station, was undertaken on 07 August 2013, by the aquatic ecology team, which was transported to the area by helicopter.

Field surveys in the reservoir area and downstream of the dam site were undertaken separately by the aquatic and terrestrial teams, which were transported to and within the area, by automobile.

Night sampling of fish was carried out at a few sites (Koropa and Choro), when aquatic animals, especially eels and prawns, are active from dusk to dawn.

A second aquatic ecology survey was conducted by Robson S. Hevalao, with the assistance of Eric Deneut, during the rainy season in February 2014.

A third field survey to was conducted in March 2016 by Ian Jowett, Mark Taylor, Robson Hevalao and David Boseto, during the 2016 rainy season. This survey was part of a study specifically designed to evaluate the impact of scheme operation on migratory fish and determine minimum environmental flow requirements for the region between dam and powerhouse tailrace. The survey involved quadrat sampling for species density in different habitats, habitat characterisation as well as the measurement of river cross sections for the purposes of determining habitat suitability curves in terms of water depth, substrate type and flow velocity.

Jowett and Hevalao conducted a follow up survey in July 2016 to obtain more low flow measurements.

7.3.3 Location of Survey Stations

Eleven aquatic survey stations (A1 to A10b) were selected to identify aquatic ecosystem habitat types, determine presence of fish species, and undertake water quality sampling. The selection of stations was based on the longitudinal geomorphological zonation of the river, previous fish survey stations used by Entura (2010), and areas that would be most likely affected by the Project. The stations were located as follows:

- ▶ 3 stations in the upper Tina River, upstream of the reservoir area:
 - one at the Tina River gauging station (A3) and two on the immediate upstream tributaries, Becho/Voraha (A1) and Mmembea (A2). The confluence of these two rivers forms the Tina River;
- ▶ 2 stations in the middle Tina River area downstream of the dam site and upstream of the power station :
 - one at Koropa (A4), and one at Senge (A5);
- ▶ 2 stations in the upper Ngalimbiu River:
 - one on the Toni River at Kathihana (A6), and one at Horohutu (A7);
- ▶ 4 stations in the lower Ngalimbiu River:
 - Ngalimbiu River bridge (A8), Saele (A9), old river mouth (A10a) and new mouth (A10b)

The first survey included the 3 stations surveyed by Entura in mid-December 2010, at Senge, Kathihana and Horohutu (see ESIA Scoping Study, page 57).

Table 7-2 lists the location of the aquatic ecology survey stations. To take into account the environmental and flow changes brought by the rainy season on the Tina River and its aquatic biota, another fish survey was carried out in February 2014. An additional station (7C) was surveyed during the rainy season, it was located at the option 7C dam site.

Table 7-2 Aquatic ecology survey stations

Station	Area	River	Location	Chainage*	WQ sample
A1	Upper catchment	Bicho-Voraha Riv.	confluence	CH -1km	X
A2	Upper catchment	Mbembea River	confluence	CH -1km	X

A3	Upper Tina R.	Tina River	Gauging st	CH 1km	X
7C	Middle Tina R.	Tina River	Dam	CH 7km	
A4	Middle Tina R.	Tina River	Koropa	CH 11km	
A5	Middle Tina R.	Tina River	Sengue	CH 11.5km	
A6	Upper Ngalimbiu R.	Toni River	Horohutu	CH 19km	X
A7	Upper Ngalimbiu R.	Ngalimbiu River	Kathihana	CH 20km	X
A8	Lower Ngalimbiu R.	Ngalimbiu River	Ngalimbiu	CH 28km	X
A9	Lower Ngalimbiu R.	Ngalimbiu River	Saele	CH 34km	X
A10a	River Mouth area	Old River mouth	Komporo	CH 36km	X
A10b	River Mouth area	New River mouth	Komporo	CH 37km	X

* Based on Entura Phase 1 chainage, starting at Tina River between the upstream confluence of the Mbeambea River and the Voraha River (chainage 0km)

The fact sheets included in Annex 1 of the Annex Report, provide a comprehensive description of the survey stations, including their exact locations by GPS coordinate, altitude, and river length chainage relative to the Tina River/Voraha River confluence. The Annex also includes photographs that identify the biophysical and social characteristics of each site.

7.3.4 Survey Methodology

The methodology used to conduct the aquatic ecology survey is explained by the following steps.

7.3.4.1 Obtain Local Knowledge

For those sampling stations located in inhabited areas (i.e., from Senge to the river mouth), local guides accompanied the experts. Fishermen, and other river users encountered in the field, were interviewed, using an interview guide.

Questions were asked pertaining to:

- ▶ river system functions (e.g., historical floods and other main features, changes in river morphology, etc.);
- ▶ river and riparian area use (e.g., domestic use, drinking water, transporting logs, fishing, gold panning, recreation, access, gravel extraction);
- ▶ fish species observed in the area, and their abundance (e.g., dominant, common, occasional); and
- ▶ main features concerning fishing activities (e.g. type of fishing gear and fishing techniques, target species, seasonal and long-term capture trends, personal consumption versus commercial sale of catches).

7.3.4.2 Describe the River

Photographs were taken at each station, and observations made regarding the following (see fact sheets in Annex 1 of the Annex Report):

- ▶ physical environment (velocity and flow pattern, turbidity, water depth, characteristics of minor and major stream beds, sediments, banks and riparian areas);
- ▶ biological environment (aquatic and riparian vegetation, wetlands and other sensitive environments); and
- ▶ human environment (uses of the river and riparian areas, access, habitations, etc.).

7.3.4.3 Conduct Fish Surveys

Fish survey techniques consisted of:

- (i) underwater observations using mask and snorkel at each site, obtaining digital underwater photographs of each encountered species; and
- (ii) obtaining information on fishermen's catches, including whether they were subsistence fishing or commercial fishing, location of fishing sites, and the type of gear they were using.

7.3.4.4 Conduct Water Quality Sampling

A 1.5L sample was collected on each sampling site, and brought to SIWA WQ laboratory in Honiara, where they were analyzed for pH, conductivity, turbidity, nitrates, and total phosphorus. Other parameters were added in the second survey campaign, as well as in situ measurements of dissolved oxygen.

In addition, the baseline level of *E. coli* contamination was surveyed on 14 August 2013 at 4 stations (Toni river, Valekotcha, Birao and Ngalimbiu River bridge). Samples were transported to SIWA laboratory for *E. coli* and total coliform analysis.

7.4 AQUATIC ECOLOGY BASELINE

In addition to the baseline physical conditions of the Tina River system (watershed, river geomorphology, and hydrology), the following sub-sections describe the aquatic ecology baseline for: (1) aquatic habitats, (2) water quality and (3) aquatic biota, with a focus on fish assemblage.

Additional details are provided in the fact sheets and photographs describing the survey stations included as Annexes 2 and 3 in the Annex Report.

While the operation of the hydro scheme will divert most of the Tina River through the headrace tunnel, there will be sufficient minimum permanent flow, referred to as environmental flow (as determined in the Aquatic Ecology section) remaining in the river, between the dam and the powerhouse downstream, to meet the current water consumption needs (i.e., for washing, bathing, drinking water, and garden irrigation) of the people living along this reach at Choro, Koropa, and Senge. However, the dynamics of the river flow will change, and most noticeably, some swimming or fishing holes will shrink during the dry season, while river crossings that are necessary for accessing Koropa and Choro will become easier and safer to access. A regime for releasing water from the dam could be implemented by the operator to provide sufficient volume of flow to keep river pools adjacent to Koropa and Senge villages filled with water. This operating regime would have to be formalized prior to operation.

7.4.1 Fisheries

As discussed later in Section 5 Social Baseline Conditions, fresh fish from the Tina River do not feature prominently in the diet of local inhabitants that reside along the river. Rather, canned tuna is their main source of fish protein. Despite their knowledge of fish species found within the river, from a livelihoods perspective it appears that fishing is only a minor activity. Fishing is undertaken during “fishing trips” in the upper catchment, upstream from Choro. The main mode of fishing is by snorkeling with a spear gun, and is sometimes carried out at night.

Fishing is a significant source of livelihood only at the mouth of the Ngalimbiu River, where semi-commercial fishing occurs using mosquito seine nets, gill nets, and other fishing techniques.

7.4.2 Aquatic Habitats

The Ngalimbiu/Tina River flows approximately 35km in a N/N-E direction, from the central ridge of Guadalcanal (Mt. Popomanaseu to Mt. Mbutohaina) to the sea. For the purpose of the study, the river was been divided into 5 areas, based on elevation and geomorphology (see Section 5.6 – River (Fluvial) Geomorphology):

Several aquatic habitats of specific ecological interest have been identified along the river. These include:

Mountain streams - though not included in the surveys, the dense network of steep streams draining the central mountain ridge (cloud forest area) is likely to represent a particular aquatic habitat. Relative to other Pacific islands, these streams form rapids under a dense cover of vegetation. A few amphihaline species (*Anguilla megastoma*, Sicyniids, *Macrobrachium sp.*) are likely to be found at such altitudes.

Runs and riffles - these habitats, which are common in the Tina River reach (Figure 7-1), are characterized by current velocities that range from 1.5m/s to 3m/s, that decrease with decreasing river bed slope and elevation, and have a substrate comprised of cobbles and pebbles. The substrate is covered with a thin film of periphyton (algae and diatoms), which requires sunlight and nutrients (nitrogen and phosphorus) to thrive. Water depths are typically less than 2m. Run and riffle areas are significantly harsh environments in the riverine system due to their velocity and depth. Fish species found here are mainly rock-suckers Gobiids (*Sicyopterus*, *Stiphodon*) that use their mouths to suck the surface film on the cobble and pebble substrate.

Figure 7-1 Typical run/riffle sequence in Tina River



Beds of pebbles, gravels and coarse sands - these habitats are common in the middle and lower reaches of the Tina River. They represent a trophic resource for detritivores like Syciidinae and other Gobiidae. However, unlike European or North America rivers, this habitat is unlikely to be used for spawning, due to the substrates constantly shifting during flash floods.

Under-rock habitats - these habitats are present in high velocity areas of the Tina River where the substrate is comprised of pebbles, sands and gravels either in interstitial cavities of boulder or block accumulations, or where boulders are laying on a bed of sand and gravels. Fast flowing water removes the pebbles, sands and gravels from under the downstream side of boulders, creating cavities. These dark areas shelter juvenile prawns and fish, and are used as spawning substrate by Syciidinae. Fertilized eggs, forming white plates, are stuck onto the boulder or block surface. The cavities accumulate organic material, including algae and diatoms, providing a source of food for bottom dwellers and detritivores. They also offer dark shelters where prawns and eels can hide by day. Bottom dwellers and detritivores are also common. Fertilized eggs of amphidromous³⁶ Gobiidae were found in under-rock habitats. *Anguilla marmorata* and prawns are also usually found in such habitats.

Pools - these habitats are deep (up to 2m or more) sections of the river (Figure 7-2), with water velocity less than 0.5m/s, or near to being still. They typically occur on outside of river bends, where the current runs deep before coming up to the surface in areas of less than 2m. Pool areas are increasingly present in the upper reaches of the Tina River where the river channel more confined, and decrease on the flood plains (e.g., Ngalimbiu River floodplain and river mouth), where the river channel is less confined and more braided. Substrates in the pools of the upper reaches are predominantly cobbles and pebbles, with associated boulders on the banks, which are bounded on either side by cliffs. Fluctuations in water levels increase with increasing elevation, due to the narrow and confined nature of the river as it flows through mountain gorges. Pool habitats are areas known to be nutrient rich, where very large fish and eels were observed.

Figure 7-2 Typical pool in Tina River



³⁶ Fish that move between fresh and salt water habitats at some point in their lifecycle, other than for purposes of spawning.

Aquatic/terrestrial contact zones (ATTZ) - these micro-wetland habitats, which are found at the margins of the river, are characterized by shallow stagnant waters, with fines (sands, silt and muck mud) deposited between boulders, pebbles and cobbles. These areas have high nutrient levels and available food resources for life cycles of various aquatic organisms, especially for Oligochaete worms, fish and larvae. Some areas are exposed to sunlight, which facilitates development of algae. Other areas are shaded under tree canopies.

Juvenile tree frogs were observed in this type of habitat at Njarimbisu. Nocturnal surveys confirmed that invasive *Bufo* sp. inhabit such areas at night to feed, mate and brood their young.

Some ATTZ, represented by ponds, were disconnected from the main river channel. These ponds were observed among boulders (see Figure 7-3) (see Station 6 factsheet in Annex 1 of the Annex Report), where species that were rarely observed at night in the river (*Anguilla marmorata*, *Macrobrachium* sp.) had become trapped.

Figure 7-3 Use of micro-wetlands by amphibians along the Tina River



Confluences where smaller tributaries enter the Tina River form another type of ATTZ. Here, the substrate is comprised of detritus, mud, clay and sand, deposited among boulders. Prawns and juvenile fish are abundant at these locations. Water velocity at some confluences is near to still, whereas at others, tributary streams enter as waterfalls, having very steep slopes at the point of confluence, and no still water pools are formed.

River mouths – this is a key habitat on the Ngalimbiu/Tina River system due to the diverse interaction between the ocean and freshwater entering from the river. Local inhabitants have confirmed that the river has changed course where it enters the sea, several times since Cyclone Namu. The new river mouth (Station A10a) is now considered as the main mouth of the river. It was formed in mid-2013 as a result of high river flood conditions and obstruction of the main channel by logs, and now flows laterally across the delta, roughly 500m West of the old river mouth. The old river mouth (Station A10b), occupied a more central position within the delta, and although it still connects the river to the sea, the outflow is much smaller.

As shown by measures of conductivity, only limited saltwater intrusion occurs into the mouth of the river. There appears to be no longitudinal gradient of brackish water. The river appears to discharge directly into the sea without forming a brackish water estuary. The presence of cane toad tadpoles and rushes along the banks of the river is evidence of sustainable freshwater conditions. Nutrients levels are high as a result of numerous connections to the many adjacent wetlands and swamps, estimated to cover 40ha. This area provides habitat for saltwater crocodiles and wetland species of fish.

The river mouth is a key habitat for fish populations, especially amphihaline species (larvae of Sicyniidae and other Gobiidae, adult and juvenile eels) that transit the area to reach the sea as part of their life cycles, and for marine forms that enter the mouth and lower reach of the river, which provides temporary feeding habitat. As observed during the field survey, the river mouth area supports intense fishing activity, for both subsistence and commercial purposes.

7.5 FISH BIODIVERSITY BASELINE

The following sub-sections present the baseline fish biodiversity conditions in the Tina/Ngalimbiu River system. Information has been compiled from the first BRLi fish survey conducted between 30 July and 06 August 2013, and from previous surveys conducted by others in Solomon Islands. A list of fish species identified from different surveys is included as Annex 2 in the Annex Report. An additional fish survey was carried out during the rainy season in February 2014.

Two fish surveys were conducted to ensure that identification was made of the widest range of species present throughout a given year. However, no conclusions can be drawn regarding migration behaviour based on the results of dry and wet season sampling. Therefore, any difference between dry and the wet season species distribution and abundance, across the different sampling stations, does not demonstrate any particular migratory behaviour.

7.5.1 Species Diversity

Table 7-3 provides a list of all fish species recorded by BRLi's local fish expert during field surveys both for dry and wet seasons. A total of 52 species, representing 30 genera and 15 families, was recorded during the dry season, and 57 species were recorded during the wet season. The letter "O" in Table 7-3 represents fishes that were observed either in the dry or the wet season, while the letter "S" represents the use of the site as a likely spawning ground, based on the literature review and observations made for other studies conducted since 2006 for the Ngalimbiu/Tina River catchment. A question mark "?" denotes a supposition of presence or use, without benefit of field verification.

Fish biodiversity in the Tina River system is difficult to assess with certainty, given the following:

- (i) scientific information on the fish of Solomon Islands is still poor, with taxonomic uncertainty and absence of field guides.
- (ii) the survey methods (underwater observations and photographs), though particularly appropriate to large fast flowing rivers with clear water, do not always facilitate a precise determination. In some cases, the determination was limited to the genus level only.

Nevertheless, underwater observations and interviews with local fishermen, combined with information from previous studies, allowed a good picture of the fish assemblage to be developed for the Tina/Ngalimbiu River.

Compared to the previous quick survey conducted by Entura in 2010, when 20 species were recorded, the number of recorded species observed during the present study was higher. This is the result of increased sampling effort across different elevations, including the River mouth with its high diversity of marine forms.

The recorded species diversity (52 dry season / 57 wet season) is similar to that recorded in scientific surveys by Jenkins and Boseto (2006) for Tetepare Island, Western Province (60 species), and by Polhemus *et al.* (2008) for all Solomon Islands (52 species), and is higher than the diversity recorded by Golder Associates (2009) at the Ngalimbiu River bridge (32 species) and in the Matepono River system (45 species).

Nevertheless, when the results of the different surveys carried out for Solomon Islands are combined, a much greater diversity (122 recorded species) would seem to be the case (see Annex 2 in the Annex Report). However, this may be the result of uncertain or wrong determination, as well as changes in the taxonomy (i.e., synonymous species being identified).

7.5.2 Longitudinal Distribution

The distribution of fish species recorded from the various survey stations located along the river, during the first and second fish surveys, is summarized in Table 7-3. An additional station was added in the rainy season, to sample fish in the area of the proposed Option 7c dam site.

Table 7-3 Results of the BRLi fish survey

River area		Upper Tina			Middle Tina			Upper Ngalimbiu		Lower Ngalimbiu			Coastal or Marine *	Life Cycle	IUCN Status **	Remark regarding the species abundance in Guadal.
Stations		A1	A2	A3	7C	A4	A5	A6	A7	A8	A9	A10				
River & location	Seasons	Bicho-Voraha River	Mbembea River	Tina river gauging station	Dam site	Tina River Korop a	Tina River Sengu e	Ngali mbiu River Horoh utu.	Toni River Kathi hana	Ngali mbiu River bridge .	Ngali mbiu River Saele	Ngali mbiu River mouth				
Family and Species																
<i>Ambassidae</i>																
<i>Ambassis interrupta</i>	Wet										OS	OS		Amphi	LC	
	Dry											O				

<i>Ambassis miops</i>	Wet												OS		Amphi	LC	
<i>Anguillidae</i>																	
<i>Anguilla mamorata</i>	Dry	O	O	O		O							O		Cata	LC	Rare
	Wet	O	O	O	O			O						S			
<i>Apoginidae</i>																	
<i>Apogon hyalosoma</i>	Dry												O		Marine form	LC	
	Wet												OS				
<i>Apogon sp.</i>	Wet												OS		Marine form		
<i>Carangidae</i>																	
<i>Carangoides malabaricus</i>	Dry												O		Marine form	NA	Common
	Wet												OS				
<i>Caranx sp.</i>	Wet	S?	O	O	Marine form		Common										
<i>Caranx sexfasciatus</i>	Dry												O			LC	

	Wet											OS	O	Marine form		
<i>Scomberoides sp.</i>	Wet											O	OS	Marine form		Rare
<i>Scomberoids juveniles sp.</i>	Dry											O		Marine form		
<i>Cichlidae</i>																
<i>Oreochromis mossambicus</i>	Wet									O			S	Non migratory	NT***	Common invasive
<i>Eleotridae</i>																
<i>Allamogurda sp.</i>	Dry						O							Amphi		
<i>Belobranchus belobranchus</i>	Dry						O				O			Amphi	DD	
	Wet	S?	S?	S?	S?	S?	S?	OS?	S?	S?	OS?	S?	S?			
<i>Butis sp.</i>	Dry															
<i>Butis amboinensis</i>	Dry							O			O			Amphi	LC	
	Wet						O	OS	S	O						
<i>Eleotris fusca</i>	Dry						O	O						Amphi	LC	

	Wet	OS	OS	OS													
<i>Ophieleotris hoedti</i>	Dry					O	O			O				Amphi	NA		
<i>Ophieleotris margaritacea</i>	Dry													Amphi	NA		
<i>Ophieleotris sp.1</i>	Wet	OS	OS	OS		O			O					Amphi		Common	
<i>Ophieleotris sp. 2</i>	Wet	OS	OS	OS	O				O					Amphi		Common	
<i>Ophiocara aporos</i>	Dry													Amphi	NA		
<i>Bunaka gyrinoides</i> (<i>Eleotris gyrinoides</i>)	Wet				OS	O								Amphi	LC	Common	
<i>Gerreidae</i>																	
<i>Gerres sp.</i>	Wet													S	Marine form	NA	
<i>Gobiidae</i>																	
<i>Awaous guamensis</i>	Dry	O	O	O		O	O							Amphi	LC		
<i>Awaous melanocephalus</i>	Wet	OS	OS	OS	O			O						Amphi	DD	Common	
<i>Awaous ocellaris</i>	Dry	O	O	O		O	O			O				Amphi	LC		
<i>Awaous sp.</i>	Wet	OS	OS	OS										Amphi		Common	

<i>Bathygobius andrei</i> ³⁷	Dry	O	O	O		O	O			O				Amphi	LC	
<i>Glossogobius celebius</i>	Dry						O			O				Amphi	DD	
<i>Glossogobius sp. 1</i>	Wet	S?	S?	S?	S?	S?	S?	O S?	O S?	S?	S?	S?	S?	Amphi		Common
<i>Glossogobius sp 2</i>	Wet	S?	S?	S?	S?	S?	S?	O S?	S?	S?	S?	S?	S?	Amphi		Common
<i>Lentipes multiradiatus</i>	Dry					O	O							Amphi	NA	
	Wet	O S	O S	O S	S	O S	O									
<i>Lentipes sp.1</i>	Wet	O S	O S	O S	O S		O							Amphi		Common
<i>Lentipes sp. 2</i>	Dry	O	O	O		O								Amphi		
<i>Redigobius bikolanus</i>	Dry	O	O	O		O	O		O					Amphi	LC	
<i>Redigobius tambujon</i>	Dry	O	O	O		O	O		O					Amphi	LC	
	Wet	O S?	O S?	O S?	S?	O S?	S?	S?	O S?	S?	S?	S?	S?			

³⁷ This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

<i>Schismatogobius sp. cf. ampluvinculus</i> ³⁸	Dry					O	O	O	O					Amphi	NA	
<i>Schismatogobius sp. cf. roxasi</i> ³⁹	Dry					O	O	O	O					Amphi	NA	
<i>Schismatogobius sp.</i>	Wet	S?	S?	S?	S?	S?	S?	O S?	O S?	S?	S?	S?	S?	Amphi		
<i>Sicyopterus lagocephalus</i>	Dry	O	O	O		O	O		O					Amphi	LC	Common
	Wet	O S	O S	O S	O	O	O	O	O	O						
<i>Sicyopterus longifilis</i>	Wet	O S	O S	O S										Amphi	DD	
<i>Sicyopterus ouwensi</i>	Wet	O S	O S	O S	O									Amphi	DD	
<i>Sicyopterus sp.</i>	Dry					O			O					Amphi		
<i>Sicyopus discordipinnis</i>	Dry					O	O		O					Amphi	DD	Rare
	Wet	O S	O S	O S		O										

³⁸ This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

³⁹ This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

<i>Sicyopus mystax</i>	Dry					O	O		O					Amphi	NA	
<i>Sicyopus sp.1</i>	Wet	O S	O S	O S	S									Amphi		
<i>Sicyopus sp.2</i>	Dry					O			O					Amphi		
<i>Sicyopus zosterophorum</i>	Dry					O	O		O					Amphi	LC	Common
	Wet	O S	O S	O S												
<i>Stenogobius hoesei</i>	Dry					O	O		O					Amphi	LC	
<i>Stiphodon atratus</i>	Dry						O			O				Amphi	LC	Rare
	Wet	O S	O S	O S	O S		O									
<i>Stiphodon sp. cf. atropurpureus</i> ⁴⁰	Dry					O	O	O	O					Amphi	NA	Common
	Wet	O S	O S	O S	O	O	O	O	O	O						
<i>Stiphodon birdsong</i>	Dry	O	O	O		O	O	O	O	O				Amphi	LC	Common

⁴⁰ This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

	Wet	OS	OS	OS	OS	O	O	O								
<i>Stiphodon sp. cf. multisquamus</i> ⁴¹	Dry	O	O	O		O	O	O	O					Amphi	NA	
<i>Stiphodon sp. cf. ornatus</i> ⁴²	Dry	O	O	O		O	O	O	O					Amphi	NA	
	Wet	OS	OS	OS	O	O	O	O	O	O						
<i>Stiphodon rutilaureus</i>	Dry					O	O		O					Amphi	LC	Rare
	Wet					S	OS									
<i>Stiphodon semoni</i>	Dry	O	O	O		O	O	O	O	O				Amphi	DD	Rare
	Wet	OS	OS	OS	OS	O	O	O	O	O						

⁴¹ This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

⁴² This identification is questionable, based on known range and current understanding of species biogeography. Records are pending further confirmation of identification.

<i>Stiphodon sp.1</i>	Wet	O S	O S	O S											Amphi		Rare
<i>Stiphodon sp.2</i>	Dry					O	O								Amphi		
<i>Kuhliidae</i>																	
<i>Kuhlia marginata</i>	Dry											O	O		Cata	LC	Rare
	Wet	O	O	O	O		O							S			
<i>Kuhlia rupestris</i>	Dry											O	O		Cata	LC	Rare
	Wet	O	O	O	O	O	O	O	O					S			
<i>Lutjanidae</i>																	
<i>Lutjanus argentimaculatus</i>	Wet												O	O S	Marine form	NA	
<i>Lutjanus fuscescens</i>	Dry											O	O		Marine form	NA	
	Wet												O	S			
<i>Lutjanus vitta</i>	Dry											O	O		Marine form	NA	
	Wet	S?	S?	S?	S?	S?	S?	S?	S?	S?	S?	S?	O S?	S?			

	Wet	O S?	O S?	O S?	O S?	S?	O S?	S?	S?	S?	S?	S?				
<i>Syngnatiidae</i>																
<i>Chelon macrolepis</i>	Dry					O				O				Cata	LC	
<i>Microphis (Oosthetus) manadensis</i>	Wet	S?	S?	S?	S?	S?	S?	O S?	O S?	S?	S?	S?	S?	?	NA	
<i>Microphis sp.</i>	Dry					O								?		
<i>Microphis leiaspis</i>	Dry											O		Amphi	LC	
	Wet							O S		O						
<i>Microphis(Doryichtys) retzi</i>	Dry											O		?	NA	
	Wet	S?	S?	S?	S?	S?	S?	S?	O S?	S?	S?	S?	S?			
<i>Terapontidae</i>																
<i>Terapon jarbua</i>	Wet									O			S	Marine form	LC	
<i>Mesopristes argenteus</i>	Dry										O	O		Marine form	LC	Rare
	Wet	O	O	O			O				S	O S				

<i>Mesopristes cancellatus</i>	Dry					O						O	O		Marine form	LC	Rare
	Wet	O	O	O	O		O					S	OS				
<i>Zenarchopteridae</i>																	
<i>Zenarchopterus dispar</i>	Wet												OS		Marine form	LC	
<i>Zenarchopterus sp.</i>	Wet												OS		Marine form		
Total number of observed species, dry season	52	12	12	12	NA	33	25	8	17	12	6	14	NA	Number of species observed per station, dry season			
Total number of observed species, wet season	57	24	24	24	15	11	14	9	10	8	1	15	4	Number of species observed per station, wet season			

*Coastal area and Site 7C dam site location were only sampled during the rainy season, as Site 7C was had not been chosen until after the dry season sampling was completed

** Source: The IUCN Red List of Threatened Species. Version 2014.3. Unidentified species are not assessed. NT: Near Threaten; NA: Not assessed; LC: least concern; DD: Data deficient.

*** Near threatened in its natural habitat in East Africa

Amphi: Amphidromous; Cata: Catadromous; Pota: Potadromous

7.5.3 Fish Assemblage

7.5.3.1 Gobioids

In Solomon Islands, like other high islands of the Indo Pacific area, the fresh water fauna is dominated by Gobioid fishes, mainly members of Gobiidae and Eleotridae families. Most species are relatively small (< 10cm in length). In Solomon rivers, the species varies considerably in size. The largest species found was *A. guamensis* (adults reach 24cm). The most common species, *S. semoni*, does not exceed 5-6cm in length. Regarding the observations made during the first BRLI survey, the Gobioid group was represented by 34 species (25 Gobiidae, 8 Eleotridae and 1 Rhyacichthidae), representing 71% of the entire ichthyofauna.

Among Gobiidae, clinging gobies of the subfamily Sicydiinae (containing genera *Stiphodon*, *Lentipes*, *Sicyopterus* and *Sicyopus*) are particularly dominant in the study area, especially in the upper sections of the river where rock dominated, fast flowing clear streams, occur. These fishes present a “sucking disk” formed by the two pelvic fins, allowing them to “cling” to rocks in rapid stream flows.

Sicydiinae are typically brightly coloured, exhibiting neon shades of blue, gold and red. This group includes many recent discoveries and the taxonomy is relatively unstable, particularly for the genus *Sicyopterus*.

These species have an opportunistic diet. They feed on filamentous algae, worms, crustaceans, insects and suspended food particles. Sicydiins, which is the most abundant group in Solomon Islands rivers, feeds by sucking periphyton that grows on pebbles. They are known to play a key role in the food chain, especially as prey for eel *A. marmorata* (the top predator in such an environment), especially in the upper watershed.

During the surveys, *Stiphodon semoni* seemed to be the most common species, being largely present from Becho/Voraha River to Ngalimbiu River Bridge.

Among amphidromous species, the Sicydiinae are characterized by a massive migration of oceanic pelagic larvae entering the river and migrating upstream. Commercial harvest was observed at the river mouth, and shoals of juveniles were observed inland, migrating upstream along the banks. No doubt this group plays a crucial role in the river ecology (Keith, 2003).

According to discussions with local communities, Gobioids’ fish size and abundance have decreased due to overfishing, both in the river and at the river mouth.

7.5.3.2 Non-Gobioids

A few non-gobioid species are likely to be found far upstream in the river. During the fish survey, the species observed beyond Choro were the giant Eel (*Anguilla marmorata*), pipefish (*Microphis sp.* *Chelon macrolepis*), jungle perch (*Kuhlia sp.*), mullet (*Liza vaiensis*) and grunter (*Mesopristes argenteus* and *M. cancellatus*). With the exception of eels, that are likely to be found very far upstream, most species have limited abilities to migrate upstream from the first encountered waterfalls.

Most non-gobioid species are itinerant estuarine and marine forms tolerant to fresh water that will inhabit the lower reaches of streams. These fish are a combination of juvenile forms and adult forms that will spend periods in freshwater for feeding. The following species were recorded: *Ambassis interruptus*, *Ambassia macracanthus*, *Carangoides malabaricus*, *Caranx sexfasciatus*, *Lutjanus vitta*, *Lutjanus fuscescens*, *Apogon hyalosoma*, *Scomberoides sp.* Some of these fish are of sufficient size to represent an interest for subsistence/commercial fisheries. Some species, like *C. sexfasciatus*, *L.vitta*, *L.fuscescens* and *A.interruptus*, can be found as far as the Toni-Tina confluence. Some species are connected to the coastal wetland area surrounding the mouth of the river, estimated to be about 40 ha.

7.5.4 Migration Pattern and Life Cycle

Similar to other tropical islands of the Indo-pacific, almost all native species encountered in inland fresh water systems are migratory species, with a life cycle between ocean and river. Two main migration patterns can be distinguished: catadromous and amphidromous. In addition, Potadromous and Oceanodromous are less important migration patterns in the Ngalimbiu/Tina River system.

7.5.4.1 Catadromous

Catadromous migration involves downstream migration for adults to spawn, and upstream migration for juveniles to mature. Spawning takes place in the ocean.

Eels are catadromous, with adults migrating to the ocean to spawn, and juveniles (glass eels) migrating back into freshwater systems. During their upstream migrations, glass eels are able to climb to the upper reaches of the river. The life cycle starts in late November with adults moving downstream toward the ocean to spawn, and May with hatching of Juveniles in the ocean. Juveniles were observed moving back upstream to mature in July 2013. At their maturing stage, *Anguilla sp.* migrates to higher elevation reaches above 300masl. It will not mate until it reaches several kilometers upstream. After spawning in the ocean, the adult eels die. Compared to eels, *Kuhlia rupestris* (another catadromous species) spawns several times before it dies. The life cycle of *Kuhlia* begins in December with downstream migration. Upstream migration occurs in July (Note: females were observed with eggs in July during 2013 BRLi surveys). As with eels, *Kuhlia* migration reaches far upstream reaches of elevation 300 masl.

7.5.4.2 Amphidromous

Amphidromous migration involves downstream migration of larvae and upstream migration of juveniles to mature. Spawning takes place in the upstream river systems.

Most migratory species like Gobioids (e.g., *Stiphodon*, *Sicyopterus*, *Awaous*, *Eleotris*, and *Glossogobius sp.*), *Mesopristes* and prawns, are amphidromous. Spawning occurs in the rivers (under rocks for some Sicydiinae). Larvae drift passively to the ocean before migrating back as juveniles to the freshwater system to grow into adults. The factors controlling such upstream migration of juveniles are not well understood. Flooding (high turbidity) and lunar cycles are assumed to play a role in some species such as Sicydiinae. Migration from the ocean to upstream rivers takes place on a monthly basis. Amphidromous species migrate to the upper Tina River catchment attracted by its cooler water, better water quality and fewer habitat disturbances. For example, *Sicyopterus lagocephalus* was observed in the mountainous region of the upper Tina River catchment. Between maturing eggs, upstream migration and spawning in the upper Tina River, the average life cycle takes 3 to 4 months to complete. Important water temperature gradients found along the Tina River are suspected to trigger migration of fishes, as water temperatures are progressively cooler upstream.

7.5.4.3 Potadromous

One Potadromous species, *Gambusia holbrooki*, was found at Station 9 downstream in the Ngalimbiu River, upstream of the river mouth. The species was introduced by the Solomon Islands Malaria Training and Research Institute (SIMTRI) in the 1980s and 1990s, to control mosquito larva in swamp sites. It may be a threat to both adult and juvenile fish species.

Potadromous fish are characterized as species that are born in the higher reaches of freshwater systems and migrate downstream, where they mature before migrating upstream again. *Gambusia holbrooki* is present in the Guadalcanal plains near river mouths, where it tolerates harsh environments. Its migration might extend upstream to the confluence of the Tina and Toni rivers. It was not found at the higher reaches, probably due to lower temperatures upstream. Most of this species spawns in the lower reaches from the Toni-Tina confluence, downstream to wetlands of the Ngalimbiu River mouth.

7.5.4.4 Marine form (Oceanodromous)

Oceanodromous species spawn and hatch on the outer edges of reefs or mangrove areas. They drift in the ocean as larvae, before settling as juveniles and growing into adults, to migrate back to their spawning sites. Marine species are tolerant of fresh water, entering into the lower reach of the River as juveniles, sub-adults or adults, to feed.

7.5.4.5 Conclusions on Migration

Catadromous and Amphidromous regimes, besides playing a crucial role in the river ecology, have been considered with particular attention through supplementary studies in the project ESIA because the hydroelectric project will affect their colonization upstream of the dam. Most of the Gobiidae family species mature and spawn in the dam area (*Awaous*, *Sicyopterus*, *Stiphodon*, etc.).

7.5.5 Locomotion Behavior

Regarding the abilities of juvenile fish to pass obstacles when migrating upstream, different locomotion behaviors can be observed. These have been taken into account when designing possible fish pass systems.

7.5.5.1 Strict swimmers

Some species like silverfish *Mesopristes sp.*, *Kuhlia sp.*, river mullet (*Liza vaiengensis*), and others, can be qualified as “strict swimmers” with a pelagic behavior. They remain constantly within the water column (i.e., make no contact with the substrate). These species are not capable of climbing obstacles, such as natural cascades, waterfalls or dams). In their natural environment, these species are not found upstream of waterfalls.

7.5.5.2 Crawlers and climbers

Other species of fish exhibit a benthic behavior (Syciidae and other Gobiidae, prawns, eels), and are able to migrate upstream of cascades and waterfalls. They can be classified in two categories:

- Syciidae juveniles or climbing gobies (genus *Lentipes*, *Sicyopterus*, *Sicyopus*, *Stiphodon*), are presumably the most abundant taxa in the Tina River, and are known to climb quasi-vertical smooth surfaces up to several hundreds of meters, using their pelvic suckers and, for some species, their buccal suckers.
- Eels and prawn juveniles, unlike Syciidae, are not able to climb sub-vertical smooth surfaces. However, they are known to climb over steep slopes with wet and rough surfaces with asperities, by crawling on substrates of rocks, earth and vegetation over which runoff waters flow. Eels use undulations of the body axis whereas prawns walk on the substrate. In Tahiti, both eels and prawn juveniles are known to climb over earth dams, 15m to 20m in height. Therefore, as species they are still present and abundant upstream of dams built in the 1980s (Moirod & Trebaol, personal communication).

Table 7-4 presents locomotion behavior of identified fishes.

Table 7-4 Locomotion behavior

Locomotion behavior	
<i>Ambassidae</i>	
<i>Ambassis interrupta</i>	Strict swimmer
<i>Ambassis miops</i>	Strict swimmer
<i>Anguillidae</i>	
<i>Anguilla mamorata</i>	Crawler
<i>Apoginidae</i>	
<i>Apogon hyalosoma</i>	Strict swimmer
<i>Apogon sp.</i>	Strict swimmer
<i>Carangidae</i>	
<i>Carangoides malabaricus</i>	Strict swimmer
<i>Caranx sp.</i>	Strict swimmer
<i>Caranx sexfasciatus</i>	Strict swimmer
<i>Scomberoides sp.</i>	Strict swimmer
<i>Scomberoids sp. Juveniles</i>	Strict swimmer
<i>Cichlidae</i>	

Locomotion behavior	
<i>Oreochromis mossambicus</i>	Strict swimmer
<i>Eleotridae</i>	
<i>Allamogurda sp.</i>	Strict swimmer
<i>Belobranchus belobranchus</i>	Strict swimmer
<i>Butis sp.</i>	Strict swimmer
<i>Butis amboinensis</i>	Strict swimmer
<i>Eleotris fusca</i>	Strict swimmer
<i>Ophieleotris hoedti</i>	Strict swimmer
<i>Ophieleotris margaritacea</i>	Strict swimmer
<i>Ophieleotris sp. 1</i>	Strict swimmer
<i>Ophieleotris sp. 2</i>	Strict swimmer
<i>Ophiocara aporos</i>	Strict swimmer
<i>Bunaka gyrinoides (Eleotris gyrinoides)</i>	Strict swimmer
<i>Gerreidae</i>	
<i>Gerres sp.</i>	Strict swimmer
<i>Gobiidae</i>	
<i>Awaous guamensis</i>	Climber
<i>Awaous melanocephalus</i>	Climber
<i>Awaous ocellaris</i>	Climber
<i>Awaous sp.</i>	Climber
<i>Bathygobius andrei</i> ⁴³	Data deficient
<i>Glossogobius celebius</i>	Data deficient
<i>Glossogobius sp. 1</i>	Data deficient
<i>Glossogobius sp. 2</i>	Data deficient
<i>Lentipes multiradiatus</i>	Climber
<i>Lentipes sp. 1</i>	Climber
<i>Lentipes sp. 2</i>	Climber
<i>Redigobius bikolanus</i>	Climber
<i>Redigobius tambujon</i>	Data deficient
<i>Schismatogobius sp. cf. ampluvinculus</i> ⁴⁴	Data deficient
<i>Schismatogobius sp. cf. roxas</i> ⁴⁵	Data deficient

⁴³ This identification is questionable, based on known range. Records are pending further identification.

⁴⁴ This identification is questionable, based on known range. Records are pending further identification.

⁴⁵ This identification is questionable, based on known range. Records are pending further identification.

Locomotion behavior	
<i>Schismatogobius sp.</i>	Data deficient
<i>Sicyopterus lagocephalus</i>	Climber
<i>Sicyopterus longifilis</i>	Climber
<i>Sicyopterus ouwensi</i>	Climber
<i>Sicyopterus sp.</i>	Climber
<i>Sicyopus discordipinnis</i>	Climber
<i>Sicyopus mystax</i>	Climber
<i>Sicyopus sp.1</i>	Climber
<i>Sicyopus sp.2</i>	Climber
<i>Sicyopus zosterophorum</i>	Climber
<i>Stenogobius hoesei</i>	Climber
<i>Stiphodon atratus</i>	Climber
<i>Stiphodon sp. cf. atropurpureus</i> ⁴⁶	Climber
<i>Stiphodon birdsong</i>	Climber
<i>Stiphodon sp. cf. multisquamus</i> ⁴⁷	Climber
<i>Stiphodon sp. cf. ornatus</i> ⁴⁸	Climber
<i>Stiphodon rutilaureus</i>	Climber
<i>Stiphodon semoni</i>	Climber
<i>Stiphodon sp.1</i>	Climber
<i>Stiphodon sp.2</i>	Climber
<i>Kuhliidae</i>	
<i>Kuhlia marginate</i>	Strict swimmer
<i>Kuhlia rupestris</i>	Strict swimmer
<i>Lutjanidae</i>	
<i>Lutjanus argentimaculatus</i>	Strict swimmer
<i>Lutjanus fuscescens</i>	Strict swimmer
<i>Lutjanus vitta</i>	Strict swimmer
<i>Mugilidae</i>	
<i>Liza tade</i>	Strict swimmer
<i>Liza vaigiensis</i>	Strict swimmer
<i>Muraenidae</i>	

⁴⁶ This identification is questionable, based on known range. Records are pending further identification.

⁴⁷ This identification is questionable, based on known range. Records are pending further identification.

⁴⁸ This identification is questionable, based on known range. Records are pending further identification.

Locomotion behavior	
<i>Gymnothorax polyuranodon</i>	Data deficient
<i>Ophichthidae</i>	
<i>Scolecenchelys macroptera (Muraenichthys macropterus)</i>	Data deficient
<i>Poeciliidae</i>	
<i>Gambusia holbrooki</i>	Strict swimmer
<i>Rhyacichthyidae</i>	
<i>Rhyacichthys aspro</i>	Data deficient
<i>Syngnathidae</i>	
<i>Chelon macrolepis</i>	Data deficient
<i>Microphis (Oosthetus) manadensis</i>	Data deficient
<i>Microphis sp.</i>	Data deficient
<i>Microphis leiaspis</i>	Data deficient
<i>Microphis(Doryichthys) retzi</i>	Data deficient
<i>Terapontidae</i>	
<i>Terapon jarbua</i>	Strict swimmer
<i>Mesopristes argenteus</i>	Strict swimmer
<i>Mesopristes cancellatus</i>	Strict swimmer
<i>Zenarchopteridae</i>	
<i>Zenarchopterus dispar</i>	Strict swimmer
<i>Zenarchopterus sp.</i>	Strict swimmer

7.5.6 Habitat requirements

Together with locomotion behaviour, the use of habitat by species' present in the river will determine the impacts that hydro scheme operation will have on migration and life cycle.

There is little published information about the habitat types in which the Tina River species are found and no specific information on the water depths, velocities and substrates in which they are found. Gobies are usually found in riffles, where coarse substrate (boulders, cobbles and large gravels) provide both shelter from the current and a food resource. Pools provide habitat for large eels, grunters and jungle perch.

Measurements of fish species and number, water velocity and depth and substrate composition in small areas (2-4 m²) were made on 11 March 2016 and 13-14 July 2016 to determine habitat suitability for common fish species in the Tina River.

Very little is known about the factors controlling fish populations in Solomon Islands. As in other island countries, most Solomon Island fish species have evolved to cope with the conditions they

experience. Eels and most gobies are capable climbers and can penetrate to the headwaters of most rivers. The diadromous life history protects their early life stages from the vagaries of the riverine environment such as strong and variable currents caused by floods and freshets. The overwhelming influence of diadromy suggests that total fish numbers and diversity in a given reach will depend on access to the sea, with instream habitat controlling the density of fish within the reach.

7.5.6.1 Habitat modelling

Modelling of instream habitat availability for selected species, over a range of flows, is a valuable tool when assessing potential effects of flow changes and making decisions about environmental flow requirements. This method is one of the most commonly used methods of assessing flow requirements (Tharme 2003). The background to methods used here is discussed in Jowett et al. (2008).

Habitat modelling entails measuring water depths and velocities, as well as substrate composition, across a number of stream cross-sections at a given flow (referred to as the survey flow). Points on the banks, above water level, along the cross-sections are also surveyed to allow model predictions to be made at flows higher than the survey flow. Calibration data for fitting rating curves are obtained from additional measurements of water level at each cross-section, relative to flow, on subsequent visits. The stage (water level) with no flow in the river (stage of zero flow) is also estimated at each cross-section to help fit rating curves. These data allow calibration of a hydraulic model to predict how depths, velocities and the substrate types covered by the stream will vary with discharge in the surveyed reach.

The habitat suitability at each point in the reach is calculated from modelled depth, velocity and substrate from habitat suitability curves⁴⁹ (HSC). Habitat suitability weighted by the area represented by each point is summed over the reach to give area weighted suitability (AWS previously known as WUA weighted usable area) with units of m²/m. The average habitat suitability of the reach is the AWS divided by the wetted area of the river and is a dimensionless number between 0 (totally unsuitable) and 1 (ideal). Habitat modelling is undertaken over a range of flows to predict how habitat availability (AWS) and average habitat suitability will change with flow.

7.5.6.2 Habitat mapping

The first step in the process is to carry out habitat mapping along the length of the reach between the dam and tailrace locations. The habitat types are assessed in the field after traversing the affected reach; usually they would include riffle, run, pool, and rapid. The length and location of each habitat type is recorded. The habitat mapping between the Tina Village and dam site is presented in Table 7-5.

Table 7-1 - provides the percentage of habitat types between Tina Village, powerhouse site and dam site on 6 March 2016

⁴⁹ HSC describe the suitability of different depths, velocities and substrate sizes for given species of interest.

Habitat Type	1 km upstream of Tina Village to powerhouse site	Upstream of powerhouse to 1 km downstream of dam site
Rapid	5%	5%
Riffle	31%	36%
Run	55%	46%
Pool	9%	13%

7.5.6.2.1 Cross-section selection

The number of cross-sections required depends on the morphological variability within the river. Studies have shown that relatively few cross-sections can reproduce the results from a survey with a large number of cross-sections (see Jowett et al. 2008 for details).

The total number of cross-sections needed to generate a robust result should be proportional to the complexity of the habitat hydraulics: 6-10 for simple reaches and 18-20 for diverse reaches.

Each cross-section is given a percentage weighting based on the proportion of the habitat type in the reach that it represents. The underlying assumption is that the cross-sections measured provide a reasonable representation of the habitat throughout the reach. Reach results can be extended to longer sections of river, if the flows, river gradient and morphology do not change significantly.

Three cross-sections were surveyed - one in a pool, one in a run and one in a riffle. Water levels were measured at flows of 8.7 m³/s and 19.7 m³/s and these were used to develop rating curves at each cross-section⁵⁰.

7.5.6.2.2 Habitat suitability

It is the quality of the habitat that is provided by the flow that is important to density of stream biota, rather than the magnitude of the flow per se. In many streams, flows less than the naturally occurring low flow are able to provide good quality habitat and sustain stream ecosystems. The magnitude of this flow will vary with the requirements of the species and with the morphology of the stream.

Water velocity is probably the most important characteristic of a stream. Without it, the stream becomes a lake or pond. In gravel bed rivers, an average velocity of 0.2-0.3 m/s tends to provide for most stream life, because velocities lower than this provide unsuitable habitat for a number of fish species and stream insects, and allow deposition of sand and finer materials. In large rivers, water depth of more than 0.4 m provides habitat for swimming species, but benthic fish are often found in shallower water. Gobies feed either on algae or small invertebrates associated with algae growing on the stable cobbles and boulders.

⁵⁰ It would have been ideal to obtain calibration measurements at three flows, one as low as possible. However, experience has indicated that there is a probability (> 50%) that 3 cross-sections in the different habitats would give the same answer as a larger number of cross-sections. Although not ideal, these measurements can give some indication of the effects of a flow reduction on instream habitat.

The flow at which limiting conditions of depth and velocity occurs varies with stream morphology. Generally, minimum flow increases with stream size, because stream width increases with stream size. However, the relationship is not linear. In general, small streams require a higher proportion of the natural stream flow to maintain minimum habitat than do large rivers.

7.5.6.2.3 Method for determining habitat suitability

Fish densities were sampled across transects in the Toni River in a variety of habitat types (riffle, run and pool) on 11 March 2016. Thirteen quadrats of between 2 m² and 6 m² were sampled by electro-fishing using EFM300 (NIWA Instrument Systems, Christchurch, New Zealand) electro-fishing equipment. Flooding and turbidity prevented sampling in the Tina River

The quadrats were at regular intervals across each transect with a distance of at least 1 metre between quadrats to avoid fish disturbance. The quadrats were selected so that there was minimal variation in water depth, velocity and substrate composition within the quadrat.

Electro-fishing was conducted with a downstream stop net and a dip net to catch any fish that missed the stop net.

Water depths and velocities were measured across a diagonal of the area fished and matched to recorded species and lengths of fish caught. Afterwards, fish were released at their capture point.

A further 56 quadrats were sampled by snorkelling on the 13-14 July 2016; 23 in the Toni River and 33 in the Tina River. A total of 18 species were either caught or observed and 8 of these species were relatively common (present in more than 3 quadrats).

After fishing, water depth and velocity were measured (at 0.4 times depth) at 5-10 points in each quadrat usually on a diagonal. The percentage of five substrate size categories (bedrock, boulder, cobble, gravel, and fines) was estimated visually.

Potential cover such as banks with overhanging vegetation or large logs was also sampled. The average depth and velocity in each quadrat was calculated from the measurements taken within the quadrat. For substrate, a substrate index (s) was calculated from the visual percentage estimates using the formula (Jowett & Richardson, 1990)

$$s = 0.08 * \text{bedrock} + 0.07 * \text{boulder} + 0.06 * \text{cobble} + 0.05 * \text{gravel} + 0.035 * \text{fines}.$$

The most suitable habitat was determined by the density of fish. For example if the highest average density of fish was in riffles and the lowest in pools, riffles would be the most suitable habitat and pools the least. A similar procedure was followed to determine habitat suitability for depth, velocity and substrate. The methods used for determining habitat suitability are described in Jowett & Davey (2007) and Jowett & Richardson (2008).

Some size-related habitat selection was observed with smaller fish in low velocity water than the larger individuals of the same species.

During the first survey, the proportion of the different habitat types was measured and cross-sections were identified in each of the habitat types. A large flood that occurred on the second day of the survey, removed more than half of the temporary staff gauges that had been installed. This meant that only 3 cross-sections could be surveyed. One cross-section was a wide riffle at the proposed powerhouse location and the other two were in a pool and run further upstream. Water levels were measured at flows of 8.7 m³/s and 19.7 m³/s and these were used to develop rating curves at each cross-section. The cross-section at the powerhouse site was selected to evaluate the effect of flow on water level between the powerhouse and Tina Village where the valley is wider than between the dam and powerhouse. Because the powerhouse cross-section was

unrepresentative of the habitat between the dam and powerhouse it was excluded from the habitat analyses.

The second survey (11-12 July 2016) comprised cross-sections in 2 pools, 5 runs, 5 riffles and 2 rapids; a total of 14 cross-sections. The flow was 9.91 m³/s on the 11 July and 9.66 m³/s on the 12 July. Water level and flow measurements were taken on 15 July and 25 July for rating calibration when the flows were 8.28 m³/s and 5.39 m³/s, respectively.

This sampling showed clearly that riffles were the preferred habitat of gobies and eels, with an average fish density in riffles of 7.2 fish/12 m² compared to an average density of 1.4 fish/12 m² in runs. We did not find any fish in association with log or bank cover.

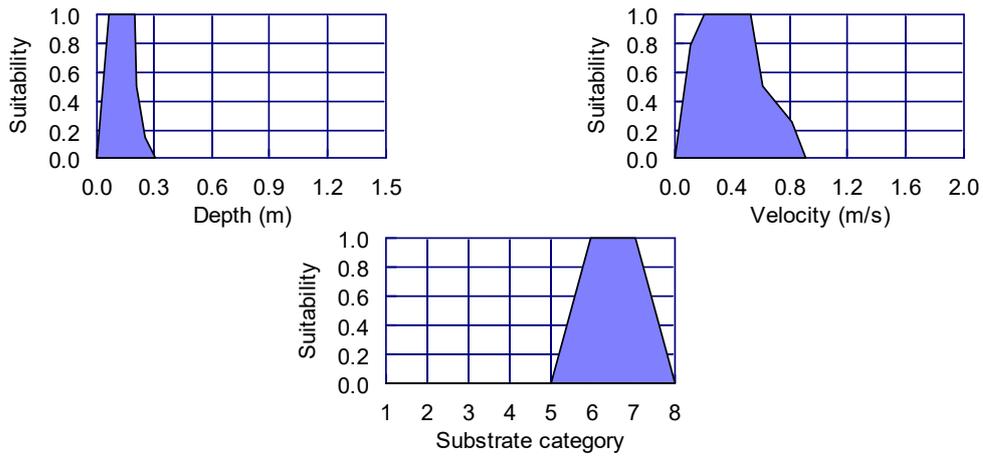
Fish density and diversity was higher in the Toni River than in the Tina River (Mann-Whitney non-parametric test, $P < 0.001$), with an average of 60.4 ± 81.7 fish/12m² in the Toni River compared to 6.7 ± 17.1 fish/12m² in the Tina River and an average number of species per quadrat of 2.61 ± 1.44 in the Toni River compared to 1.17 ± 1.09 in the Tina River. There were no significant differences between rivers in sampling depth or substrate composition (Mann-Whitney non-parametric test, $P > 0.1$) but sampling velocities were higher in the Tina River than in the Toni River (Mann-Whitney non-parametric test, $P = 0.001$).

In general, the results were as expected with these goby species in shallow low-moderate velocity riffles and eels in a wider range of depths and velocities in the riffles. Shallow water (<0.3 m), a velocity of about 0.5 m/s, and cobble substrate tended to contain the greatest density of fish and the greatest number of species.

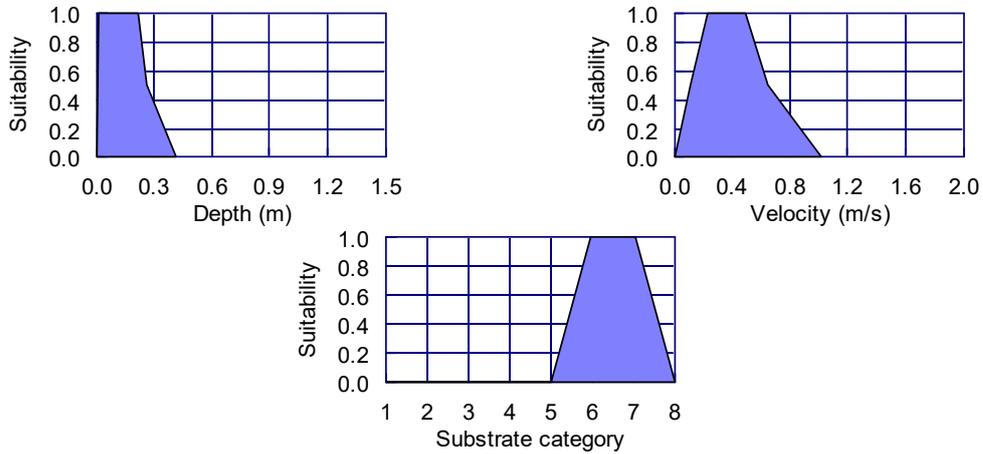
The preferred habitat of the goby species *Sicyopterus stimpsoni* in Hawaii (Fig. 7-4) was similar to the preferred habitat of the Solomon species in that they preferred low to moderate velocities and coarse substrate. However, the other Guam and Hawaii species seemed to prefer lower velocities than *Stiphodon semoni* and *Belobranchus* sp.

Figure 7-4: Habitat suitability curves for *Stiphodon semoni*, *Belobranchus* sp., *Anguilla marmorata*, fish density and species richness. The substrate categories are 1= vegetation, 2=mud/silt, 3=sand, 4=fine gravel, 5=gravel, 6=cobble, 7=boulder, 8=bedrock.

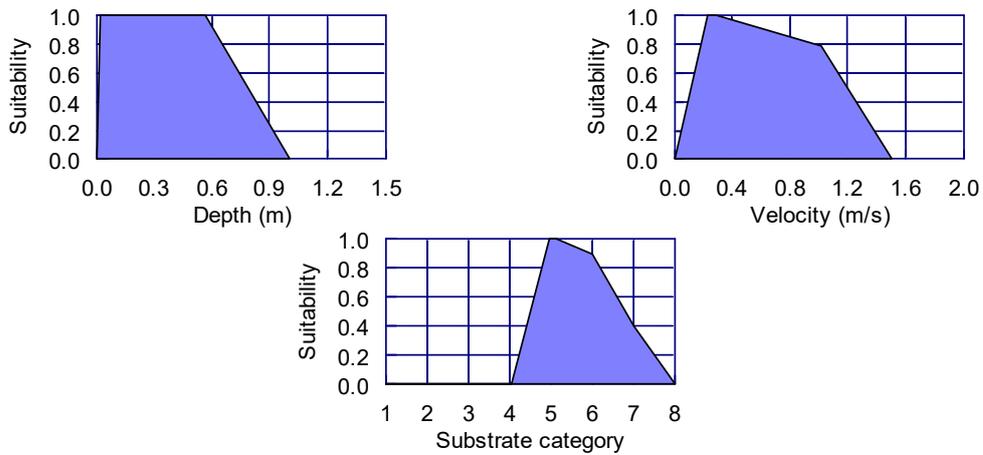
Stiphodon semoni



Belobranchus sp.



Anguilla marmorata (<150mm)



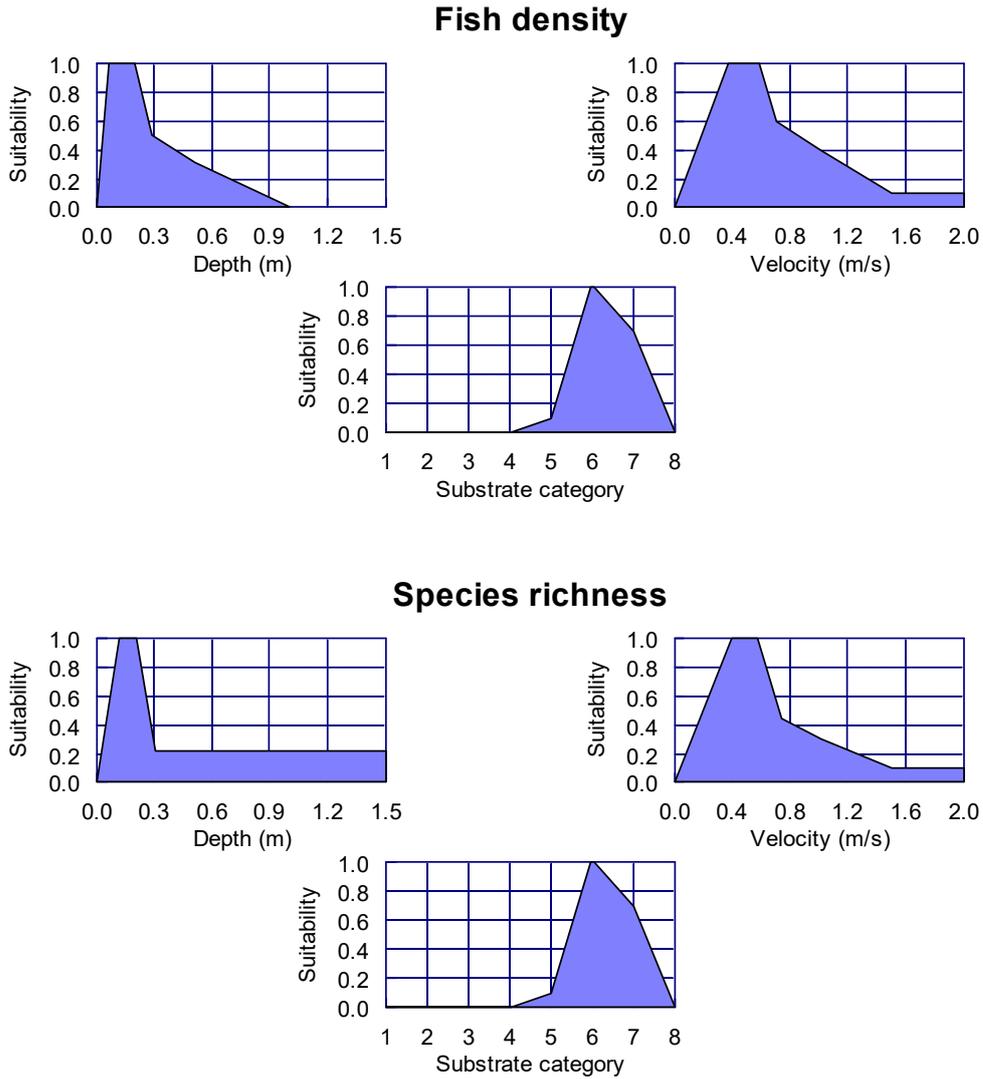
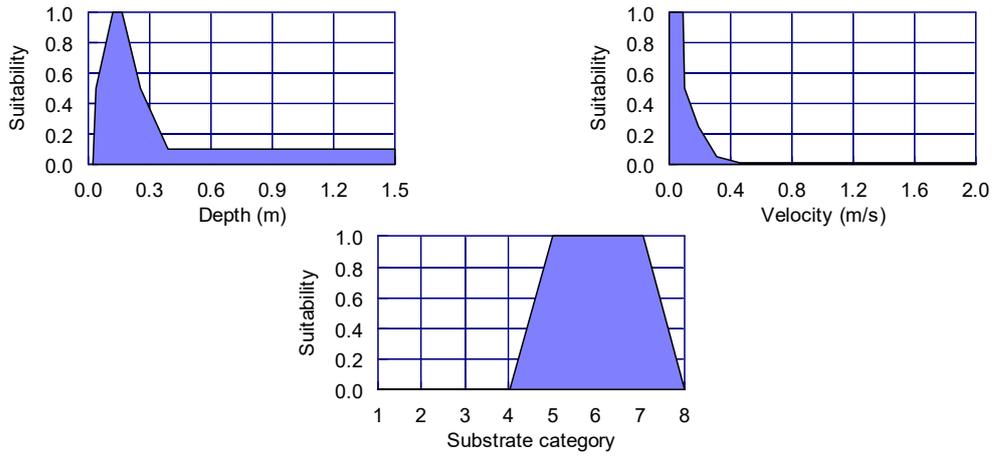
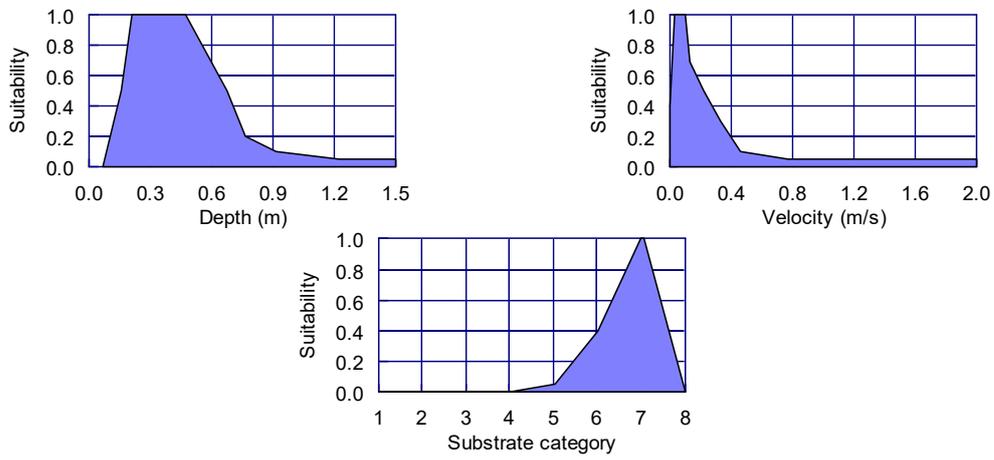


Figure 7-5: Habitat suitability curves for goby species from Guam and Hawaii from Thomas R Payne & associates. The substrate categories are 1= vegetation, 2=mud/silt, 3=sand,4=fine gravel, 5=gravel, 6=cobble,7=boulder, 8=bedrock.

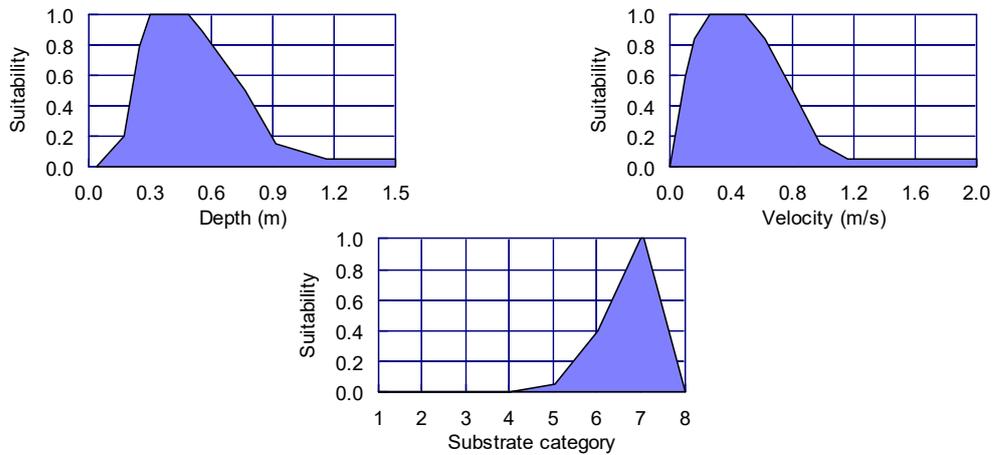
Stiphodon elegans



Awaous stamineus



Sicyopterus stimpsoni



7.6 INVASIVE, RARE, ENDANGERED, ENDEMIC AND THREATENED SPECIES

This sub-section describes observed species that are deemed ecologically important because of their migratory patterns, endemic status, threatened and protected status, and water dependence. These include migratory species, Guadalcanal island endemics species, species included by IUCN as red listed (Vulnerable, Endangered or Critically Endangered), species protected by CITES, and those that are dependent on the river water system.

Although Polhemus, et al. (2008), surveyed many islands in the Solomon Islands archipelago for aquatic insects, and compiled results in the report entitled “Freshwater Biotas of the Solomon Islands: Analysis of Richness, Endemism and Threats”, there is a lack of literature regarding specific life cycles, and breeding and feeding habits of most fauna in the Solomon Islands. Therefore, due to limited scientific data and limited previous surveys, there is only partial knowledge regarding the extent of impacts that TRHDP activities may have on terrestrial species.

7.6.1 Endemic Aquatic Insect Species

Guadalcanal is rich in aquatic insect diversity. Polhemus surveyed many islands in Solomon Islands for aquatic insects, including nine locations in Guadalcanal, four of which were in the TRHDP study area. These four stations are presented on the map in Figure 6-1. Surveys were carried out between 2004 and 2005. The table in Annex 7 of the Annex Report shows sampling results from Polhemus *et al.* (2008), aquatic insects observed by the ESIA team were added to the table.

Among the aquatic insect species of the Sub Order Heteroptera (true bugs), 12 species occur on Guadalcanal, 4 of which are endemic across Solomon Islands, and 8 of which are endemic to Guadalcanal.

Among the aquatic insect species of the Sub Order Odonata (dragonflies and damselflies), 15 species occur on Guadalcanal, 8 species of which are endemic across Solomon Islands, and 7 species of which are endemic to Guadalcanal.

Among the aquatic insect species of the Sub Order Coleoptera (beetles), 7 species occur on Guadalcanal, 1 species of which is endemic across Solomon Islands, and 6 species of which are endemic to Guadalcanal.

This richness in aquatic insect species is primarily threatened by logging activities, which can lead to stream degradation, obstruction and siltation from tree falling. Logging also creates openings in the canopy leading to an increase of stream temperatures, which affects habitat requirements of many aquatic species. Oil palm plantations also pose a threat to aquatic insects, due to runoff of water containing of fertilizers and pesticides. Finally, mining activities can cause siltation and introduce chemicals to the streams.

7.6.2 Invasive Aquatic Species

Two major invasive aquatic species, Mozambique tilapia (*Oreochromis mossambicus*) and mosquito fish (*Gambusia holbrooki*) can become very numerous in the lower reaches of Guadalcanal rivers. *O. mossambicus* was recorded at Ngalimbiu River bridge (Golder Associates, 2009) and in a billabong near the Tina Village during the scoping study (PHCG, 2010). The species was not observed during the 2013 fish survey, though its presence was confirmed by interviews with local fishermen, and by observations made during the rainy season.

The dynamics of these two invasive species are believed to be low in the Tina-Ngalimbiu River, due to dominant rheophilic conditions (fast moving water), and to the flow pulse in a short period of time. Tilapia is definitely not a species adapted to rheophilic conditions found in the middle/upper Tina River. This ESIA considers that this species will not colonize the upper Tina River catchment, and will not have consequences on local fish biodiversity. The species has already been present in the lentic environment of the Ngalimbiu River for many years, and has not invaded middle/upper Tina River.

7.6.3 Endemicity and IUCN Status

The endemicity rate of freshwater fish in Solomon Islands has been assumed to be low, compared to other taxa like aquatic insects (Polhemus et al, 2008), although recent detailed studies have revealed a level of freshwater fish endemism in the Solomon Islands that was not previously appreciated (Keith et al. 2017).

According to Polhemus et al (2008):

. . . interestingly, although freshwater fishes show notable endemism on both New Guinea and Fiji which bracket the SI region, there were no locally endemic genera or species of freshwater fishes previously recorded from the SI archipelago, nor were any unequivocally discovered during the present surveys, although there is a possibility that a few sicydiine gobies collected may prove to be regionally endemic.

In contrast, the aquatic insect biota is represented by many endemic species often confined to single islands, with an endemic rate of 44% to 90%, depending on the taxa, and 32 species new to science.

Fish surveys on Tetepare Island, Western Province (Jenkins and Boseto, 2007) show that most species have a wide geographical distribution range in the Indo-Pacific area. Though, 15% of the fish fauna is either restricted to the Melanesian archipelagoes (5%) or only known from Solomon Islands (10%). Regarding the latter, five un-described species were identified.

The Tina River and other Guadalcanal rivers are likely to present the same range of species, with a few restricted range species, especially in genus *Schismatogobius*, *Stiphodon*, *Sicyopterus* and *Lentipes*. Endemicity at the Tina/Ngalimbiu watershed level is very unlikely, given the above mentioned scientific results.

For all recorded species, IUCN status is given as least concern or not evaluated / unknown. No native vulnerable, or near threatened, or endangered, fish species have been found in the Tina/Ngalimbiu River system. Some species are rare, according to local communities, and have been identified as such in Table 4-13.

7.7 FISHERIES IN THE TINA-NGALIMBIU RIVER

Along the river, fishing activities were recorded at all surveyed stations. The remote areas at and upstream of the dam location are fished very occasionally, and only on particular occasions, due to difficult access. Further downstream, in inhabited areas along the lower Tina River and upper Ngalimbiu River, subsistence fishing is a continuous activity, practiced either by adults or children, using mainly snorkelling and spear fishing gear. From interviews with local fishermen, fisheries activities have increased with growth of human population, especially for younger people. During

the field survey conducted near Horohotu, a fisherman exhibited a catch of 6 specimens of considerable sizes (mullet and rock-sucker gobies) caught with a spear.

The shore along the mouth of the Ngalimbiu River is a very bountiful fishing location due to the concentration of adult and juvenile fish of different species entering into the lower river. About 30 fishermen from Komporo and other coastal villages are working at the mouth of the river during both daytime and night time, either for subsistence or commercial fishing, using canoe, gill nets, and mosquito seine nets. According to fishermen that were interviewed, a single fisherman can earn SBD 1,500 by selling the catch. Goby larvae are very appreciated and sell for SDB 5 per cup. The catch with 50-70 test fishing lines is very high (e.g., 40 fish per 20 minutes was mentioned) and even higher with 1" mesh gill nets.

At a monthly frequency, when full moon and sun meet at the dawning of a day, the fishers await massive migrations of juvenile fish entering into the river. In the upstream reach, increased catches have been observed during these periods. Apart from juveniles, migration of large specimens of marine forms and eels reaching maturity, are targeted in the upper reaches.

7.8 TINA RIVER UPPER CATCHMENT, A CRITICAL NATURAL HABITAT?

This sub-section discusses the significance of the upper Tina River catchment solely on an aquatic ecology basis, since it is the main upstream component that will be modified due to the Project. However, the upper Tina River catchment is also an important terrestrial habitat, since it is covered by a significant area of Montane forest, and is the location for many high peaks of Guadalcanal.

7.8.1 Critical Habitat

As defined by World Bank Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, critical habitats are "areas with high biodiversity value, including:

- (i) habitat of significant importance to Critically Endangered and/or Endangered species (IUCN classification);
- (ii) habitat of significant importance to endemic and/or restricted-range species;
- (iii) habitat supporting globally significant concentrations of migratory species and/or congregating species;
- (iv) highly threatened and/or unique ecosystems; and/or
- (v) areas associated with key evolutionary processes".

Unlike the forests in the upper catchment, the Tina River itself does not meet the critical habitat definition. It does not shelter endangered fish species (see table of fish species for definitions).. Although all fishes are migratory within the Tina River catchment, fishes in Solomon Islands do not show homing behaviour, meaning that juveniles can colonize any river, rather than just their natal stream, and do not depend on a particular river for support.

The upper Tina River also does not satisfy the definition with respect to endemic or range-restricted insect species in the groups that were sampled for the ESIA or in the literature. All

identified endemic insect species have also been identified as present in a number of other river catchments within Guadalcanal outside of the study area and well outside of the area of impact for the Project. Polhemus's account of the biogeography of Solomon Islands aquatic insects suggest that catchment-specific impacts of the Project are unlikely to have wider impacts on species populations.⁵¹

7.8.2 Value Of The Upper Tina River Catchment

7.8.2.1 Important in Fish Life Cycle

The upper Tina River and its tributaries are a significant spawning ground for most amphidromous species, and a rearing / maturing location for many catadromous species, due largely to the high water quality, the richness in habitats in tributary rivers, and food availability. In addition, the length of rivers within the catchment allows for many habitats to shelter a significant number of fishes. However, the length of rivers in the Tina River catchment is not a factor that increases fish lifespan or fertility, since these factors are determined genetically and environmentally. Some environmental signals trigger fish to migrate, to spawn and die, regardless of the length of the river system.

The absence of human settlement in the upper Tina River catchment also allows fish to thrive without significant harvest pressure. The large area of intact forest adds value to the river catchment, since leaf detritus, flowers and fallen fruits provide nutrients to the river system. In addition, the local topography, with its high peaks brings cool, rapid and well-oxygenated water to the catchment, attracts fish. The water temperature gradient found along the Tina River is an important environmental cue suspected of being a trigger for fish migration. Many Tina River tributaries originate at elevations of between 1000masl and 1600masl, bringing cool water to the system. Flash floods can be very powerful in the upper catchment, contributing rich nutrients that support biomass productivity, and provide connectivity for larvae to migrate to the ocean.

It is, however, important when comparing the value of habitat to mention that the mouth of the river is more "critical" to the life cycle of fishes, than the upper catchment. This is because the river mouth is the unique entry point for all migratory fishes when at the fragile juvenile stage of their lives. Disturbances at the mouth of the Tina/Ngalimbiu River can have greater adverse impacts on juveniles, than disturbances to the upper reaches of the river system have on adult fishes.

7.8.2.2 Tina River Uniqueness

Assessing the value of the upper Tina River catchment is rather difficult, since little scientific data exists regarding other river catchments with which to compare the Tina River. Prior to the Gold Ridge mine development, Chovohio River and Tinahulu River catchments (Matepono) were likely similar to the Tina River catchment, where 45 species of fish were identified (Golder and Associates, 2009). Likewise, the Tetepare catchment had 60 identified species of fish (Jenkins and Boseto, 2006). By looking at these two other catchments, the Tina River's fish biodiversity appears to follow the general trend in Guadalcanal. Other than its relatively large catchment area, based on

⁵¹ Polhemus (2008) p. 105. Polhemus in discussing hydropower projects notes that "...their impacts would be confined to the mid- and terminal reaches of a few individual river catchments. Given the short, discrete nature of many Solomon Islands drainage basins, and the sharp topographical divides separating them, the environmental changes caused by any one dam, although locally dramatic, would have little overall effect on the aquatic biota of a given island, and would not serve to endanger any endemic species in a global sense."

the limited knowledge of its fish biodiversity, the Tina River catchment does not appear to represent unique habitat within the Guadalcanal context. Moreover, within the South Pacific region, catadromous and anadromous fish do not present a homing behaviour. Juveniles are able to colonize any river, rather than just their natal stream.

Notwithstanding, all of the fish surveys conducted to date have been based on qualitative, rather than quantitative methodologies. Therefore, it is difficult to determine the quantity of fish that the Tina River system is able to produce, compared with other catchments. Several factors could be having a positive influence on fish biodiversity, productivity and abundance, and contribute to the uniqueness of the Tina River, including:

- ▶ Its large catchment area, the majority of which is undisturbed forest;
- ▶ It is among the few rivers that drain mountain peaks that reach to 2000masl in altitude. The topography also makes the area less accessible to human related disturbances.
- ▶ The length of the river network provides a variety of aquatic habitats for catadromous and amphidromous fishes, enabling them to thrive without human pressure.

The Tina River is among the few rivers that possess all these features, thereby making it a distinctive river in terms of its physical characteristics.

7.9 CONCLUSIONS ON FISH AND AQUATIC ENVIRONMENT

Although the upper Tina River catchment plays an important role in the life cycle of various fish species, it is not a critical role since:

- ▶ Fishes do not show homing behavior, meaning that juveniles will colonize any rivers, rather than only their natal stream;
- ▶ The mouth of the Ngalimbiu River is more critical to the life cycle of fish species found within the system, than upstream areas, as the mouth of the river is the only point between the river and the ocean that all species of fish must cross at some point in their live histories.

Based on current knowledge, the waters of the upper Tina River are a highly valued aquatic habitat, but not critical habitat .

8. SOCIO-ECONOMIC / SOCIO-COMMUNITY BASELINE

8.1 SOCIAL ENVIRONMENT

8.1.1 Meeting at Hill Top

Prior to commencing the social assessment, a meeting was held at Hill Top with Bahomea Chiefs, members of the TRHDP PO team and the ESIA team. The objective of the meeting was to present the ESIA process to the Chiefs, taking note of Chiefs' grievances, and to get their blessing prior to commencing fieldwork.

Table 8-1 lists the persons involved in the meeting:

Table 8-1 List of attendance at Hill top meeting

Name	Title	Name	Title
Timus Matthew	Chief	Aldin Roger	
Mahlon Dasi	Teller	Japan Chaku	
Kapini Sosimo	Chief	Deresa	Chief
Michael Meki	Chief	Risky Rongo	
Gilbert Avai	Elder	Zimiri Launi	
Daniel Garusi	Chief	Oscar Billy	
Alfred Ilala	Chief	Jonathan Beho	Chief
Adam Singi	Elder	Areson Handila	
Rex Ata	LOC	James kaputi	
Albert Ringo		Pastor Kedimiel Lauri	Pastor
Hudson Solo	Chief	Michael Litany	
Timothy Suigi		Peter Rocky	Paramount Chief
Richard Anisie	Chief	Mahlon Maeni	Chief
Masioth Rere		David Tapitoa	
Peter Lakale	Chief	Jabeth Lati	
Dohlan Gisi	Chief	Crystal Frenda	
Penuel Pore	Chief	Bethsaida Neka	
Enoch Mark	Chief	Dorcus Pesini	
Malcolm Rino		Eric Gorapava	TRHDP PO
Hipo Suhara		Brally Tavalia	TRHDP PO

Name	Title	Name	Title
Absuah Zapaniah		Julian Maka'a	TRHDP PO
Wickham Kesi		Daniel Una	Chief
Madrush Welmah		Eric Deneut	ESIA Team
Julia Jackie		Fred Patison Siho	ESIA Team
Lovelyn Hema			

Minutes of the meeting are included in Annex 4 of the Annex Report.

8.1.2 Social Assessment Methods

8.1.2.1 Staff Involved

The Social studies were led by Gerard Fitzgerald, Sociologist. He was accompanied by a team of National experts, including:

- **Lawrence Foana'ota, National Cultural Heritage consultant; and**
- **Kellington Simeon, National social assessment assistant.**

Additional assistance was provided by the following:

- Sharon Tabea-Para, an indigenous woman from the area, who also acted as a project Community Liaison Assistant (CLA). Ms. Tabea-Para is an independent Sociologist with independent local knowledge about local protocols, custom, village populations, kinship relations, natural resources, and the local environment. She facilitated culturally-safe access to local women and provided the team with local indigenous language translation skills.
- Zimri Laoni and Rex Ata, TRHDP office community liaison assistance (CLAs) from Bahomea, who provided liaison with local leaders and groups in the Bahomea communities.
- Community Liaison Assistants (CLAs) from Malango and Ghaobata.
- An officer of the Guadalcanal Provincial Government, who assisted in organising meetings with downstream communities.

Several observers attended village meetings during the fieldwork, including:

- Real Courcelles, an international expert in project benefits sharing, who attended at Marava
- Brally Tavalia, the TRHDP PO Community Liaison Officer.
- Fred Patison, who attended workshops at Mataruka and Ado villages in the Malango area.

8.1.2.2 Dates of Surveys

Field surveys were carried out from 29 August to 25 September 2013.

8.1.2.3 Location of Surveys

The program of fieldwork was developed by the ESIA team in consultation with Project officers, the project CLAs, and the environmental assessment team. The aim was to concentrate most of the fieldwork effort on the indigenous communities likely to be most directly affected by the proposed development options, while also allowing time and resources for input to be provided by

communities, and stakeholders, not likely to be immediately or directly affected by the project's construction or operation.

Table 8-2 shows the extent of social science fieldwork carried out by the team.

Table 8-2 Village fieldwork schedule and locations

Date	Core Venue	Target hamlets/stakeholders	Grouping	Ward
2-Sep-13	Marava	Marava, Vatupaua, Rate CHS, Ngongoti	Bahomea	Malango
3-Sep-13	Haimane,	Vuramali, Haimane, Horohutu 2, Katihana	Bahomea	Malango
4-Sep-13	Tina	Tina, Valebebe, Valebarik, Valemaota, Tahurasa	Bahomea	Malango
5-Sep-13	Antioch	Antioch, Valesala, Komeo	Bahomea	Malango
9-Sep-13	Senge	Senge, Koropa, Choro	Bahomea upstream	Malango
10-Sep-13	Pachuki	Habusi, Pachuki, Veraloka	Bahomea	Malango
11-Sep-13	Office	Fieldwork team & assistants		
12-Sep-13	Verakuji	Mangakiki, Verakuji	Bahomea	Malango
13-Sep-13	Namopila	Namopila, Komureo, Valekocho, Vatunadi	Bahomea	Malango
17-Sep-13	Mataruka Ado	Malango (Mataruka 1, 2, 3, & 4) Belaha communities	Bahomea	Malango
18-Sep-13	Vera'ande Horohutu 1	Vera'ande, Verakweli, Niumahata, Horohutu 1(settlers)	Settlers	West Ghaobata
19-Sep-13	Ravu	Ravu area hamlets (Ghaobata plains communities)	Ghaobata - downstream	West Ghaobata
20-Sep-13	Verakabikabi Old Selwyn	Settler communities, lower roadside Ghaobata plains communities	Settlers Ghaobata - downstream	West Ghaobata West Ghaobata
23-Sep-13	Honiara	Team workshop with assistants & project team		
24-Sep-13	Honiara	Institutional stakeholders	Government and non-government organisations	

8.1.2.4 Community and Stakeholder Participation

International ESIA practice guidelines specify participation by project-affected persons (PAPs), and other stakeholders in the planning of a project, and in the social impact assessment process. Such participation provides the opportunity for project planners and assessors to learn directly about local social conditions, ways of life, and existing issues among local people and communities. It also provides the opportunity for people and communities to help shape proposals that directly affect their present and future social and economic conditions. Consultation and other activities for engaging people are, therefore, normally initiated in the early stages of a project, rather than after key decisions have been made.

Current good international industry practice (GIIP) attempts to move beyond simply providing information. Rather, GIIP requires two-way dialogue to develop partnerships and empower people and communities, to enable themselves to play an active role in shaping developments to meet their own needs⁵². There is a considerable body of literature on how to achieve participation in development projects, especially by vulnerable groups. Participatory methods (such as those offered by Participatory Learning and Action (PLA)) are increasingly used in developing countries for project and programme identification, planning, assessment, and implementation.

The TRHDP PO, which is embedded within MMERE, is a well-organized, and comparatively well-resourced organization, with an explicit mandate. The TRHDP PO has planned and implemented an ongoing program of stakeholder, community, and indigenous leader engagement. The program has included, among other things:

- awareness raising activities, including suitably crafted multi-channel information dissemination.
- the creation of appropriate forums for discussion and negotiation, including formulation of access agreements for the project investigations, memoranda of understanding between the TRHDP PO and customary land owners and their leaders and an agreement for the acquisition of the Core Land with the five landowning tribes.
- establishment of a network of trained community-based liaison assistants to aid communication between villagers and the project office.
- public meetings, conferences, participatory workshops, and small group and individual discussions.
- study tours to hydropower facilities elsewhere in the Pacific.

Ongoing consultation activities implemented by the TRHDP PO have been reported in project newsletters, media releases, and on the project website <http://tina-hydro.com>.

8.1.2.5 Methods

GIIP recognises that community and stakeholder participation is integral to ESIA, and most professional organisations, such as the International Association for Impact Assessment (IAIA)⁵³, stress that the outcomes of consultation/participation should be incorporated into the project design, and into the assessment, management, mitigation and monitoring of social and other impacts.

⁵² See a recent (2014) description of landholder involvement in the TRHDP by Roughan, at <http://www.stakeholderforum.org/sf/outreach/index.php/previous-editions/sids/sids-day-7-water-food-and-waste/11724-the-tina-river-experience-power-only-through-partnership>

⁵³ The international professional body for impact assessment professionals: See www.iaia.org.

The TRHDP ESIA work itself was specifically designed and implemented to achieve active participation by project affected people (PAPs), local residents, downstream, residents, other stakeholders, project planners, and environmental technical specialists. The participatory focus workshop process, combined with face-to-face interviews and direct observation with local communities was chosen to enable active participation and interaction between the assessment team and the stakeholders. The details are outlined below in the description of the ESIA fieldwork.

Prior to conducting field visits, information was gathered from various stakeholders, including the MECDM, MHMS, Guadalcanal Provincial Office, and the Census Office. Information was obtained from personal communications with these sources. The main stakeholders consulted during the course of the assignment included the TRHDP PO, MECDM, MHMS, Guadalcanal Provincial Office, National Census Office, other international consultants and TRHDP CLAs and environmental experts working on the ESIA. Issues pertaining to the project location and settings were discussed with the TRHDP PO and its CLAs. Governance issues relating to the Project, were discussed with the MECDM and Guadalcanal Province. Health issues were discussed with the MHMS. Other relevant topics of discussion, such as benefit sharing, were discussed with other international consultants engaged by the World Bank as advisors to the Project.

A key output of the planning stage was a program schedule for the village workshops. The schedule took into consideration the amount of time available for the social studies, the size of the project area, and the impact of weather on accessibility. As part of the schedule, key focal villages were identified as optimum locations for conducting workshops and face-to-face interviews, since it was recognized that it would be difficult to carry out workshops in each and every village within the project area.

The social research fieldwork required 4 weeks to obtain primary data for the social profile and for the assessment of impacts. All members of the social assessment team were involved in the detailed planning of the fieldwork program and selection of methods, assisted by TRHDP PO project officers and CLAs - the latter serving as the main points of contact and logistics organizers within the study communities.

The social scope for the assessment, as specified by the study terms of reference (TOR), covered:

- the above geographical areas, and within them the:
 - Teha speaking customary landowning residents, including leaders, general public, groups, kinship groups, women, and youth.
 - The "settler" residents (that is, people originating from elsewhere in Guadalcanal, but residing locally as "guests" of the landowners.
- users of the Tina River in general.
- other stakeholders, including customary landowners who do not regularly reside within the project area, and environmental and community NGOs.

To ensure that the various stakeholders specified in the TOR were covered by the fieldwork investigations, the Tina River catchment area was divided into four areas or zones, based on the proposed project, - each with a different set of issues to be investigated, as follows:

1. Any communities located in the *Direct Impact Area*, that is, the lands required for the construction and operation of the proposed dam, storage reservoir, headrace tunnel, and powerhouse, as well as any borrow areas, set down areas, and yards, etc (Core Area) and any communities located in the 50 metre wide access road and transmission line corridor (Infrastructure Corridor). No communities or residences were identified in this area or in the Upstream Area above the reservoir.

2. The people and communities likely to be mainly affected by changes in the river water quality, volume, or availability during the construction or operation of the hydro scheme –downstream of the power station site. This area was designated as the *Downstream Area*. Within this group, the Senge Community are the villages located closest to the Direct Impact Area.
3. The people and communities likely to be mainly affected by modifications to, and use of, the existing or new access road/s, and transmission line corridor but who are not located within the *Direct Impact Area*. These areas were designated as the *Infrastructure Area*.
4. The people and communities who use or have ownership rights to land and resources in the project area and downstream, but do not necessarily reside in the Tina-Ngalimbiu River valley. These were designated as belonging to the *Wider Impact Area (WIA)*.

These various groupings are generally consistent with the communities' geographical distance from the Core Area. Groups 1 to 3 could also be affected by loss of access to livelihoods and resources upstream of the proposed dam, and by the potential presence of a construction workforce. All groups could benefit from employment or contracting opportunities during construction and operation of the scheme.

Using this classification, the villages and hamlets in each of the different project impact areas were identified, as shown in Table 8-3.

Table 8-3 Classification of Tina Catchment settlements by potential project affect

Impact area	Customary landowning communities	Non-customary communities
Direct Impact Area (DIA) and Upstream Area Settlements	<i>None.</i>	
Downstream Area Settlements	<p><i>In Bahomea district:</i></p> <p><i>Senge Community (proximate to the reduced flow reach):</i> Choro, Koropa, Senge</p> <p><i>Other Bahomea:</i> Habusi, Pachuki, Namopila, Komureo, Vatunadi, Tahaurasa, Tina, Valebebe 1 & 2, Vuramali, Haimane, Valebariki, Horohutu2</p> <p><i>In Ghaobata area (plains):</i> Popolo 1 & 2, Old Selwyn, Ngalimera, Selaghogoro, Pokasou, Siroigha, Kadavu, Ravu area, villages on Tenakaro Road, and</p>	<p>Horohutu1 New Birao</p> <p>GPOL village,</p>

Impact area	Customary landowning communities	Non-customary communities
	riverside road to Tetere between main road and the mouth of Ngalimbiu River .	
Infrastructure Area settlements	<i>Bahomea District</i> Mangakiki/Verakuji, Pachuki, Marava area, Vera'ande/Grassy	Verakabikabi, Namanu area
Wider Impact Area (WIA) settlements	<i>In Malango district</i> Communities of Malango area and Belaha area	

The social studies in the communities consisted of the following:

- Structured community workshops designed to collect information in each village area about a) the local way of life, social organization, history of settlement, resources, and livelihoods, and b) views on potential project impacts. Each meeting brought together several associated hamlets. The meetings typically took approximately 4 hours and followed a standard format. Discussions were conducted in Solomon Islands pidgin and occasionally in the local indigenous language (Teha), and were aided by the use of large format maps, printed satellite imagery, and sketched diagrams. Where necessary, additional explanation of the hydro scheme components and operation (as known at the time) was provided by the team. Attendance sheets were completed for each meeting. Fifteen such village workshops were held covering the residents of 40 villages and hamlets. Total attendance was at least 511 men, woman, youths, and children.
- A questionnaire survey of a random selection of female householders from each of the hamlets represented at the community meeting. This questionnaire covered household nutrition, health, gender and age division of labour, resources and income, and anticipated project impacts. Approximately 50 such interviews were conducted, each taking approximately 30 minutes.
- Individual interviews with village and tribal chiefs and older men about sacred and important cultural sites and issues. These were conducted by the team's national cultural impact specialist.
- Where time permitted, transect walks were carried out through village and garden areas, complemented by photography and recording.

The social baseline studies were carried out by both on-site social surveys and bibliographical data. Photographs in Figures 8-1 and 8-2 illustrate engagement activities at three of the villages located within the project area. The methods used to undertake the social surveys are presented in the following sections.

Figure 8-1 Verakambikambi Village; men, women and children participating in the discussion



Figure 8-2 Discussion at Segue and Tina Village



8.1.2.6 Recording People's Responses

The members of these communities were given the opportunity to inform the ESIA team of their specific communities' interests, and concerns regarding the construction and operation impacts of the proposed hydropower project. These were recorded on a white board, and detailed notes were also made. The responses to the questions and the concerns raised are presented in this report (also see Annex 15 in the Annex Report).

Time was provided in the fieldwork program for consolidation of fieldwork notes and photographs between the team members, and for reviewing and completing questionnaire forms, when necessary.

8.1.3 Summary of Results

Using the fieldwork program schedule as the reference, and with the aid of the local field assistant and CLAs, the Social research workshops were conducted in 15 focal villages, within four main districts (Bahomea/Tina, Malango/Belaha, Mid-Catchment and Roadside, and Plains).

Residents of more than 45 village communities attended the focus workshop meetings. Participants included tribal chiefs, village chiefs, youth, men, women and children. Overall, a total of 511 people attended the meetings.

Table 8-4 lists the focal villages and some of the communities that attended the workshops, including the number of participants. Figure 8-3 is a map that identifies the surveyed communities.

Results of the social assessment studies are discussed in the next sections.

Table 8-4 Surveyed communities

Date	Venue	Communities	Approx. number of Participants	District
2-Sep-13	Marava	Marava, Vatupaua, Rate CHS, Ngongoti	31	Bahomea (Upstream Communities)
3-Sep-13	Haimane	Horohotu 2, Vuramali, Haimane, Katihana	44	

Date	Venue	Communities	Approx. number of Participants	District
4-Sep-13	Tina	Tina, Valebebe, Valebarik, Valemaota, Tahurasa	38	
5-Sep-13	Antioch	Antioch, Valesala, Komeo	41	
9-Sep-13	Senge	Senge, Koropo, Choro	22	
10-Sep-13	Pachuki	Habusi, Pachuki, Veraloka	43	
12-Sep-13	Verakuji	Mangakiki & Verakuji	80	
13-Sep-13	Namopila	Namopila, Komureo, Valekocha, & Vatunadi	28	
17-Sep-13	Mataruka and Ado	Mataruka 1, 2, 3, 4, Belaha, More than ten villages (2 separate meetings held)	83	Malango/Belaha
18-Sep-13	Veraande & Horohotu 1	Veraande, Verakwele, Konga Horohotu 1, Niumahata (NB: Two separate meetings held)	24	Bahomea Settlements Communities
19-Sep-13	Ravu	(at least 5 communities represented)	19	Gaobata/Plains
20-Sep-13	Verakambikambi Old Selwyn	Verakambikambi Old Selwyn (Popoloi) (NB: Two separate meetings held)	58	(Downstream Communities)

Figure 8-3 Map of communities surveyed within the project area

8.1.4 Social Organization

8.1.4.1 Key Contextual Factors

Based on a review of reports and other secondary information, and fieldwork conducted in Guadalcanal, the following points seem to be crucial considerations for the planning of the TRHDP and the social assessment:

- the system of clan-based customary collective land ownership, coupled with shifting settlement patterns and leadership, and inter-tribal marriage, gives rise to complex claims and conflicts over resource and land rights;
- lack of services and infrastructure, underdevelopment, isolation, and poverty in Guale indigenous rural communities despite their proximity to Honiara;
- the historic settlement, agricultural development, and alienation of large areas of the Guadalcanal plains by colonial administrators and corporations, and their use of migrant labour from Malaita;
- the post-World War II development of Honiara as the modern day capital of the Solomon Islands with its associated multi-island and multi ethnic population located on Guadalcanal, and its on-going sprawl onto adjacent Guale customary land;
- on-going large-scale and unsustainable logging of Guadalcanal's indigenous forests by foreign logging companies with high level political patronage, that provides little apparent material benefit to the majority of indigenous land owners;
- the establishment of the Gold Ridge mine, with on-going grievances regarding distribution of benefits and royalties;
- the recent history of Guale rising up against the central government, the cause of which was a sense of inequity in the distribution of benefits and costs of development, and the associated violent conflict between indigenous people and "settlers" from Malaita, and other islands and regions. This ethnic tension, and associated civil unrest, was present in the project area and has abated under the authority of the Regional Assistance Mission to Solomon Islands (RAMSI), but has not necessarily been resolved⁵⁴.

At the local level, Pacific Horizon Consulting Group (PHCG) note the following are also important to the context for the TRHDP:

- The emergence of the Project Office as the primary identity for the TRHDP, rather than MMERE and its officials.
- The emergence of various groups and organizations for interacting with the Project and government, including the Bahomea House of Chiefs, the Malango House of Chiefs, the more recently formed Tina River Hydro Landowner Council (with 27 representative groups "purporting to represent a district clan within the Ghaobata and Malango areas"), along with area-based groupings of villages within the project affected area (e.g., the Upper River Catchment Community centered on Namopila)

⁵⁴ For example, during the ESIA fieldwork in September 2013, a group of intoxicated Malango youths from the Tina village area attacked a Weather Coast settler and destroyed their roadside stall/shop at the corner of the Namanu Road in the hope of evicting them. Some of the settlers are occupying "alienated"/government land.

The following sections provide a detailed description of the people and communities of the proposed project area and their socio-economic condition.

8.1.4.2 Settlement Patterns

The TRHDP study area consists of over 30 villages and hamlets of mainly indigenous people originating from the central Guadalcanal mountain lands, and several official “settler” villages made up of people originating from South Guadalcanal/Weather Coast.

The Bahomea villages and their component hamlets are mainly distributed adjacent to the Ngalimbiu River and lower-mid sections of the Tina River, and are often only hundreds of meters apart. In some cases it is hard to distinguish where one hamlet ends and another begins (e.g. Antioch and Valesala). Most hamlets in the study area are connected together by walking tracks and in some cases by dirt roads, which are prone to becoming impassable during wet weather. In recent years, settlements have been established along the main Bahomea access road and logging track that run up the ridge that marks the left side of the Tina Valley.

Settlements range in size from two-house hamlets with one extended family, up to villages with dozens of houses and over a hundred residents. These larger villages tend to be arranged around a village square/green with a substantial church, and perhaps a meeting-house and other facilities. The details of the various villages are provided in subsequent sections.

Roughan et al (2011) and Entura (2012) both provide a history of the settlement of the Tina River area, and while the accounts differ in some respects, they agree on the following key aspects:

- the present-day indigenous inhabitants of Malango Ward, and in particular the proposed project area, are closely related and have common ancestors.
- the originating communities lay at the base of Mount Popomanaseu, and were variously named Sasahakama, Belana, Tuhurutolu, and Malukuna.
- Since World War II and the establishment of Honiara city, there have been successive waves (or chains) of migration down from the villages of the central mountains to the foothills to the north, so that people could be closer to modern services and employment, to be safer from landslides and other natural disasters, and to protect clan lands from intrusion inland by squatters and others.
- In these moves, people from different originating Malango villages stayed together and settled in different areas. The people from Belana and Tuhurutolu settled in the Tina river/Bahomea area. The people from Malukuna settled in the Malango area, and people from Sasahakama settled in the Gold Ridge area and on the Toni River.
- There has been some subsequent movement from the north back up the main ridges of Malango Ward, as areas have been opened up by logging roads, and possibly to avoid exposure to ethnic conflict.
- Mixed in with the indigenous Malango-speaking communities are more recent arrivals of people from the Weather Coast who sought refuge locally from natural disasters, poverty, and conflict, and who moved to find employment in the plantations and foreign owned resource industries.
- Since the 1980s there has also been unauthorised settlement on Malango lands by migrants from Malaita, and elsewhere, that were drawn to Honiara for employment.

- The ethnic tensions of the late 1990s and early 2000's displaced the non-indigenous settlers, including many hundreds working in the (now GPPOL) palm plantation, and squatters, resulting in a major reduction in the population of the Malango and West Ghaobata wards.
- With the subsidence of the ethnic tensions, people from the Weather Coast have returned to the Bahomea area, and squatters are again moving onto the government and alienated lands within Malango Ward.

At present, the mountainous interior of Malango Ward is essentially unpopulated, apart from periodic expeditions by the traditional owners for hunting and camping, and to reconnect with customary 'homelands'. The indigenous people of the Tina River area are, therefore, aware of the locations of their key originating villages and important cultural sites. Since membership of particular clans is claimed through kinship connection with people from successive historic settlements and originating places, knowledge of such places is crucially important for establishing identity and land and resource rights.

Original migrants from these upland villages can be still found among the older residents of the TRHDP study area, and they have knowledge of the sequence of migration and village creation within the Tina catchment. A number of stories of such movements were recorded during the social impact assessment fieldwork. The sequence of movement is represented in Table 8-5.

Table 8-5 The settlement history of villages in the TRHDP area

Villages/ hamlets	Impact area	Year of establishment (approx.)	Origin notes
Senge Choro Koropa	Downstream	1970 1990s 2003	Originating place was Reiloto. Senge originally started in 1930s. In 1940s-50s moved to Marava, Vuramali, Mangakiki and Koropa. Some stayed. Senge destroyed by Cyclone Namu in 1986. Reoccupied and rebuilt in 1990s.
Verakuji Mangakiki	Infrastructure	c1984 c1987	Originally from Tangilagila/Hamilake, then Marava, then Mangakiki, and Verakuji and Verakila (1990s). From Turutolu/Malukuna, then to Tangikala, then Mangakiki.
Pachuki Habusi	Downstream	1996 Post 1986	Originally from Turutolu. Villagers moved in 1966 to Vatunandi & Valebungana, then Valekocha, then Valesala after Cyclone Namu in 1986, then Pachuki and Habusi
Namopila Komureo Vatunadi Valekocha	Downstream	2007 2004 1990 2008	Originally from Valebungana (est 1967). Cyclone Namu (1986) moved to Valekocha, then Valesala. Then dispersed to Choro, Vatunadi, Koropa, Komureo, and Valekocha
Antioch	Downstream	c 1970	

Villages/ hamlets	Impact area	Year of establishment (approx.)	Origin notes
Valesala Kolanji Komeo		1986	Movement from the hill & forests began in 1960s. Came from Kolohaji, then Talamu and Turutolu, then Vatunandi, Valekocha, and then Antioch etc
Tina Valebarik Valebebe Tahurasa Valemaota	Downstream	1950 1980 1998 1999 2006	The first village in the lower part of the Tina River valley. Originally from Belana and Vurutolu. The other villages in the community were established to cope with local population growth
Marava Ngongoti Vatupaua Rate school	Infrastructure	1962	Moved from hills & forest. Other villages are spin off communities. Rate established by government as a district school campus, with teacher housing.
Vuramali Haimane Horohutu 2 Vuvamali	Downstream	1986 c 1970 c 1960 -	
Horohutu 1	Downstream	c1980	Moved from Weather Coast of Guadalcanal to Konga in 1974 while founding family working for Foxwood Timber Milling Co. Started the settlement at Horohutu 1. Cyclone Namu struck in 1986. Other villages established subsequently.
Vera'ande Verakweli New Mahata	Infrastructure	2000 1968	Moved from Tina to Vera'ande in 2000 to take up a cocoa blocks on clan land left by Levers. Verakweli established by families from Veravolia. New Mahata established by families from the Weather Coast
Verakabikabi	Infrastructure	c1965	From Weather Coast. More settlers in 1970. Acquired custom rights to occupancy and use from indigenous land owners.

Traditionally, Guadalcanal villages were periodically moved so they could be located closer to newly cleared gardens, to move away from bad spiritual influences, or because of natural disasters. Such natural disasters feature prominently in the history of settlement of the Tina River Valley. Cyclone Namu, which hit the region in 1986, is probably the most significant event in terms

of destruction and relocation of villages. Settlers from the Weather Coast also came north as refugees from floods, earthquakes, and landslides. Some of the early upland settlement areas of the Malango people were also badly affected by natural disasters⁵⁵. Nowadays, various factors encourage villages to be permanently located, such as the building of permanent churches and houses using more durable building materials, the availability of services, roads and other infrastructure, and perennial cash crops. Reasons for relocation given by villagers who participated in the community workshops include:

- as resettlement after landslides, flooding and cyclones, especially Cyclone Namu in 1986;
- better access to employment and, therefore, the opportunity to improve living standards;
- better access to services and facilities, including health, education, transport, markets, and churches;
- to get better access to quality gardening land;
- over-crowding and shortage of resources, for example, land for a house or water supply;
- to escape influence of the Moro Movement (see description of Moro Movement in Section 8.2.5);
- to provide greater protection to clan land, especially from migrant labour squatters; and
- family disagreements or feuds.

Internal migration and the formation of new village communities are only possible because of kinship networks and clan membership, which provides access to land and livelihoods throughout the Bahomea/Malango area.

Downstream of the Tina River, where the Ngalimbu River joins the Guadalcanal plains, there are larger villages and hamlets made up of the indigenous coastal people, referred to as the Ghaobata. The plains and coastal area also contain hamlets of settlers from elsewhere, including “squatters” who have (re) occupied “vacant” marginal, or abandoned plantation land on the plains, which had been vacated during the Ethnic Tensions. The current makeup of the squatter hamlets is said to be predominantly Malaitan peoples drawn to the Honiara area for work, but this was not confirmed. It is clear from village discussions that the Bahomea and Ghaobata peoples regard the presence of these non-indigenous outsiders as a threat to their land and resource rights, and is an ongoing potential source of conflict.

8.1.4.3 The People of the Project Area

LANGUAGE GROUP

The indigenous people of the TRHDP area are often referred to as the Malango, and speak the Malango language (also known as Teha). They are hill peoples who once occupied hamlets around the central mountains of Guadalcanal, including Mt Popomanaseu, the highest point in the Solomon Islands. Up to the 1950s or so, the hill people of central-north Guadalcanal largely lived in isolated hamlets, rather than centralized larger villages that are evident today.

According to Lynch, Ross, & Crowley (2002), the Malango language belongs in the Bugotu–Gela–Guadalcanal family of languages within the overall Southeast Solomonian group, itself part of the Oceanic group within the larger Malayo-Polynesian set of languages. Other languages in

⁵⁵ Note that in early April 2014, subsequent to the ESIA fieldwork and reporting, a major flood in north and central Guadalcanal appears to have damaged the villages of Habusi, Pachuki and Namophila. The local effects of the flood are unknown.

Guadalcanal family of languages are Birao, Ghari, and Talise. According to Ethnologue (the Internet reference site for the world's languages), in 1999 there were an estimated 4,140 native speakers of Malango/Teha. The downstream neighbours of the Bahomea-Malango people of the Tina River valley, the Ghaobata people, are indigenous speakers of the Longgu language.

The Malango people are largely resident in the modern-day administrative Malango Ward of central-northern Guadalcanal, and have a population of 10,500, 95% of whom are Melanesian. The proposed TRHDP lies within the Bahomea district, and is centered on the Tina River and associated ridge/s running from the mountainous interior north towards the Guadalcanal Plains. The people of Bahomea district are kinsmen of the peoples of Malango to the west, and to those of the Gold Ridge area to the east. The Ghaobata people live on the plains, and are largely located in two administrative Wards – West Ghaobata and East Ghaobata. The Ngalmibiu River runs through West Ghaobata Ward to the sea (see the map in Figure 5-3).

KINSHIP AND TRIBAL STRUCTURE

Guadalcanal societies are known for their matrilineal descent systems, that is, where descent and inheritance are traced through the mother's line. Normally in matrilineal systems women marry outside their own kin group into a nearby community and reside with their husband's people after marriage. A woman's sons take up land from their mother's brother upon reaching adulthood. Adoption may also be used to provide matrilineages with heirs to land (Schoeffel, Fitzgerald et al, 1994). The most common pattern is for marriage partners to be chosen from a different clan, so in matrilineal systems one may not marry one's mother's kin, because they are members of the same descent group as oneself. However, one might be able to marry one's father's kin, since they are not of one's own descent group. Several matrilineal kinship systems are found on Guadalcanal.

Hogbin, in his 1930s studies of Guadalcanal societies⁵⁶, found that that the hill tribes of North Central Guadalcanal (Including the Malango people) are organized into a pair of exogenous matrilineal moieties, each with their respective custom origin stories. These moieties are known as the Manulava⁵⁷ (the eagle or “big bird”) and Manukiki (the hawk, or “small bird”). Every indigenous person belongs to one or other of these moieties. Hogbin also records that each moiety consists of a number of matrilineal clans/sub-tribes each of which carries the name of a different species of bird, and each clan has primary rights over blocks of land scattered /patch-worked across the tribal landscape, “with no piece of ground un-owned” (1964:17). That is, land and resource ownership is based on clan membership. This remains the situation today among the Malango people of the TRHDP area. In their review of the “Indigenous Terrain”, Roughan et al (2011) confirmed that the matrilineal clans (mamata) of the study area “are the sole authorities vested with authority over territory” (p. 29).

Previous studies have noted that regardless of the decent system, in the Solomon Islands women tend to move to their husband's village after marriage (known as virilocal residence). In a matrilineal descent system, this means that women will be living away from their own land, which will be under the control of their brothers. As people living in villages where they are not members of its land-owning groups, they are, therefore, outsiders when it comes to local-level decision-making, particularly about land and resource use⁵⁸. Women are far more likely to be in this

⁵⁶ For example, Hogbin, I. 1964 *A Guadalcanal society: the kaoka speakers*. London, Holt, Rinehart and Winston.

⁵⁷ Known to the Malango/Teha speaking people of the Project area *Manukama*

⁵⁸ Schoeffel, P., Fitzgerald, G, and Loveridge, A. 1994. Solomon Islands Forestry Inventory Project Working paper 19: Forest utilisation in the Solomon Islands: social aspects and issues

situation than men. This tends to be the case in the communities of the TRHDP area, although there is a degree of variation in marital residence.

Figure 8-4 represents the kinship structure of Malango society as revealed by an informant in the Bahomea area. Note that terminology varies for the types of groupings at different levels, and there is a range of spelling for names of the different groups/units. This diagram suggests that there are 29 clans within the Tribe, though the exact number is contentious. For example, Roughan et al (2011), in their work on indigenous terrain mapping, identified 13 named clans in Bahomea, and 14 in Malango (27 in all), along with their chiefly representatives (see Table 8-6).

In 2010, SIG, through intermediaries, identified 27 tribal sub groups as having a stake in the TRHDP, and they became signatories to the original access agreement with SIG to allow the project feasibility studies to proceed. Subsequently, in consultation with local leaders, the TRHDP PO identified 10 “communities” and their component villages, along with the list of clans found in each community - giving a total of 21 locally resident clans.

Not all of the clans identified by our informant are present in the project area, or necessarily represented by either of the Houses of Chiefs (HOCs) as described in project documents. Further clarification on clans in the area is provided by the ‘land identification’ process undertaken by the Bahomea Land Identification Committee comprised of Bahomea story tellers, a Paramount Chief, a church leader and tribal chiefs (TRHDP, 2013).

Figure 8-4 Tribal Structure of the Malango people

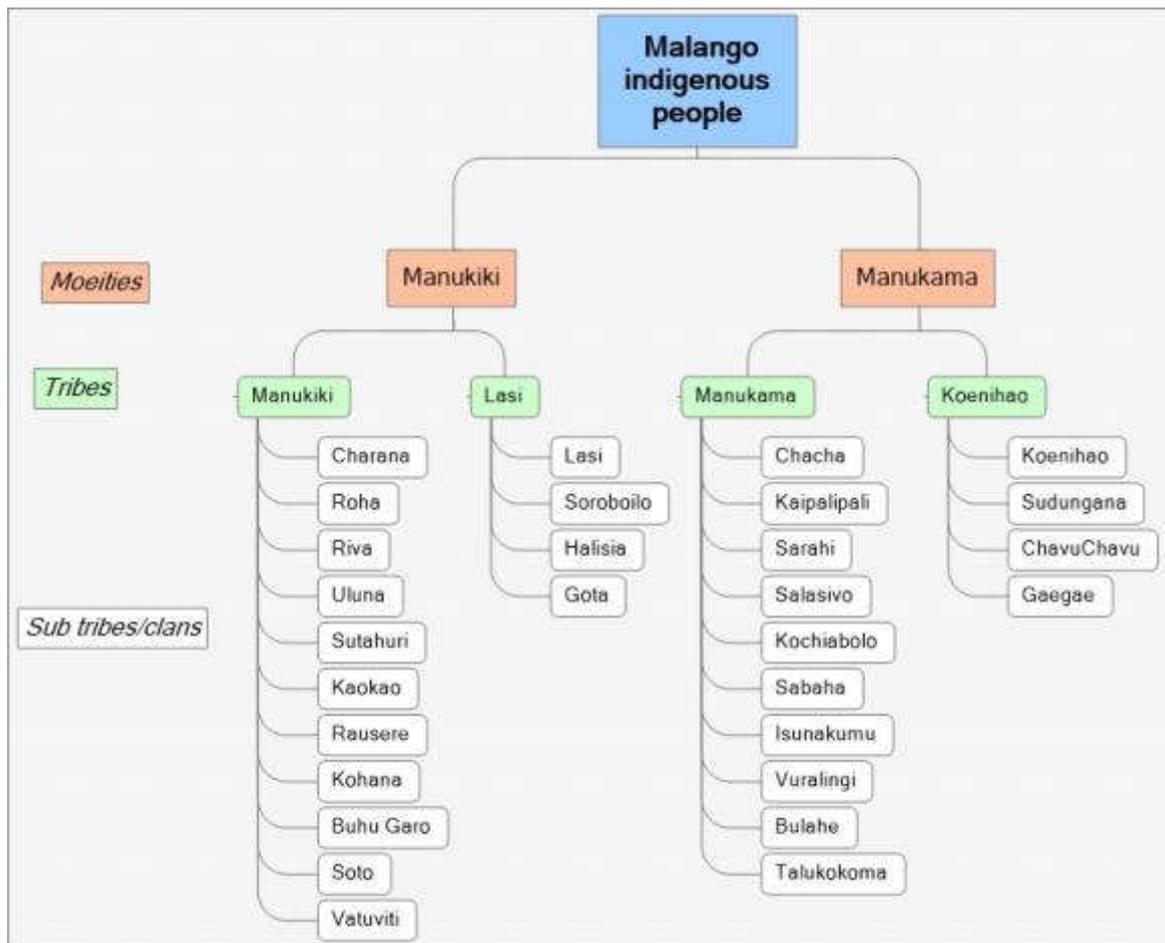


Table 8-6 Clans/sub-tribes represented in Houses of Chiefs (Roughan et al, 2011)

Clans in the Bahomea House of Chiefs	Clans in the Malango House of Chiefs
Charana	Barahau
Chavuchavu	Bolahe
Kaipalipali	Buhu/Garo
Kochiabolo	Chacha
Lango	Halisia
Rausere	Kaokao
Salasivo	Koenihao
Sarahi	Kohana
Soroboilo	Ngaengae
Sudungana	Riva
Sunakomu	Roha
Sutahuri	Sabaha
Uluna	Soto

Clans in the Bahomea House of Chiefs	Clans in the Malango House of Chiefs
	Vuraligi

According to Hogbin (1964), the tribes occupying the northern and eastern coastal area of Guadalcanal, between Point Cruz and Longgu, including the Ghaobata people who neighbour the project area, are divided into five exogamous matrilineal tribes named Hambata, Lasi Naokama, Thimbo, and Thonggo. Of these, Hogbin noted in the 1960s that:

The chief importance of the clan organisation is its application to land rights... Land is cut into named blocks of varying acreage, some 2 or 3, others 50 or 60 acres large. These are grouped into series each of which is bound up with a clan. By virtue of his birth into a clan, an individual acquires the inalienable right to select sites for his house and cultivation on the territory of that clan (1964:5- emphasis added).

Roughan et al (2011)⁵⁹ suggest that the tribal structure of the people of the Bahomea area is similar to that for the Ghaobata and other coastal people. They suggest there are 5 named tribes (or kema) in the project area, that is, Lathi, Thimbo, Negama, Thongo, and Gaobata (also known as Garavu and Hambata), and these are divided into land owning and rights-holding subunits called mamata (clans). However, this is not quite consistent with what local informants have suggested is the situation for the Malango people, and what Hogbin noted during his anthropological studies.

LOCAL COMMUNITIES

As noted above, the TRHDP PO identified various “communities” and their associated clans. The basis for “community”, which according to Roughan et al (2011), is one of the key elements of the cultural landscape and is dynamic, is not clear from the Table 8-6. However, the available information indicates that there is a mix of clans present in any particular village or geographical community. In practice, Guadalcanal communities are dynamic, and sometimes ephemeral.

As noted above, new villages are formed in response to the need for services, as a new start after natural disasters, resource scarcity and availability, spiritual threat, and internal conflict. Overlapping with communities of place, communities of interest may be formed or dissolve according to peoples’ affiliation with particular interest or group (e.g., religion or issues-based grouping). Again, overlapping with both place and interest, communities of identity are based around kinship and ethnic affiliation, which can shift or be reinvented over time, e.g., the assertion of an “Isatabu” (indigenous Guadalcanal) identity by the Moro movement in the post-war period, at the time of independence in the 1970s, and during The Ethnic Tensions.

From the social assessment fieldwork data it would seem that the groupings are based on a combination of geographical location, kinship, and religious affiliation, although this is not entirely consistent. For example, Senge Village is said to be associated with Namopila Village, but in practice the families located at Senge are closely related to those at Marava, from whom they split in the 1970s, or so. The extended family at Koropa (founded in 2003) is closely affiliated to Namopila through kinship.

During the fieldwork, it was common to hear people say that all of the people in the Malango area are related to one another, and that “we are all really one family”. It is not clear, however, to what extent these bonds extend to resource or residential rights.

⁵⁹ in the PHCG “Indigenous Terrain Mapping Report” prepared for the project

Table 8-7 lists the communities in the TRHDP study area and their tribal affiliations.

Table 8-7 Communities of the TRHDP study area and their tribal composition

Communities	Villages	Est. Pop. 2010	Paramount Chiefs	Subtribe / clan Chiefs	Village leaders/ chiefs	Sub tribes/clans In the community
Namopila community	Namopila, Choro, Senge, Habusi, Pachuki, Komureo,	300+			5	Sutahuri, Kaokao, Uluna, Koenihao, Kochiabolo, Sabaha
Antioch community	Antioch, Valesala, Valekocho, Vatunandi	150+		3	2	Kochiabolo, Lasi, Kaipalipali, Kaokao, Charana, Roha, Koenihao, Sutahuri, Uluna
Verakuchi community	Mangakiki, Verakuji, Hanilake	200+		3	3	Kochiabolo, Charana, Kaipalipali, Roha, Sarahi
Tina community	Tina, Valebarik, Valebebe, Tahurasa, Valemaota,	300+	1	6	3	Sarahi, Riva, Chavuchavu, Rausere, Sudungana,
Marava community	Marava, Ngongati, Rate CHS, Vera'ande, Verakwele, New Mahata	200+		1	3	Charana, Kochiabolo, Kaipalipali, Sabaha
Katihana community	Katihana	150+	1	*	2	Chavuchavu, Uluna, Kaokao, Halisia, Rausere, Chacha, Kochiabolo
Vuramali community	Vuramali	100+	1	1	2	Kochiabolo, Koenihao, Charana, Uluna, Soroboilo, Salasivo
Haimane community	Haimane	150+	1		2	Koenihao, Lango, Sutahuri, Uluna
Horohotu	Horohutu 2 & 3, Valele'e	100+			2	Chavuchavu, Salasivo, Kaipalipali, Charana, Sarahi, Koenihao
Settler communities	Horohutu 1, Verakabikabi, New Birao, Namanu, Vatupaua	120+			4	from Guadalcanal Weather Coast clans

Source: TRHDP PO community liaison team

POLITICAL ORGANIZATION

The Malango people are divided into two administrative groups: the Bahomea House of Chiefs (BHOC) and the Malango. According to a local informant (a member of the Bahomea House of Chiefs) the BHOC is a legally constituted body, and consists of the four Paramount (tribal) Chiefs

plus the subtribe/clan chiefs and local village chiefs, along with other representatives and elected officers (see Figure 8-5). The chairman is elected by and from the members. The Houses of Chiefs seem to exist primarily to determine resource and land rights, resolve disputes, settle matters of custom and breaches thereof, and to represent local indigenous people in dealings with outside organisations. Houses of Chiefs are a relatively new institution, and while their internal governance is unregulated modern government has given them a role in providing an initial determination of land disputes under the *Local Courts Act*.

Much has been written about the process by which leaders⁶⁰ emerge from within Melanesian societies. As elsewhere, local leaders /chiefs do not acquire their positions or authority by inheritance, although they do draw on their relationships with kin, neighbours, and fellow churchmen and with other networks (i.e., local social capital) to build a base for leadership. Despite fieldwork and the available project reports, it is unclear how the leaders are selected within the Bahomea area. From observation, clan leaders appear mainly to be elderly males who have the best knowledge of the history and customs of their clan, including the land and resources to which they have primary rights. This is crucial, since the clan is the primary land-owning group. Village leaders /chiefs appear often to be younger and show more of the characteristics of “Big Men”, i.e., they appear to have above average ability, seem able to organise and sponsor projects and events, are active in various economic and church activities and can rally both human networks and natural resources for economic and sociocultural purposes. For example, a paramount chief is also the Pastor of the South Seas Evangelical Church (SSEC) church at Tina Village; the village chief at Verakuchi is the sponsor/funder of the new local SSEC church; and a chief at Marava was the sponsor/funder of a new pre-school at Verakuchi.

More traditional “big men” activities still occur in local communities. For example, a traditional pig feast gathering took place in September 2013 at Habusi, which involved large numbers of local people and featured the distribution of pigs and other produce among the participating clans and communities.

Regarding modern politics and leadership, Malango Ward is a political unit of the Guadalcanal Provincial Government, and is currently represented on the Provincial Assembly by Mr. Amaziah Robo. It also lies within the national Parliament’s Central Guadalcanal constituency, currently represented by Hon. Peter Shanel Agovaka.

VILLAGE AND COMMUNITY ORGANIZATIONS

Kinship is the most important basis for community formation and action among the people of the TRHDP area. After kinship, church membership is the next most important. As noted, villages in the TRHDP area are often made up of several related hamlets, and sometimes these have different religious affiliations. As observed above, local clan and village leaders may also be religious leaders.

Some villages have formally structured administrations. For example, at Marava, which has a population of 180 or so, there is a central community board which has six committees covering different areas of community life and development, including: education and training; women, children and youth; culture tourism; health and sanitation; agriculture and forestry; and projects.

There are also five church groups represented locally, and each church has its own groups, such as a woman’s groups, sports groups, singing bands, and youth clubs. Also located at Marava is a community house belonging to the Malango Council of Women (MCOW), one of a network of

⁶⁰ most often referred to as “big men”.

groups organised by the Guadalcanal provincial government. MCOW has a woman's community house which is used as a meeting and educational centre (see Figure 8-6).

Figure 8-5 Women's centre at Marava



Most villages in the project area, especially the smaller ones, do not have this level of organisation or formal structure, hence most activity is organised through the churches and in association with village chiefs.

8.1.4.4 Ethnic Tension

Roughan et al (2011) note that Guadalcanal has been structured and patterned more than any other island in the Solomons, by the location of national projects, and the reactions to them. These projects have led to a broad discourse of grievance in which TRHDP specific concerns need to be understood.⁶¹ This experience has been politically articulated by the people of Guadalcanal through various textual and bureaucratic means since the 1970s⁶², with the main elements of this narrative centering on:⁶³

- The widespread and longstanding alienation of lands from the late 19th century onwards, exacerbated by their subsequent continuous habitation and evident employment in significant articles of national infrastructure, most notable of which is the capital city of Honiara
- The economic productivity of major investment projects emplaced on Guadalcanal, and their historically perceived lack of lasting positive effect on either the peoples whose territory has been host, or on the people of Guadalcanal as a whole. Chief amongst these have been SIPL (now GPPOL) and the Gold Ridge mine.

⁶¹ Roughan et al (2011)

⁶² See Kabutaulaka, T.T. (2002) A weak state and the Solomon Islands Peace Process. East-West Center Working Paper No. 14. Honolulu: East-West Center and Bennett, J (2002) Roots of conflict in Solomon Islands. RSPAS Discussion Paper 2002/5. Canberra: Australian National University for overviews of this history.

⁶³ Roughan et al (2011)

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- Invasion of cultural and social space of the Guadalcanal people by settlers from other islands and provinces. This has been recognised as a form of structural violence, taking the form of disregard and disrespect for Guadalcanal cultural forms and norms, and actual violence perpetrated on indigenous Guadalcanal persons in the shape of murder and physical assaults. Over time, a lack of comprehensive action in relation to these concerns has been apprehended as structural unresponsiveness, something which has itself been additional basis for grievance.

These grievances took most obvious shape in the initiation and evolution of the 'ethnic tension' of 1998-2003 characterised by widespread violence and militancy across Guadalcanal and other provinces and the eventual functional collapse of major state institutions including those mandated with ensuring law and order.⁶⁴

During this time the northern plains area incorporating GPPOL, and central Guadalcanal, including the Gold Ridge area, witnessed extensive fighting involving armed militants, police and civilians.

The initial stage of the unrest generally consisted of intimidation and violence against Malaitian settlers in Guadalcanal, including those working on Gold Ridge and oil palm plantations in Central Guadalcanal (Evans)⁶⁵. The placement of a (largely Malaitian) police force to secure Gold Ridge mine may have escalated the violence. According to Evans the fighting was linked largely to Malaitian–Guadalcanal differences related to issues of cultural respect, perceived inequitable revenue distributions, and Malaitians securing jobs on Guadalcanal. By May 2000, Malaitians working on the Gold Ridge mine were evacuated. It is estimated that by the end of 1999, 24,000 largely malaitian settlers had been evicted from Guadalcanal.⁶⁶

Fighting was initially centered between the Isatabu Freedom Movement (also known as the Guadalcanal Revolutionary Army) and later the Malaita Eagle Force (as well as the Marau Eagle Force). In October 2000 the Solomon Islands Government signed a peace agreement with these groups or elements of these groups, known as the Townsville Peace Agreement. The Agreement led to a fracturing of Guadalcanal militants between those that supported the peace process and those that did not. This fracture led to an era of intra-ethnic warfare including further fighting in the Central Guadalcanal area, and with fighting spreading to the Weather Coast.

Warfare largely ceased after the arrival of Australian and Pacific Island police and soldiers under the Regional Assistance Mission to Solomon Islands (RAMSI) in July 2003.

8.1.5 Socio-Economic Profile of the Communities of the Project Areas

8.1.5.1 Data Sources

The most reliable data for assembling a profile of communities associated with a proposed development usually comes from an official Census of population and dwellings. However this is not always available. For the most part, the only statistical data that are available for constructing a profile of the TRHDP study area are population estimates for the various villages, made by local

64 Roughan et al (2011)

65 Evans, D, 'Tensions at the Gold Ridge mine, Guadalcanal, Solomon Islands', Pacific Economic Bulletin Volume 25 Number 3 © 2010 The Australian National University

66 Fraenkel, J, The Manipulation of Custom: from uprising to intervention in the Solomon Islands, 2004, Victoria University Press/Pandanus Books, Canberra

chiefs for the TRHDP PO, and those data gathered in the community workshops and from householder interviews conducted by the ESIA field team.

8.1.5.2 Population

The communities potentially affected by the TRHDP all fall within the Malango and West Ghaobata Wards. The population counts of the TRHDP areas and villages within Bahomea made during the ESIA field studies in 2013 are presented in Table 8-8, along with the available census data.

Previous local estimates put the population of the TRHDP area at approximately 2000, with half of these having “direct access” to the Tina/Ngalimbu River (Entura, 2012:32). The counts made during the ESIA fieldwork put the Bahomea/Tina population at about 1800, divided among approximately 362 households.

The villages of the project area have an average population of approximately 56 people, and an average of 11 households. Settlement sizes vary from 4 persons for Choro (the isolated occupation site in the upper Tina River), to 219 for the settler community of Verakabikabi. Nearly half the surveyed settlements had 5 households or fewer, and only 11 of the 32 villages had 20 households or more. The largest indigenous villages (with 100 people or more) are Tina, Antioch, Valebebe, Haimane, Mangakiki, and Marava. Komeo near Antioch, was abandoned at the time of the survey, while the settlement at Choro appeared to be occupied sporadically by an elderly couple, and seems mainly used as a shelter during times of garden cultivation of clan lands in the upper Tina River catchment.

The average household size in the TRHDP area is 5 persons, compared with 5.9 for the whole of Malango Ward in 2009. Households of the Senge Community average 5.1 persons, 4.6 in the other Bahomea downstream villages, and 5.6 in the households in the infrastructure impacts area. Based on the limited data available, the downstream Ghaobata households are of a similar size to those in the Bahomea area and to the rest of West Ghaobata Ward. In 2009, Solomon Islands households had an average of 5.3 persons.

While having a significantly larger population than its coastal neighbours, at 19 persons per km² Malango Ward has a low settlement density compared to West Ghaobata (60 persons per km²) – reflecting the very different terrain of each group of people. West Ghaobata and East Ghaobata wards have the highest settlement densities of all wards in Guadalcanal Province.

Table 8-8 Population counts of the TRHDP areas and villages within Bahomea

Communities & affiliation	Villages/ hamlets	Impact area	2013 households (approx.)	2013 population (approx.)	2009 census	1999 census	1986 census
Senge Community - Bahomea							
Senge community	Senge	Direct	3	16			
Bahomea	Choro		1	4			
	Koropa		3	19			
Total			7	39			
Downstream Area - Bahomea							
Pachuki community	Pachuki	Downstream	14	65			
Bahomea	Habusi		6	33			

Communities & affiliation	Villages/ hamlets	Impact area	2013 households (approx.)	2013 population (approx.)	2009 census	1999 census	1986 census
Namopila comm.	Namopila	Downstream	5	27			
Bahomea	Komureo		6	28			
	Vatunadi		1	5			
	Valekocha		5	26			49
Antioch community	Antioch	Downstream	23	110			
Bahomea	Valesala		20	105			
	Kolanji		2	10			
	Komeo		0	0			
Tina community	Tina	Downstream	23	104			109
Bahomea	Valebarik		6	22			
	Valebebe		22	104			
	Tahurasa		5	15			
	Valemaota		4	12			
Vuramali comm.	Vuramali	Downstream	18	70			18
Bahomea	Haimane		26	111			
	Horohotu 2		17	84			46
	Vuvamali		16	77			
Horohutu comm.	Horohotu 1	Downstream	12	60			51
Settlers							
Total			231	1068			
Infrastructure Area (area affected by Infrastructure Corridor) –Bahomea							
Verakuji community	Verakuji	Infrastructure	11	56			
Bahomea	Mangakiki		21	111			5
Marava community	Marava	Infrastructure	28	168			54
Bahomea	Ngongoti		1	20			
	Vatupaua		5	50			31
	Rate school		?	?			4
Vera'ande community	Vera'ande	Infrastructure	6	30			78
Bahomea	Verakweli		6	24			
	New Mahata		2	15			51
Verakabikabi comm.	Verakabikabi	Infrastructure	44	219			54
Settlers							
Total			124	693			

Communities & affiliation	Villages/ hamlets	Impact area	2013 households (approx.)	2013 population (approx.)	2009 census	1999 census	1986 census
Bahomea Total			362	1800			
Malango Ward					10532	4105	6094
West Ghaobata Ward					4515	2601	4239*

* Did not exist in 1986 – Was part of the former West Tasimboko Ward

8.1.5.3 Population Trends

Little reliable data is available from which to determine population trends for the TRHDP area. Even where village level figures from 1986 are available, it is almost impossible to interpret the data without access to the census boundary maps of the time.

From the available data, it seems that Tina village has about the same population as in 1986, Marava's population has trebled, Horohutu 2 has almost doubled, and Vera'ande has decreased by more than half. The populations of the Weather Coast settler communities of Horohutu 1 and Verakabikabi have increased after having been significantly depopulated during the Ethnic Tensions. Verakabikabi appears to be about 4 times larger than in 1986. This may be because the villagers, being settlers residing in the area under a customary arrangement with the local indigenous chiefs, do not have their own local land rights outside of this area, which might enable them to spread out and establish new hamlets.

On a broader scale, census counts for Malango Ward show the socially disruptive depopulation effects of the Ethnic Tensions, and the post-tension rapid repopulation and growth: that is, from 6,094 people in 1986, to 4,105 in 1999 at the height of the tensions, and 10,532 in 2009. The population of Malango Ward is now 2.5 larger than it was in 1999. Over the same 10-year period, the population of neighbouring West Ghaobata (downstream of Bahomea) went from 2,601 to 4,962, making it almost twice the size it was in 1999.

By comparison, the population of Guadalcanal Province (excluding Honiara City) increased by 55% between 1999 and 2009, while the population of the Solomon Islands as a whole increased by 26%. Guadalcanal Province has the fastest growing population of all the provinces. Natural growth is high due to high birth rates and declining death rates, but this has been obscured in recent years by internal migration.

Fraenkel (2004), drawing on results of the 1999 census, records that 4,098 people (or 16.7% of the population at the time) were evicted or fled from Malango Ward and became displaced persons in 1998-99, as a result of the Guale uprising. In West Ghaobata 2,808 people were displaced (11.4% of the population), and in East Ghaobata 1,549 people (6.5% of the population were displaced). Most of those driven out the district were Malaitan and fled initially to Honiara.

The project is therefore taking place in a local context of considerable former social disruption and post-conflict population growth – with its associated demand for residential and garden land, natural resources, and social services.

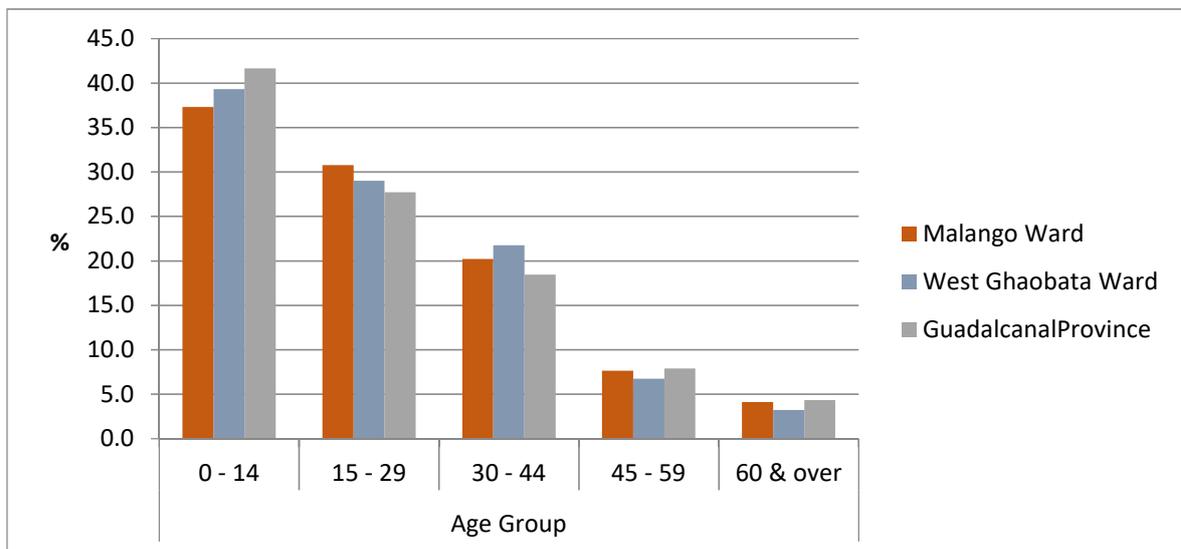
8.1.5.4 Sex and Age Structure

Figure 8-7 shows the age structure of the population of the relevant wards compared with Guadalcanal Province in 2009. The populations of Malango and West Ghaobata have very similar age structures and are generally consistent with the rest of the Province. That is, they have very

large proportions and numbers of infants and young children (aged 0-14 years), and very few elderly people, the latter of which are the repositories of traditional knowledge and customs. The high proportion of children is consistent with observations in the villages surveyed for this study, where the large number of potentially vulnerable teenage mothers and infants is very evident. However, there is some evidence that the Malango population is aging. For example in 2009, 37% of the population was aged 14 and under, compared with 45% in 1986.

Across each of the groups in the Malango and West Ghaobata ward populations, males outnumber females. Males make up 53% of the total Malango population, and 52% of West Ghaobata. In Malango Ward the gender imbalance is most evident in the 45-59 year old group, and may reflect a greater longevity among local males, compared with women.

Figure 8-6 Age Structure of Malango Population, 2009



8.1.5.5 Ethnicity

The population of Malango Ward is 95.4% Melanesian, although the available census data does not distinguish between people who are from Malango, and those from elsewhere in the Solomon Islands. This compares with 97.8% Melanesian in West Ghaobata, and 98.5% for Guadalcanal as a whole.

As noted elsewhere, there are groups of Weather Coast settlers residing legitimately in the Tina-Ngalimbiu area. In these cases, the settlers have formal customary agreements with the land owning clan and its chiefs. Through exchanges of pigs, produce and custom money (chupu), they have been granted rights to use local land for residences and gardens, but ownership is retained by the customary landowning clan. These agreements reportedly need to be renewed periodically. One of the challenges for the customary landowning peoples of North-central Guadalcanal, since the 1970s, has been the unsanctioned occupation of their land by people from Malaita and elsewhere, who have come to Guadalcanal to work in the city, in the plantations, and the resource extraction industries.

The main ethnic minorities in Malango Ward are Polynesians and Micronesians (relocated Gilbertese), possibly associated with the St Joseph's boarding school at Tenaru, and with settlements along the main road and/or close to Henderson.

The Project needs to comply with the WB Performance Standards as previously mentioned. Based on discussions with the World Bank about Performance Standard 7 and Operational Policy 4.10, both of which address Indigenous Peoples, all groups resident in the area are considered Indigenous people regardless of their status and origin in the Solomon Islands (landowner, squatters, settlers, people from Guadalcanal, Malaita or other islands), which ensures that all communities are consulted in compliance with this standard and Policy. More information on this is provided in Section 3.6 WB Performance Standards.

8.1.6 Local Peoples' Sources of Livelihood

8.1.6.1 Framework

The proposed TRHDP could have a significant effect on local people's livelihoods. Therefore, both the ESIA and householder surveys gathered background information on current livelihoods in each of the communities. This is presented below in terms of the elements of the Department for International Development's (DFID) 'sustainable livelihoods framework': that is, the range of livelihood strategies employed by local people, the livelihood capitals they deploy or utilize, the various constraining and enabling factors at play, and the various risks and vulnerabilities that people must manage to obtain the things they need to make a living, are outlined.

8.1.6.2 Livelihoods Strategies

The main livelihood goals of the people and households of the project area appear to be daily food security, and protection of the family from risks of climate and loss of resources. With a paucity of financial capital, local people use a range of strategies, including a mix of the following:

- traditional garden cultivation and gathering of staple foods for subsistence needs, combined with occasional hunting
- Cash-earning activities to raise money to pay for imported food, shop goods, school fees, technology, community obligations, and household needs. Such activities typically include one or several of the following:
 - household-scale cash crop production, with the produce sold in the central market in Honiara
 - small-scale timber milling for local and Honiara markets
 - local day laboring, for example in timber milling, garden clearing, house building, etc.
 - running a small home-based business, such as home baking, natural materials handicrafts, a local shop-canteen selling small items, vehicle hire, etc.
 - full or part time employment for a government agency or large company – typically the Gold Ridge Mining Company (GRMC) (when operational), GPPOL, Earthmovers Logging Company, market gardens.
 - Fishery at the River mouth.

These strategies, therefore, mostly rely on having good access to:

- local natural capital such as land, forests, river, gravel and forest products
- household human capital, including traditional and formal skills and knowledge, and labour power
- physical capital in the form of tools, equipment, and transport infrastructure, and social capital in the form of assistance from neighbours, relatives, and fellow church members.

The following sections outline the situation regarding livelihoods in households and communities of the TRHDP area.

8.1.6.3 Household Income and Expenditures

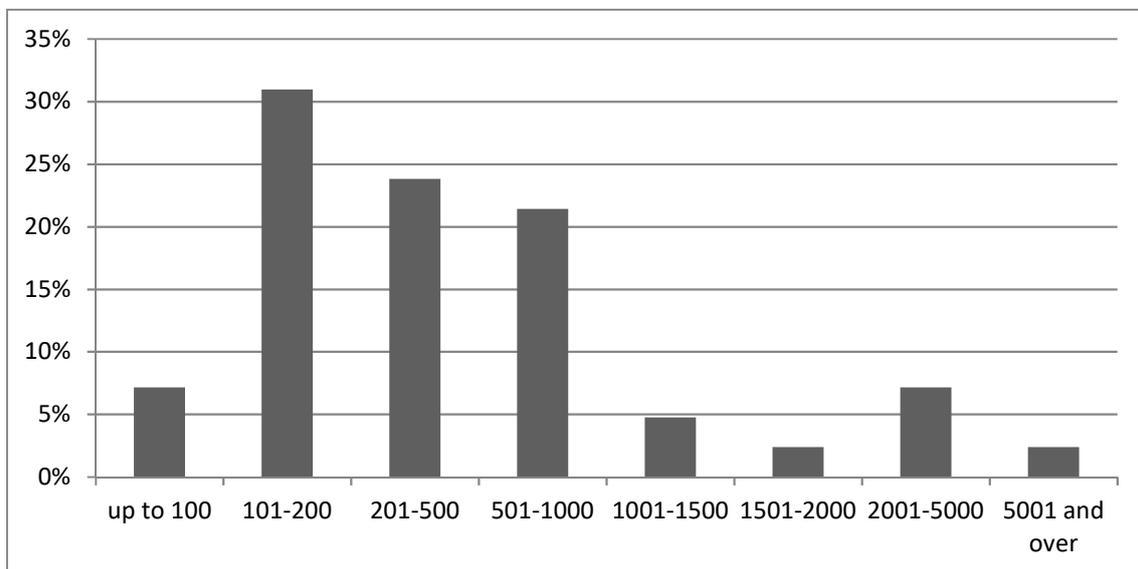
The 2006 National Household Income and Expenditure Survey (HIES) calculated that 56% of all income to rural households in the Solomon Islands (and to households in Guadalcanal province) comes from home production of goods and services. That is, they are produced by the household and predominantly consumed by the same household. Next most important for Guadalcanal households is self-employment (13.5% cf 9% nationally), and wages and salaries (12%, both provincially and nationally).

People in the TRHDP area rely on both cash and non-cash income and, increasingly, they are being drawn into the cash economy to meet their needs. Most households have some level of subsistence production, though the current annual value of this subsistence production is not known.

The survey of householders in the project area indicates that the average weekly cash income for households is approximately SBD 870 ⁶⁷, and the median income is SBD 500. However, the range of weekly cash incomes as reported to the social team (Figure 8-8) is very wide, ranging from SBD 100 to SBD 6000.

In addition to income generating activities of various kinds, some members of the communities of the project area received periodic payments of royalties from the Gold Ridge Mine when it was operational and/or receive royalties from logging on customary land. This tends to be treated as windfall income and is used to purchase major items, if possible. Hence, it is not surprising that only a weak correlation was found between the number of appliances and pieces of equipment that a household owns, and the weekly income of that household.

Figure 8-7 Weekly cash incomes in Solomon Islands Dollars (SBD) for the sampled households in the study area



No data on local household expenditure were collected in the social survey. National data from the 2006 HIES indicates that average annual household expenditure in rural areas of Solomon Islands was SBD 23,366 for an average household of 6.0 persons, giving an average per capita

⁶⁷ Approximately \$121 US.

expenditure of SBD 3,894. On average, 66% of this expenditure was on food, 11% on housing, 5% on transport, and 14.5% on miscellaneous goods and services.

8.1.7 Human Capital

8.1.7.1 Introduction

Human capital refers to the knowledge, skills, and experience on which individuals and households can draw to generate a livelihood, and the labour/work power or energy available to them. The latter depends on peoples' overall health and well-being. These various aspects of human capital are discussed below.

The people of the project area rely heavily on specialist, customary, and detailed technical knowledge, skills and abilities in a number of areas:

- knowledge of the land and geography of the Tina River catchment, including the location of particular natural resources, natural hazards, tracks, and places where they have ownership and use rights;
- knowledge of the trees, plants and animals found in the catchment, along with their characteristics, uses, and seasonal availability;
- knowledge of garden plants and other domesticated species and the skills to manage them;
- marketing and selling skills;
- carpentry and house building skills;
- numeracy and literacy; and
- knowledge and skills in hand and power tool and machinery use.

They also require the ability to resist a range of endemic diseases, which could reduce their ability to support themselves, and knowledge of basic health care necessary for family wellbeing. All of these are complemented by knowledge of local customs and social mores and, increasingly, knowledge of how to deal with bureaucracies and commercial organisations.

An important strength of the residents of the project area is the depth of their traditional knowledge and skills and ability to live in a largely natural environment, and to acquire a livelihood from it. Such skills, abilities, and qualities are acquired in the course of growing up in rural areas and participating in village life, where traditional knowledge is passed down by parents and elders through "learning by doing". This is complemented by formal education in the government and/or private school system, if it is accessible and affordable. Increasingly, people are required to interact with urban communities and conditions, and with a monetised economy that requires a different range of skills and experience, which are not always locally available.

These various aspects of human capital are dealt with separately in the following discussion on work, employment, education and health, using the official and survey data that was available.

8.1.7.2 Work

The Solomon Islands Census gathers information for each person aged 12 and over on whether they worked during the previous week, and the "type of work/activity they usually do".

Respondents are offered a choice of one of the following:

- Work for pay as an employee of government or private sector, as an employer, or as self-employed;
- Producing goods for sale;

- Producing goods for own consumption;
- Voluntary work; and
- Unpaid family work.

The implied assumption in the Census question is that people have one main or dominant kind of “work”, rather than being involved in perhaps equally important multiple activities. Taking the data for Malango Ward at face value, almost 35% of the 4,266 people of working age recorded in the 2009 census for Malango Ward were in paid employment, 10% were self-employed or employing other people, and a further 15% were producing goods for sale, for example, garden produce. This implies that 59% or so were engaged in the cash economy in some way.

The level of participation in the cash economy among people in West Ghaobata is similar (55%), but somewhat higher than for Guadalcanal as a whole (41%).

The 2009 census records that only 17% in Malango, and 24% in West Ghaobata, were engaged principally in subsistence food production, which is low in comparison to the whole of Guadalcanal province (38%). Malango and West Ghaobata may be at an advantage compared to other rural residents of Guadalcanal, since they are both located relatively close to Honiara city. Honiara has an active labour market and several large produce markets, including the Honiara central market, where most produce is sold and bought.

Importantly, the Census data show that there is a major difference in work between males and females in Malango Ward. For example, in 2009 only 471 of the 1,872 (i.e., 25%) involved in paid jobs were woman, whereas women made up 64% of those engaged in subsistence production, 53% of those producing goods for sale, and 72% of those doing unpaid family work. Apart from income from selling small volumes of cash food crops, home baking, and craft items locally and at the Honiara market, women typically have little direct access to cash.

8.1.7.3 Paid Employment

The village workshops attempted to gather information on the extent of paid employment in the communities of the TRHDP area. Table 8-9 summarizes the data.

Table 8-9 Employment in the communities of the TRHDP area

Community & affiliation	Villages/ hamlets	In paid employment	Types/sources of paid employment	Main types of self-employment
Downstream Area - Senge Community				
Senge community	Senge Choro Koropa	1?	Public service	Chainsaw timber milling, ecotourism, market gardening
Total		1?		
Downstream Area – Other Bahomea				
Pachuki community	Pachuki	2		

Community & affiliation	Villages/ hamlets	In paid employment	Types/sources of paid employment	Main types of self-employment
Namopila comm.	Habusi		GRML, Earthmovers	Timber milling, market gardening, livestock, equipment hire
	Namopila Komureo Vatunadi Valekocha	0		Timber milling, market gardening, gravel extraction
Antioch community	Antioch Valesala Kolanji Komeo	11	Public service, Earthmovers, GRML, GPPOL, church	Timber milling, firewood, market gardening, crafts, bush food marketing
Tina community	Tina Valebarik Valebebe Tahurasa Valemaota	20	GRML, GPPOL, Public Service,	Timber milling, market gardening,
Vuramali comm.	Vuramali Haimane Horohotu 2 Vuvamali	15	GRML, Public service, CBSI, Ports Company, Fisheries,	Timber milling, market gardening, copra, cocoa, canteen, handcrafts,
Horohutu (settlers) Settlers	Horohotu 1	12	GPPOL, GRML, NGO, public service, logging company	Vehicle hire, market gardening,
Total		60+		
Infrastructure impacts area				
Verakuji community	Verakuji Mangakiki	6	Public service, GRML, Earthmovers, Church,	Timber milling, market gardening, bush products marketing, vehicle hire

Community & affiliation	Villages/ hamlets	In paid employment	Types/sources of paid employment	Main types of self-employment
Marava community	Marava Ngongoti Vatupaua Rate school	4	GRML	Timber milling & marketing, handicrafts, market gardening, canteen, firewood
Vera'ande community	Vera'ande Verakweli New Mahata	19	GRML, GPPOL, QQQ farms,	Timber milling, market gardening, bakery, bush products,
Verakabikabi (settlers)	Verakabikabi	?	GRML,	Gold panning (artisanal mining), market gardening, vehicle hire
Total		29+		
Downstream Ghaobata communities		?		

8.1.7.4 Household Production and Self-Employment

The importance of multiple activities as a livelihoods strategy among the people of the greater TRHDP area is evident in the 2009, Census data on “household money earning activities” (see Table 8-10). For example, while 646 Malango residents said in 2009 that their main economic activity was producing goods for sale, 77% of households reported that they earned some money from the production and sale of crops and/or other products, such as vegetables and fruits, betel and other edible nuts, coconuts and related products, cocoa, cut flowers and wild plants, milled timber, and craft items (Table 8-11). Compared with their Ghaobata neighbours, the people of Malango are more involved in the production of flowers and timber but much less involved in coconut products and cocoa. This reflects the accessibility to Ghaobata people of established (and perhaps abandoned) commercial plantations on the Guadalcanal plains, downstream of the Tina River.

Table 8-10 Households earning cash from sale of produce, 2009

	Number of households			Percentage of households		
	Guadalcanal Province	Malango Ward	West Ghaobata ward	Guadalcanal Province	Malango Ward	West Ghaobata Ward
Food crops	12088	1110	686	70.4%	63.5%	70.3%
Coco./Copra	4518	50	203	26.3%	2.9%	20.8%

Betel Nut	7574	152	215	44.1%	8.7%	22.0%
Cocoa	6392	309	280	37.2%	17.7%	28.7%
Tobacco	1045	35	5	6.1%	2.0%	0.5%
Timber	569	52	6	3.3%	3.0%	0.6%
Flowers	1428	189	52	8.3%	10.8%	5.3%
Other products	816	78	11	4.8%	4.5%	1.1%
none	1977	401	157	11.5%	22.9%	16.1%
Households involved	15186	1348	819	88.5%	77.1%	83.9%
Total households	17163	1749	976			

* Note that households could indicate more than one product type

The 2006 Household Income and Expenditure Survey (HIES) reported that of the Guadalcanal households that were involved in some kind of self-employment, 34% were producing root crops for sale, 31% were producing other vegetables and fruits, 6% were doing livestock farming, 6% were catching and selling fish, 5% were in handicraft production, and 16% were engaged in some other kind of self-employment or small business activity.

In our householder survey, 100% of the respondents indicated their household grew crops of some kind for home consumption, while 70% said they grew or collected produce for sale. This is reasonably consistent with the 2009 Census findings for Malango Ward.

Women of the study area tend to group together to make the weekly trip to Honiara to sell their produce, and to make any necessary household purchases. Different villages seem to favour different days for marketing, though Saturday seems to be the busiest day for the Honiara Central Market. Transport typically costs at least SBD \$50 per person each way, plus a market stall fee.

The range of crops grown for consumption and sale is presented in Table 8-11. Relatively few respondents mentioned producing and selling betel nut and tobacco, despite there being an apparent abundance of betel nut in the villages of the study area, and plenty of betel nut chewers. Many indigenous village households are involved in some capacity in sawn timber production. This is discussed below.

Table 8-11 Crops produced for consumption and for sale by the surveyed households

Product	% of households growing for consumption	% of households growing for sale
Banana	90%	31%
Kasava (Manihot esculenta)	74%	19%
Kumara (Ipomoea batatas)	69%	26%

Product	% of households growing for consumption	% of households growing for sale
Beans	57%	31%
Cabbage	57%	19%
Tomato	55%	24%
sugar cane	50%	10%
slippery cabbage (Abelmoschus manihot)	43%	14%
taro (Colocasia sp)	38%	7%
yam (Dioscorea sp.)	38%	10%
Eggplant	36%	14%
Capsicum	29%	17%
pana-yam	23%	7%
potato (Solanum sp)	17%	14%
Pumpkin	17%	10%
Shallot	14%	12%
Pawpaw	12%	14%
Garlic	12%	7%
Pineapple	7%	-
Chinese cabbage (Brassica rapa var.)	9%	9%
Cucumber	7%	7%
Coconut	7%	7%
lemons/citrus	5%	2%
kangkong (Ipomoea aquatic)	5%	0%
betelnut (Areca catechu)	2%	5%
Melon	2%	2%
cutnut (Barringtonia procera)	2%	2%
Corn	2%	2%

Product	% of households growing for consumption	% of households growing for sale
Cocoa		5%
jackfruit (<i>Artocarpus heterophyllus</i>)		2%
sago palm (<i>Metroxylon</i> sp)		2%

In his guide to Solomon Island food crops, French (2011) describes the diversity of crops produced in local gardens, and notes that having a range of cultivated and wild foods available is a proven food security strategy in an uncertain environment. Table 8-11 reveals that that the variety of food produce offered for sale is greater than reportedly produced for home consumption. With home consumption there is a much greater emphasis on staples such as root crops, banana, and cooking vegetables, whereas the cash crops are more likely to include salad (green leaf) vegetables and exotic items. This suggests that there is an established pattern of growing specifically for the market and targeting more high-value food products. Importantly, some domestically and commercially important green vegetables are collected from wetland areas adjacent to the Tina River, and in some cases areas that may be required for the Hydro development.

8.1.7.5 Occupations

Among the 1,872 paid workers in Malango Ward in 2009, the most important occupations are crafts and trades (20%), service and sales (19%), professions (15%), and plant and machinery operation (13%). By comparison the most important occupational groups among those in West Ghaobata are elementary workers or labourers (34%), followed by skilled agricultural and fishing work (23%) – both probably associated with employment at GPPOL, and other nearby plantation operations. No occupational data is available at the village level.

8.1.7.6 Education

Formal education provides a means of building “human capital”, and especially the skills and knowledge necessary to participate effectively in the modern economy and society.

Nowadays, all children in Solomon Islands are expected to at least attend primary school where it is available. Primary school in Solomon Islands is free, but not compulsory. In the project area and nearby, schools are provided by both central government and by established churches.

Government statistics indicate that the majority of Solomon Islands children attend school between ages 8 and 13, after which attendance rates decline. Nation-wide, 64.5% of rural children aged 6-12 attend school. In general, the levels of female and male educational attainment in rural communities in Solomon Islands are similar.

Census data on educational participation and achievement is only available for the whole of Guadalcanal Province. These data suggests that there are problems of poor school attendance by primary school aged children. For example, in 2009 only 69% of 5-9 years olds were attending school or preschool, 85% of 10-14 year olds were attending, and 61% of 15-19 year olds were attending some kind of schooling/or training. School attendance reportedly falls off from age 13

onwards. The main differences between boys and girls in educational participation emerges in the 15 and over age group, possibly due to the relatively high cost of high school fees for ordinary rural families, which means families favour advancement of sons over daughters in the education system.

From observation in the villages of the TRHDP area, school attendance is relatively low. Interviewees indicated that this was due to the labour needs of the household, low accessibility of the local schools due to lack of school transport, and poor attendance by teachers due to low salaries and/or failure of the government to regularly pay the teachers' salaries. Some local villagers volunteered that their young people/teenagers had poor literacy skills, and were not easily employable as a result. This, in turn, leads to early marriage and child bearing among girls, and antisocial activities among boys.

At present, there are approximately seven schools within the TRHDP area (the closest ones shown on the map in Figure 8-10). Local people aspire to have greater access to schools to make it easier and safer for their children to get an education. As a result, communities sometimes use church buildings as alternative classrooms, or resort to building their own classroom using local materials. For example, in Valesala/Antioch, the community has a barely serviceable building that houses the kindergarten (see Figure 8-9) as well as Grades 1-3. However, a new permanent building, located at the intersection of Antioch and Valesala villages, was under construction and will take students from Grades 4-6. This new permanent building, like that constructed at Rate, was being funded by the Ministry of Education as part of a bundle of benefits provided to local communities through the TRHDP planning process. Construction was being done by a builder from the local community. The new school classrooms at Valesala will eliminate the need for local children to walk several kilometers to Rate School. However, high school students will still need to attend Rate Community High School. There is also a school run by the Seventh Day Adventist Church at Namanu.

Children who want to attend higher levels of secondary school often need to leave the area and attend boarding school. The closest such school is at Tenaru (St Josephs). Selwyn College was formerly located near the river in West Ghaobata, but was relocated to West Guadalcanal following massive damage by Cyclone Namu. Tertiary level trade training is available in Henderson at the Don Bosco academy, and in Honiara.

Kindergartens are located at Marava, Ngongoti and Valesala. These take children aged 3 to 5 years old, and are run by local community groups with volunteer help. At the time the social surveys were being conducted, a new community kindergarten was nearing completion at Verakuji. Students from the downstream communities such as Ravu, Popolo, the GPPOL workers village, and other plains communities adjacent to the Ngalimbiu River, attend Ngalimbiu Primary and the High School at Nguvia.

Figure 8-8 Valesala kindergarten and grades 1-3 (left) and grades 4-6 (right)



8.1.7.7 Health and Health Services

Health and wellbeing underpin personal human capital and one's ability to secure the means of existence, and to participate fully in one's society. Depending on location, Solomon Islanders face significant threats to their health and wellbeing, especially:

- diseases associated with the environment and unimproved living conditions, such as: malaria, pneumonia, diarrhea, asthma, and skin diseases; and
- increasingly common diseases and conditions associated with inadequate or modern diets, nutrition, and lifestyle, such as: diabetes, high blood pressure, anemia, (in children) wasting and malnutrition, stress, and problems of protein deficiency.

Based on village workshops and interviews with local people, the principle diseases of concern to residents of the project area are malaria, pneumonia, diarrhea, stress, flu and other respiratory conditions, diabetes, and STDs. Hernia seems to be a problem, especially among men, and is put down to the physically demanding types of work and carrying of heavy loads (e.g., timber). In several village workshops people reported incidences of gonorrhoea and dengue fever. Cuts and fractures to limbs appear to be relatively common and relate to peoples' living environment and their way of life, though no data is available on the incidence of serious injuries.

In some communities, people reported that malaria and diarrhea cases are slowly reducing, but pneumonia incidence appears to be increasing. Some of the improvements in sanitation related illnesses have resulted from environmental and sanitation improvement drives within communities (e.g., Tina Village). Respiratory conditions appear to be common among both children and adults, and may be associated with cooking over open wood fires in closed spaces, and with damp living conditions.

The people who live in the vicinity of the Tina River are constantly interacting with it in the course of their daily lives, especially women and children. Several of the villages in the project area (e.g., Koropa, Choro, Habusi, and Vuramali) are located on the right bank of the Tina/Ngalimbiu River and their residents have to ford the river to access most facilities, and to catch transport to Honiara. This can sometimes be very dangerous, since river conditions are subject to change, sometimes rapidly. Consequently there are occasional drownings or near drownings of children, reportedly about one every two years. The rainy season also brings the threat of major destructive floods which, in the past, have caused many deaths.

The overall rate of accidents and accidental deaths in the communities of the project area is not known.

For women, the main diseases and health issues for which they most often suffer include stress giving birth to premature babies, miscarriage, or death of either the mother, or baby, or both, during the time of delivery. Since there are no health facilities, including no clinics nearby any of these villages, death may occur when women encounter such problems. The other hardship women currently encounter is the lack of easy access to transportation to take them to the clinics in Honiara or the Central Referral Hospital at No. 9 (downtown Honiara) if they encounter problems when giving birth.

According to women, the main causes of stress are husbands spending all the money on alcohol and other women, husbands becoming involved in extramarital affairs, husbands not contributing enough to support the needs at home, young people taking drugs, disobeying their mothers, not doing well in schools and unwanted pregnancy among young girls.

According to the ESIA Scoping Report, in Pachuki, Habusi, Namopila, Tina Village and Antioch, the most common ailments reported were pneumonia, malaria and an observed high incidence of skin conditions, especially among children (Entura, 2012).

8.1.7.8 Child Health

In the 2007 Demographic and Health Survey (DHS), the most common health issues for young children in rural Guadalcanal were associated with poor nutrition and hygiene. These include anemia (55%), stunting of growth (34% nationally), and diarrhea. Poor nutritional status is related to maternal malnutrition, low birth weight, inadequate breastfeeding and weaning diets, and childhood diseases. For children under five years of age, 17% were reported to have had a fever in the two weeks preceding the survey, with children aged 6 to 23 months being the most vulnerable. On Guadalcanal, only 46% of those children who were reported to have had a fever were taken to a health facility for treatment. This is the lowest level of treatment of all of the provinces. In the two weeks preceding the survey, nationally 9% of all children aged less than five years were reported to have had diarrhea. However, 93% received some form of treatment. Poor children's health and lack of access to healthcare represent significant threats to the future availability of human capital for rural Guadalcanal communities.

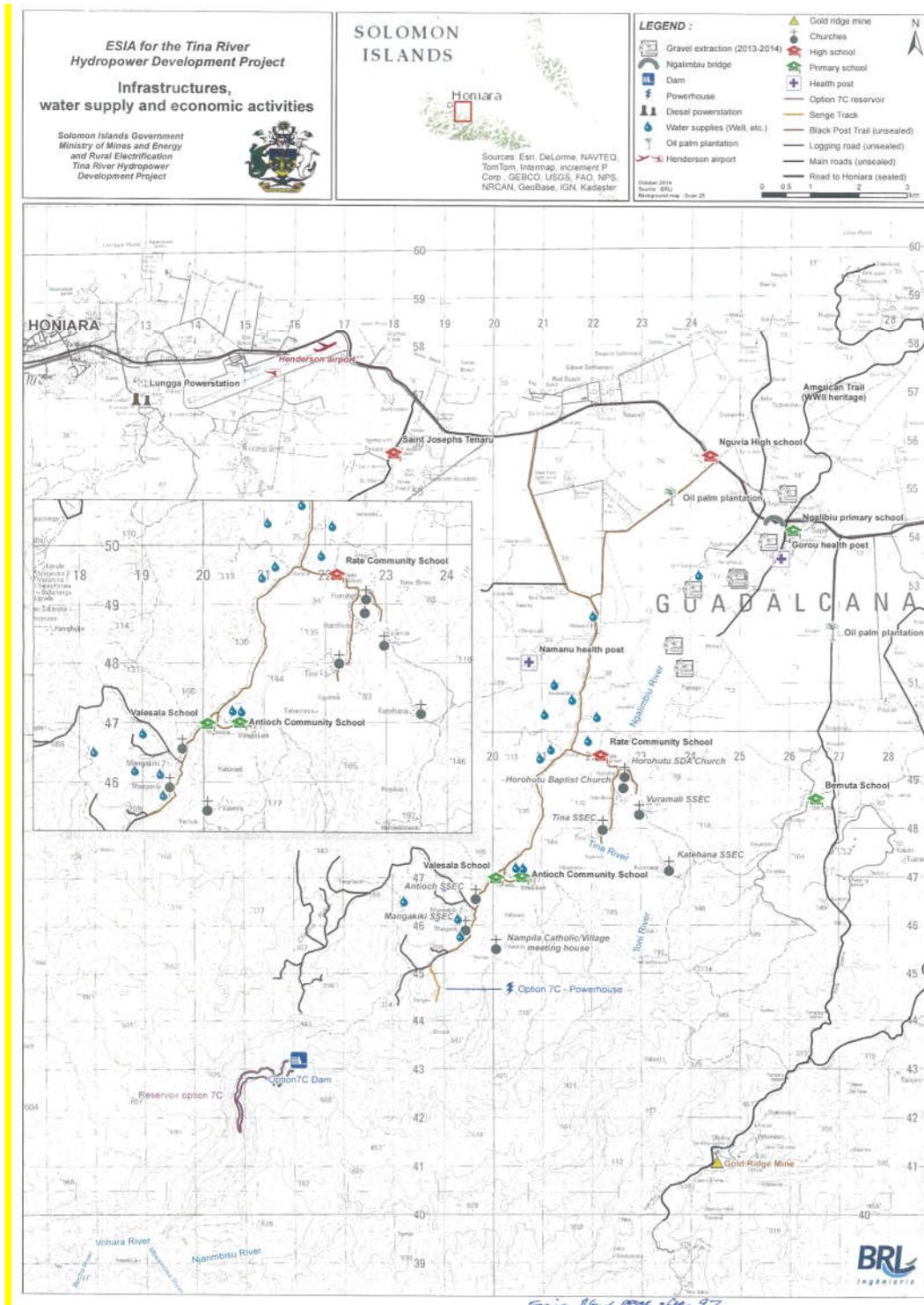
8.1.7.9 Access to Health Services

The accessibility of health services is a significant issue for communities of the project area. This is particularly problematic in cases of accidents, complications of childbirth, and child diarrhea and fever. The national 2007 DHS showed that in rural areas only 37% of children less than five years of age with diarrhea in the previous two weeks had access to oral rehydration, and 58% had been taken to a health facility. The incidence of seeking health support for sick children in the project area is not known, although it is not likely to be any better than elsewhere, since the majority of the residents of the project area have to travel considerable distances over rough roads, often on foot, to attend the basic provincial government provided health clinic at Namanu or the health post at GPPOL (Gorou health post). Even when they are able to attend the clinic, local people may not be able to obtain the drugs or treatment necessary. The main national hospital ("Number 9") in Honiara is not easily accessible by local communities.

Local villagers consider health services within and adjacent to the project area to be inadequate. Given the prevalence of illness and disease, there is clearly a need for a nursing station or a part-time attended health outpost in the Tina River area, possibly at Rate or Antioch.

The infrastructure map in Figure 8-10 indicates the location of schools and health services.

Figure 8-9 Map of local infrastructure



8.1.7.10 Household Nutrition

The householder survey included a 24-hour meal recall, for which respondents were asked to recall what they had eaten during the previous 24-hour period. It showed that over the previous 24 hours all the surveyed households in the TRHDP area had eaten breakfast, 90% had eaten lunch of

some sort, and 97% had eaten an evening meal. The details of the foods eaten are provided in Annex 6 of the Annex Report.

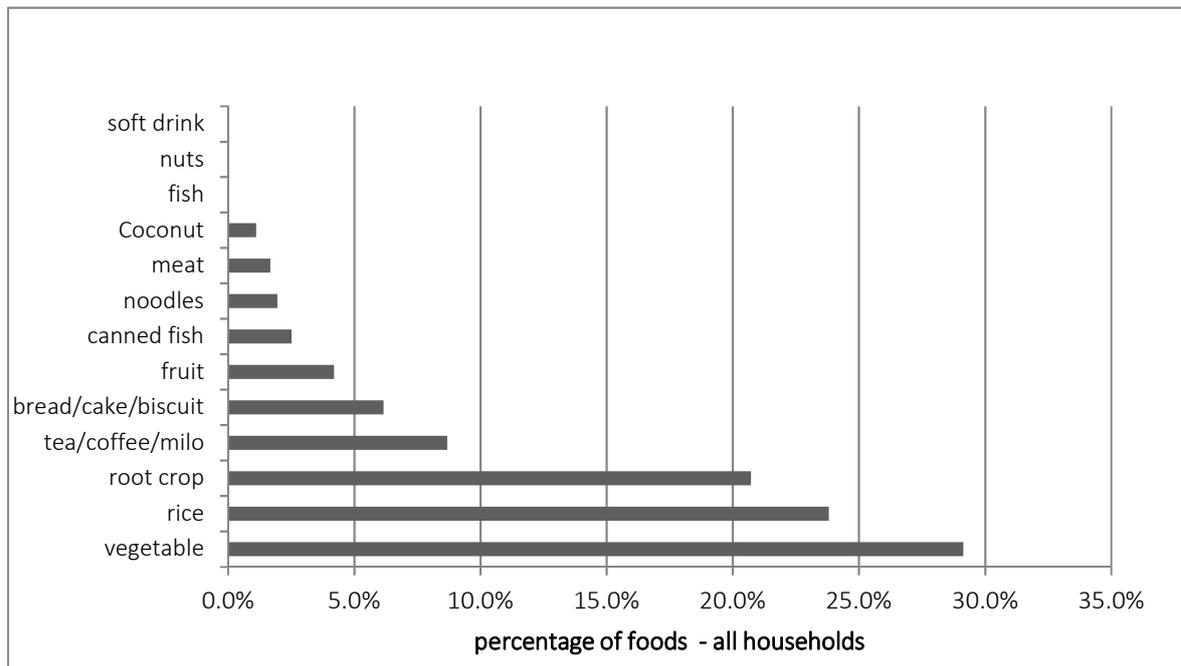
Rice is taking over as a staple food of the Solomon Islands, and for those people of the TRHDP area who can afford it, it is displacing traditional root crops in their diet:

- 43% of households eat rice as part of their breakfast, 41% in their midday meal, and 77% in their evening meal.
- 36% of households eat root crops as part of their morning meal, 42% in their midday meal, and 50% in the evening. These include mainly kumara, cassava, and potato, and occasionally taro or yam.

Figure 8-11 presents the overall picture of foods eaten by households in the project area. Local diets consist primarily of rice and/or root crops, and are eaten with a variety of vegetables, especially green leaves and ferns that are collectively referred to as “cabbage”. The main source of protein is canned tuna (domestically produced), and occasionally pork or fresh fish. Meat or fish was eaten in only 12% of meals, mainly in the evening meal. Fruit, mainly banana and pawpaw, is generally eaten at breakfast and as a snack food. While not a major feature, instant noodles are an increasing component of local households’ diets, and are commonly found in local canteen shops.

Based on the limited information available, it appears that the diets of Ghaobata people are generally similar to the people of Bahomea, although, as coastal people, they have greater access to and knowledge of seafood.

Figure 8-10 Foods consumed over 24 hours



Given that subsistence gardening is still the main source for root crops and vegetables for local households in the TRHDP area, changes in work/employment and access to horticultural land and areas where wild foods can be found will have a direct effect on diets and householders’ nutritional status. Past commercial scale logging is reported by local villagers to have had a negative effect on the availability of wild foods, both plant and animal. Also, green leafed food-plants and ferns that are collected from wetlands, and moist areas located adjacent to streams and the river, are negatively affected by drought and floods.

While not recorded as part of the household diets, homegrown tobacco smoking and beer drinking are common among males, and betel nut chewing is common to both males and females. The area is known for its high quality betelnuts, which fetch good prices in the Honiara market.

8.1.8 Physical Capital

Physical capital refers to the equipment, tools, infrastructure, and physical structures used in securing a livelihood. Data was gathered in the TRHDP area householder survey on the goods and equipment owned by the household. This is summarized on Figure 8-12.

8.1.8.1 Household Equipment and Facilities

Regarding the use of toilets, the vast majority of households rely on pit latrines or simply going into the bush. People cite this as one of the reasons for the relatively high incidence of diarrhea, especially among children.

In terms of transport equipment, very few people have their own motor vehicle: 14% reported they had a car and 7% a van or truck, but this appears to be somewhat high given that there are entire villages that have no vehicles. Therefore, the results may be due to sampling bias in the survey.

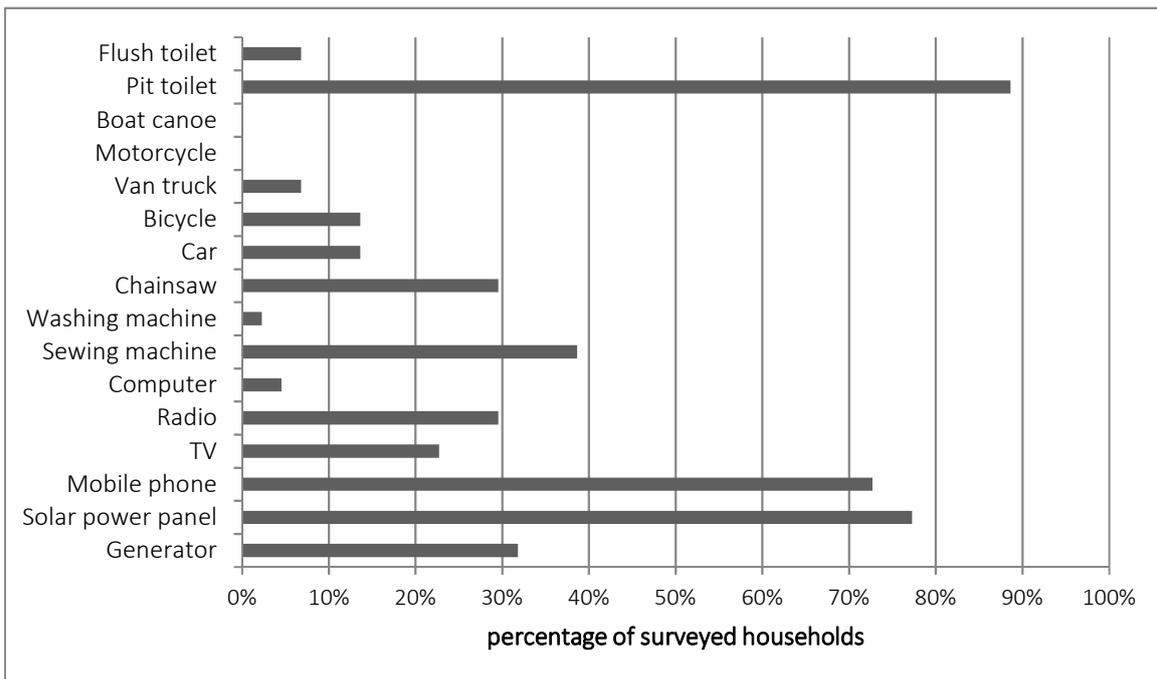
The majority of households have a small solar panel that makes it possible to have a mobile phone. This, in turn, facilitates communication both within the area and with town-based services, suppliers, and family members, and represents a major change for residents of the project area, especially since telephones were completely absent prior to mobile communications technology. Having a solar panel also enables a household to have lighting, albeit at very low power, and small appliances such as a television set, a radio and a computer. However, ownership of each of these items is relatively low. Approximately a third of households report that they have a generator but, again, based on direct observation, this appears to be somewhat high. Generators are typically used for events, such as church and community meetings, rather than for everyday use.

Nowadays, a chainsaw is one of the most important items of physical capital a household within the project area can possess. A chainsaw enables the owner, providing they have resource ownership rights in the area, to fell trees in the forest and, with the addition of a frame, break them down into merchantable timber according to customer need. As noted previously in relation to income, timber milling appears to have become the most important source of income for local households. Being able to produce timber also enables local people to build more durable, modern style houses. However, chainsaws are expensive to buy and, therefore, tend to be owned by people who have access to capital, perhaps derived from logging or mining royalties. Marketing of timber also requires having access to a truck, which few local villagers do. At present, those producing timber rely on timber merchants and hire vehicles to come out from Honiara to collect the materials.

Just less than 40% of households have sewing machines, which are mostly hand powered. These enable women to make clothes and handcrafts for home use and for sale. While not included in the survey, it is apparent that households in the project area lack refrigerators, and, therefore, are unable to store perishable foods, such as meat.

In general, the data indicate that local people lack significant equipment for supporting their livelihoods, in particular, motor vehicles able to transport goods and produce to Honiara for sale. Day to day domestic work could also be made significantly easier with reliable access to power from the main electricity grid, sufficient to run a washing machine, water pump, cooling fan, refrigerator, and household lighting.

Figure 8-11 Household Physical Capital



8.1.8.2 Housing

Local people of the project area live in extended family households, accommodated in several leaf houses depending on household size. Several types of local houses are evident in the villages of the project area:

- traditional one or two room “leaf houses” made of woven plant material walls, wooden poles, and dirt floors, and sago palm thatched roofs. In some cases these houses are raised on wooden poles. These houses are almost completely made of local materials collected from the forest. They appear to be declining in number.
- traditional style thatched houses with dirt floors or raised on piles, with floors and walls made of sawn timber. These houses are also made of local materials, and appear to be the most common style.
- larger permanent houses with multiple rooms, made of sawn timber, with concrete piles and corrugated iron roofs. Some examples include balconies. These houses incorporate both local and imported materials. It appears that these are a relatively recent introduction into the project area.

Figure 8-13 shows typical house structures observed in the TRHDP study area at Verakuji (leaf house), Haimane, Habusi, and Marava, the latter of which illustrates the use of more durable building materials.

Figure 8-12 Typical house structures in the TRHDP area

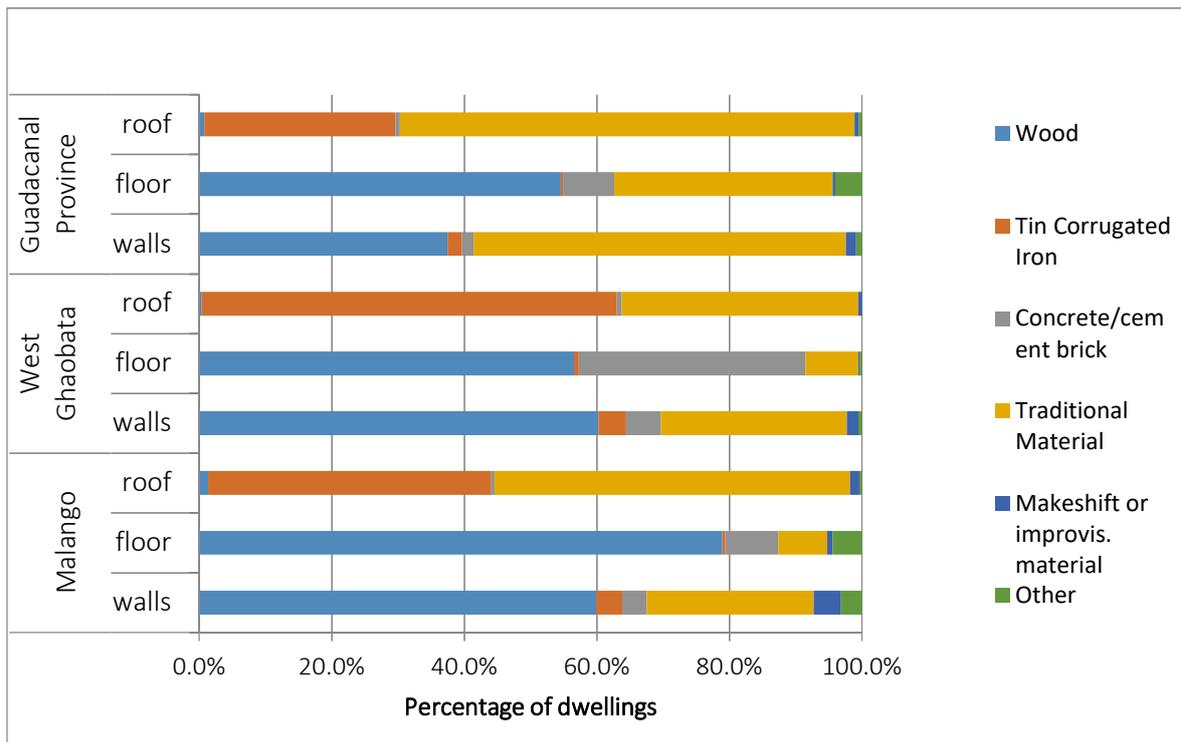


The 2009 census recorded 1749 dwellings in Malango ward and 976 in West Ghaobata. Most contained a single household, although 49 of those in Malango ward and 204 in West Ghaobata contained two or more households. This suggests a shortage of housing in the lower part of the catchment.

The Census also records the material used in houses (see Figure 8-14). For the most part Malango houses are constructed of wood or leaf material walls, wooden floors, and leaf-thatch (sago palm) or corrugated iron roofs. This is consistent with field observations made in the project area. Houses in West Ghaobata are generally similar, though they tend to have concrete, rather than wooden, floors.

Malango houses are slightly above average in size for the province, with an average 2.5 rooms each, compared with 2.2 in West Ghaobata and the Province as a whole.

Figure 8-13 House construction materials in Malango & West Ghaobata Wards, 2009



8.1.8.3 Infrastructure

Roads

Physical capital includes local infrastructure. Roads and bush tracks are the most important infrastructure in the project area. These are vital for people and communities to be able to access natural resources, to transport people, goods, and produce to the marketplace, to access services within and outside the area, and to bring home the goods they need. The roads in the area have become vital for people's livelihoods. There are regular minibus services from Honiara right through the project area, wherever there are adequate roads, and they appear to be well patronised. People from the Senge, Pachuki, and Namopila areas who wish to travel to Honiara must ascend out of the river valley along bush tracks. Most villagers in the Tina area have to walk out to the main road to catch the bus.

Unfortunately, all of the local roads are unsealed, lack an adequate or durable surface, are inadequately drained, poorly formed, and badly located in some places. The main road from Black Post (GPPOL plantation) to Marava is a government road, and is only infrequently maintained. Consequently, it is very hard on vehicle undercarriages and suspension problems are common. During periods of heavy rain the roads become deeply rutted, and sometimes impassable. The village side roads are generally poor, and mostly require a 4WD vehicle, and a lot of driving skill. The road from Marava to Mangakiki appears to have been formed as a logging road and is now only maintained as far as Verakuji. Beyond this point, it has reverted to an overgrown track and is not used by local vehicles. The road has a number of culverts that appear to be deteriorating and are likely to fail in the future. In some places, run-off from the roads during heavy rain pollutes local streams and water supplies.

In 2013, some attempts were by the Project to improve the surface of sections of the main Bahomea/Tina Road, as part of its initial development efforts in the area. However, a more serious effort is required. Upgrading of the main road into the area and preparation for the project

development was due to begin in October-November 2013, involving correcting creating a proper alignment, improving drainage, and creating a more durable carriageway. If adequately rebuilt, the new road will contribute positively to local people's livelihoods, way of life, and general wellbeing.

Water Supply and Use

Despite reports of many promises made by politicians and various agencies, the landowner and settler communities of the project area, and downstream Ghaobata, still have no formal water supplies or water treatment systems, and there is no water or sewerage infrastructure in the villages. This is seen locally as seriously unjust, given that in the nearby capital city of Honiara these services are available to most residents. Popolo/Old Selwyn has a borehole and infrastructure for water conveyance throughout the village, but this is currently inoperative. Several villages in the project area have their own fresh water wells (see Figure 8-15), but most people rely on the Tina River.

Figure 8-14 Covered village wells at Vera'ande- for washing & laundry



Lack of formal water supply systems is not uncommon in Malango Ward. With respect to drinking water, in 2009 the Census recorded that 38% (i.e. 525) of all Malango houses relied on rivers and streams, and 27% relied on a communal standpipe/well, while only 6% had metered supply from the Solomon Islands Water Authority (SIWA). However, in West Ghaobata 35% of houses had a metered supply, 29% had a communal standpipe, and 23% relied on rivers and streams. For washing water, 57% of houses in Malango Ward (i.e., 1004 houses) in 2009 used rivers and lakes, 17% used a well without a pump, 11% used a well with a pump, and 7% used a private piped supply. The pattern is quite different in West Ghaobata where only 20% use rivers and lakes, 44% used wells, and 26% used either a community standpipe or a shared piped system.

The village workshops and the household survey both enquired into local water supplies. Figure 8-16 presents the household survey findings. Households typically listed two sources of freshwater for drinking and cooking, typically the Tina River or an adjacent stream, and rainwater. Half the respondents said that their household used rainwater. However, there were relatively few rainwater tanks in evidence throughout the villages. Another 39% of households said that they obtained their water from a local well.

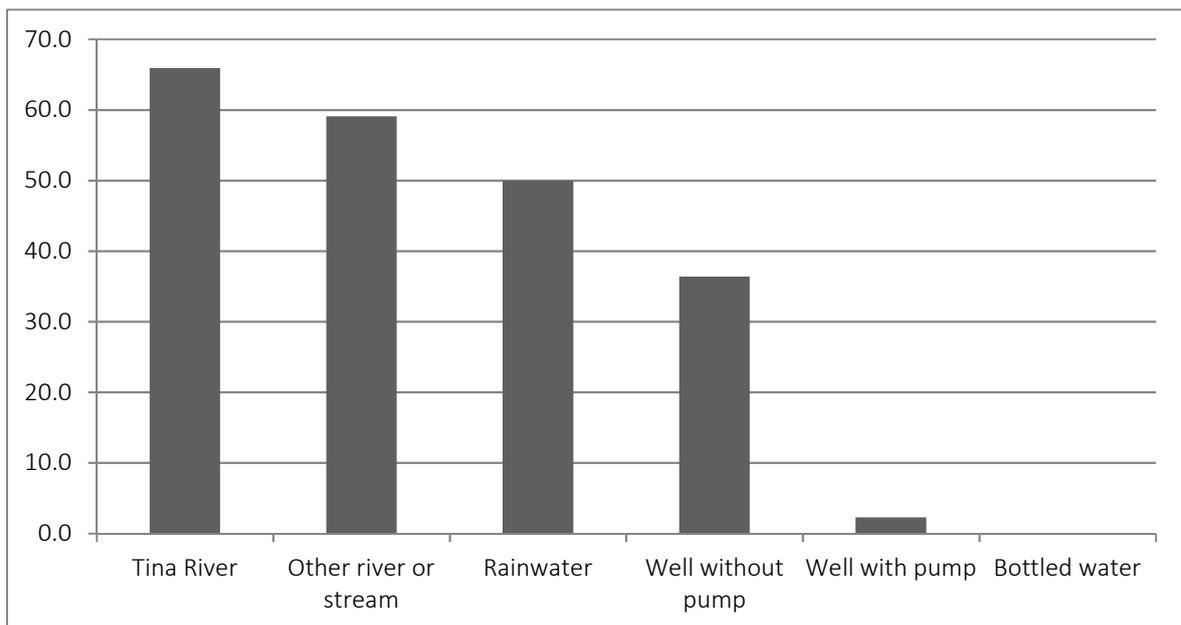
Those who take their drinking water from the river use a natural filtration method for ensuring clean water: they dig a hole in the gravel and sand immediately beside the river channel, and water seeps through the sand into the whole from where it is collected (see Figure 8-17). At Senge and

the other upstream communities, people take their water directly from the river channel without filtering it. During wet periods or flood events when the rivers and streams are high and discoloured, most villagers collect and store water in anticipation of such conditions, and also collect rainwater in buckets and basins. Only 2% of householders in the survey reported that they used any kind of treatment for their drinking water. This suggests that, generally, the Tina River is of sufficient quality to drink, and most do. As the main source of water for households located in the vicinity, local people and communities are extremely vulnerable to any significant changes in the quality of the water in the Tina River.

Hevalao (2013) has surveyed village water sources in the project area, and provides details of the locations, flow rates and conditions of the Nembo source and Mangakiki, the Rate source for the villages of the Tina River area, and the Antioch source for Antioch and Valesala. In some cases villages have installed small dams and piping to make it easier to access the water.

At Mangakiki, Marava, and Verakabikabi, householders have to walk some distance, sometimes up and down steep hills, to fetch water from local springs or small streams. Several sources are used at Mangakiki, and some villages further down in the valley have proposed that these could be the basis of a piped supply in the valley. Villages at Vera'ande have several wells close by which are used for different purposes. Villages located on the downstream flood plains tend to have greater access to wells and communal taps, and generally don't use the Ngalimbiu River for drinking water.

Figure 8-15 Main sources of drinking and cooking water in the surveyed households



The majority (i.e. 73%) of the surveyed households in the project area do their laundry in the Tina River and 77% use it for bathing.

The people of Malango Ward clearly are at a disadvantage compared with their neighbours, with respect to both drinking water supply and washing water. This disadvantage in lack of basic infrastructure and service availability, which is exacerbated by the additional labour required for collecting water, and in poorer sanitation and health.

Figure 8-16 A water collection hole in the river bed near Tina Village



Sewerage

The lack of sewerage infrastructure and basic toilet facilities in the villages of the project area has been previously discussed. The reliance on pit latrines is common throughout Malango Ward, according to the Census. In 2009 45% of households in Malango used private or shared pit latrines, 13% used a private water seal toilet, 11% had their own flush toilet and 24% had “other” or no toilet facilities, that is, they use the bush. The pattern in West Ghaobata is slightly different, where 29% used a pit latrine, 30% used a private or shared flush toilet, and 33% had other or no facilities, i.e., they use the beach, sea, or bush.

Energy for cooking and lighting

While the 2009 census recorded that 12% of houses in Malango were connected to the main electricity grid, there is no such electricity supply to the villages in the project area, notwithstanding that this is very much desired by local people. For lighting, the Census records that the vast majority (77%) use kerosene lamps and a small proportion (4%) use solar/PV power. Cooking is almost exclusively done using wood fires (90% of households), with a minority of 8% using gas from compressed gas cylinders. In West Ghaobata, Popolo village was connected to the main electricity supply grid that also serves Honiara, but the overhead power lines were stolen during the period of Ethnic Tension. Other villages in West Ghaobata are connected to the main electricity supply. The 2009 Census records that 27% of houses were connected to the main electricity grid. However, the majority of households still rely on kerosene lamps for lighting, and almost every household (i.e., 96%) cooks using heat produced from burning wood or coconut shells.

8.1.9 Social Capital

8.1.9.1 Introduction

Social capital refers to the relationships or connections that people and communities have with each other and upon which they can draw while seeking their livelihoods. Being able to access the resources and knowledge of other people and communities requires relationships of trust and reciprocity. Along with natural capital and human capital, social capital is an essential part of local people’s portfolio of livelihoods assets.

8.1.9.2 Wantoks

Within the project area, kinship or family connection is the most important form of relationship for accessing the resources necessary for life. As mentioned, the indigenous people in the project area see themselves as being part of a 'family', with a special identity, language, culture and environment. Local people generally live quite close to their extended family members and are able to call upon them to assist with a wide range of tasks necessary to achieve their livelihoods. Likewise they are expected to contribute to other members of the family, clan and community. Those connected by kinship and who are members of the same community are often referred to as "Wantoks", and there are strong customary mutual social obligations associated with this relationship. In the project area, it is common for people to call upon relatives and neighbours to help with major tasks such as clearing land for cultivation, house building, transporting produce materials and goods, and assisting in special events such as traditional clan pig feasts. Those who aspire to leadership, draw heavily on their available social capital for the resources and support necessary to succeed.

In addition to kinship and membership in the same community, people use connections with former boarding school mates, workmates, and sports team members to gain access to livelihoods resources that they need.

8.1.9.3 Religion

The second most important basis for social relationships is through membership of the same church.

Most people in villages of the project area are Christians, and actively practice their religion. In some cases, people are also affiliated with the Moro/Gaena'alu movement. Religious affiliation is a very important basis for community formation and for providing social capital for local livelihoods and activities. The main religious or denominational groups in the communities along the Tina River are the South Sea Evangelical Church, Roman Catholic, Anglican/Church of Melanesia, Seventh Day Adventist, Assemblies of God, Bible Way and the Baptist Church. There are also smaller churches such as the Church of the Living Word and Christian Mission Fellowship that are located in communities in the downstream areas. Several villages also have followers of the Moro Movement, centered mainly on Koropa and Namopila. There are twelve Church buildings across the various communities, varying in size, style, and construction.

Church buildings are usually located at one end of the village compound, acting as an "anchor site" and important meeting place for a village. They are also the most substantial buildings in the village, and represent considerable investment by the community, in terms of natural resources and materials, labour, and cash. Apart from kinship and clan affiliation, church membership is the main basis for social organisation and action.

Ward-level 2009 Census data show that the South Seas Evangelical Church (SSEC) has the greatest number of adherents in Malango Ward (33%), followed equally by the Church of Melanesia (Anglican) and the Roman Catholic Church (approximately 20% each), and then the Seventh Day Adventist Church (SDA) with 16% of the population. In West Ghaobata Ward, the predominant religion is the Church of Melanesia (with 52% of the population) followed by the Catholic Church (18%). Taken as a whole, Guadalcanal is predominantly Catholic (36%) and Anglican (23%), followed by the SSEC and the SDA.

As noted earlier, day-to-day activities often involve church membership, and along with sports groups, church groups make up the majority of social organisations in the villages of the TRHDP area. The surveyed villages typically have church-focused mothers' clubs and youth groups, Sunday school, and a local soccer, netball or volleyball team. All the larger villages have a church

building, and in some cases the church is supported or led by a paid clergyman, religious instructor, and/or youth worker. These churches are also the conduit for church-based aid project work by overseas religious organisations, such as World Vision, Charitas, and others.

Additional details regarding religion, and the Moro Movement, are provided in the Cultural Heritage sections.

8.1.10 Financial Capital

In the context of livelihoods, financial capital refers to the stocks and flows of money or equivalent assets. This includes credit that might be available to the household.

It is clear from the general profile of incomes, work, and other livelihoods assets that the people of the project area are not well endowed with financial capital, although they may have periods where they receive relatively large payments of money from the sale of goods and from royalties. There are no data available on the extent to which local people have bank accounts, loans, or access to credit. Land tenure data from the 2009 Census for Malango Ward suggests that bank mortgages are rare, since 42% of householders were listed as having freehold ownership of their homes, 39% were leasing from a customary or a private owner, 7% were leasing from government, and 12% had some other arrangements.

With customary collective land ownership, and high levels of self-employment and subsistence, it is difficult for indigenous people to get loans for business or other developments from the commercial banks. It is, therefore, easy to see how selling off logging or mineral rights on one's customary land to foreign companies may be tempting for those wanting to accumulate a block of financial capital. This seems to be the main means by which capital accumulation among indigenous people has occurred, and why logging and mineral exploration appear an appealing alternative for people of the project area and the wider Malango Ward.

8.1.11 Natural Capital

8.1.11.1 Introduction

Natural capital refers to all the "goods and services" of the natural environment that people use for their livelihoods. This includes materials and goods that are used directly (e.g., wild foods, and fresh water) or require processing or preparation before they can be used (e.g., forest trees, minerals, and wildlife). In the context of the TRHDP, the most important natural resources for local indigenous people are the land, forests, rivers and streams, sunlight and the cycles of the seasons.

8.1.11.2 Land and Land Use

Land Ownership and Occupation

As described earlier, land is central to the Malango people's identity, wellbeing, and culture. Prior to the colonial period the land, including the forests and the living things within them, provided all of the peoples' physical needs, i.e., food, drink, shelter, weapons, fuel, decoration, and medicine, and the materials required to transform or process products from the land. In modern times, this total dependence on the land and environment has been weakened through participation in the wider economy, including the use of imported food, materials, and technology.

Simultaneously, the land and its resources have been opened up to outsiders and multinational interests for large-scale exploitation. For example, much of the accessible area in Malango Ward has been logged over time, by a number of different companies⁶⁸. This has generated royalty payments for some of the indigenous landowners, and provided roads, but the scale of the forest destruction has meant negative impacts on traditional subsistence uses of the land and forest. Commonly mentioned problems include erosion and sedimentation of streams and rivers, unnecessary destruction of important resources such as sago palm, medicinal plants and food trees, introduction of unwanted exotic plants and animals (e.g., the invasive Giant African Snail), and disturbance to or loss of wildlife habitat, which among other things, has displaced wild pigs into villages garden areas.

To the indigenous people, no land is un-owned or is not connected with a clan, even if it does not appear to be occupied or utilised. The most important land to local indigenous people is the land that belongs to their particular clan, and the clan can have land in many locations. Sometimes the land is shared with other clans, for example, upland forest where people hunt and gather wild foods and materials. Within the tribal and clan domain, several types of land are particularly important:

- gardening land with soil and conditions suitable for sustained production of a range of crops for both household consumption and for sale in the market;
- well-drained safe flat areas for villages, houses, churches, meeting areas, and recreation, and which have access to fresh water;
- forest land for obtaining both timber and non-timber products (such as thatching, posts, vines, canes, materials for cordage, medicinal plants, decorative plants, fruits, nuts, edible leaves and roots), and for hunting wildlife;
- land that has been formerly occupied and been a home to clan members; and
- land which may contain important cultural sites, graves, or signs of occupation (such as planted food trees).

Full rights to occupy land and use its resources are acquired from membership of one's mother's clan, the matrilineal clan being the land-owing unit in Malango society. As Roughan et al (2011) have outlined in relation to the "indigenous terrain", clan ownership of particular blocks of land or whole areas depends on having knowledge of the history of that land, its use, and the location of culturally important sites and features to be able to prove the connection to others. This knowledge tends to reside with the oldest members of the clan. Over time this knowledge can become lost or uncertain, especially if the knowledge holders and their descendants relocate to other areas, or become deceased, as has occurred throughout Bahomea and Malango.

Since the vast majority of local people occupy, and use unregistered, customarily owned land, it is not always clear today which parts of the landscape belong to which sub-tribe or clan. Hence, there may be claims and counterclaims over particular areas, especially if there are material benefits to be had in the form of royalties or compensation.

With respect to the land in the upper catchment that may be occupied for a hydroelectric dam site and water storage reservoir, it appears that many Malango speaking clans may feel they have a land ownership or land use right over the potential project area since all originate from the

⁶⁸ In mid-late 2013, Earthmovers Ltd, who are based at Foxwood on the Guadalcanal plains, were operating elsewhere in Malango Ward, and were seeking to return to Bahomea for more logging. In 2011, Pacific Timbers were logging on the ridges above Choro.

hinterland at the top of each of the river catchments of central North Guadalcanal. At the time of this report, detailed clan ownership was being investigated by the clan leaders of Bahomea⁶⁹.

As noted previously, land use rights may be obtained by outsiders, through customary arrangements with the traditional land owning clan, involving the presentation of shell money and pigs. In this way, the original settlers from the Weather Coast were able to take up residence at Verakabikabi. Such arrangement has to be re-established or reinforced when there is a change of leadership among the landowners.

GARDEN LAND

Attempts were made in the village workshops and the household survey to gather information about the location and size of peoples' garden lands. However, this proved to be difficult. Based on field observations, most garden land is located within relatively close distance to the village, typically within 10-15 minutes walk. Proximity is important for protecting crops from wild pigs and theft, and for convenience. In some cases people cultivate gardens some distance away from their residence, usually in areas and villages where they have land ownership rights. This seems to occur right through the Tina River valley and it is common to see people walking up or down the river or the road to and from their gardens. In some cases such as Choro, where clan land that is suitable for gardens is some distance away, people may build a hut on the land and stay for periods tending their seasonal crops.

The total amount of area used for household gardens depends on the size and needs of the household, the energy of the gardeners, and the extent of their involvement in cash cropping. Also some households may have several plots for different purposes. At Antioch it was said that, nowadays, some households have only small gardens because they are not so dependent on home produced food. At Senge, people said that households typically had two plots under cultivation at one time, each plot being approximately 1600m² in size. At Namopila and Pachuki, where people have access to highly fertile river flats (prior to the serious flood of April 2014), plot sizes were also approximately 1600m², although people may only have one plot under cultivation. At Tina and Haimane, garden plots were said to be typically of a similar size, though there is considerable variation. Householders at Vera'ande have a large area of cultivated garden land adjacent to the main Tina road, some of which may be encroaching into the road reserve. This garden land, which is also adjacent to a wetland that produces useful plants, and from which groundwater is drawn, also has several pigsties. Generally, pigsties are located on garden land on the edge of the village. Pig keeping is quite common, and is sometimes a community enterprise (such as at Tina). Relatively few households appear to keep chickens and geese. Domestic fowl are usually kept on a free-range system.

8.1.11.3 Water Rights

In Solomon Islands, there are no formal allocations of water rights. Unlike, for example, rights to fish in an area or collect shells, which can be closely held under custom (and recognised by law), the High Court⁷⁰ has held that flowing water is a public right, unowned by the owners of the land

⁶⁹ This process was subsequently described in a media statement on 24 June 2014 by the "Core Land Tribes of Tina Hydro Project" as the Bhamoea Land Identification Committee (BLIC) process. It involved investigations and consultations on land ownership by "all the recognised elders and storytellers holding traditional land knowledge".

⁷⁰ *Solomon Islands Water Authority v Commissioner of Lands* SBHC 58

over which it passes. In making this determination the Court found that the English common law position also reflected customary understandings of water rights:

In spite of what we may say, it is common knowledge that water is essentially or necessity of the human being. It is always advocated by health officials in public talks and media etc that "water is life". This sum(s) up what I would say on the qualifications as local circumstances render necessary... on applying this common law on water.

And I am satisfied that the common law principles of nobody own(ing) flowing water is not inconsistent with any law or Acts and; its applicability or appropriateness in the circumstances of Solomon Islands is not inconsistent with the Schedule 3 of the Constitution and therefore make a ruling that it is the law in Solomon Islands on the flowing water.

The conclusion in the case also reflects the findings of the 1959 Alan Report that noted that customary rights holders do not ordinarily assert control of water supplies.⁷¹

8.1.11.4 Crops

The earlier Figure on local people's food and nutrition lists the range of food produced from their gardens and adjacent forest areas. As noted, the focus of garden production throughout the villages of the project area is on root crops, especially cassava and kumara, green leafed vegetables, cucumber, pumpkin, tomato, corn, spices, tobacco, fruits (such as bananas, guava, mango, Malay Apple, and citrus), sugar cane, nuts (especially coconut and betelnut), and flowers. Local gardens and nearby areas may also contain small plantations of highly valuable timber tree species such as mahogany, and sago palm. French (2011) provides a comprehensive description of the plants that are frequently grown and/or utilised in the Solomon Islands.

8.1.11.5 Forest Resources

The range of timber and non-timber forest plants to be found on Guadalcanal has been documented in the Solomon Islands National Forest Resources Inventory Project in the 1990s. Google Earth provides a 2010 satellite view of the landscape of the project area. This reveals that the settled areas of the Tina River valley and adjacent hills remain forested, although not as densely as the areas in the catchment upstream of Senge.

The village workshops confirmed that Malango's forests are essential to the livelihoods and wellbeing of Malango people, providing:

- timber and non-timber materials for housing (i.e., timber, loya cane, thatch, bamboo, and bark);
- game wildlife for hunting, such as wild pigs, possums, flying foxes, lizards, skinks, frogs, hornbill, pigeons, and ducks ducks);
- plants used for medicinal purposes and magic;
- wild foods such as fruits, wild palm, wild yam, various nuts, and ferns, megapode eggs, and emergency foods when required;
- materials for handcrafts, such as baskets;

⁷¹ Allan, C. H. 'Customary Land Tenure in the British Solomon Islands Protectorate' *Report of the Special Lands Commission* Honiara, Western Pacific High Commission, 1957. Considering customary rights to water the report found 'In general, the principle can be stated that the tenure of water supplies is subject to little control'. This was found to be in contrast to strictly held rights to fishing areas along the rivers in Northern Guadalcanal.

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- regulation of run-off from the heavy rains that occur on Guadalcanal especially around the high mountains, and climate regulation; and
 - and aesthetic appeal, and places for recreation and relaxation.

The full range of fauna and flora in the Tina Hydro study area, especially that in the upper parts of the catchment where TRHDP is planned, is presented in Section 6 – Biological Environment Baseline - Terrestrial.

8.1.11.6 Timber extraction

Apart from materials for their own homes, people in the Bahomea district use the forests in the upper catchment, including the areas proposed for the hydro scheme options, as a source of timber for sale to the construction sector in Honiara. The main species targeted by locals are vitex (*Vitex cofassus*), kwila (*Intsia bijuga*), *Calophyllum* species, and rosewood (*Pterocarpus indicus*). Parties of 2 to 3 men work with a chainsaw to fell selected trees, and then mill them on site into timber according to required sizes. The cut timber is then carried to the river, made into rafts, and floated downstream to pick up points with road access, for example, near Tina village. As discussed previously, most villages are involved in timber extraction. Some of the timber extraction is focused on the Toni River and others on forest areas adjacent to the upper parts of the Tina River, especially around Koropa and upstream as far as Choro. The river is, therefore, integral to local landowners' timber extraction operations.

8.1.11.7 Hunting and Fishing

Most hunting by people of the TRHDP area appears to take place in the uppermost parts of the Tina River catchment, upstream of Choro, and especially around and upstream of the old settlement areas of Tulongu, Tulambirua, and Namoradina on the northern slopes of Mt Popomanaseu. Hunting mostly takes place as "expeditions" lasting several days to a week and focuses on wild pigs. Hunting and fishing parties commonly base themselves at Njarimbisu at the confluence of the Mbicho and Mbeambea Rivers. Pig hunting is done with dogs, and tends to be the domain of young men, and is mostly done to raise funds for church and other events, as well as when people feel like a "feed of wild meat".

Fishing is carried out along the length of the Tina River, though nowadays it is focused on the river holes and pools in the upper catchment, upstream of Choro and as far as the Mbicho and Mbeambea Rivers. The main mode of fishing is by spearfishing with mask, snorkel and spear gun, and is sometimes carried out at night. Participants in the village workshops provided long lists of species they said they were catching and eating. The main fish being targeted are eels, helu (Silver fish), valu (Freshwater snapper *Lutjanus fuscescens*), kola (Mullet, *Cestraeus sp.*), and tilapia (in the Ngalimbiu River). People also take prawns (*Ura*) and a range of small fish. At Senge, villagers named more than 19 species of fish which they said they caught and ate; at Valesala they named 12 species; and at Marava 7 species.

According to PHCG in 2011, some fish species that used to be common in the lower and mid reaches of the Tina River can now only be found in the pools of the upper reaches. Despite the claims made in the workshops, the householder survey shows that fresh river fish only infrequently feature in people's diets, if at all, and canned tuna ("taiyo") is now the main source of fish protein. Despite local people's obvious knowledge of the fish species found in the river, from a livelihoods point of view, it seems that fishing is, nowadays, a minor activity along the Tina River. However, fishing is a significant source of livelihood at the mouth of the Ngalimbiu River, where semi-commercial fishing occurs using mosquito seine net, and gill net gear. Additional information on fishes, and their ecological and economic importance, is provided in Section 7 – Biological Environment Baseline - Aquatic.

8.1.11.8 The River

The Tina River is an important natural resource and feature in the lives of people of the project area. For example it is:

- the main source of drinking and cooking water for the whole district;
- a source of irrigation water;
- a place to bathe, wash clothes, clean vegetables , and recreate;
- a transport corridor and mode of transport;
- a source of food, including fish, crustaceans, and a range of plants found in and around the river and tributary streams;
- a fence and boundary marker (e.g. in some villages pigs are kept on the opposite bank of the river);
- a source of rocks and gravel used in local house building, and sold under royalty by the villages in the West Ghaobata area; and
- a car wash - in its lowest reaches.

Among the Ghaobata people residing in the lower catchment, sale of river gravel to construction companies is a very important source of income, and a significant component of people's livelihoods. Villagers receive royalties for each cubic meter of material extracted from the riverbed. This material originates from the upper reaches of the river, from where it has been washed downstream during periods of high flow, and then deposited in the inside meander bends in the lower reaches of the river, on the Guadalcanal plains.

Importantly, the Tina River is a source of risk to those who live near it or are required to ford it to get to their home villages or gardens. The main risk comes from flooding associated with storms and cyclones, when the river can rapidly swell in volume and, in extreme circumstances, spread out to inundate and destroy infrastructure, villages, gardens, animals and human life.

Central to people's experience of living in the Tina River area is the unprecedented storms and floods that came with Cyclone Namu in 1986. As noted in relation to the settlement pattern of villages in the Project area, the destruction by the Cyclone Namu floods resulted in a major relocation of many villages to their present-day sites.

8.1.12 Conclusions

In conclusion, the Social survey fieldwork was conducted successfully and in the expected timeframes, covering all of the settled area within the Area of Impact. A high level of participation by the village communities was achieved, with all levels of community members attending focus community workshops and follow up consultations, including adults, youth, women and children. Valuable baseline data and information was collected during the course of the Social field surveys from the village communities, householders, and culturally knowledgeable elders, as well as from various stakeholders, including government ministries and provincial offices, and civil society groups / NGOs.

8.2 CULTURAL HERITAGE AND GENDER ASPECTS

Cultural heritage and gender aspects fieldwork was carried out by Lawrence Foana'ota, a member of the ESIA team.

8.2.1 Survey Methodology

Cultural heritage and gender baseline and assessment data were gathered as part of the social workshops and survey process.

As outlined previously, meetings were held at 'core centres' either in community buildings or out in the open with members of the participating villages. The meetings generally began and closed with prayers, welcome remarks, introductions and explanation of the purposes of the visits by community representatives and ESIA team members.

During these workshops specific questions were asked about community health, cultural heritage and the role of women, as well women's as their views and feelings about the benefits and effects of the project.

In addition to the workshops and the householder interviews, interviews and discussions were conducted with individual chiefs, elders, leaders of youth and women's groups regarding cultural heritage matters, and gender aspects of life in the district.

People's responses to questions concerning cultural heritage, and the lives of women and children, were recorded in writing during social surveys (see previous section).

Additional information on cultural heritage, gender aspect and vulnerable people was gathered from secondary sources (such as published articles) and from the personal knowledge of Lawrence Foana'ota, who is a former Director of the National Museum.

8.2.2 Indigenous People

In traditional communities of the Solomon Islands, having specific names for tribes and sub-tribes or clans is by far the most important single factor in the identification of one's affiliation in society. Sometimes these names may be used to refer to a particular language group, a people or their geographical location within an island or province. The members of a particular group also use the names to distinguish themselves from other nearby groups of people.

People of Guadalcanal, like all the other communities in different parts of the country, have special names for specific groups of people. The groups of people in the Project area are called the Bahomea People within Malango Ward 20 in Central Guadalcanal.

As far as the whole of Guadalcanal Province is concerned, they have four main descendant groups. As already mentioned earlier in this chapter, they are Manukama, Manukiki, Koinahao and Lasi. The Bahomea people who live in the Tina Hydropower Development Project areas are descendants from the two exogamous moieties known as the Manukama or also known as Garavu and Manukiki. These are big lines and small lines as the people always refer to them.

Manukama or Garave is the big line, which is symbolized by the eagle or *Chacha* totem, while the small line or Manukiki is represented by the hawk or *Roha* totem. Sometimes they refer to themselves as big bird or small bird. The name for tribe in the local indigenous *Teha* language is Vunguvungu. There are reportedly twenty-seven sub-tribes living within the TRHDP area.

According to their custom, men and women of any sub-tribe belonging to these two main tribes can marry each other but not from sub-tribes of the same main tribe. For example, **A** of a sub-tribe from Manukama is allowed to marry **B** of a sub-tribe from Manukiki but **X** of a sub-tribe from Manukama, cannot marry **Y** of another sub-tribe from Manukama. This also applies to members of other sub-tribes from Manukiki.

8.2.3 Cultural Heritage Sites

In parts of the Solomon Islands, some communities do not impart information or knowledge about their cultural heritage easily, especially when it comes to dealing with cultural and historical sites. There are some sites that are sacred or still considered to have powers that people no longer want to talk about, because they fear of getting sick or dying prematurely. This appeared to be the case in some of the communities the ESIA team visited. Prior to construction of the Project, a culturally accepted protocol has been developed to implement for identifying sacred sites (Tambu sites) (see ESMP).

Cultural heritage is a subject that many communities are not interested in discussing publically. It depends very much on the importance placed on it by the people. During the visits and meetings held with the communities, it was observed that, unlike in the past, members of the Bahomea communities were not always in agreement about what they regard as important cultural heritage. In Tina Village, for example, those interviewed no longer placed much importance on tradition, due to the influence of the Christian religions. Many people have turned to Christianity, and as a result, their cultural practices, sacred sites, and various rituals have lost much of their significance and meaning, including information associated with them.

Throughout the Solomon Islands, these types of sites are usually located either along the coast or high up in the mountains where they are sometimes hard to access on foot. As a result, persons interested in any of the sites may have to walk for a few days to get to them. In some cases, no one is allowed to visit or take pictures of them. This was also the case in the communities along the Tina River.

According to the information provided to date, the main sacred sites, also called tambu sites, located within or near the project area are Tulahi opposite to Koropa Hamlet, Namuloha sacred pool, Aho stream, Vatukotiti and Vatomosa sacred stones (the latter representing a pig), Makara Tavukea (2 stones - one representing a Helu Fish), Babaruhuvia (a cave used before for sleeping when people had no built shelters), Bela hill, Chanjo, Tovu, Choga and Kabi. These sacred sites were all used by the founding families in the past, when they first settled on the land, and are located between Senge and Choro Hamlets. No details of sites upstream of the damsite were obtained.

Some of the sacred sites and objects could be affected by the Project. The Namoloha sacred pool will be affected by flow changes in the by-passed reach of the river. The customary houses built in Koropa where two boxes containing a number of heirlooms are kept will not be affected. Most of the sacred, fishing, hunting and timber milling sites are located within the areas in the upstream catchment.

It was not possible to physically visit these upper catchment sites because they are located in places that are inaccessible by road. The ESIA team only ventured as far as Senge and Koropa

One of the reasons for not speaking about or providing information on these cultural sites, including the whereabouts of grave-sites, during village gatherings is because they are associated with landownership. This kind of response to questions regarding cultural or historical sites is common to many communities throughout Solomon Islands. Chiefs, or those who have the knowledge, fear revealing information in public because someone might use it to claim ownership of land, or use the information in court against them. People from Marava, Vatupaua, Rate CHS, and Ngongoti communities noted that several burial places may be affected if the existing Tina-Black Post Road is enlarged to facilitate construction of the dam.

According to the ESIA Scoping Report, the Njarimbisu River area (upper catchment area) is known to be of significance to local tribes. It is believed that, prior to WWII, Tina Village was located near this site. During the war it is believed that it was attacked and that lives were lost (Entura, 2012).

There are no cultural heritage sites within the project study areas that are formally protected under the Guadalcanal Historic Places Ordinance 1985. So far, based on information gathered by the ESIA team, there are no “critical” cultural sites or relics to be found within the area that cannot be relocated, or compensated for, if disturbed or destroyed.

There are no WWII sites in the proposed project area. However, some sites were noticed in the downstream area, such as bunkers along the “American Trail” (see Figure 8-18). These WWII sites will remain unaffected by the Project.

Figure 8-17 WWII Bunker along the American Trail



8.2.4 Christianity

As mentioned in a previous section, there are a total of twelve Church buildings in each of the communities. These structures vary in size and method of construction, using both local and imported materials. An example of the use of modern building materials, are the SSE Churches at Antioch and in Mataruka in the Malango district. Figure 8-19 shows a photograph of the SSE Church at Antioch.

Regarding the location of religious sites, such as Church buildings and cemeteries, these vary from community to community. In some communities, Church buildings are located at one end of the village compound, while the cemeteries are either located near the houses or some distance away from the residential sites. The graves are either surrounded by wooden planks or stone boulders, which hold the soil in place. Some graves were observed next to the families’ dwelling houses or in the center near the Church building (e.g., in Tina Village, Senge, and Pachuki). In some cases, families bury their dead next to their houses (one or two graves), out of concern that someone might disturb or desecrate the graves.

At Tina Village the graves of a notable missionary couple are covered with concrete, whereas at Senge and Pachuki, wooden planks are built around important graves.

Figure 8-18 Antioch South Seas Evangelical Church



8.2.5 Moro Movement

In the Solomon Islands, as elsewhere in Melanesia, there are many stories about various cargo cult movements, which started when people began to experience a new western lifestyle, which was associated with material goods available in large quantities.

The Moro Movement is based on two main objectives: (1) the establishment of a socio-political organization of which the late Moro was the leader; and (2) the launching of a number of co-operative economic enterprises aimed at elevating the standard of living of the followers of the movement. The key premise of the Moro Movement is that the Americans would return and take control of Guadalcanal once more, and that the “Black Americans” were going to send cargo (i.e., large shipments of American materiel), to which only adherents of the Moro Kastom would be entitled. Ships from America would arrive and then transport the faithful followers of Moro to the USA.

In the late 1960s, Moro sent a deputation to Honiara to see the District Officer. “The deputation consisted of four young girls aged roughly 14 to 16 years, dressed in traditional string skirts and adorned with traditional shell money. They carried a bag containing several thousand Australian dollars to “buy their freedom.” The bag of money was sent back with a message from the District Officer to Moro telling him that they had “freedom” and that it could not be bought with cash, only by working in society” (Tedder 2008: 197).

The main headquarters of the Moro Movement is at Makaruaka, on the Weather Coast of Guadalcanal. The Malango branch of the Moro Movement is based at Koropa where Chief Hudson Micah is the main holder of everything related to the movement’s beliefs and powers. He has two boxes with three compartments in each one. In the first compartment in each box are traditional objects including some special shell money beads associated with the preservation of the Environment (Hairau). The second compartment contains items related to good health or the wellbeing, style of living, wealth and the way of doing things by Man (Tinoni). The third compartment holds the things used to ensure good yields from the gardens, or for protection from diseases affecting crops and the Land (Pari).

The Movement promotes living a very simple lifestyle (Poua), making sure that the ground (Momoru) is protected and not sold, and adopting a lifestyle based on leading by example (Vuluna), at a time that is, otherwise, characterized by the rich getting richer and the poor getting poorer. To

abide by the teachings of living a very simple lifestyle, women and young girls wear twisted string skirts with no top coverings, while men and boys wear tapa aprons or *kabilatos* (breach cloths) which cover only the front and back also without any top coverings.

According to a leader of the Movement, families living in Senge, Koropa and Choro, and some of those in the other Christian communities downstream of the Tina River, support the Moro Movement and its ideology - especially the core beliefs and teachings about the land, environment and culture. However, the fundamentalist Churches and some of the chiefs are, reportedly, very opposed to their practices and, as a result, any activities or even symbolic buildings such as the custom style built houses that represent the Movement's ideologies, are not permitted within the Christian communities or villages.

The members of some of the fundamentalist Christian Churches view the Movement and its beliefs and practices as evil and uncivilized, because of how the followers dress and the way they live in hamlets with only two or three members of a family, isolated from other communities. In fact, the late Moro was Roman Catholic, and some current followers and members of the Movement also belong to the Roman Catholic Church.

The implication for the Project of the presence of Moro followers is discussed in the impact section.

8.2.6 Gender Aspects

The Solomon Islands national census report of 2009 identifies the total number of women as 251,415 out of a total population of 515,870 - or just over 48.4% (Census Report: 2009).

Women play the very important roles in Solomon Islands society, as mothers, gardeners, sellers of garden products, caretakers of children, and implementers of household chores. In traditional Guadalcanal society, women used to play an important role with respect to land tenure, land management and access to land, and had an impact on wider decision-making in local communities. Women interviewed as part of the social survey, noted that in today's contemporary society, their interests and roles in dealing with land issues, have become marginalised. These communities, like those of other matrilineal societies "*recognize women as legitimate landowners, but there is need for legal recognition through legislation as stated in the Land and Titles Act 1969*" (Maetala 2008:39).

During field studies, women's views on issues affecting them and their responsibilities in the communities as leaders of families and women's groups, were recorded (Figure 8-20). Since it was not possible to interview women who belong to the Moro Movement, only those women leaders who belong to different Church groups were interviewed. Even though their views and decisions may be heard during community meetings, either on traditional, contemporary or religious issues, they are often not prioritized.

Regardless, it was interesting and worthwhile to hear about their responsibilities as women, and their views on the Project. During discussions, they were able to speak their minds freely concerning the possible impacts they feel the Project will have on their lifestyle, work, and the use of the water from the river. In addition to using the river for transporting timber and other materials from upstream, and obtaining gravel and sand for building houses, local people use the riverbank for drying their laundry. In other locations, there are special places where children are taken for picnics or camping trips during special events, such as the end of the year when children start their school holidays, or for Sunday School weekend outings.

Even though the communities visited appeared to want the Project to proceed, some women, especially those who are leaders and members of Church groups, expressed some reservations regarding the Project. This is because the river plays an important role in their way of life either

every day or occasionally. Some women did not provide an opinion during the meetings because they still did not know what the effects of the Project might be, and because the type and magnitude of the Project is new to the country and, particularly, their region.

Since women are the ones mostly involved in looking after the welfare of the children and, in some cases the whole family, they wanted to ensure that the Project must not interfere with their normal lifestyle. For example, they commented that, presently, they have the freedom to move freely along the river without any fears. However, according to them, free movement will be restricted because no one knows how safe the dam will be when it is completed. Their fear is based on their experience with a huge volume of water, which destroyed some of the communities along the riverbank during Cyclone Namu in 1986.

Figure 8-19 Women at Verakuji and Marava



9. ASSESSMENT OF IMPACTS ON THE PHYSICAL ENVIRONMENT

This section identifies potential direct and indirect construction and operation impacts accruing to the physical environment as a result of the TRHDP. It also identifies mitigation measures, and residual effects and their significance.

9.1 DESCRIPTION OF IMPACT GENERATING ACTIVITIES

This section describes the actions and activities of the TRHDP that could potentially affect the physical environment. Potential physical environmental impacts may include induced seismic activity, local slope stability, soil compaction and erosion, hydrology (surface water and groundwater), sediment transport, regional and local air quality, climate change and greenhouse gas (GHG) emissions. In turn, impacts on the physical environment may influence the project's viability or sustainability (see Section 15 Effects of the Environment on the Project).

9.1.1 Pre-construction and Construction Activities

9.1.1.1 Pre-construction Activities

Pre-construction work involves site investigations, including installing a hydrology monitoring station, mapping topography, undertaking geological and geotechnical surveys, and other related activities. Limited drilling and cutting of new tracks to move equipment onto survey sites was required.

9.1.1.2 Widening and Stabilizing Existing Black Post Road

Black Post Road will be widened and improved along its 13.3 km course. This will necessitate bush clearing, surfacing and stabilization with gravel or cement, creation of roadside ditches for drainage and earthworks to build embankments. The width of the right-of-way will be 50m and include the transmission lines.

Between Rate and Mengakiki the upgraded road will be diverted from the existing course of the Black Post Road to take advantage of favourable topography and to avoid the relocation of residents in the Mengakiki Village.

9.1.1.3 Construction of New Access Roads

Black Post Road will be extended from Mangakiki to the project site to serve as the main access road. This will necessitate clearing forest and other vegetation cover, grubbing stumps, removing top soil, completing earth works (cut and fill), stabilizing the roadbed, road surfacing, installing drainage gutters and ditches, and installing watercourse crossings using culverts. This section of road will be gravel or sealed road. The length of this road is about 8.31km. The primary Contractor may subcontract forest-clearing activities to a local logging company, to avoid importing forest clearing and log transport machinery.

Entura's feasibility study (2014) identified two quarry sites both in the reservoir area, which will be connected to the main construction area by access roads. The access roads to the quarry sites will

follow topographic contour lines and have the same width as other access roads for which additional width is not required for the transmission line.

9.1.1.4 Construction of Headrace Tunnel from Dam to Powerhouse

The headrace tunnel will be 3.3m in diameter, will run 3.3 km beneath the ground surface, with an 85m shaft connecting to a 130m long power tunnel. The headrace and power tunnel will be built underground using a combination of primarily mechanical excavation (road headers) to excavate rock as well as drill and blast techniques where the geological conditions require this excavation method.

Drilling and blasting above ground will generate noise and vibration due to the use of hydraulic rock drills and explosives. In addition, removal and disposal of spoil material will utilize heavy haul trucks that generate traffic and dust in the dry season. Topsoil removal will be limited to the entrance of the tunnel, surge shaft and tunnel exit. Approximately 1ha of work area for machinery and trucks to operate will likely be necessary at the entrance of the tunnel, and another 1ha will be required for a work area at the exit of the tunnel. BRLi (2013) has estimated the volume of tunnel spoils to be approximately 24,300m³, based on the dimension of underground infrastructure. These spoils will be used in road construction and in the concrete mix for the power station and proposed tunnel lining.

9.1.1.5 Construction of Dam and Powerhouse

Construction of the dam will require de-watering the river by diverting it through a diversion structure comprised of an upstream cofferdam, a diversion conduit, and a downstream cofferdam. The riverbed and valley walls will be excavated into the bedrock by drill and blast techniques for the dam foundations and dam abutments. Preparation of the dam abutments will affect approximately 2,800m² of terrestrial habitat on the right slope of the gorge and 3,700m² on the left side of the gorge.

The powerhouse will be built alongside the Tina River 5.7km by river downstream of the dam and will be founded on competent rock using drill and blast techniques to avoid settlement and vibration of the completed structure. A substation will also be constructed. The construction of the powerhouse and substation will necessitate excavation, fill placement, grouting or pilling and will cover approximately 1080m² (Entura, 2014).

9.1.1.6 Construction of Work Area

An area of 130m x 90m (11,700m²) will be required for construction work areas (e.g., staging, fabrication, materials stockpiling, equipment maintenance, etc.) and will involve forest clearing and topsoil removal.

9.1.1.7 Quarrying

Rock quarries will be developed to provide aggregate for the RCC dam. Entura (2014) estimated that 160,000m³ of aggregate will be required, from two possible quarry sites located in areas that will be occupied by the future reservoir within the Core Area. Where the identified quarry sites are suitable for construction needs, all quarry sites and access roads will be within the Core Area.

In the event that aggregate available from the identified quarry sites in the Core Area is insufficient to meet all construction needs, additional aggregate will be purchased from a licenced gravel supplier. Specific measures for quarry management, including measures applicable to independent

suppliers, will be detailed in the Quarry Management Plan to be prepared by the Developer in accordance with the framework provided in the ESMP – Chapter 13.

Quarry exploitation will require the removal of superficial deposits in or close to the river, which may release suspended material into the water.

9.1.1.8 Reservoir Preparation

Prior to reservoir impoundment, trees with a diameter larger than 10cm will be cleared from within the reservoir area up to an elevation of 186.5masl, which corresponds to Maximum Flood Level (11.5m above FSL 175masl). Loose rocks and rubble along the steep faces of the river gorge will be removed where possible.

Reservoir vegetation clearing will be conducted during the latter phase of the construction program, as the dam and powerhouse are nearing completion, just before reservoir inundation is set to commence. The timing is critical so as not to enable vegetation to regrow or become re-established before water is impounded. Depending on the schedule for reservoir filling, vegetation clearing may proceed in distinct phases, with the lowest elevation areas of the future reservoir inundation zone being cleared first, followed by the higher elevation inundation zone. Steep gorges in the reservoir area are covered with ligneous and herbaceous plant species. Due to the steep terrain, lack of access roads and the risk of flash floods, work using machinery will not be feasible. Vegetation clearance will, therefore, be undertaken using manual labour. Sawn timber will be transported by floating it down the river as is currently done from Choro and Koropa. This activity will release organic matter and suspended solids into the river. Reservoir clearing will not involve grubbing (removal of stumps) and soil stripping, since only manual work will be feasible.

9.1.1.9 Construction Traffic

Heavy haul trucks will be required to transport materials and equipment, including excavated material to the crushing plant, spoils from the headrace tunnel, heavy equipment and construction materials, fuel and other products on a regular basis. Light duty trucks and buses will be used to transport workers to and from the Project site.

9.1.1.10 Soil Stockpiling and Spoils Disposal

During the construction of the dam, topsoil spoil will be generated and will be stored (prior to reusing it for rehabilitation or before transporting it outside the Project Area). Storage will either be short term (in case of outside transportation) or long term (in case of rehabilitation of disturbed areas). An estimated 10 ha storage area will be necessary for the generation of 327,900 m³ of topsoil, using 10 round shape piles of 50m wide and 5m high. It is suggested to use remnant forests of the Core Area to create the 10 ha storage area.

9.1.2 Operation Activities

9.1.2.1 Operation of the Hydropower Facility

The operation of the dam and reservoir will modify the river flow, especially during the night (during reservoir filling) and will create a reduced flow between the dam and the powerhouse. River flow will also be reduced during reservoir impoundment. Operation will also affect sediment transport.

9.1.3 Impact Assessment

9.1.3.1 Impact Identification Matrix

Both the TRHDP construction and operation phases will generate impacts on the terrestrial ecosystem. Table 9-1 identifies impact-generating activities (X mean that there is a foreseen impact).

Table 9-1 Matrix of construction and operation impacts on the physical environment

Foreseen activities	Impact on components							GhG
	Induced seismicity	Local slope stability and geology	Soil compaction and erosion	Surface and groundwater hydrology	Sediment transport	Climate Change	Regional and local air quality	
Construction								
Widening and stabilization of Black Post road including RoW for TL		X	X	X	X		X	X
Creation of a new access road from Black Post road to Project site including quarries and RoW for TL		X	X	X	X	X	X	X
Construction of the head race tunnel from dam to powerhouse		X (minor)		X (groundwater hydrology)			X	X
Construction of dam & powerhouse		X (minor)	X (minor)	X (minor)			X	X
Work area construction		X	X	X	X	X	X	X
Quarry exploitation		X	X	X	X	X	X	X
Vegetation clearance in the reservoir		X (indirect)		X (surface hydrology)			X (burning debris)	X (net positive)
Soil stockpiling and spoil disposal			X				X	X

Foreseen activities	Impact on components							GhG
	Induced seismicity	Local slope stability and geology	Soil compaction and erosion	Surface and groundwater hydrology	Sediment transport	Climate Change	Regional and local air quality	
Operation (including initial reservoir inundation)	X (unlikely)	X		X (surface hydrology)	X (mostly indirect)	X (unlikely)	X (net positive)	X

9.1.4 Assessment of Construction Impacts

9.1.4.1 Induced Seismicity

Probabilistic seismic hazard assessment (PSHA) was carried out by the Seismology Research Centre in February 2014. Although the region is seismically active, the relatively small volume of the reservoir that will be created by damming the Tina River is unlikely to cause induced seismicity that could contribute to slope failures. Additional analysis on seismicity effects on the Project is included in Section 15 – Effects of the Environment on the Project. Conclusions of the seismic hazard assessment will be taken into consideration for the Project Design Report and the Dam Safety Plan.

9.1.4.2 Local Slope Stability and Geology Impacts

The steep slopes bordering the reservoir may be destabilised as a result of reservoir operation, due to the daily fluctuation in reservoir levels and effects that changing pore water pressures may have on soils around the reservoir margin. Given that the slopes above FSL will remain covered with forest vegetation, the potential for slope failure is likely to be confined to the area within the reservoir itself, unless failure of the slope within the reservoir was to trigger a retrogressive failure, one that works its way upslope.

The creation and operation of a reservoir may affect slope stability as a result of the following:

- Saturation of the banks of the reservoir may re-mobilise existing landslides and potentially induce new landslides;
- Deforestation of the storage area will increase landslide activity;
- Construction activity within the reservoir area will alter slope geometry and drainage patterns, thereby increasing potential landslide activity;
- Fluctuation of the storage level may induce slope instability around the reservoir margins;
- Landslides occurring upstream of the reservoir that contribute material which will reduce the available storage volume.

In addition, along the future access road, small landslides are likely to occur, a situation that may be exacerbated with the construction of the road. Retaining structures, such as gabion walls, or the removal of upslope colluvium may be required to minimize the risk of landslides occurring during both access road construction and operation.

Karst geology, which is created by the dissolution of limestone by acidic water, results in formations with cavities and/or caves. The creation of karst formations may be accelerated by the reservoir, leading to significant water leakage from the storage and dam abutments and foundations. Karst formations within the Project area have not created extensive cave systems according to Entura (2014). Therefore, the presence of karst is not considered to be an important leakage pathway. The feasibility study recommended that the maximum storage level be set at 175masl because karst appears to be less extensive below this elevation. In addition, the less stable Suta Volcanics that occur upstream will be avoided by a reservoir operated to 175masl.

9.1.4.3 Soil Compaction and Erosion Impacts

Large projects usually involve extensive land disturbance, involving removing vegetation and reshaping topography. Such activities make the soil vulnerable to erosion. Soil removed by erosion

may become airborne and create a dust problem or be carried by water into natural waterways and pollute them. Measures to address the impact of land disturbance on the environment should be included in the planning and design phase of the project, before any land is cleared.

When considering land disturbance and its consequences, priority should be given to preventative rather than treatment measures. To develop effective erosion controls it is necessary to obtain information on the erosion potential of the site where soil disturbance is planned. Erosion potential is determined by the erodibility of the soil (type and structure), vegetative cover, topography, climate (rainfall and wind), and the nature of land-clearing. Erosion potential will also be affected by the type, nature and intensity of earthwork.

9.1.4.4 Surface Hydrology

The construction of the dam will require the excavation of the riverbed and adjacent embankments, and the clearing of the area to be inundated by the storage reservoir. This will introduce sediment to the river, causing significant adverse impacts on downstream water quality likely for the whole period of project construction.

This impact is described in further detail in Section 11 – Assessment of impacts on Aquatic Environment.

9.1.4.5 Regional and Local Air Quality

The Project is set within an area that has relatively good air quality, with only periodic localised impacts from emissions caused by smoke from cooking fires in villages and from fires set to clear small patches of understory vegetation for gardens.

During the initial period of project construction, vegetation will be cleared from access road and transmission line alignments, the reservoir area, and the sites where project structures will be built. Non-merchantable vegetation (i.e., non-timber) will be removed and shredded rather than burned. This measure will prevent local air quality impacts caused by smoke generated by burning.

9.1.4.6 Noise and Vibration

The Project is set within an area of low ambient noise levels and minimal or no human generated noise in the vicinity of the tunnel or dam. The use of hydraulic rock drills and explosives at the tunnel and dam site will generate an increase in noise and vibrations. Noise generated by heavy haul trucks transporting equipment and materials will also increase noise levels along Black Post Road.

9.1.5 Assessment of Operational Impacts

9.1.5.1 Hydrology Impacts

9.1.5.1.1 Surface Hydrology

The Project will result in reduced flow in the Tina River between the proposed dam site and the powerhouse. The proposed development is unlikely to have any long-term negative impacts on the availability of fresh water in the Tina/Ngalimbiu River catchment as a whole. The TRHDP PO has indicated that the dam will be operated for 'base load' electricity generation on a daily cycle, with maximum water release from the reservoir during the daytime when electricity demand is highest.

However, during the night, the flow will be reduced downstream of the powerhouse, while the reservoir is being refilled.

To mitigate impact of reservoir impoundment, an environmental flow is to be implemented. One option is to include a low level outlet through the diversion plug for this purpose. It is suggested, that an environmental low (EF) of 1m³/s be maintained during reservoir filling.

9.1.5.1.2 Groundwater Hydrology

The Project will result in an increase of groundwater table within the slopes at the reservoir area. Reservoir impoundment has to be carried out at a slow and steady rate in order to avoid localized slope failures during initial impoundment. The change in water table due to the change in level based on standard operating range during operation of the hydro scheme is unlikely to cause slope instabilities.

The proposed development is unlikely to have any long-term negative impacts on the groundwater hydrology in the Tina/Ngalimbiu River catchment as a whole.

9.1.5.2 Sediment Transport Impacts

Changes to the Tina River hydrology will, in turn, indirectly affect sediment transport mechanisms. The reservoir will intercept most suspended and bedload sediment, which will be stored behind the dam, until either flushed out through a low level port, or excavated when the reservoir level is drawn down to a point that the accumulated sediments can be accessed. Some sediment transfer will occur during overtopping events, particularly during flood events. Likewise, the significant change to the downstream flows resulting from the operation of the dam, will radically change the process of sediment transport and recruitment to the lower reaches of the Tina/Ngalimbiu River, where it is currently excavated for use in road surfacing and building construction.

The impacts of sediment transport are described in more detail in Section 11 – Assessment of Impacts on the Aquatic Environment.

9.1.5.3 Regional and Local Air Quality

Once the Project becomes operational, there are no anticipated adverse impacts to regional or local air quality, as there will be no significant sources of air emissions. Rather, operation of the TRHDP will have a minor positive impact on regional air quality by offsetting the avoided air emissions that would otherwise be produced from an expanded Lungga Diesel Power Station, during those periods of the day when the TRHDP is generating power.

9.1.5.4 Temperature Change

While some reservoirs are known to affect the climate at a micro level in areas immediately surrounding these bodies of water, as outlined in the study set out in section 7.5.1, the small size of the proposed reservoir means that it is unlikely that it will have any effect on the local climate.

As further outlined in section 7.5.1 the temperature of the dewatered stretch of river between the dam and powerstation may rise slightly.

9.1.5.5 GHG Emissions

Reservoir impoundments emit GHG. Newly impounded reservoirs can emit large quantities of GHG, especially methane (CH₄) as vegetation and organic matter in sediments decays. This is

particularly true for reservoirs located in tropical regions if the rain forests biomass is not removed prior to inundation. Ebullition (bubbling) of methane in the reservoir and dissolved methane downstream of the powerhouse, are the main contributors to GHG emissions arising from tropical hydropower projects. However, diluted methane diffusing out of solution is less important in terms of GHG emissions (Deshmukh et al., 2014, International Hydropower Association, 2010). GHG emissions will decrease over time, as the source of decaying vegetation and organic sediments diminishes.

Quantifying impacts is difficult without long term monitoring. However, the International Hydropower Association (2010) has produced a table based on GHG emissions monitoring from several tropical regions. Table 9-2 shows the range of GHG emissions per m² of reservoir surface per day⁷².

Table 9-2 Range of average carbon dioxide and methane gross emissions from freshwater reservoir in tropical regions

GHG pathway	CO ₂ in mmol/m ² /d	CH ₄ in mmol/m ² /d
Diffuse fluxes	-19 to 432	0.3 to 51
Bubbling	0	0 to 88
Degassing	4 to 23	4 to 30
River Downstream	500 to 2500	2 to 350

Source: International Hydropower Association, 2010

The unit, mmol/m²/d means that there are “X” millimoles of the molecule per m² of the reservoir released per day. Table 9-3 converts mmol of CO₂ and CH₄ to grams, where 1 mol = 44g of CO₂ and 1 mol of CH₄ = 16g. A negative value means that the reservoir acts a carbon sink.

Table 9-3 Converting mmol of CO₂ and CH₄ into grams

GHG pathway	CO ₂ in g/m ² /d	CH ₄ in g/m ² /d
Diffuse fluxes	-0.836 to 19.012	0.005 to 0.818
Bubbling	0	0 to 1.412
Degassing	0.176 to 1.012	0.064 to 0.481
River Downstream	22.005 to 110.024	0.032 to 5.615

If the same ranges are applied to the Tina River and converted to kg, the results shown in Table 9-4 are obtained, considering that the Tina Reservoir will cover an area of 305,200m² (30.52ha at FSL).

⁷² Note: the data does not mention time of monitoring, or whether it was done at the time of reservoir impoundment.

Table 9-4 Estimated daily CO₂ and CH₄ releases (kg) from Tina Reservoir

GHG pathway	CO ₂ in kg/d in Tina reservoir	CH ₄ in kg/d in Tina reservoir
Diffuse fluxes	- 255.1 to 5,802.4	1.5 to 249.6
Bubbling	0	0 to 430.9
Degassing	53.7 to 308.8	19.5 to 146.8
River Downstream	6,715.9 to 33,579.3	9.7 to 1,713.7
Total	6,514.5 to 39,690.6	30.8 to 2,541

Using the model “GHG Risk Assessment Tool (Beta Version) 8 (2012)”, the predicted CO₂ and CH₄ gross flux, following the first years of impoundment for the Tina Reservoir, are much lower, as shown in Table 9-5. However, some of the data used to run the model, such as the amount of rain falling within the Tina River catchment (around 3500mm/yr), are out outside of the calibration range of the model, which makes it less accurate. Table 9-5 shows the gross flux of both CO₂ and CH₄ when the model is applied to the Tina Reservoir. From this model, it is obvious that GHG emissions decrease over time, and stabilise after 20 years of operation.

Table 9-5 GHG gross emissions from the model

Years after impoundment	CO ₂ in kg/d applied to Tina reservoir	CH ₄ in kg/d applied to Tina reservoir
0	523.1	3.6
1	509.4	3.4
2	496.3	3.4
3	483.4	3.1
20+	334 (+/-)	1.8 (+/-)

These data provide an approximate indication of the gross fluxes of GHG emissions. Pre-impoundment direct measurements are the only way to precisely assess net emissions.

Modelling of reservoir GHG emissions can be used to inform the assessment of the Project’s net GHG emissions. With an installed capacity of 15 MW, TRHDP is expected to annually generate, on average, 78.35 GWh, to displace an equivalent amount of energy generated by current and future diesel generators. Assuming a grid emission factor of 650 tCO₂eq/GWh for a 100% diesel-based system, the net GHG emission reduction potential of the 78.35 GWh Project is 49,500 tCO₂eq on average per year after deducting the anticipated reservoir emissions and emissions of construction and land clearing.

The net GHG emissions abated by the Project represent 8% of the Solomon Islands’ most recent estimate of total emissions of 618,000t per year.⁷³

⁷³ Solomon Islands Draft Report to UNFCCC, 2010, excluding land use change and forestry. A similar figure of 540,000t is adopted by World Resources Institute.

SIG's Intended Nationally Determined Contribution (INDC) commits to reducing GHG by 18,800 tons of carbon dioxide equivalent (tCO₂eq) per year by 2025 and by 31,125 tCO₂eq per year by 2030 with appropriate international assistance.

9.1.6 Mitigation Measures

Mitigation measures are addressed below.

9.1.6.1 Construction Impacts Mitigation Measures

9.1.6.1.1 Induced Seismicity

Given the unlikelihood of induced seismicity from such a small reservoir no mitigation measure is proposed for this potential impact.

9.1.6.1.2 Local Slope Stability and Geology Impacts

Some aspects of this impact cannot be mitigated. Retaining structures, such as gabion walls, or the removal of upslope colluvium are recommended to minimize the risk of landslides occurring during both access road construction and operation.

9.1.6.1.3 Soil Compaction and Erosion Impacts

Ground cover provides the most effective means of preventing erosion. Consequently, sediment run-off and dust controls depend on retaining existing vegetation or revegetating and mulching disturbed areas as soon as possible.

The following mitigation measures are proposed:

- Keep land clearance to a minimum.
- Avoid wherever possible clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion.
- Use shredded vegetation for production of mulch and revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum. Mulch generated from shredded vegetation can be used to stabilize steep slopes along road cuts and fills until revegetation is complete.
- Coordinate work schedules, so that there are no delays in construction activities resulting in disturbed land remaining unstabilised.
- Program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during rainy season when intense rainstorms are common.
- Stabilise the site and install and maintain erosion controls so that they remain effective during any pause in construction. This is particularly important if a project stops during the wetter months.
- Keep vehicles to well-defined haul roads.
- Keep haul roads off sloping terrain wherever practical.

-
- Designed the slope of a cut to minimise the angle of incline.
 - Cultivating the cut surface will increase infiltration of rainfall and decrease the velocity of water across the slope during rain and therefore reduce erosion.

9.1.6.1.4 Surface Hydrology

Increased suspended sediment load is an unavoidable impact, since most construction work will take place within or adjacent to the river. However, it can be mitigated by implementing best environmental management practices (BEMPs) during construction especially on terrestrial areas. BEMPs for controlling the introduction of sediment into the river include plans for (see Section 13 – ESMP):

- ▶ Reservoir preparation;
- ▶ Point source pollution management, including concrete work;
- ▶ Spoil soil management during earthwork;
- ▶ Forest clearance practices;
- ▶ Stream crossing practices; and
- ▶ Drainage and erosion control.

Notwithstanding that BEMPs will be applied to control sediment entering into the river, moderate residual impacts will continue following application of mitigation measures, since most suspended solids, as measured by TSS, will originate from sources that cannot be fully mitigated. However, due to the effects of heavy rainfall within the catchment and the flashy nature of the Tina River, including tributary streams that enter the Tina River downstream of the damsite, sedimentation will be somewhat masked by the natural situation, as long as best efforts to employ BEMPs are made to prevent soil eroded from the project site from entering the Tina River.

Specific measures for quarry management, including measures applicable to independent suppliers, will be detailed in the Quarry Management Plan to be prepared by the Developer in accordance with the framework provided in the ESMP – Chapter 13. The Quarry Management Plan shall include Good International Industry Practice measures.

Where identified quarry sites in the reservoir are not sufficient for construction needs, additional aggregate will be sourced from a licenced third party gravel supplier. The third party aggregate supplier shall hold all requisite consents for quarry operations including development consent under the *Environment Act* and consent to extract aggregate under the *Mines and Minerals Act*.

9.1.6.1.5 Regional and Local Air Quality

To minimise impacts on regional and local air quality, non-merchantable vegetation is to be shredded rather than burned. Shredded materials may be used to produce mulch for use in erosion control. Excess amounts can be used in agricultural areas or shredded and composted to produce a soil conditioner for use on gardens.

9.1.6.1.6 Noise and Vibration

To minimise impacts of noise and vibration the following measures will be employed:

Specific drill and blast methods will be used to reduce noise and vibration. Hydraulic rock drill equipment will be used instead of pneumatic equipment because it produces less noise. Moreover, blasting and drilling equipment will be equipped with silenced masts, which can reduce noise levels by up to 10dBA. Blasting charges will be covered with blasting mats and screens to reduce generation of noise, fly rock and dust.

9.1.6.2 Operational Impacts Mitigation Measures

9.1.6.2.1 Surface Hydrology

The following mitigation measures are recommended to address surface hydrology:

- Environmental Flow of 1m³/s impacts of surface hydrology during operation, to provide water for aquatic life and water for use by downstream villagers;
- Maintaining a flow of 1m³/s during reservoir impoundment;
- Maintaining a flow of 2.4m³/s through the power station during overnight reservoir re-fill;

Section 11 – Assessment of Impacts on the Biological (Aquatic) Environment discusses in more detail the impacts of changed surface hydrology, and the requirements for an EF. Section 12 discusses in more detail impacts of changed hydrology on local inhabitants residing in villages along the Tina River and mitigation measures to ensure continued access to clean water.

9.1.6.2.2 Groundwater Hydrology

As risk level is low and unlikely, no mitigation measures are proposed for this impact.

9.1.6.2.3 Sediment Transfer

Section 12 – Assessment of Socio-economic / Socio-community Impacts also discusses measures for mitigating the potential change to sediment transport mechanisms as it relates to the gravel extraction industry in the lower section of the Tina/Ngalimbiu River.

Section 11 – Assessment of the impacts on the Aquatic Environment also discusses measures to mitigate the potential change to sediment transport as it relates to the aquatic environment.

The following recommendations are proposed for the design of the Project in relation to river sediment transport:

- The storage should be designed to incorporate as much ‘dead storage’ as possible to accommodate the accumulation of sediment in the reservoir over time;
- The power intake should incorporate a sediment sluicing/flushing structure to ensure that it does not get blocked with sediments;
- Consideration should be given to the impacts of highly turbid water on the headrace tunnel and turbines. Operationally, it may be necessary to close the intake at times of highly turbid flow to prevent deposition of sediments in the headrace tunnel or to prevent any damages to the turbine runner blades, wicket gates, and other parts of the mechanical plant; and

The storage operation should be designed to enable occasional dewatering for the purposes of excavating or dredging accumulated bed load sediments. The design study should consider access to the reservoir to excavate the accumulated bed load, an activity that might help to mitigate impacts on downstream gravel extraction.

Providing an EF during operation will ensure that there is a continuous dry season flow in the 5.7km stretch of by-passed river and beyond to the Tina/Toni River confluence throughout the day. During the dry season, it is expected that up to an additional 1m³/s (or more) of flow will enter the by-passed section of river from lateral tributaries that enter the Tina River just downstream of the dam. During the rainy season, these lateral tributaries will contribute considerable flow. In addition, during heavy rainfall events in the upper Tina River catchment, water will spill over the dam's spillway.

The dam will cause a permanent change to sediment transport process of the Tina/Ngalimbiu River. This can be partly mitigated if the reservoir is periodically lowered to enable accumulated sediments to be excavated and trucked to downstream aggregate (sand and gravel) users.

Based on the available mitigation measures, these impacts will persist as low to moderate residual effects that are considered to be not significant.

9.1.6.2.4 Temperature Change

As temperature changes are expected to be minimal, no mitigation measures are proposed.

9.1.6.2.5 GHG Emissions

Mitigation measures recommended for GHG emissions relate to reservoir preparation. Reservoir preparation will primarily involve clearing of vegetation from the inundation zone of the proposed reservoir area. Vegetation clearing will be done involving local communities and local landowners. Machinery will not be used due to the remoteness of the area, the steep topography and the lack of access road upstream of the damsite. The demarcation of the reservoir will be done by spray painting trees to denote the upper elevation limit of vegetation removal, above which the natural habitat is to remain untouched.

As much vegetation as is practical should be stripped off the future reservoir to limit organic matter decomposition in the lower layer of the reservoir that would create anaerobic conditions and generate methane.

This mitigation measure is discussed in further detail in Section 11 – Assessment of Impacts on the Aquatic Environment.

9.1.6.2.6 Regional and Local Air Quality

As positive impacts identified, no mitigation measures proposed.

9.2 CONCLUSIONS ON IMPACTS TO THE PHYSICAL ENVIRONMENT

Table 9-6 - Summary of Impacts to the Physical Environment

	Impact before mitigation	Residual impact
Impact from Construction		
Induced seismicity	Low	Low
Local Slope Stability and Geology	Moderate	Low
Soil Compaction and Erosion	Major	Low
Surface Hydrology	Moderate	Moderate
Regional and Local Air Quality	Low	Not Significant
Noise and Vibration	Moderate	Low
Impact from Operation		
Surface Hydrology	Major	Moderate
Groundwater Hydrology	Low	Low
Sediment Transport	Moderate	Moderate
Temperature Changes	Low	Low
Regional and Local Air Quality	Not Significant	Not Significant
GHG Emissions	Moderate	Moderate Positive

With application of appropriate mitigation, monitoring and management methods, low to moderate direct and indirect impacts will accrue to the physical environment within the project area.

10. ASSESSMENT OF IMPACTS ON THE BIOLOGICAL (TERRESTRIAL) ENVIRONMENT

10.1 BACKGROUND

This section presents the analysis of impacts on the terrestrial ecosystem, including organisms and their habitats. Terrestrial organisms include all wildlife and plants that are not purely aquatic. It includes wetland dependent wildlife and flora. For each identified impact, measures to avoid, mitigate or compensate impacts are presented.

Four types of impacts can be described: direct impacts, indirect impacts, general impacts and cumulative impacts.

- Direct impacts are those that will likely accrue due to the Project footprint. These impacts are habitat-specific or species-specific, and are quantifiable.
- Indirect impacts are those that will take place as a consequence of the Project but with a degree of separation both temporally and spatially. These impacts are non-quantifiable since their extent and intensity are hard to predict.
- General impacts are those that will take place regardless of the Project specificity (e.g., noise from traffic, habitat fragmentation, oil spills, etc.), are not site-specific, and are not quantifiable. Best management practices help to address such impacts.
- Cumulative impacts are impacts arising from the Project that may aggravate existing impacts from other existing or reasonably anticipated projects in the study area. Cumulative impacts are presented in Section 14.

10.2 ASSESSMENT METHODOLOGY

Impact assessment methodology for environmental components (both aquatic and terrestrial) is presented in Annex 19 of the Annex Report. Impacts significance has been applied using a standardized method based on the integration of the following steps:

- Identification of impact sources - the first step of the impact assessment is to determine which activities will have an impact on environmental components. This identification is done using an impact matrix.
- assessment of impacts using the criteria of impact duration, extent, magnitude / intensity, and probability of occurrence. This assessment includes an assessment of fauna species of highest ecological importance;
- application of mitigation measures; and
- determination of post-mitigation residual effects and significance, the latter being determined to be either Not Significant, or Significant.

Where a residual effect is deemed to be Significant, it falls to decision makers within government to determine whether the need for the project outweighs the concerns for potential, non-mitigable, significant impacts.

10.3 ACTIVITIES AFFECTING THE TERRESTRIAL ENVIRONMENT

The section identifies the main project components, and the actions and activities that will affect terrestrial environment components.

Impacts on physical and biological-terrestrial environment arise from the same activities and are listed below for completeness as to each section to be regarded as a standalone section of the ESIA.

10.4 PRE-CONSTRUCTION AND CONSTRUCTION ACTIVITIES

10.4.1 Pre-construction Activities

Pre-construction work involves site investigations, including installing a hydrology monitoring station, mapping topography, undertaking geological and geotechnical surveys, and other related activities. Limited drilling and cutting of new tracks to move equipment onto survey sites was required, with only minor impacts accruing to aquatic habitats and water quality.

10.4.2 Widening and Stabilizing Existing Black Post Road

Black Post Road will be widened and improved along its 13.3 km course. This will necessitate bush clearing, surfacing and stabilization with gravel or cement, creation of roadside ditches for drainage and earthworks to build embankments. In these areas, habitats are no longer natural. Rather, they have been anthropogenically altered for use as oil palm plantations, grazing sites for cattle, grassland, settlements, and other human use. Therefore, there is no forest to clear and exposed soils will be limited. Since the transmission line will follow Black Post Road, impacts related to the transmission line are treated in the same manner as those related to widening the road. The width of the road alignment will be up to 50m, and includes the right-of-way for the transmission line.

10.4.3 Construction of New Access Roads

Black Post Road will be extended from Mangakiki to the project site to serve as the main access road. This will necessitate clearing forest and other vegetation cover, grubbing stumps, removing top soil, completing earth works (cut and fill), stabilizing the roadbed, road surfacing, installing drainage gutters and ditches, and installing watercourse crossings using culverts. This section of road will be paved. The width of the right-of-way will be up to 50m and include the easement for the transmission line. The length of this road is about 8.31km. The primary Contractor may subcontract forest-clearing activities to a local logging company, to avoid importing forest clearing and log transport machinery.

Entura's feasibility study (2014) identified two quarry sites both in the reservoir area, which will need to be connected to the main construction area by access roads. As these access roads were not identified by Entura, it has been assumed that they will follow topographic contour lines and have the same width as other access roads for which additional width is not required for the transmission line.

10.4.4 Construction of Headrace Tunnel from Dam to Powerhouse

The headrace tunnel will be 3.3m in diameter, will run 3.3 km beneath the ground surface, with an 85m shaft connecting to a 130m long power tunnel. The headrace and power tunnel will be built underground using drill and blast techniques to excavate rock. Drilling and blasting above ground will generate noise and vibration due to the use of hydraulic rock drills and explosives. In addition, removal and disposal of spoil material will utilize heavy haul trucks that generate traffic and dust in the dry season. Topsoil removal will be limited to the entrance of the tunnel, surge shaft and tunnel exit. Explosives will be stored on site in a secure, purpose built explosives magazine, surrounded by an earth berm, located away from the main areas of activity. Approximately 1ha of work area for machinery and trucks to operate will likely be necessary at the entrance of the tunnel, and another 1ha will be required for a work area at the exit of the tunnel BRLi (2013)_has estimated the volume of tunnel spoils to be approximately 24,300m³, based on the dimension of underground infrastructure. Tunnel construction will be by drill and blast.

10.4.5 Construction of Dam and Powerhouse

Most impacts of dam construction are related to fish and the aquatic environment. Construction of the dam will require de-watering the river by diverting it through a diversion structure comprised of an upstream cofferdam, a diversion conduit, and a downstream cofferdam. The riverbed and valley walls will be excavated into the bedrock by drill and blast techniques for the dam foundations and dam abutments. Drilling and blasting above ground will generate noise and vibration due to the use of hydraulic rock drills and explosives.

Preparation of the dam abutments will affect approximately 2,800m² of terrestrial habitat on the right slope of the gorge and 3,700m² on the left side of the gorge.

The powerhouse will be built alongside the Tina River 5.7km by river downstream of the dam and will be founded on competent rock using drill and blast techniques to avoid settlement and vibration of the completed structure. A substation will also be constructed. The construction of the powerhouse and substation will necessitate excavation, fill placement, grouting or pilling and will cover approximately 1080m² (Entura, 2014). The total area of terrestrial habitat disturbance is estimated to cover approximately 1.5ha.

10.4.6 Construction of Work Area

An area of 130m x 90m (11,700m²) will be required for construction work areas (e.g., staging, fabrication, materials stockpiling, equipment maintenance, etc.) and will involve forest clearing and topsoil removal.

10.4.7 Quarrying

Rock quarries will be developed to provide aggregate for the RCC dam. Entura (2014) estimated that 160,000m³ of aggregate will be required, from two possible quarry sites located in area that will be occupied by the future reservoir. Aggregate will also be sourced directly from the river bed downstream of the dam (Entura, 2014). Where the two identified quarry sites are suitable for construction needs, all quarry sites and access roads will be within the Core Area.

In the event that aggregate available from the two identified quarry sites does not meet all construction needs, additional aggregate will be purchased from a licenced third party aggregate supplier. The Developer will prepare a Quarry Management Plan in accordance with the framework plan provided in the ESMP, incorporating measures to meet GIIP.

Quarry exploitation will require the removal of superficial deposits in or close to the river, which may release suspended material into the water.

10.4.8 Reservoir Preparation

Prior to reservoir impoundment, trees will be cleared from within the reservoir area to an elevation of 175 masl. Loose rocks and rubble along the steep faces of the river gorge will be removed where possible.

Reservoir vegetation clearing will be conducted during the latter phase of the construction program, as the dam and powerhouse are nearing completion, just before reservoir inundation is set to commence. The timing is critical so as to not enable vegetation to regrow or become re-established before water is impounded. Depending on the schedule for reservoir filling, vegetation clearing may proceed in distinct phases, with the lowest elevation areas of the future reservoir inundation zone being cleared first, followed by the higher elevation inundation zone. Steep gorges in the reservoir area are covered with ligneous and herbaceous plant species. Due to the steep terrain, lack of access roads and the risk of flash floods, work using machinery will not be feasible. Vegetation clearance will, therefore, be undertaken using manual labour. Sawn timber will be transported by floating it down the river as is currently done from Choro and Koropa. This activity will release organic matter and suspended solids into the river. Reservoir clearing will not involve grubbing (removal of stumps) and soil stripping, since only manual work will be feasible.

Vegetation clearing represents important planning in terms of land access and timing, and may also require a government logging permit. The reservoir was acquired as part of the Core Land and will be part of the registered land owned by Tina River Core Land Company (TRCLC) and will be leased to the developer.

10.4.9 Construction Traffic

Heavy haul trucks will be required to transport materials and equipment, including excavated material to the crushing plant, spoils from the headrace tunnel, heavy equipment and construction materials, fuel and other products on a regular basis. Light duty trucks and buses will be used to transport workers to and from the Project site. In addition to issues related to safety and comfort of local communities, the movement of vehicles, especially heavy haul trucks, generates noise and vibration, and presents a risk of wildlife-vehicle collisions.

10.4.10 Worker Accommodation

Entura (2014) and TRHDP Office (personal communication, 2014) indicate that non-local construction workers will reside in Honiara, Lungga or Henderson, likely in existing accommodations, and be transported to and from the project site each day. The estimated number of workers will peak at approximately 175 during the construction of the dam; this number includes experienced expatriate labour and unskilled labour that will be sourced locally. There will not be a workers camp that would be a source of direct impact on terrestrial habitat.

10.4.11 Soil Stockpiling and Spoils Disposal

During the construction of the dam, topsoil spoil will be generated and will be stored (prior to reusing it for rehabilitation or before transporting it outside the Project Area). Storage will either be short term (in case of outside transportation) or long term (in case of rehabilitation of disturbed areas). An estimated 10 ha storage area will be necessary for the generation of 327,900 m³ of topsoil, using 10 conical-shaped piles of 50m diameter and 5m high. It is suggested to use remnant forests of the Core Area to create the 10 ha storage area.

10.5 OPERATION ACTIVITIES

10.5.1 Operation of the Hydropower Facility

The operation of the dam will modify the river flow especially during the night (during reservoir filling) and will create a reduced flow between the dam and the power station.

10.5.2 Access Road Use

Continued use of the access road to the dam site and powerhouse during operation will have an indirect impact on certain species of fauna, as a result of wildlife-vehicle interactions. However, given the relatively low expected volume of traffic, the impacts upon fauna are likely not significant.

10.6 IMPACT ASSESSMENT

10.6.1 Impact Identification Matrix

Both the TRHDP construction and operation phases will generate impacts on the terrestrial ecosystem. Table 10-1 identifies impact-generating activities (X mean that there is a foreseen impact).

Table 10-1 Matrix of construction and operation impacts on the terrestrial environment

Foreseen activities	Impact on components						
	Flora and habitat	Native Rainforest Rodents	Bats and marsupials	Birds	Amphibian	Reptiles	Wetland dependent insects
Construction							
Widening and stabilization of Black Post road including RoW for TL	X	X	X	X	X	X	X
Creation of a new access road from Black Post road to Project site including quarries and RoW for TL	X	X	X	X	X	X	X
Construction of the head race tunnel from dam to powerstation	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)
Construction of dam & powerstation	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)	X (minor)
Work area construction	X	X	X	X	X	X	
Quarry exploitation	X	X	X	X	X	X	X
Vegetation clearance in the reservoir	X	X	X	X	X	X	X
Soil stockpiling and spoil disposal	X		X	X	X	X	

Foreseen activities	Impact on components						
	Flora and habitat	Native Rainforest Rodents	Bats and marsupials	Birds	Amphibian	Reptiles	Wetland dependent insects
Operation (including initial reservoir inundation)	X (mostly indirect)	X (mostly indirect)	X (mostly indirect)	X (mostly indirect)	X (mostly indirect)	X (mostly indirect)	X (mostly indirect)

10.6.2 Impact Assessment Limitations

The terrestrial ecology impact assessment is lacking supporting scientific literature regarding specific life cycle, breeding and feeding habits of most fauna in the Solomon Islands. Therefore, due to limited scientific data and limited previous surveys, there is little knowledge on the specific impacts that the TRHDP activities may have on many species.

In addition, the terrestrial ecology impact assessment has some limitations due to uncertainties regarding the Project layout:

- Uncertainties regarding the location of the quarry site: the terrestrial ecology impact assessment was based on Entura feasibility report (March 2014), which identified multiple potential quarry sites. The final quarry site locations will be confirmed in the design report.
- Uncertainties regarding right-of-ways of some project components such as access roads to quarries. These are not described in Entura 2014 report.

10.7 ASSESSMENT OF CONSTRUCTION IMPACTS

10.7.1 Construction Impacts on Flora

10.7.1.1 Direct Impacts on Flora

This section presents the potential direct impacts on flora during the construction phase of the TRHDP, and proposed mitigation measures, and residual effects and their significance after mitigation is applied. Table 10-2 identifies the potential direct construction related impacts to the terrestrial ecosystem. Man-made habitats (e.g., gardens, settlements, oil palm plantations) have been omitted in the table since the TRHDP will not affect them.

10.7.1.1.1 Identification of Potential Direct Impacts

Construction activities, including clearing vegetation prior to reservoir impoundment, will reduce the biomass of forest and grassland areas. Riparian habitats will be removed or inundated to provide for the access roads, tunnel entrance and exit, transmission lines, quarries, powerhouse and the reservoir.

The assessment of impacts is based on the baseline habitat description of the study area and the proposed project layout at the time the ESIA was prepared. In total, 115.49ha of natural terrestrial habitat will be permanently lost due to construction activities. An additional 10ha will be necessary for the temporary storage of topsoil. However, this area will not be permanently lost and will be regenerated by TRHDP using native vegetation species toward the end of the construction phase.

Although the change in the area of terrestrial flora represents a permanent loss, for undisturbed forest this represents a site-specific (local area) loss of less than 0.2% within the Tina River catchment. For all forest types combined, the Project will result in the loss of only 0.4% of forest habitat. Therefore, the impact on critical forest vegetation before application of mitigation measures is considered to be low-moderate.

Table 10-2 Direct impacts on terrestrial ecosystem habitats

Project component, action or activity	Area of habitat directly lost to construction activities									
	Grasslands (ha)*	Undisturbed forests (ha)	Disturbed forests (ha)	Remnant forests (ha)	Montane forests (ha)	Riparian (ha)	Cliffs (ha)	Garden (ha)	Fallow brush land (ha)	Total Area (ha) affected by Project
Widening and stabilising Black Post Road including RoW for TL	6.09	0	3.90	4.80	0	0	0	0	6.23	21.02
Creation of a new access road from Black Post Road to Project site including quarries and RoW for TL	0	5.27	23.57	7.07	0	3.07	0	0	0.17	39.13
Construction of the headrace tunnel from dam to powerhouse	0	0	0	0	0	2	0	0	0	2 (above ground)
Construction of dam & powerhouse	0	0	0	0	0	1.55	0.60	0	0	2.15
Work area construction	0	0	1.18	0	0	0	0	0	0	1.18
Quarrying	0	4.27	0	0	0	Already calculated in reservoir clearance	0	0	0	4.27

Project component, action or activity	Area of habitat directly lost to construction activities									
	Grasslands (ha)*	Undisturbed forests (ha)	Disturbed forests (ha)	Remnant forests (ha)	Montane forests (ha)	Riparian (ha)	Cliffs (ha)	Garden (ha)	Fallow brush land (ha)	Total Area (ha) affected by Project
Reservoir Preparation	0	0	0	0	0	15	15.52	0	0	30.52
Temporary Soil storage area in the Core Area***	0	0	0	10	0	0	0	0	0	10
Total	6.09	9.54	29.65	21.87	0	21.62	16.12	0	6.40	
Area by habitat Type in Tina Catchment	59.84	5146.97	295.16	92.40	9013.21	Not assessed**	Not assessed**	4.62	25.38	
Percentage of affected Habitats by type in Tina Catchment	10.18%	0.19%	10.04%	23.66%	0%			0%	25.22%	

* Grassland will only be affected along the access road (15m wide) and not under the transmission line.

**Riparian and cliff habitats were only assessed along the future reservoir, and not in the entire catchment due to inaccessibility of the area.

***An estimated 327,900m³ of topsoil will be temporarily stored on the project site in 10 conically shaped piles of 50m wide and 5m high, requiring an area of approximately 10ha.

10.7.1.1.2 Mitigation Measures

Reservoir Preparation

Reservoir preparation will primarily involve clearing of vegetation from the inundation zone of the proposed reservoir area. Vegetation clearing will be done involving local communities and local landowners. Machinery will not be used due to the remoteness of the area, the steep topography and the lack of access road upstream of the dam site. The demarcation of the reservoir will be done by spray painting trees to denote the upper elevation limit of vegetation removal, above which the natural habitat is to remain untouched.

Ideally, all plants and topsoil should be stripped from the future reservoir to limit organic matter decomposition in the lower layer of the reservoir creating anaerobic conditions.

Due to the high cost of importing logging equipment to the Solomon Islands, the construction contractor may choose to subcontract forest-clearing activities to a local logging company. The contractor in charge of forest clearing will be governed by the commitments and assurances made by the TRHDP and included as conditions in any environmental approvals.

Prior to commencing construction, TRHDP PO should consult with local communities through the Tina Core Land Company to identify possible existing trails along which sawn timber can be transported to the river. Sawn timber could be transported downstream using the river as it is currently done from Choro and Koropa. It would then have to be hauled out at a site immediately upstream of the dam and transported from there downstream again by river, or by truck on the access road.

Prior to commencing construction, a reservoir preparation plan will be prepared by the construction contractor. Preparation of this plan should be based on an assessment of the feasibility of reservoir vegetation clearance, and involve consultation with communities. Key issues that will need to be resolved include:

- Moving logs and sawn timber safely from where they are cut, down to the river in an area that is defined by a steep-sided gorge subject to frequent flash floods; and
- The location of the access road that will be constructed from the dam site to one or both of two possible quarry sites in the reservoir, which could be used to facilitate vegetation clearance.

Trees with a diameter larger than 10cm will be cleared from within the reservoir area up to an elevation of 186.5masl. Loose rocks and rubble along the steep faces of the river gorge will be removed where possible.

Access Road

Once the final access road alignment has been determined, and all areas that require forest clearing have been identified, a botanist will walk the full length of the road (starting from Mangakiki) and other areas where construction will take place to geo-reference and fence environmentally and culturally sensitive areas such as:

- Wetlands;
- Streams;

-
- Rare, endangered plants and culturally or economically important plants colonies; and
 - Large trees that need to be kept to maintain canopy closure to decrease the amount of edge-effected forest.

Fencing will be done using orange plastic construction fencing material supported on wooden or steel pickets. Once fenced, each environmentally or culturally sensitive area will be mapped. The map of these protected sensitive areas will then be presented to a committee comprised of the resident engineer for the dam construction, construction contractors and forest clearing subcontractors, and the independent environmental expert. This committee will discuss potential solutions for protecting each sensitive area identified, including:

- Wetlands located in the right-of-way – these areas will be fenced to denote their sensitivity. If the road alignment potentially bi-sects a wetland then culverts will need to be installed to ensure water exchange continues to occur between both parts of the bisected wetland. If the work areas are located in a wetland, they should be relocated nearby.
- Streams located in the right-of-way – sites where the road will cross streams will be fenced to denote the site of the crossings, the areas outside of which would be “no go” zones. Work should not occur within the wetted perimeter of any streams. Stream crossings requiring bridging should be clear-spanned. Smaller stream crossings should be equipped crossed using open-bottomed box culverts to enable fish and wildlife to pass under the roads.
- Rare or endangered plants in the right-of-way – fencing will be installed to encircle these areas, and denote that they are to be avoided moving the road alignment or relocating work areas. If measures to avoid endangered plants are not possible, then transplanting plant colonies should be considered an option. Plants that are capable of being transplanted would be relocated as far as possible away from the area of disturbance under the supervision of a botanist, with the help of local villagers.

Large canopy trees – in the interest of maintaining important ground level shade and humidity, that is so important to the ecosystem, large trees that provide canopy cover will be protected from unnecessary clearing, wherever possible. Fencing will be placed around these trees.

Achieving No Net Loss of Biodiversity

Of the 115 ha of land that will be cleared, 50 ha has forest cover, but only 9.5 ha can be considered primary forest. Half of the other 40 ha is disturbed secondary forest, and the other half is remnant forest, i.e., secondary forest formed by natural revegetation of cleared areas.

Cliff habitat and riparian habitat (partially disturbed), approximately 15 ha of each, will be affected by reservoir preparation. The 50 ha represents 0.9% of the total area of non-montane forest and 0.3% of all forest in the catchment. In the context of the assemblage of terrestrial vegetation communities and the wildlife habitats they provide, this permanent loss within the Tina River catchment is not considered to be significant.

The proposed mitigation measures will help to ensure the direct impacts of vegetation clearing are confined to the 115 ha. However, Performance Standard 6 requires that when natural habitat is degraded or converted, measures will be designed to achieve no net loss of biodiversity where feasible. With respect to the potential impacts on critical habitat, PS 6 requires that net gains shall be achieved for the biodiversity values for which the habitat was designated.

To achieve these outcomes, the Project will take steps to protect the upper catchment biodiversity from threats of extractive industries (see Appendix K). The protection of the upper catchment is conceived as a staged approach reflecting the ownership of the land by indigenous customary landowners. Immediate protection measures will include actions of the TCLC and Project Company to restrict access to vehicles (including commercial logging machinery) to the upper catchment through the Core Area, to monitor changes in forest coverage in the upper catchment, to monitor logging truck activity on existing logging roads, and to support SIG to enforce seldom used statutory restrictions on logging at elevations above 400 masl (which if enforced would represent the vast majority of the upper catchment). This protection work will be furthered by Project Office funding for an NGO to facilitate consultations with landowners to seek support for the creation of a protected area in the upper catchment and to conduct mapping and forestry studies, towards preparation of a management plan.

In addition to upper catchment offset activities, the Project Company will implement measures including a post construction rehabilitation plan for disturbed areas, and an offset within the Core Area which will include measures to protect the remaining natural habitat in the Core Area, and to rehabilitate an area of modified habitat within the Core Area of at least 9.5 ha. These measures will be set out in the Biodiversity Management Plan.

Independent Environmental and Social Monitor

To limit habitat clearing to the strict minimum, an independent consultant specialized in environmental and social monitoring will be present on site during key activities to audit all ESMP measures. The consultant will ensure that all mitigation measures are implemented. Special attention will be paid to access road alignment clearing. The consultant will prepare a monitoring report for use by the construction contractor and its subcontractors to inform them of non-compliances. The monitoring consultant will also ensure that corrective measures are implemented (refer to ESMP).

The construction contractor and all subcontractors will also appoint a team of environmental and social specialists with proven qualifications in environmental and social monitoring. They will be responsible for following up on issues raised by the independent monitoring consultant, including ensuring corrective and preventive actions are taken to rectify and avoid environmental and social concerns. Their experience will enable them to make decisions throughout the TRHDP construction program to minimize losses of valuable biomass.

10.7.1.1.3 Residual Effects and Their Significance

Just over 115ha of vegetation cover will be permanently removed from the project area. In the context of the assemblage of terrestrial vegetation communities and the wildlife habitats they provide, this permanent loss within the Tina River catchment is not considered to be significant. The proposed mitigation measures will help to ensure the direct impacts of vegetation clearing are confined to the 115ha.

10.7.1.2 Indirect Impacts on Flora

This section presents the potential indirect impacts on flora during the construction phase of the TRHDP, and proposed mitigation measures, and residual effects and their significance after mitigation is applied. Habitat-specific impacts and residual impacts are also analysed and quantified in this section.

Colonisation by Invasive Plant Species

Construction activities, including construction of the access road, will create open spaces and gaps in the canopy. These areas are more prone to colonization of terrestrial invasive plant species, especially if the equipment used carries mud or soils from previous construction sites.

In the Study areas, risk of invasive plant colonization could occur along the access road, quarries and along the transmission line.

Depending on the species, three situations can occur with invasive plants:

- Native plant species may be out-competed by invasive plants with adverse environmental consequences.
- Invasive plant species may adversely affect agricultural and garden plants and pasture, thereby affecting livelihoods.
- Invasive plant species may affect infrastructure, thereby leading to economic consequences for the Project.

Evidence of invasive plant species in the study area was observed, especially within anthropogenically affected areas, including along roads. A good example of an invasive plant is the vine *Mikania micrantha* (Mile-a-Minute) that can grow up to 1m in a month, and is considered one of the most important weeds of this region of the Pacific. This vine invades subsistence gardens and tree plantations (oil palm) forming thick ground cover that competes with crop plants. It grows from lowland areas up to an elevation of 1200masl, and the seeds are easily dispersed by wind, and by people when seeds attach to clothing (Day et al., 2011). In the study area, the vine is already widely distributed in open areas along Black Post Road and in villages along the Tina River (e.g., Sengue). It not only competes with crop species, but also smothers native vegetation (CABI, 2013).

Mimosa invisa and *Mimosa pudica* are two invasive plant species from Brazil that have also been observed in the study area and are weeds affecting agricultural and garden plants. They form thickets along road margins and at the edge of cleared forest. They do not colonize undisturbed forests. Their behaviour as weed that competes with native plants is, therefore, limited to grassland areas (CABI, 2013).

Water Hyacinth (*Eichhornia crassipes*) is by far the biggest threat to any hydropower projects in tropical countries. It is the world's worst invasive aquatic plant in dam reservoirs, as it can quickly colonize entire reservoirs, reducing electricity production by clogging water intakes and interfering with reservoir uses (such as fisheries). Water Hyacinth is present everywhere in the South Pacific including in the Solomon Islands (SPC, 2005) and is present in Vella Lavella Island, according to Polhemus et al. (2008). Water Hyacinth have not been observed in the study area likely because of the fast flowing nature of the Tina River. Moreover, if it was to be accidentally or intentionally introduced, it would likely not thrive in the reservoir due to the extreme daily fluctuations in water levels and the expected low concentration of nutrients (see Section 7 – Biological Environment Baseline - Aquatic).

Habitat Fragmentation

Construction activities, especially road construction, may cause habitat fragmentation. Habitat fragmentation effects are more obvious on wildlife than on vegetation. Nonetheless, habitat fragmentation can lead to the “edge effect” along forested areas. The edge is the area where natural habitats come into contact with manmade habitats or infrastructure (e.g., road, transmission line). The edge effect causes abrupt changes in vegetation cover and reduces the true surface of the forest, leading to the colonization of heliophytic shrub and vine species. The edge effect also leads to local changes in soil characteristics from a cool, dark and moist to a warm, exposed and dryer environment due to solar radiation. This change can lead to a higher rate of tree mortality along the edge.

In tropical rainforests, the edge effect can affect forests and plant composition up to 100m into the forest (Laurance et al., 2009). Fragmentation increases local erosion as slopes and small landslides are created at the edge of the forests. Therefore, habitat fragmentation can lead to changes beyond the line of contact with the construction activities. The edge effect is diminished when the canopy stretches across the clearing (Goosem, 2007). In terms of edge effect on habitat, forested areas are more vulnerable than grasslands.

Local Hydrological Changes

Some plant habitats can be indirectly fragmented when local hydrologic conditions are changed by construction activities. For example, many small tributary streams within the Tina River catchment area are free flowing perpendicular to the future access road (see Section 5 – Physical Environment Baseline). These small streams are conveying water to micro wetlands and cliffs habitat (waterfalls) where hydrophilic and epiphytic plants thrive. The construction of the access road could change local small stream hydrology leading to disappearance or displacement of micro wetlands. Such changes could come from soil deposited in cut-and-fill approaches, earth works, and access road construction, blockage of water flow due to poor dimensioning of culverts or absence of culverts.

Point Source Pollution

The presence of machinery during construction activities can lead to oil spills and to the spread of other pollutants that could result in either the mortality of plants in adjacent areas along roads, or in bioaccumulation of the food chain (Goosem, 2007). Concrete wash waters, with their high pH, and high concentration of suspended solids could leak into the Tina River during the construction thereby affecting riparian habitats and forests. Suspended solids released from earthworks could also affect the vegetation. Workers may also be tempted to use the river as an open defecation area.

Impacts on Topsoil and Vegetation Regeneration

Earthworks will locally modify topsoil leading to three type of impacts: increased erosion and sedimentation of surface runoff, disturbance of soil nutrient cycles, and delayed natural regeneration due to invasive species colonization.

In the Solomon Islands vegetation regeneration is vigorous. According to a study of vegetation regeneration in Papua New Guinea (Hartley, 1991 quoted by PNG LNG Project, Coffey Natural Systems, 2009), regeneration is quick in disturbed soil in the region. Regeneration is poor to non-existent in areas made out of hard limestone pavement or compacted limestone, especially for ligneous species. This study of vegetation regeneration involved regeneration follow-up from 1991 to 2005. For the Project, most of the access road will be built on conglomerate formation. It is, therefore, difficult to qualitatively assess the rate of vegetation recovery based on this study. However, based on field observations made for previously disturbed areas, such as logging roads and on observations of the Project area, it appears that vegetation regeneration is vigorous, especially mainly in areas where the topsoil has been retained.

According to Coffey Natural Systems (2009), factors influencing vegetation regeneration include:

- Whether the topsoil remains in place or not - when the topsoil is left in place it enhances vegetation regrowth as the seed bank remains on site.
- Whether the soil is compacted or not - a compacted soil may prevent rooting of woody (e.g., tree) species.
- Length of time soils are disturbed - the longer the soil is disturbed, the higher the chances of seed bank losses due to erosion and colonization by invasive species.
- Vegetation type prior to disturbances - the richer the plant composition, the richer the seed bank in the soil.
- Rainfall pattern - the higher the rainfall, the faster the topsoil erosion will take place.
- Topography - steep slopes are prone to gullyng, causing unstable surfaces for rehabilitation, erosion and loss of topsoil.
- Altitude - disturbed lowland forests are quicker to regenerate than montane forests because of their cooler climate.

10.7.1.2.2 Mitigation Measures

During the TRHDP construction phase, good international industry practice (GIIP) will be implemented by the construction contractor, to mitigate indirect impacts on flora.

Colonisation by Invasive Plant Species

The following actions will be implemented to protect against encroachment and colonization by invasive species:

- Machinery will be checked by designated project staff before the equipment is allowed to enter the project area, to ensure that wheels, tracks, buckets and other parts of machinery that may have come into contact with mud or soil, are clean of these materials. A washing station will be installed just outside the project area at Veroande (see Section 6.4.2.1 – Invasive and Feral Species) to ensure that all machinery that enters the work area is clean. Drainage water from washing stations will be diverted away from water bodies.
- Importation of soil from outside work areas will be prohibited.
- Soil stockpiles in the construction area will never be permanent in order to avoid colonization by invasive species. Soil stockpiles will be covered with geofabric tarps or revegetated with native plants. The soil management plan (see ESMP) will be amended by the construction contractor: to assess the amount of spoils from road cuts; to assess the need for road embankment and future use of excess soil; and to locate stockpiles.
- Topsoil will be left on site and will be reused as much as possible.

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- Chemical and biological control of invasive plant species is not recommended as the extent of the impacts will be limited spatially.
 - Local population will be sensitized regarding the threat posed by Water Hyacinth and the consequences should it find its way into the area.

To mitigate indirect impacts of the terrestrial habitat fragmentation and the edge effect, the following actions will be implemented:

- Construction activities will be favoured in already affected areas (such as along the existing access road) and in disturbed and remnant forests rather than undisturbed primary forests.
- Where possible, impact-causing activities will be spatially concentrated to limit any encroachments.

Local Hydrological Changes

To mitigate indirect impacts of local hydrological changes, the following actions will be implemented:

- Small tributary streams in the vicinity of the access road will be identified and geo-referenced prior to the construction of the access road.
- All identified tributary streams in the vicinity of construction activities will be protected by fences to avoid any encroachments.
- Culverts will be installed along the access road to enable water to flow freely. More measures are detailed in Section 13 – ESMP.
- A watercourse crossing management plan will be produced by the construction contractor prior to commencing the TRHDP construction.
- Depositing soil outside the limits of access road earthworks will be prohibited within 100m of nearby streams.

Point Source Pollution

To mitigate the indirect impacts of point source pollution, the following actions will be implemented:

- The presence of on-site toilet facilities for workers will be mandatory.
- All sanitary wastewater will be regularly transported outside of the study area for treatment.
- Oil management will be clearly defined prior to commencing construction and secondary containment will be required for all hydrocarbon products (fuel, oil, lubricants) used on the Project. Hydrocarbons will be stored at least 100 meters from any water body or wetland. Any hydrocarbon storage tanks or oil/fuel drums will be free of rust and cracks. The Project will provide and maintain bund walls around the fuel storage areas within the Site. These bund walls will be of a sufficient height to contain a volume equal to one and one half (1.5) times the entire contents of its fuel storage facilities. Fuel dispensing areas and machinery maintenance areas will be built with concrete hard standing surface, which will drain to oil separators. The oil will be pumped by a tanker and sent to Honiara for treatment. A hydrocarbon (fuel, oil, lubricant) management plan will be prepared and implemented by the construction contractor(s) prior to commencement of construction.
- All necessary means will be taken to reduce sediment loads in the river, especially when earthwork activities are being undertaken for dam construction. (see Section 13 – ESMP).

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- Wash water from concrete works will never be directly or indirectly released in waterbodies or wetlands. Instead, it will be reused, stored and treated on site or collected and transported by road tankers for treatment in Honiara. A designated impermeable containment area must be used for concrete activities. To treat concrete washout onsite, a combination of settling ponds can be useful:
 - Coagulants or flocculants will need to be added before discharging the water into the first or primary pond. This will help to reduce the size of ponds. Water must flow over small weirs from one basin to the next until the quality is good enough to be reused as plant water (closed loop system). The first pond will require periodic cleaning. The hardened concrete that is removed can be crushed and sent to a landfill in Honiara or reused on site as non-structural aggregate for road ballasting or surfacing works yards. The capacity of each pond must be greater than a full day supply of wash water and will take into account that the area often receives considerable rain. Due to the sensitive nature of the area, wash water will never be released in the Tina River.
 - Each settling pond could allow for seepage and evaporation. For seepage, the water table needs to be low enough so that the water can be filtered without escaping. Settling ponds will need to be well sealed to limit any risks of infiltration of groundwater.
 - Water levels of settling ponds will be inspected daily. Before intense rain, the water levels will be lowered. Suitable cover will be installed to cover the pond in the event of intense rain (e.g., folding tarps). Tarps will cover the pond at night to keep birds and bats from drinking unsafe water. When excess water becomes a disposal issue, its pH will be adjusted with automatic pH neutralizer using CO₂ gas (the use of acids for that purpose is prescribed) prior to a potential discharge off-site in Honiara.

Impacts on Topsoil and Vegetation Regeneration

It is assumed that all excavated soil will be reused for restoration of construction work areas no longer required as the project moves into operation. Therefore, soils will be stockpiled in an area roughly 10ha in size, which will be developed with limited encroachment on natural habitats.

To ensure good soil management and revegetation, the following mitigation measures will be implemented during any earthworks conducted in forested areas where rich organic topsoil is present.

- Salvaging topsoils with high organic content, and mineral soils (i.e., subsoil not capable of supporting plant growth) - prior to commencing construction of the access road, the contractor will be required to do soil coring to assess the depth of organic soil in the right-of-way in cleared forested areas, from Mangakiki to the dam and quarry sites. This will determine the depth of soil stripping that is required. Collection of soil cores, and the management of soil stripping, will be done under the supervision of a soil expert. The aim is to conserve the topsoil for future use in rehabilitation of disturbed areas and to reuse subsoil for road embankments.

Usually, machinery will be used to strip topsoil layers to a depth of 1m. With an access road length of about 21.86 km and a width of roughly 15m, it is estimated that approximately 327,900m³ of topsoil will be removed from the access road right-of-way. Measures taken during earthworks to protect waterbodies are presented in Section 13 – ESMP).

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- Storage of topsoil – topsoils having a high organic matter content, that have good potential for plant regrowth, will be stored within a soil stockpile area. Topsoil storage will be done away from all water bodies on a flat terrain, and close to work areas. Stockpiles will be compacted and covered with geofabric tarps to avoid unwanted prolific plant growth. Another option is to seed soil stockpiles with indigenous herbaceous plant species to maintain the organic content of piles. If the supply of native plants to vegetate piles is limited then stockpiles will be covered. In both cases, stockpiles slopes will not exceed a horizontal to vertical ratio of 5H:1V, and will be surrounded by sediment control structures, such as deeply anchored sediment fences, ditches, or berms around the stockpiles.

In addition, stockpiles and all disturbed areas, including those adjacent to road alignments, will be drained to enable sediment control structures, such as settling ponds, to prevent sediment laden runoff flowing into water bodies. Stockpiles of topsoil will be maintained at a pH of greater than pH5.5, since a lower pH may lead to reduced organic matter content. With pH below 5.5, many essential nutrients may leach from the topsoils, and toxic elements may become available to plants, which in turn, will affect future plant regeneration. If necessary, agricultural lime could be spread onto the stockpiles to maintain a stable pH level.

Monitoring of stockpiles will be done throughout the construction phase. An estimate of 10 conical stockpiles each 5m high, and 50m wide, will be necessary to store 327,900m³ of topsoil. Stockpiles will be located within the Core Area, with the exact location being determined by the construction contractor, a botanist, and the independent consultant. It is recommended that spoils be stored in the remnant forest habitat to minimize forest clearing and because this habitat is located close to the access road (see Figure 6-12 – Study area habitat types and land use).

- In addition to soil spoils, non-organic (mineral subsoil spoils) and rock will also need to be removed and disposed, or reused, as follows:
 - Subsoil spoils - the Project access road will be located in steep terrain, and will require excavation of high cuts, placement of high fill embankments, and construction of retaining walls. Some soil spoils produced by cuts will be reused for fill embankments and unsuitable soil spoils will be transported outside the Project area to a designated disposal site.
 - Rock spoils - Construction of the tunnel (headrace tunnel, surge shaft, power shaft) will produce approximately 24,300m³ of spoils. Spoils may be used either for road construction as aggregate base, or for river diversion works downstream of the dam and adjacent to the powerhouse tailrace. Excess rock spoils will be disposed of in the reservoir.

10.7.1.2.3 Residual Effects and Their Significance

By applying the mitigation measures recommended above and GIIP, the indirect impacts on flora during construction can be reduced to an acceptable level of low residual impacts and are, therefore, considered to be not significant.

10.7.1.3 Conclusions Regarding Impacts on Flora

10.7.1.3.1 Conclusions Regarding Direct Impacts

Construction activities will necessitate clearing approximately 115.49ha of natural vegetation, mainly forests, to create an access road and to prepare the reservoir area. Measures to mitigate impacts include conducting a pre-construction road alignment survey to delineate environmentally sensitive areas where valued or protected species are to be avoided or, where avoidance is not possible, transplanted where feasible. Changes in road alignment may be necessary based on this survey. Good international industry practice (GIIP) will be implemented by the construction contractor that is responsible for forest clearing, to minimize impacts. Some natural habitat will be disturbed beyond the road alignment and footprint of other project components, as a result of colonization by invasive species and fragmentation of habitats.

10.7.1.3.2 Conclusions Regarding Indirect Impacts

With application of appropriate mitigation, monitoring and management methods, minimal indirect impacts will accrue to flora within the project area.

10.7.2 Construction Impacts on Fauna

Impacts on fauna arising from construction activities will generally be of short-term duration. Long-term changes and impacts resulting from operation of the dam are discussed in Section 10.5.3 – Operation Impacts on Fauna).

10.7.2.1 Direct Impacts on Fauna

This section identifies potential sources of direct impacts on valued species or group of animals. These groups have been classified according to their habitat requirements. In the Solomon Islands, the lack of scientific research on many species does not enable precise assessment of how each species will react to the construction and operation of the Project. Therefore, professional judgment of biologists and ecologists based on experience from other projects on similar species has been used to predict impacts.

The following table (Table 10-3) provides an assessment of the species specific and direct impacts that could potentially accrue to fauna as a result of project construction, and includes the following analysis:

- ▶ Fauna that could potentially be affected;
- ▶ Value within the ecosystem and as a resource utilised by local communities;
- ▶ Potential impacts;
- ▶ Impact significance, based on magnitude, extent, duration and probability of impacts;
- ▶ Mitigation measures, and
- ▶ Residual impact and significance after mitigation has been applied.

Table 10-3 Assessment of potential direct impacts on fauna resulting from construction

<i>Fauna type</i>	Native forest rodents				
<i>Ecosystem or resource value</i>	The Emperor Rat is probably extinct (IUCN, 2013), while the King Rat is endangered. Both species are, therefore, highly valued.				
<i>Potential Impact(s)</i>	The extension of Black Post Road into the forest will follow the 160masl to 200masl topographic line, thus avoiding montane forest areas. Since both species seem to prefer forests in higher altitudes (600masl), they are unlikely to be directly affected by the Project or indirectly affected by noise or vibration. Studies in tropical Queensland Australia have shown that movement of native rodents fell by 67% to 90% across narrow forest clearing (6m to 12 m), and by 90% to 100 % across larger forest clearings (20m to 60 m) Laurance (2009). However, the access road will not be located within the native home range altitude of the native rodent species. Some King Rat could be impacted at lower altitude. With most habitat in the area likely to be unsuitable this impact is considered to be of low significance and low probability.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Not in range	Short term	Unlikely	Low
<i>Mitigation measures</i>	None required.				
<i>Post-mitigation residual impacts and significance</i>	No residual impacts. Not significant.				

<i>Fauna type</i>	Bats & marsupials				
<i>Ecosystem or resource value</i>	Endemic bat species are threatened and, therefore, have a high ecosystem value. The only marsupial in the Solomon Islands (Cuscus) is widely distributed and is of moderate resource value.				
<i>Potential Impact(s)</i>	<p>The marsupial known as the “Northern Common Cuscus”, as well as fruit eating bats, may be adversely affected by project construction, as they inhabit all kinds of forests, including remnant forests and gardens. Extension of Black Post Road into forested areas is the area that will be primarily affected.</p> <p>The Cuscus tolerates degraded forested areas (IUCN, 2013). The species feeds on fruits, leaves and seeds and dwells in Ficus trees. It forages at high canopy but also in gardens. Cuscus requires shade, moderate temperatures and humidity (Pikacha, 2008). Areas that will be totally cleared, such as the access road, will no longer provide suitable habitat for this species. Impacts include disturbance from forest clearing, leading to species displacement, exposition and vulnerability to opportunistic hunters, noise and vibration disturbance from drilling and blasting, and vehicle-wildlife interactions.</p> <p>Fruit-eating bats are adaptable to disturbances and degraded areas as long as artificial light is kept to a minimum. The main threat from project construction will come from blasting, carried out close to caves, and destruction of roosting trees by forest clearing. Many fruit eating bats roost in the daytime in the inland hills and forage in coconut groves along the coast (Campbell & Beecher, 1947). Project construction activities will probably temporarily disturb this daily migration pattern, and bats will probably become disoriented if their roosting areas are destroyed. In addition, forest clearing may destroy fruit trees used as sources of food.</p>				

<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Moderate	Localised	Short term	Likely	Moderate
<i>Mitigation measures</i>	<p>Fauna-friendly underpasses at stream crossings will be installed to provide safe crossing opportunities during dam construction. Speed limits will be imposed on all construction traffic along access road.</p> <p>The use of artificial light during construction will be kept to a minimum, Lights to be of low intensity and orientated towards the ground to avoid disrupting bats in flight.</p> <p>Specific drill and blast methods identified in the ESMP to be used to minimise blasting noise and vibration.</p> <p>Measures to mitigate for habitat loss, such as the creation of shelters or nest boxes, would lead to opportunistic hunting from local villages.</p>				
<i>Post-mitigation residual impacts and significance</i>	<p>Low impacts will persist in project affected area and are considered of low significance due to wide spread availability of suitable habitats throughout Guadalcanal.</p>				

<i>Fauna type</i>	Forest-dependent birds (e.g., pigeons, doves and ground birds)				
<i>Ecosystem or resource value</i>	<p>Many of the forest-dependent birds are endemic to Guadalcanal and are not found anywhere else in the world. Some are threatened. Therefore, they have a high ecosystem value.</p>				
<i>Potential Impact(s)</i>	<p>Extension of Black Post Road into the forested area is the main location of impacts. According to a study on the edge effect in Malaysia (Hosseini, <i>et al</i>, 2009), abundance of many bird species decreases at forest edges. Forest clearing for the access road and truck traffic during construction activities will adversely affect forest-dependent birds in forested areas because the forest canopy will be completely or partially uncovered. Forest-dependent birds find shelter in the dense cover of the forest and in tree cavities. The access road will only fragment a small patch of forest, the extent of fragmentation is, therefore, somewhat localised. The intensity of the impact is moderate since there will only be a limited number of truck trips per day (e.g., roughly 40). Trucks will generate noise and vibration, which further startles birds. Impact duration, although temporary, may lead to permanent changes in bird composition in the vicinity of the new access road, where it passes through forested areas.</p> <p>Forest dependent birds will also be impacted by noise and vibration from machinery works and blasting. Other impacts will include loss of habitat through clearance of construction work area. Impact duration will be temporary.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Moderate	Localised	Short term	Highly likely	Moderate
<i>Mitigation measures</i>	<p>Forest canopy shall be “sealed” where possible by minimising large tree clearing and maintaining canopy connectivity to reduce edge effect. Botanist to identify large canopy trees for retention.</p> <p>Construction work area to be rehabilitated as part of no net loss of biodiversity measures.</p> <p>Specific drill and blast methods identified in the ESMP to be used to minimise blasting noise and vibration.</p>				

	Additional measures, such as the creation of shelters or nest boxes would lead to opportunistic hunting from local villages.
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist and are considered to be of low significance due to temporary and localised nature of impacts and wide spread availability of alternative habitat

<i>Fauna type</i>	River dependent birds				
<i>Ecosystem or resource value</i>	Most of the river-dependent birds are widespread and none are endemic to Solomon Islands.				
<i>Potential Impact(s)</i>	All construction activities along the river that are associated with the project, including dam and powerhouse construction will have an adverse effect on river dependent birds, as noise and vibration from machinery and shock waves from blasting will startle them. During construction of the dam and mining of quarries, the water of the Tina River will become turbid. This will reduce visibility which, in turn, will make it difficult for fish-eating birds, such as kingfishers, to locate their prey. During construction, the affected areas will likely not be utilized by birds. Impact duration, although moderately long, will be temporary. Impact magnitude will be low, since construction is not likely to cause any bird casualties.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localized	Short term	Likely	Low
<i>Mitigation measures</i>	Mitigation will not appreciably reduce impacts on river dependent birds. However, to mitigate encroachment on riparian habitats, work areas will be clearly delineated prior to commencement of work. Specific drill and blast methods identified in the ESMP to be used to minimise blasting noise and vibration.				
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist, but are considered to be not significant.				

<i>Fauna type</i>	Grassland & widely distributed birds				
<i>Ecosystem or resource value</i>	As most of these species of birds are widely distributed they have moderate ecosystem value.				
<i>Potential Impact(s)</i>	Grassland and widely distributed birds, such as forest edge birds, roost along the forest edge and forage in grassland and forest clearings. Birds that inhabit areas of grassland along the portion of Black Post Road that will be enlarged and improved and where the transmission line will be installed, will be adversely affected. Over the long-term, forest located openings along the access road will most likely favour some bird species that are accustomed to open spaces. However, it is expected that during construction the areas adjacent to the access road will not likely be utilized by most bird species, due to noise and vibration impacts. The traffic along the existing access road will affect grassland birds that use this area, as the access road will be see traffic from heavy haul trucks, light duty trucks and other vehicles, that will generate noise and vibration. The intensity of the impact is low since grassland species can easily find other suitable habitat in the vicinity of the access road during construction. Impacts will be moderate but the duration is temporary.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating

	Low	Localised	Short term	Likely	Low
<i>Mitigation measures</i>	To mitigate impacts on grassland dependent birds, it is recommended that as many trees and shrubs be left standing as possible along the existing Black Post Road, as they offer good roosting sites for birds.				
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist, but are considered to be not significant.				

<i>Fauna type</i>	Amphibians				
<i>Ecosystem or resource value</i>	A number of amphibian species are deemed ecologically important due to their endemism, or threatened status and, therefore, have high ecosystem value. They are further threatened by the introduced cane toad.				
<i>Potential Impact(s)</i>	<p>Access road construction will be the most affected site. Amphibians will be adversely affected by project construction in a variety of ways, including: being confined to small territories or home ranges; their restricted mobility and speed limits their ability to escape from construction activities, making them vulnerable to physical damage and pollution; they are highly sensitive to changes in humidity and vulnerable to the edge effect, and some, like tree frogs, are highly dependent of dense forest cover; increased predation by feral cats and dogs might reduce their numbers; and improved access may facilitate further encroachment into the area by cane toads. Habitat in the vicinity of the access road is largely modified habitat and is marginal habitat for high value amphibian species. The density of high value amphibian species is relatively low due to the presence of invasive cane toad populations. Blasting and construction noise and vibration would result in temporary adverse impacts to amphibians. High value amphibians identified in the baseline surveys inhabited upper forest habitats and riparian habitats unaffected by the majority of construction activities.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Short term	Likely	Low
<i>Mitigation measures</i>	<p>It is not possible to limit the incursion of new amphibian species along the extension of Black Post Road, including the cane toad, which is already present in the area. To mitigate habitat fragmentation consideration was given to installing frog-friendly crossing culverts beneath the access road to facilitate crossing the road without being hit by moving vehicles. However, since the volume of traffic is expected to be light during operation, and local species of frogs are not known to migrate end mass between hibernation and breeding wetlands in the Solomon Islands, access road traffic will not represent a serious threat to frogs. Rather it is recommended fauna-friendly underpasses be installed at stream crossings (see Figure 10-1), as these would also be beneficial to amphibians.</p> <p>Specific drill and blast methods identified in the ESMP to be used to minimise blasting noise and vibration.</p>				
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist				

<i>Fauna type</i>	Reptiles
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<i>Ecosystem or resource value</i>	A number of reptile species are deemed ecologically important due to their endemism, or threatened status and, therefore, have high ecosystem value. They are further threatened by the introduced cane toad.				
<i>Potential Impact(s)</i>	<p>The access road will be the most affected site during construction. Some reptiles will probably be favoured by the Project in the long-term, since partial opening of the canopy will create more favourable conditions (i.e., sunny and drier environment) for them. This positive impact is further discussed under operation impacts. In the short term, during forest clearing for access road construction, reptiles will be adversely affected in the same manner as amphibians. Reptile mortality will occur because of their limited mobility and small home ranges. Many reptiles found in the study area rely on trees. Therefore, forest clearing will probably lead to diminished productivity. In addition, snakes may suffer from persecution by construction workers.</p> <p>Reptiles will also be impacted by noise and vibration from machinery works and shock waves from blasting. Other impacts will include loss of habitat through clearance of construction work area. Impact duration will be temporary.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Short term	Moderate	Low
<i>Mitigation measures</i>	<p>It is recommended fauna underpasses be installed at stream crossings (see Figure 10-1). Some species of reptile will probably be favoured once the access road is finished since they thrive in sunnier and drier environments. In addition, during construction, workers will be prohibited from harming any wildlife. They will receive wildlife awareness training informs them of the requirement to request the project's environmental specialist capture and remove animals that are either in danger or are dangerous to construction workers.</p> <p>Construction work area to be rehabilitated as part of no net loss of biodiversity measures.</p> <p>Specific drill and blast methods identified in the ESMP to be used to minimise blasting noise and vibration.</p>				
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist, but are considered to be not significant.				

<i>Fauna type</i>	Wetland dependent insects				
<i>Ecosystem or resource value</i>	A number of wetland dependent insect species are deemed ecologically important due to their endemism, or threatened habitat status and, therefore, have high ecosystem value. They are further threatened by activities such as timber harvesting that threaten wetland habitats, and by the introduced little fire ant.				
<i>Potential Impact(s)</i>	The site of powerhouse construction is the most affected site. Many micro-wetlands are created by flash floods along the Tina River, especially where low relief topography occurs adjacent to the Tina River. Around the dam site, the topography is very steep and, therefore, does not support micro-wetlands. At the powerhouse site, some micro-wetlands will be destroyed leading to localized loss of wetland dependent insects, such as dragonflies and damselflies.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Short term	Moderate	Low

<i>Mitigation measures</i>	Specific measures for mitigating the production of wetland dependent insects are limited. Best Environmental Management Practices will be implemented.
<i>Post-mitigation residual impacts and significance</i>	Low impacts will persist, but are considered to be not significant.

10.7.2.2 Indirect Impacts on Fauna

10.7.2.2.1 Identification of Indirect Impacts

This section identifies potential sources of indirect impacts on fauna.

Habitat Fragmentation and Barrier Effects

As previously stated, access roads will have adverse impacts on flora. The following discusses how fragmentation may affect wildlife. According to Laurance (2009), wildlife habitat fragmentation is particularly acute in tropical rainforests, including rainforests of the South Pacific, due to road development because:

- ▶ Many tropical species are adapted to moist, dark and stable microclimates provided by forest understories;
- ▶ tropical forests sustain species with microhabitats which are sensitive to slight changes of light and humidity;
- ▶ Sediments eroded from access roads and small stream blockages at road crossing points can alter habitats;
- ▶ Waterborne pollutants, such as oil spills on roads, can easily be flushed into water courses and, in turn, may affect amphibians living in adjacent wetlands,
- ▶ In developing countries, access roads have been known to induce increase hunting pressure, settlements and population growth.

Two types of habitat fragmentation can take place:

- ▶ Fragmentation caused by roads that bi-sect wildlife habitats and cause populations to become isolated or separated. This can result from vehicle-wildlife interactions (i.e., road kills), and from species that are easily startled and, therefore, hesitate to cross roads; and
- ▶ Fragmentation that results from improved access to predators, such as birds of prey and snakes, which are provided with improved foraging along newly exposed forest edges for species such as amphibians, native rats and Cuscus.

The potential impacts of habitat fragmentation on wildlife may be:

- ▶ Decreased species adaptation to change due to genetic isolation causing population decline;
- ▶ Reduction in home range surfaces and an abandonment of the habitat by species when habitat surface thresholds are crossed;
- ▶ Change in microclimate and increase predation, leading to an abandonment of the habitat by species;
- ▶ Increased encroachment of opportunistic wildlife species.

Ultimately, habitat fragmentation leads to reduction in wildlife diversity.

In addition to contributing directly to habitat fragmentation, linear clearings such as access roads, and transmission line rights-of-way can create a barrier to wildlife movement. Many species adopt an avoidance behaviour when confronted with linear clearings (Laurance, 2009). As noted above, this behaviour can ultimately contribute to wildlife habitat fragmentation.

Most species that adopt an avoidance behaviour are those that are usually not affected by road kills. The barrier effect has been reported even in cases of narrow clearings. Species at risk are those that:

- ▶ Are strictly arboreal;
- ▶ Are adapted to fly short distances in dense forested environments;
- ▶ Are easily startled and dazzled by light, traffic noise, pollution and dust and human presence. For example, bats are disturbed by artificial lighting, especially when installed along river corridors, and forest edges;
- ▶ Align their territories with forest clearing boundaries (Laurance, 2009).
- ▶ Whose means of communication will be interfered by traffic noise (Goosem, 2007)
- ▶ Are physically unable to cross when roads include deep drainage channels, gabion baskets or when roads are built with a cut-and-fill approaches. In this case, road construction represents an impassable obstacle that leads to permanent habitat fragmentation and permanent genetic isolation of small patches of population. This issue is particularly significant in the case of the access road extension to the dam, because many cuts and embankment fills are foreseen.

Species that are of greatest concern are insects, rainforest amphibians, reptiles (such as skinks), forest-interior birds, bats and other small mammals.

Vehicle-Wildlife Interactions

Any access road represents a risk of vehicle-wildlife interactions leading to wildlife mortality (i.e., road kills). Laurance (2009) identifies species at risk as being those that:

- ▶ Require wide habitat ranges;
- ▶ Are less mobile, slow or freeze when faced with danger, such as ground dwelling species (mainly amphibians but also some reptiles, ground and understory birds and small mammals) (Goosem, 2007). The highest casualties occur when these species find good hunting or breeding ground near roads and when the activities of the crepuscular species coincide with traffic peaks;
- ▶ Are predominantly arboreal and are less agile when required to move on the ground;
- ▶ Birds and bats with low flight paths; and
- ▶ Species with poor eyesight.

Feral and Invasive Species

The access roads will have an indirect effect on native wildlife by providing improved access for feral and invasive species into new areas, and the associated predation on native species. Islands around the world are particularly vulnerable to invasive species. In the case of the Solomon Islands, dogs and feral cats are known to represent a threat to native rats and the Cuscus.

Fire Ants

In Guadalcanal, logging roads have opened the way for invasive insects such as the little fire ant (*Wasmannia auropunctata*), which is native to South and Central America. This species was introduced in the Solomon Islands as a biological control for a nut fall bug (IUCN, 2012). This species, because of its plundering behaviour, reduces insect diversity. The access road will lead to the colonization of fire ants of new undisturbed areas. Proliferation of the little fire ant in rainforests occurs approximately 60 times faster with the presence of roads, than in undisturbed forests (Polhemus et al., 2008).

Feral Animals

Cats, non-native rats (Polynesian Rat and House Rat) and dogs are known to move along roads (Goosem, 2007). In the Solomon Islands, they threaten the survival of many native small mammals and ground birds such as pigeons. Feral cats are the most dangerous introduced predator of native species in the Solomons Islands, and are a threat to native rats and the Cuscus (Pikacha, 2008). Goldridge fauna surveys revealed the presence of introduced rats in disturbed and degraded areas. The TRHDP construction phase may create new ecological niches for, or facilitate the spread of, non-native rat species, which might compete with - or spread disease to - native rats (if these are still extant).

Cane Toad

The cane toad (*Bufo marinus*), which is native to Central and South America, is an introduced species that is found throughout the Solomon Islands. In the Project area, the cane toad was found as far as the upper catchment area along the Vohara River. According to Pikacha (2008) and IUCN (2013), cane toads are a threat to snakes and native frogs that eat the tadpoles and die from the toxic poisons present in the Cane toad glands. Cane toads are more successful in open areas such as roadsides (Urban et al., 2007). In tropical Australia, a recent study has shown that cane toads colonize new habitat moving along roads and cleared fence lines, avoiding heavily vegetated habitat (Brown et al., 2006). Forest clearing for the access road will, therefore, facilitate the continuing encroachment of cane toads into the project area. Evidence of cane toad presence was observed (juvenile toad and tadpoles) on 12 May 2016 in the reach of the Tina River just upstream of the powerhouse site (see Figure 10-1).

Figure 10-1 Photo of juvenile Cane Toad caught just upstream of proposed powerhouse site

Source: Scott Hanna photo (2016)



Giant African Snail

The Giant African Snail was introduced into the Solomon Islands, probably as eggs and juvenile snails within soil that was adhered to imported logging equipment. The snail competes with native species and damages food crops. During the mitigation workshops, it was mentioned that this species has already reached Veraande village (along Black Post Road).

Noise, Vibration and Light

In addition to the fragmentation of habitat, noise, light and vibration can have adverse impacts on wildlife. However, dust will not be a significant problem thanks to the rainy climate in Guadalcanal. During the TRHDP construction phase, noise and vibration from blasting and drilling (during the tunnel construction or the quarry exploitation) and from vehicle traffic will startle many wildlife species. In addition, artificial light may disorient bats. In tropical regions, artificial light alters the foraging behaviour of fruit-eating bats (Lewanzik and Voigt, 2014).

10.7.2.2.2 Mitigation Measures

Habitat Fragmentation and Barrier Effects, and Vehicle Wildlife Interactions

To mitigate habitat fragmentation and barrier effects, and vehicle-wildlife interactions, the following measures will be implemented:

- ▶ Best Environmental Management Practices will be implemented by the Construction Contractor during the TRHDP construction phase;

-
- ▶ Faunal underpass - culverts (or bridges) across small stream will allow terrestrial species to underpass the access road. These culverts will be large enough to allow the water flow and to ensure permanent dry passage using ledges (see Figure 10-2). The dry passage will provide suitable cover such as rock piles, logs, and brush. For example, ledges will be large enough to allow Cuscus to cross (with a width of 1m).

However, these corridors can also pose a risk to prey species if predators learn that these underpasses are a source of prey. Notwithstanding, compared to the numbers of fauna that could be killed crossing the access road, the use of wildlife underpasses will likely more than make up for the number of road kills.

Figure 10-2 Faunal underpass in open bottom culvert



Source: Main roads, Western Australia, 2014

- ▶ The forest canopy will be kept intact wherever possible to maintain ground level shade and humidity levels, and to minimise creating an edge effect; and
- ▶ Vehicle speed limits will be controlled along the access roads, to ensure that drivers are able to prevent running over wildlife that may be lying on, or crossing, the access road.

Feral and Invasive Species

Only intensive long term trapping or control could attempt to stop further encroachment of feral and invasive species such as fire ants, cats, dogs, and cane toads that are already known to have entered the project area. However, to mitigate the spread of the Giant African Snail, the following actions will be implemented:

- ▶ An equipment cleaning station, employing pressurized steam, will be installed at Veraande. This location was chosen because the Giant African Snail is already located there. All wheels, tracks, excavation blades and buckets, as well as other pieces of machinery that could have come into contact with soil, will be cleaned prior to entering the project site. This measure will provide an opportunity to create small jobs for local communities; and
- ▶ Soil will never be imported into the project area.

Noise, Vibration and Light

To minimise impacts of noise, vibration and light, the following measures will be employed:

- ▶ Specific drill and blast methods will be used to reduce noise and vibration. Hydraulic rock drill equipment will be used instead of pneumatic equipment because it produces less noise. Moreover, blasting and drilling equipment will be equipped with silenced masts, which can reduce noise levels by up to 10dBA. Blasting charges will be covered with blasting mats and screens to reduce generation of noise, fly rock and dust; and
- ▶ The number of artificial lights will be kept to a minimum, while still maintaining a safe working environment. Light intensity will also be limited, where possible, and the lights will be oriented toward the ground to avoid disorienting bats in flight.

10.7.2.2.3 Residual Effects and Their Significance

By applying the mitigation measures recommended above and GIIP, the indirect impacts on fauna can be reduced to an acceptable level of low to moderate residual impacts and are, therefore, considered to be not significant.

10.7.2.3 Conclusions Regarding Construction Impacts on Fauna

Table 10-4 summarises impact significance on fauna during construction. Forest clearing is the main impacting activities. It will disturb fauna and fragment their habitats. Forest clearing will potentially lead to diminished numbers of less mobile species, such as amphibians and reptiles, but given the short duration, localised nature of the impacts, they are considered overall to be not significant.

Table 10-4 Summary of construction impact ratings on fauna

Group of animals	Pre-mitigation Impact Rating	Opportunity for Mitigation	Residual Effect
Native Rainforest Rodents	Low	No	Not significant
Bats and marsupial	Low – Moderate	Yes	Low Significance
Forest-dependent birds	Moderate	Yes	Low Significance
River-dependent birds	Low	No	Not significant
Grassland and widely distributed birds	Low (positive)	Not required	Not significant
Amphibians	Low	Yes	Low Significance
Reptiles	Neutral	Yes	Not significant
Wetland dependent insects	Low	No	Not significant

10.8 ASSESSMENT OF OPERATION IMPACTS

10.8.1 Operation Impacts on Flora

10.8.1.1 Direct Impacts on Flora

10.8.1.1.1 Identification of Direct Impacts

Project operation will necessitate vegetation control under the transmission line. Herbicides such as glyphosate will not be used for vegetation clearance, due to the potential toxic effects on amphibians and reptiles, as well as on fish and water quality. Instead, manual vegetation control methods will be employed for the Project to maintain the right-of-way.

10.8.1.1.2 Mitigation Measures

Other than vegetation control, there will not be any additional work involving forest clearing during operation. The transmission line will mainly pass through grasslands, and will most likely only require minor vegetation control. This will be accomplished using manual or equipment vegetation control techniques. No herbicides will be used to manage vegetation growth along the transmission right-of-way.

10.8.1.1.3 Residual Effects and Their Significance

During project operation, direct impacts to flora are considered to be not significant, as most of the impacts will have already occurred as a result of project construction.

10.8.1.2 Indirect Impacts on Flora

This section identifies and rates potential indirect impacts on flora that will result from project operation. Most indirect impacts are related to the presence of the access road through the forest, which will could act as an agent of change in the area, leading to a gradual degrading of surrounding ecosystems.

10.8.1.2.1 Identification of Indirect Impacts

Ongoing Encroachment by Invasive Species

Once the dam and the hydropower plant is in operation, improved access will facilitate increased presence of people in the area around the dam, which could in turn, lead to colonization of invasive, vine and pioneer species leading to local displacement or disturbance of native plant species. The primary concern is the accidental or purposeful introduction of invasive plant species. As noted previously, Water Hyacinth colonization does not represent a significant risk for the Project, if accidentally or intentionally introduced, given the daily fluctuations in reservoir water levels and the expected low concentration of nutrients.

Opening of forested areas along access roads will create on-going opportunities for invasive species to settle.

Changes in Vegetation Induced by Changes in River Hydrology

Impacts can arise from changes in the Tina River hydrology downstream of the dam. Changes could have an effect on riparian habitats and small wetlands located along the river between the dam and powerhouse. The dam will provide flood attenuation but does not provide flood control. A major effect of flood attenuation will be a reduction in flow variation. This reduced variation will lead to a reduction in littoral wetland habitats that will be most pronounced in the low flow region (there will be diurnal variation/generation related variation below the powerhouse). There will also be additional littoral wetland habitats created by variable exposure water levels in the reservoir.

Changes in the Accessibility to Forest Products

Wood and non-wood products will be under increased human pressure if the new access road facilitates access into areas presently covered by undisturbed forest (primary forest) or regenerating forest (disturbed forests) this is particularly true for the Core Area.

Improved access to the dam and reservoir area provided by the access road could lead to development of settlements in upstream areas by landowners who wish to take advantage of better access available forest resources such as fruits, nuts, medicinal plants, wild game, timber for construction, fuel wood, aggregates at the upstream end of the reservoir, and other resources. Therefore, the extent of road related impacts on habitats is not limited to the width of the access road but to newly accessible forested areas.

Improved access afforded by the new access road could also lead to increase logging activities in upstream areas. This impact has been well documented in the Gold Ridge area (Ross Mining, 1994).

Land Use Dynamics on Natural Habitats

Over the long term, the access road will allow people to modify land use since it will promote rapid deforestation and transformation to gardens. Vegetation composition will gradually change in proximity to the access road. In addition, the 4.288km² Core Area will probably be under increasing development pressure. The extent of modification is impossible to predict. However, development of gardens and increased use of timber for house construction will inevitably modify the forest and create openings in the canopy leading to modification of ecosystems.

10.8.1.2.2 Mitigation Measures

Ongoing Encroachment by Invasive Species

To mitigate impacts of ongoing encroachment by invasive plant species, the following actions will be implemented:

- ▶ Monitoring of Water Hyacinth will be undertaken to assess its presence in the reservoir and to ensure quick response in case it becomes established. This monitoring will be done twice each year and will include surveys of the entire reservoir. In the event that Water Hyacinth does become established in the reservoir, immediate removal of the plant and its roots will be carried out to limit the ability for it to propagate further.

-
- ▶ Site restoration using native plant species will be undertaken in affected areas, including the Core Area (see Section 13 – ESMP). As discussed in Section 13, native vegetation species are expected to become quickly established if planted in good quality soils.

Changes in River Vegetation Induced by Changes in River Hydrology

To mitigate impacts, an environmental flow (EF) must be implemented downstream of the dam. Details on the determination of the EF are presented in Section 11 – Assessment of Impacts on the Biological (Aquatic). This environmental flow is, however, not sufficient to mitigate impacts and long term changes in vegetation along the river banks.

Changes in the Accessibility to Forest Products, and Land Use Dynamics on Natural Habitats

To mitigate the impacts of changes in the accessibility to forest products and increased development pressure on natural habitats, the following action will be implemented:

Management of access - during mitigation workshops, local communities requested that access to the Core Area by non-local settlers be prohibited, and that the extension of Black Post Road be declared a private access only. Control of access would be done by the Tina TCLC, which will own the Core Land, including the access road from Marava Village to the dam site. The access road to the dam will be gated to prevent access to logging companies. Access would only be granted to the local population and hydropower facility operator. The TCLC will not permit anyone to live or construct housing within the land leased for the project, except where strictly necessary for project activities, including housing for rangers or security staff. A settlement policy will be developed and implemented with the assistance of the TCLC and incorporated into the Biodiversity Management Plan. The settlement policy will include enforcement measures to prevent the use of the land for a workers camp. It will also address restrictions on the use of the private project road through the Core Area by people seeking to build new settlements beyond the Core Area.

10.8.1.2.3 Residual Effects and Their Significance

By applying the mitigation measures recommended above and GIIP, the indirect impacts on flora during operation can be reduced to an acceptable level of low residual impacts and are, therefore, considered to be not significant.

10.8.1.3 Conclusions Regarding Impacts of Operation on Flora

Impacts on flora during project operation are mostly indirect, and will accrue due the presence of the access road that will allow communities to access better forest resources in upstream areas, and move deeper into the forest in areas bordering the road. The access road will be an agent of change in the area. Land use along the access road could also change with the arrival of new settlers.

10.8.2 Operation Impacts on Fauna

10.8.2.1 Direct Impacts on Fauna

The following section discusses direct species-specific impacts on wildlife, proposed mitigation measures, and examines residual impacts and significance following the application of mitigation measures. This section studies the same group of species as presented in the construction section to analyse whether the situation for these species will worsen, improve or stabilize with the Project operation. Impacts accruing from operation are permanent, as the Project will permanently modify some ecological function and habitats.

The following table (Table 10-5) provides an assessment of the species specific and direct impacts that could potentially accrue to fauna as a result of project construction, and includes the following analysis:

- ▶ Fauna that could potentially be affected;
- ▶ Value within the ecosystem and as a resource utilised by local communities;
- ▶ Potential impacts;
- ▶ Impact significance, based on magnitude, extent, duration and probability of impacts;
- ▶ Mitigation measures, and
- ▶ Residual impact and significance after mitigation has been applied.

Table 10-5 Assessment of potential impacts to fauna resulting from operation

<i>Fauna type</i>	Native forest rodents				
<i>Ecosystem or resource value</i>	The Emperor Rat is probably extinct (IUCN, 2013), while the King Rat is endangered. Both species are, therefore, highly valued.				
<i>Potential Impact(s)</i>	No direct impact due to operation. Indirect impact due to presence of an access road, relatively close to montane forest could increase human and invasive species (e.g. cats, rats) presence in previously pristine montane forest, leading to potential impacts on native rodents.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Moderate	Localised	Long term	Likely	Low
<i>Mitigation measures</i>	Access to private road through Core Land to be limited. No human habitation of Core Land to be permitted.				
<i>Post-mitigation residual impacts and significance</i>	Low				

<i>Fauna type</i>	Bats & marsupials (i.e., Cuscus)
<i>Ecosystem or resource value</i>	Endemic bat species are threatened and, therefore, have a high ecosystem value. The only marsupial in the Solomon Islands (Cuscus) is widely distributed and is of moderate resource value.

<i>Potential Impact(s)</i>	<p>Forest areas adjacent to the access road will be the main areas affected. Progressively, this impact will extend into the forest interior away from the road. Project operation and ongoing use of the access road will create ongoing impacts on mammals as hunting activities and the presence of new settlers create additional pressures on wildlife.</p> <p>In addition, if the transmission line is constructed using wooden power poles, there is a risk that cuscus may climb the poles and be electrocuted, causing power outages as circuits are tripped.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Long Term	Highly likely	Low - Moderate
<i>Mitigation measures</i>	Metal shields will be installed on wooden power poles in forested areas to prevent Cuscus from climbing poles and becoming electrocuted.				
<i>Post-mitigation residual impacts and significance</i>	Not Significant				

<i>Fauna type</i>	Forest dependent birds (e.g., pigeons and ground birds)				
<i>Ecosystem or resource value</i>	Many of the forest-dependent birds are endemic to Guadalcanal and are not found anywhere else in the world. Some are threatened. Therefore, they have a high ecosystem value.				
<i>Potential Impact(s)</i>	<p>Majority of operational impacts will affect modified forest habitats with limited suitability for forest dependent birds especially ground birds. There is current evidence of wide spread presence of feral animals particularly cats throughout the area. According to Laurance (2004), edge effect can lead to reduction in forest-dependent bird species extending up to 70m away from road margins in Amazonia. Predation by feral animals could continue. As for construction, forest near the access road will be the main impacted site. Progressively, this impact will reach forest interior away from the road. Dependent on design, the transmission line may present collision or electrocution risks to larger-bodied species, such as birds of prey, parrots and hornbills.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Moderate	Localised	Long term	Highly likely	Moderate
<i>Mitigation measures</i>	<p>Natural habitats within the Project Area to be protected and 9.5 Ha of modified habitat will be rehabilitated to forest habitat. These measures are to be set out in the developer's Biodiversity Action Plan.</p> <p>Forest canopy shall be "sealed" where possible by minimising large tree clearing and maintaining canopy connectivity to reduce edge effect. Botanist to identify large canopy trees for retention. Transmission line design and mitigation will follow well-established global best practice (e.g., from the Avian Power Line Interaction Committee and BirdLife International) to minimise the risk of both collisions and electrocutions.</p> <p>Other mitigation measures not feasible as the access road will create a clearing in the canopy and associated edge effect.</p>				
<i>Post-mitigation residual impacts and significance</i>	Low impact, not significant				

<i>Fauna type</i>	River dependent birds				
<i>Ecosystem or resource value</i>	Most of the river-dependent birds are widespread and none are endemic to Solomon Islands.				

<i>Potential Impact(s)</i>	<p>River dependent birds will be affected by the low flow conditions created by operation in the reach between the dam and the powerhouse, where water levels will be reduced. Floods, which are known to create and feed small riparian wetlands, will be attenuated by the dam. There will be some reduction in wetland habitats in the reduced flow section; less or no reduction in wetland habitats downstream of the powerhouse, and some increase in habitats on the margins of the lake. ENVIRONMENTAL FLOW CONDITIONS ARE EXPECTED TO INCREASE FISH DENSITY FROM BASELINE MEDIUM FLOW CONDITIONS. . IMPACTS MAY BE FELT IN THE UPPER CATCHMENT, SHOULD FISH NUMBERS DECLINE IF FISH PASSAGE PROVISIONS ARE NOT EFFECTIVE.</p> <p>LOWER FLOWS IN THE AFFECTED REACH COULD ALSO EXPOSE FISH MAKING THEM EASIER PREY FOR SOME FISH-EATING SPECIES OF BIRDS.</p>				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Long term	Likely	Low
<i>Mitigation measures</i>	Key mitigation measures will be maintenance of environmental flow and trap and haul fish passage.				
<i>Post-mitigation residual impacts and significance</i>	Not significant				

<i>Fauna type</i>	Grassland and widely distributed birds				
<i>Ecosystem or resource value</i>	As most of these species of birds are widely distributed they have moderate ecosystem value.				
<i>Potential Impact(s)</i>	Bird species that utilize forest edge and grassland habitats, and bird species that are otherwise widely distributed across many different types of habitats, might benefit by the extension of Black Post Road, which will create additional habitats for these species.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low (positive)	Localised	Long term	Likely	Low (positive)
<i>Mitigation measures</i>	No mitigation measures required.				
<i>Post-mitigation residual impacts and significance</i>	Not significant				

<i>Fauna type</i>	Amphibians				
<i>Ecosystem or resource value</i>	A number of amphibian species are deemed ecologically important due to their endemcity, or threatened status and, therefore, have high ecosystem value. They are further threatened by the introduced cane toad.				
<i>Potential Impact(s)</i>	<p>The river reach between the dam and the powerhouse is the main affected riparian habitat.</p> <p>A reduction in wetlands in this area may reduce habitat for the San Cristobal Treefrog (the only Solomon Islands' frog with a tadpole stage) while the creation of a dam may improve habitat in the reservoir area. Habitat of other high value amphibians is above the project affected area in the upper catchment.</p>				

	Cane toads and feral animals will continue to exert pressure on native species of amphibians where disturbed areas (e.g., access road, and along the low flow river reach).				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Periodic	Highly likely	Low
<i>Mitigation measures</i>	The steady 1 m ³ /s environmental flow will not be sufficient to recharge riparian wetlands. Floods, which are known to create and feed small riparian wetlands, will be attenuated by the dam. There will be some reduction in wetland habitats in the reduced flow section; less or no reduction in wetland habitats downstream of the powerhouse, and some increase in habitats on the margins of the lake.				
<i>Post-mitigation residual impacts and significance</i>	Low significance				

<i>Fauna type</i>	Reptiles				
<i>Ecosystem or resource value</i>	A number of reptile species are deemed ecologically important due to their endemism, or threatened status and, therefore, have high ecosystem value. They are further threatened by the introduced Cane Toad.				
<i>Potential Impact(s)</i>	The extended access road will modify habitat quality for reptiles. Some reptiles will be positively affected by the new access road, as this road will create additional open habitat along the forest edge and will bring more solar radiation to the ground. Which species will benefit is difficult to assess. However, snakes will likely benefit the most by forest openings. However, all reptiles could also be affected by the ongoing arrival of feral animals and by potential vehicle-wildlife interactions where reptiles try to cross the road or lay on the road to absorb residual heat given off by the surface of the road during the cooler parts of the day.				
<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Neutral	Localised	Long term	Highly likely	Neutral
<i>Mitigation measures</i>	No specific mitigation measures can be implemented for reptiles.				
<i>Post-mitigation residual impacts and significance</i>	Not significant				

<i>Fauna type</i>	Wetland dependent insects				
<i>Ecosystem or resource value</i>	A number of wetland dependent insect species are deemed ecologically important due to their endemism, or threatened habitat status and, therefore, have high ecosystem value. They are further threatened by activities such as timber harvesting that threaten wetland habitats, and by the introduced little fire ant.				
<i>Potential Impact(s)</i>	Micro-wetlands along the by-passed reach are the most affected sites. "Wetting" of these sites by floodwaters will be reduced due to the flood attenuation effects of the dam, however the reservoir will not have flood control storage and impacts will be short lived. Simulation of the hydro operation indicated that floods or freshets would occur on average every 6 weeks, and their average duration would be between 4 to 6 days. Additional aquatic terrestrial contact zones (ATCZ) along the shores of the reservoir are expected to provide additional habitat for wetland dependent insect species. There is therefore expected to be a minimal reduction in the number of wetland dependent insects.				

<i>Impact significance rating</i>	Magnitude	Extent	Duration	Probability	Overall Rating
	Low	Localised	Periodic	Likely	Low
<i>Mitigation measures</i>	No specific mitigation measures can be implemented.				
<i>Post-mitigation residual impacts and significance</i>	Low significance				

10.8.2.2 Indirect Impacts on Fauna

10.8.2.2.1 Identification of Indirect Impacts

Some of the indirect impacts on wildlife that will occur during construction activities will continue during operation of the Project, as the access road could facilitate increased access through the Core Area. Measures to restrict vehicle access to the new section of Black Post Road above Mengakiki will be instrumental in minimising this impact. No residences, settlements or workers' camps are to be permitted in the Core Area other than limited accommodation necessary for the Project (eg. security guards or on-call engineers). Terrestrial ecology will adapt over the long term, and ecological functions of the affected area will be redefined. Some species types will probably be favoured by road presence, but most will be disadvantaged. During operation, the access road will be a low-volume road used only for Project activities, including implementation of environmental mitigation measures, with impacts being related less to vehicle-wildlife interactions, and more to ecological modifications brought about by opening of the canopy. .

Changes in Accessibility to Bush Meat

Several studies have shown that newly created access roads in forests bring negative indirect impacts on forest products (wood and non-wood products) and wildlife, when access roads are not controlled. These impacts are generated because access roads greatly facilitate human encroachment into areas that would normally be difficult to access, thereby leading to development of new economic activities along roads (Young, 1994). Even when access is controlled by the local population, indirect impacts are still significant. Suarez et al. (2012) has demonstrated that, in Brazil, despite access along new roads being controlled by Indigenous communities, wildlife depletion accelerates due to increased hunting pressure and the establishment of new settlements along the road. Similar studies have not been carried out in the South Pacific region. However, settlements along the access road, and associated impacts on bush meat, are likely to occur over the long term.

Access provided to the local population along the road is a key issue that was discussed with local populations during mitigation workshops. Local communities indicated that the new extension of Black Post Road past Mangakiki should be controlled by local communities. However, it will not be accepted by local communities that this road be strictly prohibited to new settlements. It is also possible that some local chiefs will take advantage of the access road to sell access to logging companies to newly accessible areas. Therefore, impacts as described above are expected.

It has been decided that the TCLC will own the Core Area, including the access road from approximately Marava to the dam site. TCLC, which is a joint venture between customary landowners and government, will be subject to the terms of the lease agreement between the TCLC and the TRHDP, and will control who can access the land. Management of access as a means of mitigating impacts is presented in Section 13.2.1.4.

On-Going Habitat Fragmentation

Once the dam is in operation, the access road will be used less by heavy haul trucks. However, its presence will continue to contribute to permanent habitat fragmentation, increased human presence along the road, local population uses of forest products, land transformation into gardens, and other activities. This is particularly true in the Core Area and around the reservoir. Wildlife that is affected by the access road and the Core Area will not fully recolonize their initial habitat once the Project is in operation. Moreover, human encroachment will spread to a certain extent out into forest areas.

On-Going Feral and Invasive Species Encroachment

The permanent access road will allow for feral and invasive species to continue encroaching into new areas. Most feral animals follow human settlements. With new settlers, impacts occurring during construction will continue during operation of the Project. However, regardless of whether the Project was to proceed, or not, the feral and invasive species that currently threaten the region will continue to encroach into new areas, given enough time.

10.8.2.2.2 Mitigation Measures

The new access road will locally modify the environment and change ecological dynamics. To minimize human presence in previously undisturbed areas, it is suggested that workshops be held with local communities to raise awareness about the need for protecting the ecosystem and for applying practices aimed at the sustainable use of forest products. The TRHDP will also meet with local Chiefs to raise awareness regarding the need to sustainably use forest products, and to avoid selling access to logging companies. Raising awareness will also include discussions aimed at reducing opportunistic hunting of bats and Cuscus.

10.8.2.2.3 Residual Effects and Their Significance

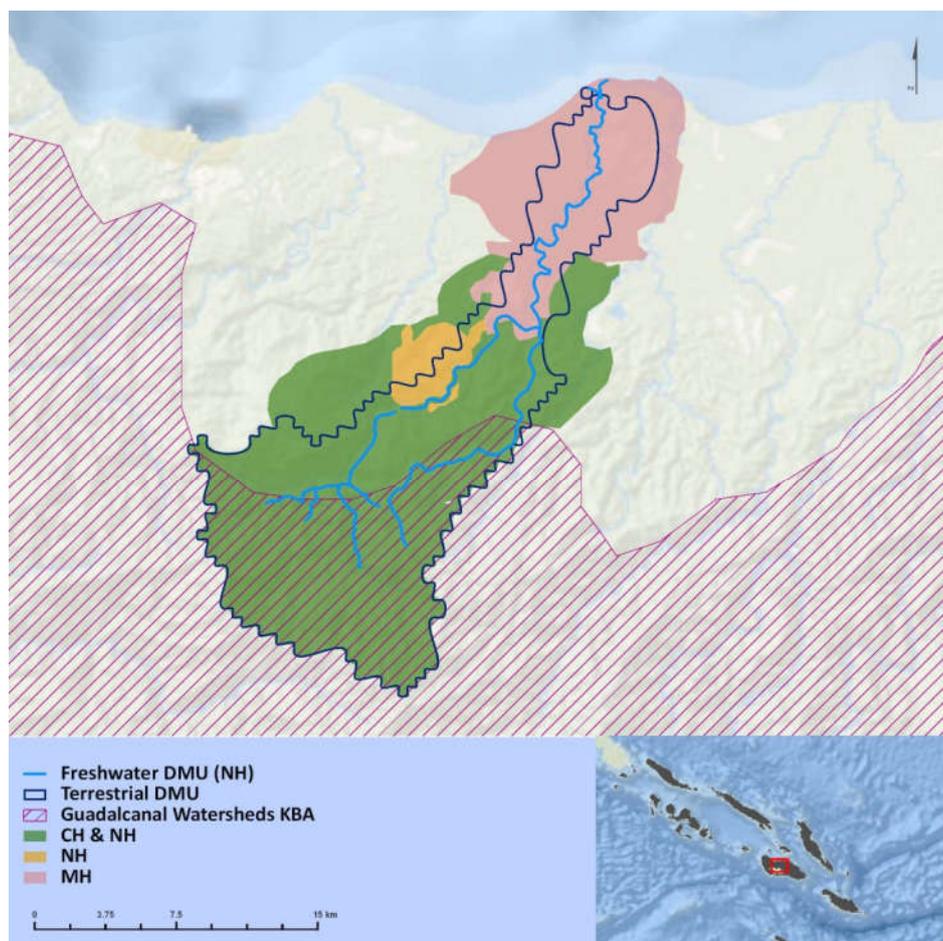
During project operation, direct impacts to fauna can be mitigated by implementing measures to raise awareness of local communities and their chiefs. If these measures are put into effect, the impacts will be considered to be not significant, as most of the impacts will have already occurred as a result of project construction.

10.9 IMPACTS ON NATURAL AND CRITICAL HABITATS

10.9.1.1 Identifying Natural and Critical Habitat

Both PS 6 and SPS require assessment of whether the project is planned in an area that may qualify as critical or natural habitat. A broad terrestrial area and a relatively long freshwater area were considered, to incorporate all potential project impacts (Figure 10-3). The natural and critical habitat assessment (refer to full report at Appendix Q), based on information in the ESIA, concludes that the project is situated within a watershed containing substantial natural habitat, comprising both undisturbed and disturbed/remnant forests as well as the Tina River and its tributaries. Critical and natural habitat assessment ideally takes place across sensible ecological or political units that are sufficiently large to encompass all direct and indirect impacts from the project. These areas of assessment, referred to as 'discrete management units' (DMUs) are thus often much broader than the direct project footprint. DMUs may be separate or combined, depending on the ecology of the biodiversity concerned.

Figure 10-3 – Map of discrete management units and areas of critical, natural and modified habitat



The species of concern in this area are freshwater fish, birds and mammals. Birds and mammals are likely to be impacted by a hydropower project in similar ways (e.g., direct terrestrial footprint, induced

clearance) and so are considered together. The Tina River watershed (including the Toni) forms a relatively discrete ecological unit, and is likely to be the focus of any project-related direct and indirect impacts. This watershed was thus taken as an appropriate terrestrial DMU, covering approximately 243 km². Given the potential for project impacts both upstream (e.g., blocked fish migrations) and downstream (e.g., owing to altered flows) of the dam, and the interconnected nature of freshwater ecosystems, the whole Tina River and its tributaries were considered together as one freshwater DMU. These two discrete management units, with mapped areas of critical, natural and modified habitat, are outlined on Figure 10-3.

Identification of these 'discrete management units' does not mean that the project has management obligations across them. The aim of this critical and natural habitat assessment is to identify whether the broad units qualify as critical habitat and, if so, for what biodiversity features. This information helps to prioritize impact assessment and to focus mitigation efforts.

Downstream from the project, large areas of modified habitat exist, owing to intensive logging and small-scale agriculture – as well as widespread incursion of invasive species. Despite some logging, the project area and surrounds have retained forest cover and basic ecological integrity, and can be considered to largely comprise natural habitat. The upper and outer watershed, upstream from the proposed dam location and further down away from the river itself, remain largely undisturbed and represent critical habitat. The freshwater area appears to have retained most of its original ecological functionality, despite extensive fishing and household use by communities, and the Tina River and its tributaries can thus be considered natural habitat.

Two restricted-range bird species (Guadalcanal Boobook and Black-headed Myzomela) and one reptile (Guadalcanal Bow-fingered Gecko) appear to qualify the Tina watershed as Critical Habitat. In addition, some threatened species might remain undetected in the area and – if present – would qualify it as critical habitat. The project should thus continue low-level monitoring for these species (King Rat and White-eyed Starling). On a precautionary basis, the project can best manage these unknown risks by acting as though the area might be critical habitat for these two species, and so ensuring that appropriate mitigation and offset measures are in place.

More broadly, as well as providing a number of important ecosystem services to local communities, natural forests in the Tina Watershed can be considered critical habitat owing to the limited global extent of this forest ecosystem type and the particularly unique nature of the species' assemblage it supports.

10.9.1.2 Assessment of Natural Habitat

Guadalcanal as a whole would originally have been largely forested. Across the lower reaches of the project discrete management unit, forest has been degraded and/or removed by logging and small-scale agriculture, and a number of invasive species are now prevalent in the area. These degraded and deforested areas in the lower Tina watershed can thus be considered modified habitat (covering 51 km² of the DMU). These comprise the potentially-impacted ecosystems identified in the ESIA as 'garden', 'fallow brush land', 'grasslands', as well as areas of farmland and oil palm nearer the coast. Although this is a coarse classification, grasslands in lowland Melanesia are, for the most part, not natural ecosystems and are comprised largely of non-native or widespread generalist species.

Despite some degradation of forest and some incursion of invasive species – particularly in the mid-reaches and closer to the river – the majority of the discrete management unit away from the coast remains largely forested and ecologically functional. Therefore, the forests of the majority of the Tina watershed can be considered natural habitat (covering 192 km² of the DMU). It is more challenging to

assess the current level of functionality in the freshwater ecosystems. There has clearly been some level of degradation from gravel mining and fishing, as well as general household use, but it appears that these ecosystems retain the majority of their original ecological functionality and thus that the Tina River and tributaries can be considered natural habitat.

Many of the terrestrial areas of natural habitat within the DMU (covering 184 km²) are also considered critical habitat (see below), owing to the intact nature of their restricted ecosystems and the unique assemblages of species they contain, including two very restricted birds and one reptile.

10.9.1.3 Biodiversity Which May Qualify the Area as Critical Habitat

Table 10-6 summarizes the candidate critical habitat-qualifying biodiversity identified within this ESIA as actually or potentially present. In each case, reasons are identified for each biodiversity feature likely meeting or not meeting critical habitat. Two categories of biodiversity that might qualify the area as critical habitat, considered briefly here, are areas that provide key ecosystem services and areas with biodiversity that has significant social, cultural or economic importance to local communities.

Table 10-6 Triggers and qualifiers for critical habitat in Project Area

Trigger	Biodiversity/Species	Discussion	Qualification
<p>(i) critically endangered and endangered species - only species assessed globally by IUCN are included since there is no national Red List. Species are included if they were found during surveys, or there is indication of their presence from literature.</p>	<p>Emperor Rat (<i>Uromys imperator</i>)</p>	<p>This globally Critically Endangered species is only known from northern Guadalcanal. There have been no confirmed sightings since the last specimen was collected in 1888, although local sightings reported by Flannery (1995) suggest that the species' range receded to higher mossy forest and that it persisted there until at least the early 1960s. It appears that this species was largely terrestrial, and so invasive species (e.g., predation from feral cats or disease from introduced rats) may thus have had significant impacts on the species' range and distribution. Even if the species is not yet globally Extinct, it seems unlikely that the project area continues to hold this species, given that it is partially degraded and already significantly impacted by invasive species.</p>	<p>Area does not qualify as critical habitat for Emperor Rat.</p>
	<p>White-eyed Starling (<i>Aplornis bruneicapillus</i>)</p>	<p>This Endangered bird occurs rarely and patchily on at least Guadalcanal, Choiseul, Rendova and Bougainville, but is very poorly-known and may occur more widely. While the species does appear to have some reliance on primary forest for nesting (in colonies in trees with high epiphyte cover), it also regularly feeds in semi- and heavily-degraded areas, where small fruit trees provide abundant food (Guy Dutson, <i>in litt.</i> 2017; Chris Filardi, pers. comm. 2017). While project surveys did not detect the species, it is not always easy to find during field surveys even when present (Chris Filardi, pers. comm. 2017), is most regularly observed nearby (at Mount Austen, around five miles from the project site), and appears to have seasonal or interannual movements which are not yet understood. There is thus potential for the species to use the project area, for example on a seasonal or periodic basis in response to fruit availability.</p>	<p>In the absence of any evidence of its presence, it is recommended that the area should not be considered as critical habitat for the species. It would, however, be advisable to put in place some adaptive management by implementing low-level monitoring for the species over the project lifetime, and help to protect nesting colonies should they be located in the project area.</p>
	<p>King Rat (<i>Uromys rex</i>)</p>	<p>This species is globally Endangered, and only known from a small number of records. In contrast to the Emperor Rat, this species is arboreal and thus more likely to be able to resist impacts from (more terrestrial) invasive species. Although likely to prefer primary forest, it has been recorded relatively recently (in 1988) even from a patch of remnant forest close to Honiara (Flannery 1995). In 1989, two individuals were captured at 600m elevation at Gold Ridge, very close to the project. A local</p>	<p>Recommended that the area should not be considered as critical habitat for the species, but <i>the project should act as though the area might be critical habitat for King Rat and so ensure that appropriate</i></p>

Trigger	Biodiversity/Species	Discussion	Qualification
		<p>hunter (per Kevin Jeanes, December 2016) reported the species was last seen in the Tina catchment in the 1980s. Relatively recent records in and near the project area, and some apparent tolerance of the species to forest fragmentation and invasive species, suggest that the King Rat may still persist in the project area. The absence of records on project surveys should not be taken as evidence of the species' absence, since it is extremely difficult to survey for rare, nocturnal, arboreal rodents.</p> <p>The species' area of occupancy is considered to be less than 500 km² (Helgen <i>et al.</i> 2016). The discrete management unit includes about 192 km² of forest which might be considered natural habitat and thus potentially suitable for this species. On a precautionary basis, and given that the population distribution of this species is not well understood, this watershed could thus potentially be considered of significant importance to the King Rat, and the loss of the area could potentially impact the long-term survivability of the species. On such a precautionary basis, the area would qualify as critical habitat for King Rat (IFC 2012, Criterion 1d). In the absence of any evidence of its presence, however, it seems over-precautionary to treat the area as critical habitat for the species.</p>	<p>mitigation and offset measures are in place.</p>
<p>(ii) endemic or restricted-range species - species were considered restricted-range if their global extent of occurrence was 50,000 km² or less (for terrestrial vertebrates) and 20,000 km² or less (for freshwater fish). Species are included if they were found during surveys, or there is indication of their presence from literature. 'Endemism' <i>per se</i> was not considered – this can be a useful approach for species such as plants for which distributions are poorly known, but is less useful for</p>	<p>Solomons Flying Fox (<i>Pteropus rayneri</i>)</p>	<p>This Near Threatened bat species has an extent of occurrence of 29,500 km². It is known from the project area, and occurs more widely across the Solomon Islands – as well as on Bougainville and Buka in Papua New Guinea (Hamilton & Leary 2008). While this is a restricted-range species, it is still relatively widespread and the project DMU is too small in its entirety to hold 1% of the species' global population.</p>	<p>This species thus does not qualify the project area as critical habitat.</p>
	<p>Malukuna Webbed Frog (<i>Cornufer malukuna</i>)</p>	<p>This species, sometimes known as <i>Discodeles malukuna</i>, is stated by Richards & Parker (2004a) as known only from the vicinity of the type locality, which lies in the upper Tina River catchment. It has since, however, been found on several islands throughout the New Georgia group and may potentially be patchily more widespread in the Solomon Islands (Scott Travers, <i>in litt.</i> 2017)</p>	<p>It is unlikely to qualify as a restricted-range species, or to qualify the area as critical habitat.</p>
	<p>Schmidt's Crocodile Skink (<i>Tribolonotus schmidtii</i>)</p>	<p>This restricted-range species is listed as potentially present in the project area by the ESIA, based on occurrence nearby (ESIA Appendix C). It is considered</p>	<p>It is unclear whether this species qualifies the area as critical habitat but, even if it</p>

Trigger	Biodiversity/Species	Discussion	Qualification
<p>better-known vertebrate species (many of which, in the Solomon Islands, are endemic to just several islands). Based on current knowledge, none of the plant species observed during ESIA surveys appear to have a restricted-range (the most restricted being <i>Palaquium firmum</i>, potentially endemic to the Solomon Islands, and <i>Syzygium onesima</i>, which appears to be restricted to the eastern Papua New Guinea islands and the Solomon Islands).</p>		<p>very common in forest on Guadalcanal between sea level and 1,500 m (Harlow 2013), so it is surprising that it was not recorded during ESIA surveys. If it does occur in the Tina River watershed, the area may well hold more than 1% of its population or distribution (given that the watershed holds c. 180 km² of Natural Habitat within its elevation range, representing about 3% of the known range of the species). In the absence of any evidence of its presence, however, it is recommended that the area should not be considered as Critical Habitat for the species. In any case, the species does not face any particular threats other than habitat loss, so impacts and necessary mitigation measures would very much reflect those for the forest as a whole.</p>	<p>does so, no additional mitigation or offset measures are foreseen to be necessary</p>
	<p>Guadalcanal Bow-fingered Gecko (<i>Cyrtodactylus biordinis</i>)</p>	<p>This fairly common restricted-range species occurs only on Guadalcanal. It is known from elevations of 300-500 m, rarely lower, and mainly lives on smaller trees and vines in the understorey of forest (Allison 2013). It appears to have been recorded from the project area, on the basis of local knowledge (ESIA Appendix C). Within the project DMU, there is only about 33 km² of suitable habitat. Nonetheless, given the limited range of this species, this is likely to represent more than 1% of the species' global distribution and population.</p>	<p>Pending confirmation that the species does occur in the project area, it is quite possible that Guadalcanal Bow-fingered Gecko qualifies the Tina River watershed as critical habitat. Pending further information on the distribution and ecology of this species in the project area, higher quality forest between 300-500 m elevation within the project DMU is preliminarily assessed as critical habitat for this species.</p>
	<p>Solomons Bent-toed Gecko (<i>Cyrtodactylus salamonensis</i>)</p>	<p>This Near Threatened species is stated to have an extent of occurrence of less than 10,000 km² (McCoy 2013), and so qualifies as a restricted-range species. It has not yet recorded from the project area, but does appear to occur nearby (ESIA Appendix C) and so may yet be found in the project area. It is a lowland species, being found in undisturbed and moderately disturbed forests up to 400 m elevation. As such, the Tina Watershed offers relatively little remaining habitat of suitable quality for this species, and is unlikely to hold more than 1% of its population or distribution.</p>	<p>This species thus does not qualify the project area as critical habitat.</p>

Trigger	Biodiversity/Species	Discussion	Qualification
	Faro Island Treefrog (<i>Litoria lutea</i>)	This is considered a restricted-range species by Richards & Parker (2004b) and is listed as potentially present in the project area by the ESIA. It is not clear, however, that this species' extent of occurrence is <50,000 km ² , and thus whether it actually qualifies as restricted-range.	It is not considered to qualify the area as critical habitat
(ii) endemic or restricted-range species...continued	San Cristobal Treefrog (<i>Papurana krefftii</i>)	This species, sometimes known as <i>Hylarana krefftii</i> , is stated by Richards & Parker (2004c) as likely to have an extent of occurrence of <20,000 km ² . It would thus qualify as a restricted-range species. However, as well as being widespread in the Solomon Islands it is known from New Ireland and Buka in Papua New Guinea.	While it has a small overall area of occupancy, it has an extent of occurrence exceeding 50,000 km ² and does not qualify the project area as critical habitat
	Guadalcanal Rail (<i>Hypotaenidia woodfordi</i>)	Guadalcanal Rail is a Near Threatened bird known only from Guadalcanal, with an estimated range of 6,500 km ² (BirdLife International 2017a). It occupies grassland and thickets up to c. 600 m elevation (Dutson 2011). The project DMU contains c. 51 km ² of Modified Habitat, of which a subset (and some degraded Natural Habitat) is likely to be suitable for this species.	Seems unlikely that the DMU holds more than 1% of the species' global range or population, and thus this species does not qualify the project area as critical habitat.
	Buff-headed Coucal (<i>Centropus milo</i>)	Buff-headed Coucal has a range of almost 47,000 km ² and also occurs on several other islands, including New Georgia, Vella Lavella and Rendova (BirdLife International 2017a). It has been observed in the project area, but the Tina Watershed as a whole is too small in comparison to the species' distribution to be likely to hold more than 1% of the population of this species.	Does not qualify the project area as critical habitat.
	Guadalcanal Boobook (<i>Ninox granti</i>)	Guadalcanal Boobook has been recently recognized as a bird species separate from <i>Ninox jacquinoti</i> (BirdLife International 2017a). It is considered Vulnerable and is known only from forests up to 1,500 m elevation on Guadalcanal (BirdLife International 2017a). It occupies grassland and thickets up to c. 600 m elevation (Dutson 2011). The project DMU contains c. 180 km ² of forest within this elevational range, representing about 3% of the known range of this species. It thus seems quite possible that the DMU holds more than 1% of the species' global range or population.	<i>It is quite possible that Guadalcanal Boobook qualifies the Tina River watershed as critical habitat.</i> Without further information on the distribution and ecology of this species in the project area, higher quality forest within the project DMU is preliminarily assessed as critical habitat for this species.
	Black-headed Myzomela (<i>Myzomela melanocephala</i>)	This fairly common restricted-range species occurs only on Guadalcanal, including in the project area, and nearby Nggela Sule. It has a range estimated at 10,200 km ² (BirdLife International 2017a) and occurs up to 1,550 m elevation (Dutson 2011). The project DMU contains c.	<i>It is quite possible that this species qualifies the Tina River watershed as critical habitat.</i> Without further information on the

Trigger	Biodiversity/Species	Discussion	Qualification
		180 km ² of forest within this elevational range, representing about 1.7% of the known range of this species.	distribution and ecology of this species in the project area, higher quality forest within the project DMU is preliminarily assessed as critical habitat for this species.
(ii) endemic or restricted-range species...continued	Other potentially restricted-range birds	White-eyed Starling is considered a restricted-range species and has the potential to occur in the project area – dealt with under trigger (i). Another set of observed species were considered restricted-range by Stattersfield <i>et al.</i> (1998) but current information (BirdLife International 2017a) clarifies that their extents of occurrence exceed 50,000 km ² , and they can thus no longer be considered restricted-range. ⁷⁴	
	Restricted-range fishes	Three <i>Schismatogobius</i> (<i>S. cf. ampluvinculus</i> , <i>S. cf. marmoratus</i> and <i>S. cf. roxasi</i>) and three <i>Stiphodon</i> (<i>S. cf. atropurpureus</i> , <i>S. cf. multisquamus</i> and <i>S. cf. ornatus</i>) were found, but not conclusively identified, by ESIA surveys (R. Hevalao, <i>in litt.</i> 2017). This is understandable, given the paucity of information available to draw from in identifying freshwater fish in the Solomon Islands. The known range of the six species which these specimens resembled (e.g., <i>S. ampluvinculus</i>) suggests that these actually represent other species.. Knowledge of <i>Schismatogobius</i> taxonomy and distribution is advancing rapidly, with many new species described to science recently from the Pacific – including three that occur in the Solomon Islands (Keith <i>et al.</i> 2017). It is quite possible that some of these unidentified fishes represent species described by Keith <i>et al.</i> (2017), or described by those authors as now known from the Solomon Islands. An alternate possibility is that these represent undescribed	If any are identified as <i>Schismatogobius</i> or <i>Stiphodon</i> species known from the Solomon Islands, many of these are known to be restricted-range species and would be likely to qualify the Tina River and its tributaries as Critical Habitat. Any undescribed fish species would inherently likely be restricted-range and thus qualify the Tina River and its tributaries as critical habitat , and represent a significant risk to the project. As such, the project should

⁷⁴ These species comprise Sanford's Sea-eagle (*Haliaeetus sanfordi*); Red-knobbed Imperial-pigeon (*Ducula rubricera*); Crested Cuckoo-dove (*Reinwardtoena crassirostris*); Solomons Corella (*Cacatua ducorpsii*); Yellow-bibbed Lory (*Lorius chlorocercus*); Green Pygmy-parrot (*Micrositta finschii*); Chestnut-bellied Monarch (*Monarcha castaneiventris*); Solomons Pied Monarch (*Symposiachrus barbatus*); Midget Flowerpecker (*Dicaeum aeneum*); Brown-winged Starling (*Aplonis grandis*); White-billed Crow (*Corvus woodfordi*). A further set of such species were considered potentially present in Appendix D of the ESIA: Melanesian Scrubfowl (*Megapodius eremita*); Yellow-banded Fruit-dove (*Ptilinopus solomonensis*); Pale Mountain-pigeon (*Gymnophaps solomonensis*); Cardinal Lory (*Chalcopsitta cardinalis*); Duchess Lorikeet (*Charmosyna margarethae*); West Solomons Boobook (*Ninox jacquinoti*); Solomon Cicadabird (*Edolisoma holopolium*); White-winged Fantail (*Rhipidura cockerelli*).

Trigger	Biodiversity/Species	Discussion	Qualification
		species. Fish from some other genera (<i>Apogon</i> , <i>Caranx</i> , <i>Scomberoides</i> , <i>Gerres</i> , <i>Polydactylus</i> , <i>Redigobius</i> , <i>Stenogobius</i> , <i>Lentipes</i> and <i>Sicyopus</i>) were not identified to species, leading to similar concerns. All of these fish species urgently need identification.	pursue accurate identification of collected specimens of these fishes as soon as possible.
(iii) migratory or congregatory species	Common Sandpiper (<i>Actitis hypoleucos</i>)	This is the only species identified in the ESIA which is migratory. It is globally common and widespread, and winters regularly in the Solomon Islands. The population of the species in the project area is likely to be considerably less than 1% of the species' global population.	This species thus does not qualify the project area as critical habitat.
(iii) migratory or congregatory species...continued	Solomons Flying Fox (<i>Pteropus rayneri</i>)	This restricted-range bat species often roosts in large colonies. As assessed for trigger (ii), the project DMU is too small in its entirety to hold 1% of the species' global population.	This species thus does not qualify the project area as critical habitat.
	Admiralty Flying Fox (<i>Pteropus admiralitatum</i>)	The ESIA considers this poorly-known colonial bat species as possibly present in the project area. It may actually comprise several different species, of which one would be restricted to the islands of Western Province, Guadalcanal and Malaita. In the absence of any evidence of its presence, it is recommended that the area should not be considered as Critical Habitat for the species. Even if the species was found to be present, the species' extent of occurrence is more than 67,000 km ² .	The project area would not contain a significant enough proportion of its population to be considered critical habitat
	Geoffroy's Rousette (<i>Rousettus amplicaudatus</i>)	This colonial bat species may ultimately be found to contain more than one species (Csorba <i>et al.</i> 2008). However, as currently understood, it has a very wide range across South-East Asia and Melanesia. Given this wide distribution, the project area is very unlikely to hold more than 1% of the species' global population.	This species thus does not qualify the project area as critical habitat.
(iv) unique assemblages of species that are associated with key evolutionary processes - the Solomon Islands are notable for their high levels of bird and mammal endemism, because their fauna has a continental origin, but many of the islands – including Guadalcanal – have experienced long-term isolation owing to deep	Solomon Islands Rainforest	Most of the project area was originally covered by forest, classified by WWF as one ecoregion, 'Solomon Islands Rainforest' (Wikramanayake <i>et al.</i> 2001). This has a small global extent (c. 36,000 km ²) and holds a particularly unique assemblage of species (e.g., 90 endemic or near-endemic bird species). The value of this ecosystem on Guadalcanal is acknowledged by other authorities. For example, CEPF (2012) and BirdLife International (2017b) recognize the 'Guadalcanal Watersheds' area as a Key Biodiversity Area and Important Bird Area, respectively. Further, the interior forests of Guadalcanal around Mount Popomanaseu – including the upper reaches of the Tina River watershed – were proposed in 2008 by the	Solomon Islands Rainforest qualifies the project area as critical habitat

Trigger	Biodiversity/Species	Discussion	Qualification
<p>marine trenches between islands.</p> <p>Unique assemblages of species can often be identified by their association with 'highly threatened and/or unique ecosystems' (GN90-93). Martin <i>et al.</i> (2015) make a first, global-level assessment of which marine ecosystems might qualify as critical habitat under this criterion, and a similar effort is ongoing for terrestrial ecosystems. In the current absence of an assessment of which terrestrial ecosystems might qualify as critical habitat, it is necessary to assess whether any ecosystems in the project area might be considered 'highly threatened' or 'unique'. The most useful ecosystem classification, while imperfect, is that of the WWF eco-regions, since it has achieved global coverage and thus allows global comparison.</p>		<p>Government of the Solomon Islands as the 'Tropical Rainforest Heritage of Solomon Islands' World Heritage Site.</p> <p>This ecosystem can be considered to comprise those forest types identified in the ESIA as relatively intact, namely 'undisturbed forests', 'montane forests' and 'riparian', totaling about 184 km² in the DMU. The riparian ecosystem is naturally more disturbed and less forested than the other two, but is included here on a precautionary basis. It is clear that actual project impacts on high quality areas of Solomon Islands Rainforest will be small (c. 32 ha of direct footprint and increased access with potential to induce additional clearance), direct project impacts on this ecosystem are not considered significant, given the small scale of project residual impacts compared to the extent of the ecosystem.</p>	
<p>(v) areas having biodiversity of significant social, economic, or cultural importance to local communities (including ecosystem services)</p>	<p>Section 8.1.6.2 - ESIA discusses local livelihood strategies, including – relying on biodiversity – small-scale timber-milling and a fishery at mouth of the Tina River.</p> <p>Sections 8.1.11.5-7 – ESIA expand on local use of natural resources.</p> <p>Section 8.1.11 - ESIA discusses natural capital.</p>	<p>The forests of the project area and Tina Watershed are important to local communities for:</p> <ul style="list-style-type: none"> • timber and non-timber materials for housing (i.e., timber, loya cane, thatch, bamboo, and bark): • game wildlife for hunting, such as wild pigs, possums, flying foxes, lizards, skinks, frogs, hornbill, pigeons, and ducks: • plants used for medicinal purposes and magic; • wild foods such as fruits, wild palm, wild yam, various nuts, and ferns, megapode eggs, and emergency foods when required; • materials for handcrafts, such as baskets; 	<p>It is clear that the forests of the Tina Watershed are important not only in their own right, but also in providing ecosystem services for local communities living in the area. However, there is little precedent for this use to qualify the area as critical natural habitat.</p>

Trigger	Biodiversity/Species	Discussion	Qualification
	Section 8.2.3 - ESIA discusses cultural heritage sites.	<ul style="list-style-type: none"> · regulation of run-off from the heavy rains that occur on Guadalcanal especially around the high mountains, and climate regulation; and · aesthetic appeal, and places for recreation and relaxation. <p>Cultural heritage sites, appear to be site- or history-based, rather than biodiversity-based</p>	

10.9.1.4 Impacts on Critical and Natural Habitat

Direct project impacts on the various ecosystems in the project area are summarized in Table 10-7.

Table 10-7 Estimation of direct project impacts on terrestrial critical, natural and modified habitat

Habitat type	Ecosystem	Direct impact area
Critical Habitat	Undisturbed forests	9.54
	Montane forests	0
	Riparian	21.62
Sub-total - critical habitat		31.16
Natural Habitat	Disturbed forests	29.65
	Remnant forests	21.87 (of which 10 ha is temporary)
	Cliffs	16.12
Sub-total - natural habitat, including critical habitat		98.80
Modified Habitat	Grasslands	6.09
	Garden	0
	Fallow brush land	6.40
Sub-total - modified habitat		12.49
Total		111.29

Project direct impacts on critical habitat total just over 31 ha (Table 10-7), or about 0.3% of critical habitat within the catchment. Moreover, the majority of Guadalcanal remains forested, with much of that area still in a good condition and thus representing critical habitat for similar reasons. Direct project impacts on critical habitat are thus not considered significant, and will not impair the critical habitat's high biodiversity value or ability to function. Induced project impacts present more of a risk.

The scale of indirect impacts on critical habitat are difficult to predict. As a first estimate, it is estimated that induced residual impacts on terrestrial critical habitat will be of a similar scale to direct impacts (e.g., complete loss of another 32 ha of forest; or a halving in condition of a wider area of 64 ha of forest). This estimate is likely precautionary.

Direct project impacts on undisturbed forests represent <0.2% of the extent of this forest type in the Tina catchment, with further impacts on riparian forest. Project direct impacts on Natural Habitat total almost 100 ha, or about 0.5% of natural habitat within the catchment. The majority of Guadalcanal remains forested natural habitat, with much of that area still in a good condition. Direct project impacts on natural habitat might thus not be considered significant at the scale of Guadalcanal, or even at the scale of the Tina River watershed. Nonetheless, the project is committed to achieving no net loss of natural habitat.

Two bird species were identified as qualifying forests in the Tina River watershed as critical habitat. These have the potential to be impacted by the project in similar ways, mostly related to loss and degradation of forest habitat. Induced access from the Black Post Road extension could lead to small-scale logging, degradation or fragmentation of forests. The project ESMP contains a set of good practice mitigation measures which have the potential to benefit both species, including: minimizing footprint; preventing disturbance from construction workers; preventing access along this road by non-local people; and restrictions on settlement along the road by local people. Project

impacts on these species are not considered likely to differ significantly from those on forest more generally.

The Tina River and its tributaries represent natural habitat. The project is expected to result in unavoidable short-term impacts on water quality during construction and long-term impacts on flow regimes. Mitigation has been planned to avoid and minimize these impacts as much as possible, based on current information.

10.9.1.5 Offsets for Residual Impacts

The developer has committed to development of a Biodiversity Management Plan (BMP), with the objective of achieving no net loss of biodiversity as a result of natural habitat conversion. This BMP will be in place at least one month prior to the Engineering Procurement and Construction mobilizing to the field. The BMP will include an offset comprising measures to protect the remaining natural habitat in the Core Area (ESIA Appendix K) and a program to rehabilitate at least 9.5 ha of modified habitat (ESIA Section 10.7.1.1.2; ESIA Appendix P). It is proposed to rehabilitate forest in an area adjacent to an unused logging road, impacted by previous logging operations.

Direct impacts on natural habitat are likely to affect c. 100 ha, of which c. 32 ha comprise critical habitat. Given the absence of quantitative spatial estimates of the scale of indirect impacts on forest ecosystems, first estimates here are that these will be at a similar scale to direct impacts, i.e. another 100 ha of natural habitat, of which c. 32 ha comprise critical habitat. Given these preliminary assumptions, the project is assumed to result in residual impacts of c. 200 ha of natural habitat (including c. 64 ha of critical habitat). Refined estimates are presented in Table 10-8.

Assessment of project offset needs requires quantification of the scale and severity of project impacts. No significant residual impacts are currently expected for species, beyond those for which their habitat already represents a useful proxy. Offset estimates regularly use 'extent × condition' metrics⁷⁵ (e.g., quality hectares or QH) to account for variable quality of impacted ecosystems and varying severity of impacts. A pristine or 'benchmark' ecosystem would be judged to be 100% quality. In general, the critical habitat areas are essentially in natural/undisturbed/pristine condition (e.g., Appendix F) and may thus – for the purposes of this exercise – be taken as a 100% benchmark condition. Appendix F and Section 6.3.5 note that many non-critical natural habitat areas of 'disturbed' forest in the project area have been affected by logging and only have a moderate ecological value, although they still show rich plant diversity, and rapid vegetation regeneration. For the purposes of this assessment, these are classed as of 60% condition. Some ('remnant forest') areas are stated to have undergone extensive disturbance, with few large remaining trees. For the purposes of this assessment, these are classed as of 30% condition.

Table 10-8 Preliminary estimation of residual impacts on terrestrial critical and natural habitat

Habitat type	Ecosystem	Impact area (ha)			Ecosystem condition ('quality')	Impact (Quality Hectares)
		Direct	Indirect (estimated)	Total		
Critical habitat	Undisturbed forests	9.54	9.54	19.08	100%	19.08
	Riparian	21.62	21.62	43.24	100%	43.24
Sub-total - critical habitat		31.16	31.16	62.32	-	62.32
	Disturbed forests	29.65	29.65	59.30	60%	35.58

⁷⁵ e.g., see Parkes *et al.* (2003) Assessing the quality of native vegetation: The 'habitat hectares' approach. *Ecological Management and Restoration* 4, supplement.

Natural habitat	Remnant forests	11.87 ⁷⁶	11.87	23.74	30%	7.12
	Cliffs	16.12	16.12	32.24	100%	32.24
Sub-total - natural habitat, including critical habitat		88.80	88.80	177.60	-	137.26

ESIA Appendix K outlines the opportunity for protection of an extensive area of critical habitat in the upper watershed of the Tina River of up to 12,5000 ha. This opportunity is at a very early stage of consideration, and considerable engagement with stakeholders, in particularly the customary landowners of the upper catchment, will be necessary before it is clear whether there is sufficient support to protect the area.

An offset as proposed would represent an ‘averted loss’ offset in which offset gains comprise the area of forest which would have been expected to have been lost in the absence of the offset action. In Solomon Islands, particularly at higher altitudes, the most likely reason for forest loss is logging. At a national level, annual deforestation rates have been estimated at about 0.2%/year (FAO 2015). Real rates are likely to be higher, but to disproportionately impact more accessible area at lower elevations nearer coasts. In the absence of any data specific to the project area, a precautionary baseline to estimate offset gains might be 0.1%/year, and that this would relate to heavy deforestation (resulting in an ecosystem of lower quality than that considered ‘remnant forest’ in the ESIA, assumed here to be of only 10% quality). The life of the project, and its accompanying offset, is expected to be very long-term. However, for the purposes of no net loss assessments, a reasonable timescale such as 25 years is usually taken.

An offset as proposed might thus be expected to produce 11.25 QH of gains in its first year (0.001 [deforestation rate averted] × 0.9 [quality loss averted] × 12,500 [offset area]). Over 25 years, this would equate to approximately 300 ha, more than double the necessary level to compensate for project residual impacts of c. 138 ha (Table 2, Section 4.1). Despite considerable uncertainties and major (albeit largely precautionary) assumptions, it thus appears very likely that the proposed offset model would – if successfully implemented – be sufficient to allow the project to achieve No Net Loss with regard to terrestrial impacts.

10.9.1.6 Achieving No Net Loss of Biodiversity

The Project’s proposed mitigation measures will help to ensure the direct impacts of vegetation clearing are confined to the 115 ha. However, Performance Standard 6 (PS 6) and SPS policy principle 8 require that when natural habitat is degraded or converted, as 31.16 ha will be directly, and 62.31 ha will be indirectly, measures will be designed to achieve no net loss of biodiversity where feasible. With respect to the potential impacts on critical habitat, PS 6 and SPS require that net gains shall be achieved for the biodiversity values for which the habitat was designated. To achieve these outcomes, the Project will take steps to protect the upper catchment biodiversity from threats of extractive industries (see Appendix K).

The protection of the upper catchment is conceived as a staged approach reflecting the ownership of the land by indigenous customary landowners. Immediate protection measures will include actions of the TCLC and Project Company to restrict access to vehicles (including commercial logging machinery) to the upper catchment through the Core Area, to monitor changes in forest

⁷⁶ An additional 10 ha represents temporary footprint for topsoil storage. The project plans to restore this area afterwards. It is likely that restoration will be able to restore this area to the previous low condition (‘30%’), so this 10 ha is omitted from calculations here.

coverage in the upper catchment, to monitor logging truck activity on existing logging roads, and to support SIG to enforce seldom used statutory restrictions on logging at elevations above 400 masl. If enforced, these restrictions would protect the vast majority of the upper catchment from the most significant biodiversity threat. This protection work will be furthered by Project Office funding for an NGO to facilitate consultations with landowners to seek support for the creation of a protected area in the upper catchment and to conduct mapping and forestry studies, towards preparation of a management plan.

In addition to upper catchment offset activities, the Project Company will implement measures including a post construction rehabilitation plan for disturbed areas, and an offset within the Core Area which will include measures to protect the remaining natural habitat in the Core Area, and to rehabilitate an area of modified habitat within the Core Area of at least 9.5 ha. These measures will be set out in the Biodiversity Management Plan (the TOR for which is provided in Appendix P).

With appropriate restrictions on access, impacts on critical habitat of deforestation and degradation from project-induced access are likely to remain low in the short-medium term. These are very unlikely to impair the critical habitat's high biodiversity value or ability to function at any meaningful scale (compared to the current extent of Solomon Islands Rainforest across the island).

Mitigation and offset measures already designed for forests are thus appropriate and sufficient to achieve no net loss for the two bird species qualifying the area as critical habitat. On a precautionary basis, the project should act as though the area might be critical habitat for King Rat and White-eyed Starling. If present, these have the potential to be impacted by the project in similar ways to the birds listed above, but also by induced increases in access leading to increased hunting or spread of invasive species which may compete with, predate or spread disease to these species. The project ESMP contains good practice mitigation measures which have the potential to benefit both species, including: preventing hunting from construction workers; preventing access along this road by non-local people; restrictions on settlement along the road by local people; and setting up an invasive species management program (see also Appendix P). It would be advisable for the BMP to include a low-level surveillance program for these species, in order that mitigation can be adapted/enhanced should the species be found in the area during the project life. Such surveillance could be achieved at low cost by, for example, developing simple posters with small rewards for anyone who finds these species in the area and can take project staff to see them alive.

10.9.1.7 Conclusions

The undisturbed (both lowland and montane) forests in the watershed are globally restricted as an ecosystem type and hold a particularly unique assemblage of species. This, their recognition as part of a Key Biodiversity Area, Important Bird Area and proposed World Heritage Site, and their importance in providing ecosystem services for local communities, mean that the upper and outer forests of the Tina watershed qualify as critical habitat. Two restricted-range bird species (Guadalcanal Boobook and Black-headed Myzomela) and one reptile (Guadalcanal Bow-fingered Gecko) also appear to qualify the Tina watershed as Critical Habitat.

Direct impacts on this critical habitat appear to be non-significant, given the remaining extent of high quality forest on Guadalcanal. Nonetheless, significant risks remain of induced increases in clearing of upper watershed forest. These will need to be carefully managed.

It is possible that the endangered King Rat and White-eyed Starling might also remain undetected in the area and – if present – would also qualify it as critical habitat.

Direct and indirect impacts on natural habitat are small, but not insignificant. Mitigation has been systematically identified in order to minimize impacts, but residual impacts will necessarily require

offsets. A staged offset program has been proposed, in order to compensate for project residual direct and indirect impacts on terrestrial critical and natural habitat. Together with mitigation measures, the proposed offset would allow the project to achieve No Net Loss for terrestrial biodiversity.

10.10 OVERALL CONCLUSIONS REGARDING IMPACTS ON TERRESTRIAL ECOSYSTEM

The operation of the hydropower facility will not directly affect terrestrial biodiversity, which will already have been adversely affected as a result of project construction. However, there may be some indirect effects, especially on wildlife species due to the improvements of access and possible river ford crossing opportunities to new habitats on either side of the river between the dam site and powerhouse, under the low flow conditions that will prevail.

Operation of the reservoir will not impact terrestrial wildlife, since there is no known diurnal or seasonal migration of terrestrial wildlife species across the area defined for the reservoir. The reservoir will occupy a steep-sided gorge that presently acts as a natural barrier to the movement of ground dwelling wildlife, but is not pose a physical impediment to avifauna, such as birds or bats, that are able to fly from one site to the other.

Some of the potential construction impacts will continue to affect terrestrial ecosystems during operation. These impacts are related to the access road and the advantages that it will bring for local communities. The access road will allow villagers and feral animals to move into the project area placing additional pressure on natural resources and wildlife. New impacts will also arise due to the presence and operation of the dam, such as shortage of water in riparian micro-wetlands along the Tina River, which will affect both amphibians and water dependent insects. Whether the access road will be beneficial to reptiles is difficult to assess. Some species such as snakes could benefit from forest openings while smaller species might be more vulnerable to feral cats and mortality from vehicle-wildlife interactions. Grassland birds will be able to colonize areas along the access road.

Mitigation measures are limited to raising awareness of with local communities, which could help to reduce pressure on natural resources along the access road.

Table 10-6 summarizes pre-mitigation impact ratings and post-mitigation residual impact significance determinations on fauna resulting from construction and operation.

Table 10-9 Summary of impacts on fauna from construction and operation of the Project

Group of animals	Construction		Operation		Species situation with Project operation
	Impact before mitigation	Residual impact	Impact before mitigation	Residual impact	
Native Rainforest Rodents	Low and improbable	Not significant	Low	Not significant	Species could be affected by human encroachment in newly accessible montane forest areas
Bats and marsupial	Low - Moderate	Low significance	Low – Moderate	Not significant	Opportunistic hunters and new settlers will create additional pressures on mammals. Residual impact low with mitigation measures.
Forest-dependent birds	Moderate	Low significance	Moderate	Low significance	Ongoing impact of low impact with mitigation measures
River dependent birds	Low	Not significant	Low	Not significant	Operation of the dam will bring forward new impacts on river dependent birds
Grassland and ubiquitous birds	Low	Not significant	Low (positive)	Not significant	New open areas created by the access road will be colonized by grassland and ubiquitous birds.
Amphibians	Low	Low significance	Low	Low significance	Cane toads will continue to colonize areas along the access road. Micro-wetlands along Tina River reach may suffer from water shortage
Reptiles	Moderate	Not significant	Neutral	Not significant	Some species will take advantage of forest openings other will suffer from ongoing feral cats predation

Group of animals	Construction		Operation		Species situation with Project operation
	Impact before mitigation	Residual impact	Impact before mitigation	Residual impact	
Wetland dependent insects	Low	Low significance	Low	Low significance	Micro-wetlands along Tina River reach may suffer from water shortage. New ATCZ habitats may arise.

11. ASSESSMENT OF IMPACTS ON THE BIOLOGICAL (AQUATIC) ENVIRONMENT

11.1 BACKGROUND

This section includes an analysis of hydrology, water quality, water use, sediment dynamics, fish and aquatic biota.

Four types of impacts can be described: direct impacts, indirect impacts, general impacts and cumulative impacts.

- Direct impacts are those that will likely accrue due to the Project footprint. These impacts are habitat-specific or species-specific, and are quantifiable.
- Indirect impacts are those that will take place as a consequence of the Project but with a degree of separation both temporally and spatially. These impacts are generally non-quantifiable since their extent and intensity are hard to predict.
- General impacts are those that will take place regardless of the Project specificity (e.g., noise from traffic, habitat fragmentation, oil spills, etc.), are not site-specific, and are not quantifiable. Best management practices help to address such impacts.
- Cumulative impacts are impacts arising from the Project that may add to or aggravate existing impacts from other existing or reasonably anticipated projects in the study area. Cumulative impacts are presented in Section 14.

11.2 ASSESSMENT METHODOLOGY

Impact assessment methodology for environmental components (both aquatic and terrestrial) is presented in Annex 19 of the Annex Report. Impacts significance has been applied using a standardized method based on the integration of the following steps:

- Identification of impact sources - the first step of the impact assessment is to determine which activities will have an impact on environmental components. This identification is done using an impact matrix.
- assessment of impacts using the criteria of impact duration, extent, magnitude / intensity, and probability of occurrence;
- application of mitigation measures; and
- determination of post-mitigation residual effects and significance, the latter being determined to be either Not Significant, or Significant.

Where a residual effect is deemed to be Significant, it falls to decision makers within government to determine whether the need for the project outweighs the concerns for potential, non-mitigable, significant impacts.

11.3 ACTIVITIES AFFECTING THE AQUATIC ENVIRONMENT

Activities that may affect the aquatic environment are, in most cases, the same as those described for terrestrial ecosystems in Section 10. However, the following additional activities related to operation of the dam and powerhouse will generate specific impacts on the aquatic environment:

11.3.1 Operation of the headrace tunnel

11.3.1.1 Reduced flows in the bypassed river section

The potential effects of hydroelectric dam developments are mostly related to the change in flows. Where there are large flow reductions, an environmental flow will usually be provided to prevent or mitigate potential detrimental effects of low or zero flow.

For the Tina River Hydropower Development Project, environmental flows will be required for the river reach between the dam and tailrace and downstream of the tailrace. The magnitude of the environmental flow will be the flow that provides an adequate amount of suitable habitat for the fish species in the river, as determined from an instream habitat survey and information of habitat use by the various fish species. No vulnerable or endangered species are anticipated to be present in the reduced flow section of river.

The necessary information on habitat use is gathered from a field survey to determine the relative densities of fish in the various habitats, depths and velocities present in the Tina River, in the vicinity of the tailrace. The instream habitat analysis uses a hydraulic model based on cross-sections surveyed in each of the habitat types, and habitat suitability models for the various species, as well as fish density and species richness. The model predicts how habitat suitability for the various species varies with flow.

A reduction in flow from the median flow of 11.1 m³/s to an environmental flow of 1 m³/s between the dam and the powerhouse reduces the water surface width by 27%, the average depth by 41%, and the average velocity by 68% (Table 11-1).

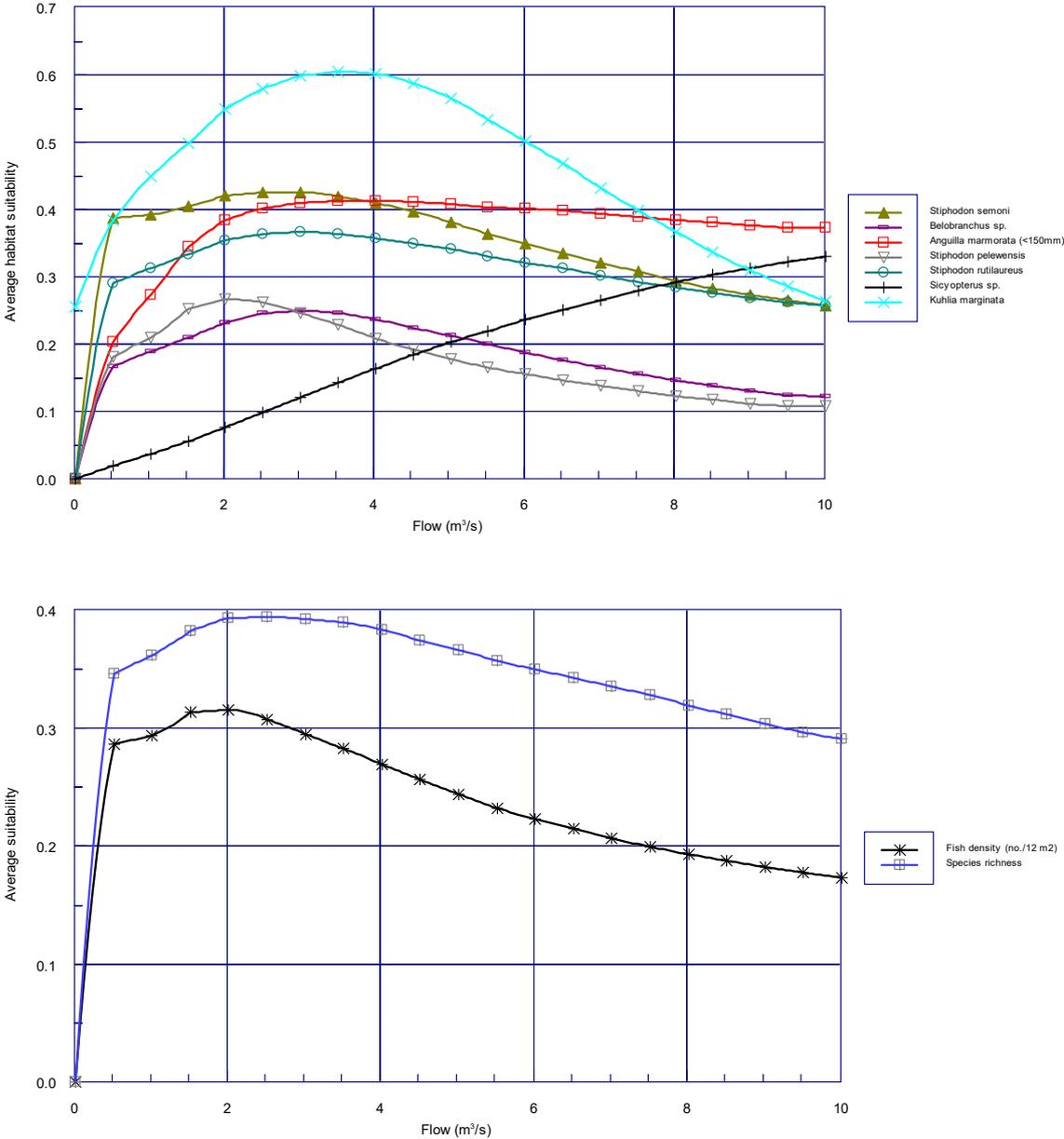
Table 11-1 Predicted variation of water surface width, average depth and width weighted average velocity with flow in the Tina River between the dam and powerhouse

Flow (m ³ /s)	Width (m)	Depth (m)	Velocity (m/s)
1	18.0	0.36	0.23
2	20.1	0.40	0.29
3	21.0	0.44	0.35
4	21.4	0.47	0.42
5	21.8	0.50	0.47
6	22.3	0.53	0.52
7	22.7	0.55	0.57
8	23.1	0.57	0.61
9	23.5	0.58	0.65
10	23.9	0.60	0.69

11	24.6	0.60	0.72
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The analysis of habitat variation with flow suggested that a flow of 2-4 m³/s would provide maximum habitat for most of the common species, fish density and species richness. Figure 11-1 shows the variation in average habitat suitability with flow for the 8 common fish species (upper) and for fish density and diversity (lower) in the reach between the dam and powerhouse. However for the species that live in very swift water (*Sicyopterus cyanocephalus* and *S. lagocephalus*), habitat suitability is greatest at flows greater than 10 m³/s.

Figure 11-1 Variation in average habitat suitability



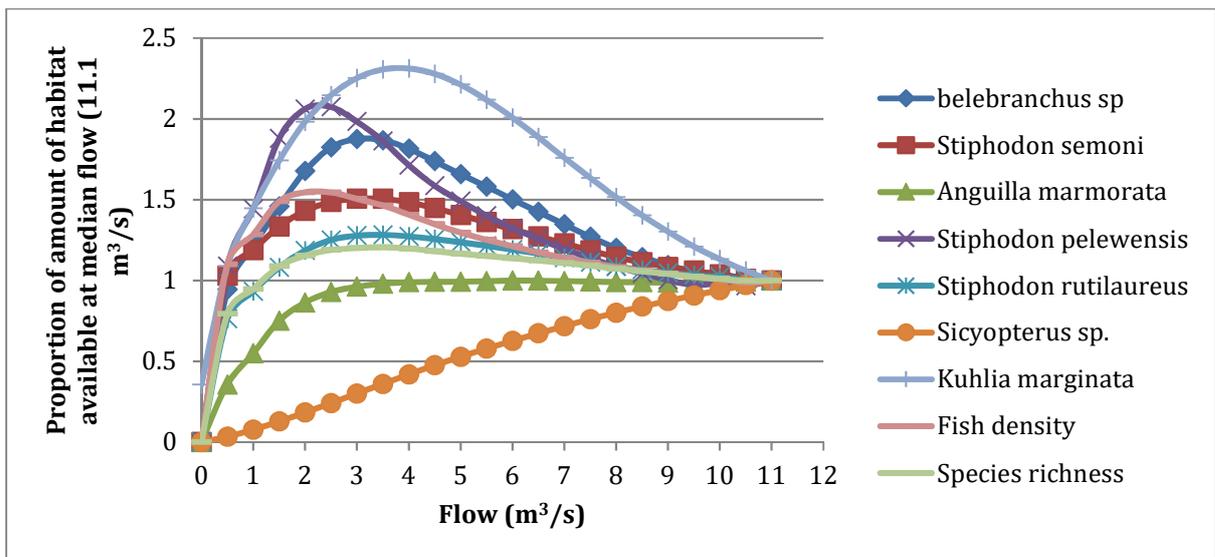
The standard of environmental protection provided by an environmental flow can be assessed by comparing the amount of habitat (m²/m of river length) at the environmental flow with the amount of habitat at median flow.

A flow of 1 m³/s would provide more habitat than is available at median flow for *Stiphodon semoni*, *Belobranchus* sp., *Stiphodon pelewensis* and *Kuhlia marginata* and a similar amount for *Stiphodon rutilaureus* (Figure 11-2). The only species showing significant decrease in modelled habitat availability are those in the *Stiphodon* genus which prefers higher flow conditions. While reduced habitat availability is probable at the environmental flow rate, population maintenance at reduced density is expected. The *Stiphodon* species identified in Tina River are widespread through the Western Pacific region from the Phillipines through New Guinea and the Bismarck Archipelgo, and do not have an endemic or endangered status.

Overall, fish density and species richness are likely to be greater with a flow of 1m³/s than with the median flow of 11.1 m³/s. The estimated fish density at an environmental flow of 1 m³/s is approximately 50 fish per 12 m². This is slightly less than the average of 60.4 fish/12m² observed in the Toni River and considerably higher than the 6.7 fish/12m² observed in the Tina River. Similarly, the estimated number of species per quadrat with an environmental flow of 1m³/s was 2.1 compared to the observation of 2.61 and 1.17 in the Toni and Tina rivers, respectively.

As illustrated in the second part of Figure 11-1, composite measures of species richness and density at the environmental flow level are modeled to be higher than at median flow levels. Species richness is expected to be 1.2 times higher than median flow, and species density to be 1.7 times higher.

Figure 11-2 Variation in habitat availability at median flow of 11.1 m³/s



At present, a large amount of sediment is transported through the steep, relatively narrow section of river between the dam and powerhouse sites. The movement of sediment during floods and in the deeper swifter areas of the river at normal flows reduces algal growth, benthic invertebrate production and fish habitat. The creation of a dam will prevent much of this sediment movement and will gradually coarsen the substrate. This will improve the fish habitat considerably, as the habitat observations showed a clear preference for coarse substrate and avoidance of deep swift water where sand was being transported along the riverbed.

The selection of an environmental flow depends on the balance between environmental effects and loss of generation, and the relative values placed on the environment and generation. Based on the available data, the amount of habitat provided by a 1 m³/s environmental flow is similar to the amount

of habitat at a median flow of 11.1 m³/s for most of the common fish species. Predicted overall fish density should be higher than at present and should be similar to that in the Toni River. A 1 m³/s flow would provide for fish passage and would maintain pool habitat for the pool dwelling species and good riffle habitat for the riffle dwelling species that comprise the majority of fish in the river. In addition, there would be an improvement in habitat quality resulting from a reduction in the amount of fine gravel and sand in the river channel.

The gradient of the Tina River between the tailrace and its confluence with the Toni River is less than the gradient between the dam and tailrace. Environmental flow requirements tend to increase as the gradient decreases, so that the flow requirement downstream of the tailrace would be higher than the flow requirement upstream of the tailrace. The critical period will be the off-peak hours in the evening, when the reservoir will be refilling. The recommendation is to maintain a discharge through the power house during that period at least equal to what is needed to operate one turbine at minimum capacity, i.e., 2.43 m³/s (which is desirable for other reasons discussed below). When added to the environmental flow of 1 m³/s and the varying amounts of inflow from the tributaries between dam and powerhouse, this would result in a minimum flow downstream of between 3.43 and 4.43 m³/s.

Entura (2015b) estimated that with a 1 m³/s environmental flow, potential long-term generation (powerhouse plus generator on environmental flow, less transmission losses) would be about 80.6 Gwh/a with 3 turbine/generator units compared to this report's estimate of 81.8 GWh/a (i.e., 83 Gwh/a less 1.2 Gwh/a transmission loss). The current design proposal does not include a generator on the environmental flow.

11.3.1.2 Disturbance of amenity values in the reduced flow section of the river

The reduction in mean flows in the Tina River between the dam and powerhouse tailrace will alter the channel size and form throughout this section. This together with changes in flow patterns will lead to a modification in the littoral zone and river bed associated wetted vegetation areas. These modifications will disturb existing amenity values of the river, which derive from its availability to provide access to water collection, recreational and clothes washing opportunities.

11.3.2 Operation of the dam and powerhouse

11.3.2.1 Changes in hydrology – Variability of flows

The river between the dam and powerhouse requires some flow variability, particularly for floods and freshets. The maximum capacity of the powerhouse and the amount of storage in the reservoir are not large compared to the flow in the river, and the sizes of floods and freshets. Thus, it is likely that there will be frequent periods of spill between the dam and tailrace. Simulation of the hydro operation indicated that floods or freshets would occur on average every 6 weeks, and their average duration would be between 4 to 6 days. This frequency is probably sufficient to prevent prolific periphyton (algae attached to substrate) accumulation in this low nutrient river.

11.3.2.2 Changes in hydrology – Hydro-peaking

Large scale hydro-peaking can severely affect fish and benthic invertebrates. During the dry season, the intention is to generate electricity at full discharge during the day and reduce to zero power station discharge during the night, leaving only the environmental flow in the river. This means that the flows

could fluctuate between 18 m³/s and the environmental flow on an almost daily basis. The maximum flow from the generators is relatively low compared to the magnitude of floods and freshes during the wet season, so that it is unlikely that fish habitat will be affected by hydro-peaking. Nonetheless, impacts remain a possibility given the very limited current understanding of fish habitat use at different times of year. Depending on the mobility of the species, there is the possibility of fish stranding and a reduction in benthic invertebrate and periphyton abundance. A reduction in periphyton or benthic invertebrates (as long as within natural variation) is unlikely to affect fish, because there is no evidence of a reduction in species richness during the wet season when there are frequent floods and freshets that reduce periphyton and benthic invertebrate abundance.

Local people make considerable use of the river, and sudden increases in water level can endanger people if they are caught in the river bed. Usually, a rate of rise of 0.3 m per hour is considered safe. Safe rates of change in flow were calculated from data collected at a wide riffle at the powerhouse tailrace site during the instream habitat survey. Water levels at this cross-section were measured at flows of 8.7 m³/s and 19.7 m³/s and a rating curve (relationship between water level and discharge) was developed. This indicated that a flow change from minimum generation (2.4 m³/s) to maximum generation (18 m³/s) will increase the water level by about 0.38 m. This is likely to be conservative since much of the river downstream of the tailrace is less confined than at the powerhouse tailrace location. Thus, it might be advisable to ramp up generation from minimum to maximum load over a period of 1 to 1.5 hours.

Sudden reductions in water level can strand fish. Therefore, it is recommended that an adaptive management approach be taken to determining whether ramping flows are needed to mitigate potential fish stranding. This would involve carrying out studies during initial operation to determine whether fish are stranded on sudden reductions in flow. If necessary, the rate at which flow is reduced (i.e., flow ramping) could then be decreased to see if that prevents stranding.

Maintaining the minimum flow downstream of the powerhouse of 3.43 m³/s, as recommended to preserve aquatic habitat, would also reduce the magnitude of fluctuations in flow and thus the risk to river users and the likelihood of fish stranding and interference with downstream water uses.

11.3.2.3 Reservoir establishment - Change from riverine to lacustrine (lake) habitat

The creation of the reservoir will replace about 2.6 km of riverine habitat with a reservoir (Entura 2014). The average width of the reservoir would be about 118 m at a FSL of 175 m amsl. There are very few lakes on Guadalcanal, so it is not known what riverine fish species will take up residence in the newly formed lake with its lacustrine environment. Non-native fish species could be introduced into the lake, but this should be avoided if possible because of potential effects on native species..

11.3.2.3.1 Sediment in the reservoir

The reservoir volume up to the invert of the sediment scour outlet (155m) is 2344x10³ m³, and 6900x10³ m³ up to Full Supply Level (175 m). Entura (2014) estimated that the annual suspended sediment load would be about 500 t/km²/year, which would deposit about 45000 m³/year of sediment in the reservoir. They estimate that it would take approximately 65 years before it became necessary to flush deposited sediment from around the power station intake.

11.3.2.3.2 Changes in downstream sediment dynamics

The dam will trap all bed load sediment (sand and coarser material) and a proportion of suspended sediment, and reduce the amount of bed load in the river downstream of the dam. This will result in a coarsening of the substrate within the river downstream of the dam, as reduced sediment input, combined with high flows that wash the sand and fine gravel component from the substrate, will leave coarser gravels and cobbles. An increase in the amount of coarse substrate will improve habitat for eels, gobies and benthic invertebrates that live around and under coarse substrates. In addition, the reduction in sand supply would tend to deepen pools and improve habitat for the pool dwelling species like kuhlia and grunTERS. Any effect of sediment removed by the reservoir will gradually reduce with distance downstream, as sediment is entrained from the sands and gravels on existing river banks and introduced from tributaries.

Observations downstream of New Zealand hydro dams on gravel bed rivers (Waitaki, Clutha) indicate that the riverbed will not degrade (erode) to any noticeable degree because the surface will be armoured by cobbles and larger gravels once the surface fines are removed.

11.3.2.3.3 Water quality

Because there is little diurnal and seasonal temperature variation and little wind mixing, tropical reservoirs often become stratified (Barrow 1988) and there is a risk that dissolved oxygen concentration is reduced in the lower layers (hypolimnion). Shallow lakes with high inflow are least at risk of stratification.

The residence time of the proposed reservoir when full is approximately 7 days at median flow of 11.1 m³/s and the average flow depth is approximately 10 m (Entura 2014). Entura's analysis (see Table 11-11 in Section 11.4.4) indicates the potential for stratification. However, relationships between temperature differential thermal (stratification) and residence time (Jorgenson et al. 2005) show virtually no thermal stratification in a reservoir with a residence time of 7 days. Some stratification may occur, and a hypolimnion with a low dissolved oxygen concentration may develop. However, with the reservoir bottom at 122 masl and full supply level at 175 masl, it is unlikely that the hypolimnion would extend upward to 162.5 masl, the level from which water is withdrawn for the turbines and the environmental outlet. Consequently, the discharge of surface water from the reservoir through the spillway, tailrace and environmental flow outlet is unlikely to cause any measurable change in dissolved oxygen downstream because these withdrawals are all from what would be the epilimnion in a stratified lake. The Reservoir Management Plan will include monitoring of dissolved oxygen and temperature at multiple depths to provide advance warning of potential water quality problems.

11.3.2.3.3.1 Water temperature

As water flows down a river, it is heated by solar radiation and cooled by evaporation until a thermal equilibrium is reached. If the amount of shade and radiation or ambient air temperatures changes, the water temperature adjusts towards thermal equilibrium. Usually, this will mean that water temperature will increase in a downstream direction.

In the Tina River during the rainy season, measured spot temperatures increased from 24.5°C at the Tina Village to 32.0°C at the Ngalimbiu River Bridge. The Toni River flows into the Tina River just downstream of Tina Village. Water temperatures in the Toni River were 28.4 to 29.4°C so that the Ngalimbiu River water temperature downstream of the Tina/Toni confluence was 26.4 to 27.2°C.

Water temperatures were also measured in the Toni River and in the Tina River between the Toni River confluence and approximately 1.5 km below the dam site over the period 11-15 July 2016. There was no rain over the period 11-15 July 2016. The daily maximum water temperature was 26°C at all sites over the 5 days. The daily minimum temperature was 23°C indicating diurnal variation of about 3°C. The lack of any downstream increase in temperature and the similarity of the water temperatures in the Toni and Tina rivers suggest that the water temperature was in equilibrium and therefore a change in flow would have minimal effect on daily mean water temperature.

The formation of a reservoir will generally alter the seasonal thermal characteristics of the river immediately downstream of the outlet. Since the thermal capacity of a reservoir is greater than that of a river, the reservoir tends to store heat resulting in smaller daily temperature fluctuations, lower summer temperatures, and higher winter temperatures. However, there is little variation in the annual air temperature in the Solomon Islands, so seasonal variation in water temperature is unlikely. Measurements in other lakes suggest that the reservoir water temperature is likely to be less than 28 °C (pers. comm., Robson Hevalao).

A reduction in flow generally does not change the daily mean water temperature significantly, but it does increase the daily maximum and decrease the daily minimum temperature. However, during the wet season at least, water velocities are high and river water temperatures may be below the equilibrium temperature, so that a reduction in flow would certainly increase the daily maximum water temperature and may increase the daily average water temperature in the river between the dam and powerhouse. With a flow of 1 m³/s in the river between the dam and powerhouse, water temperatures are likely to be similar to those in the Toni River. The fish community in the Toni River is similar to, or better than, that in the Tina River. Thus, an increase in water temperature in the Tina River is unlikely to have any effect on its fish community.

11.3.2.3.4 Fish passage

The dam will create a barrier to the passage of migratory fish species to the catchment upstream of the dam. It is possible to provide fish passage past the dam for most species. The options include a natural stream fish pass (if there is sufficient space), or a trap and haul system. These systems are used in New Zealand for a variety of climbing species and in UK, France, and the US for eels (Paterson & Boubee 2010, Solomon & Beach 2004). Fish pass systems developed in Europe and North America for salmonids and similar species are expensive, difficult to modify and will not necessarily suit the Tina River species. The 5 m operating range of the reservoir would necessitate a complicated system of hydraulic structures at the upstream end of a conventional fish pass to maintain a constant flow under the range of reservoir levels.

11.3.2.3.4.1 Upstream passage

Because of their climbing ability, it is relatively easy to provide effective upstream passage for gobies and eels using either a natural stream channel⁷⁷ pass, or trap and haul system. It is likely that a trap and haul system will be the least costly, most adaptable and most practical option for fish passage. A simplified diagram of the trap is shown in Figure 11-4. A photo of a ramp and trap components of a trap-and-haul system for climbing fish is shown in Figure 11-3. Fish from the trap can and should be released in or upstream of the reservoir at a location that will avoid the possibility of fish being

⁷⁷ A gravel/cobble channel similar to a riffle which would zig-zag up the dam face or abutments with resting pools at the changes of direction.

entrained by spillway or power station flows. The ramp allows migratory fish to climb to the trap, where they remain until transferred to an upstream location.

One advantage of a trap and haul system is that fish caught in the trap can be identified and counted before they are transferred to areas upstream of the dam. Thus, a trap system will provide very useful monitoring data on the state of the goby and eel populations which is very difficult, if not impossible to obtain by other means.

Neither a trap-and-haul system, or natural fish pass, is likely to provide passage for *Kuhlia* and grunters, both of which are a swimming species. *Kuhlia* appear to be reluctant to use fish passes (Lewis & Hogan 1987). However, if *Kuhlia* and/or grunters accumulate at either the powerhouse tailrace or the base of the dam, it will be possible to net them and transfer them to a more suitable environment such as the Toni River or upstream Tina River. This is considered to be another variant of the trap-and-haul system. Transfer to the Toni River would be preferable because some mortality would occur when the adult fish migrate from the upper Tina River to the estuary area to spawn.

Figure 11-3 Photo of ramp and trap at dam



Figure 11-4 Principle of Trap and Haul system

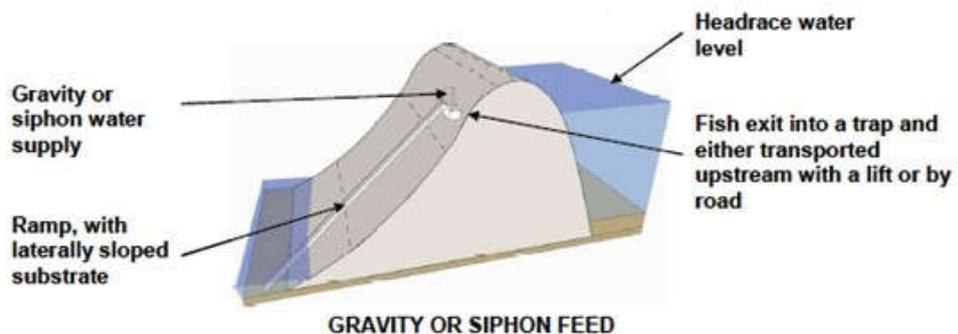


Figure 11-3 shows the trap system with ramp leading to a holding tank and piped water supply installed at Waitaki Dam, New Zealand. The ramp can be lined with bristles, gravel or a drainage product called Miradrain or Cordrain (Patterson & Boubee 2010). The optimum slope is about 15 degrees.

While bristles appear to best for eels, gravel or drainage products suit both gobies and eels. New Zealand traps have been used to collect eels, galaxiids, redfin bully (*Gobiomorphus huttoni*) and to a lesser degree torrentfish (*Cheimarrichthys fosteri*). The ramp should also have a transverse slope to provide deep water on one side and shallow water on the other to provide a choice of velocities and depths for the fish that move up the ramp. The climbing abilities and modes of locomotion of these New Zealand species are the same as those used by crawling and climbing species in the Solomon Islands, as described in the ESIA.

Gobies spawn on substrate in the area in which they live. When the eggs hatch the larvae are carried passively downstream. It is not clear whether goby spawning is seasonal, or occurs all through the year. It is possible that spawning seasonality varies between species. Larval fish return to the estuary during the dry season and this indicates that spawning and downstream migration takes place early in the wet season. Thus, it is likely that hatching and downstream movement occurs during floods and freshets with the high flows ensuring rapid and safe transport to the sea. If so, the dam may be spilling and larval fish will pass over the spillway. Although there are very few studies of larval survival through turbines, it is well known that the length of fish is the primary determinant of survival (e.g., Larinier and Travade 2002) and with larval fish potential mortality caused by striking the turbine blades or wicket gates will be low. Morris et al. (1985) describe quantitative data on entrainment mortalities that were gathered at the Ludington Hydro Plant on Lake Michigan, which has a head of 110m. Survival tests on 9 species of larval fishes indicated that passage through the Ludington turbines decreased survival rates by an average of 15%. Large smelt larvae (15-42 mm) experienced much greater mortality than did smaller (<15 mm) smelt larvae. Some larvae were apparently robust and seemed to survive turbine passage (i.e., ninespine stickleback, lake whitefish, turbot larvae). Goby larvae are small (<10mm) and there is unlikely to be significant mortality through the turbines.

Although the gobies in the Solomon Islands are generally considered diadromous, large numbers of 10 mm gobies were observed in the shallow low velocity margins of the river between the dam and power house sites on 11-15 July 2016. It is unlikely that fish of this size have the swimming ability to make the 25 km journey from the sea and this suggests that these fish are rearing in the river rather than the sea. Shallow low velocity margins are the type of rearing habitat used by non-diadromous bullies in New Zealand.

Adult eels migrate to the sea at the beginning of the wet season. They are likely to migrate on the first fresh so that the deeper swift flowing water facilitates their passage to the sea, similar to the migration of New Zealand eels. The mortality of adult eels through turbines is significant, and screens should be installed at the intake. Releases over the spillway during high flow could be timed to facilitate eel passage downstream.

11.4 IMPACT ASSESSMENT

11.4.1 Impact identification Matrix

Table 11-2 identifies potential impacts on the aquatic environment.

Table 11-2 Potential impacts on the aquatic environment

	Potential impact causing activities	Impacts on hydrology and sediment dynamics	Impacts on water quality	Impacts on aquatic life	Impacts on water uses
Pre-Construction and construction	Pre-construction site investigations (hydrological, topographical, geological, geotechnical surveys)	Increase in suspended solids and siltation	River pollution (oil, explosive residues)	Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Access road construction	Increase in suspended solids and siltation		Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Site clearing (access road, dam and powerhouse sites, quarries, transmission line, work areas)	Increase in suspended solids and siltation		Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Traffic movements (heavy haul trucks, heavy machinery, light duty vehicles) crossing the river	Increase in suspended solids and siltation		Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Construction/dewatering of the coffer dams and diversion tunnel	Increase in suspended solids and siltation	River pollution (cement leachate, explosive residues)	Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Excavation of the river bed and construction of dam foundations	Increase in suspended solids and siltation	River pollution (cement leachate)	Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Mining quarries in/near the river bed	Increase in suspended solids and siltation		Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Construction of RCC dam and powerhouse	Increase in suspended solids and siltation	River pollution (cement leachate)	Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Construction of off-site facilities (work areas, transmission line)	Increase in suspended solids and siltation			Disturbance of water uses
	On-site maintenance and work areas		River pollution (oil and other hazardous substances)	Over-fishing	Disturbance of water uses
	Reservoir preparation (clearing)	Increase in suspended solids and siltation			Disturbance of water uses

Potential impact causing activities	Impacts on hydrology and sediment dynamics	Impacts on water quality	Impacts on aquatic life	Impacts on water uses
Reservoir filling	Temporary dewatering of the river downstream of the dam		Disturbance of aquatic habitats and aquatic life	Disturbance of water uses

Operation	Operation of the dam & powerhouse	Reservoir establishment – change from riverine to lacustrine environment Sedimentation - in the reservoir Changes in hydrology - variability of flows Changes in sediment dynamics downstream	Reservoir stratification	Establishment of a lake ecosystem Barrier to migratory fish species Disturbance of aquatic habitats and aquatic life	Disturbance of water uses
	Operation of the headrace tunnel	Reduced flow in the by-passed river section Disturbance of amenity values in the reduced flow section of the river		Degradation of aquatic habitats Barrier to migratory species	Disturbance of water uses

11.4.2 Impact Assessment Limitations

Assessment of impacts on the aquatic ecology of the Tina River is constrained by the limited availability of bibliographical data available for Solomon Islands freshwater ecology and other sources of information dealing with species migratory behaviour and habitat requirements.

11.4.3 Construction Impacts on Aquatic Environment

This section identifies potential construction related impacts on the aquatic environment during construction. Proposes mitigation measures, and discusses residual effects and their significance.

11.4.3.1 Increase in Suspended Solids and Siltation

Field observations conducted in August 2013 on the Tina/Ngalimbiu River indicated that low concentrations of suspended solids except following periods of heavy rain. In the upper reach of the Tina River, the water was fully transparent (< 1NTU). In the lower reach (e.g., where the Tina becomes the Ngalimbiu River), it appeared slightly turbid (5NTU to 9NTU), with 5NTU being regarded as the perception threshold. The maximum value during the dry season was observed at the mouth of the river (12.8 NTU). However, peaks in turbidity are known to occur after heavy rains and after cyclones. No turbidity or TSS data was available for immediate post cyclone conditions. However, they are likely to be similar to turbidity levels observed during the rainy season when it was 16.1NTU at Tina village (Tina River), 8.69NTU to 15.5NTU at Ngalimbiu River, and 15.3NTU to 18.4NTU at the mouth of the Ngalimbiu River.

11.4.3.1.1 Impact Identification and Rating

During construction, increased TSS concentration (both base values and peaks) occurs due to: (i) re-suspension of fine streambed sediments due to activities within the river (e.g., gravel extraction from borrow sites located within the river, vehicles crossing through the river, construction works for diversion cofferdams and the diversion tunnel, dam foundations, intake gallery, power-plant, and tailrace); (ii) increased load of soil and organic particles following heavy rains, from runoff and erosion in clearing and earthwork areas (construction work for access road, dam and supporting site facilities, reservoir vegetation clearing); and (iii) dewatering operations during headrace tunnel construction due to intersected water seeps within the rock. The tunnel drainage will contain crushed rock materials.

The increase in turbidity is likely to temporarily affect the river far downstream of the dam area. Increased suspended matter will cause significant deposit of fine particles (siltation) of the streambed and banks in sections of slow velocity downstream of the dam.

Impacts on aquatic life and water users downstream of the dam are considered to be moderate, since construction impacts will most likely persist only for the short 3-year construction period. Table 11-3 summarises the impact significance rating for suspended sediments on the aquatic ecosystem and water uses.

Table 11-3 Suspended sediment impacts on aquatic ecosystem and water uses during construction

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Major	Localised – dam to river mouth	Temporary (3 years)	Moderate	Moderate

11.4.3.1.2 Mitigation Measures

Unfortunately, increased suspended sediment load, as measured by TSS is an unavoidable impact, since most construction work will take place within or adjacent to the river. However, it can be mitigated by implementing best environmental management practices (BEMPs) during construction especially on terrestrial areas. BEMPs for controlling the introduction of sediment into the river include plans for the following (see Section 13 – ESMP):

- ▶ Reservoir preparation;
- ▶ Point source pollution management, including concrete work;
- ▶ Spoil soil management during earthwork;
- ▶ Forest clearance practices;
- ▶ Stream crossing practices;
- ▶ Drainage and erosion control;

11.4.3.1.3 Residual Effects and Their Significance

Notwithstanding that BEMPs will be applied to control sediment entering into the river, moderate residual impacts will continue following application of mitigation measures, since most suspended solids, as measured by TSS, will originate from sources that cannot be fully mitigated. However, due to the effects of heavy rainfall within the catchment and the flashy nature of the Tina River, including tributary streams that enter the Tina River downstream of the damsite, sedimentation will be somewhat masked by the natural situation, as long as best efforts to employ BEMPs are made to prevent soil eroded from the project site from entering the Tina River. Overall, the residual effect is considered to be not significant.

11.4.3.2 River Pollution

Pre-project physico-chemical and bacteriological water quality is considered to be: (i) excellent in the vicinity of the damsite as human activities are almost non-existent here and upstream into the upper catchment (e.g., due to there being no habitation, only selective harvesting of trees in the last 10 years, and no gold placer or bedrock mining); and (ii) slightly degraded downstream, due to community activities (e.g., domestic uses of the river, domestic waste waters, gardening, pig rearing).

11.4.3.2.1 Impact Identification and Rating

Construction works will represent an important additional source of potential river pollution originating from different activities, including: (i) loss of cement leachate from the pug mill, concrete batch plant, and concrete pours on the RCC dam, head race tunnel and powerhouse; (ii) risk of fuel / oil spills and spills of other hazardous substances, and release of explosive residues from blasting; and (iii) release of waste waters from worker cafeteria and toilets (175 staff) and from potential increased population in the nearby villages.

Impact significance is considered to be potentially major in the Tina River downstream of the construction site for a distance of approximately 9km by river. Impacts are likely to be less significant in the Ngalimbiu River, after being diluted with the discharge of the Toni River. The risk of river pollution will last throughout the construction phase, approximately for 3 years.

Overall impact significance is considered to be moderate, as river pollution is considered a potential risk rather than a confirmed impact. Table 11-4 summarises the impact significance rating for potential river pollution and water uses.

Table 11-4 River Pollution impacts on aquatic ecosystem and water uses during construction

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Major due to risk of accidental release of pollutants	Localised – dam to river mouth	Temporary (3 years)	Low if BEMPs implemented	Moderate

11.4.3.2.2 Mitigation Measures

River pollution is an avoidable impact if BEMPs are implemented during construction. BEMPs for controlling the introduction of pollutants into the river (see Section 13 – Environmental and Social Management Plan) include plans for:

- ▶ Point Source pollution management, including concrete work;
- ▶ Spoil soil management during earthwork;
- ▶ Forest clearance practices;
- ▶ Stream crossing practices;
- ▶ Drainage and erosion control; and
- ▶ Localization of hazardous material.

11.4.3.2.3 Residual Effects and Their Significance

Even with the implementation of BEMPs, the moderate pre-mitigation impacts will persist as residual impacts, primarily because of the potential risk posed by a release of hazardous substances into the river. However, this residual impact is considered to be not significant if BEMPs are properly implemented.

11.4.3.3 Disturbance to Aquatic Habitats and Aquatic Life

11.4.3.3.1 Impact Identification and Rating

Water quality degradation, including increased TSS, and stream bed siltation due to construction activities and alluvium extraction in the river bed, are likely to affect aquatic life downstream of the construction area, if no appropriate mitigation is applied, especially where ecological conditions are almost pristine.

These changes may affect aquatic habitats and the life of existing aquatic communities: impact on trophic resources, spawning microhabitats and shelters, survival of migrating larvae and pollution-sensitive species. Although, aquatic communities are naturally exposed to habitat disturbance associated with frequent flash floods that result after heavy rain episodes, and exceptional events such as occurred with Cyclone Namu (1986).

In the event of an accidental spill of fuel /oil or other toxic substance, the effects on aquatic life might manifest far downstream.

The potential for impacts on aquatic life will last throughout the construction phase, approximately for 3 years. Overall pre-mitigation impact significance is considered to be moderate, as the spill of hazardous substances into the river is considered to be a potential risk as opposed to a certainty. Table 11-5 summarises the impact significance rating for disturbance to aquatic habitat and on aquatic life.

Table 11-5 Impacts of disturbance to aquatic life and water uses during construction

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Major due to risk of accidental release of pollutants	Localised – dam to river mouth	Temporary (3 years)	Low if BEMPs implemented	Moderate

11.4.3.3.2 Mitigation Measures

Disturbance to the aquatic ecosystem is unavoidable, and is the consequence of constructing a hydropower dam. BEMPs will be implemented to minimize disturbance wherever possible. BEMPs for controlling the disturbance to aquatic habitats and aquatic life (see ESMF) include plans for:

- ▶ Point Source pollution management, including concrete work;
- ▶ Spoil soil management during earthwork;
- ▶ Forest clearance practices;
- ▶ Stream crossing practices;
- ▶ Drainage and erosion control; and
- ▶ Localization of hazardous material.

11.4.3.3.3 Residual Effects and Their Significance

Even with the implementation of BEMPs, the moderate pre-mitigation impacts will persist as residual impacts, primarily because of the potential risk posed by a release of hazardous substances into the river. However, this residual impact is considered to be not significant if BEMPs are properly implemented.

11.4.3.4 Overfishing

11.4.3.4.1 Impact Identification and Rating

The presence of workers in the construction area where the fishery pressure is currently low, and the potential influx of population in villages along the Tina River downstream, may represent an additional pressure on the fishery resource, especially on those fish species considered to be particularly valuable (i.e., Khulia, Mesopristis, gobbies, prawns) to communities, which could be potentially overfished.

Impacts will last throughout the construction phase, approximately for 3 years. Although the magnitude of potential impacts is considered to be moderate, it is of short duration and confined to the local area. Therefore, impact significance is considered overall to be low. Table 11-6 summarises the impact significance rating for potential overfishing.

Table 11-6 Impacts of potential overfishing during construction

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Moderate	Localised – dam to powerhouse	Temporary (3 years)	Low if BEMPs implemented	Low

11.4.3.4.2 Mitigation Measures

It is recommended that workers be prohibited from fishing in the Tina River, and that the Project's food services / caterers be prohibited from purchasing fish from local villagers.

11.4.3.4.3 Residual Effects and Their Significance

It is expected that the pre-mitigation moderate impacts will be mitigated through worker and camp prohibitions of catching or buying fish. Therefore, residual effects are low and considered to be not significant.

11.4.3.5 Diminished Water Quality and Water Quantity

11.4.3.5.1 Impact Identification and Rating

Water quality degradation, including increased TSS, bacteriological and physico-chemical pollution, and siltation may lead to diminished availability of water for occupants of riparian villages, for which the river represents the major source of water.

Turbid water makes it difficult or impossible to practice subsistence fishing especially using the preferred method of snorkelling / spear fishing, to wash clothes, and to bath. Turbid water is also less attractive for recreational activities.

Bacteriological pollution caused by leaking portable toilets that will be used in the work areas, or urinating or defecating out in the open in areas adjacent to work sites, presents a potential risk of waterborne diseases for people using the river for drinking or bathing.

In the event of a major accidental spill of hazardous material (e.g., fuel / oil) from the construction area all water uses all along the river, including commercial fishing at the mouth of the river, would be significantly affected.

Concrete production from the onsite batch plant will require 30Mm³ of water from the Tina River to construct the dam over two dry seasons..On average, this will lead to an estimated reduction of flow downstream of the dam ranging from 7% to 10% as shown in Table 11-7.

Only minimal impacts to water quality are anticipated at the mouth of the river as a result of project construction. The use of cofferdams and diversion works will ensure that construction of the dam, and powerhouse tailrace, are undertaken in isolation from the river, thereby preventing introduction of concrete slurry, fine sediments and other potential contaminants. Use of good practice techniques for clearing and grubbing operations, and implementation of sound management plans to control erosion and sedimentation, construction wastes, hazardous materials, and other similar plans, will minimise the threat to water quality. With these measures in place, along with on-site monitoring to identify potential issues, it is unlikely that any construction related adverse water quality impacts would accrue to the estuary.

Table 11-7 Water required for concrete production

Total water extracted for concrete in m3	Total time for concrete work in months	Water extracted for concrete in m3 per month	Water extracted for concrete in m3 per second	Average Tina flow in dry season at dam site (m3/s)*	Estimated additional flow between Dam and Tina junction with Toni in m3/s**	Estimated additional flow from Toni***	Estimated total flow during dry season downstream of Toni river
30,000,000	8 to 9	3,750,000 to 3,333,333	1.29 to 1.45	12.72	1	4.24	17.96

Estimated average flow reduction in % due to concrete work	Between dam and Tina junction with Toni	Downstream of Toni (Ngalimbiu River)	
	9.37 to 10.54	7.18 to 8.07	

* based on gauging station data from June 2010 to September 2013. Dry season range from April to November.

** based on Average specific yield of 0,097 m³/s/km² of Tina River

*** based on BRLi field measurement showing that Toni has roughly 1/3 of Tina's flow

Impacts will last throughout the construction phase, approximately for 3 years. Although it is of short duration and confined to the local area, the magnitude of potential impacts water quality and quantity is considered to be moderate, due to the potential for the project water requirements to become a larger percentage of dry season flows, especially in a very dry year, and due to the risk of project related pollution affecting downstream water quality. Therefore, impact significance is considered overall to be moderate. Table 11-8 summarises the impact significance rating for potential water quantity and quality issues.

Table 11-8 Potential water quantity and quality impacts during construction

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Moderate due to potential for project water use to become higher percentage of available water, and risk of pollution	Localised – dam to river mouth	Temporary (3 years)	Moderate without BEMPs implemented	Moderate

11.4.3.5.2 Mitigation Measures

Mitigation measures, such as the provision of domestic water supply system to local affected communities, is proposed (see Section 12 – Assessment of Socio-economic / Socio-community Impacts), to offset the of the Project withdrawing a quantity of water during construction that could affect availability of water to downstream communities. In addition, the same BEMPs that would be used for pollution control (see Section 11.2.3.2.2 – Mitigation Measures for river pollution) would apply to protecting water quality.

11.4.3.5.3 Residual Effects and Their Significance

Post-mitigation residual impacts are considered to be moderate due to the potential for affecting the availability of water for downstream communities, and due to the risk that water quality of the Tina River could be adversely affected by a project related spill of a hazardous substance. However, with application of BEMPs to control potential pollution, and compensation measures, such as distribution of water for domestic use, the post-mitigation residual effects are considered to be low (i.e., not significant).

11.4.3.6 Temporary River De-watering During Reservoir Filling

11.4.3.6.1 Impact Identification and Rating

Reservoir filling is estimated to take 7 days, based on a FSL reservoir of 7Mm³, and an average filling rate of 11.5m³/s). However, reservoir filling could significantly longer or shorter, depending on the hydrology and occurrence of heavy rains /floods following closure of the dam.

Unless some flow is released, the river will be dewatered during the period of reservoir filling, with severe consequences on the aquatic ecosystem and water uses, especially on the reach between the dam and the confluence with the Toni River.

Impacts will be very short in duration, confined to a short section of river, but severe in magnitude, and are considered overall to be moderate, but recoverable. Table 11-9 summarises the impact significance rating for potential water quantity and quality issues.

Table 11-9 Potential river dewatering impacts during reservoir filling

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate to high	Severe due to potential complete dewatering of Tina River between dam and Toni River confluence	Localised – dam to confluence with Toni River	Very short (estimated 7 days)	Moderate without EF	Moderate

11.4.3.6.2 Mitigation Measures

To mitigate impact of reservoir impoundment, an environmental flow will be implemented. In its 2014 feasibility Study, Entura recommended that a low level outlet through the diversion plug be provided for this purpose. It is suggested that an environmental low (EF) of 1m³/s be maintained through this outlet during reservoir filling.

11.4.3.6.3 Residual Effects and Their Significance

With a minimum EF release of 1m³/s at all time during reservoir filling, the post-mitigation residual impact of dewatering the river is considered to be low (i.e., not significant).

11.4.3.7 Conclusions Regarding Construction Impacts

Table 11-10 summarises the pre-mitigation impact ratings, and the significance of residual impacts that will potentially remain following the application of mitigation measures, for the construction phase of the Project.

Table 11-10 Pre-mitigation and residual impact ratings for construction phase

Impact from construction	Pre-mitigation impact rating	Post-mitigation Residual impact rating
Increase in suspended solids and siltation	Moderate	Not Significant
River pollution	Moderate	Not Significant
Disturbance to aquatic habitats and aquatic life	Moderate	Not Significant
Overfishing	Low	Not Significant
Disturbance to water uses	Moderate	Not Significant
Temporary river dewatering during reservoir filling	Moderate	Not Significant

Many impacts resulting from dam construction activities are unavoidable and mitigation measures are limited. Residual impacts will, in most cases, reflect the pre-mitigation impact significance ratings. Notwithstanding, it is recommended to maintain an EF during reservoir filling. By employing BEMPs during construction, providing domestic water supplies to all affected communities, and monitoring water quality, construction related impacts can be held to acceptable levels, especially if the construction contractor is required to address any issues that arise during construction.

11.4.4 Operation Impacts on Aquatic Environment

This section discusses potential impacts on the aquatic environment that may accrue during operation, proposes mitigation measures, and assesses residual impacts and their significance.

11.4.4.1 Reservoir Operation

The project will create a reservoir with the characteristics shown in Table 11-11.

Table 11-11 Characteristics of proposed dam & reservoir

Feature	Measurement
Location of the reservoir	3.7km upstream of Senge (CH 7km)
Reservoir level & depth	
Max flood level	186masl
Full supply level (FSL)	175masl
Normal operating level.	172masl
Minimal operating level.	170masl
River level at dam	122masl
Reservoir depth at FSL (deepest point) (= dam height above river bed)	53m
Reservoir volume	
Volume at FSL	7Mm ³
Active volume (NOL to MOL)	1.4Mm ³
Dead storage to spillway gate level	3.2Mm ³
Length of impounded river (FSL)	2.5km
Reservoir surface area at FSL	30.52ha
Froude coefficient	0.02 (*)
Retention time	7d
Water intake level to powerstation(head race tunnel)	161-164masl
Mean water inflow	11.5m ³ /s
Length of river with reduced flow (dam to powerhouse)	5.7km

Source March 2014: Entura TRHD Phase 3 Report

(*) Froude (F) = $320 (L/D)(Q/V)$ where L = length of the reservoir (meters); D = mean reservoir depth (for which dam height may be a proxy) ; Q = mean water inflow (m³/s) and V = reservoir volume (m³)

Entura's TRHD Phase 3 Report (March 2014), provides a description of the reservoir for the preferred alternative, Option 7C. The reservoir at FSL is approximately 53m (max depth), 150m wide at its downstream end, and 2.5km long, with an estimated volume of 7Mm³.

11.4.4.1.1 Impact Identification and Rating

The aquatic habitat within the impounded section of the Tina River will change from lotic conditions (fast flowing river with rapids and pools on a streambed of cobbles and pebbles) to lentic conditions (deep reservoir, up to 53 m in depth, with slow velocity).

The predicted exchange period for reservoir water is estimated to be 7 days. This is low compared to other reservoirs on tropical rivers that have a more seasonal flow regime. In terms of minimizing negative impacts on water quality (i.e., increased temperature, oxygen depletion, and other adverse effects), short exchange periods are preferable to long exchange periods.

The reservoir's presence reflects a permanent impact, in a very localized area, having a moderate magnitude on the river system. Therefore, impact significance is considered to be moderate. Table 11-12 summarises the impact assessment rating for reservoir operation.

Table 11-12 Reservoir operation impact rating

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate for its power generating capacity	Moderate	Localised – over 2.5km length of Tina River	Permanent	High	Moderate

11.4.4.1.2 Mitigation Measures

The reservoir will be operated for many decades in support of a peaking hydropower generating station and, therefore, represents a permanent change to the Tina River. There are no mitigation measures that can be applied to the reservoir operation to reduce the impact of converting 2.5km of riverine habitat to lentic habitat.

11.4.4.1.3 Residual Effects and Their Significance

Loss of 2.5km of riverine habitat is a long-term (permanent) condition that will continue as long as the hydropower project is operational. Therefore, no mitigation is possible, and the residual impacts are considered to be moderate, but not significant.

11.4.4.2 Reservoir Sedimentation

5.1.1.1.1 Impact Identification and Rating

The flux of solid material from the upstream watershed consists of: (i) bed load of coarse materials (i.e., boulders, cobbles, pebbles, gravels, coarse sands); and (ii) suspended sediments (clay, fines and organic particles), the concentration of which is very low except after heavy rains.

All of the bed-load is expected to be trapped in the reservoir, with larger materials deposited at the upstream end of the reservoir, and lighter fractions deposited at the deeper downstream end. However, a significant proportion of suspended sediments will likely pass through the reservoir, either through the power intake and turbines, or spillway (i.e., during floods).

Over time, the trapping of solid material in the reservoir will result in a decrease in its active volume. At a FSL of 175masl, and assuming a sediment inflow of 45,000m³/y, it is estimated that the dead storage volume would be full within a period of 65 years (Entura, March 2014).l

Impact significance is considered to be moderate. Table 11-13 summarises the impact assessment rating for reservoir sedimentation.

Table 11-13 Reservoir sedimentation impact rating

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Low as it is an artificial environment	Moderate	Localised – over 2.5km length of Tina River	Permanent	High	Moderate

11.4.4.2.1 Mitigation Measures

Inclusion of large flushing outlets as part of the dam’s design has been ruled out, primarily because they are only efficient at removing sediment deposited within relatively close proximity to the dam. Constructing large flushing outlets into an RCC structure is complicated and costly, for very little benefit. However, in place of flushing outlets, an outlet of 3x3m is proposed near the power intake at 160masl, to extend the filling period. Once sediments reach this level, the outlet will be used either for local flushing or for lowering the reservoir to permit dredging/excavating of accumulated sediments.

11.4.4.2.2 Residual Effects and Their Significance

As there is no feasible mitigation, residual impacts are considered to be moderate, but not significant.

11.4.4.3 Barrier to Passage of Migratory Fish Species

As with other Indo-pacific islands, all native fish species in streams and rivers on Guadalcanal (i.e., gobioids, eels, Kuhlia, prawns, and other endemic species) are amphihaline migratory species with a life cycle that shifts between the sea and the river.

11.4.4.3.1 Impact Identification and Rating

The dam and reservoir, and to some extent the associated by-passed section of the Tina River, will represent a barrier to the upstream and downstream migration of all native fish species that currently utilise the river system upstream of the dam site.

As mentioned in Section 7, fish within the Tina River follow either a catadromous or amphidromous lifecycle migration scheme, as follows:

- Catadromous migration involves downstream migration of adults to spawn in the sea, and upstream migration of juveniles to mature within the upper catchment area.
- Amphidromous migration involves downstream migration of larvae and upstream migration of juveniles to mature, reach adulthood, and spawn in the upper catchment area.

Creating barriers to fish migration is not so much an issue of depriving communities of fish resources that support a livelihood as it is an issue affecting fish biodiversity and local cultural experience for those who venture into upstream areas on traditional fishing trips.

Impacts on the Upstream Migration of Juveniles

For both catadromous species (e.g., eels) and amphidromous species (e.g., gobies, prawns), juveniles undertake mass upstream migrations from the sea to colonize rivers and streams to the upstream areas of the watershed.

Juveniles show different migration behaviors according to their taxa. Syciinidae are able to climb a quasi-vertical wet smooth concrete surface whereas eels or prawns need a less steep slope and a rough surface for crawling. Many other species are strict swimmers (e.g., *Kuhlia sp.* / silver fish, mullets, *Mesopristis sp.*).

Unless mitigation measures in the form of trap-and-haul systems are put in place to enable upstream migrating fish to move past the dam, or releasing EFs to enable fish to pass upstream of the powerhouse tailrace to the base of the dam, the TRHDP facilities will present a non-passable obstacle to upstream migrating fish given:

- (i) the height of the dam (approximately 53m);
- (ii) the absence of water discharge along the face of the spillway (no possibility for Syciinids to climb);
- (iii) the length of the by-passed section of river and its reduced flow stage most of the time; and
- (iv) the absence of attractive outflow towards the by-passed section and toe of the dam.

Furthermore, Syciinids might be attracted by the power-station outflow and climb up into the turbines were they might accumulate and die in mass, causing a potential maintenance issue.

Without measures to enable fish to move up to, and over, the dam those fish species that currently utilize sections of the Tina River upstream of the dam will disappear from the river above the dam. The catchment upstream of the dam covers approximately 125km² and represents 50% of the Tina/Ngalimbiu watershed.

Some short life cycle species, like Gobiidae and prawns, will quickly (within 2 to 4 years) disappear from the upper catchment, whereas eels with a life span of up to 10 years or more, will continue to be found as large specimens many years after the dam is built. There are examples of Anguillidae (e.g., European eels), which are known for their longevity and are able to survive in captivity over a period of 80 years.

Assuming a sufficient EF is released in the by-passed section to attract upstream migrating juvenile fish, to the toe of the dam, an efficient trap-and-haul system will be required to enable climbing / crawling juveniles to pass up over the dam. Since it is technically difficult to reliably design a fish pass for strict swimmers, a trap-and-haul system is recommended. Strict swimmers represent about 40% of the number of identified species in the Tina River.

Impacts on Downstream Migration of Silver Eels and Larvae Of Migratory Species

Assuming an efficient system for moving upstream migrating juvenile fish (e.g., eels, Syciinids, Gobiids, prawns) past the dam is implemented, the downstream migration of mature eels and larvae of migratory species is likely to be significantly affected by entrainment into the power intake and headrace tunnel, followed by mortalities in the turbines due to contact with the runner blades, pressure fluctuation, turbulence and cavitation.

However, unlike Salmonids, these species do not present a homing behavior that sees adults returning to their natal streams. Rather, the upper watershed will be continuously stocked by upstream migration of juveniles that have had a life cycle in other coastal rivers in the Solomon Islands, as long as they can move, or be moved, upstream past the dam. In addition, downstream migrating species will be able to pass the spillway when floods take place since the spillway will release flood-waters in by the by-passed river, on average, 8% of the time (when the flow is higher than 24m³/s). Otherwise, TRHDP will raise reservoir levels to spill water over the dam spillway during the short windows of seasonal outmigration.

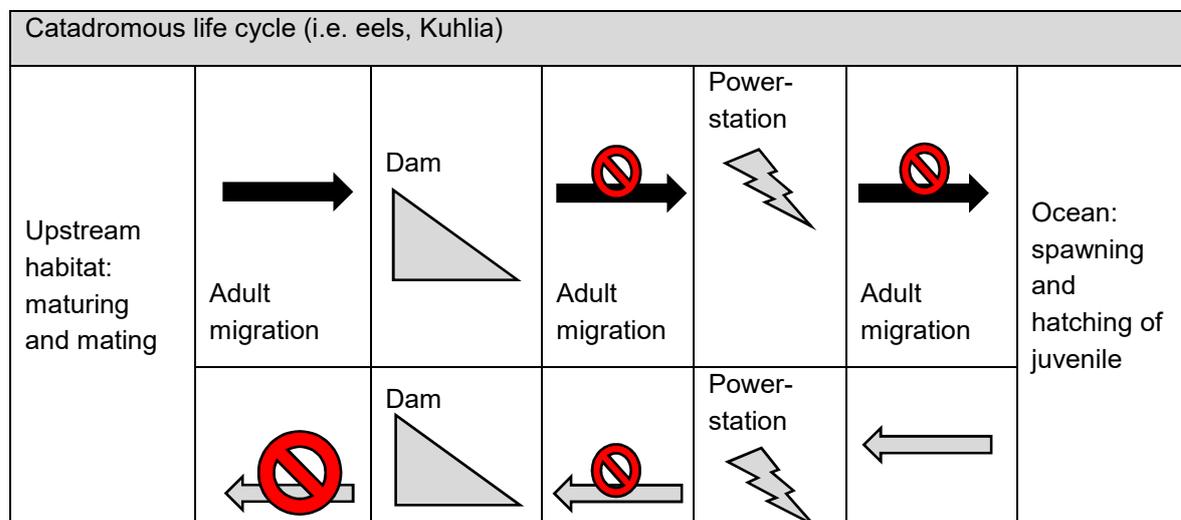
Impact significance pre-mitigation is considered to be major, since without specific measures to enable fish to move past the dam to the upstream Tina catchment, populations will become depleted within a few years. Table 11-14 summarises the impact assessment rating for barrier to fish passage.

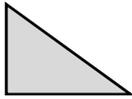
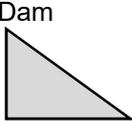
Table 11-14 Impact rating for barriers to fish passage

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
High for fish and crustaceans	Major – potential disappearance of fish in upper Tina River catchment	Localised – within Tina River	Permanent	High	Major

Table 11-15 is a synthesis of fish migration impacts on the two types of lifecycle migration schemes (catadromous and amphidromous) due to the dam and the powerhouse. The large bi-sected circles represent total blockage to fish migration, and the small bi-sected circles represent partial blockage or mortality of some fish species.

Table 11-15 Synthesis of fish migration stages and impacts



	Juvenile/ maturing migration		Juvenile migration		Juvenile migration	
Anadromous life cycle (i.e. Gobiidae, Sicydiinae)						
Upstream habitat: maturing, mating and spawning	 Larvae migration	 Dam	 Larvae migration	 Power- station	 Larvae migration	Ocean: larvae maturing into juvenile
	 Juvenile migration	 Dam	 Juvenile migration	 Power- station	 Juvenile migration	

Impacts on Fish Movement at the Mouth of the Ngalimbiu River

Sicydiinidae juveniles gather en masse at the mouths of rivers before commencing their upstream migration. This massing of fish in a relatively confined area supports important traditional fisheries. This has been described in rivers on other Islands (e.g., Tahiti, La Reunion), and was observed at the mouth of the Ngalimbiu River during the field survey (see Annex 1 of the Annex report).

Local fishermen have a certain knowledge regarding what the triggers mass gatherings. Concentrations of Sicydiinidae juveniles at the mouths of rivers is said to be triggered by freshwater flow into the marine environment, together with tidal cycles, with the drop in salinity in the coastal zone being the main factor.

At the mouth of the Ngalimbiu river, the daytime (peak hour) operation of the dam will not noticeably affect flow given the short retention time of water in the reservoir. During nighttime, flow will be reduced by up to 66% at the Ngalimbiu River mouth. Considering the long term, the Project is unlikely to affect the baseline situation of juveniles massing at the mouth of the river and subsequently entering the river as they commence their migration upstream.

Overall, the effects of changed water flows between the dam and the powerhouse will have only minimal effects on aquatic ecosystems downstream at the mouth of the river, where the effects will be diminished due to proportional changes that will occur as the river flow is supplemented by contributions from tributaries downstream of the project.

Blockage of the river mouth due to changes in river discharge brought about by the project are unlikely, since the combination of peaking flow releases, E-flow releases during non-generation periods, and periodic flood releases over the dam spillway, will ensure that a channel continues to be cut through the bar at the mouth of the river. This will ensure access into and out of the river for fish species undergoing diurnal or seasonal migration.

11.4.4.3.2 Mitigation Measures

To mitigate impacts, the following measures will be implemented:

- Trap-and-haul system for upstream migration of “target species” juveniles; and
- Fish screens at the power intake to minimise entrainment of adult eels (i.e., silver eels) into the turbines

These measures are detailed in Appendices G and H, respectively.

11.4.4.3.3 Residual Effects and Their Significance

With the installation of a trap-and-haul system, and fish grids to prevent eels from becoming entrained into the power intake and suffering damage or mortality in the turbines, the major pre-mitigation impacts could be reduced to moderate impacts, as long as a minimum EF release is implemented.

11.4.4.4 Changes of Flow Downstream of the Dam

11.4.4.4.1 Impact Identification and Rating

The flow to the powerhouse will be diverted through a 4.5km long power tunnel. The 5.7km by-passed section of river between the dam and the powerhouse, will experience reduced flow most of the time.

The engineering assessment showed that the power station will generally operate at, or in excess, of historic minimum river flow, supplemented by water from the reservoir when inflow is less than minimum machine flow. The maximum machine flow is 24m³/s (4 turbines x 6 m³/s).

Figures 11-4 and 11-5 provide the following information:

- River inflow to dam upstream of the dam (blue line)
- River flow directly downstream of the dam (with the 1m³/s EF) (red line)
- River flow directly upstream of the powerhouse (with the lateral inflow in the by-passed river section estimated to be about 1m³/s) (green line)
- River flow directly downstream the powerhouse (purple line).

These figures do not show the daily variation in flow pattern due to storage and daily release for peak hours. For the daily variation, see Figure 11-6.

Figure 11-5 Dry year river flows - daily balance operation of Tina Hydro (no peak operation)

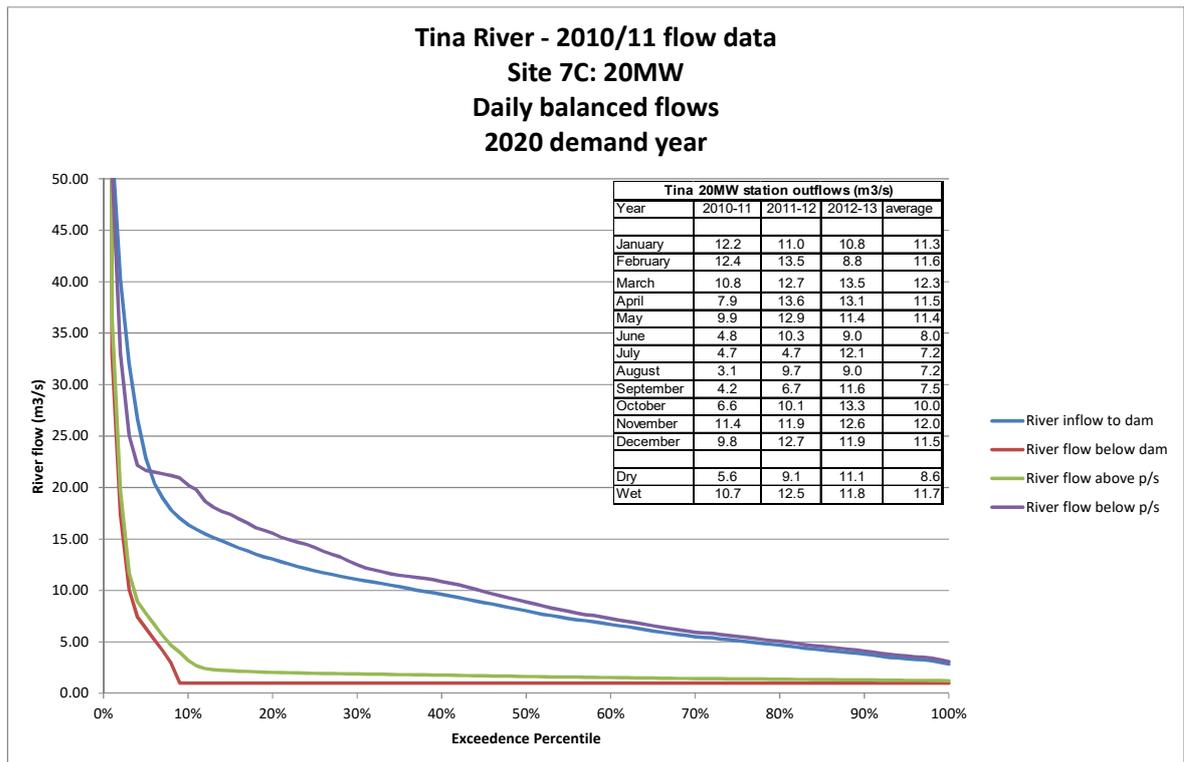
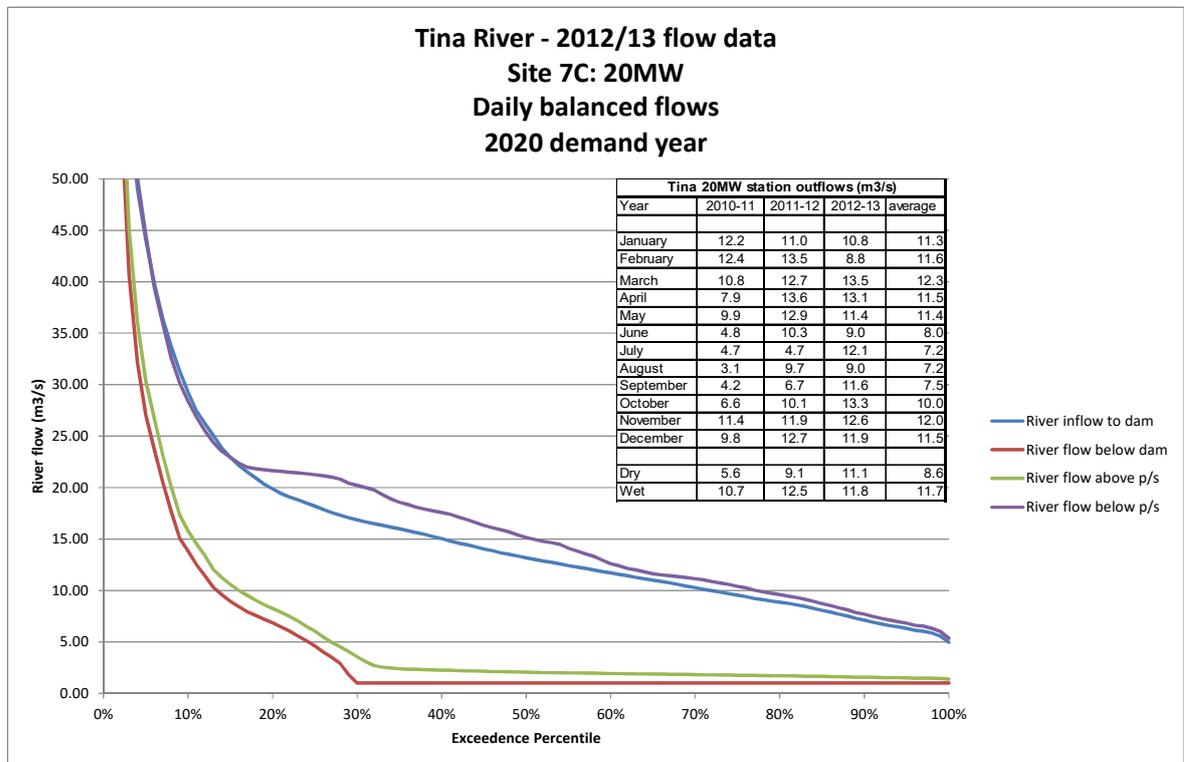


Figure 11-6: Wet year river flows – Daily balance operation of Tina Hydro (no peak operation)



Based on these figures, the following impacts are predicted to occur:

During a dry year:

- River flow directly downstream of the dam (red line) – for 92 % of the time, the River will not receive more than 1m³/s EF, and 8 % of the time the spillway will overflow releasing floods.
- River flow directly upstream of the powerhouse (green line) - lateral inflow in the by-passed river section is estimated to be about 1m³/s and will add to the 1m³/s EF directly downstream of the dam.
- River directly downstream of the powerhouse (purple line) – the flow daily balance will mimic natural flows as seen upstream of the dam (blue line). However, variation within a given day will be significant as shown in Figure 11-6.

During a wet year:

- River flow directly downstream of the dam (red line) - for 70% of the time, the River will not receive more than 1m³/s EF, and 30% of the time the spillway will overflow releasing floods.
- River flow directly upstream of the powerhouse (green line) - lateral inflow in the by-passed river section is estimated to be about 1m³/s and will add to the 1m³/s EF directly downstream of the dam.
- River directly downstream the powerhouse (purple line) - flow daily balance will mimic natural flows as seen upstream of the dam (blue line). However, variation within a day will be significant as shown in Figure 11-6.

Flows will not change upstream of the reservoir as a consequence of the Project.

Flow Variation Within a Typical Day

TRHDP PO has provided an example of a typical weekday flow regime and a typical weekend day flow regime, as shown in Figure 11-6.

Figure 11-7 Flow variation within a typical day

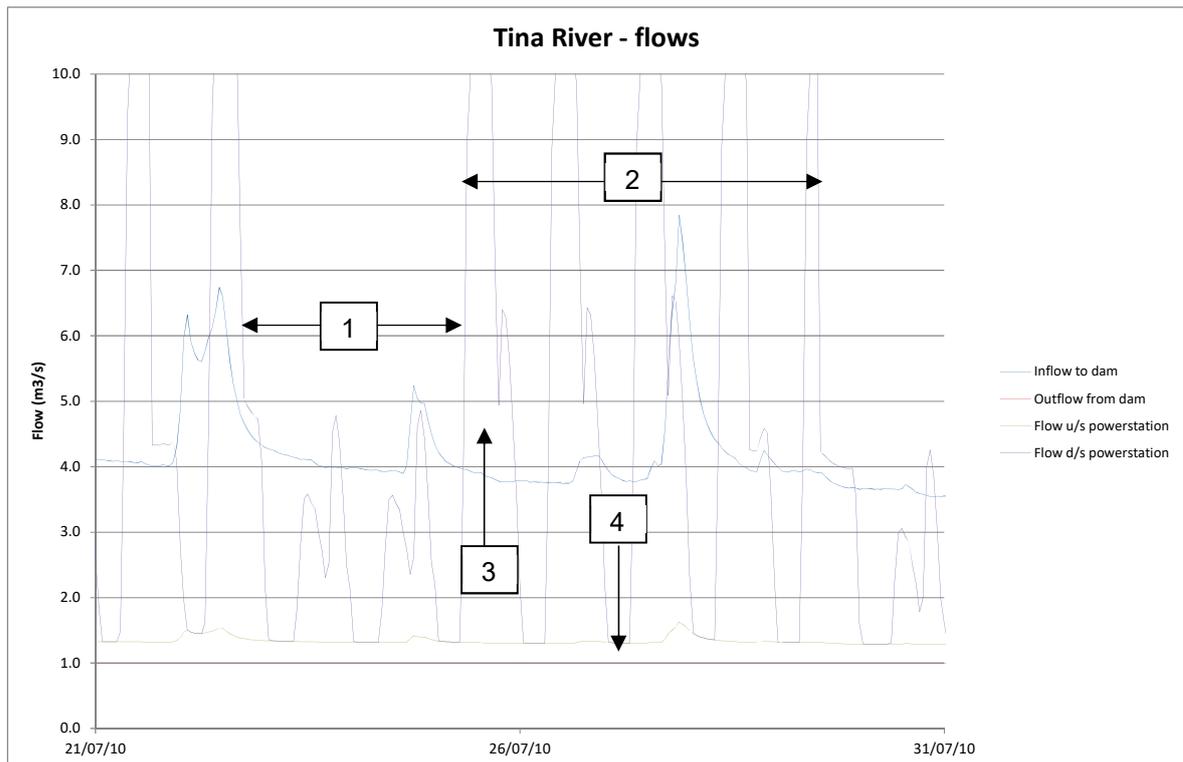


Figure 11-6 can be interpreted as follows:

- Box 1 - during weekends, the powerhouse will generate less power, creating lesser flow releases downstream of the powerhouse ($4\text{m}^3/\text{s}$ to $5\text{m}^3/\text{s}$).
- Box 2 - during weekdays, the powerhouse will generate more power, creating higher flow releases downstream of the powerhouse (up to $24\text{m}^3/\text{s}$).
- Box 3 - shows an example of release during a weekday. These releases will take place during the daytime and evening (peak hours).
- Box 4 - shows an example of powerhouse not producing any electricity during the nighttime (off-peak hours), thus not releasing any water. During nighttime, flow downstream of the powerhouse will equal the $1\text{m}^3/\text{s}$ EF (red line in Figure 11-5) plus the $\sim 1\text{m}^3/\text{s}$ of inflow from the lateral tributaries (green line). During nighttime, the flow will, therefore, be significantly reduced until the confluence with Toni River ($\sim 2\text{m}^3/\text{s}$) and will be reduced by 66% in the Ngalimbiu River (i.e., since the Toni River accounts for roughly 33% of the Ngalimbiu River system).

A significant flow reduction, mainly noticeable during nighttime and during dry years, will break ecological continuity of the river and create disturbance for water uses. As mentioned in Section 7 – Biological Environment Baseline - Aquatic, in the Solomon Islands, many aquatic animals, especially eels and prawns, are active at night.

In comparison to current baseline flow conditions, the nighttime flow of $2\text{m}^3/\text{s}$ in the Tina River will be slightly lower than the lowest recorded flow of $2.85\text{m}^3/\text{s}$, which is the lowest recorded flow between 2010 and 2013. The daytime flow of approximately $24\text{m}^3/\text{s}$ will be higher than the average flow during a typical wet season month (i.e., March with $21.94\text{m}^3/\text{s}$).

Due to a lack of specific details on planned operational regimes, it is still not possible to assess the dam and reservoir operation impact on the river hydrology on a seasonal basis.

Figure 11-6 assumes that the EF will be released during off peak and peak hours, with the bypass valve continuing to remain open to release the EF.

River System Response to Rainfall

Under baseline flow conditions, the Tina/Ngalimbiu River system is highly responsive to rainfall on the upper watershed. The flow varies over short periods of time and the river is subject to several flash floods throughout the year.

The operation of the hydropower systems is driven by power demand and is unlikely to mimic natural flow regimes. As such, schemes typically result in major changes to flow patterns from baseline conditions.

Once the dam is operational, the flow regime will be attenuated due to the presence of the reservoir, with low flows being supported and high flows being reduced.

The design of the dam may allow a certain regulation of flash flood events, especially if a storage capacity is planned to store these peak inflows for energy production. Entura (2014) anticipated such a management regime - the dam is designed a normal operating level (NOL) of 172masl three meters lower than full supply level (FSL) of 175masl), giving a flood storage volume of approximately 1Mm³.

It should be noted that this regulation effect is only valid for a moderate rainfall event. The regulation volume of 1Mm³ corresponds to a runoff volume after 8mm of rainfall on the whole watershed

Beside this regulation, exceptional discharge of storage water from water outlets may occur (e.g., to create a storage capacity or for maintenance or safety reasons), resulting in an artificial flash flood effect.

11.4.4.4.2 Impact Identification and Rating

The impact is considered to be major as the change to the flow regime is permanent and will lead to:

- Major modifications of the 5.7km by-passed river reach; and
- Noticeable changes at night, downstream of the powerhouse.

In addition to this, there is some health and safety risk associated with the sudden release of flows downstream of the powerhouse as power is dispatched. A warning system that reaches as far as the river mouth would need to be implemented (Section 12 – Assessment of Socio-economic / Socio-community Impacts, and ESMP).

Table 11-16 summarises the impact on changes of flows downstream of the dam.

Table 11-16 Impact rating for river flows downstream of the dam

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating

Moderate – for river ecosystem	Major – impact on ecological continuity	Localised – 5.7km section of the Tina River	Permanent	High	Major
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11.4.4.4.3 Mitigation Measures

To mitigate the effects of peaking operation dewatering of the Tina River between the dam and the powerhouse, it is proposed to release an EF of 1m³/s into the by-passed section of river.

The main rationale for EF release is to create an environment within the by-passed section of the river current that enables fish to move to the toe of the dam, and an attraction flow at the top of the dam, to entice fish to enter a trap-and-haul fish pass system.

The release of an EF is a necessity required to maintain spatial and temporal hydraulic continuity in the by-passed river section to provide for the needs of aquatic life and riparian communities. This EF must be maintained day and night expect during flood spill events.

If no EF is released, the 5.7km section of by-passed river is likely to be severely dewatered most of the time (i.e., approximately 92% of the time) (see Entura Phase 3 report, March 2014) as the capacity of the 4 turbines (24m³/s) will exceed the Tina River inflow.

11.4.4.4.4 Residual Effects and Their Significance

With the implementation of EF of 1m³/s EF, combined with an expected additional 1m³/s dry season inflow from smaller lateral streams, and designing the system to release up to 2m³/s based on an adaptive environmental management approach, the pre-mitigation impacts that were noted as major, would be reduced to moderate and, therefore, are not significant.

11.4.4.5 Conclusions Regarding Barriers to Fish Movement

11.4.4.5.1 Fish Passage and Exclusion

Various types of mitigation measures were considered for maintaining upstream and downstream fish passage, and protecting fish from physical damage. These include:

- ▶ Upstream migration of juveniles of targeted fish species:
 - Trap-and-haul system – trap juvenile fish that have congregated at the toe of the dam, and haul them up over the dam by tanker truck to be released in the upper catchment area. This would require an EF of 1m³/s to facilitate movement of fish upstream through the 5.7km of by-passed section of river and provide sufficient attraction water to entice fish into the trap.

A variant of this mitigation method would involve capturing juvenile fish at the mouth of the Ngalimbiu River, when they congregate to commence their seasonal upstream migration, then trucking them to a point upstream of the dam.

-
- Fish barrier – fish screens or other form of barrier would be installed at the turbine tailrace to exclude upstream migrating juvenile fish of climbing species from entering the turbines.

▶ Downstream migration of adult eels:

- Adjust reservoir level – during the period when adult eels move downstream on their annual migration, the reservoir would be filled to the point where water is spilled over the spillway, drawing adult eels with it.
- Install fish screens – fish screens would be installed at the power intake structure to exclude eels from being entrained into the power tunnel and turbines (see Appendix H).

A trap-and-haul system combined with an EF of 1m³/s is considered the only potentially viable system to ensure fish can continue to populate the upper catchment area and, therefore, warrants additional study. The EF of 1m³/s has the further advantage of ensuring river users along the by-passed section of river (i.e., at Choro, Koropa, Sengue) continue to have access to water, that ecotourism at Sengue is maintained, and that the aquatic ecology of the by-passed stretch of river is supported.

A fish barrier or repelling system is recommended for installation in the powerhouse tailrace to prevent mortality of upstream migrating juvenile Syciinids when they enter the turbines.

Further, it is recommended that the potential to farm fish within the reservoir be considered if this could be accomplished using species of fish that are native to the Ngalimbiu river system, and which could thrive in a lentic environment. Monitoring of species would need to be done to verify the efficacy of such a program.

Although, none of the fish species utilizing the Tina/Ngalimbiu River system will be permanently lost from the Solomon Islands if these mitigation measures are not implemented, the loss of viable fish populations from the upper Tina River catchment is an unnecessary impact, given the apparent efficacy of mitigation measures that are available.

11.4.4.5.2 Adaptive Environmental Management

An adaptive environmental management approach will be implemented in support of the proposed trap-and-haul fish passage system. This will involve the implementation of new or modified mitigation measures in response to unanticipated environmental effects. This could include the need to modify environmental flows at given times of the year, or modify the location, timing or design of trap structures to improve the efficiency of the trap-and-haul fish pass system.

The adaptive environmental management approach will follow that suggested by the European Bank for Reconstruction and Development (EBRD)⁷⁸, and includes the following five steps:

1. Incorporating structural and operational mitigation measures into project design and construction, that are tailored to the fish population(s);

⁷⁸ EBRD, Environmental and Social Guidance Note for Hydropower Projects (undated).

-
2. Maintaining mitigation structures (e.g., attraction water flows, trap structures, tanker trucks, etc.) to ensure functionality;
 3. Monitoring fish populations throughout project development (pre-, during, and post-construction) to identify residual impacts;
 4. Modifying structural components (e.g., location and design of trap-and-haul system) or operations (e.g., quantity, ramping, timing of flow releases; timing of trap-and-haul activities), to mitigate significant unexpected impacts; and
 5. Striving for no net loss, and preferably net gain, of fish biodiversity and abundance within the Tina River.

11.4.4.6 Changes in Sediment Downstream Dynamics

11.4.4.6.1 Impact Identification and Rating

Suspended sediment and bed-load will enter the reservoir from the upper catchment. A significant proportion of suspended sediment is likely to pass through the reservoir through either the powerhouse or. However, bed load will be trapped in the reservoir. According to Entura (2014) the dam could accumulate approximately 50,000m³/y of suspended sediment, and 45,000m³/y of bed load material.

Dams interrupt the action of the conveyor belt of bed load sediment transport. Typically, downstream of a dam water will have enough energy to move lighter sediment fractions (i.e., silts, sand), but has little or no capacity to transport the heavier (pebbles, cobbles and boulders) bed load sediment, thereby starving the river below the dam of the lighter sediment fractions. The effect will be to erode the channel bed and banks, and produce a river channel that is incised and comprised of coarse bed material.

The lack of sediment recruitment, downstream of the dam, especially sand and gravel sized particles, is associated with the changes in hydrologic and hydraulic conditions, including a decrease in occurrence and magnitude of flash floods. The effect is a significant change in sediment dynamics on the riverbed and banks downstream of the dam.

These changes may occur over the long term, since in the short term, unrestricted sediment inflows will continue from below the damsite and from the Toni River. Potential increased erosion and geo-morphological changes of the banks and riverbed may have consequences on river dependent biota (terrestrial and aquatic), and river uses (see Section 12.8 – Impacts on Natural Capital).

Effects on gravel recruitment will be somewhat augmented by the periodic flood releases over the dam spillway. Although gravel recruitment into downstream reaches will be regulated by the dam, there is a significant amount of gravel remaining within the river bed and along its banks, such that recruitment will continue downstream to the mouth of the river with each flood release. An assessment by a fluvial hydrologist will be undertaken to determine the approximate time period before these processes may have a negative impact on the mouth of the river. Periodic flushing or dredging of sediments from the reservoir will be required to control reservoir sedimentation. The assessment to be undertaken by the fluvial hydrologist will help to determine the extent to which reservoir sediment removal will mitigate the issue of downstream gravel recruitment.

Impacts associated with changes in downstream sediment dynamics are considered to be moderate. Table 11-17 summarises the impact assessment.

Table 11-17 Impact rating for downstream sediment dynamics

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for river ecosystem and resource users	Minor	Localised – damsite to Toni River confluence	Permanent	Moderate – but difficult to predict	Moderate

11.4.4.6.2 Mitigation Measures

According to Entura (2014), provision of large flushing outlets at the base of the dam would be expensive and technically complicated due to the RCC type of dam. The feasibility study proposes a local flushing outlet (scour outlet) in front of the headrace tunnel intake, which would enable flushing material from within the vicinity of the intake tunnel. The beneficial effect of flushing on sediment continuity would be limited, since flushing would affect only a localised area nearby the tunnel intake and would only be done once the tunnel intake is threatened by buildup of sediments.

The design of the dam does not provide for a low-level outlet to sluice sediments. To mitigate impacts of reduced sediment transport and recruitment an equal amount of sediment that is retained within the reservoir could be artificially added downstream by dredging or excavating from within the reservoir, hauling the material to locations downstream of the dam, and depositing it along the riverbed. According to Entura (2014), mechanical removal of trapped sediment or upstream sediment from gravel bars to inject into an area downstream would cost roughly US\$1m every 5 years, based on a few US\$/m³. By comparison, sediment removal from California reservoirs ranges from US\$15/m³ to US\$50/m³ (Kondolf, 1997). When required, the reservoir level could be lowered through the outlet during the dry season to expose the sediment beds, which could then be excavated and removed from the reservoir and injected downstream of the powerhouse or provided to downstream affected communities that rely on gravel extraction as a source of cash income. This measure would mitigate the impact on sediment dynamics downstream.

Monitoring of river geomorphology and sediment transport could be done to study long terms effect of sediment recruitment downstream and to follow up on erosion downstream. Parameters that could be studied include:

- Quantity of gravel extracted along Ngalimbiu River by local industries, versus quantity that would need to be artificially injected;
- Sand and gravel inputs from upstream areas;
- River bed sediment grain size analysis; and
- Depositional areas and pattern of sediment-starved water erosive behavior.

11.4.4.6.3 Residual Effects and Their Significance

The residual impact is considered to be low if sand and gravel is artificially deposited downstream and is, therefore, not significant.

11.4.4.7 Reservoir Stratification

11.4.4.7.1 Impact Identification and Rating

Stratification in a reservoir occurs when the upper zone of the reservoir (epilimnion), which is characterized by well-oxygenated water, is thermally divided from the deeper zone (hypolimnion), such that the hypolimnion becomes stagnant and is lacking in dissolved oxygen. This results in an anaerobic environment.

According to Entura (2014), a rapid estimate of stratification tendencies in a reservoir can be obtained with the Densimetric Froude Number (F):

$F = 320 (L/D)(Q/V)$ with L = length of the reservoir (meters); D = mean reservoir depth (for which dam height may be a proxy); Q = mean water inflow (m³/s) and V = reservoir volume (m³)

Therefore, for the TRHDP reservoir, the Froude number is:

$$F = 320 (L/D)(Q/V) = 320 \times (2,500 / 53) \times (11.5 / 7,000,000) = 0.024$$

If the Froude number is less than 1, some stratification is expected, the severity of which increases with a smaller F. If the Froude number is greater than 1, stratification is not likely to occur (Ledec and Quintero, 2003).

The Froude number for the proposed reservoir, calculated based on the characteristics of the preferred alternative (Option 7c) is 0.024.

This rapid assessment suggests stratification is possible and a further analysis of reservoir residence time is required. The more detailed analysis of residence time (Jorgenson et al. 2005) suggests that reservoir stratification is not likely but may occur.

The residence time of the proposed reservoir when full is approximately 7 days at median flow of 11.1 m³/s and the average flow depth is approximately 10 m (Entura 2014). Relationships between temperature differential thermal (stratification) and residence time (Jorgenson et al. 2005) show virtually no thermal stratification in a reservoir with a residence time of 7 days. Some stratification may occur, and a hypolimnion with a low dissolved oxygen concentration may develop. Stratification will be more likely during the lower inflows of the dry season. There is a significant possibility of short-lived periods (weeks to months) of stratification during periods of low flow. Higher flow periods are likely to break down the stratification.

However, with the reservoir bottom at 122 masl and full supply level at 175 masl, it is unlikely that the hypolimnion would extend upward to 162 masl, the level from which water is withdrawn for the turbines and the environmental outlet. Consequently, the discharge of surface water from the reservoir through the spillway, tailrace and environmental flow outlet is unlikely to cause any measurable change in dissolved oxygen downstream because these withdrawals are all from what would be the epilimnion in a stratified lake.

A variable-depth outlet for the environmental flow is under consideration, and the Reservoir Management Plan will include monitoring of dissolved oxygen and temperature at multiple depths to provide advance warning of potential water quality problems.

Based on this analysis, the impact is considered to be moderate. Table 11-18 summarises the impact assessment.

Table 11-18 Impact rating for reservoir stratification

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for aquatic life in the reservoir	Minor	Localised – reservoir	Permanent	Low - Moderate	Moderate

11.4.4.7.2 Mitigation Measures

No mitigation is required to address reservoir stratification since the location of the water intake for the headrace tunnel and the outlet valve for the EF are both located in the epilimnion of the reservoir, not the deeper hypolimnion. EF releases downstream of the dam and released from the powerhouse will not be affected by low oxygen concentrations.

11.4.4.7.3 Residual Effects and Their Significance

As long as the water intake takes water from the epilimnion there will be no appreciable impact on water quality and, therefore, no impacts to downstream ecosystems. Residual impact significance is low and, therefore, not significant.

11.4.4.8 Reservoir Water Quality

11.4.4.8.1 Impact Identification and Rating

Unless the reservoir area is cleared of vegetation, reservoir filling will inundate rainforest covering the slopes and bottom of the valley.

The decomposition of organic matter can result in depletion of oxygen levels in the hypolimnion layer of the reservoir, and produce greenhouse gases and other reductive compounds (ammonium, hydrogen sulfur, carbon dioxide and methane).

Even with most of the vegetation removed, water quality in the hypolimnion layer is likely to be significantly altered, at least during the first months after impoundment.

However, impact significance is considered to be low, as this impact is temporary. Table 11-19 summarises the impact assessment.

Table 11-19 Impact rating for reservoir water quality

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for aquatic life in the reservoir	Moderate	Localised – reservoir	Temporary – first few months after impoundment	Moderate – based on the Froude Number	Low

11.4.4.8.2 Mitigation Measures

To mitigate impacts on reservoir water quality and production of GHG, vegetation will be cleared from the area of the future reservoir. This vegetation consists mainly of herbaceous and woody stemmed (bushes, vines and tree) plant communities. Their removal will mitigate impacts on water quality by reducing oxygen demand as vegetation disintegration consumes oxygen. Vegetation clearance will be carried out during the dry season. Organic matter in the riverbed and sediment matrix will also contribute to some oxygen depletion. However, relative to the amount of organic material bound up in vegetation, the amount of organic material in the river bed and sediments is low.

Access in the forest to allow for vegetation clearing within the future reservoir area is an issue since:

- Access from the river valley to clear vegetation will be difficult due to the topography of the steep-sided river gorge, where flash floods would pose a threat to worker safety; and
- Two possible quarry sites have been identified by Entura (2014) in the reservoir area without defining any access road. Once access roads have been identified, they could be used to provide access for vegetation clearing and timber removal.

Due to the steep topography, it is recommended that vegetation be manually removed by workers hired from local communities, and that the relatively thin layer of organic topsoil be left in place. Sawn timber could be transported either by access road or by river as it is currently done from Choro and Koropa.

11.4.4.8.3 Residual Effects and Their Significance

By removing most vegetation from the reservoir prior to inundation, the residual impacts resulting from decomposition effects on water quality are considered to be low, and not significant.

11.4.4.9 Alteration of Water Quality Downstream of the Reservoir

11.4.4.9.1 Impact Identification and Rating

The intake to the headrace tunnel at 161masl to 164masl will be situated a few meters below the MOL (170masl). The operation of the powerhouse will release water from the epilimnion layer. Although the reservoir will be stratified, by taking water from the upper oxygen rich layer, water quality issues will be avoided. The lower oxygen concentration and toxic reduction compounds found in the hypolimnion will not affect downstream water releases.

Nevertheless, in comparison with the baseline condition, the presence of the reservoir may induce a small increase in water temperature, a higher concentration of organic matter and nutrients, and a lower concentration in suspended solids during heavy rain periods. On those occasions when accumulated sediment is expelled from in front of the power tunnel intake, sediment-laden waters will be released downstream. Otherwise, the water released downstream will be clear.

Water released as EF from the dam and from the powerhouse tailrace is unlikely to have significant impacts on aquatic life and water uses. Therefore, impact significance is considered to be low. Impact duration will be temporary, likely lasting only a few months after impoundment. Table 11-20 summarises the impact assessment.

It is not anticipated that reservoir operation will have a deleterious effect on water quality at the mouth of the river during operation. Rather, the reservoir will act as a sediment filter, settling out sediments and organic debris, as water it enters and passes through the reservoir. The exception will be during major flood events, when suspended sediment laden water will be released over the spillway and through the powerhouse tailrace. However, this condition is already part of natural storm events that regularly affect the Tina River

Table 11-20 Impact rating for downstream water quality

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for aquatic ecosystem and water uses downstream	Minor – in the hypolimnion	Localised – river downstream of dam and powerhouse	Temporary – first few months after impoundment	Moderate – based on the Froude Number	Low

11.4.4.9.2 Monitoring Measures

No mitigation is anticipated to manage quality of water released as EF and power generation flows from the reservoir. However, dissolved oxygen and temperature will be monitored at multiple depths in the reservoir and water quality monitoring will be undertaken downstream (see Section 13 – Environmental and Social Management Plan) to confirm this prediction.

11.4.4.9.3 Residual Effects and Their Significance

No residual impacts are anticipated and, therefore, impacts are low and not significant.

11.4.4.10 On-Going Disturbance to Downstream Aquatic Habitats and Aquatic Life

11.4.4.10.1 Impact Identification and Rating

Changes in flow patterns and sediment dynamics downstream of the dam, have the potential to affect aquatic life in this part of the river, with possible loss of breeding and rearing habitats. However, aquatic life downstream of the powerhouse is naturally adapted to rapid flow changes and should be quite resilient to new flow patterns caused by the TRHPD facilities.

Assuming water quality is not appreciably affected during operation of the dam, no significant impacts should accrue to the most sensitive species or life stages, or to the commercial fisheries at the mouth of the river.

Therefore, impacts are considered to be moderate, it is a permanent impact. Table 11-21 summarises the impact assessment.

Table 11-21 Impact rating for disturbance to downstream aquatic habitats and aquatic life

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for aquatic life and habitats downstream	Low – no significant disturbance	Localised – river downstream of dam and powerhouse	Permanent	Moderate – based on the Froude Number	Moderate

11.4.4.10.2 Mitigation Measures

Measures mitigate impacts on downstream aquatic habitats and life of aquatic organisms will include:

- Water quality monitoring, including for suspended solids downstream of the construction site;
- Ensuring EF releases to the by-passed section of the river;
- Maintaining a minimum flow of at least 3.43m³/s below the powerhouse plus inflows (equivalent to the minimum operational discharge of one turbine (2.43 m³/s), in addition to the by-passed reach environmental flow (1 m³/s)); and
- Installation of fish screens to prevent entrainment and mortality of silver eels.

It is recommended that as part of the Stakeholder Engagement Plan downstream communities who depend on the fishery at the mouth of the river be consulted on a regular basis.

11.4.4.10.3 Residual Effects and Their Significance

Since mitigation is primarily in the form of monitoring to ensure problems are avoided, residual impacts will persist as moderate impacts, but are not significant.

11.4.4.11 Establishment of a Lake Ecosystem in the Reservoir

11.4.4.11.1 Impact Identification and Rating

The construction of a reservoir usually leads to a change in the baseline fish assemblage, with development of pelagic or low velocity/stagnant water species and regression of rheophilic species.

In Guadalcanal, some native species are likely to benefit from the reservoir environment, assuming that trophic resources are available. These species include *Kuhlia*, *Mesopristes* (silver fish), and mountain mullet. These are usually strict swimmers that are not expected to migrate upstream of the dam if a fish pass was available. However, with a trap-and-haul place is implemented, these fish species will potentially be moved above the dam and continue to produce within the upper catchment area.

Invasive aquatic plant macrophytes such as Water Hyacinth, are unlikely to become well established in the reservoir if accidentally or intentionally introduced, given the short water retention time with its expected low concentration of nutrients, and the daily fluctuations in water levels. Nonetheless, a prevention and control plan will be prepared and implemented.

Impact significance is considered to be moderate. Table 11-22 summarises the impact assessment.

Table 11-22 Impact rating for lake ecosystem in reservoir

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – for aquatic life and habitats in the reservoir	Low – assuming no introduction of invasive species	Localised – reservoir	Permanent	Moderate – based on the Froude Number	Moderate

11.4.4.11.2 Mitigation Measures

Aside from proposing a plan to prevent / control the introduction and growth of invasive aquatic plant macrophytes within the reservoir, no other mitigation measures are considered. Reservoirs generally provide an opportunity for a fishery to be developed. Such fisheries have the potential to be more productive than the previous riverine fisheries, depending on whether native or invasive fish species are to be introduced.

In the Tina River, native species such as silver fish (*Kuhlia* or *Mesopristes*), which grow to relative large size, and are appreciated by local communities, may potentially thrive in the reservoir and might support a fishery. However, due to their freshwater / ocean life cycle that will be interrupted by the dam, it will be necessary to stock the reservoir by collecting fry at the toe of the dam, or at the mouth of the Ngalimbiu River and then transfer them into the reservoir.

11.4.4.11.3 Residual Effects and Their Significance

Restocking native Tina River fish into the reservoir to maintain a viable population, if successful, will reduce potential residual impacts to a level where they could be considered not significant, notwithstanding that the species assemblage will change.

11.4.4.12 Ongoing Disturbance to Water Uses

11.4.4.12.1 Impact Identification and Rating

Though people in local communities are used to flash floods on the Tina River, the flow variations induced by the dam and powerstation operation - and to a lesser extent, the alteration of water quality - might disturb the way people use the river for subsistence fishing, collection of drinking water, washing clothes, and recreational activities, especially between the dam and the confluence of the Tina/Toni rivers. This will require that people their activities. Another challenge will be to ensure the safety of people downstream of the powerhouse as flow releases ramp up in response to peaking generation flow releases.

Impact of disturbance to water uses is considered to be moderate, based on it being a permanent impact. Table 11-23 summarises the impact assessment.

Table 11-23 Impact rating for disturbance to water uses

Component value	Impact Significance Rating				
	Magnitude	Extent	Duration	Probability	Overall Rating
Moderate – water uses	Moderate	Localised – river downstream of dam and powerhouse	Permanent	High	Moderate

11.4.4.12.2 Mitigation Measures

Proposed mitigation measures to address disturbances to water use are provided in Section 12 – Assessment of Socio-economic / Socio-community Impacts. In summary they include:

- Providing river-based supply with appropriate treatment systems and supply points for each village;
- Providing rainwater collection and storage tanks;
- Establishing alternative supplies from local streams, and;
- Providing borehole / ground water supplies, piped to several villages / hamlets.

Transportation and distribution of clean water will be done by tanker truck on a regular basis. The water will be stored in tanks at the village level.

11.4.4.12.3 Residual Effects and Their Significance

Although the proposed mitigation measures will help to reduce impacts, residual impacts will continue. They are considered to be moderate, but not significant.

11.4.5 Conclusion Regarding Operation Impacts

Impacts on aquatic ecology during operation are related to the presence of a dam, which presents an impassable barrier to all native fish due to its height. In addition, the by-passed section of the river, with its modified flow will also affect fish migration. Unless mitigation is implemented, all native fishes will disappear from the upstream Tina River catchment. In addition, fish mortality in the powerstation turbines is foreseen as some larvae will be entrained into the power intake and juvenile fish will be attracted to the tailrace outflow of the powerhouse.

With the implementation of an EF of 1m³/s (almost 2m³/s when combined with inflow from the intermediate catchment area), a trap-and-haul system to move eels, silver fish and Gobidea over the dam, use of fish screens or barriers at the powerhouse outlet, and fish monitoring, impacts may be reduced to an acceptable level.

Due to the limited efficacy of fish pass systems the fish pass option was rejected. However, combining an EF of 1m³/s with a trap-and-haul system to move upstream migrating juvenile target fish species past the dam remains a potentially viable mitigation option, especially when combined with an adaptive management approach. The minimum flow of 1m³/s will also be maintained in the by-passed reach to ensure that social impacts are mitigated (see Section 12 – Assessment of Socio-economic / Socio-community Impacts) and fish stocking/farming program will be developed for reservoir fishery as a separate study.

Long-term operation of the Project should not adversely affect on the baseline situation regarding juvenile fish entering en masse the mouth of the Ngalimbiu River from the sea. Since observed species do not present a homing behavior, juveniles can colonize any river, not only their natal stream, so the Ngalimbiu River will continue to support fish.

Table 11-24 summarises impacts as well as residual impacts during operation of the Project.

Table 11-24 Summary of aquatic impacts

Impact from operatio	Impact before mitigation	Residual impact
Establishment of a reservoir	Moderate	Not Significant
Sedimentation of the reservoir	Moderate	Not Significant
Changes of flow downstream of the dam	Major	Not Significant ⁷⁹
Changes in sediment dynamic downstream	Moderate	Not Significant
Stratification in the reservoir	Moderate	Not Significant
Alteration of water quality in the reservoir	Low	Not Significant
Alteration of water quality in the river downstream	Low	Not Significant
Barrier to migratory fish species	Major in the upstream catchment. Minor in terms of overall fish biodiversity in the Solomon Islands	Potentially significant if recommended mitigation is not successful – follow adaptive management approach
On-going disturbance of aquatic habitat	Moderate	Not Significant
Establishment of a lentic biocenosis in the reservoir	Moderate	Not Significant
Disturbance of water uses	Moderate	Not Significant

⁷⁹ Pending results from ongoing Project monitoring

12. ASSESSMENT OF SOCIO-ECONOMIC / SOCIO-COMMUNITY IMPACTS

12.1 INTRODUCTION

This section addresses the potential socio-economic / socio-community effects of construction and operation of the preferred project alternative (Option 7c), while taking into account the issues identified by the local communities, stakeholder agencies and organisations, and the potential funders of the project. This section also presents the potential means of avoiding, mitigating, and managing project impacts that are consistent with policies and regulations of the SIG, World Bank, and donor agencies. It also addresses compliance of the TRHDP planning process with the World Banks Operational Policies and WB Performance Standards, including PS 7 on Indigenous People.

12.2 APPROACH

Each hydro development project has its own particular characteristics and features and will, therefore, generate specific beneficial and adverse social impacts. A Social Impact Assessment (SIA) was undertaken, the aim of which was to identify opportunities to maximise the benefits of the Project for the project-affected communities, and to minimise problems.

To assess the TRHDP, identification and evaluation of the social and cultural impacts were based on:

- Analysis of the records of consultations and awareness campaigns undertaken by the Project Office;
- Analysis of the project features and the social context by the ESIA team, drawing on experience of similar projects elsewhere, and international research (e.g., the World Commission on Dams), and;
- Several rounds of consultation via community workshops, and a householder survey, carried out by the ESIA team with the potential project-affected communities, individuals, and stakeholder agencies and groups

The SIA was prepared as part of the SIG's project environmental approvals. The assessment report ensures that the proposed development will comply with the World Bank *Performance Standards for Projects Supported by the Private Sector* (e.g., Performance Standard 7 on Indigenous Peoples).

A separate report, the Land Acquisition and Livelihood Restoration Plan (LALRP), sets out the impacts of the land acquisition for the Project. As the Solomon Islands' Government is responsible for land acquisition, the LALRP is prepared in compliance with World Bank Operational Policy 4.12 (involuntary resettlement).

12.3 SOCIAL IMPACT ASSESSMENT METHODOLOGY

The social impact assessment methodology included the following:

- Review of the project planning documents, including the social impacts scoping study conducted by Entura, the fieldwork and background reports by the Pacific Horizons Consulting Group (PHCG), and other reports and briefing materials prepared for the project;

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- Review of existing information (secondary data) covering the project area, its population and local customs, recent history of conflict, available census and other quantitative data related to population and resources as well as a review of any recent hydroelectric developments in Melanesia and in the South Pacific region;
 - Review of the records of the three-year awareness raising/education programs and consultations conducted by the PO with local communities, organisations, agencies, and individuals;
 - Rapid fieldwork visit in mid-2013 combined with consultation with key agencies and community leaders in the project area. This fieldwork enabled the project area to be zoned into 3 areas for social assessment: Downstream Area, Infrastructure Impacts Area and Wider Impact Area.
 - Four-week interview program and participatory workshops in July-September 2013 with the Tina and Ngalibiu River communities, and adjacent land owner's communities in Malango. The 15 community focus workshops covered all of the villages in the project area, and had a total recorded (minimum) attendance of 511 people, 45% of whom were females, and covered the full range of age groups. In the Bahomea district at least 48% of participants attending the workshops were females. The workshops were arranged in advance with the help of the TRHDP PO and involved directly the locally-based community liaison assistants (CLAs);
 - Rapid fieldwork visit in mid-2013 combined with consultation with key agencies and community leaders in the project area. This fieldwork enabled the project area to be zoned into 4 areas for social assessment: Direct Impact Area (DIA), Downstream Area, Infrastructure Impacts Area and Wider Impact Area.
 - Four-week interview program and participatory workshops in July-September 2013 with the Tina and Ngalibiu River communities, and adjacent land owner's communities in Malango. The 15 community focus workshops covered all of the villages in the project area, and had a total recorded (minimum) attendance of 511 people, 45% of whom were females, and covered the full range of age groups. In the Bahomea district at least 48% of participants attending the workshops were females. The workshops were arranged in advance with the help of the TRHDP PO and involved directly the locally-based community liaison assistants (CLAs);
 - List of all of the households in the villages that were involved in the community workshops. This was done by the local indigenous member of the ESIA team in discussion with senior women of each village;
 - Face-to-face survey of over 50 female householders from across the villages within the project area. Survey questions covered the following topics: household's livelihood/s; division of labour; food and nutrition; health issues; access to resources; and anticipated issues with the TRHDP. The survey interviews were conducted, for the most-part, by the female community liaison assistants for the project in Bahomea and Ghaobata districts, and by the cultural issues specialist on the ESIA team.
 - Face-to-face interviews and discussions with male and female officers of government agencies and non-government organisations having a direct or indirect interest in the Project;
 - Review of the results of the community public awareness, consultation and mitigation workshops (e.g., in Bahomea (x2), Malango (x2), and Ghaobata (x1) in January-February 2014). These ESIA findings provided information on the potential impacts of the project and proposed responses to those impacts. Senior TRHDP officers were present to respond to technical questions or policy issues.

12.3.1 Village Community Workshops

All consultations, including workshops, were preceded by local announcements of the timetable, the purpose and the program. They were facilitated locally by members of the TRHDP PO CLAs and by community relations officers.

During the brief introduction of the village community workshops (which was given in English, Pidgin, and relevant indigenous language), participants were advised that:

- The ESIA team was independent of the TRHDP PO;
 - Individuals' comments and viewpoints would be treated anonymously in the assessment; and
 - People were free to stay or leave the meeting as they wished.
- A consent form was distributed by the village chief/s.

During the workshops, questions were asked regarding peoples' awareness of the proposed project, and whether the participants and their communities supported the proposed Project, or not. As shown by the following photographs (see Figure 12-1 and 12-2), the community workshops were participatory and interactive. Each key topic of the project was discussed and displayed on a whiteboard.

Figure 12-1 Young people discussing the Project's impacts during the village workshops (Antioch (left) and Pachuki (right))



Figure 12-2 Householder's interviews



12.3.2 Mitigation Workshops

Mitigation workshops were used to discuss and obtain input on opportunities to mitigate potential project related impacts. The mitigation workshops followed the same methodology as the village community workshops: prior announcements, on the ground organisation by the project liaison officers and community liaison assistants, a brief introduction of the Project and meeting, and the distribution of consent forms.

The mitigation workshops were district-wide and were, therefore, larger than the village community workshops with larger venues (e.g., meeting halls). The workshops were attended by the TRHDP PO technical personnel who answered questions and provided technical explanations, when required. A buffet meal was provided by the TRHDP PO, in keeping with local custom. The minutes of these meetings are provided at Annex 14.

Figures 12-3 and 12-4 present photographs of mitigation workshops held in Bahomea and Malango.

Figure 12-3 Mitigation workshop in Bahomea



Figure 12-4 Mitigation workshop in Malango



12.3.3 Requirement for Free, Prior, and Informed Consent

The World Bank Performance Standards 1 and 7 stipulate that Free, Prior, and Informed Consent (FPIC) (see Appendix J) is required for the affected indigenous peoples at each stage of the project development. The TRHDP PO was responsible for planning delivery of the program and for informing, and consulting with, local communities and other stakeholders regarding the Project, including the overall project concept and design, generation option investigations and selection, detailed proposals, and matters related to the use of land and resources belonging to local communities. As noted in PS 1, paragraph 32, FPIC is also required for the assessment of the project's adverse and beneficial impacts.

12.3.3.1 Free, Prior and Informed Consent and Project Planning

As part of the ESIA, the question must be asked regarding whether the project processes have been consistent with the WB PS requirements for FPIC. This assessment can be made in two ways: a) by evaluating the awareness raising and stakeholder engagement plans of the TRHDP PO and the records of its meetings and interactions with stakeholders, combined with observations of field practice by the TRHDP PO's offices, and b) by noting feedback received from the communities and other stakeholders regarding the TRHDP PO's activities.

The TRHDP PO's community-wide engagement began in July 2010 with a program of awareness raising in the Bahomea and Malango districts, working with members of the then Land Owner Council (LOC). Prior to these activities, the TRHDP PO had been working with local leaders to establish processes and terms for involvement and land identification, and had participated in the establishment of the LOC, which included landowners from Gold Ridge, Bahomea and Malango.

Since 2012, consultations were largely guided by MMERE's 'Tina River Hydro Development Project's Stakeholder Engagement Plan, March 2012', supplemented by additional activities as required. Annex 14 contains an overview of the TRHDP's community engagement activities. The objectives of the stakeholder engagement, as stated in the plan, included:

1. Deliver accurate, free and timely provision of information, manage expectations, and promote widespread awareness of the project;
2. Facilitate two-way communication with communities directly affected by the Project to:
 - (a) Understand the views and opinions of the community, including vulnerable, social and cultural groups regarding ways the Project may affect people, how these impacts can be limited or mitigated, and ways the project may provide benefits;
 - (b) Ascertain the level of broad community support for the Project at all stages;
 - (c) Ensure those being resettled (if any) by the Project have ample avenues to participate in resettlement planning and implementation, including their location and housing structure; and
 - (d) Address project concerns in a timely manner (MMERE, 2012).

As noted in the Socio-economic / socio-community Baseline, the engagement plan, MMERE's records of meetings with communities and their representatives, and other engagement activities since 2010, together suggest an ethical, well-organised, well-resourced, adaptative, and culturally appropriate ongoing program of consultation and involvement by the TRHDP PO with the project-affected people and communities.

With respect to “free” consent, the TRHDP PO’s activities and program suggest that there has been no coercion or intimidation on the part of the developers, and there has been no evidence of bribery or inducement for local people to be involved in discussions about the project. Conversely, some landowners and their tribal/clan leaders have demanded and received sizeable “access payments” from the government, to allow site investigations, consultations, and related planning activities and meetings to proceed in the proposed project areas. In keeping with local custom and the expectations of local communities, the TRHDP PO has presented chupu (customary presentations) and extended hospitality to local chiefs and communities, as part of its activities.

Since the Ethnic Tensions, expectations of ‘compensation’ payments by communities, and expectations of cash benefits derived from project planning steps, appear to have become the norm for any development in the Solomon Islands. This is in part born out of a concern that projects will not reach an operational stage, (exacerbated by repeated closures of Gold Ridge Mine and neighbouring oil plantations), and a concern that communities which lose access to natural resources will not receive adequate benefits from operational stages. This mentality, sometimes referred to as ‘rent seeking’ is a considerable problem for ethical developers. Since the TRHDP represents a significant development for Guadalcanal and Solomon Islands, from time to time aspiring clan leaders, politicians, and “big men” have attempted to utilize the community engagement and internal tribal consultation processes for their own purposes. So far as these attempts affect the sharing of cash benefits from the land acquisition, they are discussed and considered in the Land Acquisition Livelihood Restoration Plan. Local awareness-raising (information sharing) and consultation activities have been strongly supported by communities and local leaders.

Among the Ghaobata communities and their HOC, which have a lot of experience in dealing with industrial and resource developments within their region of the Guadalcanal plains, requests for payments to engage in project planning have been quite explicit. Under advice by knowledgeable senior people from this area, the TRHDP PO has avoided being drawn into direct negotiations with the HOC, and has instead been working through a Guadalcanal provincial government officer, and its own CLAs to provide information and to encourage local people to consult about the Project among themselves.

The flow of information from the TRHDP PO to the affected communities appears to have been of a high standard. The TRHDP PO recruited a well-known indigenous media person to develop and document the information sharing and awareness raising activities of the TRHDP PO. The presentation of information briefings to local communities and various groups of stakeholders at key points in the project planning process has been done in local languages, and has been accompanied by the use of audio-visual aids. Examples of material produced for communicating with stakeholders and the public generally included a project website, information booklets in English and Pidgin, posters, satellite and aerial photographs, and a DVD. Engagement activities by the TRHDP PO were recorded, lists of attendees were taken, and minutes were prepared of consultations, meetings, and issues arising. The TRHDP PO has also made a photographic record of its community awareness raising and consultation activities within the indigenous communities.

The awareness raising and consultation activities by the TRHDP PO commenced in the Tina/Ngalimbiu River catchment early in the development process (2009-10), prior to any investigations of suitable dam sites. Initially, consultations focused on landowner consent to undertake geological and hydrological investigations in the catchment. This involved identifying all the relevant clans and developing processes and arrangements for consultation with them. These arrangements evolved over time, and - as noted above - consultation processes were formalized in a stakeholder engagement plan, which was made available to

the public. Project planning, including environmental and social assessment, has been ongoing, with information about the project design and its potential impacts being regularly provided to the relevant communities and stakeholders. At the time of this assessment report application for project approvals had not been made, nor had construction commenced. The early and sustained engagement with the affected communities has enabled the development of a good working relationship between the Project and local people, and for the inclusion of their concerns and knowledge into the consideration of various options for the hydro development.

The TRHDP PO has made use of a variety of culturally acceptable means for communicating with local communities and stakeholders. Important communications have been, and continue to be, done face-to-face, starting with clan and village chiefs, and senior women, and then extend out to the wider village communities. Local communications are undertaken by the project's indigenous community relations staff and CLAs, and endorsed by community leaders. A wide variety of communications tools have been used to inform the communities, and to receive comment and advice in return. Among these are: printed materials, including a project booklet; face-to-face briefings and discussions with groups of community leaders, individuals, community interest groups (e.g., mother's clubs, and church groups) and agency representatives; and mobile phone and SMS, presentations using video, photographs, maps, and posters and site visits.

Based on the records of the TRHDP PO, discussions with TRHDP PO staff and CLAs, observations, and explicit comments from participants during the 2013 ESIA village community workshops and 2014 mitigation workshops, it appears that:

- There is broad support among local communities for the Project and there is no clear direct opposition to it. A minority of clan leaders and aspirants objected publically to the land identification and acquisition process. A discussion of some of the current issues raised by a minority of clan leaders with respect to compensation is provided in the LALRP;
- Hydroelectric development is widely seen as the most preferred and least destructive development opportunity for the Tina/Ngalimbiu River catchment (others being gold mining and logging of primary forest);
- community concerns about the project are generally confined to the mitigation of potential impacts and the securing of benefits;
- There has been a comparatively high level of participation of community members of both genders and all ages in the TRHDP PO's activities.
- There is wide-spread understanding of the purpose of the TRHDP, and what it generally involves, although the details of particular hydropower generation options are not well understood, especially by women;
- There is a high degree of trust of the TRHDP PO and the information it has provided, and a sense that local peoples' concerns are being heard and dealt with, even though there is little trust in government, generally; and
- There has been considerable discussion within the communities about the Project, including its benefits and potential impacts.

In addition, written consent to the Project was provided by the five landowning tribes who negotiated with SIG for the acquisition of the land to construct and operate the Project ('Process Agreement'). This is discussed further in the LALRP.

Further to the common or mutual concerns outlined above, the particular concerns of each village, relating to the preferred alternative, are presented in Annex 15 of the Annex Report, along with the perceived benefits of the development. These were recorded in the participatory workshops and in the follow-up mitigation workshops.

A summary of the feedback received in the 15 ESIA mitigation workshops and the manner in which the feedback has been incorporated into project design and key safeguard documents is set out in Appendix N – Resoulution of Community Feedback.

In summary, the TRHDP planning process appears to comply with the requirement of FPIC and, to date, community consent has been achieved at each stage.

12.3.3.2 Free, Prior and Informed Consent and the Social Impact Assessment

The ESIA process has been described in the Socio-economic / socio-cultural Baseline and above. As noted, the community workshops and consultations conducted by the ESIA team with the people of the project area were consistent with FPIC. That is:

- The community workshops and interviews were preceded by a briefing on the forthcoming ESIA, and then advanced notice was given of the workshop date, program, and the purpose of the meeting;
- Meeting organisation, selection of venue and timing was brokered by local members of the TRHDP PO's team of indigenous CLAs and agreed with the relevant communities. Women were specifically encouraged to attend and to participate;
- local community leaders agreed in advance for the ESIA team to visit and engage with local people on the impacts issues, to record the participants' comments and information, and to make observations in the community. Village and clan chiefs attended the meetings. One of the mitigation workshops was held for the members of the Bahomea HOC;
- a verbal briefing about the ESIA was provided to workshop participants in English, Pidgin, and the local language. Participant consent was explicitly sought to proceed with the workshop and individual interviews, to record discussions, and make use of the findings, and;
- the workshop process also included specific questions on whether the participants and their communities broadly supported the proposed hydroelectric development, or not.

12.3.4 Women's Participation

The TRHDP PO's records on awareness raising and consultation activities indicate that women have attended and participated in community level activities and stakeholder consultations. This was facilitated by the recruitment of mature local women as CLAs. In general, women in Solomon Islands tend to have a lower status than men and are often unable to attend workshops due to their home duties. This means that younger women are not always able to attend presentations to receive information and to engage in discussion regarding the Project during meetings. However, older women, especially those with a higher level of education, tend to be more actively involved. In addition, due to customary gender roles, women may not be encouraged by men to state their point of view or raise issues in larger gatherings. This issue did not seem to be a significant problem during the ESIA workshops.

It appears that women were successfully involved in workshops, awareness raising programs and consultation activities. Ninety-three percent reported they attended community meetings (see Annex 16 of the Annex Report). On the other hand, the household surveys suggest that

women are less involved in land acquisition discussions, as only 41% of adult women reported that they were involved in deciding on land issues in their household. By comparison, in a national survey in 2007, 55% of adult women reported that they were involved in land decisions.

For example, 45% of the participants of the ESIA community workshops in 2013 were indigenous women and girls. Although it seems that women have limited decision-making power in Guadalcanal societies, their active involvement in the ESIA process is a positive sign, especially when looking at their willingness to participate in the household survey. Finally, the SIA takes into account women's perceptions and concerns about the proposed TRHDP as well as their preferences for mitigations and benefits sharing. Measures to incorporate gender inclusion in land acquisition discussions and agreements are set out in the LALRP.

12.4 CONSTRAINTS OF THE SIA

A lack of or delay in information sharing in some key areas limited the conduct of the ESIA and of the mitigation workshops. This information included:

- The preferred project option and its location, scale, and access road alignments;
- Ownership and use rights for the “core area”; and
- Current census statistics.

12.4.1 Preferred Project Option

The SIA for the TRHDP was commenced at a time when Option 6E was being evaluated, but when Option 7C was being discussed as a lower impact alternative, as described in Entura's Phase 3 Report (2014). This uncertainty presented some challenges for the workshop consultations in Senge Communities that could be impacted by the choice of dam and power station location, in particular whether they would experience physical displacement. The workshop discussions therefore had to cover the impacts of Option 6E and Option 7C. In practice, the choice of option made little difference to the impacts likely to be experienced in the Infrastructure Impact Area, Downstream Area, and the wider Malango district (Wider Impact Area), providing the basic project parameters were similar. Despite the uncertainty, the discussions in the Senge Communities helped the TRHDP PO to refine the project's concept and parameters, design policies, and ultimately the preferred option (Option 7C), which was announced as the preferred alternative in early 2014.

In late January 2014, the TRHDP PO provided a verbal briefing prior to the community and agency consultations on proposed impact mitigations. The draft ESIA was subsequently updated to reflect specific requirements and potential impacts of Option 7C. However, opportunities to conduct additional SIA fieldwork were not available.

12.4.2 Land Ownership

At the time of the SIA and of the Socio-economic / socio-cultural Baseline, no details on land ownership were available for either Option 6E or Option 7C.

The new, localised land identification process was underway at the time of the draft ESIA preparation. Since it had not been completed, its findings had not been disclosed beyond the TRHDP PO and the particular landowners. Direct consultation with the landowners in the Core Area was therefore not possible, with “the impacts resulting from land acquisition” only being covered at the community or village level. In practice, however, SIA workshops, householder interviews, and follow-up consultations on mitigations were conducted in those communities where most of the landowners for the Option 7C Core Area reside.

Since a LALRP was necessary for the loss of livelihood assets acquired for the Project, relevant data needed to be subsequently collected to enable the Plan to be prepared. This additional research was done in 2015 by means of a Livelihoods Assets survey and through fieldwork for the creation of the Tribal Register.

12.4.3 Census Data Availability

Despite several attempts by the TRHDP PO, individual government officers, and ESIA team members, it was not possible to obtain project area or village level data from the 2009 Census of Population and Housing in time for the initial preparation of the ESIA report. This data became available in 2015 for all census enumeration areas and has been integrated into the ESIA where possible.

12.5 POTENTIAL ADVERSE SOCIAL IMPACTS AND MITIGATION

Below is a summary of the construction and operations phases of the Project, and the potential socio-economic / socio-community impacts that may potentially accrue.

12.5.1 Potential Impact Causing Activities

12.5.1.1 Construction Phase

Specific activities are likely to generate impacts during the construction phase of the TRHDP, include:

- ▶ Building the RCC dam, including installing temporary diversion works within the river, excavating the dam site, and upstream and downstream quarrying of materials;
- ▶ Constructing new access roads, one from Managikiki [\[1\]](#) to the core land and then to the dam site, and a second road from near Managikiki to the power station and tailrace site upstream of Pachuki. Construction of both roads will require felling and clearing forests and disposing of vegetation, earthmoving (cutting/benching and filling to create a roadway), and installing culverts and drains. Some of the roadways may interact with existing tracks, household food gardens, and/or areas where materials are collected;
- ▶ Presence of road works to improve and widen the existing Black Post Road, from the Black Post (on the Kukum Highway) to Managikiki;
- ▶ Movement of equipment, materials, and people to and from the construction sites, using the new and improved roads;
- ▶ Excavating the headrace tunnel;

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- ▶ Clearing forested areas within the hydro storage reservoir, and possible recovery of the logs and/or timber;
 - ▶ Erecting the transmission line pylons and conductors from the powerhouse along the Black Post Infrastructure Corridor, and;
 - ▶ Employment and management of local and non-local workers to undertake the various tasks involved in building the hydro scheme and in mitigating its impacts.

12.5.1.2 Operation Phase

Once constructed and commissioned, the Tina River hydro scheme could cause long lasting impacts on local communities. Operation activities that may affect them include:

- ▶ Modifying the natural flow of the Tina/Ngalimbiu River between the storage reservoir and the ocean in the dry season - mainly arising from peaking operation that will involve reservoir filling and refilling and releasing water through the headrace tunnel to the powerhouse. The reservoir will be refilled at night and water will be released for power generation during the peak daytime power demand periods;
- ▶ Diverting much of the Tina River's flow from the natural river course into the head race tunnel, located between the dam and the powerhouse, leaving the river with a supplementary environmental flow (EF) from the dam, combined with inflow from lateral streams;
- ▶ Using the access roads by workers and contractors working on the maintenance of the dam, reservoir, power station, and transmission lines;
- ▶ Employing and managing local and non-local workers to undertake various tasks involved in operating, protecting, and maintaining the hydro scheme, and;
- ▶ Possibly using the storage reservoir and the access roads by non-project personnel, including local community members and outsiders.

12.5.2 Types of Social Impacts

During the three-year construction phase and the long-term operation phase of the TRHDP, a combination of direct, indirect, positive and negative social impacts on local communities may arise.

Several types of social impacts may occur. These include:

- ▶ Direct physical impacts on nearby communities (e.g., intrusive noise, vibration, explosion shockwaves, dust, air and ground discharges, and visual intrusion) some of which could have potential health consequences and negative impacts on way of life and local amenities;
- ▶ Loss of access to abundant clean fresh water;
- ▶ Damage to and/or loss of access to livelihoods assets, including fishing areas, food garden areas, hunting areas, plant and related materials, planted and wild fruit and nut trees, and timber woodlots and plantations, with potential negative impacts on household and community wellbeing;
- ▶ Opportunities for improved incomes due to increased employment opportunities;

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- ▶ Opportunities for improved quality-of-life, through the upgrading of services and facilities.

 - ▶ Increased risk of accidents due to project related vehicle traffic;
 - ▶ Improved road mobility between villages in the project area, and with Honiara; and
 - ▶ Threats to indigenous lands, natural resources, security, community health and well-being, and local culture.

The communities that are most likely to be negatively affected by the project are those located adjacent to, and make livelihoods-related use of, the Core Land area, and/or the low-flow section of the Tina River.

12.5.3 Health, Safety and Wellbeing - Impacts and Mitigation

12.5.3.1 During Construction

The construction of the TRHDP may present threats to local people's health and wellbeing. These threats include:

- Outbreaks of gastrointestinal and skin infections arising from run-off and contamination of drinking and washing water from the Tina/Ngalimbiu River and local streams;
- Increase in malaria outbreaks due to more standing water around construction sites;
- Rise in road accidents, lost loads and spillages due to more traffic on Black Post Road, as well as work related accidents;
- Social threats arising from inappropriate behaviour of outside construction workers, and local people employed on the Project. Issues of concern are associated with a potential increase in:
 - unwanted pregnancies;
 - sexually transmitted diseases such as HIV/AIDS;
 - domestic financial issues due to gambling or drinking; and
 - alcohol and drugs consumption by men, leading to domestic conflict and violence, and sexual abuse.

Nevertheless, with sufficient preparation and investment by the TRHDP PO and the SIG, each of these potential health threats may be avoided or mitigated, as follows:

- The construction of the project (and access roads) should be planned and executed according to good international industry practice (GIIP) to avoid any physical or biological contamination of water sources. This should be explicitly addressed in a Construction Environmental Management Plan (CEMP), along with cleanup procedures. Alternative drinking water supplies should also be installed throughout the project area, prior to the beginning of the construction phase.
- Unfortunately, some social threats cannot be completely avoided, as they involve individual personal choices of community members (e.g., level of alcohol and drug consumption). However, it is the responsibility of the Project to prohibit disruptive behaviours and one means of prohibiting such behaviors is the decision already taken to avoid the establishment of a workers camp in the Tina/Ngalimbiu River catchment.

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- The threat of anti-social behaviour by local male workers could be minimized by the TRHDP PO and the construction contractor implementing strict drug and alcohol prohibition for all workers. This prohibition may also help reduce the risk of work related accidents and road accidents on Black Post Road.
 - In addition, the development of a Health and Safety Plan by the construction contractor, for both workers and villagers living near the site, could minimize the potential risks for road accidents, injuries and property damage resulting from lost loads. The Plan should include measures such as:
 - For work-related accidents, the construction contractor will need to provide tailored workplace health and safety training and personal protective equipment (PPE) (helmet, safety boots, gloves, goggles or safety glasses, hearing protection) for construction workers prior to the work commencing; provide a full-time first aide/nursing post on site and arrangements for medical evacuation (including helicopter transport) for serious injuries.
 - Ensuring that all drivers and plant operators are appropriately qualified and trained for their work;
 - Installing protective roadside fencing (particularly in the most vulnerable areas such as Mangakiki/Verakuji), and hamlets (in the Grassy hill area);
 - Installing a separate pedestrian walkway and well-marked road crossing points in the vicinity of Mangakiki/Verakuji, Marava, Rate, Verakabikabi, and on the roadside hamlets in the Grassy Hill area;
 - Enforcing speed limits for all traffic on the upgraded Black Post Road;
 - Using good international industry practice for the transport of dangerous goods, and;
 - Developing a protocol for managing contractor-related road accidents and injuries, including compensation and compensation arrangements.
 - The TRHDP PO and the Construction Contractor will have to conduct awareness on HIV/AIDS and STD to prevent and mitigate the impacts of social behaviors which will encourage sexual behaviours. The TRHDP PO and construction contractor may have to engage outside parties to carry out these awareness programs if these issues are sensitive and cannot be discussed openly by project area parties such as the community Liaison Assistant currently engaged by the TRHDP PO.

12.5.3.2 During Operation

Stakeholders' are concerned about water quality in the Tina/Ngalimbiu River once the project is operational, especially with respect to the water in the reservoir and in the stretch of river that will have a significantly reduced flow on which three villages depend.

Communities are concerned about increased water-borne diseases, especially diarrhea and malaria. Downstream communities are concerned about water borne diseases from human waste, and have requested independent water quality monitoring and reporting. The monitoring of water quality and the incidence of water borne diseases should begin just prior to commencing construction, and should be part of an ongoing environmental management and monitoring program.

It is unlikely that the operation of the hydro-scheme will cause any noise disturbance to local households. Locally, the project operation will have no effect on air quality. Owing to reduced diesel being consumed for power generation, the air quality should improve in the Lungga area, which may have positive impacts on villagers' health.

Despite repeated awareness raising and consultations regarding the dam design and dam safety, local communities, especially women, are still concerned about the potential risk of possible dam failure during earthquakes or cyclones. Some community members expressed a lack of trust in the SIG to safely manage the hydro facility and are asking the SIG and the TRHDP PO to resettle them away from the river. However, according to the TRHDP PO, the

risk of a dam failure is extremely low and there is no need for resettlement. This position is consistent with the World Bank's policies on resettlement. However, it remains crucial to implement carefully tailored awareness programs to educate communities about hydro dams, the TRHDP design, and the provisions being made for dam safety in order to prevent unnecessary fears amongst local communities and to avoid any unnecessary resettlement.

Finally, the sudden release of up to 24 m³/s of water from the powerhouse tailrace is seen as a potential safety hazard to local communities, particularly for persons who use the footpaths along the rivers bars and riverbanks. At times, the powerhouse will operate during daytime (peak hour) and will shut down during the night, with the potential ramping flow releases occurring during the daily startup of power generation. To mitigate this hazard a staged release of flows is proposed to alert people to the rising water level, together with awareness on the staged releases and approximate proposed release times.

12.5.4 Women - Impacts and Mitigation

During the village household surveys, women were asked to indicate their thoughts about potential adverse and beneficial impacts of the proposed TRHDP on them and their household.

The greatest concerns expressed by women include: water pollution, reduced river use/amenity, children's safety, bad influence of outsiders, loss of fish stocks and noise (see Figure 12-5). In terms of the long-term adverse impacts of the TRHDP, women were most concerned about catastrophic failure of the dam, and potential for social and cultural disruption arising from increased outside influences and access to money, by youth and men (see Figure 12-6). Measures to avoid or mitigate short and longer terms impact concerns are outlined in the relevant sections.

Figure 12-5 Women's perception on potential adverse impacts of the TRHDP

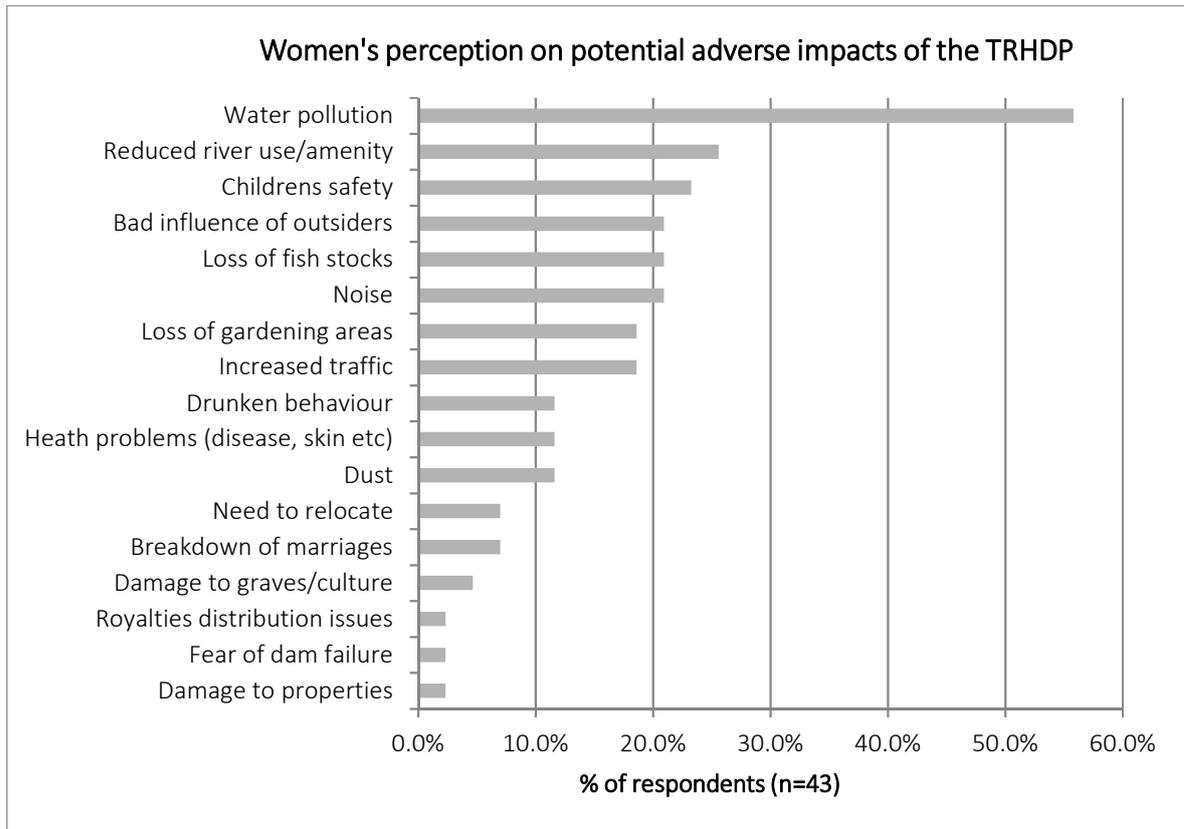
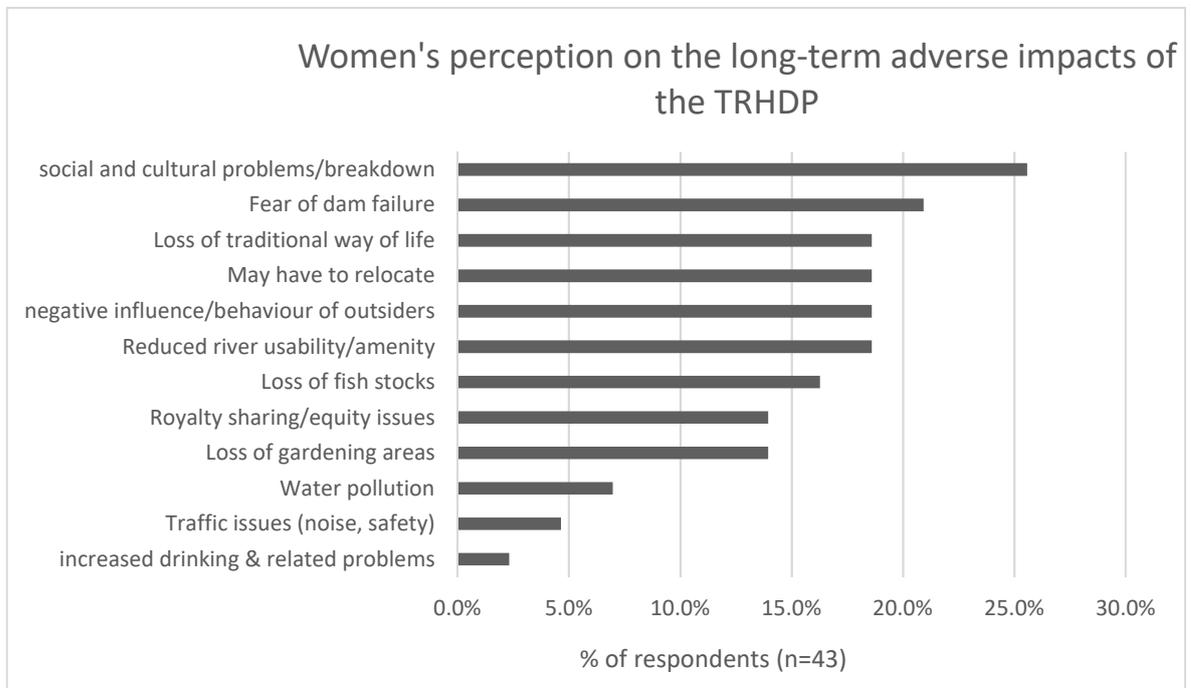


Figure 12-6 Women's perception on the long-term adverse impacts of the TRHDP



12.5.4.1 Women's Safety and Wellbeing

Women in the project area are concerned about possible risks and threats to their overall safety and wellbeing, as well as that of their children. Their primary concerns include:

- Disaster caused by dam failure;
- Sexual or other assault by outside workers or strangers involved in the Project;
- Road accidents;
- Negative social influences coming from people that are unfamiliar with, or are not sensitive to, local customs;
- Family breakdowns due to potential increase of alcohol consumption, drug use, promiscuity, and gambling associated with increased incomes of men employed on the Project.

According to Slovic's findings on risk perception, people tend to rate the risks of new technology (such as a hydroelectric dams and household electricity in the Solomon Islands context) greater than the actual risks. To avoid or reduce feelings of anxiety associated with the dam's safety, the TRHDP PO and/or the construction contractor and operator should carry out, prior to the start of construction, educational programs about dams and their risks, safety around power transmission lines and powerhouse outlets. Prior to electrification of villages, which will occur under the proposed benefits sharing program, public education about electricity and its safe use in the home and community will be proposed for communities and children in local schools.

No workers camp shall be established for the TRHDP. Security jobs will be given to local villagers. To avoid potential social and cultural issues for women, the construction contractor should maximize as much as possible the employment of local people on the project, develop and enforce a Code of Conduct for appropriate behavior for incoming workers, and provide cultural awareness training for all staff. To minimize potential social disruption due to increased amounts of cash in the community, budgeting and money management education should be provided as part of the induction and training of locally recruited workers.

Local communities adjacent to the Black Post Road have suggested a number of measures to improve the safety of children travelling to and from school at Rate and Valesala. These measures include footpaths, boundary fencing at Vera'ande, Marava, Verakuji, and Mangakiki, and speed controlled areas and/or a police checkpoint near the beginning of the road. The TRHDP PO, construction contractor and transport providers for the Project should be required to ensure that all their drivers are suitably qualified and skilled, and enforce strict codes of practice and road safety rules.

12.5.4.2 Women's Work and Roles

The household survey included questions on the division of labour and on the responsibilities within the household. These findings have been summarised and presented graphically in Annex 16 of the Annex Report. The data clearly show that women are heavily involved in working in the household (e.g., laundry, growing, preparing and cooking food, caring for the household yard, cleaning the house, and selling produce and cash crops), whereas men tend to be involved in building and maintenance of the house, clearing forest, hunting, fishing, and dealing with land issues.

Potential adverse impacts that may especially affect women and girls and, therefore, require additional work to avoid or mitigate the effects, include:

- Deterioration of the river water quality and supply, and/or damage to other water supplies;
- Increased amount of dust from exposed river bed, road building, and additional road use;

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- Loss of nearby gardening area; and
 - Loss of forest resources (materials, foods).

As a result of the TRHDP, women's quality of living may improve due to the provision of safe and reliable water supplies, safer roads and more reliable public transport. As part of a benefits package, women's and girl's lives are expected to be made easier by the provision of education and health facilities, and electrification of houses (with labour-saving devices, home entertainment, and opportunities for home-based small businesses). The mitigation measures and the benefits package are crucial to women's welfare and development in the TRHDP area, and arrangements should be included in project implementation for ongoing consultation with local women, perhaps through existing women's groups and associations.

12.5.4.3 Minority and Vulnerable Groups

Potentially the most vulnerable group in the Wider Area is comprised of people who lack formal rights to the land they occupy and to local resources (e.g., 'squatters'). These people are primarily located in the lower part of the catchment adjacent to the northern section of Black Post Road and on abandoned or government land between Grassy Hill and Kukum Highway Road. Squatters are vulnerable to attacks by landowners who accuse them of consuming local resources.

The second most vulnerable group in the project area is comprised of the 'settler' communities. While they lack of formal ownership of land and local resources, their occupancy is legitimate because they have made customary agreements with landowner tribes. Their vulnerability is primarily due to limits of the land and resources available to them for their livelihoods, as well as their lack of participation in local tribal decision-making. Despite being Guale people, they remain vulnerable to occasional attack by community members from villages in Bahomea. These communities could be affected by the construction and use of the Transmission Corridor(s). The effects are discussed in depth in the LALRP.

As the project progresses, issues affecting the communities will need to be dealt with through procedures such as the grievance mechanism and nominated community representatives for project liaison.

The main concern noted by the Bahomea villages is the loss of their lands. Landowners and the PO/SIG are responsible for avoiding and resolving these issues by actively engaging with the informal settlers during the detailed design of the transmission corridors.

12.5.5 Social Relations and Social Organisation – Impacts and Mitigation

12.5.5.1 Identification of Potential Social Conflicts

Participants of the community workshops highlighted the existence of potential social and political conflicts and their concerns about trusting local leadership and the central government. The planning, construction, and operation phases of the TRHDP may affect local social organization.

Members of the consulted communities expressed their anxiety about the potential risk for social conflicts between landowners groups and the SIG over various issues including: land and resource ownership and access rights; rent sharing; royalties; compensation payments; and access to development opportunities and benefits. Construction and operation of the TRHDP have the potential to generate both beneficial and adverse impacts on social capital

in the project area. According to consulted communities, there are two main concerns regarding social relations:

- Potential internal tribal conflicts over the distribution of benefits, which may lead to social fragmentation; and
- Potential conflicts between local clans and the SIG.

According to the members (especially women) of the Bahomea communities (those closest to the main construction area) the main concerns about impacts on social relations are:

- Possible disruption of the local customary way of life and values due to the impacts of outsiders working on the TRHDP and passing through local communities. These disruptions may affect dress codes, behaviour, crime rates, and may represent a possible moral danger to young women;
- Possible social and family problems caused by local men having greater access to cash and, therefore, potentially greater access to prostitutes, alcohol, drugs, and gambling. These concerns are based on the previous experience with Gold Ridge mine.

To avoid the conflicts identified above, local inhabitants requested greater input and transparency on issues related to identification, monitoring and evaluation of land and resources that will be affected by the TRHDP. It is also important that development of the Project be undertaken in an inclusive and participatory manner with all of the affected communities. Chiefs and village leaders need to be reassured that all landowners in the project area will receive a share of the benefits. Conflicts and social disruptions may arise if these matters are not dealt with sensitively, and they may pose potential threats to the viability of the Project. These social matters have been dealt with so far by the TRHDP PO, government leaders, and the traditional Chiefs of Bahomea, in accordance with indigenous customs and practices. The process of engagement on land identification, and measures to ensure fair distribution of benefits between land owning tribes and within each tribe, are documented in the Land Acquisition and Livelihood Restoration Plan.

International and domestic development agencies could assist by providing training in conflict identification and resolution to church, community leaders and NGOs. The churches and existing civil societies have an important role to play locally in conflict avoidance and conflict resolution. Finally, the implementation of a social impact management plan and the benefit-sharing program aims to deal positively with the issues raised above.

12.5.5.2 Project Construction Workforce

The TRHDP PO has indicated that the peak construction workforce for the TRHDP will include approximately 175 workers. However, at the time of reporting, no definitive information was available on the proposed construction or operations workforce, its timing, occupational structure, required levels of skill and experience, and origin.

It is envisaged that residents of Bahomea, Ghaobata, and Malango would be employed as semi skilled and unskilled labour in the construction of the Project, along with non-local technical specialists and tradespeople. Entura suggested that the construction of the dam would take place at least six days per week, with work suspended during the rainy season, when the river is high. The Project shall have no workers camp on site. It is anticipated that expatriate staff, and workers outside of Central Guadalcanal, will be housed in Honiara and local staff will be bussed to the site from their villages. The size and characteristics of the population of the project area will, therefore, not change due to the project construction.

Suitable accommodation will need to be planned for well in advance, by the construction contractor, to cope with a temporary (seasonal) increase in Honiara's population.

12.5.5.3 Uninvited Visitors, Jobseekers and Settlers

As a significant construction project, the TRHDP may attract uninvited visitors, jobseekers and settlers, who are otherwise unable to find employment in Honiara, or in Solomon Islands. This is believed especially to be the case for young men. Some may squat on government-owned land within the Tina Valley if they are able to obtain indirect employment. In such cases, the whole family may move to the area, putting additional pressures on local services such as health clinics, schools, and water supplies. The TRHDP PO should investigate what occurred during the establishment of the Gold Ridge mine, to obtain better knowledge and understanding of what occurred on the Gold Ridge Mine Project, so that it is better able to manage the impacts of the potential migration and settlements issues in the Tina River Valley.

The project construction contractors could limit the influx of transient jobseekers and squatters by establishing a policy that would prioritise the recruitment of construction workers from: a) the existing registered members of the customary tribes within Bahomea and Malango; and b) local settler communities. Finally, when it is necessary to recruit others, the project construction contractors should publicize and use a formal application and vetting process through a recruitment office to be located in Honiara, thereby discouraging job-seekers from going directly to the construction site. The participation of local workers and youth should be promoted through the provision of relevant job skills training programs.

12.5.6 Local Customs and Way of Life – Impacts and Mitigation

12.5.6.1 Local Communities

The migration of Malango people from the slopes of the central mountain range into the river valleys and ridges to the north has meant increasing exposure to multicultural Solomon Islands life and to Western cultural influences. The traditional hill peoples' mixed livelihoods strategy of shifting subsistence agriculture, combined with hunting and gathering, has been supplanted by wage labour, royalty payments from large-scale logging, purchased goods and food, increasing contact with Honiara, and the use of Solomon Islands Pidgin. In the process, older people of Bahomea say that their traditional culture has changed considerably.

From the 1950s onward, such changes were resisted through the Guale cultural revival advocated and practiced by the followers of the Moro Movement (see below). In some cases, families have relocated away from larger settlements to quieter, and more natural areas, where they can practice a subsistence way of life, for example, in the upper part of the Tina valley. However, they remain quite strongly connected to modern day northern Guadalcanal and its urban influences and dependencies.

Some members of local communities expressed concern that developments such as electrification of houses and other lifestyle changes would lead to the loss of the traditional way of life. Others are fearful that construction workers and other outsiders will disrespect local customs and standards of behavior.

As noted previously, the likelihood of outsiders causing offence through culturally inappropriate behavior, or being inappropriately dressed, shall be largely avoided by preventing contractors from establishing a workers' camp within the project area. In addition, the TRHDP PO and construction contractor should put in place an enforceable Code of Conduct for workers, and require all non-local employees to undergo cultural awareness training as part of their induction. This training should be provided with the assistance of the indigenous people of Bahomea. Households or groups that wish to follow a more isolated and

traditional way of life will still have ample opportunity to do so. Local residents will be somewhat inconvenienced by construction activities, such as by periodic construction and traffic noise, and delays on roads related to construction traffic. However, these are likely to be minor and temporary.

In the longer term, the TRHDP, and the proposed package of benefits, could catalyze the process of exposure to other communities, and of cultural and social change that is already occurring. Increasing and more intense contact with the outside world could accelerate the loss of the Teha language, traditional knowledge of the natural environment and how to obtain a living from it, of tribal genealogy and history, and of the ancestors and spirits. Conversely, most people in the community have indicated that they welcome the possibility of an improved quality of life through electrification, improved water supplies and incomes, better services, and better quality roads. The most effective way to mitigate the impacts of cultural and social change, including loss of language, is to prevent a workers camp which would otherwise involve outsiders in the day to day lives of nearby communities. Given the remoteness of the key work sites, aside from road and transmission line construction, outside workers are expected to have limited daily interactions with all but the closest villages. The majority of awareness meetings and consultations will be undertaken by Solomon Islanders.

Impacts on the nature of traditional livelihoods are also expected to eventuate from the paid employment of local workers, and the possible paid engagement of local groups for catering or security services. Staff for semi-skilled construction positions are expected to draw from previous workers of the Gold Ridge, many of whom remain unemployed following the closure of the mine in April 2014. In this context, many of the project's workers will have had existing exposure to working with outsiders and to engaging in cash employment in lieu of traditional livelihoods. Baseline studies show an existing dependence on cash incomes in the area (with a weekly average income of SBD\$870 per household), and a higher than average paid employment rate. While the Project embodies a growing trend towards greater involvement with Honiara and outside cultures, the temporary nature of the majority of jobs and impacts (during the construction period) will limit social and cultural change to an extent.

In part, TRHDO PO's method of customary land identification, and the involvement of a committee of elders and storytellers (the Bahomea Land Identification Committee), has created an increased emphasis on tribal genealogies, histories, ancestors, spirits and cultural sites, not just in the Core Land, but in the wider Bahomea area considered by Bahomea Land Identification Committee (BLIC).

12.5.6.2 Gaena'alu (Moro Movement)

The TRHDP has the potential to disrupt the lives of those residents of the area who follow a less western influenced and more traditional way of life, such as the followers of the "Gaena'alu Way" (also known as the Moro Movement).

Fear of disruption to, and loss of, culture is the primary concern for the senior Moro/Gaena'alu priest and village leader of Koropa and its related community of Namopila. With the selection of the preferred alternative (Option 7C) for the Project, much of the feared disruption to the quiet traditional Gaena'alu lifestyle, and to sites of cultural significance, will be reduced. Fear that the customs and lifestyle of the Gaena'alu followers will be disrespected will be avoided by not having a workers camp located within the Tina/Ngalimbiu area, and by the TRHDP PO and construction contractor enforcing a strict Code of Conduct for its workers with respect to contact with local minorities (see Annex 18 of the Annex report).

12.5.7 Livelihoods and Key Resources – Impacts and Mitigation

The TRHDP is likely to affect the livelihoods of households using resources located close to the dam, reservoir, headrace, powerhouse, power transmission line, or access roads.

Based on the fieldwork and consultations with local people, stakeholders and experts, the impacts on local livelihoods of the development of the Project can be expected to mainly come from:

- Loss of, or damage to the natural assets upon which local communities' livelihoods depend, including the Tina /Ngalimbiu River, food gardens, forests, and areas used for hunting, gathering and fishing;
- Damage or improvement of physical assets and infrastructure, such as tracks, roads, and water supplies, and;
- The opportunity for paid employment and provision of services to the project.

Most households of the study area rely on their own local natural capital as the basis of their livelihood and to meet their basic needs. However, they are increasingly tied into the modern urban-based economy. This is evident in the growing role of cash, which is needed for goods and services, such as food, household fuel and consumables, telecommunications, transport, and school fees. The construction and operation of the TRHDP could bring about change or opportunities for change, in the way some people obtain their livelihoods.

12.5.7.1 Infrastructure

The main impact of the TRHDP on the physical infrastructure of local communities is likely to be unintentional damage to infrastructure (e.g., houses, fences, foot tracks, village access roads, bridges, and water supplies), due to the construction and upgrading of the Black Post Road to allow the construction traffic. Once completed, the proposed road is expected to accommodate 25 to 40 project related vehicle trips per day, during the construction season, over a three-year construction period (Entura, 2014). Project traffic will mainly consist of light, medium and heavy vehicles, including vehicles carrying workers, materials, and heavy equipment. Most traffic movements will be confined to daytime.

Infrastructure damaged as a result of construction activities will be repaired or replaced by the TRHDP. A water system will be installed to provide villages with clean potable water. In addition, the access road will be an improved transportation infrastructure facility connecting villages in the project area with Honiara. Access to electricity will be provided through electrification of villages.

12.5.7.2 Small-Scale Timber Harvesting and Timber Milling

Small-scale timber milling represents a major financial input for indigenous communities of Bahomea. Forested lands, currently accessed for small-scale timber production, will be affected by the land acquisition process.

Landowners engaged in timber extraction in the Tina Valley (mainly between Senge and Choro) expressed their concerns regarding the impacts of an altered river flow on their ability to raft sawn timber downstream from the harvest sites to various transport pick up points. Non-timber forest products, including wild foods, medicinal plants, and building materials that are currently available in areas that may be required for the Project (e.g., near Mangakiki and Senge where new access roads will be built) will be lost and become locally scarcer.

Construction of the Project will require permanent clearing of 115.49ha of native vegetation, of which 51.0ha is forest (see Table 12-1). The majority of forest will be removed from within the reservoir area and along the access roads. In addition, the Project will modify the river hydrology, affecting the ability to transport sawn timber from the areas where it has been harvested, downstream to village haul out sites.

The potential impact of forest clearing is low; the amount of forest that will be cleared represents 0,9% of the total area of non-montane forest in the catchment. In the short term, the loss of timber will be partially offset by the plan to engage local workers to clear trees from the reservoir area.

Table 12-1 Area of vegetation permanently lost due to project

Grasslands (ha)	Undisturbed forests (ha)	Disturbed forests (ha)	Remnant forests (ha)	Montane forests (ha)	Riparian (ha)	Cliffs (ha)	Gardens (ha)	Fallow brushland (ha)	Total surface of habitat directly lost to construction activities
20.30	9.54	29.65	11.87	0	21.62	16.12	0	6.40	115.49 ha
51.06ha total forest area removed									

The reduction in the river flow between the dam and the powerhouse, will make it impossible during normal flow to float timber down the river from where it is harvested in the Choro and Koropa areas to the traditional haul out sites that are located near villages downstream. The TRHDP PO has suggested that, if necessary during periods of extended natural low flow, additional water could be released down the river channel to assist in timber rafting. If this is done, it should be preceded by warning to the public, since villagers, may increasingly use the dry banks created along the Tina River as walking paths. Other arrangements are also feasible, such as timber rafting during the anticipated dam spillover events, and if necessary, the creation of regular truck-accessible haul out sites beside the river and at the future reservoir, using the dam access road.

In the long term, the creation of a new dam access road could provide better access to areas in the upper catchment for small-scale timber production by local landowners. Use of the road for this purpose will depend on the proposed management by TRHDP, and the land-owning/holding company to be established as part of the Project. At present, it is proposed to limit the use of the road to Project related activities to prevent increasing logging of native forests.

12.5.7.3 Extraction of Aggregates from the River

The following discussion is predicated on the assumption that the proposed TRHDP dam may significantly reduce the recruitment of construction grade aggregates (i.e., sand and gravel) in the lower Ngalimbiu River where they are currently mined. However, the recent study by Ian

Jowett predicts that changes to downstream gravel levels, if any, will not eventuate for a considerable period of time.

Communities in the lowest part of the catchment are particularly concerned about the potential effect of the dam on the transport and deposition of aggregates. Were the dam to have such an effect, the construction of the dam may also have an impact of sale of sand and gravel, which is an important source of income for many communities in the project area.

The Ghaobata people, located in the lower part of the catchment on the Guadalcanal plains, rely on royalties from gravel extraction from the Ngalimbiu River. This particular material is of high quality and is a key source of aggregate on northern Guadalcanal⁸⁰. Gravel extractions by communities located in the Upper Ngalimbiu River and in the lower part of the Tina River catchment are sporadic, of low volume, and for domestic use. Throughout the Bahomea district, people occasionally use gravel and sand from the riverbed to make concrete for building their houses, or other types of construction. These extractions do not appear to be a source of revenue for the Bahomea landholders.

Participants in the ESIA workshops, household surveys (with the Ghaobata communities at Ravu and old Selwyn) and the mitigation workshops (held by the GPPOL settlement) expressed their concerns about the future of gravel resources once the upper part of the Tina River is dammed and once the flow regime is altered. They also expressed their willingness to provide more information about the gravel extraction rates and the royalties paid to local tribes.

Sand and gravel is excavated by loaders and trucks directly from several places in the lower river near Ravu, and downstream of the Ngalimbiu Bridge. There are stockpiles of sand and grit near old Selwyn, and there is a gravel yard, screen, and elevator at the Lee Kwok Kuen and Co (LKK) farm. In mid-2013, the Ghaobata landowners received royalties ranging from SB\$390/m³ to SB\$500/m³ of material. The main client was Dalgro Ltd, which was sourcing approximately 200 m³ per day during the dry season. Solomon Sheet Steel Ltd was also reported to be sourcing gravel from the Ngalimbiu. Apart from the commercial operation of LKK, the communities involved in gravel extraction include Ravu (with about 16 hamlets) and Old Selwyn/Popoloi.

As confirmed from Geotech investigation at site option 6A, the alluvium depth at this site is 25 meters. As such, the river will continue to replenish gravel for the downstream communities, and the impact of reduced gravel may not be experienced, if at all, by the downstream communities for a very long time. A regular monitoring program to confirm gravel levels at intervals downstream of the dam should be carried out to confirm whether any impacts on downstream gravel users are likely to occur.

⁸⁰ According to Tawake (2005:17), in the Ngalibiu River near the bridge, “the river aggregate deposits are composed largely of igneous rock fragments with lesser limestone constituents. Igneous rock fragments comprise plutonic rocks and slightly less volcanic rocks”. The surface area of the resource at the extraction site in 2005 was estimated at 10,000 sq. m. Tawake also noted that there was “No standard compensation and royalty rate paid to resource owners to compensate for the use of sand and gravel on traditionally-owned land” (p25).

12.5.7.4 Natural Capital

12.5.7.4.1 Access to Natural Capital

The loss of natural livelihoods assets is one of the main concerns of local communities. All the indigenous people of Bahomea and Malango have rights to utilise natural resources of the Tina/Ngalimbiu River catchment, though it is mainly the people of Bahomea who actively exercise those rights for their livelihoods. These include the people residing in the Downstream Area and Infrastructure Impact Area. However, only a limited number of local clans have ownership rights of the land and resources of the 4.288km² project Core Area⁸¹.

Most of the permanent loss of natural capital will result from the creation of the hydro storage reservoir, the creation of the access roads and, to a lesser extent, the construction of the dam and powerhouse. Temporary loss of access to natural resources within the upper Tina River watershed will occur during construction.

12.5.7.4.2 Land Use

The land required for the project includes:

- Partially logged and intact forest lands, used by some households as a source of wild foods, building and craft materials, traditional medicines, hunting, and bush tracks;
- Sections of the Tina River, including:
 - the water of the river, along with the environmental and human-related services it provides (e.g.washing, bathing, water supply, transporting timber, and gravel extraction);
 - the riverbed, including rock pools, and other locations used for fishing, tracks, and sacred sites;
 - tributary streams, used as sources of wild foods, and as ownership markers, and;
 - riparian margins, used as sources of wild foods, and containing former habitation and sacred sites.

The creation of the proposed access road above Mangakiki is likely to require only minimal disturbance to garden land or areas for collecting forest resources, since the area has already been harvested for its timber and modified by logging. Building the road section down into the dam site from the ridge will require the removal of small amounts of relatively intact natural forest. Land for the access road, dam site, quarries, and the storage reservoir will be acquired by the project⁸². No land used directly for human occupation will be required for the construction of the project.

The powerhouse will require an area of very steep land several hundred meters downstream of Senge on the left bank of the Tina River. This area does not appear to be used by existing villages. The proposed powerhouse access road, which begins at the logging road south of

⁸¹ The identification of the relevant landowners was completed subsequent to the preparation of the SIA report. According to a press release (dated 17 July, 2014) it was determined that the Core Area belongs to 4 landowning tribes: Kochiabolo, Roha, Buhu Garo, and Vuralingi, who together consented to make their land available to the SIG for the project.

⁸² Subsequent to the SIA, the identified landowners and the SIG entered into an agreement for the government to acquire the land for the project, and the formal declaration for acquisition by the Minister of Lands was gazetted in August 2014 (project office press release, 3 September, 2014).

Mangakiki, on the ridge above Senge, is likely to require land containing trees and plants that are used by local households, and will possibly subsume parts of the main bush track to Senge (see Figure 12-8). Satellite imagery from August 2013 suggests that the road may affect land previously cleared for food gardens. The earthmoving required to construct the road, which traverses the ridge and slopes above Senge, could potentially damage resources belonging to the village if not carefully managed.

Section 12.4.2 – Land Ownership, noted that all of the customary land taken for the project was previously owned by local indigenous people and is valued by them. The LALRP sets out the process and measures for identifying and compensating for land value and loss of resources (plants/hunting etc.). However, it is not expected that the loss of the land required for the project will have significant adverse impacts on local livelihoods.

The LALRP assesses and addresses the livelihood impacts of the land acquisitions and covers the impacts of acquiring title to the Core Land.

The TRHDP PO has proposed that the land in the designated Core Area become legally owned/leased and registered to a Tina Core Land Company – a 50:50 joint venture between the traditional land owners and the SIG. This company would then lease the various sites to the developer and would then determine future rights of access and uses of the Core Area, including the storage reservoir.⁸³

12.5.7.4.3 Water Use

Water Quantity

Notwithstanding that there will be reduced flows in the Tina River between the proposed damsite and the powerhouse, the TRHDP PO reports that there will be sufficient permanent flow to meet the consumption needs of villagers from Choro, Koropa, and Senge, once the project is operational. As noted, at minimum flow there will not be sufficient water or current in this section of the river to float rafted timber downstream to haul out sites at Habusi, Antioch, and Tina Village. The powerhouse tailrace structures and outflow may also present a physical barrier to timber rafting and a safety hazard. Reduced river flow for most of the time will make the riparian areas between Senge and the dam site more accessible to landowners, and possibly encourage an expansion of livelihoods activities in that area.

The reduced nighttime flows downstream of the powerhouse will likely to be noticeable during periods of natural low flow in the Tina/Ngalimbiu River catchment. There are implications for communities living adjacent to the river downstream of the powerhouse in terms of timing and safety of river-based activities such as bathing, washing and recreation. A staged release of flows through the power station in the mornings is proposed to minimize safety risks.

Water Quality

The construction, upgrading, and use of the road, during the project construction period, may disturb and damage existing water resources used by villages adjacent to the road (e.g., Marava, Vera'ande, Verakabikabi, Valesala/Antioch, Verakuji, and Mangakiki) (see Figure 12-7). In addition, the construction of the new section of road at Rate may also damage the catchment area for the Verakabikabi water supply, and minimally, will pollute the water (see Annex 17 in the Annex Report). Water quality could also be reduced due to fuel spills, sewage disposal, and chemical leaching and spills at the dam and powerhouse construction

⁸³ See Project Office press release, "Tina River Core Land Owners Give Consent" dated 17 July, 2014)

sites, or the incorrect management of concrete waste water or sediment run-off from cleared areas.

Almost all of the communities in the Tina/Ngalimbiu catchment rely on the Tina/Ngalimbiu River for their domestic water supplies. Consequently, the potential loss of access to clean and potable water due to river pollution and sedimentation during the construction of the dam, is a major health concern for all the riverside communities of the Downstream Area, especially for women. While villages along the Tina Road get their water from other sources, they are still concerned that construction activities, such as road building, will disturb and contaminate these sources of water. Water pollution problems often occur after heavy rains, due to land disturbances, such as logging.

In addition to concerns about the water taken from the Ngalimbiu River for domestic purposes, the Ghaobata communities of the lower catchment on the Guadalcanal Plain, are worried about the effect of the dam on the water levels in their wells and boreholes, especially in the dry season. Throughout the project area, members of all riverside communities noted the potential impacts of reduced water quality and availability on bathing, washing of clothes and food, recreation, and fishing. Women expressed particular concern about these matters.

The TRHDP PO has agreed to provide alternative water supplies to local communities.

Options include:

- River-based supply with appropriate treatment systems and supply points for each village;
- Rainwater collection and storage tanks and/or regular transportation and distribution of clean water by tanker truck;
- Establishment of alternative supplies from local streams, and
- Borehole / ground water supplies, piped to several villages / hamlets..

Figure 12-7 Locations of the known water supplies adjacent to the Tina Road (blue drops)



Source: base map from Google Earth, 2014

12.5.7.4.4 Hunting and Fishing

As described previously, all of the indigenous communities of Bahomea and some of the adjacent Malango communities occasionally use the rivers, streams and forests of the upper Tina River catchment for hunting, fishing and camping. The household survey found that game animals and fresh river fish are no longer common in local peoples' diets. Hence, hunting - and to a lesser extent fishing - tend to be seen as a cultural activity involving young people and to provide wild pork for church and community feasts, rather than as an essential part of peoples' livelihoods. In contrast with some Ghaobata households, fishing is not a source of income for people of Bahomea.

The extent of the loss of fishing, hunting and gathering opportunities will depend on the access arrangements for and future management of the upper catchment.

Some fishing spots could be permanently lost. Conversely, the proposed storage reservoir may provide future aquaculture and fishing opportunities.

Downstream of the dam site, the river will become more turbid due to reservoir clearing, cofferdam installation and removal, and other riverbed disturbances during construction, and will be less suitable for spear fishing using snorkel diving gear. Conversely, the new access road will enable landowners (and potentially outsiders) to access fishing spots upstream of the construction area more easily. The TRHDP PO has suggested that access to upstream areas via the new road, would ultimately be determined by the Core Land Company, subject to the mitigation measures recommended in the ESIA.

Poorer water quality caused by construction could also have a negative impact on the fishery at the mouth of the Ngalimbiu River, although this is considered unlikely. Gravel mining in the lower Ngalimbiu River bed already introduces sediment to the river, yet fishing appears to continue.

During project operation, the main effect on fishing will be the reduced number of rock pools where people spearfish. This will occur in the reach of the Tina River covered by the reservoir, and in the reach that will have reduced flow. In addition, there may also be changes in the fisheries due to the barrier to migration of the dam and powerhouse turbines. The study by Ian Jowett suggests that the reduced flow in the river will be advantageous to certain fish species, detrimental to others, and provide an overall increase in fish densities. Proposed mitigations include using trap and haul methods to move fish over the dam.

Hunting areas will also be lost, although the reservoir may provide better access to areas in the upper Tina River catchment, where hunting effort seems to be concentrated.

Specific hunting-related impacts mentioned by villagers include:

- Displacement of wild pigs, the main game animal, from riparian areas and possibly pushing them downstream and closer to settlements and gardens as occurred with logging. This migration of pigs could be accelerated by the creation of the new road, and;
- Displacement of waterfowl that rely on the river and adjacent streams for their habitat.

Measures to address livelihood impacts of reduced access to hunting and fishing, including providing ongoing access for local communities during the operational period, are set out in the LALRP.

12.5.7.4.5 Food and Materials Gathering

The riparian area (micro-wetlands) between Senge and Choro is reported to be a source of wild fruits, edible ferns, nuts, medicinal plants, plants deemed to have magical properties, and bush materials. These plants will be affected by the reduced river flow, since floods that periodically replenish the riparian areas, will be controlled by the dam. This could have consequences on the livelihoods and wellbeing of the four households in the two villages. It seems, from discussions with local people, that most materials should be available in other locations. The creation of the dam access road will reduce the availability of some materials and plants (e.g., in the road corridor), but will also make it easier to access alternative areas and supplies.

As part of any resettlement planning for the project, SIG has, in close cooperation with the affected landowners, investigated the occurrence of culturally or economically important plants in the core project area, that may be destroyed by the Project and for which compensation would be payable. A process for compensation and retained access for local users of the Core Land Area is set out in the LALRP.

12.5.8 Cultural Heritage – Impacts and Mitigation

The local indigenous people of Bahomea and Malango have traditional authority and use rights over the project area, and are concerned about the potential desecration and damage to their cultural sites as a result of the Project.

The most significant cultural impact of the project will be the loss of, and/or damage to, sites of importance to the indigenous people. The potential adverse cultural impacts include:

- the permanent loss of tambu sites, including natural features and objects, rock pools, streams, and former habitation sites within the proposed project area (Core Land); and
- during construction, disturbance to or desecration or destruction of tambu sites, graveyards and other places of social and cultural importance located next to the Black Post-Tina Road, and in the new road corridors.

The construction and operation of the TRHDP could have direct physical effects on several types of culturally sensitive sites. These include places of:

- long term cultural significance such as archaeological sites, historical places and former village sites; and
- religious or spiritual significance and associated with custom stories and ancestors (e.g., tambu sites, graves, custom houses, places of worship, and boundary markers such as special trees, rocks, streams). For example, people from Marava, Vatupaua, Rate CHS, Ngongoti communities noted that several burial places may be affected if the existing Tina-Black Post Road was to be enlarged.

Sacred sites may be owned by, or have particular importance to individual groups or clans, and underpin notions of identity and land ownership. Knowledge of the location and meaning of tambu places can, therefore, be a proof of land ownership. Thus, the information can be highly confidential. Unfortunately, only the very old members of a clan may have such knowledge, and there is “no effective system” for the management and protection of ancestral and sacred sites and objects (Ministry of Culture and Tourism, 2012).

The protection of sites and cultural materials is covered by the “Nasinol Policy Framework *blong Kalsa*” (The National Cultural Policy Framework, 2012), which sees protection and preservation of Solomon Islands indigenous languages, arts, customs, traditional knowledge, and heritage as crucial for maintaining Solomon Islands peoples’ dignity and identities, and as

‘an essential component of the socioeconomic, political, and spiritual development aspirations of the Solomon Islands’ (SIG, 2012: 3). Policy goals listed in the framework document that are relevant to the TRHDP include:

19.1 The country has a proper and effective system for the management and protection of ancestral and sacred objects and sites;

19.2 The cultural heritage of the country is protected and preserved for the cultural education of today’s youth and future generations;

24.1 The country has a national database and effective system for the management and protection of cultural landscapes of archaeological and historical significance;

24.2 Cultural landscapes of archaeological and historical value are integrated into cultural tourism development; and

24.3 Cultural education, historical knowledge and field research are enhanced and facilitated through the availability of well-protected and well-managed sites throughout the country.

Other than proposing a database, the Framework proposed no concrete steps for protecting culturally important sites.

The ESIA is limited as far as baseline studies of cultural heritage in the project area are concerned. Because most of the knowledge is kept confidential, investigators were not able to gain detailed information to locate all sacred or cultural sites for the potentially affected communities and landowners. In some cases, broad descriptions were provided during interviews with senior men. Riparian surveys conducted by Pacific Horizons Consulting Group (PHCG) in 2011 noted and mapped the locations and names of various streams and features between the upper end of the Tina River catchment and Pachuki (see Section 5 –Physical Environment Baseline). In addition, the approximate locations of some old villages were recorded. During the ESIA village workshops, the names of originating villages and the sequence of village settlements prior to the current settlement patterns were recorded, though exact locational data was not obtained. Also, the existence of present day graves and other cultural features were noted during the village workshops, though except in the case of Mangakiki and Verakuji villages, their exact locations were not recorded.

It is recommended that, prior to commencing any construction on the access roads or on the hydropower development sites, the SIG or project developers carry out a more detailed cultural heritage and sites monitoring program within the designated Core Area, and in the communities adjacent to any road building or upgrading. This monitoring should be undertaken by a suitably qualified heritage expert, working closely with the landowners, accompanied by an advisor from the National Museum. All sites should be recorded, mapped and photographed. Also, prior to construction, the TRHDP should be required to implement a protocol for managing cultural heritage (see Annex 18 of the Annex Report and the ESMP).

12.6 POTENTIAL BENEFICIAL SOCIAL IMPACTS

During the mitigation workshops, participants were asked to share their expectations and hopes on the benefits of the Project to them and their communities.

12.6.1 Access to Electricity

According to the communities, bringing electricity to villages, churches, and houses is the main benefit of the TRHDP. This is a strong indicator that local people understand the nature of the proposed hydroelectric development and the benefits of having electricity.

Based on the workshop consultations and the householder surveys, electric lighting is the most sought after benefit of the project because it will:

- Enable children and adults to study in the evenings;
- Provide security in the home and around the village, especially for women;
- Increase levels of community interaction, by facilitating evening gatherings and, thus enriching the community life.

Having their own electricity supply will enable households to take advantage of modern electrical appliances and machines, specifically:

- Refrigeration, providing greater food hygiene and security and, therefore, providing financial and health benefits;
- Electric cookers and washing machines, which will reduce the level of manual labour and resources currently required for cooking and washing, and improve the quality of women's lives;
- Home and community entertainment systems, which are seen as providing educational, psychological, and socio-political benefits, and reducing the sense of isolation; and,
- Use of power tools and machinery, especially for carpentry and building, sewing, and craft work, which will enable the establishment of small businesses and workshops, and provide additional income opportunities for both males and females. Power tools will also considerably reduce some of the heavy labour for men in building, improve efficiency and productivity, and improve working conditions.

12.6.2 Increase in Employment Opportunities

The principal benefit to human capital from the TRHDP will be additional employment opportunities. Stakeholders believe that the construction of the project will provide opportunities for direct and indirect employment, for both males and females, and for landowners. The TRHDP PO anticipates that the construction of the TRHDP will require up to 175 workers at its peak. The percentage of locals in the workforce is expected to be high, as the developer for TRHDP will not be permitted to employ any semi-skilled or unskilled foreign workers and training is to be provided to improve local residents' opportunities. The actual number of people recruited locally will depend on the skills required and the availability of jobseekers.

The landowners and communities of Bahomea and Malango are expected to be given priority for employment on the Project and to receive training in plant and machinery operation, administration and security work. Some local people will take advantage of providing goods and services to the project such as food preparation, cleaning, and security. On the operations side of the project, young people may see opportunities of developing new careers and providing ongoing services. New opportunities associated with the new reservoir (e.g., tourism and possibly fish farming) are also possible. Finally, these potential business and employment opportunities could improve income diversification and standard of living.

The World Commission on Dams (WCD) notes that the wages paid to construction workers represent the single largest social benefit during the construction phase of a hydropower project. The social benefits have positive consequences on the workers' families and community. Jobs may be created to provide support services to workers and to the Project

(e.g., accommodation, meals, transport and retail). Off-site jobs may also be created in the manufacture, supply of construction materials, and transportation.

Priority is given to employment of people from the project's immediate area of influence. Workers from outside the host community will also be needed, chiefly for technically specialised skills which may not be available locally. An influx of job-seekers into rural and isolated areas can have an adverse impact on local communities and the environment; to preclude this induced effect the developer will provide for accommodations for all non-local workers in Honiara.

Some local residents may be trained to fill operational positions. There may be a small number of other paid jobs (e.g., site security) for local people during the operations phase of the Project once it has been commissioned. Routine maintenance will be done under an Operations and Maintenance contract with the SPC. The required operational workforce is still under consideration.

12.6.3 Livelihoods Strategies

During construction of the Project, people who are working on the TRHDP are likely to spend less time producing food from their gardens. Findings of the community workshops highlighted a variation in nutrition, with an increase in intake of imported carbohydrates. These variations were attributed to an increased reliance on cash from paid employment, timber sales, rents and royalties from Gold Ridge mining and from natural forest logging.

Finally, in the longer term, the TRHDP is likely to have a positive benefit in local people's livelihoods. Improvements to the road infrastructure could make life easier, and provide better access to Honiara's markets. The much-desired electrification of local villages could bring diversification in household livelihoods, with the opportunity for home-based manufacturing and artisan activities. This would reduce household income vulnerability. Provision of other benefits, such as reliable water supplies within the villages, would reduce the domestic workload on women and girls, and free them up for other income-generating work.

12.6.4 Improved Education and Skills

If suitable training and learning arrangements are put in place, the Project offers an opportunity for developing new skills for the indigenous people through pre-employment job training through institutions, and on the job training⁸⁴.

The local landowners anticipate that the SIG will provide education and training sponsorships and scholarships as part of a benefits program. The opportunities for education and training will become clearer once project planners have identified the workforce requirements, and employment policies have been developed.

It is recommended that the TRHDP PO survey local villagers to identify people interested in working on the project construction, and that the survey include a preliminary skills and experience audit. On the basis of the survey and the workforce requirements, the contractors,

⁸⁴ Don Bosco Technical Institute and the Solomon Islands Association of Rural Vocational Training Centres offer village-based and residential training in relevant areas (See <http://www.siarvc.org.sb/publications.html>)

working with SIG and local training providers, should facilitate community participation in the project, by providing:

- Project work-readiness courses to job seekers/aspirants in the project area, including resume preparation, work safety and health, and money management, and;
- Training, where possible, in specific skills (e.g., driving, plant operation, trades assistants, etc).

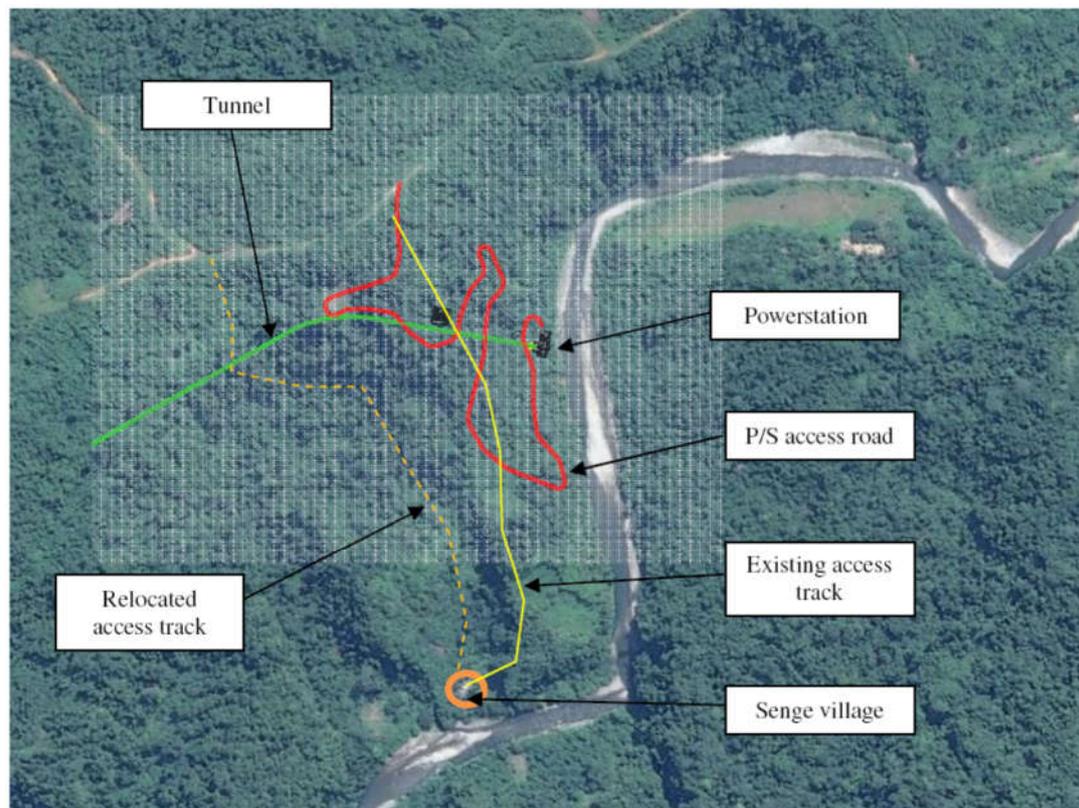
As part of a promised benefits sharing program the SIG has begun implementing a much needed and well-received \$2 million upgrade to schools in the Bahomea area. The project could also support transportation to the schools.

12.6.5 Ecotourism Opportunities

One on hand, tourism could be enhanced as a result of improved roads and access to the upper catchment. However, the reduced flow in the by-passed section of the Tina River could reduce the site's attractiveness for eco-tourists.

The access track to Senge Village (see Figure 12-8), which used to run a small-scale ecotourism operation⁸⁵ (receiving over twenty international visitors in 2013), will be disrupted by the access road to the powerhouse. Sadly the manager of the Senge operation passed away and the homestay is no longer running.

Figure 12-8 Relocation of the footpath to Sengue



⁸⁵ See [http:// www.sengevillage.com](http://www.sengevillage.com).

Various tourism development opportunities may be available for tribes/clans that are owners of the core land as well as neighbouring lands. These tourism opportunities are associated with the creation of the hydro reservoir and the possible future creation of a forest reserve in the upper Tina River catchment. Tourism could become a source of employment and revenue for these people. Over the long term, such development could be linked to a potential development of a trans-Guadalcanal trail, linking the North coast with the central mountains and the Weather Coast.

12.6.6 No Population Displacement or Resettlement

One of the main concerns of local people regarding the TRHDP is the change in the size and composition of the population in the project area. People fear that they will be swamped by squatters, and by workers from other islands. There are two ways in which hydroelectric developments typically affect the size, character, and distribution of the population by:

- Displacing existing residents from particular locations; and
- Introducing a construction and/or operations workforce which becomes temporarily or permanently resident in the host area.

The potential for such effects is discussed below.

12.6.6.1.1 Damsite and Reservoir

No houses or community facilities are located within the Core Area or the land required for the Infrastructure Corridor. For example, the village of Choro, is the closest settlement to the dam site, but is located 2.3km downstream outside the project Core Area, and has two elderly part-time residents. Senge Village is located 4.8km downstream from the dam site and has 3 households and approximately 16 residents. Although the construction of the powerhouse access road may cause disruption to people from Senge Village, no households will need to be relocated to make way for construction of the dam, quarries, or storage reservoir.

12.6.6.1.2 Powerhouse Site and Access Road

The proposed powerhouse will be located 5.7km downstream of the dam. Habusi settlement, which is located on the right bank of the river, is approximately 0.5km downstream of the proposed powerhouse site. Pachuki lies on the left bank 1km downstream of the powerhouse. Neither Habusi or Pachuki will require temporary or permanent relocation due to the construction of the powerhouse and tailrace.

Upgrading and realignment of the main access road to the project area (Black Post Road) will not require the resiting of any individual houses. Houses located very close to the road reserve could experience temporary disruption (vibration, noise, dust, physical danger) during the construction period.

In summary, the construction and operation of the preferred alternative (Option 7C) will not require any current villages to be relocated or residents to be displaced from their homes. Physical resettlement is, therefore, not required.

12.6.7 Improved Roads and Accessibility

The Black Post Road provides access to several communities located around the Tina village but not to settlements adjacent to the Ngalmibu/Tina River. Settlements between the Tina village and Senge village can only be accessed on foot by bush tracks or along the river bed.

The upgrading of the existing Black Post-Tina-Mangakiki Road are seen by local people as a considerable benefit to the community. The improvement of the road will allow:

- Better and more reliable transportation services throughout the area;
- Reduce the maintenance costs for those who already have vehicles; and
- Improve access to health and other public services, facilities, markets, events, and employment opportunities both within and outside of the immediate district. Women see considerable benefits in being able to better access health services for themselves and for their children.

In the longer term, and providing the roads are maintained, the people of Bahomea will benefit from having a much higher quality and safer road than at present, which will enable the provision of better public transportation services to and from Honiara. Better quality roads will also mean shorter travel times and higher service reliability, especially during wet weather. Accessibility should, therefore, improve for all local rural communities, with flow-on effects to people's welfare and development.

12.6.8 Local Financial Capital and Economic Development

Local communities have considerable expectations that the TRHDP will be accompanied by a SIG funded benefits program, which aims to improve local services and facilities, such as schools, health centres, roads, water and electricity supplies. New schoolrooms and road improvements have already been provided by the SIG, which has fostered a degree of confidence in the ability of the Project to deliver benefits to local communities.

Based on previous and ongoing experience of developments in the Central-north Guadalcanal area, people in the wider project area believe that the TRHDP may be a good (and perhaps easy) source of income. Local people expect this to come from access fees, meeting fees, compensation (for the purchase of land and loss of livelihood assets) and community or individual payments for agreeing to the project. Some also expect to receive cash rather than traditional 'compensation' payments for damages to their land and resources. According to the local communities, such payments are seen to potentially improve their standard of living and status.

The TRHDP has already contributed - and will continue to contribute - to the amount of financial capital available to the communities of the project area. This contribution has come from:

- Payments to land owners for access fees, and for provision of services during planning and feasibility studies, and;
- Payments for the acquisition of the rights to use the Core Area.

Unfortunately, it is often reported in Solomon Islands that the distribution of royalties or other project payments is not done properly. Solomon Islands newspapers regularly feature articles about intra and intertribal conflicts and legal battles over land ownership, resource sales, and royalty entitlements. Research shows that only a fraction of the cash from logging royalties goes to the actual owners of the forest resources⁸⁶. As a case in point, only a small amount of the SB\$2.7 million paid by the SIG to the 27 tribes/clans of the Landowners Council to

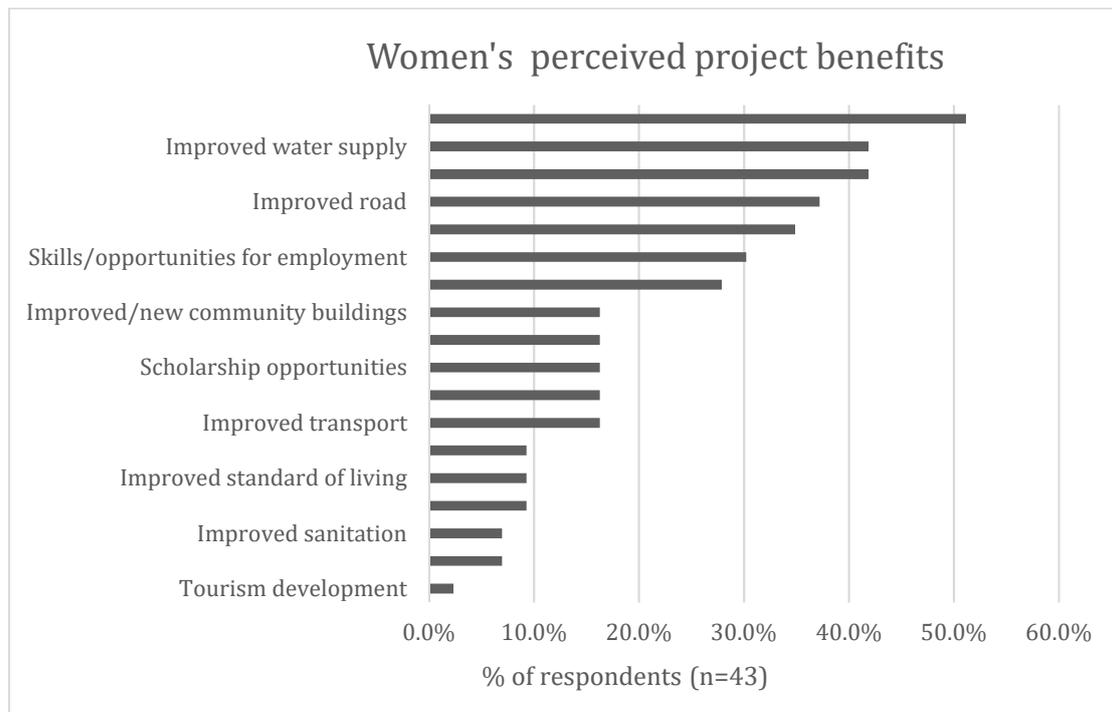
⁸⁶ Wairiu (2007) outlines a typical situation for Solomon Islanders with respect to logging income: 60% of the return goes to the contractor (often foreign owned), 25% goes to the government, and the rest (15%) goes to the 'fixer' – the local licensee (commonly a local leader/chief and deal organiser who obtain the legally required Government Timber Right – who in theory distributes the money to the land owners).

obtain access to the project area for geotechnical and other studies appears to have found its way to individual households. The PO has terminated working with the Landowners Council and has addressed potential distribution problems. This is addressed through the arrangements in which compensation and acquisition payments have been and are being distributed directly to individual tribal members, set aside for investment, or paid transparently towards cultural expenses as set out in the LALRP.

12.6.9 Potential Project Benefits for Women

According to women's perception on the benefits of the TRHDP, the main benefits are: electric lighting; improved water supply; electric supply; improved roads; community facilities (e.g., clinic); and skills and opportunities for employment (see Figure 12-9). Other potential benefits of the Project are reflected in the survey results.

Figure 12-9 Women's perception on the benefits of the TRHDP



13. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

13.1 INTRODUCTION

This section sets out TRHDP's Environmental and Social Management Plans. It is, among other things, the basis for the construction (CESMP) and operations (OESMP) ESMPs that will be prepared by the Project Company. Information is provided on environmental and social mitigation measures, monitoring programs, capacity development and training, implementation schedule and budget, and project integration. Information is provided on environmental and social mitigation measures, monitoring programs, capacity development and training, implementation schedule, an indicative budget, and project integration.

The developer is to prepare a CESMP and an OESMP as stand-alone documents, regarding this ESMP as setting out the minimum requirements. The developer is also to prepare a number of management sub-plans in accordance with section 1.1. The detailed management plans will identify specific measures for environmental protection and for mitigation of social impacts in line with this ESMP and the applicable policies of the World Bank and ADB, and will provide specific actions to be taken during construction and operation, including roles and responsibilities, and timeframes.

In addition to World Bank assessment and approval, the developer's CESMP will be reviewed and assessed as a component of the developer's Environmental Impact Statement under the *Environment Act* and the OESMP will be prepared and submitted to the Ministry of Environment, Climate Change and Disaster Management prior to commissioning.

Overall responsibility for environmental and social management of the Hydropower Project will rest with the Special Purpose Company managed by K-Water (SPC), which will, in turn, contract the construction day-to-day environmental and social management to the EPC contractor (HEC).

Solomon Power will have primary responsibility for the implementation of measures applicable to the construction and operation of the transmission lines. The Ministry of Mines, Energy and Rural Electrification will be the key actor for measures applicable to the access road upgrade from the Black Post turnoff to Mengakiki (Lot 1), and will delegate the day to day management to the road construction contractor.

SIG (through the TRHDP-PO), and WB, will undertake monitoring and oversight of environmental and social management, and project finance is allocated to supporting SIG in this role.

13.2 MITIGATION MEASURES

Mitigation measures are identified as those aimed at protecting the natural (physical and biological environment) and those that are focused on protecting the social (socio-economic / socio-community) environment, during construction, operation and post-operation phases, and ultimately, project decommissioning.

13.2.1 Measures to Protect the Natural Environment

This section presents good international industry practice (GIIP) for activities such as forest clearing, vegetation control, earthworks, and access road construction, that may adversely affect terrestrial and aquatic ecosystems.

In addition to the specific measures outlined in this section, it is recommended that the following information sources be consulted:

- Best Management Practices presented in the document “Low-Volume Roads Engineering Best Management Practices Field Guide, USAID (2013); and
- Roads in Rainforest: Best Practice Guidelines for Planning, Design and Management. Guidelines prepared for the Queensland Department of Transport and Main Roads and the Australian Government’s Marine and Tropical Sciences Research Facility (2010).

13.2.1.1 Reservoir Preparation, Filling and Operation

Reservoir vegetation clearing will reduce the emission of GHG from the reservoir. The level of reduction is, however, impossible to predict since GHG are also produced from organic matter trapped in river bed load material and sediment. Clearing will also reduce the amount of biochemical oxygen demand resulting from decaying plant material that can impair reservoir water quality.

Impacts Addressed:
<p><u>Reservoir Preparation:</u></p> <p>Impacts of GHG Emissions on physical environment (see section 9.2.3.5)</p> <p>Impacts of increased suspended solids and siltation on aquatic life (see section 11.4.3.1)</p> <p>Impacts of River Pollution on aquatic life (see section 11.4.3.2)</p> <p>Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)</p> <p>Impacts of temporary diminished water quality and quantity on aquatic environment (see section 11.4.3.5)</p> <p>Temporary de-watering impacts on aquatic environment (see section 11.4.3.6)</p> <p>Reservoir Water Quality (see section 11.4.4.8)</p> <p><u>Reservoir Impoundment:</u></p> <p>Impacts on Surface Hydrology (see section 9)</p> <p>Impacts on aquatic life of reduced flow (see section 11)</p> <p>Impacts on water users (see section 12)</p>
Measures:
<p><u>Reservoir Preparation:</u></p>

Prior to reservoir impoundment, trees with a diameter larger than 10cm will be cleared from within the reservoir area up to an elevation of 186.5masl, which corresponds to Maximum Flood Level (11.5m above FSL 175masl). Loose rocks and rubble along the steep faces of the river gorge will be removed where possible.

Reservoir vegetation clearing will be conducted during the latter phase of the construction program, as the dam and powerhouse are nearing completion, just before reservoir inundation is set to commence. The timing is critical so as not to enable vegetation to regrow or become re-established before water is impounded. Depending on the schedule for reservoir filling, vegetation clearing may proceed in distinct phases, with the lowest elevation areas of the future reservoir inundation zone being cleared first, followed by the higher elevation inundation zone.

Ideally, all plants and topsoil should be stripped off of the future reservoir to limit organic matter decomposition in the lower layer of the reservoir creating anaerobic conditions.

Due to the steep topography, vegetation is to be manually removed by workers hired from local communities, and that the relatively thin layer of organic topsoil be left in place. Sawn timber could be transported either by access road or by river as it is currently done from Choro and Koropa.

Vegetation clearance will be carried out during the dry season where possible.

Use of Glyphosate or any herbicide to kill trees is strictly forbidden during all vegetation clearing activities including vegetation control under the transmission line.

Reservoir clearing will not involve grubbing (removal of stumps) and soil stripping, since only manual work will be feasible.

Reservoir to be demarcated with spray paint to avoid encroaching on additional natural habitat

Reservoir Impoundment:

- Maintain an environmental flow of 1m³/s during reservoir impoundment at all times.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer Local Community (for reservoir clearing)	TRHDP PO	PPA

13.2.1.2 Hydro Facility Operation

Impacts Addressed:

Reduced Flow Between Dam and Powerhouse:

Physical impact of reduced flow between the dam and power station during normal operations on surface hydrology (see section 9)

Indirect impacts on fauna species (see section 10.6.1.2.1)

Impacts of changes of flow downstream of dam on aquatic life (see section 11.4.4.4)

On-going disturbance to downstream aquatic habitats (see section 11.4.4.10)

Impacts on water users (see section 12)

Reduced Overnight Flow:

Impacts of reduced river flows downstream of dam site during overnight reservoir refill on surface hydrology (see section 9)

Impacts on aquatic life of reduced flow (see section 11)

Impacts on water users (see section 12)

Reduced Sediment Transport:

Impact of physical reduction of sediment transport (see section 9)

Impact of reduced sediment transport on aquatic life (see section 11)

Impact of reduced sediment transport on gravel extraction activities (see section 12)

Impacts of reservoir sedimentation on aquatic environment (see section 11.4.4.2)

Measures:

Reduced Flow Between Dam and Powerhouse:

Maintain a minimum environmental flow of 1m³/s at all times in the bypassed section of river between the dam and power station

Reduced Overnight Flow:

Recommended to maintain a minimum flow of 3.4 m³/s flow below the power station during over night reservoir refill. One option for achieving this is to maintain the 1m³/s environmental flow and continue to run 2.4m³/s through the power generators.

Reduced Sediment Transport:

Flushing to be undertaken periodically. An outlet of 3x3m is proposed near the power intake at 160masl. Once sediments reach this level, the outlet will be used either for local flushing or for lowering the reservoir to permit dredging/excavating of accumulated sediments.

Storage operation to be designed to enable occasional dewatering for the purposes of excavating or dredging accumulated bed load sediments. The design study should consider access to the reservoir to excavate the accumulated bed load.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.1.3 Barrier to Fish Passage, and Fish Entrainment

Impacts Addressed:		
<p><u>Barrier to Fish Passage:</u></p> <p>Barrier to passage of migratory fish species (see section 11.4.4.3)</p> <p><u>Fish Entrainment:</u></p> <p>Barrier to passage of migratory fish species (see section 11.4.4.3)</p> <p>On-going disturbance to downstream aquatic habitats (see section 11.4.4.10)</p>		
Measures:		
<p><u>Barrier to Fish Passage:</u></p> <p>Implement a trap and haul system in accordance with section 11.3.2</p> <p><u>Fish Entrainment:</u></p> <p>Proposed to increase the normal operating level to near full supply level, during the first month of the wet season, to facilitate the downstream movement of adult eels over the spillway during floods. The loss of generation resulting from increasing spill would be partially offset by the increased generation from the extra head on the turbines.</p> <p>Proposed to install 15-25 mm screens in front of the intake structure to prevent the ingress of large eels.</p>		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.1.4 Access Road Location, Design, Construction and Operation

Impacts Addressed:
<p><u>Location and Design:</u></p> <p>Slope stability and geological impacts (see section 9)</p> <p>Erosion (see section 9)</p> <p>Human encroachment to upper Tina (see section 12)</p> <p><u>Installation of Drainage Works and Stream Crossings:</u></p> <p>Construction and operation impacts on fauna (see section 10.5.2.1)</p> <p>Impacts of hydrological changes on flora (section 10.5.1.2.1)</p> <p>Impacts of increased suspended solids and siltation on aquatic life (see section 11.4.3.1)</p> <p>Impacts of River Pollution on aquatic life (see section 11.4.3.2)</p> <p>Impacts of diminished water quality and quantity on aquatic environment (see section 11.4.3.5)</p> <p>Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)</p> <p><u>Environmentally and Culturally Sensitive Areas:</u></p> <p>Impact of deforestation on environmentally and culturally sensitive areas (see section 9)</p> <p><u>Road Access Restrictions:</u></p> <p>Operational impacts on flora (see section 10.6.1.2.1)</p>
Measures:
<p><u>Location and Design:</u></p> <p>Retain structures, such as gabion walls and remove of upslope colluvium to minimize the risk of landslides occurring during both access road construction and operation.</p> <p>Upgrading of Black Post Road to be carried out in close consultation with the relevant villages, including with respect to village water supply locations.</p> <p>Access roads to quarries to be unsealed to allow vegetation to regrow after use and to avoid encouraging human settlement in upper Tina areas.</p> <p>Temporary roads to be permanently closed at Project completion. This requires removal of all stream crossings, breaking of road surface (scarification) to allow vegetation to regrow and installing earth mound at road entrance. Important cut areas to be refilled with excess soil.</p>

Road shall have surface drainage and subsurface drainage. Proper compaction of the subgrade and pavement will improve subsurface drainage. If necessary, under-drains to be installed.

Sufficient cross drains will be installed to avoid erosion. Drains will not be hydraulically connected to streams. Instead, they will exit via ditches into stable, vegetated areas or discharge into settling ponds.

The period of time between forest clearing and sealing of the road will be minimised to avoid erosion of exposed soil. Sediment control structures (e.g., silt fences, settling ponds, blind ditches, French drains, etc.) will be installed as earthworks progress along the access road. Along earthworks and work areas where disturbed soil may remain exposed during construction, ditches will installed to receive stormwater, and to drain exposed soils. These ditches will drain to vegetated areas or, in the case of spoils disposal sites or soil stockpile areas, to settling ponds. Settling ponds will be built to allow for percolation and dimensioned to receive stormwater inflows during heavy rainfall events, and to allow sediment to settle out of suspension. Wherever small channels of stormwater are identified during construction, they will be temporarily diverted away from areas to be cleared of vegetation. However, this does not apply to permanent streams whose channels will not be diverted. After initial clearing, culverts will be installed within small channels.

Ditches along the access road will never directly drain water to water bodies or wetlands. Surface drainage will be directed to silt fences, vegetated areas or erosion control mats.

Keep haul roads off sloping terrain wherever practical.

Depositing soil outside the limits of access road earthworks prohibited within 100m of nearby streams.

Design the slope of a cut to minimise the angle of incline.

Installation of Drainage Works and Stream Crossings:

A watercourse crossing management plan will be produced by the construction contractor prior to construction

Surface watercourses in vicinity of access road shall be geo-referenced and physically delineated during the rainy season, to ensure that crossings are properly sized taking into account high flows.

All identified tributary streams in the vicinity of construction activities to be protected by fences.

Sites for crossings shall be identified prior to forest clearing to ensure that they are excluded from alignment clearing since clearing at stream crossings will be undertaken within a narrower corridor. Deeply anchored silt fences will be positioned to avoid sediment from entering streams during earthworks.

Where a road will cross a stream the road crossings shall be constructed perpendicular to the stream to reduce the area of disturbance

Culverts shall be equipped with head walls to ensure long-term stabilization of the crossing and their outlet shall be protected with riprap to avoid erosion. Culverts will be open bottomed, and not alter stream bottom elevations.

Culverts and stream crossings will be constructed with the use of an excavator, instead of a bulldozer, to avoid excessive soil disturbance and to avoid sediment laden soils from entering into the watercourse.

Fauna friendly underpasses/culverts shall be constructed under access road at stream crossings. Culverts shall be large enough to provide dry passage for terrestrial animals (i.e., reptiles and small mammals). In addition, it is recommended that wildlife passage culverts be installed in such a manner as to allow wet passage for amphibians and fish, and dry passage for amphibian, reptiles, and small mammals (see Figure 13-3).

The dry passage will provide suitable cover such as rock piles, logs, and brush. For example, ledges will be large enough to allow Cuscus to cross (with a width of 1m).

Size and type of stream crossing will be designed to avoid affecting the flow (i.e., the crossing will be large enough to pass design flood flows), to allow debris to pass and to minimize environmental impacts. In addition, due to the nature of the environment, metal trash-rack should be installed just upstream from stream crossings to prevent debris from blocking culverts.



Figure 13-1 Culvert with dry passage for reptiles



Source: Vinci autoroute, 2014

Environmentally and Culturally Sensitive Areas:

Once the final access road alignment has been determined, and all areas that require forest clearing have been identified, a botanist will walk the full length of the road (starting from Mangakiki) and other areas where construction will take place to geo-reference and fence environmentally and culturally sensitive areas such as:

- Wetlands;
- Streams;
- Rare, endangered plants and culturally or economically important plants colonies; and
- Large trees that need to be kept to maintain canopy closure to decrease the amount of edge-effected forest.

Fencing will be done using orange plastic construction fencing material supported on wooden or steel pickets.

Once fenced, each environmentally or culturally sensitive area will be mapped. The map of these protected sensitive areas will then be presented to a committee comprised of the resident engineer for the dam construction, construction contractors and forest clearing subcontractors, and the independent environmental expert. This committee will discuss potential solutions for protecting each sensitive area identified, including:

- Wetlands located in the right-of-way – if road alignment bi-sects a wetland then culverts shall be installed. If the work areas are located in a wetland, they shall be relocated nearby.
- Streams located in the right-of-way – sites where the road will cross streams will be fenced to denote the site of the crossings, the areas outside of which would be “no go” zones. Work should not occur within the wetted perimeter of any streams. Stream crossings requiring bridging should be clear-spanned.
- Rare or endangered plants in the right-of-way – in case of encounter avoidance measures will be discussed to adapt road alignment or to relocate work area. If measures to avoid endangered plants are not possible, then transplanting plant colonies should be

considered an option. Plants would be relocated as far as possible away from the area of disturbance under the supervision of a botanist.

Large canopy trees – large trees that provide canopy cover will be protected from unnecessary clearing, wherever possible. Fencing will be placed around these trees.

Road Access and Land Occupation Restrictions:

Extension of Black Post Road from Mangakiki to dam site to remain a private access road that will be gated. Access will be restricted by the Project Company and the TCLC to local population and hydropower facility operator. Commercial logging trucks will be prohibited.

The TCLC and Developer will not permit anyone to live or construct housing within the land leased for the project, except where strictly necessary for project activities, including housing for rangers or security staff.

These measures will be developed and implemented with the assistance of the TCLC, and set out in the Biodiversity Management Plan and Construction ESMP. The plans will include enforcement measures to prevent the use of the land for a workers camp. The BMP will also address restrictions on the use of the private project road through the Core Area by people seeking to build new settlements beyond the Core Area.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
<p>Ministry of Mines, Energy and Rural Electrification (MMERE)</p> <p>Road Design Contractor</p> <p>Road Construction Contractor</p> <p>Developer with respect to maintenance of the access road:</p> <ul style="list-style-type: none"> - from Mengakiki to dam site for BOOT period - from Black Post turnoff to Mengakiki until commissioning <p>Ministry of Infrastructure Development (MID) with respect to maintenance of access road from Black Post turnoff to Mengakiki following commissioning</p> <p>Tina Core Land Company (for controlling access to Core Lands)</p>	<p>TRHDP PO</p>	<p>Incorporated into Road Design Contract</p> <p>To be incorporated into road construction contract between MMERE and road construction contractor</p> <p>PPA (with respect to road closure)</p>

13.2.1.5 Vegetation and Forest Clearance

Impacts Addressed:
<p><u>Extent of Clearing:</u></p> <p>Physical impact of soil compaction and erosion (see section 9)</p> <p>Impact of sediment run-off on aquatic life (see section 11)</p> <p><u>Clearing and Grubbing:</u></p> <p>Impacts of vegetation burning on regional and local air quality (see section 9)</p> <p>Physical impact of soil compaction and erosion (see section 9)</p> <p>Loss of or disturbance to terrestrial natural habitat (see section 10)</p> <p>Impacts of increased suspended solids and siltation on aquatic life (see section 11.4.3.1)</p> <p>Impacts of River Pollution on aquatic life (see section 11.4.3.2)</p> <p>Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)</p> <p>Impacts of diminished water quality and quantity on aquatic environment (see section 11.4.3.5)</p> <p>Construction impacts on grassland dependent birds (see section 10.5.2.1)</p> <p>Construction impacts on river dependent birds (see section 10.5.2.1)</p>
Measures:
<p><u>Extent of Clearing:</u></p> <p>Coordinate work schedules so no delays in construction activities resulting in disturbed land remaining unstabilised.</p> <p>Program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during rainy season when intense rainstorms are common.</p> <p>During any pause in construction, stabilise site and install and maintain erosion controls so that they remain effective during pause. This is particularly important if project stops during the wetter months.</p> <p><u>Clearing and Grubbing:</u></p>

Forest and vegetation clearing activities shall be strictly limited to the minimum footprint required. Work areas to retain riparian forests where possible. Contractors may be tempted to fell trees of commercial value that will remain close to clear-cut areas. However, this activity is prohibited, even if requested by landowners. An independent environmental expert will monitor clearing activities to ensure compliance with this measure. The developer's Biodiversity Action Plan will provide for an offset to achieve no net loss of biodiversity as a result of conversion of natural habitat. It will include protection of remaining natural habitat in the Core Area and rehabilitation of modified habitat at least equal in area to the amount of natural habitat that is cleared.

Where vegetation clearance subcontracted to logging company, work shall be subject to strictest contractual measures to ensure compliance with environmental plans and shall be monitored by the independent environmental expert.

Cleared vegetation shall not be stored or dumped into streams.

Use of Glyphosate or other herbicides to kill trees or other vegetation will be strictly prohibited during all vegetation clearing activities, including vegetation control under the transmission line.

Vegetation control shall be carried out during the dry season to limit erosion and sediment-laden runoff from disturbed ground.

Existing vegetation or revegetating and mulching disturbed areas to be done as soon as possible.

Wherever possible, clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion to be avoided.

Work areas to be clearly delineated near riparian habitats prior to commencement of work.

Revegetate and mulch progressively as each section of work as completed. The interval between clearing and revegetation should be kept to an absolute minimum.

Wetlands in the transmission line right-of-way not to be drained, unless they represent a threat to stability of the access road, and will be protected from machinery.

Use of machinery to control vegetation to be limited to stable areas.

Close to streams, machinery will not be used to clear vegetation to minimise disturbance to stream banks;

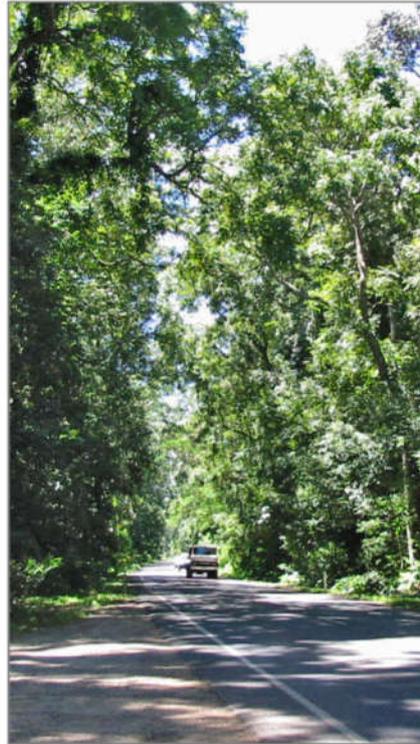
Workers in charge of vegetation control will be trained on health and safety issues and will wear suitable personal protective equipment, when removing or cutting vegetation, especially when felling trees.

For safety reasons, local communities will be notified prior to vegetation control activities in the vicinity of residential areas.

Non-merchantable vegetation shall be shredded rather than burned and shredded materials used to produce mulch to assist with erosion control.

Wherever possible, the canopy shall be "sealed" by minimizing large tree clearing to maintain canopy connectivity and reduce the edge effect. Along the road alignments, a botanist will identify large canopy trees that will be retained to maintain canopy closure (see Figure 13-2). However, for the transmission line, electrical grid protection prevails over this measure.

Figure 13-2 Monitoring canopy closure to mitigate edge effect



Source: Goosem et al., 2010

Transmission Line - After the initial vegetation clearance, Solomon Power or its contractors will carry out vegetation control to cut back vegetation that could potentially grow to a height that would interfere with the electrical conductors of the transmission line. Training shall be conducted to ensure workers identify and leave low-level native vegetation to prevent spread of invasive weeds.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer (including botanist for demarcating environmentally and culturally sensitive areas) Solomon Power	TRHDP PO	PPA

13.2.1.6 Drilling and Blasting

Impacts Addressed:		
Construction impacts on physical environment of noise and vibration (see section 9)		
Construction impacts on fauna (see section 10.5.2.2.2)		
Measures:		
The Project Company will prepare a Drill and Blast Management Plan that includes specific drill and blast methods to reduce noise and vibration. Hydraulic rock drill equipment will be used instead of pneumatic equipment because it produces less noise. Moreover, blasting and drilling equipment will be equipped with silenced masts, which can reduce noise levels by up to 10dBA. Blasting charges will be covered with blasting mats and screens to reduce generation of noise, fly rock and dust.		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.1.7 Accidental Release of Sewage and Other Wastewater

Impacts Addressed:		
Impacts of Point Source Pollution on Flora (section 10.5.1.2.1)		
Impacts of River Pollution on aquatic life (see section 11.4.3.2)		
Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)		
Impacts of diminished water quality and quantity on aquatic environment (see section 11.4.3.5)		
Measures:		
The presence of on-site toilet facilities for workers mandatory.		
All sanitary wastewater will be regularly transported outside of the study area for treatment.		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.1.8 Hazardous Materials, Explosives and Concrete Works Handling

Impacts Addressed:

Impacts of Point Source Pollution on Flora (section 10.5.1.2.1)
Impacts of increased suspended solids and siltation on aquatic life (see section 11.4.3.1)
Impacts of River Pollution on aquatic life (see section 11.4.3.2)
Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)
Impacts of diminished water quality and quantity on aquatic environment (see section 11.4.3.5)

Measures:

A hydrocarbon (fuel, oil, lubricant) management plan will be prepared and implemented by the construction contractor(s) prior to commencement of construction.

Facilities for storing hazardous materials, including fuel, lubricating oil, concrete curing agents, form releasing agents, sealants, and other hazardous products, will be approved by the resident engineer.

The resident engineer will also approve a separate secure "bunkered" facility for storing explosives.

Secondary containment will be required for all hydrocarbon products (fuel, oil, lubricants) used on the Project. Hydrocarbons will be stored on flat ground at least 100 meters from any water body or wetland.

Any hydrocarbon storage tanks or oil/fuel drums will be free of rust and cracks. Bund walls shall be provided and maintained around hydrocarbon storage areas within the Site. These bund walls will be of a sufficient height to contain a volume equal to one and one half (1.5) times the entire contents of its fuel storage facilities.

Fuel dispensing areas and machinery maintenance areas will be built with concrete hard standing surface, which will drain to oil separators. The oil will be pumped by a tanker and sent to Honiara for treatment.

Wash water from concrete works not to be directly or indirectly released in waterbodies or wetlands. Must be reused, stored and treated on site or collected and transported by road tankers for treatment in Honiara. A designated impermeable containment area must be used for concrete activities. To treat concrete washout onsite, a combination of settling ponds can be useful:

- Coagulants or flocculants will need to be added before discharging the water into the first or primary pond. This will help to reduce the size of ponds. Water must flow over small weirs from one basin to the next until the quality is good enough to be reused as plant water (closed loop system). The first pond will require periodic cleaning. The hardened concrete that is removed can be crushed and sent to a landfill in Honiara or reused on site as non-structural aggregate for road ballasting or surfacing works yards. The capacity of each pond must be greater than a full day supply of wash water and will take into account that the area often receives considerable rain. Due to the sensitive nature of the area, wash water will never be released in the Tina River.
- Each settling pond could allow for seepage and evaporation. For seepage, the water table needs to be low enough so that the water can be filtered without escaping. Settling ponds will need to be well sealed to limit any risks of infiltration of groundwater.

<ul style="list-style-type: none"> Water levels of settling ponds will be inspected daily. Before intense rain, the water levels will be lowered. Suitable cover will be installed to cover the pond in the event of intense rain (e.g., folding tarps). Tarps will cover the pond at night to keep birds and bats from drinking unsafe water. When excess water becomes a disposal issue, its pH will be adjusted with automatic pH neutralizer using CO₂ gas (the use of acids for that purpose is prescribed) prior to a potential discharge off-site in Honiara. 		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.1.9 Excavation and Movement of Soils

Impacts Addressed:
<p><u>Soil Stripping and Stockpiling:</u></p> <p>Construction impacts of soil management on flora (section 10.5.1.2.1) Impacts of increased suspended solids and siltation on aquatic life (see section 11.4.3.1) Impacts of River Pollution on aquatic life (see section 11.4.3.2) Impacts of diminished water quality and quantity on aquatic environment (see section 11.4.3.5) Disturbance to aquatic habitats and aquatic life (see section 11.4.3.3)</p> <p><u>Accidental Colonisation by Invasive Species:</u></p> <p>Impacts of Colonisation by Invasive Species on Flora Species (see Section 10.5.1.2.1) Impacts of invasive species on Fauna Species (see Section 10.5.2.2.2)</p>
Measures:
<p><u>Soil Stripping and Stockpiling:</u></p> <p>Salvaging topsoils with high organic content, and mineral soils (i.e., subsoil not capable of supporting plant growth) - prior to commencing construction of the access road, the contractor will be required to do soil coring to assess the depth of organic soil in the right-of-way in cleared forested areas, from Mangakiki to the dam and quarry sites. This will determine the depth of soil stripping that is required. Collection of soil cores, and the management of soil stripping, will be done under the supervision of a soil expert. The aim is to conserve the topsoil for future use in rehabilitation of disturbed areas and to reuse subsoil for road embankments.</p> <p>Usually, machinery will be used to strip topsoil layers to a depth of 1m.</p>

Storage of topsoil – topsoils having a high organic matter content, that have good potential for plant regrowth, will be stored within a soil stockpile area. Topsoil storage will be done away from all water bodies on a flat terrain, and close to work areas. Stockpiles will be either compacted and covered with geo-fabric tarps to avoid unwanted prolific plant or seeded with indigenous herbaceous plant species to maintain the organic content of piles. If the supply of native plants to vegetate piles is limited then stockpiles will be covered. In both cases, stockpiles slopes will not exceed a horizontal to vertical ratio of 5H:1V, and will be surrounded by sediment control structures, such as deeply anchored sediment fences, ditches, or berms around the stockpiles.

In addition, stockpiles and all disturbed areas, including those adjacent to road alignments, will be drained to enable sediment control structures, such as settling ponds, to prevent sediment laden runoff flowing into water bodies. Stockpiles of topsoil will be maintained at a pH of greater than pH5.5.

Monitoring of stockpiles will be done throughout the construction phase. Exact location being determined by the construction contractor, a botanist, and the independent consultant.

Recommended that spoils be stored in the remnant forest habitat to minimize forest clearing

In addition to soil spoils, non-organic (mineral subsoil spoils) and rock will also need to be removed and disposed, or reused, as follows:

- Subsoil spoils - Soil spoils produced by cuts to be reused for fill embankments and unsuitable soil spoils to be transported outside the Project area to a designated disposal site.
- Rock spoils - Spoils not utilised in construction to be disposed of in quarries.

Accidental Colonisation by Invasive Species:

Machinery to be checked by designated staff before equipment can enter project area. Wheels, tracks, buckets and other parts of machinery must be clean of mud and soil materials. Washing station will be installed just outside the project area at Veroande (see Section 6.4.2.1 – Invasive and Feral Species). Drainage water from washing stations to be diverted away from water bodies.

Importation of soil from outside work areas will be prohibited.

Soil deposited in the construction area will never be permanent in order to avoid colonization by invasive species. Soil stockpiles will be covered with geofabric tarps or revegetated with native plants. Soil Management Plan will be prepared by developer to assess the amount of spoils from road cuts, the need for road embankment and future use of excess soil; and to locate stockpiles.

Topsoil will be left on site and will be reused as much as possible.

Chemical and biological control of invasive plant species is not recommended as the extent of the impacts will be limited spatially.

Local population will be sensitized regarding the threat posed by Water Hyacinth and the consequences should it find its way into the area.

Terrestrial habitat fragmentation:

To mitigate indirect impacts of the terrestrial habitat fragmentation and the edge effect, the following actions will be implemented:

- Construction activities will be favoured in already affected areas (such as along the existing access road) and in disturbed and remnant forests rather than undisturbed primary forests.
- Where possible, impact-causing activities will be spatially concentrated to limit any encroachments.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer (Soil Expert) Overseen by Environmental Monitoring Consultant	TRHDP PO	PPA

13.2.1.10 Activities Causing Disturbance to Wildlife

Impacts Addressed:
<p><u>Workers Affects on Fauna:</u></p> <p>Construction and operational impacts on fauna (see section 10.5.2.1)</p> <p><u>Lighting Disturbance:</u></p> <p>Construction impacts on fauna (see section 10.5.2.2.2)</p> <p><u>Transmission Line Operation:</u></p> <p>Operational impacts on bats, birds and marsupials (section 10.6.2.1)</p> <p><u>Harvesting by Workers:</u></p> <p>Impacts of over fishing (see section 11.4.3.4)</p> <p>Operational impacts on fauna (see section 10.5.2.2.2)</p>
Measures:
<p><u>Workers Affects on Fauna:</u></p> <p>Workers prohibited from harming wildlife.</p> <p>Workers to receive wildlife awareness training informing them of the requirement to request the project's environmental specialist capture and remove animals that are either in danger or are dangerous to construction workers. Workers will be restricted to work areas and shall not enter adjacent natural habitat except where required for Project purposes.</p>

Workers to discard all rubbish and food waste in designated areas.

Lighting Disturbance:

The number of artificial lights during construction period shall be kept to a minimum, while still maintaining a safe working environment.

Light intensity will also be limited, where possible, and the lights will be oriented toward the ground to avoid disorienting bats in flight.

Regular use of artificial lights during operational period shall be avoided.

Transmission Line Operation:

Metal shields to be installed on wooden power poles in forested areas to prevent Cuscus from climbing poles and becoming electrocuted.

Harvesting by Workers:

Workers will be prohibited from fishing in the Tina River, noting that this restriction will not prevent local villagers who also work on the Project from continuing their existing subsistence fishing activities outside of work hours.

Project's food services / caterers will be prohibited from purchasing fish from local villagers.

Vehicle speed limits will be controlled along the access roads, to ensure that drivers are able to prevent running over wildlife that may be lying on, or crossing, the access road.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer Solomon Power (for transmission line)	TRHDP PO	PPA

13.2.2 Measures to Protect the Social Environment

This section consolidates the recommendations made throughout the ESIA on the avoidance, mitigation, and management of the adverse social impacts of the TRHDP. The recommendations draw upon:

- Consultations and findings of local people, communities and stakeholders on the potential social impacts of the project during the ESIA fieldwork, community and stakeholder mitigation workshops;
- Review of related projects and studies; and
- Comments of peer reviewers, World Bank experts, and members of the TRHDP team.

The objectives are to:

- Specify the strategies to mitigate the adverse social impacts identified in the ESIA, and to maximise the benefits, as required under the World Bank Operational Policy 4.10 regarding indigenous peoples;

- Establish the responsibilities for managing the social impacts during the construction and operation phases of the TRHDP, including implementation of specific impact mitigation and avoidance measures;
- Outline a strategy to ensure ongoing community and stakeholder communications, consultation and involvement in project decision-making, including the management of impacts and benefits. Arrangements for including women in decision-making should be explicit;
- Specify issues regarding loss of livelihoods resources and vulnerable people to be addressed in a Resettlement Action Plan or Livelihood Restoration Plan, as required under the World Bank’s operational policies;
- Present a plan for ongoing social impacts monitoring and reporting; and
- Present benefits intended for females, children, and vulnerable communities.

13.2.2.1 Siting of Workers Camps

Impacts Addressed:		
Local Customs and Way of Life (see section 12.5.6)		
Health Safety and Wellbeing During Construction (see section 12.5.3)		
Measures:		
To avoid unwanted long-term residence of outsiders in the Tina River communities, the construction contractors are required to provide residential accommodation for incoming construction staff and workers outside of the Tina Valley, preferably in Honiara.		
No workers camps or similar facilities shall be permitted in the project area. The Developer shall explore accommodation options on the east side of Honiara (eg. Panatina) and at Lungga and Henderson, for the workers who live outside of Malango and Bahomea.		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.2 Employment and Recruitment Practices

Impacts Addressed:
Uninvited Job Seekers (see section 12.5.5.3)
Increase in Employment Opportunities (see section 12.6.2)
Measures:

The construction contractor shall implement a recruitment policy prioritizing work-seekers from Bahomea and Malango. If additional recruitment is necessary, job applications shall be open to residents of the nearby areas and Honiara. This measure will be a condition of the Implementation Agreement between SIG and the contractor.

The construction contractor shall include a quota for women and be able to identify explicit strategies to ensure that women are recruited to work on the TRHDP.

It is recommended that the TRHDP PO conduct a survey of local villagers to identify those interested in working on the project construction. The survey should aim to identify preliminary skills and experience.

Based on the survey, the Project Office, together with local training providers, shall provide training to youth and other job seekers in the project area, on subjects such as safety and health, money management, driving, plant operation, trades, and other relevant subjects. Funding for this training is proposed to be provided through a JSDF grant.

Facilities created for the construction of the Project (e.g., storehouses and offices) shall be made available, if requested, for any future use by the community. This use will be facilitated through the Tina Core Land Company and it is proposed that this measure form part of the lease between TCLC and the Developer.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer TCLC (Facilities Retention) TRHDP PO (pre-employment training) Training Provider Contractor (pre-employment training)	TRHDP PO	PPA (recruitment policy and quota) Pre-employment training (JSDF Community Benefit Share Fund Grant)

13.2.2.3 Worker Behaviour, and Activities that could Affect Worker Health and Wellbeing

Impacts Addressed:
Local Customs and Way of Life (see section 12.5.6.1) Moro Movement (see section 12.5.6.2) Health Safety and Wellbeing (see section 12.5.3)

Measures:		
<p>The Developer is required to implement the workers' code of conduct (see Annex 18 of the Annex Report) covering, for example, working hours and conditions, safety, driving, socially and culturally appropriate behaviour, alcohol and drug use, prohibition on hunting and fishing, driving and use of vehicles, conflict and violence, gender based harassment and cultural heritage protocols. The code of conduct should also set a dress code for women workers who interact with local communities.</p> <p>The Developer shall conduct Code of Conduct pre-commencement training with workers.</p> <p>The construction contractor will provide tailored workplace health and safety training for construction workers before the start of the project.</p> <p>A full-time first aid / nursing post will be established on site and arrangements will be made for medical assistance and evacuation facilities. These matters will be covered in the construction contractor's Health and Safety Plan as part of their overall CEMP.</p>		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.4 Activities that could Affect Villagers' Safety, Wellbeing, and Amenities

Impacts Addressed:
<p>Health Safety and Wellbeing – Construction (see section 12.5.3.1)</p> <p>Health Safety and Wellbeing - Operation (see section 12.5.3.2)</p>
Measures:
<p>Road safety concerns related to traffic on Black Post Road will be addressed by:</p> <ul style="list-style-type: none"> ▶ Installing roadside fencing and speed controls near residential areas; ▶ Creating separate footpaths and safe crossing points and bus stop bays; and ▶ Using best practices for transportation of dangerous goods. <p>The construction contractor will develop a protocol for managing contractor-related road accidents and injuries (including compensation and restitution arrangements). The protocol will also address accidents involving power transmission lines. This plan be included in the construction contractor's health and safety management plan.</p>

To avoid traffic-related noise and dust, access roads will be sealed in areas adjacent to villages, community facilities, and food gardens.

Educational programs will be organised by the TRHDP PO to reduce the level of fear expressed by communities regarding potential risks of dam failures and catastrophes. Moreover, to reduce any potential opposition to the development of the Project, the TRHDP PO will design and run a village level educational program to present information, at an overview level, on modern-day dam engineering, construction and operation. The program will pay special attention to reaching women and young people. Community briefings from the World Bank's Dam Safety Panel could complement this program.

As the time for villages to be electrified gets close, Solomon Power shall carry out educational programs in communities and schools to familiarize residents on electricity and its safe use in homes and communities, including safe behaviour around transmission lines and other power infrastructure components.

Specific measures will be implemented to avoid any social threats or mis-conduct.

A strict drug and alcohol prohibition for all workers will be implemented by the construction contractor to minimise any threats of antisocial behaviour. The ban also aims to reduce risks of road accidents on the Tina Road and on the project site.

Awareness will be conducted on STDs including HIV/AIDS to prevent and mitigate the impacts of social behaviors which will encourage sexual behaviours. Outside parties will be engaged to carry out this awareness program.

Condoms will made freely available at the first aid/nursing post to be established on site.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer Road Design and Construction Contractors Solomon Power TRHDP PO	TRHDP PO	PPA Road Design and Construction Contracts

13.2.2.5 Activities that could Affect Vulnerable Groups and Minorities

Impacts Addressed:
Minority and Vulnerable Groups (see section 12.5.4.3)
Measures:

Social Impacts Monitoring Plan shall include monitoring of impacts of the project's construction and operation phases on squatters and settlers. The Stakeholder Engagement Plan shall assist communities in having their issues dealt with as the project progresses. This should include a grievance / complaints mechanism, and nominated community representatives for CLAs.

These plans shall include measures directed towards isolated communities, such as Senghe, Choro and Koropa, as these are particularly vulnerable due to changes of flow in the by-passed section of Tina River and due to their remote location.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.6 Activities that could Affect Water Supplies

Impacts Addressed:

Water Quality and Quantity (12.5.7.4.3)

For the three-year period of project construction, the water of the Tina/Ngalimbiu River may become, without treatment, unusable for some human domestic purposes. This is likely to continue for several years after the construction has ended. Many of the downstream riverside villages, which represent more than 2,000 people, will be affected. Many villages rely on the river as their main water source, while a number of villages further downstream on the Ngalimbiu have access to water supplies.

Uncertainty exists in the community about the long-term effects of the dam and reservoir on water quality.

Measures:

Downstream Alternative Water Supplies

In consultation with local communities, the Developer is to undertake a detailed survey and mapping of community drinking and washing river use downstream of the dam site. The downstream area will include communities using the Tina River as well as the Ngalimbiu. The survey is also to identify communities with existing alternative water supplies. These measures will form part of the Developer's Water Supply Feasibility Study.

The Study is to include modelling of predicted impacts on water quality and assess whether these impacts will affect community river use.

Access to alternative water supplies shall be provided for all river dependent communities whose use of the river is anticipated to be affected. Appropriate water supply solutions will be site specific. Alternatives may include:

- River-based supply with appropriate treatment systems and supply points for each village;
- Rainwater collection and storage tanks;
- Establishment of alternative supplies from local streams, and;
- Borehole / ground water supplies, piped to several villages / hamlets.

Transportation and distribution of clean water could also be done by tanker truck on a regular basis. The water will be stored in tanks at the village level. Regardless of the method, it shall not create an additional workload for women. For example, the villages of Valesala and Antioch could obtain water from the Kolohio stream. Therefore, the design of replacement or alternative water supplies should explicitly include the views of women and teenage girls, and consider the impacts to them.

Alternative water supplies shall be provided to affected communities prior to construction work on the dam, powerstation, river quarries or reservoir. During the impact mitigation workshops, community leaders specifically requested the provision of alternative reliable clean water supplies to affected communities.

A list of affected communities along the Tina River and a map showing their locations is provided below. Communities reliant on the Ngalimbiu River shall be mapped as part of the Water Supply Feasibility Study:

Table 13-1 Table of Water Supply Affected Communities on the Tina River

Communities & affiliation that rely on Tina River for their domestic use and/or as a drinking water supply	Villages/ hamlets	2013 households (approx.)	2013 population (approx.)
Senge community	Senge	3	16
	Choro	1	4
	Koropa	3	19
Pachuki community	Pachuki	14	65
	Habusi	6	33
Namopila comm.	Namopila	5	27
	Komureo	6	28
	Vatunadi	1	5
	Valekocha	5	26
Antioch community	Antioch	23	110
	Valesala	20	105
	Kolanji	2	10
	Komeo	0	0
Tina community	Tina	23	104
	Valebarik	6	22
	Valebebe	22	104
	Tahurasa	5	15

Communities & affiliation that rely on Tina River for their domestic use and/or as a drinking water supply	Villages/ hamlets	2013 households (approx.)	2013 population (approx.)
	Valemaota	4	12
Vuramali comm.	Vuramali	18	70
	Haimane	26	111
	Horohotu 2	17	84
	Vuvamali	16	77
Horohutu comm.	Horohotu 1	12	60
Verakuji community	Verakuji	11	56
	Managikiki	21	111
Marava community	Marava	28	168
	Ngongoti	1	20
	Vatupaua	5	50
	Rate school	?	?
Vera'ande community	Vera'ande	6	30
	Verakweli	6	24
	New Mahata	2	15
Verakabikabi comm.	Verakabikabi	44	219
Total		362	1800

Figure 13-3 Map of Tina River dependent affected communities



Water quality monitoring

Management of water quality will need to be investigated, monitored, and managed as part of the overall environmental management of the TRHDP over the long term.

The construction contractor shall commence monitoring water borne diseases in the Tina/Ngalimbiu River catchment just prior to commencement of construction. This should continue as part of the ongoing environmental management and monitoring throughout construction and the initial years of reservoir operation.

During the period of construction and initial years of reservoir operation, when water quality may be impaired, all affected villages will be made aware that water in the Tina River may not be drinkable, and that the use of traditional small “sand point” holes in river gravel will not be sufficient to treat water.

Survey of water supplies near road works

In consultation with local communities, all present and alternative village water supply resources in the vicinity of the access road works will need to be identified, surveyed, mapped, and engineer-assessed, prior to construction work on the access road.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.7 Activities that could Affect Ecotourism Opportunities

Impacts Addressed:		
Ecotourism Opportunities (see Section 12.10.5)		
Measures:		
Senghe village foot track will be disrupted by heavy traffic on the access road to the powerhouse. It is important to relocate the access track prior to the construction of the access road, so that visitors are not affected by traffic.		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.8 Damage to, or Loss of, Core Area Resources

Impacts Addressed:		
Natural Capital (see section 12.5.7.4)		
Measures:		
<p>Use-rights for the storage reservoir and its margins, dam and powerhouse access roads, and other land acquired for the project Core Area shall be defined by the proposed TCLC as the entity responsible for managing the use of the core area resources.</p> <p>The Land Acquisition and Livelihood Restoration Plan shall discuss local householders' use of the land and resources on sites required for the Project, and quantify impacts as a basis for compensation. The LALRP provides an entitlements matrix where local households lose access to livelihoods resource areas because of the project.</p> <p>Where construction activities damage or destroy resources outside of the acquired Direct Impact Area, compensation for these resources should be payable using transparent formulae.</p>		

Where feasible, the TRHDP PO should contract out the reservoir vegetation clearing work to local community members.		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.9 Activities that could Affect Cultural heritage

Impacts Addressed:		
Cultural Heritage (see section 12.5.8)		
Measures:		
<p>As part of the Construction ESMP (CESMP), the Developer shall put in place a protocol for managing cultural heritage. This should include arrangements for relocation and for compensation.</p> <p>This Cultural Heritage Protocol is presented in Annex 18.</p> <p>Prior to any construction commencing, the Developer, with the assistance of the Project Office, shall carry out a “tambu site compensation follow-up” to identify areas that will require compensation in the designated Core Area and in the communities adjacent to any road building or upgrading and construction. A suitably qualified cultural heritage expert, working closely with knowledgeable elders and the National Museum, should undertake this task. All sites that will be destroyed and compensated will be recorded and photographed for monitoring purposes, but the details and records of the sites shall only be disclosed to affected communities and the construction contractor and the SIG for confidentiality purposes to ensure that the construction contractor does not destroy any sacred (tambu) before compensation for losses are granted to communities.</p> <p>Prior to construction, the Developer, in conjunction with culturally knowledgeable locals and a botanist, shall survey the project and road construction sites to identify culturally important medicinal and magical plants that may need to be protected or relocated.</p> <p>Fear that the customs and lifestyle of the Gaena’alu followers will be disrespected will be averted by not having a workers camp located within the Tina/Ngalimbiu area, and by the contractor establishing and enforcing a strict code of conduct for its workers with respect to contact with local villagers.</p>		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

		Tambu Site Disturbance Compensation – Component of allocated SIG budget for land compensation
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13.2.2.10 Decisions Made on the Project

Impacts Addressed:		
Social Impacts (see section 12)		
Measures:		
<p>The Developer will continue consulting directly with the project-affected communities throughout the life of the Project using culturally appropriate, inclusive and proven methods and arrangements. District-level consultations could be done through a representative of the Community Liaison Committee or any similar forum.</p> <p>The Developer will address any issues raised by communities and should report any corrective measures to the communities and to the SIG.</p>		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.11 Dam Failure and Emergency Flow Releases

Impacts Addressed:
Fear of dam failure (see section 12)
Measures:
<p>The Design study shall prepare a disaster/extreme event model showing the submersion wave in case of dam break, covering the management or responses to situations of extreme floods and cyclones in the catchment, emergency water releases, and dam beaching or overtopping. Such plan shall be part of the design report and then integrated in the Emergency Preparedness Plan.</p> <p>Through training and sensitization carried out by the Developer, powerhouse start-up and shut-down procedures must be clearly understood by local communities to avoid any accident with sudden release of water at power station outlet (peak hour releases).</p>

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.12 Daytime Peaking Flow Releases

Impacts Addressed:		
Operational Impacts (12.5.3.2)		
Measures:		
<p>The detailed design study shall include a disaster / extreme event model showing the inundation zone that would result in the event of a dam break, and cover emergency management or responses to situations of extreme floods and cyclones that may affect the catchment, emergency water releases, and dam beaching or overtopping.</p> <p>This plan shall be part of the design report.</p> <p>The Developer shall install an early warning system when floods will flow over the spillway along the by passed section of the River. This shall be incorporated into an Emergency Preparedness Plan which shall include:</p> <ul style="list-style-type: none"> • The need to train local communities on actions to follow in the event of floods, • How to recognise and respond to the powerhouse flow release / flood warning system. 		
Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.13 Changes Associated with Diminished River Flows

Impacts Addressed:

Sediment Recruitment:

Extraction of Aggregates from the River (section 12.5.7.3)

There is potential for reduced or altered stream flow in the Ngalmibiu River on gravel deposition and the sustainability of gravel extraction. However this effect will only be noticeable over the long term.

Timber Transport and Recovery:

Small scale timber harvesting (section 12.5.7.2)

Measures:

Sediment Recruitment:

Monitoring of gravel transport shall be undertaken by a river geomorphologist. This may include:

- Identifying key river points
- Taking annual transect measurements, including gravel depth
- Taking additional transect measurements after 1 in 10 year flood events.

Further mitigation measures to be considered where measured changes in gravel distribution affect livelihoods of downstream communities.

This measure is in addition to other mitigation measures in this ESMP in relation to sluicing of sediments.

Timber Transport and Recovery:

An alternative to timber rafting as a mean to transport sawn timber down the Tina River will be proposed by the TRHDP PO, so timber millers can continue to transport and recover their timber around the dam and the bypassed section of Tina River. Arrangements for the transport of timber extracted by local landowners from their lands above the proposed dam site will need to be put in place prior to dam construction and operation. One option to do this is through the creation of a truck pickup point beside the river and future reservoir, connected to the dam access road.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.14 Activities that could affect fishing effort

Impacts Addressed:
Livelihood Impacts (Chapter 12)
Measures:
Fish monitoring is to be undertaken in accordance with a fish monitoring plan to be prepared by the Developer in accordance with section 13.4.3.3.

Monitoring will include fish quantity and species diversity in the Tina River and Ngalimbiu River including the estuary, and in the Toni River as a control site. Monitoring is to include both comprehensive baselines studies and ongoing monitoring throughout the operational period.

Where monitoring identifies statistically relevant reductions in fish quantities or species during operations, adaptive management procedures for fish migration are to be implemented.

Where construction impacts on water quality have a statistically relevant affect on fish species used as a source of food or income for downstream communities, compensation measures will be implemented for impacted communities. If this measure is triggered, the Developer shall undertake a study of the impacts on fishing efforts, and the compensation payable. A compensation management plan is then to be prepared and approved by SIG.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA

13.2.2.15 Activities that could Strain Relations with Project-Affected Communities

Impacts Addressed:
<p><i>Community Liaison, and Capacity Buiding:</i></p> <p>Social Impacts (numerous, see section12)</p>
Measures:

Community Liaison:

This measure is intended to ensure communication between affected communities and the Developer/TRHDP Project Office

Community liaison committees (CLC) shall be established for the construction and the operations phases, supported by a small group to oversee monitoring and mitigation measures and provide input to reporting on conditions in the project-affected communities.

This monitoring shall include the state of relationships between the different clans as well as the distribution of water to affected communities. Each Community liaison committee will include the existing Community Liaison Assistant (CLA) as well as women and youth. The former role of the CLA will be formalized by the CLC so that grievances are documented in reports and in the Stakeholder Engagement Plan.

Each committee shall have a secretary that will be in charge of producing regular reports on community grievances and monitoring of impacts. These reports will aim at communicating with the Developer, the SIG and TRHDP as well as the independent Consultant specialized in environmental and social management.

Capacity Building:

Capacity building is required to CLAs as discussed separately in this ESMP.

The Developer with assistance of TRHDP PO shall provide capacity development, training and administrative support to the Community Liaison Assistants and Community Liaison Committees.

TRHDP PO's ongoing training with landowning tribes in money management and administrative procedures shall continue throughout the pre-construction and construction stages of the Project. This work includes facilitation of financial benefit sharing among all tribal members.

TRHDP PO to facilitate management training for TCLC board members where required.

The Benefit Sharing Program facilitated by TRHDP PO shall focus on delivering pre-employment training to members of the Bahomea and Malango areas.

To minimise any social disruptions arising from increased amounts of cash in the community, the Developer/TRHDP PO provide budgeting and money management training as part of the induction and training of locally recruited workers.

Implementation Actor:	Oversight Actor:	Costing/Funding Source:
Developer	TRHDP PO	PPA
TRHDP PO		Pre-employment training through JSDF Grant.
Community Liaison Committees		

13.3 MANAGEMENT PLANS

In preparing the CESMP and OESMP, the constructor/operator shall develop and include a number of detailed management plans. A list of these plans, the timeframes for these and the framework for review and approval is set out in Table 13-2.

13.3.1 Table of Management and Monitoring Plans

Table 13-2 Management Plan Timeframes and Approvals

No.	Name	Completion Date	Prepared by	Implemented by	Review/Approval by	Applicable Policy/PS
Dam Safety Plans						
DS-1	Construction and Quality Assurance Plan	By appraisal (as TOR of Owner's Engineer)	SPC (Sponsors)	SPC and Owner's Engineer	DSAP/MMERE/WB	PS4 (OP4.37)
DS-2	Instrumentation Plan	Before tendering EPC (as part of PPA MFS and EPC contract)	SPC (Sponsors)	EPCC	SPC/DSAP/MMERE/WB	PS4 (OP4.37)
DS-3	Operation and Maintenance Plan	Draft by appraisal; final 6 months before reservoir filling	SPC	SPC and O&M Contractor	SPC/DSAP/MMERE/WB	PS4 (OP4.37)
DS-4	Emergency Preparedness Plan	Framework by appraisal; plan 1	SPC	SPC throughout PPA; O&M	SPC/DSAP/MMERE/MECDM/WB	PS4 (OP4.37)

No.	Name	Completion Date	Prepared by	Implemented by	Review/Approval by	Applicable Policy/PS
		year before reservoir filling		Contractor during operation		
Preparation Phase Plans						
P-1	Construction ESMP (CESMP)	Before contractor mobilization	EPCC	EPCC	SPC/MMERE/MECDM /WB/ADB	PS1
P-2	Biodiversity Management Plan	Before contractor mobilization	EPCC	EPCC, SPC and O&M Contractor	SPC/MMERE/MECDM /WB/ADB	PS6.OP4.04
P-3	Stakeholder Engagement and Communications Plan	Before contractor mobilization	SPC	SPC	MMERE/WB/ADB	PS1.PS4
P-4	Human Resources and Labour Management Plan	Before engagement of contractor employees	SPC/HEC	SPC/HEC	SPC/MMERE/WB/ADB	PS2, PS4
P-5	Influx Management Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE/WB/ADB	PS2.PS4
P-6	Grievance Redress Mechanism	Before contractor mobilization	EPCC and SPC	EPCC and SPC	SPC/MMERE/WB/ADB	PS1,PS2,PS4
P-7	Security Management Plan	Before contractor mobilization	EPCC and SPC	EPCC and SPC	SPC/MMERE/WB/ADB	PS4
P-8	Worker's Health and Safety Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE/WB/ADB	PS2 EHS Guidelines
P-9	Workers Code of Conduct	Before contractor mobilization	EPCC	EPCC	SPC/DMMERE/WB/ADB	PS2.PS4
P-10	Community Health and Disease Vector Management Plan	Before contractor mobilization	EPCC	EPCC and SPC	SPC/MMERE/WB/ADB	PS4

No.	Name	Completion Date	Prepared by	Implemented by	Review/Approval by	Applicable Policy/PS
P-11	Traffic Management Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE	PS1, PS4
P-12	Waste Management and Point Source Pollution Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE/WB/AD B	PS3 EHS Guidelines
P-13	Hazardous Materials Management Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE/WB/AD B	PS3 EHS Guidelines
P-14	Spill Prevention and Emergency Response Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE	PS1,PS3
P-15	Air Quality Management and Dust Control Plan	Before contractor mobilization	EPCC	EPCC	SPC/MMERE	PS1,PS4
Construction Phase Plans						
C-1	Cultural Heritage Management Plan	Two months before land clearing	EPCC	EPCC	SPC/MMERE/WB/AD B	PS8
C-2	UXO Management Plan	Before land clearing	EPCC	EPCC	SPC/MMERE	PS1,PS2
C-3	Forest Clearance Plan	Before land clearing	EPCC	EPCC	SPC/MMERE/MECDM /WB/ADB	PS6,OP4.04, OP4.36
C-4	Post-construction Rehabilitation and Revegetation Plan	Before land clearing	EPCC	EPCC	SPC/MMERE/MECDM	PS1,PS6
C-5	Quarry Management Plan	Before construction start	EPCC	EPCC	SPC/MMERE/MECDM	PS1,PS2,PS4 EHS Guidelines
C-6	Reservoir Preparation Plan	Before biomass removal	EPCC	EPCC	SPC/MMERE/MECDM /WB	PS1,PS6
C-7	Water Supply Replacement Plan	Before construction start	EPCC	EPCC	SPC/MMERE	PS4

No.	Name	Completion Date	Prepared by	Implemented by	Review/Approval by	Applicable Policy/PS
C-8	Watercourse Crossing Management Plan	Before land clearing	EPCC	EPCC	SPC/MMERE	PS1
C-9	Spoil and Topsoil Management Plan	Before land clearing	EPCC	EPCC	SPC/MMERE	PS1
C-10	Drainage, Erosion and Sediment Control Plan	Before land clearing	EPCC	EPCC	SPC/MMERE	PS1
C-11	Drill and Blast Management Plan	Before construction start	EPCC	EPCC	SPC/MMERE/MECDM /WB/ADB	PS2,PS4 EHS Guidelines
C-12	Stormwater Management Plan	Before construction start	EPCC	EPCC	SPC/MMERE	PS1
C-13	Noise and Vibration Management Plan	Before construction start	EPCC	EPCC	SPC/MMERE/MECDM /WB/ADB	
C-14	Cumulative Impact Management Strategy	Within one year of mobilization	SIG	various public and private entities	MMERE/WB/ADB	PS1
Operations Phase Plans						
O-1	Operations ESMP (OESMP)	3 months before reservoir filling	O&M Contractor	O&M Contractor	MMERE/MECDM/WB/ ADB	PS1
O-2	Reservoir Operation & Management Plan	3 months before reservoir filling	O&M Contractor	O&M Contractor	MMERE/MECDM/WB/ ADB	PS1,PS6
Decommissioning Phase Plans						
D-1	Decommissioning Plan	1 year before station closure	SPC (SIG, if it continues to operate after PPA period)	SPC	MMERE	PS1,PS2,PS3, PS4,PS6
D-2	Retrenchment Plan	1 year before station closure	SPC (SIG, if it continues to	SPC	MMERE	PS2

No.	Name	Completion Date	Prepared by	Implemented by	Review/Approval by	Applicable Policy/PS
			operate after PPA period)			
Transmission Line Plans						
T-1	ESIA/ESMP	Before start of construction	SIEA	SIEA	MMERE/MECDM/WB/ADB	OP4.01,4.04, 4.10,4.11,4.36 EHS Guidelines
T-2	LALRP	Before right of way clearance	SIEA	SIEA	MMERE/WB	OP4.10, 4.12
Monitoring Plans						
M-1	Suspended Sediment Monitoring Plan	Before land clearing	EPCC	EPCC and SPC	SPC/MMERE/MECDM/WB/ADB	PS1,PS
M-2	Water Quality Monitoring Plan	Before land clearing	EPCC	EPCC and SPC	SPC/MMERE/MECDM/WB/ADB	PS1
M-3	Fish, Algae, and Macro-Invertebrate Monitoring Plan	Before land clearing	EPCC	EPCC and SPC	SPC/MMERE/MECDM/WB/ADB	PS6
M-4	Social Impacts Monitoring Plan	Before contractor mobilisation	TRHDP-PO	TRHDP-PO	MMERE/MECDM/WB/ADB	PS1,PS7
M-5	Flora and Fauna Monitoring Plan	Before land clearing	SPC and EPCC	SPC and EPCC	MMERE/MECDM/WB/ADB	PS1,PS6
M-6	Construction Works Monitoring Plan	Before land clearing	EPCC	EPCC	SPC/MMERE/MECDM/WB/ADB	PS1
M-7	Air Quality and Noise Monitoring Plan	Before land clearing	EPCC	EPCC	SPC/MMERE/MECDM/WB/ADB	PS1,PS3

SPC shall report on the implementation of the above plans, and the results of studies executed as part of the plans, to the PO, WB, ADB and MECDM.

13.3.2 Management Plan Frameworks

Frameworks for key plans and sub-plans are provided below. Each plan should contain at least the following:

- Purpose
- Definitions
- Links, as required, with other plans (i.e. grievance redress mechanism (GRM), stakeholder engagement and communication plan, CESMP, health & safety etc)
- Organizational structure and arrangements for implementation of the plan
- Risk assessment (or other) methodology to identify aspects/impacts/risks to focus on for mitigation and management
- Performance indicators or standards to be followed/met plus any additional targets cited in ESMP in ESIA
- Mitigation and management measures
- Site-specific plans for each of the components (maps, drawings, overlays etc),
- Costs and budget
- Monitoring and reporting requirements (to link with monitoring plans)
- Checklists and forms (for recording compliance, registry, monitoring, corrective actions etc).

13.3.2.1 D-1 – D-4 Dam Safety Plans

Management Plans required shall include the following Dam Safety Plans in accordance with World Bank OP 4.37:

- Construction and Quality Assurance Plan
- Operation and Maintenance Plan
- Instrumentation Plan
- Emergency Preparedness Plan

All plans relating to dam safety and response to operations related emergency events will be prepared by the SPC and reviewed by the TRHDP's Dam Safety Panel.

13.3.2.2 P-1 Construction ESMP

The CESMP may also comprise a number of sub-plans as per Table 13-3 and will include site-specific plans for the infrastructure components, with the linear elements - access roads and transmission lines - comprising several site-specific plans. Each site-specific plan should be prepared following steps including:

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- Define boundaries
 - Identify sensitive receptors and environmental values
 - Specify construction activities (according to program and schedule)
 - Conduct risk assessment
 - Assign environmental mitigation and management measures
 - Prepare site plans and construction methodologies
 - Prepare environmental work plans for when different work activities are required at different times or at different locations. Environmental work plans are similar to work method statements.

The CESMP also needs to identify how the developer will implement the relevant aspects and processes of the GRM.

As a guide to preparation of CESMP an outline of environmental specifications for construction is provided at Appendix O.

13.3.2.3 P-2 Biodiversity Management Plan

The Developer shall be responsible for preparing the Biodiversity Management Plan (BMP). The BMP shall develop an appropriate and detailed methodology and program for managing all key biodiversity issues during the construction and operation of the Project.

Because of its particular importance, the terms of reference for the BMP are included with the ESIA as Appendix P. The BMP, together with the proposal for upper catchment protection in Appendix K, will include measures to achieve no net loss of biodiversity as a result of natural habitat conversion, degradation, or fragmentation in the area of influence, including protected set-asides, restoration of areas temporarily disturbed, and offsets in the form of rehabilitation of modified habitat. It will also contain wildlife management measures to protect fauna that may pass through or reside in the project footprint, including prohibition of hunting and on-call experts to assist in relocations. The requirements for minimum flows that have been established in the ESIA and the provisions in the design to move migrating fish past the dam are also measures that contribute to no net loss of biodiversity in the aquatic ecosystem. The BMP will also include detailed management provisions to mitigate the impacts of invasive species, incorporating as a minimum standard this ESMP's measures, including machinery washing stations.

Impacts the project may cause, if any, on the river upstream of the reservoir are difficult to predict, and the BMP will therefore link to the monitoring plans so that benthic organisms, fish fauna, and water quality are monitored upstream of the reservoir. Findings of adverse impacts will lead to adaptive management measures. The BMP will also include measures to restrict public vehicular access, including commercial logging access, south of the end of the existing road close to Mengakiki.

At a minimum, the BMP shall be structured as follows:

- Executive Summary

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- Methodology
 - Biodiversity Context
 - Priority Biodiversity Features
 - Biodiversity Objectives and Targets
 - Recommended Management Actions (legal requirements; biodiversity actions; responsible parties; etc.)
 - Implementation Mechanism
 - Monitoring and Surveillance (including adaptive management process)
 - Budgets and Timelines
 - Internal and External Reporting
 - References
 - Appendices (maps; photo documentation; etc.)

13.3.2.4 P-3 Stakeholder Engagement and Communication Plan

The Stakeholder Engagement and Communication Plan (SECP) describes the purpose, method and outputs of the project being implemented by the MMERE, SPC, EPCC and the stages and processes for communication. The SECP covers the requirements of relevant country laws, current practice in respect of communications and consultations and also complies with the development partner requirements.

The purpose of the Stakeholder Engagement and Communication Plan (SECP) is to guide what types of information need to be provided to and obtained from stakeholders, when and how such information is communicated, and how the information is to feed into the different project stages and aspects including feasibility study, detailed design, construction, and operations. It provides an overall mechanism for guiding communications about the project for the SPC, other relevant government agency staff, implementation and supervisory consultants, and the primary beneficiaries and other stakeholders (such as civil society organizations). Importantly, the SECP is based on local custom and tradition to ensure it facilitates meaningful consultation.

Not all of the stakeholders need to receive or provide information at all times, therefore a hierarchy of communication can be used ranging from the most intense and frequent communications with the directly affected and beneficiary communities through to releases of more general information to the wider public at specific times within the project.

In terms of processes for communication with different project stakeholders, these can range from meetings (including focus group discussions) and interviews through to releases via radio, electronic or print media.

The main channels of communications will depend on the stakeholders, the information to be provided or received, and the purpose and timing of the communication. Methods include face to face meetings with stakeholders, focus group discussions, community meetings, establishing community liaison committees, preparation and dissemination of posters, information sheets or booklets, and use of media including electronic, radio, newspaper and

social media when/where appropriate. Information communication technology such as mobile phones, internet and website can also be utilized by the project to inform stakeholders about the progress of the project.

The SECP is integrally linked with the project's grievance redress mechanism (GRM) that will also be reflected in the CESMP and other plans as required. The GRM (refer plan P-5) sets out the process for resolving concerns or complaints and shows how communities and other stakeholders can lodge any complaints or concerns about the project at different stages/levels.

The SECP will cover:

- Project communications
 - Meaningful consultation principles
 - Overall communication approach
 - Stakeholders and target audiences
 - Key communication outcomes
 - Medium of communications with external stakeholders
 - Key messages
- Project stages and communication outcomes
 - Preparation
 - Construction
 - Operations
 - Decommissioning
 - Monitoring
- Project's GRM and disclosure requirements

13.3.2.5 P-4 Human Resources and Labour Management Plan

The priority recruitment of members the local Benefit Share Community over other workers (as defined in the Community Development Plan), as well as the preferential recruitment of Solomon Islands' nationals over non-nationals is a key mitigation measure of the Project. Further details are provided in the Project's Implementation Agreement.

This plan shall identify hiring processes to implement these recruiting measures, together with a grievance mechanism, and audit, reporting and review process.

In addition, the plan shall specify the HR policies of the SPC and EPC Contractor, to meet at a minimum the following objectives:

- To attract and retain a skilled and competent workforce;
- To ensure employees are aware of their rights and entitlements including pay, holiday, sickness and bereavement leave, and rest breaks ;
- To deliver a fair and equitable environment that includes mechanisms for responding and resolving employees questions, difficulties or concerns, and to provide a clear process for performance management;

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- Ensure compliance with relevant industrial relations legislation, and any applicable requirements of Project donors;
 - Ensure employee relations issues are managed justly, and in a coordinated and consistent manner.

13.3.2.6 P-5 Influx Management Plan

Construction projects, especially those comprising large civil works, require labor force and associated goods and services that cannot always be fully supplied locally. A partial component of the labour force may need to be brought in from outside the project area. In many cases, this influx is compounded by an influx of other people (“followers”) who follow the incoming workforce with the aim of selling them goods and services, or in pursuit of job or business opportunities.

The purpose of the influx management plan (IMP) is to set out the objectives in relation to management of project-induced in-migration and its impacts and to successfully implement measures to manage the in-migration, and avoid, prevent, and mitigate the direct and indirect adverse impacts associated with project-induced in-migration. All stakeholders have a role to play in managing in-migration.

The IMP will need to:

- Identify project components/requirement for labor and potential for in-migration
- Scale of in-migration and its impacts
- Management of project-induced in-migration into the project area, which includes minimizing in-migration, managing the inflow of in-migrants, and managing the physical and social footprint of in-migration within the project area
- Mitigation of adverse impacts associated with in-migration
- Buy-in and capacity of potential partners to collaborate in the design and implementation of the measures to manage the in-migration
- Resource costs of selected management approaches
- Stakeholder engagement and monitoring and information flows.

The IMP needs to be clearly linked with the SECP and the Human Resources and Labour Management Plan.

13.3.2.7 P-6 Grievance Redress Mechanism

This ESMP shall utilise the following process as the mechanism for addressing grievances between the different project stakeholders. The GRM is designed to facilitate feedback from any project participant or stakeholder regarding project operations, management, use of resources and impacts of activities, intentionally or otherwise, and resolution of the same by the developer. Grievances related to land acquisition will be dealt with separately under the GRM proposed in the LALRP.

Grievance mechanism allows the developer to interact with communities living along the Tina/Naglimbiu Catchment. The document will be reviewed as project development stages progress.

The SPC will advertise and inform communities including isolated communities of the grievance mechanism and also ensure that communities are well aware of its structure. In the event that the communities of the Tina/Ngalimbiu Catchment feel that environmental and social complaints have not been adhered to or followed, those stakeholders have the right to raise their concerns and to seek satisfactory acknowledgement and resolution of their grievances. This right is essential to ensure transparency and accountability. Communities will be informed of the Project GRM through community meetings, project documentation and through the local media.

Grievance mechanism structure. Community liaison committees (CLC) will be established for the construction and operation phases of the project supported by a team from the TRHDP PO to oversee the monitoring and implementation of the mitigation measures. The monitoring team will also provide report on any impacts that may be happening in the project affected communities. The CLCs will be the focal points for information dissemination to the project affected communities.

Documenting grievances. The CLC would be responsible for recording the grievance or complaint through regular meetings with members of each community. Raised concerns will be written down in a report and presented to the TRHDP PO and the Developer. The CLC will consult with the developer on all complaints received to respond to any systematic issues or problems.

Responding to grievances. Responses to grievances will be the responsibility of the Developer. If, due to its nature, the grievance requires immediate attention, the developer should commit to address raised issues in an acceptable time frame. The developer shall keep minutes of meetings and other form of records regarding the way they have addressed the issues.

Where grievances cannot be resolved at this level, the aggrieved party or person will have recourse to a review and a decision made by the TRHDP-PO where a grievance relates to a construction impact and to MECDM where a grievance relates to an operational impact. If the CLC cannot resolve the issue, or at any other time, an aggrieved person may have recourse to the Solomon Islands' Courts.

13.3.2.8 P-7 Security Management Plan

The purpose of the security management plan (SMP) is to protect the site, physical assets, workers and information.

The SMP will include:

- Identification of risks, threats and security issues
- Risk mitigation and assurance measures
- Alarm systems
- Lighting and CCTV coverage
- Guards, personnel and schedule
- Site security plans
- Crime prevention

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- Visitor control
 - Perimeter access control – fences, walls, vehicle and pedestrian barriers
 - Other controls.

13.3.2.9 P-8 Worker’s Health and Safety Plan

The purpose of the Worker’s Health and Safety Plan (WHSP) is to establish and maintain an effective health and safety management system. The WHSP will demonstrate the developer is committed to implementing a structured approach to workplace health and safety in order to achieve a consistently high standard of safety performance. The WHSP applies to all officers and workers and to other persons at risk from work carried out at workplaces.

The WHSP will assist in meeting its obligations in accordance with work health and safety legislation of Solomon Islands and comply with the requirements of the World Bank Group’s Environmental Health and Safety Guidelines (EHSG).

The WHSP will cover:

- Health and safety arrangements
 - Responsibilities
 - Communication arrangements (incl. important contact numbers)
 - Risk assessment
 - Risk register
- Inspections, training and reporting
 - Emergency procedures (link to emergency response and evacuation plan)
 - Hazard and injury reporting
 - First aid
 - Training and induction
 - Record keeping (incl. register, documents to be displayed etc)
- Health and safety requirements
 - Behavior (link to code of conduct)
 - Dangerous good and hazardous substances
 - Electrical safety
 - Plant and equipment
 - Incidents (slips, falls, trips)
 - Drugs and alcohol
 - Vehicles
 - Personal protective equipment.

13.3.2.10 P-9 Workers Code of Conduct

The project developer and construction contractors will be expected, in advance of any construction work commencing on the project, to prepare and promulgate a code of conduct for its workers (and related visitors), including locals, other Solomon Islanders, and immigrants/expats. Induction training should include a cultural induction, delivered with the help of local knowledgeable elders.

The project developer and construction contractors will be expected, in advance of any construction work commencing on the project, to promulgate this code of conduct for its workers (and related visitors), including locals, other Solomon Islanders, and

immigrants/expats. Induction training shall include a cultural induction, delivered with the help of local knowledgeable elders.

The following is the code of conduct:

- Prior to entering a village or hamlet for the first time, the Chief, a leader from a church, or the head of a family (usually the father) shall be met for the construction contractor to show their respect.
- All workers must always consult the Chiefs, and community leaders (such as a church pastor or an elder) about any issues that may not be clear in the local culture
- If no male members of the community are present, the outsider/visitor must not enter and talk to women, especially young girls and married women. This will help avoid any unnecessary arguments arising between a man and his wife or parents with their daughters.
- When talking or shaking hands with someone (whether a man or woman) do not look straight at them in the eyes or press their hands strongly because to some it is disrespectful, shameful or could mean something different.
- Custom requires that visitors who enter a village are suitably attired. In particular, all genders should wear clothes that cover thighs.
- Do not criticize someone openly but always call the person aside and talk to him or her separately to avoid any ill feelings. Such incidents may even escalate to a stage where other relatives may become involved.
- Saturdays and Sundays are days when some people in the communities go to Church. The Human Resources and Labour Management Plan shall provide workers the right to take one or both of these days off as required for their religious observance. Death and funerals are also times when work and other activities stop in the community. Always seek advice and clearance from the Chiefs or community leaders in such cases whether work should continue on or temporarily stop.
- No alcohol or any form of drugs shall be consumed in the communities by any project employees. The contractor/developer should have and enforce an alcohol and drug-free policy (in the work place, while driving vehicles, or use of the access roads). The company policy should develop a position on the use of betel nut in the workplace.
- All employees should respect the local custom or culture of the people. For example one must always ask before taking any produce growing in the area, such as bananas, kumara, cassava/root crops, nuts, fruits from trees, and coconuts etc. There is always someone in the community who owns them. Picking something without asking first is regarded as disrespect for the owner, or stealing, and may require payment of compensation to the owner.
- Workers and visitors should not make any disrespectful gestures or use any swearing words to anyone either in the community, or along the access road, especially to women or coworkers in the company workforce. These may lead to demand for compensation fees from communities.
- No unlicensed person shall drive work vehicles. Drivers shall be tested prior to starting work on the project, and have a valid license.
- Construction company vehicles or trucks shall not be permitted to pick up anyone who is not an employee of the Project, except in case of an emergency.

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- Heavy machinery shall only be operated by those who have the license and proven skills to use those types of machines. This shall be embedded in the recruitment and other policies of the contractor/s. This will help avoid health and safety problems and the unnecessary destruction of property, resources, and tambu sites.
 - Workers and visitors shall drive slowly when passing villages that are very close to the access roadside or a pedestrian walking along the side of the road.
 - Drivers and passengers shall watch out for domesticated animals or people crossing the access road.
 - Take Prior Consultation, Careful Listening, and Paying Respect (PC-CL-PR) seriously because they are the key to avoiding conflict. Incidents can easily escalate into company/community conflicts.

13.3.2.11 P-10 Community Health and Disease Vector Management Plan

The purpose of the Community Health and Disease Vector Management Plan (CHDVMP) is twofold; firstly it is to protect the health, safety and well-being of the communities within the project area; and secondly it is to control disease vectors and pests namely mosquitoes and vermin.

The CHDVMP will cover:

- Community health and safety
 - Health and safety impacts
 - Communicable diseases (incl. sexually transmitted infections and HIV/AIDS)
 - In-migration (links with the IMP)
 - Non communicable diseases due to changes to lifestyle leading to chronic conditions
 - Nutrition related diseases
 - Food security
 - Increased pressure on health care services
 - Site access and security (links with the SMP)
 - Management and mitigation measures
 - Approved service providers delivering awareness and prevention
 - Public awareness and prevention (link with SECP)
- Disease vector management
 - Identify vectors, species and diseases
 - Methods to control vectors of disease
 - Identify triggers for treatments and types of treatment options
 - Review methods of vector management
 - Working with Ministry of Health
 - Increasing public awareness (links with SECP)

13.3.2.12 P-11 Traffic Management Plan

The traffic management plan (TMP) describes how the developer proposes to safely manage vehicular and pedestrian traffic during the preparation and construction phases of the project. The safety of road users and the effective management of traffic to and around the site is paramount to the successful day-to-day activities during the construction phase of the project.

The purpose of the TMP is to describe how the developer will implement the work in accordance with the requirements of the contract, specifications and ESMP requirements, in addition to meeting national laws and regulations in respect of traffic safety.

Traffic accidents, minor or major, will have significant consequences and must be managed carefully.

The TMP will cover:

- Key traffic management and safety issues (incl. safety and amenity of road users and on-site)
- Traffic management responsibilities
- Access road upgrading and new site road construction
- Traffic control plans
- Managing construction vehicle movement
- Traffic and road user delay management
- Traffic flow arrangements and control
- Traffic control devices
- Traffic controllers, plant and equipment
- Information and awareness (links with SECP)
- Emergency response, including immediate and culturally appropriate responses to any traffic accidents. The plan should include clear processes for dealing with any accidents and the support to be provided for any impacts on persons or property (links with WHSP and SPERP).

13.3.2.13 P-12 Waste Management Plan and Point Source Pollution

The waste management plan (WMP) will provide guidance on waste management in relation to construction activities and to understand what excess materials are likely to be generated and then focus on how the generation of those excess materials can either be avoided.

The WMP will cover:

- Waste streams - likely to be generated (by type and condition) and estimates of the approximate amounts of material (by type and condition)
- Waste management options with a focus on waste avoidance/reduction
- Management of concrete wash water
- Opportunities to recycle and reuse
- On-site management – segregation of wastes, selection of disposal sites and methods, how the waste management system will work on-site, including bin placement and access
- Off-site management – selection of third-party waste management contractor who will provide services for the waste streams generated and data on waste/recycling generation
- Transportation

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- Responsibilities – identification of those involved in relation to construction activities and WMP
 - Monitoring and evaluation.

13.3.2.14 P- 13 Hazardous Materials Management Plan

The hazardous materials management plan (HMMP) is to describe the procedures for storing, using, managing, and disposing of hazardous materials in a safe manner. The HMMP will describe the requirements under national laws and standards, EHSG, and international codes for hazardous materials.

The HMMP will cover:

- National laws and regulations and international best practice requirements
- Hazardous materials inventory including:
 - Summary of storage and usage of chemicals and materials
 - Hazard class of chemical and material
 - Volume/amount of each hazard class and the container
 - Maximum allowable quantity (MAQ)
 - How the chemical/materials is to be used and stored (incl. labeling)
- Identification of risk associated with hazardous chemicals and materials
- Facility description and site plan that illustrates all buildings, roads, yards, outdoor chemical storage, sewers, wells, rivers and streams, and adjacent villages
- Facility storage map that shows the location of:
 - All hazardous materials
 - All storage areas
 - Emergency equipment and exits
 - Evacuation points
 - Spot where designated individual will meet emergency personnel
 - All tanks/sumps/ piping
- Accidental exposure measures
- Emergency response (links with WHSP and SPERP)
- Recording and reporting incidents.

13.3.2.15 P-14 Spill Prevention and Emergency Response Plan

The purpose of the spill prevention and emergency response plan (SPERP) is to: (i) develop a proactive hazard identification system so as to prevent (or lower the likelihood) of spill events; (ii) establish the prevention measures and response process and responsibilities for managing these situations; and (iii) establish emergency response procedures.

The SPERP will set out the requirements for management of unplanned spills of dangerous or hazardous materials during the project including spillages of: hydrocarbons (including diesel,

petrol, greases, oils and other lubricants); drilling chemicals; hazardous chemicals; and, waste water, including sewage.

The SPERP will cover:

- Spill Prevention and Response
 - National laws and regulations and international best practice requirements
 - Spill response and containment strategies and capabilities
 - Framework for reducing the potential for spills
 - Sources of potential land contamination associated with construction
 - Sources of potential pollution of streams and rivers associated with construction
 - Categorize potential spill hazards
 - Training
 - Measures and process for rapid and efficient response to and manage hazardous material spills
 - Identify and document management measures to prevent, control and mitigate spill events
 - Responsibilities for implementing the management measures
 - Verification and monitoring and reporting measures
 - Monitoring operations to confirm that preventative measures are in place and followed

- Emergency Response
 - Approach to emergency planning
 - Potential threats and emergencies (fire, landslide, tunnel collapse, earthquake, tsunami and medical emergencies)
 - Incidents and emergencies
 - Evacuation procedures (including drills)
 - Communication protocols
 - Emergency control structures
 - Personnel and warden teams
 - Checklists and logs
 - Post-incident review procedures.

13.3.2.16 P-15 Air Quality Management and Dust Control Plan

The purpose of the air quality management and dust control plan (AQMDCP) is to minimize: greenhouse gas (GHG) emissions resulting from construction activities; impacts of dust generated due to the construction works; impacts of dust generated during transport of materials and other traffic; and, complaints from the community in relation to dust generated from construction activities.

The AQMDCP will cover:

- National laws and regulations and international best practice requirements
- Air quality baseline and existing environment
- Location and type of sensitive receptors
- Criteria and performance standards
- Identification of plant and activities that generate emissions
- Identification of plant and activities that generate dust

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- Management, mitigation and control measures
 - Water spraying schedule
 - Monitoring and reporting.

13.3.2.17 C-1 Cultural Heritage Management Plan

This ESIA identifies that cultural heritage sites may be adversely affected by the project, including Tambu Sites. The Developer will carry out a detailed assessment of physical cultural resources before construction work commences.

A Cultural Heritage Management Plan (CHMP) will be prepared for the TRHDP. The objective of the plan is to identify cultural heritage sites that may be impacted by project construction and operation, to protect sites where possible, and to provide culturally appropriate compensation to land owning groups associated with sites where avoidance is not possible. Further information to inform this plan is set out in Annex 18.

The Plan will identify sites that will require preservation, or excavation and relocation where appropriate, and the steps to be taken, timing, and responsibility for carrying out these measures. These activities will be undertaken in conjunction with authorities of the Ministry of Culture, and the National Museum. Additional physical and cultural resources (chance finds) may be encountered during construction. SPC/HEC will develop Chance Find Procedures (refer to Annex 18) that identify what measures will be taken to protect these cultural resources. The Plan will also address measures to monitor any physical cultural sites that may be affected by on-going operation of the TRHDP.

The CHMP will be in place two months prior to the commencement of construction works involving land clearing and grubbing, or other land disturbing activities. This includes access roads, and main project site(s).

The SPC/EPC Contractor will be responsible for the preparation and implementation of the Plan, which will be reviewed by the TRHDP PO and the Ministry of Culture, and the National Museum.

The CHMP will identify measures to be followed for both the construction and operation phases of the Project.

Chance Find Procedure. For unknown Tambu sites, the following procedure specify how the construction contractor will act if a site is discovered. This process shall be subject to consultation with the five identified landowning tribes:

- first work will stop,
- the relevant previous customary land owning tribe (pre SIG land acquisition) to be identified,
- a scientific examination and/or cultural rituals performed and compensation agreement shall take place (in case of destruction),
- additional actions shall be carried out to protect the rest of the site if the tambu is to be preserved (fencing the site).

Cultural Heritage Management Plan. The following is provided by way of guidance in the preparation of the CHMP by the future TRHDP developer and contractor/s.

- i. First, talk with the members of the Landowners Core Group (LCG – the representatives of the landowners of the “core” project area) concerning the need to identify someone among them who has the knowledge of any tambu site(s) and their location(s) in the Project Impacted area(s).
- ii. An expert with experience in recording the information associated with the tambu sites should be deployed from within or outside of the LCG to assist the knowledgeable person(s) they have identified and selected.
- iii. Such knowledgeable and experience persons must be approved by the representatives from the LCG prior to involving them in this task.
- iv. After the known tambu sites within the Project Impacted areas have been identified and the data collected and recorded, it must be stated clearly whether they will be completely or partly destroyed or only disturbed during the construction work on the Project.
- v. It is of paramount importance that any tambu sites that are certain to be completely or partly destroyed should be prioritized for documentation while those that may be only disturbed could be clearly marked by using red and white painted posts erected around them to show that they are tambu sites and to be avoided. Where cultural sensitivities exist to the publicizing of a tambu site, alternate ways of bringing the site to the attention of workers will be adopted.
- vi. Any tambu sites located within the construction areas that the LCG really feels should not be destroyed should be demarcated with fence, and worked around where possible. This will help avoid any disagreements or demands for huge compensation payments which might delay the construction programme.
- vii. Any decisions or agreements to move, relocate, or destroy any sacred objects from tambu sites must come either from the LCG or the heritage protection expert. This should be done before the construction work on the Project starts.
- viii. For unknown tambu sites, it is important that, prior to construction, a clear understanding is reached and recorded (in the form of an accidental discovery protocol) between the LCG and the contractor. This should specify how a contractor will act if a site is discovered, e.g., work will stop, the nominated LCG representative contacted (if not already on site supervising the work), the site owner identified, a scientific examination and/or cultural rituals performed, and any additional actions carried out to protect the rest of the site if required.
- ix. The current compensation rates for disturbance or damage to tambu sites depend on the significance of the site, scale of destruction, and the distances between the sites and where the construction work is being carried out. Logging, and to a lesser extent mining agreements, can provide indicative national rates. An example of such compensation rates is provided in Table 13-3. Rates should be discussed with the National Museum.

Table 13-3 Costs associated with compensation for Tambu site destruction

Destruction or Disturbance of Tambu Sites	Compensation rates (Solomon Dollars)
Major Scale	\$50,000
Minor Scale	\$20,000
Disturbances:	
50 meters from Sites	\$10,000
100 meters from Sites	\$15,000

Graves in Cemetery (per grave)	\$10,000
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Note that disturbances are caused when trees fall into nearby tambu sites, and machines or employees pass through these sites during construction work even though they might not cause any physical damage to them.

13.3.2.18 C-2 UXO Management Plan

Regarding unexploded ordnance (UXO) management there is a chance that UXO, which is a historic remnant of WWII, may be found within the project area. A UXO Management Plan (UMP) shall be included as part of the stand-alone CESMP for the Project, the aim of which is to reduce the risk of interaction between workers/communities and UXO, and identify the procedures to follow in the event of a “chance” find.

Following finalization of the project layout, and prior to commencement of construction, the Royal Solomon Islands Police Force Explosives Ordnance Unit (RSIPF EOU) will be engaged to review the project layout, including access roads, temporary and permanent construction sites, and areas where project-related infrastructure is to be provided. The RSIPF EOU will, if necessary, carry out a site survey and, if UXO is encountered, clear the UXO, following best practices for protecting workers and the surrounding communities.

13.3.2.19 C-3 Forest Clearance Plan

The purpose of the forest clearance plan (FCP) is to clearly identify trees and vegetation to be removed by the project and trees and vegetation to be retained and protected. The FCP will be based on accurate and scaled maps and plans.

The FCP will cover:

- Demarcation of area on the ground (fencing etc)
- Identification of trees (incl. drip-lines) to be protected
- Site plans (showing cleared areas, protected trees, designated storage areas, areas to be cleared manually only etc)
- Methods (machinery and manual clearance)
- Notification to communities (links with SECP)
- Schedule of forest clearance activities (avoiding wet season as much as possible)
- On-going vegetation control measures
- Re-use (mulch) and cut-timber collection by locals
- Storage, transportation and disposal of cut timber
- Sanctions for felling trees beyond footprint
- Coordination with independent environmental expert
- Recording of clearance activities

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- Monitoring and reporting.

13.3.2.20 C-4 Post-construction rehabilitation and replanting plan

There will be two stages of rehabilitation, 1) upon the completion of the construction phase; and 2) upon the decommissioning of the hydropower facility. Rehabilitation at decommissioning will be covered by the Decommissioning Plan.

Toward the end of the construction phase, the developer will amend its Post-Construction Rehabilitation Plan. Amendments will detail how the construction contractor intends to carry out the following:

- Remove hazardous materials, hazardous materials storage facilities, and concrete production works;
- Remove other structures that are not required for operation, and which the TCLC does not wish retained on the site (e.g., work areas, work sheds and storage buildings) and which may become safety hazards;
- Test for soil and groundwater contamination at key sites, including fuel and lubricant storage facilities, machine shops and other locations where hazardous materials were stored and/or used;
- Remediation measures that may be required following testing, including removal of contaminated soil and spreading of clean topsoil, and treating contaminated groundwater; and
- Rehabilitate work areas by spreading clean topsoil over former temporary work sites and access roads. As previously noted, based on observations of disturbed sites within the project area, it appears that vegetation regeneration is vigorous in areas where topsoil has been retained. Weeds will likely invade some sites as long if natural regrowth of trees is delayed. According to preliminary assessment, rehabilitation will be necessary in the following areas:
 - Work areas, covering approximately 1.18ha;
 - Construction areas at the entrance to the headrace tunnel covering roughly 2ha; and
 - Temporary quarry access roads (approximately 1.5km long and 15m wide), covering roughly 2.25ha. The project intends to have most of the quarry sites to be within the reservoir and will be inundated by the reservoir

If one meter of topsoil is spread over these areas, the total amount of topsoil necessary for rehabilitation will be about 54,300m³. The total amount of topsoil to be stockpiled is estimated to be about 327,900 m³. Therefore, there will be an excess of soil to deal with. It is recommended that the site of the soil stockpiles be re-contoured using the excess soil and allowed to naturally re-vegetate.

On areas to be rehabilitated, soil should be spread no closer than 100m from any water body and be uniformly distributed to a thickness of 1m, and compacted. Sites where soil has recently been spread will be surrounded by deeply-anchored silt fences. Soils will not be spread during the rainy season., Silt fences will be removed after one year by a local contractor that has been contracted by the TRHDP PO.

Site restoration using native plant species will be undertaken in affected areas. Native vegetation species are expected to become quickly established if planted in good quality soils.

Since the two rock quarries are expected to be inundated by the reservoir they will not have to undergo rehabilitation. However, if other quarry sites are used that are outside of the reservoir area, a re-vegetation plan will be required as part of the Quarry Management Plan.

Temporary access roads, including those to the quarries, will be permanently decommissioned once construction of the Project has been completed, to avoid unnecessary human encroachment into the upstream Tina River catchment area. Road decommissioning will involve removing all stream crossings, breaking up the road surface (scarification), spreading topsoil to allow vegetation to regrow, and installing an earth mound at road entrance to prevent vehicle access. Significant cut areas along the road will be refilled with soil.

13.3.2.21 C-5 Quarry Management Plan

The developer shall prepare a Quarry Management Plan incorporating the following measures as appropriate. Some measures, including rehabilitation, will not be required for quarry sites located within the reservoir area.

- Water quality monitoring to be undertaken, including baseline monitoring before works commence. Water quality monitoring will be incorporated into the water quality monitoring plan and sediment transport monitoring plan;
- Fish and invertebrate monitoring to be undertaken, including baseline monitoring. This monitoring will be incorporated into the Aquatic Life Monitoring Plan;
- Maintain natural continuity of sediment transport through the river system by implementation of good international industry practice for river mining;
- Minimise impacts on riverbank and channel by maintaining a buffer zone either side of river banks to maintain their integrity. Channel not to be undermined by extracting from or below banks. Protect vulnerable banks and remedy erosion where apparent;
- Ensure trucks and industrial machinery are in proper working condition to minimise avoidable exhaust fumes
- Fuels, lubricants, coolants, waste oil and chemicals must be stored in an approved manner such as in drums or surface tanks with impervious bunds to contain spillage and located away from operating areas, natural or engineered drainage pathways, waterways and areas prone to flooding ;
- Minimise total disturbed area at any one time to reduce erosion potential and transfer of suspended solids to adjacent surface waters ; and
- Minimise areas exposed to vegetation removal (if any), and rehabilitate each disturbed area immediately after use.
- Detail measures to construct and rehabilitate quarry access roads, incorporating access road measures set out in 13.2.1.4.
- Where additional aggregate is purchased from a licenced gravel supplier, the supplier shall show:

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- Compliance with approval requirements under the *Environment Act*;
 - Compliance with applicable licensing requirements under the *Mines and Minerals Act* ;

The SPC and EPC Contractor will be responsible for ensuring that third party suppliers comply with the Quarry Management Plan.

13.3.2.22 C-6 Reservoir Preparation Plan

The Reservoir Preparation Plan will describe the types of vegetation to be cleared, the extent of removal to be achieved, methods of clearing, methods and arrangements for use or disposal of cleared biomass, and arrangements for plan implementation including opportunities for local community members and small businesses to benefit from contracts and timber.

13.3.2.23 C-11 Drill and Blast Management Plan

In addition to addressing technical and worker and community safety issues, the plan will include measures prepared in conjunction with the Noise and Vibration Management Plan to minimize adverse impacts on local fauna. Plan preparation will include modelling of noise levels at various distances from blasting locations and a review of literature to identify noise levels likely to disturb wildlife.

13.3.2.24 O-1 Operations Environmental Social Management Plan

The OESMP will set out the detailed management of all environment and social measures during the period of operations. See also section 13.11. The SPC, together with the O&M Contractor, shall prepare a framework for the OESMP to be submitted to the PO for review and approval prior to the preparation of the plan.

13.3.2.25 O-2 Reservoir Operation and Management Plan

This plan will cover the environmental aspects of reservoir management, including options to establish a reservoir fishery (natural development versus stocking), to prevent arrival of invasive species, and to monitor fishery status. It will also address water quality; it will be linked to the Reservoir Preparation Plan and will provide predictions of water quality in the reservoir, identify potential impacts on water quality in the river downstream, describe real-time monitoring techniques to detect deterioration in quality that could result in adverse downstream impacts, and propose remedial actions.

13.3.2.26 D-1 Project Decommissioning Plan

Although it is expected that the TRHDP will operate for many decades, there may come a time when the facility is no longer required. In the run-up to that time, a dam closure plan will be prepared by the operator and submitted to the Ministry of Environment (MECDMM) for approval. A new ESIA will be prepared at that time by the operator. Information that will be required in a decommissioning plan includes:

- Detailed engineering design dealing with:

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- Relocation and/or stabilization of nearby structures prior to decommissioning (e.g., access roads, bridges, etc.);
 - Site access requirements (e.g., access roads), temporary easements, construction staging and lay down areas;
 - Method for dewatering the reservoir and restoring flows to the by-passed section of the river;
 - Method for demolishing the dam and removal of concrete and metal debris;
 - Material testing for safe disposal and identification of locations for off-site disposal; and
 - River channel improvement works, including natural channel design (bio-engineering techniques), especially within the former reservoir reach.
- Regulatory permits, including a new ESIA which will focus on the following:
- Environmental impact assessment:
 - Fish surveys in the reservoir;
 - Invasive plant species survey in the reservoir;
 - Identification of impacts from the sudden release of fish and plant species adapted to lentic environment downstream into the river;
 - Water quality monitoring, including stages of stratification in the reservoir and downstream impacts of releasing sudden deoxygenated water.
 - Bathymetry mapping to assist in determining thickness of accumulated sediments in the reservoir;
 - Characterization of accumulated sediments both above and below the dam (granulometry, volume, presence of pollutants);
 - Estimation of the duration of natural flushing to achieve a sediment distribution pattern similar to pre-dam conditions.; and
 - Assessment of impacts on the Tina River's geomorphology; and
 - Mitigation measures for demolition methods based on staged release of sediments; and
 - Assessment of impacts on the mouth of the river.
 - Socio economic impact assessment:
 - Consultation with riparian communities ;
 - Description of users and uses of the modified Tina River environment (i.e., reservoir, and 5.7km by-passed section of river below the dam);
 - Economic impacts of sudden changes in the dam area and economic impacts of sediment releases on downstream communities;
 - Description of settlements on the right bank of the Tina River that had become dependent on the by-passed river reach for easy crossing to the left bank; and
 - Fate of the Core Area post-project monitoring:
 - Water quality monitoring;
 - Long-term monitoring of sediment distribution patterns and river geomorphology; and
 - Long-term monitoring of socio economic modifications.

13.4 MONITORING ACTIVITIES

13.4.1 Measures for Ensuring Environmental and Social Monitoring Implementation

Measures will be put in place to ensure that environmental and social mitigation and monitoring is implemented and communicated with stakeholders. Mitigation measures will be monitored by an environmental and social safeguards management specialist engaged by the SPC (SPC ESS Specialist), and audited by an environmental and social safeguards specialist engaged by the Project Office (PO ESS Specialist).

- Both specialists shall have extensive experience in issues and impacts related to the Project such as aquatic ecology, water quality, etc.
- The SPC ESS Specialist will ensure that all general mitigation measures are implemented especially those that apply to the construction contractor and health and safety.
- The following reports/plans shall be prepared by the Developer (with the assistance of the SPC ESS Specialist). All reports will be submitted to the PO for review with support of PO ESS Specialist:
 - Recruitment policy(ies) of the Developer (part of the Human Resources and Labour Management Plan)
 - Worker's Health and Safety Plan of the construction contractor as well as data on accident and injuries. Minutes of meeting of various trainings to workers
 - CESMP and OESMP
 - Reports from the Community Liaison Committees
 - Minutes of meetings on the educational programme about modern day dam engineering and other sensitization trainings
 - Reports of STD awareness training
 - Report on protection of sensitive habitats prior to construction
 - Data on water quality, bed load and sediment model, environmental flows in the by-passed section and flows through the powerstation
 - Reports on aquaculture results and any fishery monitoring
 - Report of the soil expert regarding topsoil stripping and stockpiling.
- The PO ESS Specialist will:
 - assess compliance of SPC with ESMP and management plans throughout the lifespan of the Project;
 - report to the PO and support the PO and MECDM in ensuring SPC compliance; and
 - build MECDM capacity to monitor compliance during operations.
- It is required that the PO ESS Specialist be present 3 times a year to audit measure implementation as well as consult with other actors of the ESMP. During each mission, the specialist will produce a report to the attention of the Developer and its subcontractors to inform them of non-compliances. The PO ESS Specialist will work with the SPC ESS Specialist to ensure that corrective measures are implemented. The role of PO ESS Specialist is expected to be undertaken by an independent NGO or firm.

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- It is expected that the SPC ESS Specialist will be a full time role during the period of construction.
 - The tasks of the Developer ESS Specialist and the PO ESS Specialist are to be described in detail in sub plans.

In addition to these monitoring and auditing roles, it is anticipated that the EPC contractor will appoint a safeguards specialist as part of their key personnel to oversee the implementation of construction mitigation measures.

13.4.2 Monitoring Plans

Environmental monitoring will be undertaken in accordance with the ESMP and supporting Environmental and Social Action Plans (ESAPs), the LALRP, and good international industry practice for preparing and implementing management plans.

The Developer will develop monitoring plans for each key area including:

- Construction Works Monitoring Plan
- Air Quality and Noise Monitoring Plan
- Social Impacts Monitoring Plan
- Sediment Transport Monitoring Plan
- Water Quality Monitoring Plan
- Aquatic Life Monitoring Plan
- Flora and Fauna Monitoring Plan

Each monitoring plan will identify the parameter being monitored, how it will be monitored, how frequently and who will be responsible for monitoring.

Monitoring plan frameworks for a number of plans are set out below.

13.4.3 Monitoring Plan Frameworks

13.4.3.1 M-1 Suspended Sediments Monitoring

Water quality during construction is a central issue for local communities (see social impact) and communication with stakeholders regarding water quality is important. A typical indicator of water quality is TSS, as this parameter is the main element that will change during construction. This section presents how TSS should be monitored.

The Tina/Ngalimbiu River exhibits natural peaks in TSS during heavy rains/fast flood events, with direct impacts on water uses by riparian communities (subsistence fishing by sight, clothes washing, water consumption).

During the planned 3-year construction period, the river is assumed to be exposed to accentuated peaks of TSS, due to sediment-laden run-off from cleared areas and works within the river bed. This extra-load of TSS might represent a significant inconvenience for riparian populations.

It is recommended that TRHDP collect regular TSS data on the natural suspended sediment load and to monitor TSS during construction,

Besides being a good indicator of water quality, monitoring TSS at a location immediately upstream of the damsite and reservoir, it will be useful as a means of estimating the rate of siltation of the reservoir. Monitoring TSS downstream of the damsite will provide reliable data about TSS peaks, information that may prove useful if disputes arise with communities over what are natural versus project caused increases in turbidity..

This type of monitoring was undertaken in Tahiti, where construction of new dam and emptying/mucking out operations of existing reservoirs was a source of conflict with downstream populations.

Notwithstanding that TRHDP may undertake regular monitoring of TSS, this should not be used as an excuse to abandon or relax measures to control the release of sediment laden runoff from disturbed areas or worksites

The objective of monitoring TSS is to determine the load of suspended solids in the Tina/Ngalimbiu River over a long period, through regular monitoring of TSS during peak river flows prior to, and during, construction.

Monitoring should begin one month before construction work begins and continue until the work is completed.

The following protocols should be implemented:

- Water samples / measurements should be made at four stations: (i) upstream of the reservoir; (ii) immediately downstream of the toe of the dam; (iii) at Horohutu or Valekotcha, approximately 10km downstream of the dam; and (iv) at Ngalimbiu bridge, approximately 20km downstream of the dam.
- The samples / measurements should be done at least once a week on a fixed day. Additional sampling should be conducted during floods.
- TSS will be analyzed at SIWA laboratory. Turbidity will be measured using a turbidity probe. For each sampling event, a blank sample will be taken to assess the laboratory accuracy.

The results will be treated as follows:

- Correlation between TSS and turbidity.
- Correlation between suspended solids and flow measured at the gauging station.
- Comparison of peaks of suspended solids during construction work with those observed in natural conditions.
- Commented results will be made available to stakeholders (e.g., on the project website) or by mean of regular environmental reports.

Since the Tina River has natural peaks of TSS during flash floods, trigger values should not be used to describe thresholds where specific measures need to be implemented. Rather, a comparison should be made between pre-construction and construction conditions, as an important indicator of the efficiency of sediment control structures, such as silt fences and settling ponds. The efficiency of sediment trapping structures will be monitored throughout construction, to ensure that peaks in TSS do not originate from sediment erosion associated with work being conducted on land.

Monitoring should begin at least one month prior to commencing construction and continue at least two months after reservoir inundation and commencement of dam operation.

Several stakeholders should be involved in putting into practice the monitoring program:

- Local environmental specialist under the direct responsibility of TRHPD - or construction contractor (sampling / measurements)
- SIWA Water quality laboratory (analysis).

13.4.3.2 M-2 Water Quality Monitoring

In addition to applying GIIP, construction environmental management and water quality monitoring will be necessary.

Throughout the 3-year construction period and initial reservoir impoundment a constant concern of TRHPD will be: (i) to ensure implementation of the environmental and social management plan (ESMP), and the associated health, safety and environment (HSE) policies, and environmental management system (EMS), standards and national regulations; and (ii) to follow-up on environmental impacts and to adapt mitigation measures or implement new ones as necessary.

The construction environmental supervision and monitoring activities will be undertaken by an independent environmental monitor.

During construction of the dam, when the risk of water quality alteration is highest, a program of water quality monitoring will be undertaken to assess key parameters.

Water quality monitoring during construction and impoundment will include communication of results to stakeholders in an appropriate form. Besides monitoring of TSS (see Section 13.4.1.1 – Suspended Sediment Monitoring), daily water quality monitoring of the Tina/Ngalimbiu River will be undertaken for key parameters shown in Table 13-1.

During operation, monitoring will be undertaken at the environmental flow outlet of the dam, in the by-passed river reach (i.e., upstream of the powerhouse), and downstream of the powerhouse, for the key pollution indices shown in Table 13-1. Monitoring will be conducted weekly for the first 2 to 3 months following commissioning, then quarterly for the first year, followed by annually when annual testing is conducted of the project electro-mechanical systems. Trigger values (threshold values for health and biodiversity protection) will include:

- ANZECC Water Quality Guidelines for tropical Australia, for upland or lowland rivers for parameters that can affect aquatic life; and
- Australian Drinking Water Guidelines (ADWG), or World Health Organization (WHO) guidelines for potable water, for parameters that can affect domestic use.

Table 13-4 Key water quality parameters

Construction phase water quality parameters	Operation phase water quality parameters	Reference	Trigger values (or range of acceptable values)
Temperature	Temperature	-	-

pH	pH	ADWG	6.5-8.5
		ANZECC	6.4-7.9
Conductivity	Conductivity	ANZECC	20-250 uS/cm
Dissolved oxygen	Dissolved oxygen	ANZECC	> 6 ppm
Oil and grease	Oil and grease		Any detection is a sign of spills
Nutrients NH ₄ -N	Nutrients NH ₄ -N	ANZECC	< 0.006 mg/L
Nutrients NO ₃ -N	Nutrients NO ₃ -N	WHO	< 10mg/L
Nutrient P _{tot}	Nutrient P _{tot}	ANZECC	< 0.01mg/L
Fecal contamination : Ecoli		WHO	0 MPN
Fecal contamination : total coliforms		WHO	< 10 MPN

Environmental management and monitoring of the construction works and operation of facilities will facilitate minimal environmental impacts and risks, under a continuous supervision.

Some pollution of the river is anticipated if GIIP are not followed during construction. If monitoring determines that trigger values have been reached, the root cause will be determined (e.g., release of sewage, concrete leachate, fuel / oil, spoils, or other contaminants), and procedures will be refined to prevent future occurrences.

Water quality results will be disclosed to local villagers. The construction contractor will implement an alarm system in case of oil/concrete/dangerous substance spill. This includes alerting local villages along the Tina River., An emergency warning system will be used in the event of a dangerous spill to alert downstream communities in the event of a spill of a hazardous material into the river (e.g., fuel / oil, concrete leachate, or other hazardous substance), without first waiting for laboratory results to confirm the risk posed by the spill.

During construction, regular environmental monitoring and supervision of impacts and activities, with regular assessment reports will be undertaken on a daily basis. Monitoring of nutrient parameters will be carried out on a monthly basis. Regular (weekly) monitoring will be carried out for the first 2 to 3 months after the project has been commissioned and is operational. Quarterly monitoring will be undertaken for the first year of operation and then reduce to annual monitoring to coincide with annual inspections of the dam and powerhouse systems.

Several stakeholders will be involved in the monitoring program as follows:

- Water quality laboratory (water quality analysis reports);
- TRHDP and / or construction contractor environmental management and monitoring staff (self monitoring and auditing); and
- Local environmental authorities (compliance auditing).

Aside from very limited sand and gravel extraction for personal or village use in communities upstream of the Tina and Toni rivers, there is little anthropogenic disturbance (e.g., no gold placer mining, no major sources of TSS, no agriculture activities, or other enterprises) that could presently affect the rivers. Therefore, heavy metals such as mercury, arsenic, cadmium that are associated with industrial mineral processing, or agricultural pesticides, are unlikely to be a pre-project water quality issue. However, it is probable that the downstream reach of the Ngalimbiu River experiences fertilizer and pesticide pollution introduced from waters that drain adjacent oil palm plantations. Therefore, it is strongly recommended to conduct a single sampling of water, sediment and fish flesh to test for these pollutants in the river system prior to construction of TRHDP. National laboratories do not have the capacity to analyse such sources of pollution. Samples could be sent to Brisbane, Australia.

The following potential contaminants will not be generated by the Project. However to ensure proper cover in the event of complaints from downstream communities, these parameters should be analyzed as par of a single monitoring event prior to construction:

- Pesticides such as Glyphosate CT, Basta, 2-4-D Amine, Ally (Metsulfuron Methyl), Kamba 500 Selective herbicide (present as the dimethylamine salt). Gramoxone Tropical (Paraquat) in the Ngalimbiu River system. These sources of pollution are suspected from oil palm plantations.
- Metals such as Cyanide, Nickel, Aluminium, Copper, Arsenic, Cadmium, Lead, Cobalt, Mercury, Silver, Copper, Lead and Zinc in water and sediment. These are the common sources of pollution from the mining industry.
- Bioaccumulated metals in fish flesh related to mining activities for the following metals: Silver, Arsenic, Cadmium, Cobalt, Copper, Mercury, Lead and Zinc.

The sample site for pesticides should be located downstream in the Ngalimbiu River reach, and the sample site for metals should be located on the Tina River. If any of the metal parameters exceed detection levels on the Tina River, additional samples will be collected and analysed. Pesticides are expected to be found in Ngalimbiu River samples. In addition to these measures, wastewater from the cement plant will not be directed to any water body. Rather, it will be collected and treated.

13.4.3.3 M-3 Fish, Algae and Macro-invertebrate Monitoring

The Tina River is a relatively pristine, low nutrient watercourse originating from bedrock-controlled substrate in the undisturbed montane forests found on the higher elevation slopes of Guadalcanal. Lower trophic level aquatic organisms, such as algae and macro-invertebrate species support many of the fish species found within the Tina River. Species assemblages and populations can be used as an index of aquatic ecological health.

This fish monitoring plan is to frequently monitor the physical changes of the Tina River during and after the construction of the hydro electrical system. This is to conduct a long term water shed health monitoring in the Tina River reaches and its tributaries over time.

Field studies conducted in support of the ESIA involved only limited sampling of aquatic macro-invertebrates, primarily aquatic dependent insect species, mostly in their emergent adult forms. In the interest of monitoring potential impacts of TRHDP construction and operation on the health of the aquatic habitat, TRHDP will implement a program of algae and macro-invertebrate monitoring. Baseline algae and macro-invertebrate data collection will be undertaken pre-construction during a typical low flow period, when it is safe to enter the river to collect samples. Periodic algae and macro-invertebrate sampling will be subsequently carried out to measure potential changes to these lower trophic levels that may result from construction and operation

of the Project. At least one station will be located upstream of the reservoir, to be used to determine whether the project is having any impact on the aquatic ecosystem there.

The monitoring plan shall:

1. Review and understand the terrain, river and hydrology of Tina River through the series of respective studies especially the hydrology, fish and fisheries and water quality. gather information from relevant stakeholders and plan for specific indicators for aquatic health. In this area, the expert will do and formulate baseline data of the area and the gaps that may be considered during monitoring.
2. Identify sampling locations. It is proposed to have at least eight consistent sample stations in the Tina, Toni and Ngalimbiu areas. This should include 2 sample stations on the Toni River, 4 sample stations on the Tina River and 2 sample stations on the Ngalimbiu river, including one station in the river mouth to monitor the commercial fishing area. Sample stations are to be homogenous to allow consistent monitoring over time. Sample stations should be reference by either human features (e.g. roads, barriers) or any natural attributes due to changes of stream physical changes. Baseline data should be collected for each sampling station.
3. Identify parameters to be tested and observed
4. Formulate schedules of tests/sampling dates
5. Data collection tools
 - Field data sheets
 - Hand-held GPS
 - Waders
 - Digital camera
6. Reporting framework and policy in the case of emergency declarations

Stakeholders are to be involved in the process with proper awareness of the results analysed during the monitoring.

13.4.3.4 M-5 Flora and Fauna Monitoring Plan

The flora and fauna plan will include monitoring of invasive plant and animal species, e.g., Water Hyacinth to assess its presence in the reservoir and to ensure quick response in case it becomes established. This monitoring will be done twice each year and will include surveys of the entire reservoir. In the event that Water Hyacinth does become established in the reservoir, immediate removal of the plant and its roots will be carried out to limit the ability for it to propagate further.

13.5 PROTECTION OF THE TINA RIVER UPPER CATCHMENT

The protection of the upper Tina River catchment has the potential to create one of the largest terrestrial protected areas in Solomon Islands, providing conservation support to a key portion of the cloud forests of Guadalcanal identified as habitat Key Biodiversity Area by the IUCN and Bird Life International. Protection could bring potential benefits to the ecosystem, the landowners and the wider community.

As customary land owned by a number of indigenous tribes, the protection of the catchment depends upon the leadership and support of the indigenous landowners. Appendix K provides an outline of (a) the legal process for according protected status to customary land – a process that is landowner driven; (b) actions that have already been taken by the Project to promote the protection of the area, including the support of the University of South Pacific’s ‘Islands in the Sky’ biodiversity expedition; and (c) a framework of the stages needed to promote and facilitate protection.

As a component of project financing SIG will fund an NGO within a year of receipt of funds to consult with landowners and communities and to conduct studies towards the creation and management of a protected area. Also as a component of the first stage of establishing a protected area, SIG will work with the Developer to monitor and report on changes in forest cover using satellite imagery, and to monitor trends in logging truck traffic into and out of the catchment through existing logging roads.

The Biodiversity Management Plan will also incorporate measures for the Project Company and Tina Core Land Company (TCLC) to restrict vehicular access to the catchment through the Project’s access road.

13.6 COMMUNITY BENEFIT SHARE

TRHDO PO is preparing a benefits sharing package for the host communities of Malango and Bahomea.

The Community Benefit Share is proposed as two components, a construction period pilot scheme and an ongoing sustainable

13.6.1 Construction period Community Benefit Share Pilot

To prepare the community for the benefit share arrangement, the TRHDP and the World Bank propose to pilot a project with financing from the Japanese Social Development Fund (JSDF). MMERE through the TRHDP PO, is in the process of applying for US\$ 2.8 million (approximately SB\$22.6 million) to “*establish the institutional arrangements and capacity for affected communities to effectively manage benefit sharing revenues from the Tina River Hydropower Development Project and improve their basic services and economic opportunities*”.

The fund is proposed to provide pre-operation community infrastructures such as water supply and electricity access, as well as training for jobs during construction. The JSDF is intended to provide community benefits from the project before the power scheme becomes operational.

This pilot stage will design and establish the detailed operational arrangements and build capacity for the ongoing community benefit share fund (post operation). It will also facilitate the following three sub-projects:

- Electricity distribution to identified communities in the Bahomea and Malango Area;
- Provision of pre-employment training to members of the Bahomea and Malango Area; and

-
- Water supplies for identified communities.

13.6.2 Operational Period Community Benefit Share Fund

The structure of the ongoing benefit sharing package is not yet finalised. This will be completed as part of the overall financial structure of the Project in 2017. The flow of finances from the benefit sharing scheme will be associated with the flow of funds under the Power Purchase Agreement, but the precise methodology has yet to be agreed. The magnitude of funds will be calibrated so as to enable investments in community development that will result in significant impacts.

The internal management of the benefit sharing fund, and its formal objective, will be designed in partnership with the community under the Community Benefit Share Pilot project. The fund is intended to focus on community benefits and services and is not intended to incorporate cash payments. Early consultations suggest that some key objectives of the fund may include:

- Permanent provision of reliable clean water supplies;
- Provision of sanitation and drainage facilities with improved water supplies;
- Provision of better quality, more accessible education for the young people of this community;
- Implementation of in-village and residential training for local youth in technical skills;
- Improvement of access to health services, especially for women and children;
- Skills based training for women and utilisation of women's centres; and
- Development of ecotourism opportunities in the Central Guadalcanal area, involving people of Malango ward.

13.7 LAND ACQUISITION AND LIVELIHOOD RESTORATION PLAN (LALRP)

13.7.1 Rationale for Preparing a LALRP

The land required for the TRHPD was identified at the end of the feasibility Study. It was an objective of Solomon Islands Government (SIG) to ensure that only the minimum amount of land reasonably necessary to enable the project to proceed would be acquired from the indigenous owners. It was also an objective of the SIG that there be "No Loss". That is, that none of the indigenous peoples affected by the Project would be worse off as a result of its construction and operation.

World Bank Environmental and Social Safeguard Policies require that where a project undertaken by a Client of the Bank involves World Bank funding, the Operating Procedures (OP) must be followed. In the case of the acquisition of the project land, OP 4.10 (Involuntary Resettlement) and OP4.12 (Indigenous Peoples) were identified as relevant Safeguards against which the Project needed to comply.

A usual consequence of these two safeguards would be the preparation of Resettlement Action Plan and an Indigenous Peoples Plan. For the TRHDP, it became clear after Option 7C was ultimately identified as the preferred option, that the project area was sufficiently far upstream and sufficiently small that no residential buildings or households would need to be relocated. Therefore, to provide clarity to all stakeholders, the nomenclature was changed to Land Acquisition and Livelihoods Restoration Plan to reflect that land was being acquired, and that the consequent impacts on livelihoods and livelihood assets were assessed and mitigated in accordance with the Safeguards.

As currently proposed, the transmission line component of the project will be constructed along the road corridor acquired for the project area to a point where it travels West to the Lunnga Power Station. The transmission line will be constructed using IDA funding, by Solomon Power, a commercial enterprise owned by the SIG. Therefore, its impacts will be addressed under the World Bank Performance Standards in accordance with OP4.03 (Performance Standards for Private Sector Activities). The route of the line to Lunnga has not yet been finalised by Solomon Power. The LALRP provides a framework for a separate ESIA to be prepared by Solomon Power and TRHDO PO.

The related Indigenous Peoples Plan is incorporated into this ESIA and the associated ESMP and LALRP.

13.7.2 Summary of the LALRP

13.7.2.1 Land Acquisition

The LALRP identifies the actions that will be taken to avoid, minimise, mitigate, and otherwise manage the adverse livelihoods impacts of the land acquisition and restrictions on land use arising from the Project, by achieving an equitable and socially and economically sustainable situation for the people and whose land has been acquired. This includes ensuring those affected by the hydro development are engaged in its planning, and have opportunities to participate in devising and implementing livelihoods mitigations and enhancements where offered.

The construction and operation of Tina Hydro Option 7C requires the acquisition of 428 ha of land - referred to as the "Core Land". The Core Land is described in the acquisition 'Process Agreement' with the customary landowners as the area required *"to provide all things necessary for the construction and operation of the scheme, including a concrete dam, reservoir, 3.5 km water tunnel, power station, access road, surge shaft, substation... transmission lines, telemetry, and helicopter landing pads"*. It will also contain temporary sites and structures required for construction, such as quarries, materials borrow pits, a concrete batching plant, set down and storage areas, office and workshop buildings, generator sheds and so on.

The Core Land is in the customary ownership of five local tribal groupings or lineages, as determined by the Commissioner of Lands.

In 2011, to facilitate site investigations and other fieldwork for the Tina Hydro Project, the SIG entered into a land access agreement with the 27 land owning tribes of the Ngalimbiu-Tina River area. In the agreement, the customary landowners guaranteed to provide physical access to their lands for 18 months to enable investigative drilling, environmental and social impact studies to be carried out. In return the SIG gave each tribe a "goodwill payment" SB\$100,000,

i.e., a total of \$2.7 million, paid into a “*special account held on behalf of the landowners, and under control of the [then] Landowner Council*”.

In February 2013, following a programme of community consultations involving more than 500 members of the affected communities, the landowners agreed to extend the access agreement for a further 18 months to enable finalisation of the technical studies.

While the process used was a ‘compulsory’ process under the Land Titles Act, the acquisition of the Core Land was contingent on first obtaining the consent of all identified landowning tribes. This consent was obtained through the negotiation of a written ‘process agreement’. The land acquisition process is consistent with the requirements of the World Bank’s OP 4.12 and 4.10, and the IFC’s PS5 and PS7 where there must be free prior and informed consent by the landowners and communities. Community support for the overall project was evident in the community SIA workshops held in 2013 and 2014.

Through the Process Agreement the Core Land Tribes consented to the compulsory acquisition of the land by the SIG under the LTA, and unimpeded access to the Core Land for the constructor, and developer / operator. In exchange, the SIG agreed to: a 50% ownership in the acquired land after the acquisition through the creation of the Tina Core Land Company (TCLC); assistance to the Core Land and Reservoir Land tribes for each to establish a corporation to receive and invest or distribute the royalty payments, dividends from the TCLC, and the compulsory acquisition compensation; a revenue share (royalty) of 1.5% of the price paid by SIEA to the developer each year; a consent fee for each tribe and signatory; financial, management and investment training for tribal members; a guaranteed minimum payment per hectare for the acquired land; and other benefits.

The LALRP sets out a series of measures undertaken by the TRHDO PO to ensure an equal sharing of benefits to tribal members and to support opportunities for the tribes to invest in businesses.

The land required for the project infrastructure corridor (for the road and power transmission lines) included customary land compulsorily acquired for the infrastructure corridor, plus an additional four parcels of registered land at the northern end of the corridor. One parcel is owned by the Commissioner of Lands, for which acquisition is not required. Consultation with the interest holders on the remaining registered land required for the infrastructure corridor has occurred on multiple occasions over the last 2 years, and negotiations for its purchase are continuing.

13.7.2.2 Livelihoods Restoration Plan

Livelihood restoration is not required under Solomon Islands law but is required by the World Bank. The aim is to ensure that the livelihoods of people affected by the land acquisition for the TRHDP are maintained at the same level, and preferably, improved – both in terms of sustainability and standard.

The consideration of livelihoods restoration measures and entitlements has been guided by the findings of the social studies and consultations carried out as part of the project planning, along with the documented socio-economic and cultural circumstances of those likely to be affected by the project land acquisition.

The LALRP proposes a range of mechanisms and actions to protect and maintain the livelihoods of those potentially affected by the acquisition of the land for the Tina Hydro project. The entitlements provided for are intended to protect, restore, and where possible improve the livelihoods of all persons and households affected by the acquisition of land for the construction and operation of the project. The main agent for the implementation of the livelihoods restoration plan will be the TRHDP PO. It is proposed that it establish sufficient in-house capacity to undertake the day-to-day implementation of the LRP early in the project design phase.

Other participants in the plan include the BOOT Contractor, various government departments including the Ministry of Agriculture and Livestock, the Ministry of Forests (and/or forestry consultants) and an independent external specialist.

While not strictly part of the livelihoods restoration programme, people belonging to tribes that are part of the Bahomea or Malango Houses of Chiefs will be included in benefit share arrangement made possible by the Tina Hydro project, even if their land or assets are not being acquired for the project.

The details of the proposed community benefit share are still being developed by the Project Office in consultation with the beneficiaries communities. It is anticipated that the design of the benefits programme and its implementation will involve a high level of community involvement and that the various benefits programme activities will result in livelihoods improvements and increased wellbeing for local people.

The IFC and World Bank require that the SIG as the client “*establish procedures to monitor and evaluate the implementation of a Livelihood Restoration Plan and take corrective action as necessary*”. The extent of monitoring activities should be “*commensurate with the project’s risks and impacts*”.

The principal purpose of any monitoring will therefore be to assess whether the livelihoods of those affected by the acquisition of the land for the project have been sustained or improved. Internal monitoring will be undertaken by the TRHDP PO to confirm the delivery of the livelihoods restoration entitlements to the affected persons, and their outcomes. External monitoring and evaluation will be carried out by an independent consultant to: assess the overall performance of the LRP and its goal of sustaining the livelihoods of affected persons; verify that the particular livelihoods restoration activities have been undertaken, and the compensation funds appropriately delivered; review the community engagement and awareness activities of the TRHDP PO; review the overall performance of the grievance resolution mechanisms; and assess the adequacy of measures put in place to protect vulnerable groups and households.

A grievance mechanism is provided. Grievances relating to land acquisition, livelihoods restoration, compensation and related matters will be separated from grievances relating to the impacts of the project on local communities that arise from the construction and operation of the hydro power facility.

13.8 INSTITUTIONAL RESPONSIBILITIES FOR ESMP IMPLEMENTATION

A full description of Government, NGOs and Stakeholders, and their roles with respect to this ESIA, is set out in Section 3.1 – Institutional Framework. This section describes the roles and responsibilities of key actors with respect to the implementation and oversight of the ESMP.

13.8.1 Construction and Operation Contractor (Developer)

13.8.1.1 Role

The Developer plays the key role in the implementation of the mitigation and monitoring measures relating to the construction and operation of the Project. The “Developer” encompasses both the Special Purpose Company (SPC) (proposed to be jointly owned by Korea Water Resources Corporation and the Investment Corporation Solomon Islands, a SIG state owned enterprise), and its Engineering, Procurement and Construction (EPC) contractor, proposed as Hyundai Engineering Company.

The Developer is not responsible for mitigation measures relating to the construction of the Access Road or Transmission Lines which are intended to lie with the road design/construction contractors and Solomon Power respectively. However, the Developer is responsible for operational measures relating to the use of the Access Road and for the maintenance of the road from Mengakiki to the dam site (during the BOOT period) and from the Black Post turnoff to Mengakiki (until commissioning).

The ESMP will form an annexure to the Power Purchase Agreement (PPA) between Solomon Power and the SPC and is also proposed to form part of the Implementation Agreement between SIG and the SPC. Compliance with the ESMP will become a contractual obligation and Solomon Power and SIG will hold contractual rights to enforce these requirements.

The Developer will assign specific responsibilities to key personnel in the stand alone Construction Environmental and Social Management Plan and Operation Environmental and Social Management Plan and accompanying action plans.

In terms of organization, the SPC will assign an experienced, senior environment, social, health and safety manager. A lesson learned from the Star Hydropower Project supported by IFC in Pakistan is that early, continuous, and authoritative presence of this manager is essential for satisfactory performance of the company, its contractors, and its consultants. The manager is anticipated to supervise a team of local staff in a unit which will hold responsibility for Environmental/Social Impact Mitigation, Health/Safety Management, Stakeholder Engagement/Government Agency Liaison, and Monitoring/Data Management/ Reporting.

It is likely that the EPC contract between the SPC and HEC will allocate responsibility for the preparation of the CESMP and the construction management plans to the HEC. The HEC is expected to engage environment and social specialists to lead and oversee the implementation of the ESMP construction measures. It is possible that some of the EMU functions during construction will be contracted to the Owner's Engineer. The SPC will retain the responsibility for environmental, social, health and safety compliance with ESMPs, the project's Environmental and Social Action Plan (ESAP), the Performance Standards, and applicable SIG regulations. The SPC will ensure that the HEC, and Owner's Engineer where appropriate, are contractually obligated to provide the necessary number of qualified personnel and will monitor to ensure they perform according to the contract.

The SPC and its contractors will ensure that all staff, as appropriate with their job profile, understand the environmental and social policies, procedures and mitigations. Contractors will be required to provide sufficient resources to manage the E&S aspects of their work. They will be required and responsible for the training and awareness of their staff on the project environmental and social setting, potential environmental and social impacts of their work activities, management and mitigation measures, and the existence of, and importance of complying with, the TRHDP CESMP and OESMP, including relevant interfacing with contractor's management systems.

The Developer's final stand alone ESMPs are intended to form part of the conditions of the Development Consent issued by the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDMM) under the Solomon Islands' *Environment Act*. The SPC will apply for and hold the Development Consent and will be responsible for compliance under the Act.

13.8.1.2 Capacity

It is anticipated that the Developer shall engage personnel with the relevant skills and experience to implement the mitigation and monitoring measures of this ESMP. As such, no capacity building is considered to be required.

13.8.2 TRHDP PO

13.8.2.1 Role

The Project Office will have a key oversight role for ESMP compliance during the construction period. The Project Office will appoint an Environmental and Social Safeguards Expert to facilitate this role.

As part of this role the Project Office shall:

- Review and approve the final ESIA and stand alone ESMPs prior to submission by the Developer to MECDMM for development consent approval (under the *Environment Act*);
- Review and approve Developer's management action plans in accordance with Table 13-2;
- Undertake audits in accordance with the schedule set out in 13.9.1; and

-
- Facilitate expert training for PO staff and MECDMM staff on monitoring skills specific to the Project and specified safeguards.

These Project Office roles will be incorporated in the Implementation Agreement between SIG and the Developer.

13.8.2.2 Capacity

The Project Office and its local contractors have capacity to oversee some mitigation measures, with particular strengths in social monitoring and water quality monitoring, but will require further support and training in others areas. World Bank and DFAT propose significant funding to the Project Office to be used for training Project Office staff and responsible agencies, including MECDMM, to conduct environment and social audit and oversight roles.

13.8.3 Environment and Conservation Division of MECDMM

13.8.3.1 Role

The Environment and Conservation Division (ECD) will play an important role under the *Environment Act* in evaluating and issuing the development consent for the Project and in monitoring the environmental impacts of the Project.

ECD will be responsible for reviewing and assessing the developer's final environmental impact statement and stand-alone CESMP and OESMP under the *Environment Act*. In undertaking this review the Director of the Environment and Conservation Division will confirm that the documents meet the requirements of the Act and Regulations. The Director will run a public consultation process and ultimately determine whether or not to issue a development consent and with what conditions.

ECD staff will have ultimate responsibility for ensuring that the Developer complies with the Development Consent and its conditions, breaches of which constitute an offence under the Act.

13.8.3.2 Capacity

The increasing number of large scale developments in the country has put pressure on the division, which has limited capacity in terms of staff and technical ability to assess and monitor environmental and social impacts.

ECD has developed some recent experience addressing the social and environmental issues facing the neighbouring Gold Ridge Mine, however, it has had little involvement in ongoing management of other major projects and no experience with a large hydro dam.

ECD would benefit from technical inputs and analysis of water quality and other parameters by third parties. For this reason, the Project Office will engage an environmental and social safeguards specialist and other personnel as relevant to provide assistance and training to the ECD in undertaking its approval, statutory monitoring and compliance roles.

13.8.4 Solomon Power

13.8.4.1 Role

Solomon Power (the trading name of Solomon Islands Electricity Authority) will have the central responsibility for all mitigation measures relating to the construction and operation of the transmission line corridor from the Solomon Power owned Lunnga power station to the Project's power station.

In addition to this role, Solomon Power shall oversee the developer's ESMP compliance during the operational stage of the Project. Solomon Power will work closely with MECDMM in undertaking this role.

13.8.4.2 Capacity

The organisation is currently going through an institutional reform with support from the World Bank to increase its revenue collection capacity and improve its services. If capacity shortcomings are identified before the operational stage commences, the World Bank shall arrange monitoring and compliance training for Solomon Power.

13.8.5 Road Design and Road Construction Contractors

13.8.5.1 Role

The Access Road upgrade and construction from the Black Post turn off to the dam site shall be designed and constructed by contractors engaged by the Ministry of Mines, Energy and Rural Electrification.

As a component of the road design contract, the road design consultants shall prepare a stand-alone environmental impact assessment report for review and approval by MECDMM under the *Environment Act*. This EIA shall incorporate the conditions of this ESMP document.

The road design contractors shall incorporate access road design measures, including culverts and drainage measures, into the final road design.

The road construction contractor has not yet been engaged. Contractual arrangements will require the contractor to comply with the measures set out in this ESMP and the detailed stand-alone access road EIA to be completed as a component of the road design contract.

13.8.5.2 Capacity

Contractors selected through international tender are anticipated to have sufficient skills and experience to implement the mitigation measures.

13.8.6 Ministry of Infrastructure Development

13.8.6.1 Role

The Ministry of Infrastructure Development (MID) plays a role in maintaining the access road from the Black Post turnoff to Mengakiki once the Project is commissioned.

13.8.6.2 Capacity

Current indications are that the capacity of the MID is sufficient to respond to the post construction maintenance requirements with the support of the TRHDP PO and donor agencies.

13.9 IMPLEMENTATION SCHEDULE AND BUDGET

13.9.1 Schedule

The schedule for implementing the ESMP is presented in Table 13-4.

Table 13-5 Proposed schedule for implementing environmental and social management program

Phase	Activity	Constructor/operator (Manage and Monitor)	TRHDP PO (Auditor)
Detailed design	Prepare detailed construction ESMP; Provide environmental inputs to design	3 Months from execution of the PPA Monthly review meetings during design process until developer submits detailed design	Review and sign-off "No Objection" "No Objection"- PO to ensure that environmental inputs are captured in developer's final design
Construction	Implement Construction ESMP;	3 months prior to commencement of construction through completion of construction	Schedule of reporting and monitoring to be included in final CESMP forming conditions of the Development Consent under the <i>Environment Act</i> . PO to oversee developer's monitoring programme and arrange regular audits –quarterly in first year and then

13.9.2 Budget

KW-HEC, has been granted an exclusive development right to prepare the project within a period ending on June 30, 2017, by when the PPA should be signed. HEC will be primarily responsible for the EPC development; K-Water will be responsible for the Operation and Maintenance contract during the BOOT period. The BOOT concession period is expected to be for a period of 30 years from commissioning, approximately 34 years from mobilisation. Unless otherwise stated, costs of ESMP implementation are incorporated into the EPC contract for the construction period and through the ongoing budgets for the SPC for the life of the PPA. Compliance monitoring by PO and MECDM during construction will be a component of the project financing managed by SIG. Compliance monitoring during operations will be continued by the relevant ministries, in particular MECDM.

13.9.3 Contractual Arrangements

The environment and social safeguard measures will be accommodated and enforced through contractual and approval arrangements between institutional actors. Table 13-6 sets out the key project agreements and actors. Figures Figure 13-5 Figure 13-4 demonstrate these arrangements for the hydropower, transmission line and access road project components respectively.

Table 13-6 – Contractual Arrangements

Agreement/Approval	Safeguard Responsibility	Safeguard Oversight
Implementation Agreement (IA)	SPC	SIG
Power Purchase Agreement (PPA)	SPC	Solomon Power
Engineering Procurement Construction Contract (EPC Contract)	HEC	SPC
Financial Agreements	SIG (Ministry of Finance)	Financiers
Project Agreements	SPC	Financiers
Development Consent	SPC	MECDM
Subsidiary Finance Agreement	Solomon Power	SIG
Project Agreement (Transmission Line)	Solomon Power	Financiers
Works Contract	Road Contractor	MMERE

Figure 13-4 – Hydropower Project Contractual Arrangements

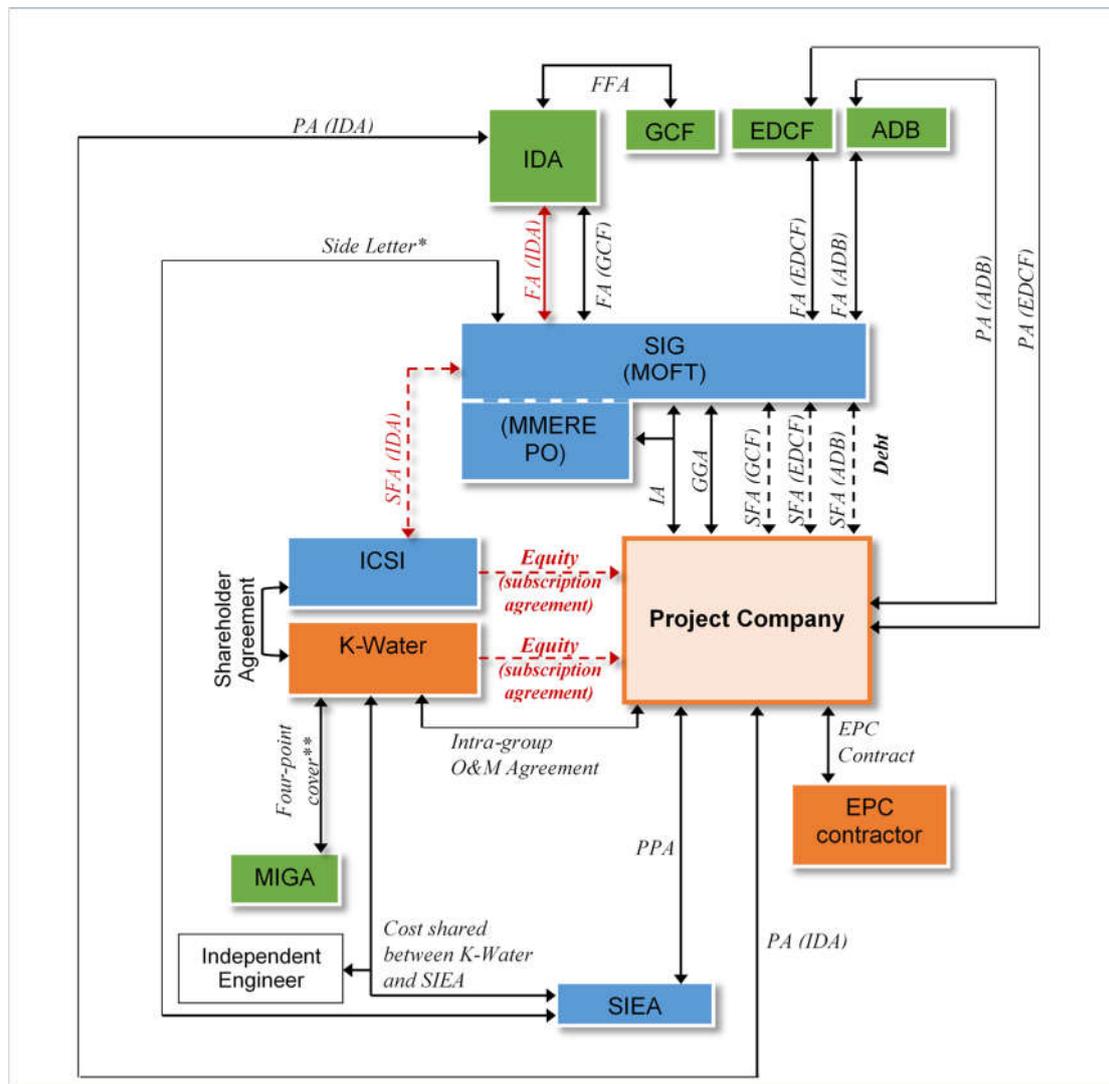
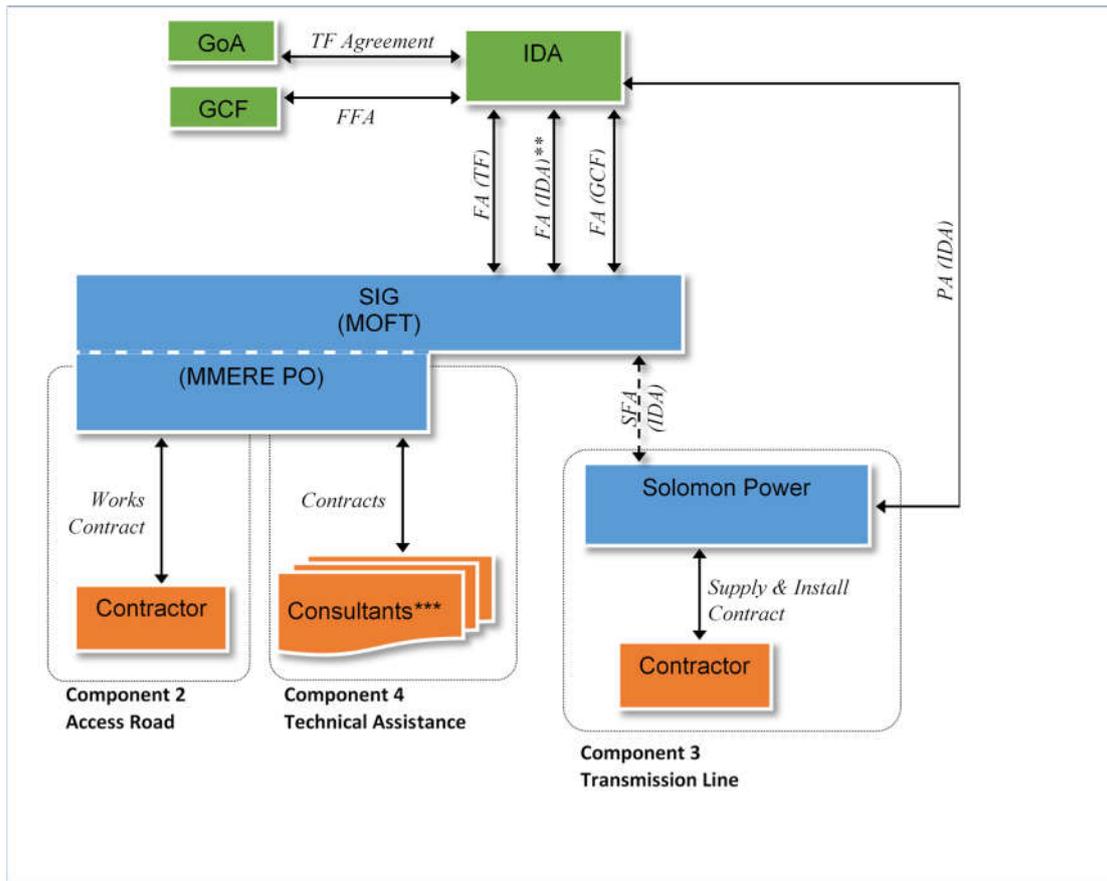


Figure 13-5 – Transmission Line and Access Road Contractual Arrangements



13.9.4 Integration of ESMP in Project Management

As the TRHDP will be designed, constructed and operated under a build-own-operate-transfer project delivery model, the construction contractor and the operator will be one and the same (i.e., constructor/operator). The constructor/operator will be responsible for establishing an environmental management office that employs environmental and social specialists to provide their input during detailed design, construction and operation of the TRHDP. The constructor/operator’s environmental and social management team will be required to function autonomously, from the constructor/operator, to ensure the contractor complies with GIIP, and they will be given “stop work” authority to halt specific project-related actions or activities that are deemed by the monitors to be immediately threatening valued environmental or social components.

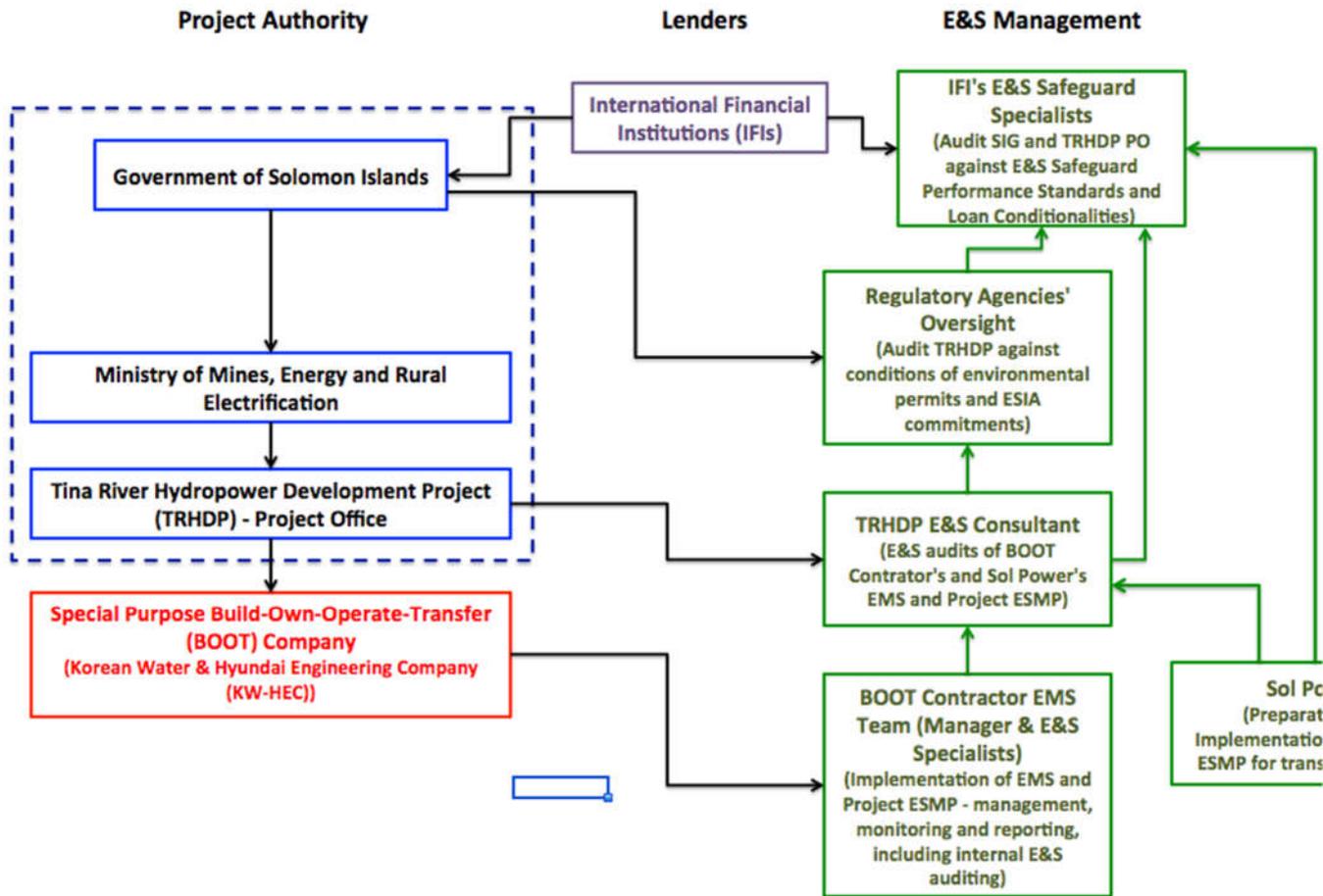
During construction and operation, the TRHDP PO will engage an environmental and social expert to audit the performance of the constructor/operator’s environmental management, monitoring and actions.

A Dam Safety Advisory Panel (DSAP) has been engaged to ensure that the design for the dam complies to international accepted dam safety standards. The PPA will also ensure that the project complies with the applicable environmental, social and labour Legal Requirements. Some of these requirements include WB performance standards, the World Bank Group / IFC Environmental, Health and Safety Guidelines.

Figure 13-1 illustrates the reporting structure for developing and implementing the main Environmental Management System and Environmental Management Plan components into the TRHDP.

Table 13-5 provides a summary matrix of the Environmental and Social Management Plan, including project activities / actions, effects, mitigation measures implementation and monitoring and reporting roles and responsibilities, project phase timing and budget.

Figure 13-6 EMS and ESMP reporting structure



13.10 SUMMARY ESMP MATRIX

Table 13-7 Summary ESMP matrix

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
1	<i>Reservoir Preparation, Filling, and Operation</i>					
	<p>GHG emissions; suspended solids on aquatic life; river pollution on aquatic life; temporary diminished water quality; reservoir water quality</p> <p>Surface hydrology; reduced flows on aquatic life; water users</p>	<ul style="list-style-type: none"> • Prepare Reservoir Preparation Plan • Clear trees >10cm dbh and strip loose soil and rocks from reservoir area during dry season prior to inundation; • Use of herbicides will not be permitted • (see also Vegetation Management Plan) • (see also Sediment and Erosion Management Plan) <p>• Maintain minimum E-flow of 1.0m³/s in bypassed section of river at all times</p>	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction; • BOOT Contractor to implement with support from local Community labourers in last dry season of construction phase; and operation phase <p>• BOOT Contractor / late construction phase; and operations phase</p>	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures <p>• Monitor and report on implementation of mitigation</p>	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation <p>• TRHDP PO to Audit BOOT Contractor;</p> <ul style="list-style-type: none"> • BOOT Contractor E&S Subconsultant to 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	Reduced overnight flows on surface hydrology, aquatic life, and water users	<ul style="list-style-type: none"> Maintain minimum of 3.4m³/s flow downstream of powerhouse 	<ul style="list-style-type: none"> BOOT Contractor / operations phase 	measures	monitor and report / operations phase	
	Reduced sediment transport, with changes to aquatic life; reduced gravel extraction; reservoir sedimentation	<ul style="list-style-type: none"> Periodic flushing of sediments from reservoir, or drawing down of reservoir to excavate/dredge sediments 	<ul style="list-style-type: none"> BOOT Contractor / operations phase 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / late construction phase; and operations phase 	
2	<i>Hydro Facility Operation</i>					
	Reduced flows between dam and power station; indirect impacts on fauna; direct	<ul style="list-style-type: none"> Prepare Environmental Flows Management Plan Maintain minimum E-flow of 1.0 m³/s in 	<ul style="list-style-type: none"> BOOT Contractor to prepare plan / pre-construction 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S 	<ul style="list-style-type: none"> Included in BOOT Contractor's

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	impacts on aquatic fauna; water users	bypassed section of river	<ul style="list-style-type: none"> • BOOT Contractor to implement in operation phase 	measures	Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation	USD2.0M ESMP budget
3	<i>Barrier to Fish Passage and Fish Entrainment</i>					
	Dam as barrier to upstream fish migration	<ul style="list-style-type: none"> • Prepare Fish Passage Plan • Implement trap and haul fish passage system 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement onwards from commissioning stage of late construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	Dam as barrier to downstream fish migration; entrainment of fish into power intakes	<ul style="list-style-type: none"> • Spill water over spillway early wet season; install fish exclusion screens 	<ul style="list-style-type: none"> • BOOT Contractor / operations phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / operations phase 	
4	<i>Access Road Location, Design, Construction and Operation</i>					
	Slope stability; erosion; human encroachment into upper watershed	<ul style="list-style-type: none"> • Locate roads away from sloping terrain where possible; • Engineer for road stability and drainage; • Roads to quarries to remain unsealed to facilitate decommissioning; • No spoils within 100m of watercourses • Restrict vehicular use of the access road to project staff. Commercial logging vehicles prohibited. 	<ul style="list-style-type: none"> • Ministry of Mines, Energy and Rural Electrification; • BOOT design and construction contractors / design phase and construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / design phase and construction phase 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	<p>5.1.1.1.2 Installation of drainage and stream crossing works - operation effects on fauna; hydrological changes on flora; soil erosion; suspended solids and siltation on aquatic life; river pollution on aquatic life; diminished water quality on aquatic environment; disturbance to aquatic habitats and aquatic life</p>	<ul style="list-style-type: none"> • Prepare Watercourse Crossing Management Plan • Geo-reference watercourses in vicinity of access road for proper sizing of crossing; • Protect tributary streams with fencing; • Exclude proposed stream crossings initial forest clearing as they will be selectively cleared; • Construct road crossing perpendicular to stream; • Culverts to be equipped with headwalls to ensure bank stability; • Fauna friendly underpasses to be installed in culverts; • Construct crossings using excavators, not bulldozers to minimise excessive soil disturbance; • Size culverts to facilitate dry passage of terrestrial animals, and wet passage for amphibians and fish, including provision of suitable cover; • Size crossings to pass design flood flows; • Install upstream trash racks; • (see also Drainage Management Plan) • (see also Erosion and Sediment 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation 	

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	Vegetation clearance on environmentally and culturally sensitive areas	Control Plan) <ul style="list-style-type: none"> • Prepare Vegetation Management Plan • Botanist to walk access road / TLine alignments to geo-reference, and fence environmentally and culturally sensitive areas using orange plastic fencing, and map for presentation to clearing committee of resident engineer, BOOT sub-contractors and independent environmental expert • (see also Physical Cultural Heritage Management Plan) 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 		
	Road Access Restrictions - Operations effects on flora	<ul style="list-style-type: none"> • Black post road to remain private access between Mangakiki to dam site; • Access restricted to local populations. Vehicular access restricted to TRHDP operator; • No occupation of Core Area lands except for necessary Project housing (eg.security staff or on call engineers); • No workers camp on Core Area lands; BMP to be developed, implemented and enforced to restrict access through Core Area to prevent establishment of 	<ul style="list-style-type: none"> • TCLC to assist BOOT Contractor in preparing settlement policy within the Biodiversity Management Plan 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures / operation phase 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / operation phase 	

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
		new settlements in areas beyond				
5	<i>Vegetation and Forest Clearance</i>					
	<p>Soil compaction and erosion; suspended solids and water pollution on aquatic life;</p> <p>Burning on air quality; disturbance to aquatic habitats and biota; grassland dependent birds; river dependent birds; loss of terrestrial natural habitat and associated biodiversity</p>	<ul style="list-style-type: none"> • Prepare Erosion and Sediment Control Plan • Minimise spatial and temporal extent that soils are exposed to water erosion; • Stabilise sites and install / maintain erosion controls in wet season • Prepare Vegetation Management Plan • Minimise clearing footprint; • Strict contract language to be applied to BOOT logging contractor; • Clearing to be monitored by independent expert; • Incorporate in the Biodiversity Action Plan an offset for conversion of natural forest habitat in the Core Area • No storing / dumping cleared vegetation into streams; • No use of herbicides; 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement construction phase • BOOT Contractor to prepare plan with input from Solomon Power (for TLine) / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation, and operation phase implementation for TLine 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
		<ul style="list-style-type: none"> • Vegetation control during dry seasons; • Avoid where possible vegetation clearing on erodible / steep slopes; • Revegetation / mulch progressively; • No draining TLine wetlands unless threatening access roads; • Avoid using machinery on stable areas or close to streams; • Train workers in EHS; • Notify communities to avoid active clearing works; • No burning of non-merchantable vegetation. Vegetation to be shredded. • Minimise removal of large canopy trees; • TLine vegetation control during operation by trained persons. • (see also Sediment and Erosion Management Plan) 				
6	<i>Drilling and Blasting</i>					
	Physical impacts from noise and vibration; disturbance to	<ul style="list-style-type: none"> • Prepare Drilling and Blasting Plan • Select methods to reduce noise and vibration; 	<ul style="list-style-type: none"> • BOOT Blasting contractor to prepare plan / pre- 	<ul style="list-style-type: none"> • Monitor and report on implementation of 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S 	<ul style="list-style-type: none"> • Included in BOOT Contractor's

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	fauna	<ul style="list-style-type: none"> Hydraulic instead of pneumatic drills; equipment to be equipped with engine exhaust silencers / mufflers; Use blasting mats to reduce noise, fly rock and dust. (See also Wildlife Protection Plan) 	construction <ul style="list-style-type: none"> BOOT Contractor to implement construction phase 	mitigation measures	Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation	USD2.0M ESMP budget
7	<i>Accidental Release of Sewage and Other Wastewater</i>					
	Point source pollution on flora; river pollution on aquatic life; disturbance to aquatic habitat and aquatic life; diminished water quality and quantity	<ul style="list-style-type: none"> Prepare Wastewater Management Plan – mandatory installation of toilets for workers; transport wastewater offsite for treatment 	<ul style="list-style-type: none"> BOOT Contractor to prepare plan / pre-construction BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget
8	<i>Hazardous Materials, Explosives and Concrete Works Handling</i>					
	Point source pollution on flora; increased suspended solids and siltation on aquatic life; disturbance to aquatic	<ul style="list-style-type: none"> Prepare Hazardous Materials Management Plan (which includes Hydrocarbon [fuel, oil, lubricants] Management Plan – Resident Engineer to approve hazardous 	<ul style="list-style-type: none"> BOOT contractor(s) / plans prepared pre-construction; BOOT Contractor to implement before 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	habitats and aquatic life; diminished water quality and quantity on aquatic environment	<p>materials storage, including explosives storage bunker; secondary containment required for hydrocarbon storage; no hydrocarbons to be stored closer than 100m from any water body or wetland; hydrocarbon storage systems must be sound; fuel dispensing areas to be located on concrete hard stand, with drains to oil/water separators, from which product will be removed and transported by tanker truck to Honiara; concrete wash waters must not be released to water bodies or wetlands; concrete washwater control system will be constructed in the form of settling ponds</p> <ul style="list-style-type: none"> • Prepare Emergency Response Plan - • (see also Drainage Management Plan) • (see also Sediment and Erosion Control Plan) • (see also Solid Wastes Management Plan) 	construction commences, then throughout construction phase		pre-construction completion of plans, and construction phase implementation	
9	<i>Excavation and Movement of Soils</i>					

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	Loss of flora; increased suspended sediment and siltation on aquatic life; river pollution on aquatic life; diminished water quality and quantity on aquatic environment; disturbance to aquatic habitats and aquatic life	<ul style="list-style-type: none"> • Prepare Soils Management Plan – • Under supervision of soil expert, collect soil cores to determine depth of organic soils and strip organic soils along access roads; stockpile soils for later use for revegetation; store soils in remnant forest habitat to minimise clearing, and locate away from water bodies on flat terrain; compact or cover to prevent re-colonisation; surround stockpiles with sediment control works including settling ponds • (see also Sediment and Erosion Control Plan) • (see also Biodiversity Management Plan) 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget
	Accidental colonisation by invasive flora and fauna	<ul style="list-style-type: none"> • Prepare invasive species measures as a component of the Biodiversity Management Plan • Machinery to be washed by designated staff before entering site; • Mud and soil to be removed at designated wash station; • No importation of soils from outside work areas 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction phase implementation 	

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
		<ul style="list-style-type: none"> Control of waste food to avoid attracting feral animals 				
10	<i>Activities Causing Disturbance to Wildlife</i>					
	Workers effects on fauna	<ul style="list-style-type: none"> Prepare Wildlife Protection Plan Workers prohibited from harming wildlife; Workers to receive wildlife awareness training (see also Environmental Awareness Training Plan) 	<ul style="list-style-type: none"> BOOT Contractor to prepare plan / pre-construction BOOT Contractor to implement / construction and operation phases 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans, and construction and operation phase implementation 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
	Lighting disturbance to fauna, especially bats	<ul style="list-style-type: none"> • Prepare Wildlife Protection Plan • Use only enough artificial lighting to maintain safe work conditions; • Minimise light intensity and orient to ground, where possible; • Avoid use of artificial light during operation 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction and operation phases 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 		
	Electrocution of Cuscus during T-Line operation	<ul style="list-style-type: none"> • Install metal shields on wooden poles prior to operation to prevent climbing 	<ul style="list-style-type: none"> • BOOT contractor(s) / construction 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / construction phase 	
	Harvesting by workers	<ul style="list-style-type: none"> • Prepare Environmental Awareness Training Plan • Prohibit workers from fishing in Tina River; • Prohibit food services from 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on 	

#	Project Activity / Action and Its Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility / Timing	Monitoring & Reporting Activity	Responsibility / Timing	
<i>Measures to Protect the Natural Environment During, or as a Result of:</i>						
		purchasing fish from local villagers; limit vehicle speeds on access roads <ul style="list-style-type: none"> • (see also Wildlife Protection Plan) • (see also Traffic Management Plan) 	construction and operation phases		pre-construction completion of plans, and construction and operation phase implementation	

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
1	<i>Siting of Worker Camps</i>					
	Disruption to local customs and way of life; concerns for health, safety and wellbeing of community during construction	<ul style="list-style-type: none"> Accommodation for incoming workers and workers from outside Tina area to be located outside project area; No workers camps in project area; Accommodation to be planned well in advance 	<ul style="list-style-type: none"> BOOT Contractor to establish accommodation / pre-construction 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of worker accommodation 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget
2	<i>Employment and Recruitment Practices</i>					
	Uninvited job seekers from outside the region; increased employment for local inhabitants	<ul style="list-style-type: none"> Recruitment policy to favour those seeking work from Bahomea, Malango, and landowning clans; Expand recruitment further afield if necessary; Include quota for women; Conduct job-seeker survey of local villages; Provide training to local job-seekers; Future access to post-construction buildings to be provided to community 	<ul style="list-style-type: none"> BOOT Contractor to implement TRHDP PO's recruitment policy / pre-construction, construction and operation phases; TRHDP PO to provide pre-employment training through contracted training provider / pre-construction, 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of worker accommodation 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget; Funding for training to come from JSDF grant

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
			construction and operation phases; <ul style="list-style-type: none"> • TLC to manage buildings / post-construction 			
3	<i>Worker Behaviour, and Activities that could Affect Worker Health and Wellbeing</i>					
	Affects on local customs and way of life; Moro movement; health, health safety and well being of workers	<ul style="list-style-type: none"> • Implement the Workers' Code of Conduct • Conduct Code of Conduct training; • Provide tailored workplace health and safety training before workers commence work on the project; • Establish a full-time first aide / nursing post on site, and arrange for medical assistance and evacuation facilities • (see also Health and Safety Plan) 	<ul style="list-style-type: none"> • BOOT Contractor to implement / prior to worker mobilising to work on project 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-commencement worker health and safety training 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget
4	<i>Activities that could Affect Villagers' Safety, Wellbeing, and Amenities</i>					
	Threats to health, safety and wellbeing due to project construction and operation activities	<ul style="list-style-type: none"> • Address potential road safety concerns; • Develop protocol for managing contractor-related road accidents / injuries; • Roads to have sealed surfaces through villages to control noise and dust; 	<ul style="list-style-type: none"> • BOOT Contractor, Subcontractors, Solomon Power and TRHDP PO / construction and operation phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / construction and operation phases 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget • Included in TRHDP PO Budget

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
		<ul style="list-style-type: none"> • Provide information sessions to local communities to explain dam safety measures; • Educate local communities on the use of electricity before villages electrified; • Implement strict measures to avoid worker misconduct toward locals; • Zero drug and alcohol tolerance for workers on site; • STD awareness training; • Free condoms to be available at first aid/nursing post to be established on site • (see also Traffic Management Plan) • (see also Health and Safety Plan) 				
5	5.1.1.1.3 Activities that could Affect Vulnerable Groups and Minorities					
	Threats to wellbeing of vulnerable groups and minorities due to construction and operation activities	<ul style="list-style-type: none"> • Prepare a Social Impacts Monitoring Plan; • Monitor impact of squatters and settlers on vulnerable and minority people; • Establish grievance mechanism and nominate community representatives; • Ensure coverage of isolated communities 	<ul style="list-style-type: none"> • BOOT Contractor to implement / construction and operation phases 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / construction and operation phases 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
6	<i>Activities that could Affect Water Supplies</i>					
	Diminished water quality and quantity due to project construction activities for construction and commissioning period	<ul style="list-style-type: none"> Identify, survey, map and engineer assess village water supplies pre-construction; Establish alternate water supplies that are reliable and clean, where required; Conduct water quality monitoring, including for water borne pathogens; Establish village water committee(s); Notify communities of risks of using river and sand-point water sources 	<ul style="list-style-type: none"> BOOT Contractor to implement / construction and early operation phases 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / construction and early operation phases 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget
7	<i>Activities that could Affect Ecotourism Opportunities</i>					
	Disruption to Senghe Village foot track due to heavy access road traffic; loss of ecosystem opportunities	<ul style="list-style-type: none"> Relocate access track prior to construction; Monitor effects on ecotourism 	<ul style="list-style-type: none"> BOOT Contractor to relocate foot track / pre-construction 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of foot track relocation, and construction phase ecotourism 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget
8	<i>Damage to, or Loss of, Core Area Resources</i>					

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
	Damage to and/or reduced access to natural capital due to construction related site disturbance	<ul style="list-style-type: none"> • Prepare Land Acquisition and Livelihood Restoration Plan; • Define use rights for Core Area lands; • Compensate for lost resources or diminished access to resources; • Rehabilitate modified habitat of at least 9.5ha in the Core Area and protect remaining natural habitat within the Core Area • Contract local community members for reservoir clearing where feasible 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plan, and construction and operation phase implementation 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget
9	<i>Activities that could Affect Cultural Heritage</i>					
	Adverse affects on cultural heritage from site disturbance during construction	<ul style="list-style-type: none"> • Prepare protocol for managing cultural heritage, including arrangements for relocation and compensation; identify Tambu Site compensation follow-up; survey project and road construction sites to identify medicinal and magical plants for protection or relocation; • Workers to reside outside Tina/Ngalimbiu area; enforce strict code of worker conduct 	<ul style="list-style-type: none"> • BOOT Contractor to prepare plan and conduct Tambu Site assessment / pre-construction • BOOT Contractor to implement / construction phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report on pre-construction completion of plans and Tambu Site assessment, and construction and operation phase implementation 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget; • Tambu Site Disturbance Compensation (paid out of SIG land compensation budget)
10	<i>Decisions Made on the Project</i>					

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
	Concern that local communities will be left out of project management decisions that may affect them	<ul style="list-style-type: none"> Continue to consult with project-affected communities using culturally appropriate, inclusive, proven methods; Address issues raised through grievance mechanism process 	<ul style="list-style-type: none"> BOOT Contractor to implement / all project phases 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / all project phases 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget
11	<i>Dam Failure and Emergency Flow Releases</i>					

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
	Concern of local communities of risks posed by potential dam failure and emergency releases	<ul style="list-style-type: none"> • Prepare Dam Safety Plan; • Prepare Emergency Preparedness Plan; • Model extreme events and prepare inundation zone maps; • Install early warning system to warn of flood / emergency spillway releases • Deliver information sessions to local communities on dam design, operation and maintenance 	<ul style="list-style-type: none"> • BOOT Contractor to implement / commissioning and operation phases 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / commissioning and operation phases 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget
12	<i>Daytime Peaking Flow Releases</i>					

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
	Operational flow release effects on community safety under during daylight peaking and non-peaking	<ul style="list-style-type: none"> • Provide ramping flow releases to enable local inhabitants that may be within the river bet to safely remove themselves as water levels rise during peaking generation; • Deliver notification sessions to local communities on expected daily flow releases and water levels are specific locations along the river 	<ul style="list-style-type: none"> • BOOT Contractor to implement / commissioning and operation phases 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / commissioning and operation phases 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget
13	<i>Changes Associated with Diminished River Flows</i>					
	Diminished sediment recruitment from upper watershed; reduced supply of riverbed construction aggregates only noticeable in long term	<ul style="list-style-type: none"> • River geomorphologist to monitor gravel transport; • Develop mitigation measures, including potential sluicing sediments from reservoir, where changes in gravel distribution affecting livelihoods 	<ul style="list-style-type: none"> • BOOT Contractor to implement / operation phase 	<ul style="list-style-type: none"> • Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> • TRHDP PO to Audit BOOT Contractor; • BOOT Contractor E&S Subconsultant to monitor and report / operation phases 	<ul style="list-style-type: none"> • Included in BOOT Contractor's USD2.0M ESMP budget

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
	Affects on ability of small-scale timer harvesters to mill, transport and recover timber when river flows are curtailed	<ul style="list-style-type: none"> Develop alternative method to rafting timber down the river to enable timber to be recovered from upstream of dam, and in dewatered sections of the river 	<ul style="list-style-type: none"> TRHDP PO to develop alternative / pre-construction phase; BOOT Contractor to facilitate alternative timber transport system / construction and operation phases 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / construction and operation phases 	
14	<i>Activities that could Strain Relations with Project-affected Communities</i>					
	Potential for relations to be strained between community, BOOT Contractor and TRHDP PO	<ul style="list-style-type: none"> Establish community liaison committees (CLCs) for monitoring and mitigation input; Each CLC to include existing Community Liaison Assistant (CLA), as well as women and youth representation; Each CLC to be supported by a secretary and report on community grievances and monitoring of impacts; Provide capacity building through training and administrative support for CLCs, CLAs, and landowner tribes; Deliver pre-employment training to Bahomea and Malango areas; 	<ul style="list-style-type: none"> BOOT Contractor with support from TRHDP PO to implement CLC and CLA training, including budget / construction and operation phase; TRHDP PO to continue training of landowner tribes in money management and administrative procedures, and facilitate management training of TCLC board 	<ul style="list-style-type: none"> Monitor and report on implementation of mitigation measures 	<ul style="list-style-type: none"> TRHDP PO to Audit BOOT Contractor; BOOT Contractor E&S Subconsultant to monitor and report / construction and operation phases 	<ul style="list-style-type: none"> Included in BOOT Contractor's USD2.0M ESMP budget; Included in TRHDP PO's E&S budget

#	Project Effect(s)	Mitigation		Monitoring & Reporting		Budget
		Mitigation Measure(s)	Responsibility & Timing	Monitoring & Reporting Activity	Responsibility & Timing	
<i>Measures to Protect the Social Environment During, or as a Result of:</i>						
		<ul style="list-style-type: none"> • Provide budget and money management training to locally recruited workers; • (see also Stakeholder Engagement Plan) 	<ul style="list-style-type: none"> members as required; • BOOT Contractor with support from TRHDP PO to implement money management training for local workers 			

13.11 PROCESS FOR PREPARATION OF CESMP AND OESMP

As noted above, this ESMP focuses on design and construction of the Project, and is intended to be a guide for the constructor/operator. The constructor/operator will be required to further refine this ESMP to turn it into its own detailed construction ESMP (or CESMP), which takes into consideration the specific construction timing, location and work methods. The CESMP will be reviewed for adequacy by the TRHDP PO. As required by law, the document will then form part of the constructor's Environment Impact Statement to be reviewed and assessed by the Ministry of Environment, Climate Change, Disaster Management and Meteorology prior to the granting of development consent under the *Environment Act*.

As project construction nears completion, and before the Project is commissioned, the constructor/operator will be required to prepare a detailed stand-alone operation ESMP (or OESMP). The OESMP will be reviewed for adequacy by the TRHDP PO's environmental and social expert.

The stand-alone CESMP and OESMP shall include the following information:

- ▶ Parties responsible for implementing the ESMP and ESAPs and capacity assessment;
- ▶ Regulatory agencies;
- ▶ Permitting procedures and IFC Performance Standards requirements;
- ▶ Mitigation measures;
- ▶ Action plans that identify roles and responsibilities, rudimentary levels of effort and schedules, management and monitoring actions as set out in section 1.1; and
- ▶ Cost estimates and sources of budget.

All OESMP and CESMP mitigation measures should be designed, discussed and implemented with the participation of the relevant affected persons, regardless of their affiliation. Mitigation targeted at specific groups should be designed in partnership with those groups.

Mitigation programs should be available to all project-affected communities including Bahomea landowner communities, settler communities, Ghaobata communities, and squatters who were already living in the area on the cut-off date of 23 August 2014, which is the date of the publication of the Gazette notice for the taking of the land.

Where possible, works associated with mitigating impacts should employ local people as a priority.

As part of the overall ESMP, community liaison committees should be established during project construction and operation phases of the TRHDP. These committees should be supported by a small group to monitor, and provide input on, the conditions in the project-affected communities.

14. CUMULATIVE IMPACT ASSESSMENT

14.1 INTRODUCTION

This section provides a cumulative impact assessment (CIA) for the TRHDP.

14.1.1 Objective of the CIA

The overall objective of the CIA is to identify environmental and social impacts associated with the TRHDP, that when combined with potential impacts of existing, planned and reasonably foreseeable developments or activities, may generate cumulative impacts that could jeopardise the sustainability of the TRHDP.

14.1.2 Scope and Methodology of the CIA

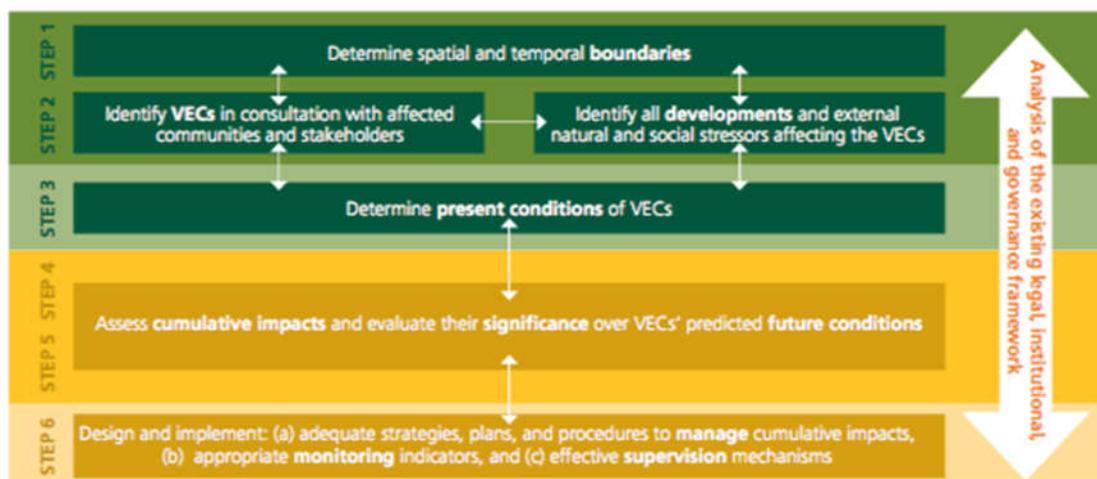
The CIA for the TRHDP examines the cumulative impacts of the Project against past, present and reasonably foreseeable projects and activities within the Tina/Ngalimbiu River catchment.

The approach follows the six steps recommended by the *Good Practice Handbook on Cumulative Impact Assessment and Management for the Private Sector in Emerging Markets* (IFC, 2013).

The CIA focuses on the environmental and social attributes of the Tina/Ngalimbiu River catchment that are considered to be most important to community and government stakeholders. These attributes are referred to as Valued Environmental and Social Components or VECs.

The six-step process used to undertake the CIA is illustrated in Figure 14-1.

Figure 14-1 Six-step process for conducting a CIA



Steps 1 and 2 – CIA Scoping - VECs for the TRHDP, and their respective spatial and temporal boundaries, were identified through consultations with local communities and SIG during the course of preparing the ESIA. Information on other past, present and reasonably foreseeable future developments was obtained through review of existing documents, direct observations in the field, and discussions with various SIG resource agencies.

Step 3 – Present VEC Conditions - Baseline conditions of the VECs were also identified as part of the baseline physical environment, biological environment and socio-economic / socio-community environment studies undertaken for the ESIA.

Steps 4 and 5 – Assess CIA and Evaluate Significance – A VEC centred approach was followed, whereby, direct and indirect impacts to VECs arising from proposed TRHDP-related actions were evaluated against impacts on the same VECs arising from other past, present and reasonably foreseeable future projects and activities.

Step 6 – Prepare Management Framework - Wherever significant cumulative impacts were identified, control measures to mitigate these impacts were recommended. These will be carried over to the ESMP.

14.2 ENVIRONMENTAL AND SOCIAL CONTEXT

14.2.1 Regional Context

14.2.1.1 Introduction

The proposed TRHDP will be located in the Tina/Ngalimbiu River basin on the North side of Guadalcanal Island, Solomon Islands. The Tina River emerges from the higher elevation mountains and flows North to the sea. The total catchment covers an area of 150km². Elevation of the catchment progressively decreases in a downstream direction toward Tenaru Bay. For the purposes of this assessment, the river was divided into three main reaches: upper, middle and lower. The main features of each of these areas are described in the following sub-sections.

14.2.1.2 Upper Tina River Catchment

The upper catchment area is defined as the area upstream of the proposed TRHDP dam. It covers an area of 125km², and represents 83% of the total Tina/Ngalimbiu catchment area. The Tina River upper catchment is characterized by mountainous terrain, with peaks ranging from 800masl to 2300masl. Approximately 60% of the catchment is higher than 800masl.

The Tina River headwaters (270masl), which are comprised of the junction of two main rivers: Vohara River (1) and Mbeambea River (2) and a minor tributary: Njarimbisu River (3). Becho River (4), a tributary of the Vohara is located further upstream.

At its headwaters, the Tina River flows through a very narrow, steeply sided and incised, limestone gorge. The Tina River upper catchment area is comprised of undisturbed montane forests and aquatic ecosystems. The river itself is characterized by sequences of pools and rapids and sharp meanders. Major boulders, some greater than 3 m diameter, have accumulated along the channel bars. These large boulders indicate that intense floods occasionally occur within this reach.

This reach of the Tina River flows along a north-south orientated thrust fault (GeoRisk Solutions, 2012).

14.2.1.3 Middle Tina River Catchment

For the purposes of this assessment, the middle Tina River is defined as the stretch of river from immediately downstream of the dam to the Tina/Toni river confluence, and includes the 5.7km section of by-passed river. The upper half of this reach is dominated by the steep-sided Tina River gorge. Moving down the river toward the Tina/Toni river confluence, the slopes gradually become less steep and are dotted with a few human settlements and gardens.

14.2.1.4 Lower Tina River/Ngalimbiu River

The Tina River joins the Toni River 17km downstream from the Tina River's headwaters. The Toni River is a much smaller river with a catchment area of roughly 45km² and flows that are 1/3 that of the Tina River. From the confluence of the Tina/Toni river, the river becomes the Ngalimbiu River, which flows through a coastal plain before discharging into Tenaru Bay in Iron Bottom Sound, on Guadalcanal's North coast.

The Toni River, which flows from a hilly area of elevation 600 masl to 200 masl, meets the Tina River at 40 masl, which marks the beginning of the Ngalimbiu River plain.

The Ngalimbiu River flows across an area characterized by denser human settlement, and other anthropogenic human activities, such as gravel extraction. Drainage from agricultural lands, such as oil palm plantations, enters the river. A small delta has formed at the mouth of the Ngalimbiu River where it enters the Solomon Sea at Lasa Point (close to Tenaru Bay).

14.2.2 Environmental Conditions

Historic rainfall records for Tina River do not exist. However, based on modelling it is estimated that annual rainfall at the dam site exceeds 2500mm. The same model predicts in excess of 3500mm of total annual rainfall in the headwater reaches of the Tina River. Average daily temperatures in Guadalcanal range from 22°C to 31°C throughout the year, with a yearly average of 26.6°C in Honiara.

From the flora survey, a total of 159 plant species were identified. Among the species identified, 5 are listed as vulnerable, and 19 are listed as threatened. A total of 66 species of trees, fern trees and palm trees were identified. They are classified in the "tree stratum". Many species are regrowth and secondary trees species and are, therefore, good indicators of past disturbances, whether from natural events (e.g., cyclones; landslides) or anthropogenic activities (e.g., timber harvest). At least 23 identified tree species are of commercial timber value. A total of 36 shrubs and vines, and a total of 57 herbaceous plants were identified.

The upstream area is dominated by highly valued, undisturbed lowland forests, whereas, the downstream area near Choro, is dominated by disturbed forests. This is mainly the result of anthropogenic activities (e.g., logging, settlements, garden, trails, etc.). However, even though the forests are disturbed, they still show rich plant diversity, which is a factor of rapid vegetation regeneration due to a tropical humid climate and fertile soils.

Wildlife observed within the project included: 9 amphibian species out a total of 13 potential species⁸⁷ from 4 families; 5 reptile species out a total of 23 potential species representing 5 families; 41 bird species, representing 28 families, out of a total of 67 potential species previously recorded; and 5 mammals were observed out of a total of 14 potential species from 4 families.

14.2.3 Socio-economic / socio-community Conditions

The TRHDP study area consists of over 30 villages and hamlets of mainly indigenous people originating from the central Guadalcanal mountain lands, and several official “settler” villages made up of people originating from South Guadalcanal/Weather Coast. Settlements range in size from two-house hamlets with one extended family, up to villages with dozens of houses and over a hundred residents.

Most hamlets in the study area are connected together by walking tracks and in some cases by dirt roads, which are prone to becoming impassable during wet weather. In recent years, settlements have been established along the main Bahomea access road and logging track that run up the ridge that marks the left side of the Tina Valley.

At present, the mountainous area of the upper catchment is essentially unpopulated, apart from periodic expeditions by the traditional owners for hunting and camping, and to reconnect with customary ‘homelands’.

Previous local estimates put the population of the TRHDP area at approximately 2000, with half of these having “direct access” to the Tina/Ngalimbu River (Entura, 2012:32). The counts made during the ESIA fieldwork put the Bahomea/Tina population at about 1800, divided among approximately 362 households.

The villages of the project area have an average population of approximately 56 people, and an average of 11 households. Settlement sizes vary from 4 persons for Choro (the isolated occupation site in the upper Tina River), to 219 for the settler community of Verakabikabi. Nearly half the surveyed settlements had 5 households or less, and only 11 of the 32 villages had 20 households or more. The largest indigenous villages (with 100 people or more) are Tina, Antioch, Valebebe, Haimane, Mangakiki, and Marava. The average household size in the TRHDP area is 5 persons

⁸⁷ The term ‘potential species’ is defined as species that were found in the vicinity by previous studies and have a likelihood of being present, even if they were not observed in the course of this study.

The main livelihood activities of communities and households of the project area appear to be daily food security, and protection of the family from risks of climate and loss of resources. With a paucity of financial capital, local people use a range of strategies, including: a mix of traditional garden cultivation and gathering of staple foods for subsistence needs, combined with occasional hunting; cash-earning activities (e.g., cash crops, small-scale timber milling; day labouring; fishing; small home-based businesses; full or part-time employment for government and private sector companies).

14.3 SCOPE FOR CIA

This section identifies the VECs, their spatial and temporal boundaries, and the past, present and reasonably foreseeable projects and activities that could contribute to cumulative impacts on VECs.

14.3.1 Identification of VECs

As previously noted, VECs were defined for the ESIA baseline and assessment studies based on the following:

- ▶ Consultation with project-affected communities;
- ▶ Consultation with SIG resource management agencies; and
- ▶ Review of existing documents.

The VECs, the rationale for their selection and their spatial and temporal boundaries are presented in Table 14-1.

Table 14-1 VEC selection, rationale and boundaries for CIA

VECs	Rationale for Selection	Area of Influence Boundaries	
		Spatial	Temporal
Slope Stability, Soil Erosion and Water Quality	Potential impacts from an expanded Gold Ridge Mine, timber harvesting, soil damage, GPOL oil palm plantation chemicals in drainage, gravel extraction turbidity	Tina River/ Ngalimbiu River – from upper catchment to ocean, and Toni River catchment	TRHDP construction operation period
Terrestrial and Aquatic Habitat and Biodiversity Loss	Potential impacts from timber harvesting, and gravel extraction	TRHDP Core Area, access road and transmission lines, and upper catchment	TRHDP construction operation period

VECs	Rationale for Selection	Area of Influence Boundaries	
		Spatial	Temporal
Employment	Potential conflicts between locals and expatriates for jobs; competition with other key projects	Villages in vicinity of TRHDP Core Area	TRHDP construction period
Food Security	Potential resource depletion owing to food supplied to the key projects	THRDP Core Area and surrounding communities that grow and sell food	Primarily TRHDP construction period
Challenges to Cultural and Traditional Practices	Potential conflicts arising from presence of workers from outside Core Area	TRHDP Core Area and surrounding communities from which workers may be drawn	Primarily TRHDP construction period
Substance Abuse, Domestic Violence and other Increased Crime	Potential conflicts arising due to increased cash economy.	TRHDP Core Area and surrounding communities from which workers may be drawn	Primarily TRHDP construction period
Visual Intrusion	Potential reduction in visual amenity due to large man-made structures and intrusive lighting at night	TRHDP damsite and powerhouse, GPPOL and Goldridge facilities	Primarily during operation period
Natural Resources Availability	Pressure on natural resources due to increased population	TRHDP Core Area and upstream and downstream catchments	TRHDP construction and operation periods
Natural Hazards and Dam Safety	Potential for catastrophic dam failure primarily from natural hazards	TRHDP damsite and upstream catchment	Primarily TRHDP operation period

14.3.2 Projects or Activities Considered for CIA

Only those projects or activities whose impacts on the selected VECs potentially overlap (spatially and temporally) with the impacts of the same VECs for past, present or reasonably foreseen projects or activities, were considered for CIA.

There are four key projects or activities whose impacts could potentially overlap with the impacts generated by the TRHDP to create cumulative impacts. These include:

- Potential expansion of mining on the Gold Ridge tenement;

-
- GPPOL's Oil Palm production;
 - Artisanal and commercial harvesting of timber; and
 - Gravel extraction on the Ngalimbiu River.

14.3.2.1 Mining Activities

5.1.1.1.4 Past and Present Mining Activities

As stated in the Gold Ridge Mining Agreement, dated 14 September 1995, Gold Ridge's prospecting license (SPL194 – Vanusa Tenement) extends over a rectangular portion of the Bahomea area and covers 130 km² (see Figure 14-2). The lease overlaps with the middle section of the Toni River watershed, and overlays much of the Tina/Ngalimbiu River watershed near the Tina/Toni river confluence. However, at present, none of the pits, mineral processing or tailings facilities affect the Toni/Ngalimbiu river system.

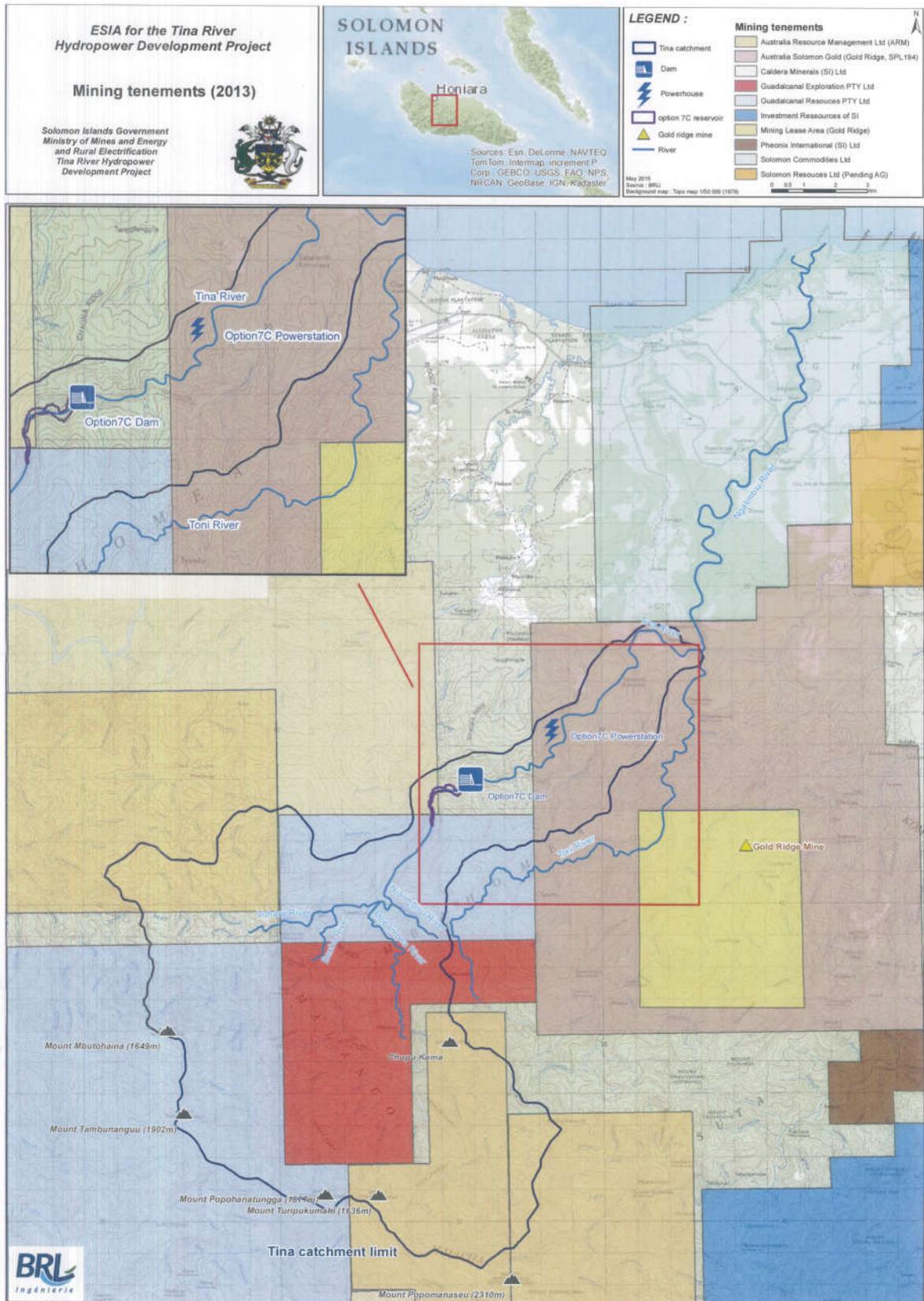
Gold Ridge Mining's facilities, including its Tailings Storage Facility, are presently located on the upper Tinahulu River, which is part of the larger Matepono River catchment. The tailings facility is located approximately 10.5km to the east, and outside of, the Toni River watershed. The tailings dam contains turbid water with high concentrations of cyanide, arsenic, copper, zinc and nickel, particularly in the sediments, which is not supposed to be released into the Tinahulu River. A water quality monitoring program is in place for the Matepono catchment, to confirm whether mine related contamination is occurring, or not. Arsenic, Mercury, Cadmium and other metals were found in sediments of the Chovohoi and Matepono Rivers, many of which exceeded ANZECC guideline values. However, aluminium, copper, arsenic, cadmium, lead, cobalt and mercury levels also exceeded the ANZECC guidelines at some surface water sampling sites that were unaffected by the Project. Some heavy metal concentrations in groundwater samples also exceeded ANZECC guidelines. Highly turbid surface water is also common. Other activities carried out within this river catchment include artisanal placer gold mining, and logging (Golder Associates, 2009).

Fish sampled from the Tinahulu River showed high concentrations of bio-accumulated metals (silver, arsenic, cadmium, cobalt, copper, mercury, lead and zinc), relative to reference samples. It was determined that these high concentrations were attributable to mining activities. Some metal concentrations were potentially detrimental to human and animal health (Golder Associates, 2009).

As part of mine decommissioning, tailings water is to be treated before being released into the river. The substrata of the tailings dam is made of impermeable clay which prevents groundwater pollution. (Ross Mining NL, 1996).

The mine was recently closed and all shares in the holding company sold to a special vehicle corporation established for the purpose, owned primarily by landowners in the Central Guadalcanal area. To reduce the tailings dam level, water from the dam is currently being treated and released in accordance with the terms of the sale.

Figure 14-2 Map of mining tenements (2013) relative to the project area



14.3.2.1.1 Reasonably Foreseeable Mining Activities

Before the closure of the mine, some discussions were underway with landowners regarding possible future extension of mining activities.

A Western extension of the Gold Bridge mine was planned, with new ore pits potentially opening in the upper Toni River watershed. However, with the mine closed and infrastructure and facilities largely destroyed, any mine expansion project is indefinitely on hold unless and until a new investor is found. The current owner of the mine, Goldridge Community Investment Limited, paid a purchase price of \$100 and does not have the resources to develop and re-open the mine without investor support. If new mine pits are established, the excavated ore will probably be processed at existing process facilities, once restored, located within the Tinahulu watershed, rather than within the Toni River watershed.

14.3.2.2 Oil Palm Plantation Activities

14.3.2.2.1 Past and Present Oil Palm Activities

The existing oil palm industry, operated by GPPOL, is located on the coastal plain in the lower Tina River catchment. The industry is currently affecting the aquatic ecosystem of the Ngalimbiu River through the use of herbicides, such as Glyphosate CT, Basta (Glufosinate), 2-4-D Amine, Ally (Metsulfuron Methyl), Kamba 500 Selective herbicide (dimethylamine salt), which are manually applied to keep vegetation under control. Use of other herbicides, such as Gramoxone Tropical (Paraquat), has been discontinued (New Britain Palm Oil Limited, 2011).

Water quality in the Ngalimbiu River has also been affected by GPPOL's use of soil nutrients, including nitrogen-based fertilisers, Keiserite (magnesium), Muriate of Potash (potassium) and boron.

According to Sol-Law Lawyers, monthly water quality sampling of discharges from ponds and watercourses that drain the plantations, is done for BOD, pH, TSS, and Oil and Grease. However, the Ngalimbiu River is not being monitored for pesticides or fertilizers. Also, water quality results are not publicly available.

14.3.2.2.2 Reasonably Foreseeable Oil Palm Activities

There is no indication that the existing oil palm industry plans to expand further up the Tina/Ngalimbiu River, beyond the current coastal plain. Given the hilly topography of the upstream area and the issues of land ownership, it is doubtful that expansion would occur in this direction.

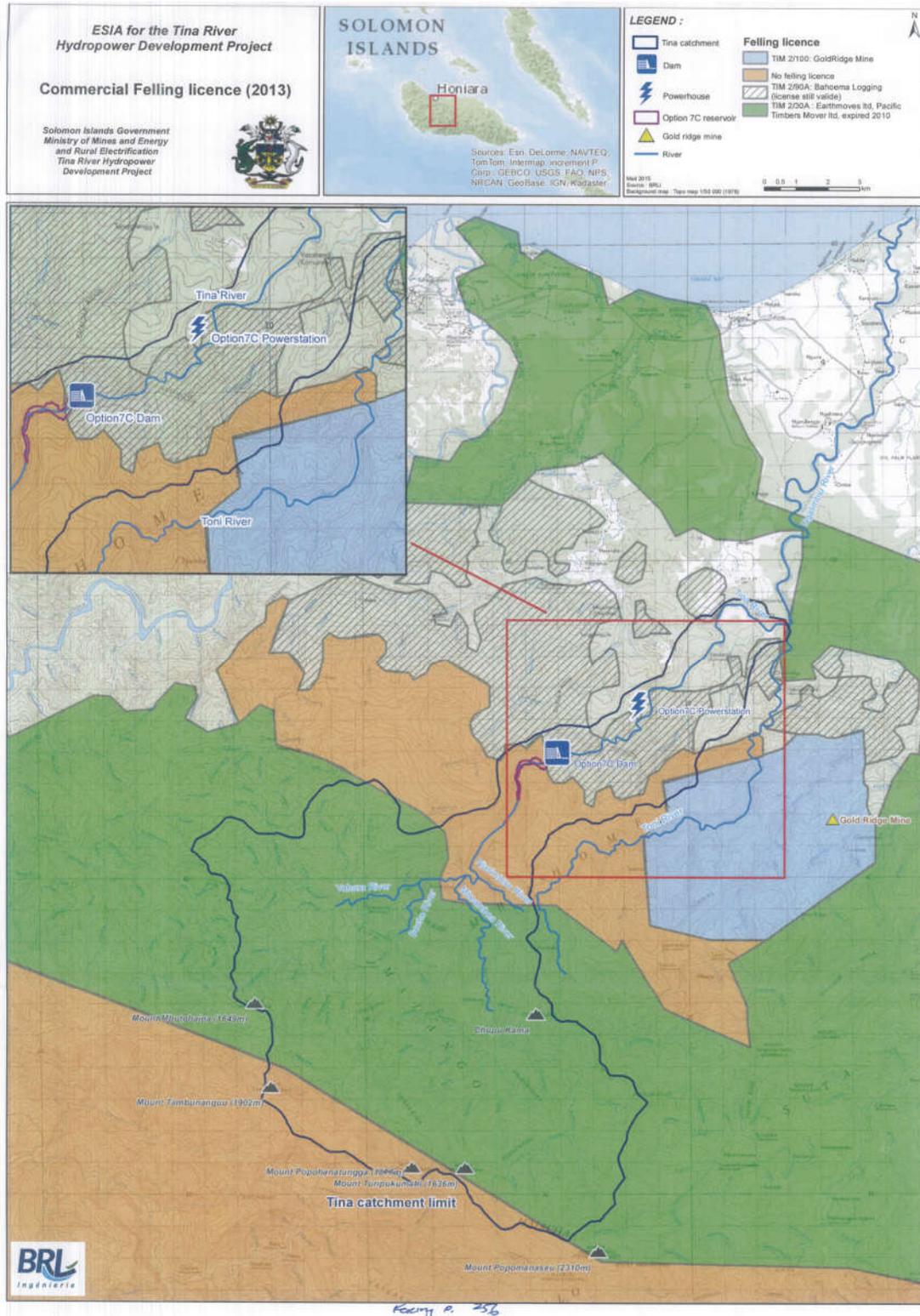
14.3.2.3 Timber Harvesting Activities

14.3.2.3.1 Past and Present Timber Harvesting Activities

As mentioned previously, timber in Tina River catchment is either commercially exploited, when a customary landowner sells the timber rights, or is selectively harvested by local communities. Either way, timber harvesting is poorly documented.

No information appears to be available regarding the type or volume of timber harvested, or the royalties being paid by timber companies to customary landowners. A single timber harvesting license (TIM 2/90A), which is held by the Bahomea Logging Company, is the only license in the Tina River catchment (see Figure 14-3). Since logging is a poorly documented activity, the full extent of both social and environmental impacts is difficult to assess.

Figure 14-3 Map of timber harvesting licenses relative to the project area



Based on field observations, impacts from selective logging are currently minimal along the banks of the Tina River catchment. Whereas, many areas along the Ngalimbiu River are prone to landslides, either as a result of naturally unstable slopes, or because of past forest clear-cutting or other human activities. The photographs in Figure 14-4 provide examples of landslide features along the Ngalimbiu River, downstream of the confluence of the Tina/Toni rivers in an area that appears to have been recently clear-cut.

Figure 14-4 Landslides on Ngalimbiu near confluence of Tina and Toni rivers



14.3.2.3.2 Reasonably Foreseeable Timber Harvesting Activities

It is reasonable to predict that communities will continue to practice selective timber harvesting in the Project area, which will be made easier with the new access road. However, it is not possible to predict whether legal or illegal commercial logging will occur, as this is largely dependent on whether customary landowners will (or will not) sell the rights to their timber.

Commercial timber harvesting will not be permitted within the area of land acquired for the TRHDP.

14.3.2.4 Gravel Extraction in the Ngalimbiu River

14.3.2.4.1 Past and Present Gravel Extraction Activities

Current gravel extraction in the Ngalimbiu River removes bed material (primarily sand and gravel) to be used as aggregate material in construction activities.

As it is the case with logging activities, there are no official records regarding the amount of gravel extracted, and whether the rate of extraction is faster than the rate of natural replenishment. The latter may be the case, as the activity currently contributes to erosion of river-banks. In the long term, the industry is probably not sustainable. As an industry, it is not monitored by the SIG, and does not pay royalties to government. Instead, royalties are paid to customary landowners (SOPAC Secretariat, 2006).

14.3.2.4.2 Reasonably Foreseeable Gravel Extraction Activities

Given that the TRHDP will act as a barrier to recruitment of sand and gravel to the downstream Ngalimbiu reach, it is unlikely that new gravel extraction enterprises will develop within the river in future.

14.3.2.5 Other Past, Present or Reasonably Foreseeable Projects

No other projects or activities, past, present or reasonably foreseeable, were identified by local community or SIG stakeholders that would have a spatial or temporal overlap with the TRHDP, such that they would contribute to cumulative impacts.

14.3.3 Assessment of Cumulative Impacts

14.3.3.1 Slope Stability, Soil Erosion and Water Quality

The downstream communities are important stakeholders for any development on the Guadalcanal plains. The GPPOL and Gold Ridge experience have shown that not taking downstream communities seriously will result in operations being frequently sabotaged. Gold Ridge, in particular, has had to deal with a disgruntled downstream community that blames many issues relating to the river system and water quality on the mining operations located upstream. The downstream communities are related to those upstream and, generally, when they take matters into their own hands the upstream communities usually do not interfere. Gold Ridge is faced with all the risks of disturbance to their operation. This risk will probably be no different for the TRHDP.

The cumulative impacts are in part based on the fact that the hydropower, oil palm and mining activities all overlap temporally, and have a degree of spatial overlap as well (see Table 13-4). The oil palm industry is located downstream of the TRHDP partly within the Ngalimbiu River catchment, and partly within the Matepono River catchment, while the Gold Ridge mine is located on the Tinahula / Chovohoi River catchment, with both rivers joining into the Matepono River. SPL194 Mining Tenement is located on both the Tina River and Toni River catchments (see Figure X-Y), and the actual Gold Ridge mining lease is located partly on the Toni River, although no activity has taken place in the Toni River catchment.

Water quality for many of the major rivers on Guadalcanal has been a source of concern. The communities along the Matepono River, downstream of the Gold Ridge operation, are in frequent conflict with the company. They claim that the river was contaminated by mining operations, resulting in the loss of livelihoods that are dependent on the river. Changes in water quality during rainy seasons are also blamed on the mining operation. The construction of the hydropower dam for the TRHDP will be a source of concern for downstream communities, due to changes to flow levels and perceived pollution levels.

An important aspect is the pollution from the use of chemicals during the construction phase of the dam, in particular, the use of large quantities of concrete. In terms of pollution, the Gold Ridge tailings dam is a potential threat for downstream communities along the Matepono River. In addition, GPOL uses herbicides. Table 14-2 summarizes the threat to water quality caused by various projects or activities.

Table 14-2 River reaches potentially affected by cumulative impacts

Activities	River systems concerned					
	Tinahulu River (headwater tributary of the Matepono River)	Chovohoi River (headwater tributary of the Matepono River)	Matepono River	Tina River (headwater tributary of the Ngalimbiu River)	Toni River (headwater tributary of the Ngalimbiu River)	Ngalimbiu River
Actual Gold Ridge Mining Limited activities	X	X	X			
Actual mining lease of Gold Ridge Mining Limited	X	X			X	X
Foreseen activities of Gold Ridge Mining Limited (SPL 194, Vunusa Tenement)	X	X	X	X	X	X
Actual Oil Palm activities			X			X
Tina River Hydropower Development Project				X		X

There is a present risk of cumulative impacts on water quality and aquatic habitats due to the interaction of the TRDHP and GPPOL projects, and a potential interaction of these two projects with the Gold Ridge project if the Gold Ridge project expands westward into the Tina River catchment, such that there is spatial overlap between all three. The previous Gold Ridge mine activities did not spatially overlap with the TRHDP or GPPOL projects and any expansion of the Gold Ridge mine is now less likely following the closure of the mine. Therefore, at present there are no cumulative impacts foreseen arising from the TRHDP and Gold Ridge's mining activities on water quality; previous mining activities, including drainage from existing tailings outlets, do not connect to the Toni River, i.e., there is no spatial overlap with the TRHDP's area of influence. Therefore, the cumulative impact is presently not significant.

If any Gold Ridge's mining activities expand to involve tailings works, mine access roads, or overburden spoils dumps within the Toni River catchment during the period when the TRHDP is being constructed, cumulative impacts on water quality and suspended sediment loading could occur downstream of the Tina/Toni river confluence. Additional indirect cumulative impacts would then accrue to aquatic habitats, aquatic organisms, and to water uses. However, at present, there is no indication that the mine will actually be reactivated or, if it is, whether mine development would expand into the Toni River drainage. Therefore, the cumulative impact continues to be not significant.

The TRHDP and oil palm industry overlap both spatially and temporally, insofar as potential releases of sediment-laden runoff and contaminants into the Tina and Ngalimbiu rivers during construction of the TRHDP, and herbicide and nutrient containing runoff releases from oil palm plantations into the Ngalimbiu River, coincide. However, until sampling data on contaminant levels in oil palm plantation drainage waters released into the Ngalimbiu River are available, it is difficult to assess the magnitude of cumulative impacts to water quality in the lower Ngalimbiu River. Notwithstanding, it is anticipated that surface water and sediments in the river will contain traces of the chemicals used on the plantations. During TRHDP construction, water will become turbid due to sediment-laden runoff draining the earthworks. This impact will combine with the impacts from oil palm fields, and will be more significant on days with high rainfall, when drainage water from the field will discharge pollutants into the Ngalimbiu River.

Construction and operation of the TRHDP, when combined with logging activities, will generate cumulative impacts. These will be brought about because:

- The presence of a new access road into the forest could make it easier for timber companies to access areas of standing timber than it is with the logging roads that presently exist; and
- Construction of the access road will further degrade the state of disturbed forest in the area, as it will be easier to remove remaining trees.

Selective logging has less impact on topsoil erosion than forest clear-cutting. Regardless of the type of logging activity, the threat to water quality from current logging or past logging activities along Tina River is a reality, particularly at stream and river crossings.

With the creation of the access road, logging activities could intensify if no formal protection of the Tina River catchment is implemented. Increased logging could contribute to erosion or slope failure, and increased suspended sediment loading of the river. If this occurred upstream of the reservoir, it would speed up reservoir sedimentation, and impact aquatic life both in the reservoir and in the river downstream. As documented in the Gold Ridge ESIA, an increase of logging activities occurred as a result of improving road access around Gold Ridge mine.

Gravel extraction is likely to be the most important cause of current turbidity level in the Ngalimbiu River. Therefore, during construction of the TRHDP dam, there will be cumulative impacts on water quality. Operation of the dam will, however, release clear water, thereby eliminating the cumulative impacts.

14.3.3.2 Terrestrial and Aquatic Habitat and Biodiversity Loss

Cumulative impacts of habitat and biodiversity loss will also be significant between the TRHDP (hydropower) and GPPOL (oil palm) projects. However, unless the Gold Ridge (mining) project expands westward into the Toni River catchment area, there is no spatial overlap and, therefore, no cumulative impact with mining. A portion of forest will be removed and a portion of the river system will be impounded to create the reservoir behind the dam. This is in addition to the significant habitat loss that occurred when the GPPOL operation expanded its production to new “out-growers” who supply oil palm kernels from new satellite plantations, and Gold Ridge prospected onto new sites in central Guadalcanal. This will result in a net loss of habitats and biodiversity.

How the combination of the TRHDP and chemical contaminants discharged from the oil palm plantations into the Ngalimbiu River will affect fish and other aquatic life is difficult to assess, since most studies on herbicide toxicity are carried out using organisms that are not present in Solomon Islands (see Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2012; Dinehart *et al.*, 2008; USDA, Forest Service, 2006; and USDA, Forest Service, 2004).

The presence of the TRHDP dam will act as a barrier to sediment coming from upstream. Without mitigation in the form of periodic replenishment of downstream bed load, there will eventually be a net deficit in recruitment of sand and gravel into the Ngalimbiu River. Such deficit may eventually lead to river-bank erosion and may impact fish communities that rely on gravel for spawning. However, there is sufficient material present as bed-load and on river terraces in the middle and lower reaches of the Tina River to provide for downstream sediment recruitment for many decades to come. Any dewatering and excavation or dredging of accumulated bed load sediments from the reservoir will further ameliorate any cumulative impacts over this time period.

14.3.3.3 Land Acquisition and Tenure

A major cumulative environmental impact will be the land tenure change from customary land tenure to alienated land in the Core Area in addition to the land already alienated to GPPOL for the oil palm plantations, and to Gold Ridge Ltd., for mine development.

The process of land tenure alienation sometimes leads to land disputes, although the process followed for TRHDP has averted any serious disagreements. This situation remains prevalent on Guadalcanal with, for example, recent disputes at Gold Ridge. Many of the landowners of the TRHDP area are also landowners of the Gold Ridge mining sites. The disagreements over land ranges from land boundaries, to royalty payments, access rights, tambu sites and even access to developed lands.

Tensions for land acquisition could flare as families, tribes and villages attempt to reconcile the customary land ownership with the government's requirement for landowners to be legally registered, so that the developer can gain land access rights. In the process of acquiring land, identifying the lawful landowners is usually difficult, sometimes leading to more conflict in the community, and ongoing tensions amongst tribes and families. Some disputes of land boundaries are many years old, and have not been resolved sometimes due to a delay in process.

Disputes over royalty payments for land access, is the most common cause of disagreements. Where no clear guidelines and transparency of process is defined, it amounts to continuous tension and disruption of the development activities. This is the experience of both Gold Ridge and GPPOL.

Reclamation of alienated land is among the most challenging land issues, the background of which was the recent civil-conflict which in part involved a request for alienated land on Guadalcanal to be returned to indigenous landowners. At Gold Ridge, after the civil-conflict, some 400 relocated villagers returned to the mine area. Among them, 100 do not have recognizable claims to the land.

14.3.3.4 Employment

Employment is among the most important benefits that all projects have brought to communities and landowners on the Guadalcanal plains and the broader Solomon Islands. The development of the TRHDP would mean a new employment opportunity for communities in the project area.

Post-conflict Guadalcanal has also been resistant to allowing workers from other provinces to work on development projects within their province. This is a challenge that GPPOL and Gold Ridge have had to address, in particular, when skilled workers were needed.

Employment of non-local workers for jobs that could be done by locals could be a threat to the stability of activities. Gold Ridge's experience with the employment of Fijian security officers exacerbated tensions and resulted in resentment by the communities within the project area. GPPOL, on the other hand recently employed local contractors to provide security for its operation, which resulted in significant improvement of the company's operations.

14.3.3.5 Food Security

The combination of three large-scale developments (hydro, oil palm and mining) could further increase the pressure on food security for many communities around the project site. Many of these communities are already supplying local produce to the GPPOL and Gold Ridge work forces, and TRHDP will be an additional one. The increasing dependence on the cash economy will mean that most farmers could produce more to meet market demands, which could mean more pressure on food security of the communities.

14.3.3.6 Challenges to Cultural and Traditional Practices

The added pressure on traditional norms and cultural practices due to the presence of three large-scale developments will result in potential tensions and conflicts within the project area.

Existing internal issues and tensions between communities, tribes and individuals created by existing activities nearby could spill over to affect TRHDP. Also, issues relating to Gold Ridge or GPPOL could spill over to affect the TRHDP, due to relationships of kinship and land shared among the people and communities.

The pressures on traditional norms and cultures from the influence of “western” and modern ways, will increase significantly as communities interact with those participating in the development activities. These interactions could be beneficial in terms of cross-cultural interaction but, at other times, will result in strains on project-affected communities. It could be argued that Gold Ridge is gone, and GPPOL is an example of good practice that TRHDP is following, so the cumulative impact if any is likely to be positive.

14.3.3.7 Substance Abuse and Increased Crime

Substance abuse and alcohol related abuse are frequent among men working at both GPPOL and Gold Ridge. This issue was frequently raised during the Project social surveys, as well as during the February 2014 Mitigation Workshops. The main reason is that some men are unused to regularly receiving a cash salary and do not have the necessary experience to manage their money. Consulted communities fear that the TRHDP will be no exception. This is a challenge that the TRHDP will need to take seriously, to develop appropriate prevention measures. Alcohol and drug abuse result in domestic disputes and issues that threaten peace and harmony within the communities. The experience is that many of the disputes are often started with alcohol and drug abuse. The relatively sudden availability of cash can also result in inappropriate and illegal social behaviour, ranging from petty crimes to criminal related activities.

14.3.3.8 Visual Intrusion

The Guadalcanal Plains already have a very distinct visual impact due to the presence of oil palm. The GPPOL plantations and Gold Ridge are highly visible from a distance. The TRHDP access road and the by-passed river reach would create a significant additional visual intrusion to the area, reducing the natural visual amenity of the whole area. The development of the dam and hydropower station will also be distinct features, although they will only be visible to nearby observers, owing to the steep topography. Already at night the GPPOL oil palm and Gold Ridge mine projects emit light that can be seen at a distance, and TRHDP will be an additional light source. To mitigate this impact, it is recommended not to light the dam at night during operation, or to use only low flux lighting if security lighting is required.

14.3.3.9 Natural Resources Availability

The three major projects - TRHDP, Gold Ridge mines and GPPOL oil palm – have allowed, and will continue to allow, local communities to significantly improve their livelihoods. Although social challenges, such as land tenure issues and disruption of traditional ways of life, are still present, these projects contribute to positive changes to local communities. These projects also have a downside, insofar as improved livelihoods contribute to increased population, new human settlements and demand for land. The projects will, therefore, contribute to increased pressure on natural resources such as wildlife, fish, and forest products. Increased population will lead to degraded water quality, primarily as measured by turbidity and coliform. There is also a risk that squatters will arrive on site and initiate land disputes with local villagers. Human settlement expanding into previously forested areas could bring domestic animals that can become feral, and could open the path for invasive species.

14.3.3.10 Natural Hazards and Dam Safety

Community consultations indicated a concern for dam safety, particularly catastrophic dam failure that could send a wave surging down the Tina River valley, destroying homes and taking lives as it inundated villages. The primary activity that would combine with the TRHDP to create a cumulative impact is timber harvesting in the upper catchment area of the Tina River. The concern is related to commercial clear-cutting, as opposed to select harvesting as it is currently carried out. Clear-cutting on steep slopes could expose fragile soils, destabilise slopes, and result in flooding, landslides and debris flows that could endanger the dam and reservoir. If commercial timber harvesting were prohibited in the catchment upstream of the dam, the potential cumulative impact would be mitigated and not significant. Commercial timber felling of sloped land above 400m is currently not permitted under the relevant law (*Forest Resources and Timber Utilisation Act*). Where this law is enforced it will prevent commercial logging over the vast majority of the upper catchment area.

14.4 MEASURES FOR ADDRESSING CUMULATIVE IMPACTS

Many cumulative impacts are related to land tenure issues, water quality issues, loss of biodiversity and economic growth in the area, the latter of which is a positive impact. Most measures presented in this ESIA already address TRHDP's contribution to cumulative impacts. However, this section focuses specifically on additional means of addressing cumulative impacts.

Addressing cumulative impacts requires measures that encompass a larger area of influence than that for the TRHDP on its own, to reflect the spatial overlap of the projects and activities discussed above. Since cumulative impacts are the result of projects or activities that are beyond the jurisdiction of any one project developer or operator, they must by necessity involve the SIG along with the project staff. Three measures are proposed to address cumulative impacts. These include:

1. The Solomon Islands Government (SIG) could create an inter-community environmental and social action committee comprised of representatives of the government, affected communities and local industries.

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- The committee would need to include representatives of all communities in a defined area. It would meet on a regular basis to discuss the activities of the various industries whose impacts on VECs overlap spatially and temporally. Subjects of discussion would include water quality and environmental monitoring results, health and wellbeing of communities, safety issues, and other relevant topics. The committee would base its discussions on Stakeholder Engagement Plans of the various activities in the area.
 - A constraint to the efficiency of such a committee is that the focus of discussions could be drawn into land ownership and royalty payment issues.
 - Another constraint is that each community has its own interests regarding industries. The oil palm industry mainly benefits downstream communities, while TRHDP will likely benefit upstream communities. Discussions may be counter-productive and may be hindered by community rivalry.
 - The committee would, therefore, require a facilitator/mediator to ensure that discussions were focused on the common issues related to managing cumulative impacts and directing individual grievances from communities to specific industries, landowners and the government, to be dealt with outside the committee process.
2. The Solomon Islands Government (SIG) could develop a Local Spatial Development Plan for alienated and customary lands, to ensure good management of the rapid land development in the area:
- Many of the lands that will be utilized for both construction and operation of the TRHDP will be alienated from customary ownership. In addition, many lands in the area are still under indigenous ownership. A Local Spatial Development Plan for the project area would guide and manage the growth of peri-urban (i.e., rural-urban transition) areas, and set goals for good governance of land. The plan would aim at defining long-term developments and a vision for the desired spatial form and structure of the area, to ensure that land use demands are well managed both socially and environmentally.
 - Such a plan would define strategies aimed at safeguarding environmental quality, improving health and education, and peoples' livelihoods. For example, it would define biodiversity networks and assess ecosystem values and services.
 - Such a plan would define area zoning, and restrict some land use in highly valued areas.
 - Such a plan would spatially coordinate and align public investment, and provide policy guidance for decision-making processes.
 - A challenge to such a plan would be that there are both alienated lands and customary lands. Currently planning legislation does not extend national jurisdiction to planning controls on customary land. The SIG would, therefore, need to fully involve communities in spatial planning procedures, and be adaptable and flexible. However, given the difficulty in reaching agreement for land development in the area, and given indigenous land tenure conflicts (i.e., Indigenous land identification process is lengthy), and the limited capacity of the SIG, implementing such a plan may not be realistic.
3. All industries in the area would cooperate to implement common actions:
- Local industries could create a fund to implement common actions for the benefit of communities, or could join to create a global community communication plan.

- A major constraint to such a measure is that some activities in the area are unorganized and, therefore, have no communication system.. This includes the timber harvesting and gravel extraction industries, neither of which are transparent, have a Stakeholder Engagement Plan, or a formal means of communicating with communities.

In conclusion, many constraints limit the implementation of global actions to mitigate cumulative impacts, particularly the lack of capacity of the SIG, the mixed-land tenure system in the area, and the lack of transparency of some local industries. Since TRHDP will be located in the upstream area of the Tina River system, mitigation measures designed for the Project will also address some of the cumulative impact issues.

14.5 LIMITATIONS

The primary limitation in conducting the CIA was the lack of available information on other reasonably foreseeable projects or activities that may have either a spatial or temporal overlap with the TRHDP. A second phase of the CIA is anticipated during project implementation, to focus in greater depth on the most pertinent VECs and explore possible management responses in more detail.

14.6 CONCLUSIONS ON CUMULATIVE IMPACTS

A summary of the CIA analysis is presented in Table 14-3.

Table 14-3 CIA summary

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Decrease in slope stability, leading to increased soil erosion, and decreased water quality during construction	Low risk of cumulative impacts as long as no clear cutting are allowed nearby Tina River		If new gold mines are exploited in the SPL 194, there is a high risk of cumulative impacts in the Tina/Ngalimbiu River Catchment	Cumulative impacts along the Ngalimbiu River
Disturbance to aquatic habitats and aquatic life during construction	High risk of cumulative impacts if, in the future, clear cutting is practiced nearby Tina River	Aquatic habitat disturbance from drainage of the palm fields in the Ngalimbiu River Catchment		
Disturbance of water uses during construction				

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Colonization by invasive species	Risk of cumulative impacts if additional logging activities take place in the upstream area thanks to improved access	Oil Palm has opened the way for plant and wildlife invasive species		
Habitat fragmentation				
Direct habitat and biodiversity loss		Oil Palm has transformed some downstream areas in monoculture fields		
Land Related Issues	Land dispute	Land tenure alienation and land dispute	Land tenure alienation and land dispute	Land dispute
Employment	Creation of non-qualified employment	Creation of non-qualified and qualified employment	Creation of non-qualified and qualified employment	Creation of non-qualified employment
Food security pressure		Increased pressure on food security	Increased pressure on food security	
Challenges to cultural and traditional practices		Added pressure on traditional norms and cultural practices	Added pressure on traditional norms and cultural practices	
Substance abuse and increased criminal activities	Substance abuse and alcohol related abuse among men	Substance abuse and alcohol related abuse among men	Substance abuse and alcohol related abuse among men	
Visual intrusion	Degradation of landscape quality	Degradation of landscape quality	Degradation of landscape quality	Degradation of landscape quality

Impacts of TRHDP	Timber Harvesting	GPPOL Oil Palm	Gold Ridge Mine	Gravel Extraction
Degraded water quality	Suspended solids release due to logging	Herbicides and fertilizers pollution in both water and sediment in Ngalimbiu River	Turbidity, metal and heavy metal pollution in both water and sediment in Matepono River and in the Tina/Ngalimbiu River Catchment if SPL 194 is developed	Major increase of turbidity in the Tina/Ngalimbiu River Catchment
Pressures on natural resources availability	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	Improved livelihoods – leads to increased population and related increased pressures on land and availability of natural resources	
Natural hazards and dam safety	Removal of forest upstream of dam, leading to floods, landslides and debris flows that could threaten the dam			

15. EFFECTS OF THE ENVIRONMENT ON THE PROJECT

People in most riverside communities, especially women, expressed concern about potential failure of the dam and the devastating consequences that would result from a sudden release of water stored in the reservoir. This concern is related to the effects that cyclones, earthquakes and/or landslides could have on the Project. Some members of the community suggested that to avoid such risks, all riverside villages should be relocated to higher ground. However, the TRHDP PO does not believe that this is a required course of action, given that the project will be designed to withstand the various impacts of the environment on the Project, as discussed below.

15.1 IMPACTS OF SEISMIC EVENTS

As noted in Section 5.5.2, the damsite is located in an area of significant seismicity (GeoRisk Solutions, 2012), and large earthquakes are common. Fourteen earthquakes having a magnitude of greater than 7.5 have been recorded in the South Solomon trench since 1900 including a 7.8 magnitude earthquake in December 2016.

A series of reports have been undertaken to assess seismicity risks and incorporate these into design. The Seismology Research Centre undertook a Seismic Hazard Assessment of the Project in December 2014. This assessment included an examination of historical seismological data, and identified peak ground acceleration (PGA) and horizontal and vertical seismic co-efficients.

A severe earthquake can have a direct impact on a dam by causing it to fail. To mitigate this potentially significant environmental affect on the Project, the dam, headrace tunnel, powerhouse and associated power generation equipment will be designed to sustain an Operating Base Earthquake (OBE) (Annual Return Period 1 in 500 years) and to withstand a Maximum Design Earthquake MDE (Annual Return Period 1 in 10,000 years). An MDE means that the dam can suffer significant damage and movements but will not collapse and cause an uncontrolled release of the reservoir water. These design stipulations are incorporated into the earthquake design requirements of the Minimum Functional Specifications, forming an annexure to the PPA between the Developer and Solomon Power.

Table 15-1 – Peak Ground Acceleration and Seismic Co-efficients, Dam Safety Advisory Panel Report, March 2016

<i>Return Period</i>	<i>PGA (g)</i>	<i>Horizontal Seismic Coefficient (kh)</i>	<i>Vertical Seismic Coefficient (Kv)</i>
145 (OBE)	0.179	0.12	0.08
475 (DBE)	0.286	0.19	0.13
10,000 (MDE)	0.678	0.45	0.30

The Developer has compiled a Geotechnical Design Review Report which sets out the geotechnical conditions and design criteria that they intend to use for the Project's outline design. This document, together with the Geotechnical Baseline Report for Construction

(GBR-C), stipulate the design measures proposed to meet the OBE and MDE seismic risk requirements.

The Dam Safety Advisory Panel, engaged in accordance with World Bank OP 4.37, has reviewed the relevant reports, including the Seismic Hazard Assessment, Geotechnical Design Review Report and GBR-C and has prepared recommendations to be incorporated into final design in the Dam Safety Panel Advisory Report, March 2016. The design requirements include:

- foundation excavations for diversion conduit to take place on the left bank where the bedding dip of the sandstone/conglomerate is into the abutment; and
- RCC concrete compressive strength to be not less than 10-15MPa to prevent cracking during an OBE.

The Dam Safety Advisory Panel will continue to review design iterations, and final design, in accordance with the dam safety management plans under WB OP 4.37, discussed further in the Environment and Social Management Plan – Chapter 13. In the event of an earthquake occurring, a post quake assessment would be undertaken of all components of the project to ensure they are structurally and functionally sound. In the unlikely event that quake damage occurred to the dam, the reservoir would be lowered to ensure no additional strain was placed on the structure and a full assessment would be carried out to identify measures required to remedy any engineering concerns.

A severe earthquake could also adversely affect power generation, by causing switches to be automatically thrown in the switchyard, and transmission line pylons to fall over. Whilst this would be a significant inconvenience to Guadalcanal for the period of time it would take to affect repairs, it would not present a threat to the safety of villagers residing in the downstream communities.

Indirect impacts associated with an earthquake event include triggering landslides or mass wasting. This is discussed in Section 15.2. An earthquake could also cause trees to topple over and block the access road, or knock out the transmission line.

15.2 LANDSLIDES AND DEBRIS FLOWS

Landslides and debris flows triggered by earthquakes, floods undermining toe of slopes, wind thrown trees losing root cohesion and exposing soils to water-logging

As noted in Section 5.5.1, a significant number of landslides occur within the Tina River catchment, particularly on the steeper slopes. However, they remain relatively small (100m³ to 200m³), and are primarily associated with rockslides along bedding planes. Other slope failures are located in the upstream end of the proposed reservoir, in Suta Volcanics. Debris flows are also a feature of the upper watershed, and are caused when boulders and logs that are trapped in steep gullies or streams are suddenly mobilised due to a flash flood or small headwall landslide being released in the upper reach of the stream during a major rainfall event.

According to Entura (2014), large landslides can have a detrimental effect on the dam and its reservoir if they occur near the dam, or if the landslide causes wave propagation that could overtop the dam, which is a particular concern for earthfill dams. The TRHDP dam will be an RCC dam with an open spillway. Therefore, the risk of overtopping is not an issue, due to the

solid concrete construction and the open spillway design that would pass a landslide propagated wave, should a landslide of significant mass enter the reservoir.

Likewise, debris flows that enter the Tina River upstream of the dam as a result of cyclone generated rainfall deluge, are unlikely to affect the dam or the downstream powerhouse, providing that the fish screens are in place over the power intake, to prevent entrainment of floating woody debris entering the reservoir from debris flows, into the headrace tunnel, as this material could damage the turbine runner blades.

Notwithstanding the above, Entura (2014) has suggested that design of the dam and construction planning should assess the risk of remobilizing existing landslides during construction work. They note that large-scale landslides are unlikely to directly affect the dam.

15.3 IMPACTS OF SEVERE WEATHER OR CLIMATE RELATED EVENTS

Depending on how global climate change is manifested in the Solomon Islands, it is possible that one of three effects will be felt: 1) no significant change to the pattern and volume of rainfall within the region (status quo); 2) increasing frequency of severe tropical cyclones and rainfall events; and 3) reduced frequency and magnitude of rainfall patterns that by present standards would be considered “drought” conditions.

15.3.1 Status Quo Weather and Climate Conditions

As noted in Section 5.6, the Tina River is a single channel meandering river. It has a torrential behavior with regular flash floods. High rainfall events generate periodic flash floods, and debris flows. These events are unlikely to have any direct impact on the dam or associated power generation facilities. The open spillway will pass floodwaters, and the fish screens on the power intake will prevent debris from entering the headrace tunnel and turbines.

15.3.2 Cyclones, Severe Rainfall Events and Floods

As noted in Section 5.4, the project area is subject to periodic cyclone events. In May 1986, cyclone Namu contributed 1200mm of rainfall over a period of a few days, causing rivers to overflow their banks. Water depth at the project site was said to be 7m. The floods and mudflows precipitated by Cyclone Namu reshaped the course of the Tina River.

The primary affect of a cyclone on the Project is the extremely high rainfall that would fall within the catchment area, generating flash floods, debris torrents and, potentially, landslide events. The RCC dam will incorporate an open spillway feature which will be capable of passing a 1:10,000 year flood event without any threat to the dam or its facilities. As the spillway does not have gates or stoplogs, floodwaters will pass over the lip of the spillway unimpeded.

Significant flooding would have the potential to cut off immediate access to the dam due to the likelihood that roads would be flooded or washed out. Due to the small size of the reservoir, it would not have any flood attenuation capacity to mitigate floods generated by high rainfall patterns that accompany a cyclone.

A severe rainfall event can also cause indirect impacts to the Project by saturating soils on steep slopes making them less stable and prone to mass wasting. Where this happens along the access road, the road could be buried in debris or washed out.

15.3.3 Droughts

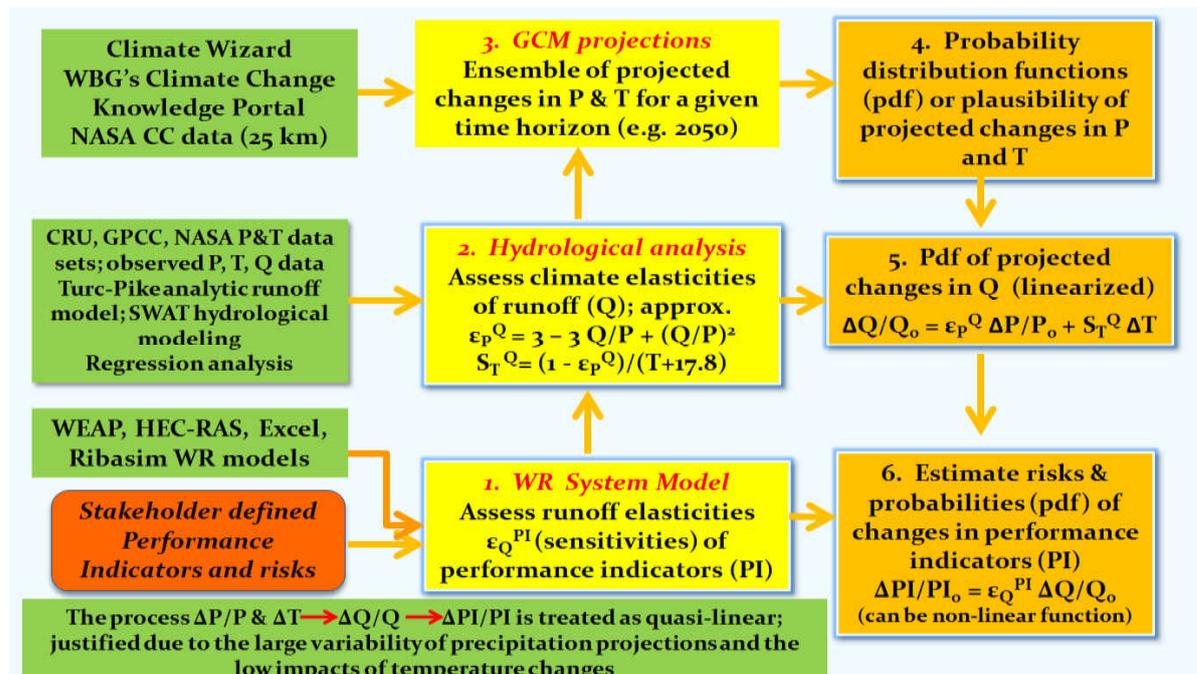
Owing to the reduced flows in the Tina River during the dry season, the TRHDP has been designed to operate as a peaking facility. Power will be generated during the peak load periods during the day, with water released to the river from the powerhouse tailrace. During the night, less power will be generated, and a minimum flow of 3.4m³/s will be released to the river below the powerstation (2.4 m³/s from one turbine plus 1 m³/s environmental flow plus tributary inflows), as the reservoir is refilled for the next cycle of power generation.

If climate change results in reduced average daily dry season flows in the Tina River, then power generation will be affected either by shortening the periods of peak generation during the daytime hours, or reducing the number of turbine/generator sets in operation at a given time. The net effect would be the same – reduced power output for a given volume of water available.

15.3.4 Climate Risk Assessment

With the support of the World Bank, the Solomon Islands Government prepared a *Climate Risk Assessment* (CRA) of TRHP (the Project) by engaging an independent expert. The assessment was completed in June 2016. The objective of the CRA is to assess the impact of climate change on the Project, particularly on the hydrology which affects the economics of the Project. The bottom-up CRA methodology adopted is summarized in the schematic diagram below.

Figure 15-1 - Climate Risk Assessment Process



In view of the perceived economic life time of the Project, the CRA focused on the projected climate and runoff changes for the project area by 2050 and their impacts on the hydro-energy generated by the project. Conclusions are as follows:

- Changes in precipitation explain most of the inter-annual and long-term variability in stream flow. Precipitation changes projected by CMIP5 climate models are distributed fairly uniformly over the year; by 2050 projected changes range between a decrease with 15% and an increase with 15%, on average no significant change. Temperatures are projected to increase uniformly over the year, by 2050 mostly between 0.5 °C and 2 °C, on average with 1.3 °C.
- Based on an analysis of multiple ensembles of CMIP5 and CMIP3 climate projections, it is concluded that by 2050 the average basin runoff can vary between 80% (-20%) and 120% (+20%) of the present runoff due to the combined impacts of a 1.3 °C increase in temperature and potential shifts in precipitation between 85% (-15%) and 115% (+15%) of the present regime; by 2090 the range would likely be between 70% and 130% of the present runoff. On average no significant decrease in runoff is expected but – as indicated here above - the spread between projections of individual climate models is moderate to significant, with an ensemble standard deviation of about 10% by 2050 and 15% by 2090. The analysis shows that only 3 out of 23 combinations of CMIP3 global circulation models and emission scenarios project reductions in river discharge exceeding 10%.
- Generated annual energy could vary most likely between -20% and +10% of the energy generated under the baseline hydrological conditions. This range of annual energy generation is reflected in the economic analysis.
- It is recommended to review at the detailed design stage the preliminary design capacity of the plant's spillway (assessed in 2011), since this estimate was indeed declared to be tentative and also since on a global scale tropical cyclones are projected to be more intense in the future. Climate models agree in general that globally there will be an increase in rainfall rates of the order of 20% within 100 km of the cyclone centre, which could cause for the Tina River basin an increase in extreme flows with 25% to 30%. The operation manual, dam break analysis and emergency preparation plans should also take the possibility of extremely high flash flood flows during tropical cyclone conditions into account.
- Few floods have been accurately measured in the Pacific and there is limited measured flood data to support flood related community risk initiatives, flood mitigation, or water related infrastructure design. Therefore, a concerted effort should be made to monitor rainfall at multiple locations across the upper Tina catchment and monitor river flows at or near the Tina Hydropower dam site. This will allow over time a better assessment of the hydro-meteorological baseline conditions, as well as permit the detection of positive or negative trends in precipitation and runoff caused by climate change.

A new stream gauging station was installed in December 2016 on the Tina River. The contractor is expected to be responsible for monitoring the river water level during construction. The contractor will also update the design of temporary and permanent structures based on these updated hydrological data and in line with the recommendations being made by the Dam Safety Advisory Panel which will be retained by the Solomon Islands Government throughout the construction period and the initial years of operation.

15.4 DAM SAFETY

The World Bank's operational policy 4.37 (see Section 3) requires that the TRHDP prepare and implement a Dam Safety Plan, and that qualified professionals be enlisted to design and operate the project, and prepare the various safety plans. The TRHDP has contracted world class hydropower engineers, who have examined the various environmental risks to the Project. The final layout and design will take into consideration the various effects of the environment on the Project that are discussed above, and produce the requisite safety and operations plans. In addition, the TRHDP PO has engaged a panel of engineering, geotechnical, environmental and social experts to evaluate the Project to ensure that all risks are addressed.

As noted in Chapter 13 Environmental and Social Management Plan, all plans relating to dam safety and response to operations related emergency events will be prepared by the TRHDP's Dam Safety Consultant. The Construction and Quality Assurance Plan, and Operations and Maintenance Plan, are being developed by the TRHDP, and will be submitted for review and approval prior to Bank Appraisal. An Instrumentation and Emergency Response Plan will be developed by the TRHDP during the project design phase, and will be submitted for review and approval prior to project commissioning.

15.5 CONCLUSIONS

The Project will be designed and operated to withstand the various environmental calamities identified above, to ensure the structural integrity of all its components, especially the dam.

16. CONCLUSION

The Tina River Hydropower Development Project (TRHDP) Project Office (PO) is proposing to construct a peaking hydropower facility on the Tina River in northern Guadalcanal Province, Solomon Islands. The Project would be comprised of a 53m high RCC dam, 3.3km headrace tunnel and penstocks, and 3x5MW powerhouse. The Project would provide clean, reliable, renewable power for 80 to 100 years.

The environmental and social impact assessment of the Project was undertaken in accordance with the Solomon Islands' *Environment Act 1998*, World Bank Performance Standards and guidelines, and relevant World Bank operational policies for safeguards. The ESIA demonstrates: 1) that a comprehensive assessment has been completed for the project, 2) the project-affected communities have been provided a clear understanding of the Project and have been properly consulted regarding their issues and concerns; 3) the guidelines for free, prior and informed consent (FPIC) have been followed and the Project satisfies the FPIC requirements; and 4) the TRHDP PO has engaged with customary land owners / Indigenous peoples since early in the planning process, to receive their input.

Based on the results of this environmental and social impact assessment, the TRHDP PO concludes the Tina River Hydropower Development Project is not likely to cause significant adverse environmental, socio economic / socio-community (including to Indigenous peoples) or other effects, taking into account the implementation of appropriate mitigation, management and monitoring measures, as identified in the assessment and mitigation chapters and the Environmental and Social Management Plan (Chapter 13) of this ESIA.

The most significant potential impact is the barrier presented by the 53m high dam to upstream and downstream migrating fish species. However, through a combination of mitigation measures that involve environmental flow (EF) releases, a trap-and-haul system to move upstream migrating juvenile fish past the dam, spillway flow releases to effect adult downstream eel migration, fish screens to prevent entrainment into the power intake and turbines, and an adaptive environmental management program to assess the success of these measures and adjust them accordingly, the potential significant impacts to migrating fish can be reduced to acceptable levels.

The Tina River is a clean and renewable resource for energy generation. Only 115.49ha of forested land will be cleared, of which only 9.5ha is undisturbed forest. Much of this area is within the relatively small footprint of the reservoir area. The developer's Biodiversity Action Plan will provide for an offset to achieve no net loss of biodiversity as a result of the conversion of natural habitat. It will include the protection of the remaining natural habitat in the Core Area, rehabilitation of at least 9.5 Ha of modified habitat in the Core Area, and measures to protect the upper catchment including forest monitoring and restrictions on access through the Core Area. No net loss of biodiversity will also be sought through support for the creation of a protected area in the upper Tina River catchment.

Most of the vegetation from within the reservoir will be removed. This will ensure that the volume of organic material to be inundated contributes very little GHG production as it decomposes. Other areas no longer required for construction will be revegetated with native plant species at the end of the construction period. Overall, the TRHDP will deliver electricity with very low GHG emissions per kWh of energy generated.

Greenhouse gas emissions from Solomon Islands are approximately 618,000 tCO₂e/year. The estimated net GHG emissions abated attributable to the operation of the TRHDP represents an average of 49,000 tCO₂-equivalent. Emissions abated significantly exceed

SIG's INDC commitments to reduce GHG by 18,800 tons of carbon dioxide equivalent (tCO₂eq) per year by 2025 and by 31,125 tCO₂eq per year by 2030 with appropriate international assistance per year.

The effects of the Project, as discussed in this ESIA, have been examined using assessment methods and analytical tools that reflect current good international industry practice of environmental and socio-economic practitioners. After consideration of the potential residual effects, and taking into account the site selection, engineering design, and identified mitigation measures, the TRHDP PO believes that the Project can be constructed, operated, and decommissioned without significant adverse effects.

Further, it is the conclusion of this assessment that the Project will bring substantial net positive benefits, both locally to the communities within the Tina/Ngalimbiu River catchment, and to Guadalcanal in general. The Project will assist in reducing the current cost of electricity, reinforce and expand the electrical system of Guadalcanal, provide direct economic benefits to customary land owners, and provide a "green" source of electrical generation.

Based on these conclusions, TRHDP PO requests that the Project be approved.

TINA RIVER HYDROPOWER DEVELOPMENT PROJECT
Environmental and Social Impact Assessment

Annexures and Appendices

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Appendix I: Analysis of Requirements for Environmental Flow

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Appendix K: Analysis of Opportunities to Conserve Tina River Catchment

Appendix L: Report on Environment Flow Requirements and Fish Passage
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Appendix M: Fauna Report by Edgar Pollard

Appendix N: Matrix of Resolution of Community Concerns

Appendix O: Construction Environment and Social Management Plan
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ANNEXURES

This report includes all Annexures to the ESIA Main Report. It contains valuable information such as minutes of meeting, photoplates of fishes, list of aquatic insects, etc. Annexure sequence in this report is classified in a chronological order and reflect the time at which information was gathered or obtained.

Station A1		Voraha/Becho river	05/08/2013
Location			
<p><u>Coordinates</u>: S9°35.713 - E160°01.676</p> <p><u>River</u> : Voraha River (= Becho river)</p> <p><u>Kp</u>: 38.1km from the river mouth</p> <p><u>Elevation</u>: approx. 300m asl</p> <p><u>River section</u>: Upper Tina river</p> <p><u>Nearest village</u>: no village in the vicinity</p>		<p><u>Location</u>: Station A1 is located on the Voraha/Becho river approx. 200m upstream of the confluence with the Mbembea river and 1km upstream of the TRHDP gauging station</p> <p>The river seems to be designated either as Voraha or Becho (= Bicho, Mbicho) which are the two main tributaries.</p> <p>The confluence with Mbembea river forms the Tina river.</p> <p><u>Access</u>: helicopter drop at Gauging station + upstream walk</p>	
Physical environment			
<p><u>Valley geomorphology</u> : at station A1, the valley is oriented East to West. The valley is quite narrow upstream of the Voraha/Becho confluence, with gorges along the two tributaries. It becomes progressively wider downstream, from the Voraha/Becho confluence to the Mbeambea confluence.</p> <p><u>River system</u>: At station A1, the Voraha/Becho river drains approximately two third of the gauging station watershed. Two main tributaries, Vohana river, from the East and Becho river from the South, collect a dense fanlike network of fast flowing streams on the northern slope of the Popomanaseu ridge oriented NW to SE (Mt Mbutohaina, 1649m, to Mt Turipukumlani, 1636m) and covered with cloud forest.</p> <p><u>Banks & river bed</u>: At station A1, the river bed is 15m in width. The right bank (bedrock) is very steep with a waterfall, whereas the left bank (boulders and cobbles) presents a slope of about 20% The substrate is dominated with cobbles from different origins. Presence of wood detritus.</p> <p><u>Flow pattern</u>: Sloppy river with high velocity. The river upstream of the confluence shows a long ladder of pools and running/riffle waters on a bed of pebbles. The velocity of the station, observed on a 10m radius, is 0,6-2,5m/s on running and riffle areas.</p> <p><u>Water depth</u>: ranging 0 to 1m during the visit. High water marks were observed 4m above the river.</p> <p><u>Water quality</u>: the water was clear (0,61NTU) although there was rain the day before. No source of pollution on the watershed. Conductivity was low (166,3µS/cm).</p>			
Biological environment			
<p><u>Riparian vegetation</u>: Rain forest on the slopes with giant ferns. Large deposit areas with regrowth (trees and shrubs). Banks are shadowed with a dense cover of riparian trees.</p> <p><u>Aquatic vegetation</u>: no aquatic plants or development of green algae.</p> <p><u>Fish</u>: rheophilic gobies are dominant with 5 species observed: <i>Stiphodon semoni</i> & <i>S. rutilaureus</i>, <i>Awaous sp1</i> & <i>sp2</i>, and <i>Sicyopterus sp.</i> Large specimen of other species are likely to be found in pools, due to considerable distance from communities.</p>			
Human activities			
<p>The area is uninhabited (no domestic use & associated pollution) and beyond every day reach of Tina river communities. Though people from Tina occasionally access the place for hunting and fisheries (snorkeling and pole line fishing). No evidence of logging activities in the area.</p>			
Potential impacts of the project on river ecology & resources			
<p>The Voraha/Becho river at station A1 is situated upstream of the future reservoir and dam construction work area, whatever the selected final option. The river physical conditions (flow pattern, velocity, water quality ...) should not be affected by construction and exploitation.</p> <p><u>Impact on fish migration</u>: amphihaline fish juveniles will encounter difficulties to pass upstream of the hydropower facilities and colonize the upper watershed, depending on their specific migrating abilities and on the implementation of an efficient fishpass system. Combined with an increased fishing pressure due to an easier access, a significant impoverishment of aquatic life is expected in the Voraha & Becho rivers.</p>			

Station A1**Voraha/Becho river**

05/08/2013

**1A.** Waterfall on the right bank of station A1**1B.** Pool at the waterfall upstream station A1**1C.** Fish sighting at station A1**1D.** View of the substrate at station A1**1E.** Rapids immediately downstream of stat.A1**1F.** Detail of the bank (bedrock)**1G.** Voraha river upstream of the confluence**1H.** Voraha-Mbembea confluence

Station A2		Mbembea river	05/08/2013
Location			
<p><u>Coordinates</u>: S9°35.751 - E160°01.842</p> <p><u>River</u> : Mbembea</p> <p><u>Kp</u>: 37.96km from the river mouth</p> <p><u>Elevation</u> : approx 300m asl</p> <p><u>River section</u> : Upper Tina river</p> <p><u>Nearest village</u>: no village in the vicinity</p>		<p><u>Location</u>:</p> <p>Station A2 is located on the Mbembea river approx. 100m upstream of the confluence with the Voraha/Becho river and 800m upstream of the TRHDP gauging station</p> <p>The confluence with Voraha/Becho river forms the Tina river.</p> <p><u>Access</u>: helicopter drop at Gauging station + upstream walk</p>	
Physical environment			
<p><u>Valley geomorphology</u> : the Mbembea valley, oriented South to North, is quite narrow upstream of station A2 and becomes larger at the confluence area.</p> <p><u>River system</u>: At station A2, the Mbembea river drains approximately one third of the Tina watershed at the gauging station. The river collects a dense network of fast flowing streams from the western part of the ridge (Mt Turipukumahi, 1636m to Mt Popomanaseu 2310m), covered with cloud forest.</p> <p><u>Banks & river bed</u>: At station A2, the river bed is estimated 7m in width. Big boulders (5m high) are dominants. The substrate is made of cobbles, pebbles and coarse sands, with some detritus of wood and leaflet from upper reach of the river. Banks are very steep on both sides ("V" shaped valley).</p> <p><u>Flow pattern</u>: Sloppy section with high velocity (estimated to more than 2m/s). Succession of fast running sections and pools due to the boulder arrangement. The flow is less important than in the Voraha/Becho river.</p> <p><u>Water depth</u>: up to 3m in pools. High water marks were observed 4m above the river level.</p> <p><u>Water quality</u>: the water was clear (1,07NTU) although there was rain the day before. No source of pollution on the watershed. Conductivity was low (135,7µS/cm).</p>			
Biological environment			
<p><u>Riparian vegetation</u>: Rain forest on the slopes. The river is partially shadowed with a dense cover of riparian trees. Creeping plants on the gorges. Regrowth trees and shrubs on lateral deposits.</p> <p><u>Aquatic vegetation</u>: No aquatic plants. Development of green algae from natural dissolved nutrients have been observed in shallow & calm places along the bank.</p> <p><u>Fish</u>: rheophilic gobies are dominant with 2 species observed: <i>Stiphodon semoni</i> & and <i>Sicyopterus lagocephalus</i>. Large specimen of other species are likely to be found in pools, due to considerable distance from communities.</p>			
Human activities			
<p>The area is uninhabited (no domestic use & associated pollution) and beyond every day reach of Tina river communities. Though people from Tina occasionally access the place for hunting and fisheries (snorkeling and pole line fishing). A shelter has been built on the left bank, between the confluence and the gauging station.</p> <p>No evidence of logging activities in the area.</p>			
Potential impacts of the project on river ecology & resources			
<p>The Mbembea river at station A2 is situated upstream of the future reservoir and dam construction work area, whatever the selected option (6E or 6F). The river physical conditions (flow pattern, velocity, water quality ...) should not be affected by the project construction and exploitation.</p> <p><u>Impact on fish migration</u>: amphihaline fish juveniles will encounter difficulties to pass upstream of the hydropower facilities and colonize the upper watershed, depending on their specific migrating abilities and on the implementation of an efficient fishpass system. Combined with an increased fishing pressure due to an easier access, a significant impoverishment of aquatic life is expected in the Mbembea river.</p>			

Station A2

Mbembea river

05/08/2013

**2A.** Rapids on a bed of boulders**2B.** Crossing a pool**2C.** Ferns growing on cobble deposit**2D.** Green algae in a pool near the shore**2E.** Fast flowing section, pebbles & bedrock**2F.** Becho-Mbembea confluence (aerial view)**2G.** Shelter on the left bank near the confluence.**2H.** Becho-Mbembea confluence

Station A3		TRHDP gauging station	05/08/2013
Location			
<p><u>Coordinates</u>: S9°35.698 - E160°02.036</p> <p><u>River</u>: Tina</p> <p><u>Kp</u>: 37.14km from the river mouth</p> <p><u>Elevation</u>: 267m asl</p> <p><u>River section</u>: Upper Tina river</p> <p><u>Nearest village</u>: no village in the vicinity</p>		<p><u>Location</u>: Station A3 is located on Tina river at the TRHDP gauging station, approximately 1 km downstream from the confluence of the two tributaries Voraha/Bocho and Mbembea which forms the Tina river.</p> <p><u>Access</u>: helicopter drop just near the station</p>	
Physical environment			
<p><u>Valley geomorphology</u>: downstream of the Voraha/Mbembea confluence, the Tina valley, first oriented E-W, enlarges at the gauging station, forms a horse-shoe meander immediately downstream, and turns to a N/N-E direction, entering into a very steep and deep section of gorges for about 5km.</p> <p><u>River system</u>: At the gauging station, the Tina river drains a watershed of 115km² and collects a dense fan-like network of fast flowing streams from the Mt Mbutohaina-Mt Popomanaseu ridge (cloud forest). The station is situated 20m from the Njarimbisu waterfall into the Tina river.</p> <p><u>Banks & river bed</u>: At station A3, the width of the river is approx. 40m. The substrate is dominated by gravels and coarse sand, plus cobbles and pebbles. Upstream of the gauging station, the right is made of bedrock, whereas the left bank presents an accumulation of boulders with regrowth vegetation, forming a flood channel. A pond of stagnant water isolated from the river was observed in the middle of this channel (6m in length and 0,8m in width).</p> <p><u>Flow pattern</u>: At the gauging station, the river forms a large and long pool with a fringe of coarse sand deposit, framed upstream and downstream by rapid sections on a bed of small boulders. The average velocity was estimated 1-2 m/s. At the gauging station, TRHDP monitoring 2010-2012 gives an average flow of 13,2m³/s.</p> <p><u>Water depth</u>: up to 3m in the external side of fast flowing sections.</p> <p><u>Water quality</u>: the water was clear (0,98NTU) although there was rain the day before. No source of pollution on the watershed. Conductivity was low (154,7µS/cm).</p>			
Biological environment			
<p><u>Riparian vegetation</u>: Rain forest on the slopes. The vast area clear of vegetation, with sunlight allows a drop zone. Steep gorges are cover with trees and creepy vegetation. Regrowth trees, shrubs and ferns on deposits.</p> <p><u>Aquatic vegetation</u>: No aquatic plants. Development of green algae from natural dissolved nutrients have been observed in localized puddles among boulder accumulations.</p> <p><u>Fish</u>: rheophilic gobies are dominant with 4 species observed: <i>Stiphodon semoni</i>, <i>Redigobius sp</i> and <i>Stenogobius sp</i>. <i>Kuhlia rupestris</i> was observed in deep waters. Large specimen of other species are likely to be found in pools, due to considerable distance from communities. The isolated pond among boulders showed an important biodiversity, with an eel (30cm) and 2 species of prawns – rarely observed by day - freshwater shrimps, <i>semoni</i> and other gobiids (<i>Glossogobius</i>, <i>Stenogobius</i> ...)</p>			
Human activities			
<p>The area is uninhabited (no domestic use & associated pollution) and beyond every day reach of Tina river communities. The area is occasionally accessed by the project office to collect hydrology data from the gauging station, and by local people for hunting and fishing. No evidence of logging activities.</p>			
Potential impacts of the project on river ecology & resources			
<p>The Tina river at station A3 is situated upstream of the future dam construction work areas (option 6E or 6F) and the water quality will remain undisturbed during implementation phase. The end of reservoir is expected to extend at a short distance downstream of the gauging station, but no disturbance on water level and hydrology is expected.</p> <p><u>Impact on fish migration</u>: amphihaline fish juveniles will encounter difficulties to pass upstream of the hydropower facilities and colonize the upper watershed, depending on their specific migrating abilities and on the implementation of an efficient fishpass system. Combined with an increased fishing pressure due to an easier access, a significant impoverishment of aquatic life is expected in the rivers upstream of the dam.</p>			



3A & 3B. Tina river downstream of the Voraha- Mbembea confluence (boulders and rapids)



3C. Upstream of gauging station – large pool

3D. The gorges upstream of gauging station



3E. Gauging station – limnimetric scale

3F Gauging station – solar panels



3G. Tina river downstream of gauging station

3H.View of the gorges downstream of A3

New Station		7C Dam site	26/02/2014
Location			
<p><u>Coordinates:</u> S 09°33'32.01"-E 160°03'28.01"</p> <p><u>River:</u> Tina</p> <p><u>Kp:</u> 30 km from the river mouth</p> <p><u>Elevation:</u> approx. 230m asl</p> <p><u>River section:</u> Middle Tina river</p> <p><u>Nearest village:</u> Choro</p> <p><u>Weather condition:</u> The weather was fine with few isolated showers during the late afternoons. Cloud cover was 40% with winds blowing SSE direction.</p>		<p><u>Location:</u> New Station is located on Tina river about 0.8 kilometer from Choro hamlet.</p> <p><u>Access:</u> by car up to the village of Mangakiki, then by walk upstream following the river or by chopper from Henderson Airport.</p>	
Physical environment			
<p><u>Valley geomorphology:</u> The new station is upper Choro hamlet. It has a gorge from 160 meter (asl) to about 300 meters on either side of the river. From Njaribisu (gauging station) there is a terrain of 4-5 kilometers contour of high region (300-500 meters), stretching north east towards the Koropa and Senge gorge identified as 6E and 6F dam site options.</p> <p><u>River system:</u> No streams confluences with Tina River in this station.</p> <p><u>Banks & river bed:</u> The width of the river is approximately 10m. The banks have a 80% slope on each side with bedrock at 45° to the river, 20% pebbles/cobbles deposit and 10% of boulders. The substrate is of cobbles, pebbles, coarse and fine sands. There is absence of silt and mud at the station</p> <p><u>Flow pattern:</u> runs and riffle on a bed of cobbles, with deep water (2-3m) on the external side of meanders. Velocity is estimated 0,5 to 1m/s.</p> <p><u>Water quality:</u> the water was clear. Water temperature range estimated to 20-25°C</p>			
Biological environment			
<p><u>Riparian vegetation:</u> The forest is defined undisturbed due less people accessing the area. The vegetation is disturbed in between the gorges (about 1-2 meters either sides). Along the 80% slope there potential large <i>Pometia</i> sp., <i>Callophylum</i> sp., that were used as commercial trees also ginger plants, shrubs and ferns. The station is partially covered canopy.</p> <p><u>Aquatic vegetation:</u> No aquatic plants. No pollution from anthropogenic activities, however few on the sides due to the influence of the terrain and vascular plants i.e. localized runoffs.</p> <p><u>Fish:</u> the observed biodiversity was high (10 species), with observations by day and night. <i>Khulia rupestris</i> and <i>Stiphodon birdsong</i> were dominant. Other gobiids are present (<i>Redigobius bikolanus</i>, <i>Redigobius</i> sp., <i>Awaousocellarus</i>, <i>Glossogobius</i> sp.) as well as <i>Mesopristis</i> sp., <i>Khulia rupestris</i>, <i>Anguilla marmorata</i>.</p>			
Human activities			
<p>There were less people accessing the area unless for hunting and fishing (spear fishing). Such activities were done twice maybe in a month, depending on community activity demands for freshwater foods and bush foods. There were no any other usages of the vegetation since then.</p>			
Potential impacts of the project on river ecology & resources			
<p>The station is the dam site and operations may affect the riverine system. This includes, heavy machineries, labor personals, cutting of trees which will increase sedimentation in rainy times. This will happen during the construction and exploitation stage. Once the dam will be built, the hydrological conditions in this area will be completely modified (reservoir upstream, artificial outflow downstream). This applied to several kilometers from up and downstream of the dam.</p> <p>Water quality before at and after the dam will deteriorated in the first months and years of construction and during exploitation stage (organic matter in the reservoir (high nutrients) , deoxygenated water at the bottom of the reservoir, possible release of NH4, As, Hg, CH3...).</p> <p>Significant impacts are expected on aquatic biodiversity especial the migration fish upstream and downstream for feeding and spawning and resources for subsistence fishing. Though, a new fishery resource should develop in the reservoir.</p>			



1. View from top



2. View from Chopper



3. Viewing boulders from upstream



4. Right bank cobbles and pebbles. The mid reach of the 7C.

Station A4		Koropa	01/08/2013
Location			
<u>Coordinates:</u> S9°33.184 - E160°04.868 <u>River:</u> Tina <u>Kp:</u> 28.29km from the river mouth <u>Elevation:</u> approx. 140m asl <u>River section:</u> Middle Tina river <u>Nearest village:</u> Koropa		<u>Location:</u> Station A4 is located on Tina river at the village of Koropa <u>Access:</u> by car up to the village of Mangakiki, then by walk down to the river	
Physical environment			
<u>Valley geomorphology:</u> Upstream of Choro, the valley has leaved the long section of deep and steep gorges extending on 5km from the gauging station. The Chorro to Habusi section, oriented in a general N-E direction, forms important meanders with gorge passages identified as potential dam sites (options 6E and 6F), in alternance with open sections with vegetated deposits. <u>River system:</u> In the vicinity of station A4, the Tina river receives two secondary tributaries (Koropa and Pihu) <u>Banks & river bed:</u> The width of the river is approximately 15m. The banks have a 50% slope on each side with bedrock, pebbles/cobles deposit and a few boulders. The substrate is of cobbles, pebbles, coarse and fine sands. Locally silt and muddy areas at the confluence of the two tributaries. <u>Flow pattern:</u> runs and riffle on a bed of cobbles, with deep water (2-3m) on the external side of meanders. Velocity is estimated 0,5 to 1m/s. <u>Water quality:</u> the water was clear. Water temperature range estimated to 20-28°C			
Biological environment			
<u>Riparian vegetation:</u> The forest is defined disturbed due to people accessing the area for timber extraction and gardening. The vegetation along the river is dominated with regrowth trees, ginger plants and shrubs. An endemic piper tree was observed in the area. The sampling station had an open canopy cover. <u>Aquatic vegetation:</u> No aquatic plants. Evidence of pollution with green algae possibly due to timber mills and localized runoff. <u>Fish:</u> the observed biodiversity was high (10 species), with observations by day and night. <i>Khulia rupestris</i> and <i>Stiphodon birdsong</i> were dominant. Other gobiids are present (<i>Redigobius bikolanus</i> , <i>Redigobius sp</i> , <i>Awaous ocellarus</i> , <i>Glossogobius sp.</i>) as well as <i>Mesopristis spp</i> , <i>Anguilla marmorata</i> , and <i>Gymnothorax sp</i> .			
Human activities			
Excepted an isolated house at Choro (2km upstream) Koropa is the most upstream inhabited village along the Tina river, with two families (43 members). The village is situated on the right bank Local people use the river for bathing, fishing, crossing point, water collection and recreational, Small scale logging using chain saw. The timbers from Koropa were transported using the river to the nearby road at Tina village			
Potential impacts of the project on river ecology & resources			
Koropa, situated in the immediate vicinity of the dam site (option 6E or 6F), will be heavily affected both during construction and exploitation phases. Once the dam will be built, the hydrological conditions in this area will be completely modified (reservoir upstream, artificial outflow downstream) Water quality at the dam foot is likely to decrease both at construction stage (increase of suspended matter due to works on the slopes and in the river ; risk of pollution due to oil spill, cement leaching, wastewaters from workers camp...) and during exploitation, especially in the first years (degradation of organic matter in the reservoir, desoxygenated water at the bottom of the reservoir, possible release of NH4 ...). Significant impacts are expected on aquatic biodiversity and resources for subsistence fishing. Though, a new fishery resource should develop in the reservoir			

Station A4**Koropa**

01/08/2013

**4A.** The Tina river at Koropa (station A4)**4C.** View of the banks (bedrock/ cobble deposit)**4D.** View of the substrate at station A4**4E.** View of the river at station A4**4F.** Riffle on a bed of cobbles**4G.** Riparian gardens near Koropa**4H.** House near Koropa

Station A5		Senge	01/08/2013
Location			
<p><u>Coordinates</u>: S9°32.964 - E160°04.904</p> <p><u>River</u> : Tina</p> <p><u>Kp</u>: 27.69km from the river mouth</p> <p><u>Elevation</u> : 133m asl</p> <p><u>River section</u> : Middle Tina river</p> <p><u>Nearest village</u>: Senge</p>		<p><u>Location</u>: Station A5 is located on the Tina river, at the village of Senge</p> <p><u>Access</u>: by car up to the village of Mangakiki, then by walk down to the river on a very steep slope.</p>	
Physical environment			
<p><u>Valley geomorphology</u>: Upstream of Choro, the valley has leaved the long section of deep and steep gorges extending on 5km from the gauging station. The Choro to Habusi section, oriented to a general N-E direction, forms important meanders with gorge passage identified as potential dam sites (options 6E and 6F)</p> <p><u>River system</u>: In the vicinity of station A5, the Tina river receives the Senge, a secondary tributary on the left bank. Senge is also the name of the village.</p> <p><u>Banks & river bed</u>: The width of the river is approximately 15m. The side slopes are 40% on the left bank (were the village is located) including boulders and 10% slope on the right bank, The substrate is dominated by large deposits of cobbles and pebbles, with locally coarse sand and vegetal detritus (leaflet and tree branches).</p> <p><u>Flow pattern</u>: During the survey, the velocity ranged approx. 0,5 to 2m/s. During floods and wet season, the water overflows towards Senge village which is 2m above.</p> <p><u>Water depth</u> : cross sectional depth in front of Senge ranges 0,2 to 3m.</p> <p><u>Water quality</u>: the water was clear.</p>			
Biological environment			
<p><u>Riparian vegetation</u>: The forest is defined disturbed due to people accessing the area for timber extraction and gardening. The regrowth vegetation on the flat area is of <i>Saccharum sp.</i> The sampling station had an open canopy cover.</p> <p><u>Aquatic vegetation</u> :No aquatic plants. Film of brown algae on the rocks.</p> <p><u>Fish</u>: the biodiversity was high (about 15 species observed or mentioned by local fishermen) with dominance of <i>Stiphodon semoni</i>. Other species were gobiids (<i>Stiphodon rutilaureus</i>, <i>Sicyopus sp.</i>, <i>Lentipes</i>, <i>Awaous ocellarus</i>, <i>Redigobius sp.</i>, <i>Glossogobius sp.</i>), <i>Ophielotris sp.</i>, <i>Anguilla marmorata</i>, <i>Kuhlia rupestris</i>, <i>Mesopristes cancellatus</i> and prawns (<i>Macrobrachium lar</i>).</p>			
Human activities			
<p>Senge, situated on the left bank, approx. 500m downstream of Koropa, is occupied by more than 10 peoples (4 houses). A shelter has been installed fo ecotourists. The village use the river for drinking water, bathing, fishing, crossing point and washing.</p> <p>Logs from timber extraction upstream (Choro/Koropa area) are lying on the flat area. Evidence of small scale logging using chain saw.</p>			
Potential impacts of the project on river ecology & resources			
<p>Senge, situated in the immediate vicinity of the dam site (option 6E or 6F), will be heavily affected both during construction and exploitation phases.</p> <p>Once the dam will be built, the hydrological conditions in this area will be completely modified (reservoir upstream, artificial outflow downstream)</p> <p>Water quality at the dam foot is likely to decrease both at construction stage (increase of suspended matter due to works on the slopes and in the river ; risk of pollution due to oil spill, cement leaching, wastewaters from workers camp...) and during exploitation, especially in the first years (degradation of organic matter in the reservoir, desoxygenated water at the bottom of the reservoir, possible release of NH4 ...).</p> <p>Significant impacts are expected on aquatic biodiversity and resources for subsistence fishing. Though, a new fishery resource should develop in the reservoir.</p>			

Station A5

Senge

01/08/2013

**5A.** The Tina river downstream of Senge**5B.** The Tina river upstream of Senge**5C.** Riffle on a bed of cobbles**5D.** Fish survey at station A5**5E.** Evidence of logging along the path to Senge**5F.** Large deposit of pebbles in front of Senge**5G.** Option 6 dam site between Senge & Habusi**5H.** Idem 5G, downstream view

Station A6		Toni river at Kathihana		30/07/2013
Location				
<u>Coordinates</u> : S9°31.419 - E160°07.449 <u>River</u> : Toni <u>Kp</u> : 19.81km from the river mouth <u>Elevation</u> : approx 90m asl <u>River section</u> : Lower Tina/Toni <u>Nearest village</u> : Kathihana		<u>Location</u> : Station A6 is located approx. 800m upstream of Tina-Toni confluence and 12km upstream of Ngalimbiu bridge (same place as station D ; Entura, 2010) <u>Access</u> : by car up to Horohutu, then by walk along the river		
Physical environment				
<u>Valley geomorphology</u> : The Toni river valley, approximately 15km long between Chupu Kama Mounts and the confluence, is located between the Tina valley and the Matepoto watershed where Goldridge mining facilities are implemented. <u>River system</u> : the Toni river is the major tributary of the Tina river. Both rivers flow parallel and converge to form the Ngalimbiu river. <u>Banks & river bed</u> : The width of the river at station A6 was not more than 5m. The right bank is 10% whereas the left bank has a 70% slope, used as access point by the village of Kathihana. The confluence is an area of important deposit with a dominance of cobbles/pebbles of diverse geological origin, gravels and coarse sand. At station 6, evidence of vegetal detritus (leaves, branches and logs) from past weeks flood were observed. <u>Flow pattern</u> : the lower course of Toni river presents pool and riffle with a velocity estimated to 0,1-0,6m/s. High water marks were estimated 2-3m above the river level. <u>Water depth</u> : ranging 0,2 to 1m across the section. <u>Water quality</u> : the water was slightly turbid (9,7NTU) due to rain on the last day of survey. Conductivity was significantly higher than in Tina river (243,8µS/cm).				
Biological environment				
<u>Riparian vegetation</u> : the sampling station was partially covered with vegetation (riparian forest with shrubs grasses and ferns). <u>Aquatic vegetation</u> :No aquatic plants. Algal development observed locally among cobbles at the confluence (probably associated with domestic uses). <u>Fish</u> : about 10 species were observed underwater (<i>Stiphodon semoni</i> , other sicyaniid gobies, pipe fish <i>Microphis lepsis</i> , <i>Kuhlia rupestris</i> , <i>Mesopristes cancellatus</i>) or in fisherman catches (mullet <i>Liza vaigensis</i> + 2 rock-sucker gobies: <i>Hypostomus plecostomus</i> & <i>Glossogobius</i> sp.).				
Human activities				
The village of Kathihana is located on the left bank of the Tina/Toni confluence People from Kathihana use the river for bathing, washing, fishing, crossing point, water collection (observation of small pits dug into the gravel bank) and recreation. A fisherman, using spear and goggles, was met on the river. Though Goldridge mining perimeter officially encompasses a part of the upper Toni watershed, there is no mining activities in this area. Floating boards observed on the bank are an evidence of logging activity on the watershed. Presence of pig-rearing in the area.				
Potential impacts of the project on river ecology & resources				
This main tributary will not be affected by the project (no direct impact of the hydroelectric facilities, either on water quality or hydrology). The Toni river will remain free of obstacle from the upper reach to the mouth and might represent a refuge for amphihaline species colonizing the upper watershed.				

Station A6**Toni River at Kathihana**

30/07/2013

**6A.** Toni river upstream of station A6**6B.** The banks near station A6**6C.** Riparian gardens near Kathihana**6D.** Floating boards from logging activity**6E.** Erosion cliff on the right bank**6F.** Detail of the vegetation on the cliff**6G.** Algal development at the confluence**6H.** Drinking water pit dug in the gravels

Station A7		Horohutu	30/07/2013
Location			
<p><u>Coordinates</u>: S9°30.546 - E160°07.160</p> <p><u>River</u>: Ngalimbiu</p> <p><u>Kp</u>: 16.12km from the river mouth</p> <p><u>Elevation</u>: 35m asl</p> <p><u>River section</u> : Upper Ngalimbiu</p> <p><u>Nearest village</u>: Horohutu & Vuramali</p>		<p><u>Location</u>: Station A7 is located in front of the village of Horohutu, approximately 1km downstream of the Tina-Toni confluence and 10km upstream of Ngalimbiu bridge</p> <p><u>Access</u>: by car</p>	
Physical environment			
<p><u>Valley geomorphology</u>: Downstream of Senge, the Tina valley, oriented to the N-E direction, enlarges progressively until reaching the coastal plain at Ngalimbiu. The large meander at the Toni/Tina confluence (Valekotcha-Horohutu section) is filled with material deposit (cobbles and gravels).</p> <p><u>River system</u>: the Ngalimbiu resulting from the junction of Tina river and Toni river, has a length of about 19km from the confluence to the sea.</p> <p><u>Banks & river bed</u>: The river is approximately 100m in width. The banks with a 10% slope on each side are made of cobbles, pebbles, coarse and fine sand, with locally muck mud and detritus from nearby gardens. Extended cobble deposit on the right bank. Substrate in the river bed is dominated by cobbles, lying on gravels and coarse sand. The width has small billabong areas which defined unstable movement of the waterway. Since 2010, it has shift twice as mentioned by local communities.</p> <p><u>Flow pattern</u>: pool and riffle areas on a bed of cobbles. The velocity is estimated to 0,5-1m/s. High water mark observed at 1,5m above the river level.</p> <p><u>Water depth</u>: ranging 0,3 to 1m across the section.</p> <p><u>Water quality</u>: the water was clear during the field work. Conductivity was 173μS/cm. The water was slightly turbid (6,87NTU). In late afternoon, following a heavy rain, the river level raised for more than 20cm, and a stripe of very turbid water, 3m in width was visible along the shore.</p>			
Biological environment			
<p><u>Riparian vegetation</u>: Gardens and vegetation (grass and trees) on the banks. No canopy cover on the river.</p> <p><u>Aquatic vegetation</u> :No aquatic plants. The film of algae on the cobbles was the evidence of nutrients input from domestic or natural origin.</p> <p><u>Fish</u>: the diversity of fish was poor compared to the previous stations. <i>Stiphodon semoni</i> was dominant and <i>S. rutilaureus</i> was present. Evidence of high fishing pressure.</p>			
Human activities			
<p>The two villages at station A7 are Horohutu on the left bank and Vuramali on the right bank. People use the river for bathing, fishing, crossing point, water collection and recreation.</p> <p>Farming activities increasing along the upper Ngalimbiu river (pig rearing and gardening).</p>			
Potential impacts of the project on river ecology & resources			
<p>Horohutu being located approximately 10km downstream from the dam site (option 6E or 6F), impacts will be less important than in Senge/Habusi area, located close to construction area, immediately at the dam foot. The distance from the dam site will contribute to mitigate water quality degradation to a certain extent, with auto-purification / oxygenation of outflow waters from the dam and waste waters from the worker camp, plus dilution with Toni river discharge.</p> <p>Though, the risk of significant TSS increase, oil spills and fecal contamination is likely to occur during construction, with possible impacts on aquatic biodiversity, subsistence fisheries and domestic uses of the river.</p> <p>The artificial flow pattern (daily variations, flush outflow) might have incidence on human activities and security if no mitigation measure ins implemented.</p>			



7A. Ngalimbiu river upstream of Horohutu



7B. Ngalimbiu river downstream of Horohutu



7C. View of the right bank in front of Horohutu



7D. View of the left bank – vehicle access



7E. Houses along the bank at Horohutu



7F. Domestic use of the river

Station A8		Ngalimbiu bridge		02/08/2013	
Location					
<p><u>Coordinates</u>: S9°27.439 - E160°08.747</p> <p><u>River</u>: Ngalimbiu</p> <p><u>Kp</u>: 7.76km from the river mouth</p> <p><u>Elevation</u>: 33m asl</p> <p><u>River section</u>: Lower Ngalimbiu</p> <p><u>Nearest village</u>: Ngalimbiu</p>			<p><u>Location</u>: Station A8 is located at Ngalimbiu bridge, crossing point of the main road, approx. 20km West of Honiara</p> <p><u>Access</u>: main road</p>		
Physical environment					
<p><u>Valley geomorphology</u>: The river flows and forms meanders across the lowland plain. The general N/N-E direction turns to a North direction after the bridge.</p> <p><u>River system</u>: no visible tributary in the area - the river channel is probably connected to the alluvial aquifer and to a network of agricultural drainage ditches (drainage of plantations)</p> <p><u>Banks & river bed</u>: The width of the river is approximately 15m. The side slope were 20% on the left bank and 30% on the right bank. The observed granulometry is far smaller than on the upper reaches of the river. Substrate is dominated by sands and gravels, accumulating on the right bank (very few cobbles). Presence of trunks downstream of the bridge.</p> <p><u>Flow pattern</u>: running waters & riffle. Velocity is estimated to 0,7m/s. Near the bridge, pools of stagnant water separated from the main channel were visible, due to piles and accumulation of wood detritus.</p> <p><u>Water depth</u>: ranging 0,1 to 1,5m across the section. High water marks were observed 2m above the river level.</p> <p><u>Water quality</u>: the water was slightly turbid during the field work (5,1NTU) due the "spiral effect" (development of primary productivity in the lower reaches of river from degradation of organic matter further upstream) and/or to the number of human settlements downstream of the Tina Toni confluence. Conductivity (186µS/cm) was not very different than those at the gauging station.</p>					
Biological environment					
<p><u>Riparian vegetation</u>: Dominant riparian vegetation are the paper mulberry tree and <i>Saccharum sp</i> (grass) with fern also. The sampling station had no canopy cover. <u>Aquatic vegetation</u>: No aquatic plants.</p> <p><u>Fish</u>: 5 observed species: 3 Gobidae (<i>Stiphodon semoni</i>, <i>S. birdsong</i> and <i>Awaous sp.</i>), <i>Eleotris sp.</i> and <i>Opheleotris sp.</i> Tadpoles in the pool (probably cane toad). Tilapias and eels were mentioned as present by local people.</p>					
Human activities					
<p>The Ngalimbiu bridge, crossing point of the Ngalimbiu river by the main road, was destroyed by the cyclone Namu. A new bridge was built in 1986 and rehabilitated in the late 90's by Ross mining.</p> <p>The area is accessible for most people of Honiara and Guadalcanal and used for washing of trucks and clothes, bathing, recreation, etc.</p> <p>Important accumulation of logs and tree branches upstream of the bridge piles.</p> <p>The village, located upstream of the bridge, is rather important with several houses along the banks. Approx. 20 m from the left bank is the Ngalimbiu Guadalcanal sub-station.</p>					
Potential impacts of the project on river ecology & resources					
<p>Ngalimbiu bridge being located approximately 25km downstream from the dam site (option 6E or 6F), impacts of the dam will be less important than immediately at the dam foot, due to auto-purification and dilution by discharge of Toni river and small tributaries.</p> <p>Though, the risk of significant TSS increase, oil spills and fecal contamination increase during construction remains, with possible impacts on aquatic biodiversity, subsistence fisheries and domestic uses of the river.</p> <p>The artificial flow pattern (daily variations, flush outflow ...) might have significant incidence on human activities that should be further assessed, e.g. change in lateral erosion with consequences for houses built on the banks.</p>					



8A. Ngalimbiu river upstream of the bridge



8B. Sand deposit & lateral erosion



8C. Sand deposit on right bank – old pile



8D. Accumulation of wood at the bridge pile



8E. Ngalimbiu bridge, viewed from upstream



8F. Detail of the vegetation on the left bank



8G. Ngalimbiu river downstream of the bridge



8H. Ngalimbiu river, further downstream

Station A9		Saele	06/08/2013
Location			
<p><u>Coordinates</u>: S9°25.351 - E160°09.242</p> <p><u>River</u>: Ngalmibiu</p> <p><u>Kp</u> : 2.62km from the river mouth</p> <p><u>Elevation</u>: 11m asl</p> <p><u>River section</u> : Lower Ngalmibiu</p> <p><u>Nearest village</u>: Saele</p>		<p><u>Location</u>: Station A9 is located at the village of Saele, 5km downstream of the Ngalmibiu bridge and 2,6km upstream from the mouth. The station was chosen to characterize the saline intrusion into Tina River.</p> <p><u>Access</u>: by car to the village</p>	
Physical environment			
<p><u>Valley geomorphology</u>: In Saele area, the river flows to the North, straight across the lowland plain.</p> <p><u>River system</u>: no visible tributary in the area – probable connection with the alluvial aquifer.</p> <p><u>Banks & river bed</u>: The width of the river is approximately 50m. The slope is 40% on both banks. Substrate is dominated with sand, silt and muck mud, with presence of wooden detritus. Sans deposit along the banks far upstream of the station.</p> <p><u>Flow pattern</u>: velocity is uniform across the section and estimated to 0,7m/s.</p> <p><u>Water depth</u>: 1,5m uniformly across the section. High water marks were observed 2m above the river level.</p> <p><u>Water quality</u>: the water was slightly turbid during the field work (9,6NTU), due to the “spiral effect” (development of primary productivity in the lower reaches of river from degradation of organic matter further upstream), and/or to Palm oil plantation and agriculture drainage waters, or wastewaters from riparian human settlements. Conductivity (215µS/cm) was not significantly higher than on the upper reach stations, showing no saline intrusion at 2.6km from the mouth.</p>			
Biological environment			
<p><u>Riparian vegetation</u>: The natural vegetation in the plain has been cleared for plantation, agriculture and gardening. Riparian vegetation is dominated with paper mulberry trees, <i>Saccharum</i> sp. (grass), para-grass, banana plants and sago palms (used for housing construction).</p> <p><u>Aquatic vegetation</u> :No aquatic plants.</p> <p><u>Fish</u>: no direct observation because of turbidity</p>			
Human activities			
<p>Saele is a small village of about ten houses, on the right bank, with gardening activities. It is located in the most important plain of Guadalcanal and SI, devoted to palm oil plantations, intensive agriculture and gardening (taro, yam, cassava, bananas, sweet potatoes ...).</p> <p>The river is used for washing, bathing, recreation and fishing.</p>			
Potential impacts of the project on river ecology & resources			
<p>Saele being located very far from the project area, the incidence of the dam on a section of river already impacted by human activities are likely to be low or insignificant due to the distance, auto-purification processes, sedimentation, etc..</p>			



9A. The left bank at Saele



9B. The Ngalimubiu riv. downstream of Saele



9C. The Ngalimbiu river, upstream of Saele



9D. View of the vegetation on the bank



9E. Coconut plantation in the coastal plain,



9F. Coastal plain landscape near Saele



9G. Crops in the coastal plain



9H. The village of Komporo, near the Mouth

Station A10	Ngalimbiu mouth area	02/08/201
Location		
<p><u>Coordinates</u>: A10a : S9°24.543 - E160°08.881 A10b : S9°24.242 - E160°09.387</p> <p><u>River</u>: Ngalimbiu</p> <p><u>Kp</u>: 0</p> <p><u>Elevation</u>: 0m asl</p> <p><u>River section</u>: Lower Ngalimbiu</p> <p><u>Nearest village</u>: Komporo</p>	<p><u>Location</u>: The East and West mouths are located approx. 1km and 1,5km West of the village of Komporo</p> <p><u>Access</u>: car access to Komporo + walk along the shore</p>	
Physical environment		
<p><u>River system</u>: It was confirmed by local people that the river course to the sea has changed several times since the cyclone Namu. The new mouth (station A10a) now considered as the main mouth, was formed mid last year in a lateral position of the delta, about 500m West of the old mouth, as a result of high flood of the river and obstruction of the main channel by logs. The old mouth (station A10b), occupying a central position, is still in activity, though the outflow is much smaller.</p> <p><u>Banks & river bed</u>: Substrate is dominated with sand. Presence of logs and wooden detritus are observed along the sea and mouth shore.</p> <p><u>Flow pattern</u>: outflow velocity at the main river mouth was estimated 1,5m/s at the contact between the river and the sea.</p> <p><u>Water quality</u>: the level of turbidity at the mouth was rather high (12 to 13NTU) compared to other stations upstream in the river. Conductivity was measured at different places of the main mouth (on the Western bank, in the middle of the pass, upstream and downstream) in order to approach spatial distribution of salinity. Conductivity was in a range of 191 to 319µS/cm, showing a very limited salt intrusion in the river mouth. No longitudinal gradient of brackish water was observed: the river seems to discharge directly into the sea (no brackish water estuary).</p>		
Biological environment		
<p><u>Riparian vegetation</u>: The back-swamp vegetation in the vicinity of the mouth is dominated by <i>Pandanus</i>, coconut trees, pines, marsh plants and <i>Saccharum sp.</i> that can tolerate wind. Presence of rushes growing on on sand deposit around the main mouth is an evidence of freshwater conditions in superficial groundwater.</p> <p><u>Fish</u>: a diversity of fish species was observed in the fishermen captures, with two categories: marine forms entering into the mouth (mullet, trevally, Jacks, <i>Caranx</i>, <i>Apogon</i>, <i>Mesopristis</i>, <i>Lichia</i>....) and shoals of sicydiine goby larvae (probably <i>Stiphodon sp.</i> or <i>Sicyopterus sp.</i>) captured in large amount, using mosquito nets.</p> <p><u>Other animals</u> : traces of a marine crocodile were sighted on the sand around the back-swamps. The specimen was supposed to be approximately 2m long. Crocodiles are frequent in the swamps, though large specimen (up to 7m) are becoming rare because of over-hunting. Concentration of tadpoles (probably cane toad) were observed along the bank of the main mouth, another evidence of freshwater conditions in the river mouth.</p>		
Human activities		
<p>The mouth area is a very bountiful fishing spot along the shore, due to the concentration of adult and juvenile fish of different species entering into the lower river.</p> <p>About 30 fishermen from Komporo and other coastal villages are working at day time and night time, either for subsistence and commercial fishing, using canoe, gill nets, and mosquito seine nets. According to interviewed fisherman, they can make a single day market of SBD 1,500. Goby larvae are very appreciated and cost SDB 5 per cup. The area is also used for recreation and communication/crossing of the river.</p>		
Potential impacts of the project on river ecology & resources		
<p>The mouth being located very far from the dam site, impacts of the project should be low or insignificant with a possible effect on water quality mitigated with the distance (auto-purification process, sedimentation, etc..) but likely to impact aquatic ecology and induce possible changes in hydro-sedimentary dynamic (a monitoring might be required).</p>		

Station A10**Ngalimbiu mouth**

02/08/2013

**10A.** View of the mouth area with backswamp vegetation and sand deposit**10C.** Coconut trees and back-swamp vegetation**10D.** Ngalimbiu river upstream of the mouth**10E.** Fishermen preparing for seine fishing**10F.** Herbaceous vegetation on the banks**10G.** Views of the old mouth (station 10B). The discharge is limited to a narrow channel

The following table is a compilation of freshwater & brackish water fish species recorded in the SI, in Guadalcanal and in the Ngalimbiu/Tina river system from the different existing sources since 1974, both scientific reports and EIS baseline reports.

The phylogenetic sequence of families follows Eschmeyer 1990. Subfamilies, genera and species are arranged alphabetically within each family.

Legend: **X** : recorded in Tina/Ngalimbiu river system ; **X**: recorded in Guadalcanal ; **x**: observed in other Solomon islands ; () : reported present by local people but not seen.

Note : species name from the same family/genus might be synonymous due to changes in the taxonomy and/or wrong determination.

	Source	Gray, 1974	Polhemus et al, 2008		Golder Asso 2009.		Jenkins & Boseto,	Entura, 2011	BRLI, RS Hevalao current	
		Guadalcanal	SI	SI	Ngalimbiu	Matepono	Tetepare	Tina	Tina	Tina
	Year	1974	Nov 2004 March 2005	July Aug 2005	1998 to 2006	1998 to 2006	Sept 2006	Sept 2010	July 2013	July 201
Family	Species									
Megalopidae	<i>Megalops cyprinoides</i>	X					X			
Anguillidae	<i>Anguilla marmorata</i>	X	x	X	X	x	X		X	X
	<i>Anguilla megastoma</i>				X	x	X			
	<i>Anguilla reinhardti</i>					x				
Muraenidae	<i>Gymnothorax polyuranodon</i>	X	x		X	x	X	(X)	(X)	X
	<i>Muraenichthys macropterus</i>	X							X	X
Chaniidae	<i>Chanos chanos</i>	X					X			
Apogonidae	<i>Apogon hyalosoma</i>	X					X		X	X
	<i>Apogon lateralis</i>						X			X
	<i>Apogon sp.</i>			X				(X)		X
Hemiramphidae	<i>Zenarchopterus dispar</i>		x							X
	<i>Zenarchopterus sp.</i>						X			X
	<i>Rhyncorhamphus georgi</i>	X								
	<i>Hemirhamphus commersoni</i>	X								
Syngnathidae	<i>Microphis (Oosthetus) manadensis</i>	X			X	x				X
	<i>Microphis (Oosthetus) brachyurus</i>	X	x					(X)		
	<i>Hippichthys (Bombonia) spicifer</i>	X								
	<i>Hippichthys (Bombonia) djarong</i>	X								
	<i>Microphis leiaspis</i>		X		X	x			X	X
	<i>Microphis(Doryichthys) retzi</i>	X	x		X	x			X	X
	<i>Microphis mento</i>				X					
	<i>Microphis spinachoides</i>				X	x				
	<i>Doryichthys brevidorsalis</i>	X								
<i>Microphis sp</i>			X			X				
Ambassidae	<i>Ambassis buruensis</i>				X	x				
	<i>Ambassis gymnocephalus</i>	X				x				
	<i>Ambassis interruptus</i>	X	x				X		X	X
	<i>Ambassis macracanthus</i>	X				x				
	<i>Ambassis miops</i>		x	X		x	X		X	X
<i>Ambassis urotaenia</i>					x					
Terrapontidae	<i>Mesopristes argenteus</i>	X	x	X			X		X	X

	Source	Gray, 1974	Polhemus et al, 2008		Golder Asso 2009.		Jenkins & Boseto,	Entura, 2011	BRLi, RS Hevalao current		
		Sampled area	Guadal cana	SI	SI	Ngali m-biu	Mate pono	Tete- pare	Tina.	Tina	Tina
		Year	1974	Nov 2004 March 2005	July Aug 2005	1998 to 2006	1998 to 2006	Sept 2006	Sept 2010	July 2013	July 201
	<i>Mesopristes cancellatus</i>		x	X	X	x	X		X	X	
	<i>Terapon jarbua</i>	X		X			X			X	
	<i>Amphitherapon caudavittatus</i>	X									
Kuhliidae	<i>Kuhlia marginata</i>	X	x	X	X	x	X	(X)	X	X	
	<i>Kuhlia rupestris</i>		X	X	X		X	X	X	X	
Carangidae	<i>Caranx papuensis</i>		X				X	(X)			
	<i>Caranx sexfasciatus</i>			X		x			X	X	
	<i>Caranx ignobilis</i>	X									
	<i>Caranx sp.</i>								(X)	(X)	
	<i>Carangoides malabaricus</i>								X	X	
	<i>Decapterus cf macarellus</i>						X				
	<i>Scomberoides sp.</i>						X		X	X	
Lutjanidae	<i>Lutjanus argentimaculatus</i>	X	X	X		x	X			X	
	<i>Lutjanis monostigma</i>	X									
	<i>Lutjanus fuscescens</i>		X	X				(X)	X	X	
	<i>Lutjanus fulvus</i>						X				
	<i>Lutjanus vitta</i>								X	X	
Gerreidae	<i>Gerres sp.</i>								X	X	
Polynemidae	<i>Polydactylus sp.</i>						X		X		
Monodactylidae	<i>Monodactylus argenteus</i>	X					X				
Mugilidae	<i>Crenimugil heterochellius</i>		x		X	x					
	<i>Crenimugil crenilabrus</i>						X				
	<i>Liza tade</i>				X	x				X	
	<i>Liza vaigiensis</i>						X	X		X	
	<i>Vagamugil buchani</i>				X	x					
Cichlidae	<i>Oreochromis mossambicus</i>										
Poeciliidae	<i>Poecilia reticulata</i>					x					
	<i>Gambusia holbrooki</i>					x	X			(X)	
Toxotidae	<i>Toxotes jaculatrix</i>	X	X		X						
Cichlidae	<i>Oreochromis mossambicus</i>				X	x				X	
Serranidae	<i>Epinephelus polystigma</i>						X				
Scorpaenidae	<i>Tetraroge sp.</i>						X				
Rhyacichthyidae	<i>Rhyacichthys aspro</i>		(X)	X	X	x	X		X	X	
Eleotridae	<i>Belobranchus belobranchus</i>		X		X	x	X		X	X	
	<i>Butis amboinensis</i>		X			x			X	X	
	<i>Butis butis</i>	X		X			X				
	<i>Eleotris fusca</i>	X	X	X	X	x	X		X	X	
	<i>Eleotris melanosoma</i>						X				
	<i>Hypseleotris guentheri</i>	X			X	x	X				
	<i>Hypseleotris sp</i>		X	X							
	<i>Ophieleleotris (Giurus) hoedti</i>		X	X			X	X	X		

	Source	Gray, 1974	Polhemus et al, 2008		Golder Asso 2009.		Jenkin s & Boset o,	Entura , 2011	BRLI, RS Hevalao current	
		Sampled area	Guadal cana	SI	SI	Ngali m-biu	Mate pono	Tete- pare	Tina.	Tina
	Year	1974	Nov 2004 March 2005	July Aug 2005	1998 to 2006	1998 to 2006	Sept 2006	Sept 2010	July 2013	July 201
	<i>Ophieleotris (Giurus) margaritacea</i>						X		(X)	X
	<i>Ophieleotris (Ophiocara) aporos</i>	X			X	x				(X)
	<i>Ophiocera porocephala</i>						X			X
	<i>Oxyeleotris gyrinoides</i>				X	x				X
Gobiidae	<i>Glossogobius celebius</i>				X	x			X	
/ Gobinae	<i>Glossogobius sp. 1</i>		X	X			X		(X)	X
	<i>Glossogobius sp 2</i>		X							(X)
Gobiidae	<i>Awaous grammepomus</i>					x				X
/ Gobinellidae	<i>Awaous guamensis</i>			X					X	
	<i>Awaous melanocephalus</i>				X	x				X
	<i>Awaous ocellaris</i>				X	x	X		X	
	<i>Awaous sp</i>		X	X				X		X
	<i>Redigobius chrysosoma</i>					x	X			
	<i>Redigobius bikolanus</i>		X				X	(X)	X	
	<i>Redigobius leptochilus</i>		X					(X)		
	<i>Redigobius tambujon</i>								X	(X)
	<i>Redigobius sp</i>			X					X	
	<i>Schismatogobius marmoratus</i> ¹		X						X	
	<i>Schismatogobius ampluviculus</i> ²								X	
	<i>Schismatogobius sp.</i>						X		X	X
	<i>Schismatogobius roxasi</i> ³								X	
	<i>Schizogobius bruynis</i>				X	x				
	<i>Stenogobius hoesei</i>		X						X	
	<i>Stenogobius cf beauforti</i>				X	x				
	<i>Stenogobius sp.</i>			X						X
	<i>Bathygobius andrei</i> ⁴								X	
Gobiidae	<i>Lentipes multiradiatus</i>		X	X					X	X
/ Sicydiinae	<i>Lentipes sp.</i>		X					X	X	X
	<i>Sicyopterus cf hageni</i>				X	x				
	<i>Sicyopterus lagocephalus</i>		X	X			X	X	X	X
	<i>Sicyopterus longifilis</i>		X		X	x	X		X	X
	<i>Sicyopterus ouwensi</i>				X	x				X
	<i>Sicyopterus sp</i>		X	X			X			
	<i>Sicyopus mystax</i>		X					X	X	

¹ This identification is questionable, based on known range and current understanding of *Schismatogobius* biogeography. Records are pending further identification.

² Ibid.

³ Ibid.

⁴ Ibid.

	Source	Gray, 1974	Polhemus et al, 2008		Golder Asso 2009.		Jenkins & Boseto,	Entura, 2011	BRLi, RS Hevalao current	
		Guadal cana	SI	SI	Ngali m-biu	Mate pono	Tete- pare	Tina.	Tina	Tina
	Year	1974	Nov 2004 March 2005	July Aug 2005	1998 to 2006	1998 to 2006	Sept 2006	Sept 2010	July 2013	July 201
	<i>Sicyopus zosterophorum</i>		X	X		x			X	X
	<i>Sicyopus discordipinnis</i>		X					X	(X)	X
	<i>Sicyopus sp.</i>		X						X	(X)
	<i>Stiphodon atratus</i>		X					X	X	X
	<i>Stiphodon autopurpureus</i> ⁵								X	X
	<i>Stiphodon birdsong</i>		X					X	X	X
	<i>Stiphodon multisquamis</i> ⁶								X	
	<i>Stiphodon ornatus</i> ⁷								X	X
	<i>Stiphodon rutilaureus</i>		X	X			X	X	X	X
	<i>Stiphodon semoni</i>		X	X	X	x		X	X	X
	<i>Stiphodon sp</i>				X	x	X			X
Scatophagidae	<i>Scatophagus argus</i>	X		X		x	X			
Siganidae	<i>Siganus vermiculatus</i>	X							(X)	
Tetraodonidae	<i>Arothron immaculatus</i>	X								
	<i>Arothron reticularis</i>	X								
	<i>Chelonodon potoca</i>	X								
Anthenaridae	<i>Anthenarius notophtlamus</i>	X								
	Number of species	36	43	29	32	45	60	20	55	59

⁵ Ibid.

⁶ Ibid.

⁷ Ibid.

Plate 11 Fish survey methodology

11A. Direct visual observations & camera



11C. Direct observation in Upper Tina river



11E. Fishermen spear capture in the river

11B. Aquatic ecology team during survey



11D. Spear used for subsistence fishing in the Tina river



11F Sicyadiinae larvae fishing at the mouth

Photo L. Trebaol

11G. Gill net fishing at Ngalimbiu mouth

Photo G Pahin



11H. Determination of captured specie

Photo L. Trebaol

Plate 12 Gobiidae / Sicydiinae (Savutu / Vosu in local language)



12B. *Stiphodon semoni* (male) Photo RS Hevalao

12A. Different species of *sicydiins* Photo RS Hevalao



12C. *Stiphodon rutilaureus* (male) Photo RS Hevalao



12D. Sicydiinae spawn Photo RS Hevalao

12E. *Sicyopterus* sp. Polhemus et al

12F *Sicyopus mystax* Polhemus et al, 2008



12G. *Lentipes* sp. Polhemus et al, 2008

12H *Lentipes solomonensis* Photo RS Hevalao

Plate 13 Sicydiinae juveniles & other Gobiidae



13A. Gobiidae/Sicydiinae larvae captured at Ngalimbiu mouth
Photo L. Trebaol



13B. Shoal of Sicydiinae juveniles moving upstream along Ngalimbiu river
Photo L. Trebaol

13C. *Awaous guamensis*

Photo RS Hevalao



13E.

Photo RS Hevalao



13G. *Belobranthus belobranthus*

13D. *Awaous* sp.

Polhemus et al, 2008



13F

Photo RS Hevalao



13H. *Eleotris fusca*

Plate 14 Non-gobioids fish - inland river



14A. *Anguilla marmorata* (Giant Eel) fishbase



14B. *Gymnothorax polyuranodon* (Moray eel) www.australianmuseum.net.au



14C. *Microphis* sp. (Pipefish) Photo RS Hevalao

14D. *Liza vaigiensis* (Mullet) calphotos.berkeley.edu

14E. *Mesopristes argentus* (juvenile)



14G. *Kuhlia marginata* (Jungle perch) fishbase



14F. *Mesopristes cancellatus* (juvenile)



14H. *Ambassis interruptus*

Plate 15 Non-gobioid species – Mouth Area



15A. *Gerres* sp.



15B. *Apogon* sp.



15C. *Polydactylus* sp.



15D. Flatfish



15E. Chub Mackerels



15F. Flatfish



15G.



15H. *Muraenichthys macropterus* (Worm Eel)

**MINUTES OF 1ST MEETING HELD AT THE MINISTRY OF AGRICULTURE
AND LIVESTOCK WITH PERMANENT SECRETARY, MR. FRANK WICKHAM**

Date: 1st August 2013

Time: 8.30 am

Venue: Permanent Secretary's Office
Min. of Agriculture & Livestock
Mud Alley

Present:

Mr. Frank Wickham - Permanent Secretary/MAL

Mr. Gilles Pahin - Team Leader

Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts

Mr. Lawrence Foana'ota - Social and Cultural Expert

Mr. Gilles Pahin

- Thanked the PS for availing himself to meet with us
- Explained the purpose of our visit and meeting
- Informed the PS of his position as the team leader from BRLi, a company in France, Fred Patison, the Coordinator of the local experts and Lawrence Foana'ota is the Social and Cultural Expert in the team
- Pointed out that the ESIA team consists of six local (6) and four (4) outside experts totaling to ten (10)
- Asked if any information is available regarding future plans for agricultural activities in the area earmarked for the Tina Hydropower Development Project
- Enquired re-compiling any information on the agricultural activities

PS-Mr. Frank Wickham's Response

1. Large Scale Farming in Food Production:

- Lee Kwok Kuen is involved with large scale farming in food production
- Sweet potato or kumara farming is one of the main crops the Company is producing
- Plans are underway for the farming of other crops and food stuff

2. Guadalcanal Plains Palm Oil Limited Plans:

- As far as other agricultural activities are concerned, Guadalcanal Plains Palm Oil Limited plans to extend eastward
- Suggest Mr. Gilles and team should meet with Officials from GPPOL in order to know more about their operations and any expansion plans in the future

3. Adjacent Land To Tina River Area:

- SI Government is interested in purchasing land owned by RIPEL
 - So far no concrete agreement has been reached as yet on the issue of government purchasing the land
-

- Present challenges included the fact that Government owns cocoa farms and cattle in the area but people are serving themselves with them

4. Gold Ridge Situation:

- Three main groups have been formed to take care of the concerns of the communities
- Dam tailing group
- Mid-stream group
- Down-stream group

5. Some Suggestions and Issues of Concern for the Tina Hydropower Development Area:

- If communities are planning to engage in farming, they would need some form of irrigation system to be built such as a small dam
- One major effect the dam would have during the construction period and probably two years after its completion is that the quality of the water might be low
- It is important that some form of monitoring system should be considered
- The concern is that people might start to ask compensation when this happens just like the Gold Ridge Mining where people have been demanding compensation payments for the Metabona River. This could also happen for the Tina River when the dam is constructed
- There should be baseline assessment of the down stream area of the Ngalibiu River carried out first before the dam is constructed to avoid such problem of demanding compensation arising in the future

6. Some Points for Consideration:

- Benefit and Profit sharing between the communities, government and landowner
- Commissioner of Lands should release some part of the RIPEL land for recreation activities and sporting facilities
- PS indicated that he will be leaving the government soon

7. Meeting closed at 9am

MINUTES OF 2ND MEETING HELD AT THE MINISTRY OF ENVIRONMENT & CONSERVATION WITH STAFF

Date: 1st August 2013

Time: 11.15 am

Venue: Environment & Conservation Office
Old Public Service Training Center Building at Vavae Ridge

Present:

Ms. Rosemary Ata - Environment Safeguarding and Monitoring Officer

Ms. Rose Papaua - Conservation Officer

Mr. Edward Danitofea - Rep from the Government on the ESIA Team

Mr. Melvin Zama - Environment Officer

Mr. Gilles Pahin - Team Leader

Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts

Mr. Lawrence Foana'ota - Social and Cultural Expert

1. Introduction:

- Fred S Patison thanked the Officers and introduced Mr. Gilles stating that he is the overall leader for the ESIA or Environmental and Social Impact Assessment Team as well as the Project Manager
- He is the Regulatory Expert and the Coordinator of the National Experts and
- Lawrence is the Social and Cultural Heritage Expert.
- The ESIA team consists of 10 members, 4 foreigners and 6 nationals

2. After that the officers from the Ministry introduced themselves.

3. Then Mr. Gilles Pahin explained the purpose of the meeting which was mainly to

- get officers' views and any concerns they may have on the Environment before the Tina Hydropower Development Project starts
- find out if they have any information available on any Conserved areas within the propose hydro site
- let them know that general survey for the baseline report will be carried out
- inform them that major works will be mainly in the downstream area from any protected sites upstream above the main reservoir
- inform them that four foreign experts are in the country for two weeks
- that the members of the ESIA team have already visited the proposed area of the Project
- while he and the two nationals accompanying him for the meetings with other government agencies and stakeholders, Mr. Eric Deneut who is the Assistant Team Leader is already with those national experts looking at the fish, wild life and other environmental issues within the proposed hydro project site

4. The Officers then spoke on some issues they wanted the ESIA team members to consider and take note of as follows:

- In December this year (2013) experts from USA will carry out wildlife study of the Popomanisiu in the upstream area
- It was also important to have some protected areas downstream
- It was suggested that may be one protected area should be in the downstream for gravel extraction
- There needs to be social impact assessment carried out in the downstream areas to include some baseline study
- Ministry staff will not involve in any social impact assessment but will participate in the environment impact assessment under government's cost.
- Water quality should be tested during the construction period
- Review should be covered by the Tina Hydropower Development Project Office
- The Ministry is in the process of reviewing the Environment Act
- Noise pollution will have temporary impact on the flora and fauna in the hydro project area
- Baseline study indicated people claim that Guadalcanal Plains Palm Oil Limited (GPPOL) caused hardship on water downstream

5. It was confirmed to the officers that

- Socioeconomic impact will also be taken into consideration and
- Health issues too will be looked into by the Social Impact Assessment team

6. The meeting closed at about 12 noon.

MINUTES OF 3RD MEETING HELD AT THE NATIONAL STATISTIC DIVISION**Date:** 1st August 2013**Introduction:**

- Presentation of BRLi – Gilles P., Fred P. and Lawrence F.
 - Gilles P. introduced the BRLi team and the important of getting accurate data for the Tina Hydro national project. In particular data on population and other social data of community within the Tina hydro site.
 - The statistician expressed the fact that the data is available and will be provided to them as requested. He further noted that social issues will be of particular importance for the project.
 - The statistics office agreed to provide all the information for the Tina Hydro project area. This will be collected by Mr Lawrence Fonoaota, the national social and cultural expert.
-

**MINUTS OF 4TH MEETING HELD AT THE STATISTIC DIVISION, MINISTRY
OF FINANCE & TREASURY WITH JOSEPH NAESOL, GOVERNMENT
STATISTICIAN**

Date: 1st August 2013

Time: 2 pm

Venue: Statistic Office
Old Government Printers Building
Central Honiara

Present:

Mr. Joseph Naesol - Government Statistician/Ministry of Finance & Treasury
Mr. Gilles Pahin - Team Leader
Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts
Mr. Lawrence Foana'ota - Social and Cultural Heritage Expert

The meeting was held in the Conference room at about 2.15 pm.

1. As usual, Mr. Gilles Pahin introduced the members of his team before he explained the purpose of the meeting as follows:-

- Find out if any recent census documents on the population for the Tina area are available
- Seek advise from this particular Government Division regarding any issues that may be useful to know about before carrying out the Environment and Social Impact Assessment work
- Since Mr. Joseph Naesol is from the Tina area he should know if there are any specific cultural or social issues that the ESIA team should watch out for or consider in order to avoid any misunderstandings that might affect the progress of the Hydro Project

2. In response to the points raised above Mr. Naesol provided the following:-

- The last census was carried out in 2009
 - The national census is carried out after every ten (10) years
 - So far only the census data is available
 - The complete census report is still not completed
 - Migration is basically internal
 - GPS map showing the village locations within the area will be provided
 - Lawrence Foana'ota will pick up the documents from Joseph on Monday 5th in the afternoon
 - The documents he will provide will include tables with associated data of population of some of the villages within the catchment of the Tina River
 - Any reports should be independent
 - Important to hear directly from communities regarding their views and concerns
-

- 3. The Social Impact Assessment will be carried out by Mr. Gerard Fitzgerald, a Social Key Expert from New Zealand with the assistance of**
 - Kellington Simeon and
 - Lawrence Foana'ota

- 4. There being no other matters the meeting closed at about 3.45 pm**

**MINUTES OF 5TH MEETING HELD AT THE DEPARTMENT OF ENERGY,
MINISTRY OF ENERGY, MINES AND RURAL ELECTRIFICATION
WITH MR. GABRIEL AIMAE**

Date: 5th August 2013

Time: 10 am

Venue: Department of Energy Meeting Room
Lingakiki
Central Honiara

Present:

Mr. Gilles Pahin - Team Leader

Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts

Mr. Gabriel Aimae - Representative Energy Division

Mr. Lawrence Foana'ota - Social & Cultural Heritage Expert

1. The original arrangement made on Thursday 31st July when Lawrence Foana'ota went around meeting various government officials and stakeholders informing them of the planned meetings was supposed to be with the Director of Energy Mr. John Korihona.
 2. Mr. Gabriel Aimae was met instead of the Director.
 3. Mr. Gilles Pahin explained the purpose of the meeting with a brief introduction
 4. Mr. Gabriel Aimae informed the team of the following:-
 - Government's main focus at this time is to provide power to communities and schools in the country by using solar
 - Currently the Government is looking into developing geothermal power from Savo Island
 - Ground work had already started with
 - (a) visits to the island and
 - (b) initial negotiations with the local population
 - Government's present need is for Environment Specialists to assist in the Project
 - Government through the Energy Division are working closely with Kenta Co. in the USA
 - Compiling a document on a National Energy Policy in collaboration with South Pacific Community (SPC), United Nations Development Program (UNDP) and World Bank (WB)
 - The Plan is once completed, it will form the National Energy Policy
 - Government's view regarding power/benefit sharing from the Tina Hydropower Development Project is that while it is still not yet developed; the communities around the Tina area will be provided with Solar Panels for lighting
 - The Energy Division does not have enough staff but when the Social Impact Assessment work starts in three weeks time, a staff will be made available
-

5. The briefing by Mr. Gabriel Aimaé was noted by the three members of the ESIA team
6. Mr. Gilles Pahin informed Mr. Aimaé of the following:
 - Field survey has already started by the Environmental Expert team
 - The main focus at this time is on the flora and fauna
 - Most of the survey work is conducted specifically within the area expected to have much of the impact from the proposed Tina Hydropower Development Project when it is constructed
7. **There being no other business, the meeting closed at 10.55 am**

**MINUTES OF 6TH MEETING HELD AT WATER RESOURCE DIVISION,
MINISTRY OF MINES, ENERGY AND RURAL ELECTRIFICATION
WITH THE DIRECTOR MR. ISAAC LEKELALU**

Date: 5th August 2013

Time: 11 am

Venue: Water Resource Division Office
Min. of MERE, Lingakiki

Present:

Mr. Gilles Pahin - Team Leader

Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts

Mr. Isaac Lekelalu - Director Water Resource Division/MMERE

Mr. Lawrence Foana'ota - Social and Cultural Expert

1. Mr. Gilles Pahin started the meeting with following remarks:

- Thanked the Director for availing himself to meet the team members
- Briefed him of the purpose of the visit and meeting
- Informed him that work had already started by the Environment Expert team
- Field survey focuses mainly on the flora and fauna as well as collected water sample for testing from the Tina River
- A brief visit to the downstream communities revealed that people do not use the Tina River instead they use rain water collected into tanks

2. The following points were put forward to the Director for consideration:

- Request the Director to inform the ESIA team of what plans are in place by the government as far as water resource management is concerned when work starts on the Tina Hydropower Development Project
- There are plans to provide water supply so the Water Division need to assist in identifying possible sources
- Water tanks need to be provided and wells dug to help communities get clean water during construction and possibly a two year period after the completion of the dam when vegetation might start falling into the reservoir affecting the quality of the water
- The Water Division is need to recommend to the Social Impact Assessment team the best sites for placing water tanks, wells and possibly identifying tributaries that the people could use

3. The Director, Mr. Isaac Lekelalu responses as follows:

- He is the Government's representative on the Tina Hydropower Development Project Committee and so he can look into these issues
 - The problem in the area as far as the use of water tanks is concerned is the low rainfall
-

- During the first six months of the year, the rainfall in the area is limited and so using tanks for storing water will not ease the problem of water shortage
 - But during the second half of the year there is always very heavy rainfall, constructing and use of water storage dams might be a possibility
 - The problem with using dams that do not have covering over them to store water is that the quality of the water might not be good
 - He mentioned the fact that the rainfall in the area is measured by using a rain-gauge they have installed at the Rate Community High School within the Tina area
 - He also suggested the other option is to develop facilities to extract ground water or use water tanks to capture rainwater during the rainy season in the area for the communities
 - He also raised the point that once the dam is completed conditions needed to be in place on the use of the water from it. This could be discussed with the people to get their views
 - Use of water purifiers should be looked into and communities should be encouraged to take care of such facilities and equipments once they are installed.
 - He expressed the concern that it is a well known fact in many places throughout the country where the majority always reluctant to contribute to the maintenance of water supplies once they are installed
 - The Water Division also has other Water Policies that are currently being developed with outside assistance
 - One other Policy that will be developed soon with the help of an expert from the Australian National University (ANU) in Canberra, Australia and is funded by the European Union is a Sanitation Policy
 - Apart from these policies, a number of legal instruments or laws are also being drafted
 - One such law is the “Water Resource Legislation” which is currently in draft form
 - The Water Resource Unit/Division’s main operation is on Hydrological Assessment and Development in the country
- 4. There being no other matters to discuss the meeting closed at 12 pm**
-

**MINUTES OF 7TH MEETING HELD AT THE SOLOMON ISLANDS NATIONAL
MUSEUM, MINISTRY OF CULTURE AND TOURISM WITH MR. TONY
HEORAKE,
DIRECTOR OF MUSEUM & MR. JOHN TAHINAO, DIRECTOR OF CULTURE**

Date: 5th August 2013

Time: 2 pm

Venue: Director's Office
National Museum Division Building
Coronation Garden
Central Honiara

Present:

Mr. Gilles Pahin - Team Leader
Mr. Tony Heorake - Director of Museum
Mr. John Tahinao - Director of Culture
Mr. Lawrence Foana'ota - Social and Cultural Heritage Expert

- 1. Since not much research work was carried out or written materials available for this specific area of Guadalcanal Province, the meeting was very brief**
 - 2. Mr. Gilles Pahin briefed the two Directors about the Tina Hydropower Development Project and he wanted to find out the best way to carry out the cultural heritage work in the area that will be affected**
 - 3. During his briefing he used his laptop computer to show the following to both Directors:**
 - A map of the area to be covered by the project and the villages within the project site
 - He also pointed out the location of the reservoir which will be near the Senge Village in the upstream of the Tina river
 - He also pointed out that 5 weeks will be spent in discussing the project with the people
 - Studies by the various national and overseas experts will continue until March 2014
 - The main requirements which the Directors are requested to look into were (i) whether any documents on cultural heritage sites in the area and (ii) any written documents which may be worth looking at are available or not
 - 4. The former Director of Museum, Lawrence Foana'ota, who is a member of the ESIA team responsible specifically for the Social and Cultural Heritage Impact Assessment, pointed out during the brief discussions the following:**
 - This is a new area so much of the data on the Social and Cultural Heritage will be collected from the people in the communities during the initial field survey
 - The only written information available so far is on *"The fresh and brackish water fishes of Guadalcanal"*, by Noel Gray published in one of the volumes of the Solomon Islands National Museum Association Journals in **1974:45**
-

- There may be documents or reports that may have been produced on the surrounding areas regarding other development projects which would involve literature research in the libraries or other institutions
 - Since this is going to require more work, with limited time given to carryout the baseline field survey it will not be possible
- 5. The meeting which lasted only for about half an hour ended at 2.30 pm**
-

MINUTES OF 8TH MEETING HELD AT THE GUADALCANAL PLAINS PALM OIL LIMITED WITH MR. ANDREW KERR, SUSTAINABILITY MANAGER, MS. REGINA GATU, COMMUNITY RELATIONS OFFICER & MR. ERNES KOLLY, SUSTAINABILITY OFFICER

Date: 6th August 2013

Time: 8.45 am

Venue: GPPOL Conference Room
Tetere Complex
Northeast Guadalcanal

Present:

Mr. Andrew Kerr - Sustainability Manager
Ms. Regina Gatu - Community Relations Officer
Mr. Ernest Kolly - Sustainability Officer
Mr. Gilles Pahin - Team Leader
Mr. Fred S Patison - Regulatory Expert & Coordinator of National Experts
Mr. Lawrence Foana'ota - Social and Cultural Heritage Expert

- 1. Since it was a long way to drive from Honiara to the Guadalcanal Plains Palm Oil Limited Complex for the meeting, the team has to left the Mendana Hotel around 7.30 am. The trip took about one hour and fifteen minutes**
 - 2. The three member team used Mr. Fred Patison's vehicle while the Environment Impact Assessment team members used the hired vehicle from Budget.**
 - 3. Mr. Andrew Kerr met the team and went straight for the meeting into the Conference Room**
 - 4. After a brief introduction and Mr. Gilles informed Mr. Kerr of the purpose of the visit and meeting the Sustainability Manager went straight into his presentation**
 - 5. During his talk he cover a lot of areas which highlighted the processes they apply right from the beginning when they first established the company until now including the following:**
 - They started with zero dollar
 - The land is being leased for a period of 99 years
 - Local Contractors were hired to do all construction jobs
 - Negotiation was done first with Contractors before they purchase any trucks
 - The Company decided to employ local laborers to prevent social problems
 - Whenever any problems arise, they use the custom to sort them out
 - Encouraged the five main tribes including small holders to be members of the Land Association
 - So far the Land Association has a total of about 1,000 members
 - When deploying contractors 40% should be local
-

- Currently GPPOL has 1,600 plus workers and only 14 are expatriates
- The company employ people in the area to run the Security service
- They have three Memorandum of Understanding or MOU in place with SI Government, Guadalcanal Province and the Land Association
- They pay diffidence to Local Land Association and not to individuals
- Pay royalties
- Pay land rentals
- The company provides 4,500 houses for its workers
- Provide own power and medical free for their employees
- The company generates its own power

6. Apart from providing the above information Mr. Kerr also made some suggestions for consideration by the Tina Hydropower Development Project as follows:

- When deploying Contractors make sure 40% should be local
- Make sure expatriate employees are limited in number
- Laborers should be of people from the local area
- Use the communities to involve in the construction
- GPPOL needs to involve with the Tina Hydropower Development Project
- Watch out for new tribes coming up as the project develops because they have already experienced this social development when the company started operating
- Recommend to the Tina people to form their own Land Association and avoid using middlemen to involve in the project on their behalf
- Warned to watch out for Chief Benedict Garamane and Sam who lives downstream of the Tina River
- The area earmarked for possible expansion of the oil palm plantation is at Malatoha, apart from that there is no plans for expansion westward

7. When the issue about compensation came up he brought in two of his staff who are directly involve with this area in the communities

- The staff who is directly responsible for handling of any issues relating to compensation or other community matters is Ms. Regina Gatu who deals directly with the community leaders and chiefs on behalf of the company
- One of the main issues that she sometimes deal with in consultation with the chiefs and community leaders is compensation
- Any incidents between any members of the local communities and the company such as compensation payments or security problems are dealt with by the members of the local staff who are directly responsible for these areas.

8. The former Director of the SI National Museum, Mr. Lawrence Foana'ota provided the following information to those present:

- He had done some research work on the abusing of compensation payment in contemporary Solomon Islands society
- What he found was that people use this custom or cultural practice mainly to demand money from other people
- When someone pays or gives compensation, it is mainly to mend broken relationships, bring people together and to show that the perpetrator is sorry for the wrong he or she has done to the victim
- Today some people use this custom or cultural practice as an excuse to get what they want and instead of solving the problem, they create more hardship. It is one way of getting easy money from vulnerable victims
- He suggested paying or giving compensation should be made using the appropriate and acceptable custom and traditional materials instead of cash

9. This was the last issue that was raised and discussed before the meeting closed at about

10.15 am

MEETING WITH THE BAHOMEA TRIBAL CHIEFS – TINA HYDRO PROJECT SITE

Compiled by Zimri Launi

Project Office:

Eric Gorapava

Brally Tavalia

Julian Maka'a

Daniel Una

ESIA Team:

Eric Deneut

Fred Patison Siho

The meeting was to inform the leaders about a Baseline Study on the Flora and Fauna of Tina River by BRLi.

Brally thanked and welcomed all present and introduced his team then asked Eric Deneut to do his presentation, assisted by his local counterpart Fred Siho.

The presentation basically touched on why the study was necessary in terms of understanding direct and indirect effects on communities who depended on the river. It wants to establish the relations of the people with the river and also investigate social issues and people must say what they want, what they don't want etc. about the project.

Social Assessments will address what livelihoods there are of the people in the Tina River. The Social Assessment group will also provide a baseline report after its work.

They said the study is to assess what sorts of impacts the hydro will have on the environment and their livelihoods so that mitigation measures can be addressed before, during and after construction.

They stressed that BRLi is an independent group that is neutral and is carrying out the work in line with World Bank Safeguard Policies and IFC Performance Standards.

A Mitigation Workshop is earmarked for November this year. After the workshop, mitigation plans will be in place on how to address potential impacts.

They stressed the report will be a big one which will cover all the information gathered from the communities.

Eric and Jefferson assured the leaders that the government has embraced their work and recognized it so they should feel good about their effort. The work they'd carried out is not for the government or the Project Office. It is their business and they have done well.

Comments from leaders were varied.

Zimri stressed that in case BRLi encounters any disturbances during their work, they shouldn't panic as these are considered normal in the community. Such disturbances shouldn't be seen as from the communities but more as personal ones and shouldn't be taken to represent the community.

One tribal chief wants the involvement of the older people in the ESIA and SIA and someone suggested that in focus group discussions during the studies, chiefs should have one by themselves.

One question asked whether or not BRLi had involved in similar studies anywhere in the world to which Eric said he'd worked in Africa, Asia and the Caribbean so he has a vast experience. Fred also gave examples of his work with mining companies in Choiseul and Isabel Provinces.

Eric also clarified the social assessments will concentrate on communities in the proposed dam area down to the confluence of the Toni River.

Pastor Kedimiel asked whether or not BRLi would support them during in a Development Agreement but the response was no, but the information gathered in the studies would be of help.

Oscar Billy Pego said he saw the BLIC group as a model that should have been used in the early stages of the project, saying going through other bodies as was the case, created a lot of personal interests. He said land on Guadalcanal is the number on livelihood of the people and so they should talk about it, not anybody else. So the BLIC make up is the right make up. He said the HOC is merely responsible for harmony and peace in the communities, not land issues. Tribes own land not chiefs. He also wanted a copy of the ESIA report to be available for communities of Bahomea before the Mitigation Workshop.

Daniel Una said he saw the model as the best and the disturbances are internal. They are something they can sort out. As long as the government appreciates the process about the land id, that's it because the disturbances are minor and can be sorted.

Zimri added that the inclusion of three former LOC members is a good move. The fact that misinformation is going around the communities is because the BLIC group is yet to go around communities to clarify things. He said if this happened, there would be wide support among all communities.

Dohlan Gisi suggested that if all tribal chiefs were part of the BLIC process, it would strengthen the body and become a positive move for Bahomea in the long run. Right now, he said, only a few of them who attended sessions of the process and understood what it is and how good it is have already signed. But other tribal chiefs should become party to the process – very important for the future of Bahomea.

Chief Mahlon Maeni suggested that those disturbing the process have lost their power base and hence their actions. He said they are their sons but don't know what's going to happen – they only know how to harvest but not how to plant, he said.

Community awareness will be held in Bahomea on Wednesday and Thursday next week, Antioch, Marava, Tina and Horohotu, funded by the Project Office. Those included for this are PO and some senior members of the BLIC process.

Paramount Chief Peter Rocky thanked everyone for the positive messages conveyed by those who presented. He said the disturbances created a few worries for the Bahomea people but the messages of today's discussions were heartening. Tribal chiefs and the communities of Bahomea aren't interested in media stories. It's normal in life that every positive thing will always have negative ones. But Bahomea people are not interested in the disturbances – it is their heart that the project materializes for their future. He stressed all the people of Bahomea like the project. He suggested that those disturbing were worried about power but that is not the interest of the communities of Bahomea. When they have power, there's a place they gain something. But he said such things can be sorted. He said they were very happy about the messages about the environment studies today. He was happy that the messages have encouraged them because the findings would give them ammunition for a future agreement about the project. He thanked the government for its recognition of their work; they took up the task because they valued the traditions handed down by their ancestors. They believe in peace and harmony. He said when they presented their work to the World Bank reps recently; they were greatly encouraged by their comments. He apologised about the venue but said venue quality is not important, it's what's discussed and gained is more important. He also thanked the Project Office for organising the meeting.

The Paramount chief also acknowledged the comments already made by others but the issues being raised currently by some opponents are internal and they can sort them out.

WEEK 1-DAY 1: Monday 2nd September 2013**SIA Team Visit to-**

- I. **Marava** – the main center where the meeting was held
 - II. **Targeted Communities were:** Marava, Vatupaua; Ngongoti; and Rate Community High School
 - III. **Attendance:**
 - (a) Twenty males & twelve females
 - (b) Total 32
 - IV. **Program:**
 - (a) Opening Prayer- Zimri Laoni
 - (b) Welcome by- Zimri Laoni
 - (c) He also explained to those representatives from the other communities who attended the purpose of the meeting and told them to give the right information concerning the proposed Tina Hydro Project when they are asked questions.
 - V. Introduction of each of the Team Members by Gerard Fitzgerald the SIA Team Leader.
 - VI. **Presentations:**
 - (a) **Marava:** The presentations began by providing information about Marava Village which was first established in 1962. Before that families used to live in settlement up in the mountains.
 - (b) Families moved to Marava and other nearby villages because of easy access to work in Honiara town, transportation and health facilities.
 - (c) They moved during the time of the Colonial Government's administration. Marava and the other places were chosen because the areas are good for gardening and also it is safer than in the mountains where landslides sometimes occur.
 - (d) There are 28 households in Marava. The biggest family has 8 children while the smallest family consists of 3 children. The total number of families is 168.
 - (e) **Vatupaua:** 3 households with five families consisting of 50 members.
 - (f) **Ngongoti:** 1 household consisting of 20 family members.
 - VII. **Language:** The main language spoken by people of the area is called "Teha"
 - VIII. **Family Ties:** All the family members belong to the two main moieties known as *Garave or Manukama* and *Manukiki*. The people of Tina area belong to sub-tribe of the Malango tribe known as **Bahomea** in Central Guadalcanal. They originally moved from their bush settlements in the early 1960s. There are about 21 sub-tribes or *vuvuga* in the Tina area. According to the culture of the people, members of *Garave* sub-tribes are not allowed to marry each other. It also applies to members of
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Manukiki sub-tribes. But if any members of *Garave* sub-tribes want to marry any members of *Manukiki* sub-tribes or vice-versa it is allowed. When it comes to any members of the two main tribes wanting to marry, there is no problem,

IX. Community Groups/Organizations: In these communities, there are women, youth and chief's groups. These groups form a Central Board that has committees responsible for the following areas-

- (a) Education & Training
- (b) Women, Youth & Children
- (c) Culture & Tourism
- (d) Health & Sanitation
- (e) Project Development
- (f) Religion

X. The Main Churches are:

- (a) South Sea Evangelical Church or SSEC
- (b) Seventh Day Adventist or SDA
- (c) Bible Way Church or BWC
- (d) Roman Catholic Church or RCC and recently
- (e) Assembly of God or AOG

XI. Church Groups/Organizations are:

- (a) Roman Catholic Women's Group
- (b) Sports Group-Soccer, Volleyball & Futsal
- (c) Youth Singing Band and
- (d) Church Outreach groups

XII. Livelihood: People in the communities earn a living by:

- (a) Marketing at the Honiara Central Market;
- (b) Going sometimes to the Market at Gold Ridge to sell betel nut;
- (c) Working at Gold Ridge Mining Company;
- (d) Farming for marketing and family use;
- (e) Milling timber for sale and own use;
- (f) Selling firewood bundles;
- (g) Harvesting cocoa including coconuts and selling them to local buyers;
- (h) Plans are underway for raising cattle;
- (i) Operating small canteens; and
- (j) Receiving royalties from Gold Ridge Mining Company

XIII. Women's Roles:

- (a) Weaving baskets;
 - (b) Sewing calico and children's school uniforms;
 - (c) Baking cakes & bans;
 - (d) Planting vegetables like slippery cabbage, tomato, beans and egg plants;
 - (e) Cultivating root crops such as potato or kumara, cassava;
 - (f) Looking after the children;
 - (g) Taking the children when they are sick to the clinic or school;
 - (h) Cooking for the family using fire;
 - (i) Fetching drinking and cooking water from the main Tina River;
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- (j) Collecting firewood for cooking;
- (k) Feeding the pigs and other domestic animals;
- (l) Going to the markets in Honiara and Gold Ridge to sell or buy goods for the family;
- (m) Washing the clothes & dishes; and
- (n) Cleaning in and around the home

XIV. Health Issues: The most common diseases are-

- (a) Malaria caused by parasites transmitted from person to person by mosquitoes;
- (b) Pneumonia affects the lungs and is caused by very bad cold from diving in the river at night or working in the rain;
- (c) Diarrhea affects both young and old people and is caused by germs carried by flies, rats and cockroaches contaminating water for drinking or food.
- (d) Measles often affects young children;
- (e) Influenza or flu is also a common sickness affects both old and young; and
- (f) Stress affecting women due to pressure from overworking, husband's un-control behavior when they get drunk and youth people involving in drugs.

XV. Health Concerns:

- (a) 8 cases of malaria have been recorded in these communities early this year (2013);
- (b) Long distances to the Clinics is a major health concern to the people;
- (c) Rove, Mataniko and Kukum Clinics are all located in Honiara;
- (d) Lack of transportation when there is an emergency is great concern to families;
- (e) Worry about youths taking drugs can cause hypertension or high blood pressure;
- (f) Unhealthy habits like no proper toilets but mainly pit latrines;
- (g) Heavy alcohol drinking causing accidents;
- (h) Suffering from high blood pressure and diabetic;
- (i) Husbands involving in extra marital affairs with other women causing stress;
- (j) Women over working themselves without husbands helping;
- (k) No. 9 Central Referral Hospital is often overcrowded;
- (l) Fear of witchcraft known as Vele which has symptoms like malaria; and
- (m) Currently buses only operate four trips per day and each trip costs \$20.00 a person.

XVI. Communities' Needs:

- (a) A health clinic near the communities is urgently needed;
 - (b) Frequent transportation between Honiara and the communities;
 - (c) Going to town only once a week and too expensive;
 - (d) Canteens operating in these communities to sell small basic goods are limited;
 - (e) Police Posts are at Henderson and Tetere so need for one at a nearby community;
 - (f) Reliable lighting is needed because solar is only good during sunny days;
 - (g) The need to establish a few more Primary Schools to cater for youths in the area;
 - (h) More young people need to attend school up to secondary and even to tertiary levels;
 - (i) There is a need to setup an internet café at Rate Community High School; and
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- (j) Rate Community High School computer is not reliable so need a reliable computer.

XVII. Education:

- (a) The only Primary and Community High School in the area is at Rate;
- (b) Two Early Childhood Education or ECE schools at Marava and Ngongoti;
- (c) Rate School is both Primary and Community High School;
- (d) At the Secondary level, students undertake their studies from Forms 1 to 3 only;
- (e) Parents see educating their children as important and a priority;
- (f) Currently only 1 student studying at the University of the South Pacific in Suva, Fiji;
- (g) 1 student is studying at the USP Honiara Center.

XVIII. Sports Facilities and Activities:

- (a) 1 playing field for local sports at Rate Community High School;
- (b) Main sports are soccer, volleyball and futsal;
- (c) Sometimes organize 7 aside soccer knockout competition; and
- (d) Play grounds for children at Marava and Ngongoti.

XIX. Gardening Techniques:

- (a) Different gardening areas for different crops;
- (b) Before planting the crops, they burn the grasslands;
- (c) Rotation of crops plant cassava first followed by the planting of bananas;
- (d) Each household is responsible for making their own garden;
- (e) They always plant a mixture of crops in one garden in some instances;
- (f) Return to the same gardening area after 2 to 3 years;
- (g) Gardens are either 1 km or a few meters away from residential houses; and
- (h) Garden sizes may be 20m x 30m depending on individuals.

XX. Varieties of Crops and Wild Plants:

- (a) Cassava, potato or kumara, yam, taro;
- (b) Banana, mango, Malaya apples, pineapple, pawpaw, breadfruit, coconut, nali nuts, oranges, lemon, pomelo, mandarin, betel nut and cut nut;
- (c) Melon, cucumber, egg plants, tomatoes;
- (d) Slippery cabbage and beans;
- (e) Right now Cassava, banana and tomatoes are being harvested;
- (f) Wild yam is called Uvikambe;
- (g) Wild taro is known as Kai chui; and
- (h) Picho is a kind of local ice-cream.

XXI. During Disasters:

- (a) Seek government aid like in 1986 when Cyclone Namu struck;
- (b) Seek help from Guadalcanal Disaster Management Committee in 2010's flooding; and
- (c) People eat swamp taro or kakake and banana during times of disasters.

XXII. Hunting and Fishing:

1. Are carried out at their old settlement sites at Malukula and Tulotrea;
 2. Always go in 2 or 3 groups of 8 to 10 men;
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3. Accompanied by women because of fear of witchcraft known as vele;
4. Usually spend between three to four days in the mountains while hunting and fishing;
5. Women accompanied the men to cook and help carry the catch back home; and
6. Used guns to hunt for animals, mammals and birds and spears to fish for the following but now they only use spears:
 - (a) Pigs;
 - (b) Opossums;
 - (c) Fly foxes;
 - (d) Pigeons or kurukuru;
 - (e) Eels or tapurara;
 - (f) Fish known as helu;
 - (g) Valu;
 - (h) Kola; and
 - (i) Tilapia found only in Betisasanga stream

1. Diving and fishing done without hunting;
2. Choro and upstream of the river fish mainly for eel and scrimp;
3. From Antioch to Senge, Marava people usually spent the weekends fishing for small fish and eel using spear guns;
4. Area upstream of the river, fishing is usually done for important occasion only;
5. Hunting for wild pigs is also carried out only when they are organizing a big feast or fund-raising events.

XXIII. Building Materials:

- (a) Timber used for flooring, rafters, studs and knockings, cross beams and beams;
- (b) Loya cane is used for tying, sewing sago leaves together and weaving;
- (c) Bamboo use for building, cooking and as light when it is dry;
- (d) Palm- bark for walling, planks for sewing sago leaves along;
- (e) All these materials are collected from the bushes upstream of the river;
- (f) Both men and women help to collect the building materials; and
- (g) Only the men build and carry out maintenance of buildings.

XXIV. Land Boundaries:

1. From Vuramali to Birao, the land belongs to another tribe.
2. From Birao to Senge the land belongs to the tribes in the Malango area or Bahomea people which include Marava communities.
3. Land boundaries sometimes are not clearly demarcated.
4. In some cases streams, special trees and plants or natural objects like big stone boulders are sometimes used as boundary markers.

XXV. Cultural and Religious Sites:

1. In these three communities, no archaeological or historical sites exist.
 2. About 13 cemeteries are within the area.
 3. Six of these cemeteries may be in the way of the road to the Dam Site
 4. Seven are in areas still in question
-

XXVI. Concerns Regarding the Impacts of the Hydro Project:

- (a) The Hydro Project will affect the people's fishing activities along the Tina River.
- (b) They want free access to continue to their fishing and hunting grounds.
- (c) The quantity of gravel might be less than at present once the dam is constructed,
- (d) Tina, Vuramali and Antioch are the places where they normally get their gravel.
- (e) Recreational areas on the river banks will be affected, especially in the Vuramali area where the children and their parents use for picnicking.
- (f) The environment will no longer be safe for the women and children.
- (g) Quality of water will be affected especially during the construction of the dam.
- (h) Water will no longer be safe for drinking, cooking or washing.
- (i) Marava get water from a Stream which they run the water through a pipe for about 1 emeter and collect it into containers.
- (j) They use this stream when the Tina River floods.
- (k) Cemeteries may have to be relocated if they are in the way of the road.
- (l) Downstream water quality will no longer be the same.
- (m) Fish stock and their habitat will be greatly reduced.
- (n) Disturbance to social lifestyle by outsiders.
- (o) Disturbance during construction with heavy machineries going up and down the road.
- (p) Abuse and inappropriate behavior by outsiders like at Gold Ridge will happen.
- (q) Traffic and safety are of great concern to families.
- (r) Peaceful lifestyle currently enjoy by everyone will no longer be the same.
- (s) Disturbance and damage of important sites and gardens.
- (t) Problems of relocation will greatly affect people's lives.
- (u) Fear of increasing social problems once money started following into the communities

XXVIII. Electricity: Current Situation-

- (a) Families use solar for lighting but only when the sun is bright during the day.
- (b) Generators for lighting, charging mobile phones & screening videos
- (c) They need fuel for the generators which is currently very expensive

XXIX: Expected Benefits from the Hydropower Project-

- (a) If have power they would use refrigerators for preserving food
 - (b) Operate workshops & joinery shops using electrical tools
 - (c) If work on the project and earn money would build permanent houses
 - (d) Start income generating businesses
 - (e) Operate transportation services using cars for taxis and buses
 - (f) Set up canteens
 - (g) Own and Sell fuel
 - (h) Women want to generate income by operating businesses, catering and home-stay
 - (i) Men and women want to involve in contracts, road construction and driving heavy machineries
 - (j) Provide accommodation for visitors
 - (k) Employment opportunities for local skillful workers
-

- (l) Training on the jobs offered by the Hydro Project for locals
- (m) Government to grantee loans from banks for capital needed to start a business
- (n) Establish good partnership between the communities, government and stakeholders
- (o) Want a government that has concerns for the people (lesson learnt from Gold Ridge)
- (p) Mainly looking forward for improvement of their standard of living
- (q) Easy access to power, better services and equal opportunities in the employment sector
- (r) Long term benefit will depend on the landowners and trustees.
- (s) Looking forward to involving in contract work with the Hydro Project.

XXIX. Some Final Issues Worth Taking Into Serious Consideration:

- 1) Marava Community is located on registered land owned by the Government through the Commissioner of Lands in the Ministry of Lands and Housing.
- 2) As far as the communities at Marava, Ngongoti and Vatupaua are concerned, the main destructions that may affect some of their grave sites and probably parts of their gardening areas would be from the construction of the road to the main dam and the power station sites.
- 3) In such cases, some forms of compensation payments need to be negotiated with the owners to assist them move the graves and gardens to new sites. Some houses may have to be relocated especially in Ngongoti. These issues will become clearer when the surveyors and engineers decide on the plans for the roads and the power-lines.
- 4) For the time being the general feeling is that everyone within these three communities supported plans for the Tina Hydropower Development Project.

WEEK 1-DATE 2: Tuesday 3rd September 2013

SIA Team Visit to-

- I. Vuramali-**The main Center for the meeting

 - II. Targeted Communities were-**Vuramali, Horohotu (1 & 2) Katihana and Haimane

 - III. Attendance:** 44 persons
 - IV. Program-**
 - (a) The program started with a prayer and a welcome
 - (b) Vuramali was not possible to get to because it meant crossing the river
 - (c) It was decided to hold the meeting at Haimane.
 - (d) The Paramount Chief of Vuramali, David Tabea was present
 - (e) Zimri Laoni gave the introductory remarks in the local language
 - (f) He also encouraged those present to talk openly and share their views about the Hydro Project
 - (g) Gerard Fitzgerald, the SIA Team Leader introduced himself and explained that he is an independent researcher.
 - (h) He then explained the main purpose of the visit is to-
All the villages along the Tina River
-

Talk about the areas the Hydro Project might affect in people's lives

Find out the views of the people regarding this Project

(i) All the information was translated by Kellington Simeon, the Assistant Sociologist

V. Discussions: Chief Alfred Ilala expressed his views as follows-

(a) Up until now major projects like the Gold Ridge Mining, Guadalcanal Plains Plantation Oil Limited and Logging operating in the country are implemented in Central Guadalcanal and yet they still have not benefited.

(b) So he questioned "if the Tina Hydro Project is built would they receive any benefits"?

(c) He expressed these issues basically because this is another new huge undertaking which has not been done anywhere else before in the country.

Penuel Pore, a Church Elder (SSEC) and Chief also spoke about the need to-

(a) Build and relocate them

(b) Have their lives built up and improved

Zimri told those present that the SIA team is not an awareness group

Sarah Estela (a lady) then asked what will happen to the information the team collects.

Gerard Fitzgerald responded as follows-

(a) First all the data is collected

(b) Second the data is put together or compiled into a report

(c) Third the report is then presented to the Government and the Project Developer

(d) Fourth depending on the data provided, they then decide whether to go ahead with the Project or not

VI. Movement of People:

The next lot of information collected was about the movement of people from one place to another. According to the data they provided they used to live in the following places before moving to where they are today:

(a) Belana

(b) Railoto

(c) Chipukiki

VII. The Reasons for Moving:

People Move because of the need for-

(a) Easy access to employment

(b) Better living standards

(c) Better and easy access to services like health, transport, market, schools and Church

(d) Natural disasters like flooding, cyclone, landslides, etc.

VIII. Years of Settlement:

(a) Horohotu(2) -c1960

(b) Horohotu (1) -1970

(c) Haimane -1970

(d) Vuramali -c1990

(e) Katihana -No information available

IX. Attendance at the Meeting:

Not everyone turned up for the meeting

(a) Horohotu(1) - Nil

(b) Horohotu(2) - 2

- (c) Haimane -12
- (d) Vuramali -10
- (e) Katihana -Nil

X. Community Church Groups:

- (a) Haemane-Baptist Church Women's and Youth Groups
- (b) Vuramali-South Sea Evangelical Church Women's Fellowship and Youth Groups
- (c) Horohotu-Seventh Day Adventist Church Women and Youth Groups

XI. Livelihood:

In Haemane 11 men and 4 women involve in paid employment in the following:

- (a) Gold Ridge Mining Co.
- (b) Ministry of Finance & Treasury-SIG
- (c) Ministry of Fisheries-SIG
- (d) Solomon Islands Ports Authority
- (e) Teaching Services
- (f) Royalties from Gold Ridge Mining

Formal Employment:

- (a) Vuramali 6 men and women
- (b) Horohotu 5 men and 1 woman
- (c) Katihana no information

Other activities which they also involve with for their livelihood are-

- (a) Milling timber
- (b) Gardening/Marketing
- (c) Fishing/Hunting
- (d) Cutting Copra/Selling Cocoa
- (e) Operating Canteen
- (f) Sewing School uniforms
- (g) Weaving baskets for sale

The kinds of crop, fruit and veges which they sell in the markets are;

- (a) Slippery cabbage
- (b) Paw paw
- (c) Cassava
- (d) Kumara/Potato
- (e) Ferns-Kasume

No one in either Haemane or the other communities involved in any tourism projects but some of them are signatories to the Gold Ridge Mining Company and Paramount Chief David Tabea is one of them.

XII. Fishing and Hunting:

Both men and women go diving and hunting up to Pachuki and all the way up the riverand in the bush following bush road, and the valley looking for

- (a) Ura & eel in the river; and
- (b) Pigs in the bush

XIII. Historical & Sacred Sites:

- (a) Tulahi is an ancestral sacrificial site
 - (b) Namuloha is a sacred pool
-

- (c) Aho is a stream with a half Eel living in it and since everything else in it is all half no one is allowed to eat anything in it
- (d) Pela is also a tabu site
- (e) Naukotiti is a historical place of worship with a stone and a sacred tree known as vaovao still standing in it today. It is located in the area between Senge and Choro
- (f) Vuho which literally means to catch in a net is a sacred site at Vuramali

XII. Currently People Use the Water from the River for:

- (a) Cooking
- (b) Washing
- (c) Drinking
- (d) Swimming
- (e) Watering cabbages, egg plants, beans and other vegetables
- (f) Boiling and making tea
- (g) Transportation

XIII. Main Concerns if the Dam is built:

- (a) Their hunting grounds will be affected because the pigs resting place will be under water
- (b) Fishing will be affected, especially diving because the best spots will become so deep that no one will be able to dive
- (c) Quality of the water will no longer be the same
- (d) It will no longer be safe for the children to play freely in the river
- (e) Drinking the water directly from the river will become a health problem
- (f) Fear of the dam breaking and destroying everything in its path including lives of people

XIV. Health Issues and Concerns:

Currently the most common diseases or sicknesses that often affect people in these communities and their concerns are-

- (a) Malaria
- (b) Pneumonia
- (c) Influenza
- (d) Diarrhea
- (e) Measles
- (f) Clinics very far
- (g) Lack of transport in emergence cases

XV. The first things people buy when they have money:

- (a) Rice- because easy to cook
- (b) Soap
- (c) School fees
- (d) Generator for lighting, video show (3-4 hrs a day)

XVI. Benefit they see if Hydro is Constructed:

- (a) Provide lighting
 - (b) Refrigerator for preserving food/cold water
 - (c) Good communication
 - (d) Clinics
-

- (e) Permanent School/Church buildings with lights for night programs
- (f) Employment opportunities for women
- (g) Electric sewing machines
- (h) Men will be employed
- (i) Operate small income generating businesses

XVII. People's general feeling toward the Tina Hydro Project:

- (a) Generally those present at the meeting seemed to appreciate the discussions
- (b) They were happy to express their feelings freely but still not sure since hydro development of this magnitude is a new undertaking by the SIG in this country
- (c) Since this huge development project will be on their land, fairness in the benefit sharing must be taken seriously and they need to fully participate as equal partners
- (d) They do not want the situations they already experienced with Gold Ridge Mining Company and Guadalcanal Plains Palm Oil Limited repeated
- (e) Therefore, SIG, the financier of the Project and all stakeholders must take on board seriously the people's concerns.

WEEK 1-DAY 3: Wednesday 4th September 2013

SIA Team visit to-

- I. Tina:** The main center for the Meeting

 - II. Targeted Communities:** Tina, Valebebe, Valebarik, Valemaota & Tahurasa

 - III. In attendance:** 38

 - IV. Program:**
 - (a) Met on arrival by the founding father of Tina Community, Chief Gabriel Gi.
 - (b) Meeting was held at the Church Community Hall
 - (c) Welcomed by the Village Chief Asher Wini
 - (d) Opening Prayer by Jeremiah
 - (e) Opening remarks by Zimri Laoni who was one of the three Field Guides
 - (f) Kellington Simeon and Gerard Fitzgerald explained the purpose of the visit and told those who attended that the SIA team consists of independent Scientists and not from the SI Government or the Tina Hydropower Development Project Office.
 - (g) The SIA team's visit is paid for by the World Bank
 - V. History of the Communities/Villages:**
 - (a) Tina started by Chief Gabriel Gi, his wife and father in the 1950s after WWII
 - (b) Before that they were living in Belana and Vurutolu
 - (c) He converted to Christianity through the teaching of a Missionary from North Malaita by the name of Gideon Fangalea who used to accompany him as a young man to get things from the American Soldiers and carry them back to mountain settlements.
 - (d) Gabriel Gi's wife attended Afio Girls Bible School in South Malaita before they got married
-

- (e) Current population is between 400 to 500
- (f) Main religion is South Sea Evangelical Church
- (g) From Tina the others move to settle in the other communities such as
- (h) Valebarik started in 1980
- (i) Valebebe started in 1998
- (j) Tahurasa started in 1999
- (k) Valemaota started in 2006

VI. Main Reasons for moving from the mountains and later spreading to establish other communities include:

- (a) Escaping from the Moro Movement in the 1950s when it was very strong
- (b) Need easy access to medical services
- (c) Close to Honiara for other services such as market, shops and main Church Head Office
- (d) Employment opportunities
- (e) Natural disaster such as the Cyclone Namu in 1986

VII. Church and Social Groups:

Since all the family members now living in the other communities started from Tina which is predominantly SSEC, they all have the same social groupings such as:

- (a) Women's Fellowship Groups
- (b) Men's Fellowship Groups
- (c) Youth Groups
- (d) Sunday School Groups
- (e) Soccer Teams
- (f) Volleyball Teams
- (g) Netball Teams

VIII. Livelihood:

- (a) Women's activities involve gardening
- (b) Marketing vegetables and other crops like potato, cassava, taro etc at the Honiara Market
- (c) Sewing cloths for themselves and extras for sale
- (d) Every Friday go to Honiara main Market
- (e) Sell flowers
- (f) Feed and sell pigs
- (g) 12 workers employed at Gold Ridge
- (h) 1 work for GPPOL
- (i) 3 School Teachers
- (j) 1 work in the THP Office
- (k) 1 Public Servant
- (l) 2 work as Police Officers at Tetere Police Post -(Chief Gabriel Gi's son and grandson)
- (m) Milling timber for sale or personal use
- (n) Dive for fish to sell or family consumption
- (o) Hunt for pig for sale or to eat
- (p) Logging in the area

IX. Women's Current Lifestyle in the Communities:

- (a) Free to walk wherever they wish without fear
- (b) Free to fee and raise their pigs and children
- (c) Free to fee their dogs
- (d) Free to breath fresh air
- (e) Free to fish using fishhooks or their bare hands to catch the fish
- (f) Free to walk along along the river banks
- (g) Free to go to their gardens alone

X. Community Projects:

In Tina Community, the South Sea Evangelical Church had introduced in August 2012village projects that involved:

- (a) **Sanitation** – which individual families are taught how to make proper sealed toilets
- (b) **Environment Cleaning** – cutting down the grass, digging proper drainage systems, general village cleaning around residential dwellings and proper disposal of rubbish
- (c) **Piggery** – the Church provided a boar and female pig
- (d) **Aims** - to prevent unhealthy habits such as using the bushes and streams as toilets
- (e) - toreproduce piglets for distributing to individual families to feed.
- (f) Unfortunately, both pigs are so huge that they are unable to reproduce.
- (g) Two persons from Tina community attended a training courseon how to properly manage pig farming at the Taiwan TechnicalFarm in Honiara

XI. Sacred/Tabu Sites:

- (a) Vatulina is a sacrificial site from before
- (b) Namuloaha is a fish spurning big pool at Korobawhich is regarded as sacred
- (c) The Pool is regarded sacred so that while the fish is spurning they are protected and preserved and later they can spread to other parts of the Tina River

XII. Health Issues:Main diseases/sicknesses

- (a) Malaria (cases drastically reduced)
- (b) Diarrhea (reduced)
- (c) Hookworm (also reduced)
- (d) Pneumonia (cases are increasing)
- (e) Stress amongst women (slightly increasing)
- (f) Still birth or other related difficulties in child delivery is not a problem

XIII. Main Health Concerns:

No health clinics close by so they have to travel to Honiara especially to

- (a) Rove clinic
- (b) Mataniko clinic
- (c) Kukum clinic
- (d) No. 9 Central Hospital
- (e) Heavy alcohol consumption
- (f) Youths involving in drug use
- (g) Transportation is sometimes difficult in emergency cases

XIV. Problems with the construction of the dam for the Tina Hydro Project:

- (a) Polluting the water
 - (b) No fishing
 - (c) No diving
-

- (d) No clean drinking water
- (e) No clean water for swimming
- (f) No clean water for washing cloths and dishes
- (g) Fear for the children
- (h) Fear of the dam breaking during earthquakes and cyclones
- (i) Fear of landslides causing the water to overflow from the dam
- (j) Diseases like diarrhea might increase

XV. Men and Women's Concerns:

- (a) Employment should involve locals who already have skills
- (b) Nor respect for the custom/culture by those from outside
- (c) Camp sites should have proper waste disposal in place
- (d) Contracts should consider the locals first not like Gold Ridge Mining Company
- (e) Dumping of raw sewerage straight into the water without treating like Gold Ridge Mining Company not acceptable
- (f) Disrespect for young girls and even married women
- (g) Security
- (h) Women do not want the type of treatment Gold Ridge Mining Company has done to the local women in the Gold Ridge area
- (i) Women want the Project to provide the opportunity for them to do catering, laundry and even driving some of the light vehicles
- (j) They want the first chance for employment for unskilled work to be given to their men-folks

XVI. Long Term Concerns:

- (a) Landslide into the lake/dam
- (b) Trees for timber along the river bank in the dam area will not be possible to cut
- (c) Will they continue to use the lake/dam for fishing
- (d) Diving will no longer be possible
- (e) Using the river as a means of transportation will be greatly affected

XVII. Benefits from the Hydro Project:

- (a) Provide lighting for the communities
- (b) People will be able to use refrigerators to store food/cold water
- (c) Build mini hospital
- (d) Improve the road and other infrastructures
- (e) Provide good water supply system
- (f) Use the Dam as part of tourism attraction
- (g) Provide employment
- (h) Building permanent houses
- (i) Set up scholarships for local students
- (j) Invest any money they earn from the project
- (k) Involve in joint investment schemes
- (l) Involve in eco-tourism development projects
- (m) Operate canteens
- (n) Set up furniture making workshops

XVIII. Some Mitigation Measures:

- (a) Provision of water tanks
- (b) Build water supply to provide water from other sources
- (c) Possible use of lake/dam for transportation
- (d) Sailing
- (e) Fishing
- (f) Other recreational activities

XIX. Final decision on the Benefits and Effects:

- (a) 90% of those present supported the Project
- (b) 10% undecided
- (c) More information is still needed on the effects

XX. Concluding remarks:

When people do not benefit from any project on their land they cause social disturbance

XXI. Lunch was kindly provided:

Consisting of boiled bananas which was greatly appreciated

WEEK 1-DAY 4: Thursday 5th September 2013

SIA Team visit to-

I. Valesala: The main center for the Meeting

II. Targeted communities: Antioch, Valesala and Komeo

III. Total Attend Meeting: 41

IV. In attendance:

- (a) Paramount Chief of Antioch Community, Eron Nose;
- (b) Tribal Chief of Komeo Community, Mark Enoch;
- (c) Tribal Chief of Valemaota, Enoch Maki who did not attend meeting at Tina;
- (d) Ishmael Wesi, Elder of the Church and Village of Antioch;
- (e) 38 Men and Women as well as children

V. Program:

- (a) Opening pray by Elder Ishmael Wesi;
- (b) Brief introduction of team members including local guides and field assistants by local Anthropologist;
- (c) Chief remarked saying they did not receive any prior information about the SIA team's visit;
- (d) SIA team leader, Gerard Fitzgerald expressed his regret about the information not reaching them in time before the team arrived even though it was sent earlier;
- (e) Kellington Simeon explained the purpose of the visit by the SIA team; and
- (f) Zimre Laoni further explained in language the purpose of the visit in response to a question from the former SSEC Pastor Osca Billy

VI. History of people migration from place to place:

- (a) First wave of migration to these villages started around 1960s;
- (b) First settlement at Kolohaji;
- (c) From Kolohaji people move to Talamu and Torotolu;
- (d) From Talamu to Vatunadi;
- (e) From Vatunadi to Valelokea;
- (f) From Valelokea to Valekocha;
- (g) From Valekocha to Valelokea or Antioch and Valesala in the 1970s; and
- (h) These movements also included members of the Moro or Gaena Alu Movement

VII. Reasons for moving from one place to another place:

- (a) Easy access to Honiara town;
- (b) Easy access to clinics;
- (c) Easy access to schools;
- (d) Easy access to other services like transportation, shops etc.;
- (e) Also natural disaster like Cyclone Namu in 1986 caused people to move; and
- (f) People move along their relationship ties, land boundaries and landownership

VIII. Livelihood:

- (a) Full time employment
- (b) 3 Teacher (Government)
- (c) 2 GPPOL
- (d) 4 Earth Movers Logging Company
- (e) 1 Gold Ridge Mining Company
- (f) 1 Pastor

IX. Other sources of income:

- (a) Milling timber
- (b) Fire wood
- (c) Flowers
- (d) Handicraft
- (e) Garden products
- (f) Fishing
- (g) Hunting
- (h) Gardening
- (i) Marketing
- (j) Day labor (earn between \$50 and \$100 or provide food)
- (k) Contracted jobs
- (l) Megapod or wild turkey eggs
- (m) Chicken/Duck/Pigs
- (n) Betel nut fruits
- (o) Local building materials-sage palm leaves, vines, etc
- (p) Local tobacco (lekona or savusavu)
- (q) Nali Nut and Coconut (young and dry fruits)

X. Common Health Diseases/Sicknesses and Concerns:

- (a) Malaria both adults and children
 - (b) Pneumonia
 - (c) Diarrhea both adults and children
-

- (d) Measles mostly with children
- (e) Influenza/common flu both adults and children
- (f) Yellow fever rare
- (g) Sugar or Diabetic common amongst adults
- (h) High blood pressure adults only
- (i) Main clinics far away at Rove, No. 9 for emergency cases only
- (j) Namanu health aid center lacks fulltime medical staff and medicine
- (k) Stress affects women because of drunken husbands and extra marital affairs
- (l) Difficult child birth can cause death
- (m) Accidents
- (n) Children drowning in the river
- (o) Body shaking, cold, fever-people associate this new kind of feeling in the body with the use of chemicals in the mining activities at Gold Ridge Mining sites

XI. Main Church and Groups:

- (a) South Sea Evangelical Church
- (b) Women's Fellowship Group
- (c) Men's Fellowship Group
- (d) Youth Group
- (e) Music Group
- (f) Sunday School Group

XII. Moro or Gaena Alu Movement:

- (a) Preservation of Culture and Inheritance
- (b) Moro's vision was to preserve the culture
- (c) Preserve the Environment- **(Hairau)**
- (d) Preserve the Land- **(Pari)**
- (e) Preserve custom money, way of doing things and lifestyle of People- **(Tinoni)**
- (f) Live simple life- **(Poua or Poor)**
- (g) Look after the Ground/Land- **(Momoru)**
- (h) Life of today (rich becomes richer and poor becomes poorer)- **(Vulua or Head)**

XIII. Current Situation:

- (a) Use Kerosene for light
- (b) Generator
- (c) Solar Panels

XIV. Future Plans if Hydro Project is completed:

- (a) Lighting
- (b) Refrigerator
- (c) Video
- (d) Electric sewing machine
- (e) Improve and upgrade Church Musical Instruments
- (f) School computers

XV. Household:

If women have extra income they would

- (a) Start income generating businesses
 - (b) Improve housing from thatched to iron
-

- (c) Pay school fees

XVI. If men have extra income they would

- (a) Purchase truck for marking timber
- (b) Purchase truck and put on hire or rental
- (c) Involve in Tourism/Home-stay
- (d) Spend it on housing
- (e) Purchase tools (chain saw)
- (f) Build Community health
- (g) Build Community hall

XVII. Final Remarks:

One of the women expressed her concerns regarding

- (a) Road block to drinking water (Gold Ridge)
- (b) Road block to gardening area (Gold Ridge)
- (c) Continue the dialog after 1 year
- (d) People in the affected areas to have maximize benefit and minimize the effects
- (e) Communities should involve with the management of the project
- (f) Any agreements should consider inclusion of any clause that will take into account reviewing the agreement.

WEEK 1-DAY 5: Friday 6th September 2013

SIA Team Program

- I. Household Survey Review
- II. **Venue:** Hyundai Office
- III. **Time:** 8 am – 5 pm
- IV. **Attended by:** All SIA Team members
- V. Discussions led by Gerard Fitzgerald, SIA team leader, assisted by Kellington Simeon, Lawrence Foana'ota, Anthropologist and Sharon Para, Local Assistant Guide and Interpreter
- VI. Went through the four days' field work results and fill in any gaps with the help of the other local guides such as Zimri Laoni and Rex Ata
- VII. Planned the field work program for the rest of Week 2.

WEEK 2-DAY 6: Monday 9th September 2013

SIA Team Visit to-

- I. **Senge** – the main center where the meeting was held
 - II. **Targeted Communities were:** Senge, Koeroba and Choro
 - III. **Present:**
 - (a) Chief Joe Maneisu of Senge, & Son Clement Tovia
 - (b) Chief Hudson Micah of Koeroba, wife and Son-inlaw
 - (c) Chief of Choro did not attend
 - (d) Rest of those present were of those who went with the team
 - (e) SIA team-GF, KS, SP & LF
 - IV. **Program:**
 - (a) Brief welcome by Clement Tovia
 - (b) He also explained to those representatives from the other communities who attended the purpose of the meeting and told them to give the right information concerning the proposed Tina Hydro Project when they are asked questions.
 - VI. Introduction of each of the Team Members by Gerard Fitzgerald the SIA Team Leader.
 - VII. **Presentations:**
 - (a) **Senge:** was settled before World War 2.
 - (b) After the War some families decided to move to communities like Marava, Vuramali, Managikiki and Koeroba
 - (c) Joe Maneisu and family remain until today.
 - (d) In 1986 Senge was destroyed by Cyclone Namu.
 - (e) People moved to Marava and after the cyclone return back to Senge again.
 - VIII. **Reasons for moving:**
 - (a) Natural disasters like cyclone Namu of 1986
 - (b) Easy access to job opportunities in Honiara
 - (c) Easy access to transportation
 - (d) Quicker to get to Health clinics
 - IX. **First information about the Hydro Project:**
 - (a) The people's first time to hear about the HP was in 2007;
 - (b) The person who first told them about the Project was Texas from Guadalcanal;
 - (c) He visited Koeroba and Senge;
 - (d) Life after the dam is built, is still unknown;
 - (e) Life now is all they know; and
 - (f) Little they know about the project at this time is that it will change their way of life and affect their use of the river
 - X. **Main Livelihood Activities:**
 - (a) Gardening;
 - (b) Hunting with dog & spear;
 - (c) Fishing;
 - (d) Diving;
 - (e) Marketing of ferns/tomatoes/egg plants;
-

- (f) Milling timber for sale and own use (small scale);
- (g) Development of Eco-Tourism (from 2009 till early 2013 already had 29 guests);
- (h) Charging for accommodation (from beginning of 2013 already had 17 guests who paid a total of \$17,000.00);
- (i) Marketing of the Eco-tourism lodge at Senge overseas has already been made; and
- (j) Foraging in the forest

XI. Other Village/Community Activities:

- (a) Hunting and fishing may take villagers away from their homes for a week;
- (b) Daily hunting and fishing take place between Senge and Terobisi;
- (c) They may also hunt or fish along the Beahea or Bicho Rivers;
- (d) Namutamadira Pool people believed in the past a family drowned inside after a landslide and still live in it. After Cyclone Namu people started fishing inside;
- (e) Used fishing lines (in Senge they have about 6 fishing lines);
- (f) Use goggles for diving (only 1 left);
- (g) Hunt for pigs with dogs and spear;
- (h) Opossums; and
- (i) Large lizard known as Hunu

XII. Women's Roles:

- (a) Weaving baskets;
- (b) Planting vegetables like slippery cabbage, tomato, beans and egg plants;
- (c) Cultivating root crops such as potato or kumara, cassava;
- (d) Taking care of the household chores;
- (e) Cooking for the family using fire;
- (f) Fetching drinking and cooking water from the main Tina River;
- (g) Collecting firewood for cooking;
- (h) Feeding the pigs and other domestic animals;
- (i) Washing the clothes & dishes; and
- (j) Cleaning in and around the home

XIII. Varieties of Crops, Plants, Animals & Materials for family use and for Sale:

- (a) Cassava, potato or kumara, yam, taro and banana;
- (b) Betel nut;
- (c) Ferns or Kasume planted;
- (d) Slippery cabbage and beans;
- (e) Wild yam is called Uvikambe;
- (f) Wild taro is known as Kai Chui leaves;
- (g) Swam taro or Kakake;
- (h) Fish & Pigs;
- (i) Loya cane; and
- (j) Picho is a kind of local ice-cream.

XIV. How much they earn per month:

- (a) In the past they used to earn between \$250 to \$500 per month;
 - (b) Now they may earn between \$500 to \$1,000 per month by selling betel nut; and
 - (c) Providing accommodation for tourists
-

XV. The main Church & Organization at Senge, Koerob & Choro:

- (a) Roman Catholic;
- (b) Moro or Gaena Alau Movement; and
- (c) Seventh Day Adventist (1 person at Senge).

XVI. Main Diseases:

- (a) Malaria (not a major problem);
- (b) Pneumonia (caused by very bad cold);
- (c) Influenza or common cold
- (d) Hernia (caused by hard work); and
- (e) Generally people in these communities are healthy

XVII. Health Concerns:

- (a) Long distances to the Clinics like Rove, Mataniko and No. 9 Hospital;
- (b) Namanu and Good Samaritan Clinic (near Nguvia) unable to deal with serious cases;
- (c) Lack of transportation; and
- (d) Being far away from any good roads and health facilities

XVIII. Communities' Needs:

- (a) A health clinic;
- (b) Good access roads;
- (c) Need to setup an internet café; and
- (d) Proper accommodation facilities for tourists

XIX. Education:

- (a) The only Primary and Community High School in the area is at Rate;
- (b) The children from Koeroba have to reside at Antioch to go to school and only return home during school holidays;
- (c) Main worry is for food because they do not have any land for gardening at Antioch; and
- (d) So far only 1 person at Senge attended High School and is currently operating an Eco-Tourism lodge

XX. During Disasters or the Tina River floods:

- (a) Seek government aid like in 1986 when Cyclone Namu struck;
- (b) Seek help from Guadalcanal Disaster Management Committee in 2010's flooding;
- (c) People eat swamp taro or kakake and banana during times of disasters; and
- (d) People use Senge & Nembo streams to fetch water for drinking and cooking

XXI. Cultural Sites:

The following sites were used by the founding fathers who settled the land between Senge and Choro:

- (a) Tulahi opposite Koeroba Settlement;
 - (b) Aho is a sacred Pool;
 - (c) Namoloha is a sacred Pool;
 - (d) Choga
 - (e) Vatukotiti is a sacred Stone;
 - (f) Bela located on Tulahi hill;
-

- (g) Tovu;
- (h) Babaru Luvia is a cave used in the past for sleeping; and
- (i) Kabi

XXII. Their Sacred Totems:

- (a) Helu (Big fish) represented by 2 stones;
- (b) Eel – Mouvo;
- (c) Prawn used for sacrifice;
- (d) Hahate-poisonous snakes (2 types)
 - One red in color is a totem;
 - 2nd is called Hurusuli - dark-blue in color is poisonous but very rare and lives in the river; and
- (e) Vatumosa is a Pig represented by a stone totem.

XXIII. Forest & Logging:

- (a) Logging happened at the top of the mountains in 2011;
- (b) Recent logging activities in the area was by Earth Movers;
- (c) Problem of logging causing streams to get dirty and undrinkable;
- (d) Arguments usually occur between family members regarding benefit sharing;
- (e) Causes a bit of soil erosion;
- (f) Tapu sites were marked with red paint;
- (g) Koeroba main reasons for milling timber are for sale and house building;

XXIV. Benefit of Electricity if the Dam is built:

- (a) Currently use solar (sun only heats up the panels from 11 am to 2 pm);
- (b) Kerosene (now facing out);
- (c) Sustainable lighting;
- (d) Able to screen video/movies;
- (e) Refrigerator for the Eco-Tourism Lodge;
- (f) Set up internet café
- (g) Relocation of the communities;
- (h) Improvement of standard of living;
- (i) Have proper water supply;
- (j) Have protected area;
- (k) Provide employment
- (l) Contribute to the Development of Eco-Tourism Activities and Attractions;
- (m) Provide Sports Facilities for communities;
- (n) Provide scholarships and training;
- (o) Provide close health facilities like clinics and even a mini-hospital;
- (p) Improve the level of education in specialized skills;
- (q) Tourists might be interested to come and see the lake; and
- (r) It will make it easier for people to travel upstream by canoe or boat

XXV. Other Benefits if get extra Money:

- (a) Buy an Out Board Motor & Canoe to use in the lake;
 - (b) Buy a truck;
 - (c) Establish a Fuel Station;
 - (d) Buy a laptop computer for entering data concerning tourists; and
-

- (e) Set up a Tire Repair Workshop

XXVI. People's Concerns if the Dam is built:

- (a) The use of plants for medicine will be affected;
- (b) The use of plants for food may no longer available;
- (c) Plants use to feed dogs in order to know where pigs live will be destroyed;
- (d) Access to medicinal plants use for fishing, hunting and women will be limited;
- (e) Leaves of plants use for separating married couples will be hard to find;
- (f) Number of tourists visiting the place might be less;
- (g) Some species of fish might migrate while those like living deep waters might stay;
- (h) Calvelum trees and creepers need to be removed because they are poisonous and might kill the aquatic life in the dam;
- (i) Logging trees must be compensated;
- (j) If paid for the trees, the Project would have the right of ownership;
- (k) Property lose;
- (l) Lose of river access;
- (m) Water contamination;
- (n) Access for normal use will be affected;
- (o) Pollution of the air, noise, and water;
- (p) Tribal conflict over land and royalty sharing;
- (q) Two graves at Koeroba will be under water;
- (r) Gardening areas for potato, cassava, yam, taro, banana, betel nut, coconut and all kinds of fruit trees will be flooded;
- (s) Aho stream on Tulahi land owned by Charana sub-tribe of Manukiki will be under water in the dam;
- (t) Change of culture which might lead to women wearing shorts & driving trucks;
- (u) Broken families;
- (v) Ethnic differences and misunderstanding between locals and international employees might cause frictions; and
- (w) Introduction of new diseases

XXX. Chief Hudson Micah of Koeroba's Movements:

- (a) Chief Hudson Micah was born at Valehaitora within Manukiki land;
 - (b) From Valehaitora he moved to Muritovavi;
 - (c) From Muritovavi he moved to Hailake (on Garavu land);
 - (d) From Hailake he moved to Tavura (Manukiki land);
 - (e) From Tavura he moved to Vatumosa;
 - (f) From Vatumosa he moved to Turutolu;
 - (g) From Turutolu he moved to Valehaona;
 - (h) From Valehaona he moved to Valebokoboko;
 - (i) From Valebokoboko he moved to Malatoa;
 - (j) From Malatoa he moved to Tavura;
 - (k) From Tavura he moved to Hanilake;
 - (l) From Hanilake he moved to Marava (where he married in 1975);
 - (m) In that year he started Vuramali;
-

- (n) From Vuramali he moved to Komeo (which was damaged by Cyclone Namu in 1986);
- (o) From Komeo he moved back to Marava;
- (p) From Marava he moved to Vuramali;
- (q) From Vuramali he moved to Tina;
- (r) From Tina he moved back to Vuramali;
- (s) From Vuramali he moved to Valesala;
- (t) In 1993 he moved from Valesala to Koeroba. and
- (u) Established a hamlet on his land at Koeroba

XXXI. Main Reasons for Moving from Place to Place are:

- (a) He was not accepted by Church leaders who disagree with the Moro Movement;
- (b) He was not allowed to promote any activities associated with the Movement;
- (c) Disrespecting the Movement's beliefs and teachings which he practices;
- (d) Not allowing him to make money on land owned by other people;
- (e) Disturbing his plans to build custom houses by taking him to court;
- (f) His interaction with other community members was restricted; and
- (g) His desire to return to his ancestral land where everything is free

XXXII. Some Information on the Moro or Gaena Alu Movement:

- (a) Name Gaena Alu was given to the Moro Movement after it was registered under its Constitution.
- (b) The Movement's main base is at Koeroba where Chief Hudson Micah is the main holder of everything related to the Movement.
- (c) He has two boxes containing the things that he keeps in three compartments in each box.
- (d) The purpose for keeping them in boxes is for security and safety reasons.
- (e) Also when the dam is built and the place is flooded, they are easy to move to another safe location.
- (f) By keeping them safe, he would use them to attract tourists.
- (g) He is interested in developing eco-tourism facilities in his own place.
- (h) He is not sure at this stage if the Hydro Project or Government would assist him finance his proposed plans.
- (i) Items kept in the boxes are shell money rings use for life saving.

XXXIII. Some Issues Worth Noting:

- 1) Reiloto is the original place of settlement by the founding ancestors of the present families of Senge and Koeroba hamlets.
 - 2) Descendants of the Charana sub-tribe continue to move around in the surrounding areas of land in search of good gardening, hunting and fishing spots along the Tina River.
 - 3) Even though they move around, they still continue to think about their relationship and ownership of their land. Therefore, they continue to live until today in the hamlets at Senge and Koeroba.
 - 4) The families in these hamlets continue to depend on what grows and lives in these areas of land along the river for their survival.
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- 5) It was in 2007 that he first heard about the Hydro Project from one Government Officer who visited them.
- 6) From that time he started replanting his betel nut trees at Namopila away from the dam site.
- 7) He wants to relocate at Vukuraunaba further up in the hills from Koeroba.
- 8) To mitigate he needs to relocate his Custom House where he keeps the heirloom.
- 9) In each box he divided into three rooms.
- 10) Room 1: items relate to environment;
- 11) Room 2: items relate to good health; and
- 12) Room 3: items that make gardens produce high yields
- 13) These items represent similar ones held at the Movement's headquarters in Makaruka, on the Weather Coast of Guadalcanal Province

WEEK 2-DAY 7: TUESDAY 10TH SEPTEMBER 2013

SIA Team visit to-

- I. Pachuki** – main venue of the Meeting
 - II. Targeted Communities:** Pachuki, Habusi and Veralokea
 - III. Habusi Settlement:** A brief stopover was at Habusi where the power station will be located on the way to Pachuki. Only one person met the team at the settlement.
 - IV. Program:**
 - (a) Introduction of the SIA Team members by Lawrence Foana'ota-National Anthropologist/Health and Cultural Heritage Expert
 - (b) Explaining the purpose of the visit by Gerard Fitzgerald-International Sociologist
 - (c) Questions and discussions about social aspects of the communities led by Kellington Simeon-National Assistant Sociologist assisted by Sharon Para, Zimri Laoni and Rex Ata, the local guides and interpreters
 - V. Attendance:**
 - (a) Avai Gilbert, Chief of Pachuki Village
 - (b) Risiki Rongo, Chief of Habuchi Village
 - (c) Including men, women and youths from both communities
 - (d) SIA team- GF, KS, SR & LF
 - VI. History of the two Settlements:**
 - 1. Pachuki**
 - Started after Cyclone Namu in 1986
 - Before that members were in Torotolu
 - In 1966 they left Torotolu for Valekocha
 - From Valekocha they moved to Valesala
 - From Valesala they moved to Pachuki
-

2. Habuchi

- Also started after Cyclone Namu in 1986

VII. Livelihood:

- (a) 1 person working at Gold Ridge
- (b) 1 person worked with Earth Movers Logging Company
- (c) Work on Contracts or Hiring bases
- (d) Marketing flowers, cassava, kumara, fern (kasume), betel nut fruits
- (e) Milling timber is rated number 1
- (f) Gardening of cassava, kumara, taro and banana is rated number 2
- (g) 1 chain saw owner from Habuchi is hired by others to cut timber
- (h) Feed pigs and local chicken (sale in the village)
- (i) Selling fruits like lemon, cut nut (*barringtonia*)

VIII. Concerns regarding the Construction of the Dam:

- (a) Fear of losing their dependency on the river for transporting timber, swimming washing, diving and fishing etc
- (b) Flow of the river between Senge, Habuchi and Pachuki will be low and so they cannot float their milled timber from Senge to Habuchi
- (c) Habuchi and Pachuki will be badly affected so the only option is to be relocated.
- (d) They are looking more towards relocating upstream rather than downstream because of their tribal connection to the land and resources upstream
- (e) Right now they enjoy the free lifestyle, at the same time they are starting to worry about the future in relation to the dam and the power station

IX. Alternative River for Diving and Hunting area is

- (a) Toni River

X. Cultural and Religious Sites:

- (a) All their cultural and 1 grave sites are located at Koeroba
- (b) While 1 grave is at Senge

XI. Health Issues:

- (a) Main diseases are-
 - Malaria
 - Pneumonia
 - Hernia
 - Diarrhea
 - Influenza or flu, etc

XII. Main Health Concerns:

- (a) Namanu Health Aid Post-no permanent Medical staff based here
- (b) Rove Clinic
- (c) Mataniko Clinic
- (d) Kukum Clinic
- (e) No. 9 Central Hospital all located in Honiara

XIII. General Comments on the Current Situation:

- (a) Like other communities, and hamlets already visited, everyone expressed the same concerns, fears and lack of knowing the future situation
- (b) Despite of that they all wanted the Hydropower Project

WEEK 2-DAY 8: Wednesday 11th September 2013

SIA Team Program

- VIII. Alteration to the planned field trip program to Namopila, Komureo, Valekocha and Vatunadi which was supposed to be made today
- IX. This was because most of the people in these communities were away and so the only Chief who was around on Tuesday 10th was told about the change of date from Wednesday to Friday.
- X. Therefore instead of going to the field today, the time was spent reviewing the Field Trip Programs based on the changes of dates and communities to be visited
- XI. **Venue:** Hyundai Office
- XII. **Time:** 8 am – 5 pm
- XIII. **Discussion Session Attended by:** All SIA Team members
 - Led by Gerard Fitzgerald (team leader);
 - Kellington Simeon;
 - Lawrence Foana'ota; and
 - Sharon Para
- XIV. Planned the field work program for the rest of Week 2.

WEEK 3-DAY 12: Tuesday 17th September 2013

SIA Team Visits to:

- I. **Main Venue for the Meeting:** Mataruka 2
 - II. **Targeted Communities:** Malango, Mataruka 1, 2, 3, & 4
 - III. **In Attendance:**
 - (a) Allen Billy, Chief-Mataruka 1
 - (b) Malachi Rubu, Chief-Mataruka 2
 - (c) Timothy Palo, Chief-Mataruka 3
 - (d) Justice Deni, Chief-Mataruak 4
 - (e) SIA team-Gerard Fitzgerald, Kellington Simeon, Fred Patison, Lawrence Foana'ota & Sharon Para
 - IV. **Program:**
 - (a) Welcome & Opening Prayer by Daniel Una-Council Member from Rota Tribe
 - (b) Lawrence Foana'ota made the opening remarks in thanking those who have turned up for the Meeting on behalf of the team members
 - (c) Explaining the purpose of the visit –Gerard Fitzgerald, team leader
-

- (d) Effects of the proposed Tina Hydropower Development Project-Discussions led by Kellington Simeon
- (e) Fred S Patison was also present with the team and expressed the importance of taking note of the communities' concerns regarding land and its use. He gave examples of cases in Choiseul and Isabel Provinces regarding land issues.

V. Visitation by Staff from Project Office:

- (a) It was confirmed that staff from the Project Office already visited the area and talked about Government's plan regarding the project

VI. Landownership & Rights to the Tina River:

- (a) Those present explained that even though they are in Malango, their connection to the Bahomea tribe and landownership rights including rights to the Tina River are equally the same.
- (b) Some of them expressed their disappointment regarding the fact that those who signed the documents allowing the government to develop the hydropower project on the river had not included them.

VII. Original Places of Settlements & Graves:

- (a) Nala
- (b) Turahi
- (c) Makuricha
- (d) Luga
- (e) Tasi (4 graves, betel nut and cut nut trees)
- (f) From Tasi to Chichinge (Garry is from Chichinge)
- (g) From Chichinge to Namoraoni (Jeremiah Matebasia is from Namosa)
- (h) From Namoraoni to Nala

The last place in the catchment area people left in 1950 to settle where they are today

VIII. Other Important Resources in the Catchment Areas:

- (a) Minerals
- (b) Logging
- (c) Potential for Eco-tourism development
- (d) Salt
- (e) Hot spring (use for healing)
- (f) Streams for growing water crease

IX. Their Relationship to the catchment's area:

- (a) Hunting
- (b) Fishing
- (c) Diving

All these activities take place between Vatumosa to Choro and they continue until today. They always go to carry out these activities when they are holding Church fundraising programs, feast for the opening of a Church building or Christmas

X. Livelihood:

- (a) Gardening-Kumara, cassava, taro, yam
- (b) Marketing of yams, mushrooms and vegetables
- (c) Cocoa (own small plots and sold dried beans)
- (d) Coffee (“ “ “ “ “ “ “ ”)

- (e) Piggery- 10 to 20 (feed them with millrun)
- (f) Milling timber (have about 30 chain saws)
- (g) Hunting for pigs, opossum and lizards to sell
- (h) Employment at Gold Ridge Mining Co. (50 employees)
- (i) Earth Movers Logging Co.
- (j) Guadalcanal Plains Palm Oil Ltd (GPPOL)- (5 employees)
- (k) Teachers - (30 –Secondary and Primary)
- (l) Central Government - 10
- (m) Provincial Government - 2
- (n) Medical - 1
- (o) Ports Authority - 1
- (p) Operating Canteens - many
- (q) Bus - 6 Contracted out
- (r) PhDs Qualification- 2

XI. Cultural Sites:

- (a) Manukiki - owned by Wisely Sie of Havaina village who was born at Tanabou Village and belongs to a sub-tribe known as Uluna

XII. Health Issues/Main Diseases and Clinics:

- (a) Malaria
- (b) Pneumonia
- (c) Diarrhea
- (d) Still birth (big concern amongst women)
- (e) Rove Clinic
- (f) Mataniko clinic
- (g) No.9 Hospital-(Emergency cases only)
- (h) Transport hardship

XIII. Benefits if Hydro is Constructed:

- (a) Improved standard of living
- (b) Receive more cash
- (c) Training and managing resources
- (d) Government acting as guarantor for person loan
- (e) Opportunity for improvement of businesses
- (f) Pastors are paid
- (g) Operate small businesses
- (h) Light for Church groups to meeting at night & other community programs
- (i) Refrigerator
- (j) Electric Sewing Machines
- (k) TV
- (l) Video
- (m) Charging Mobile Phones
- (n) In Services

XIV. Youths:

- (a) Access to proper and good education
 - (b) Everyone is provided technical and specialized training
-

- (c) Establish workshops for furniture making
- (d) Purchase equipments and tools
- (e) Provide lighting for students to study at night

XV. Women:

- (a) Sew calico for family & school uniforms
- (b) Make ice blocks
- (c) Have cold storage for keeping food
- (d) Good housing

XVI. Main Church and Social Groups/Facilities:

- (a) South Sea Evangelical Church
- (b) Church Building
- (c) Women's Fellowship
- (d) Youth Groups
- (e) Sports Groups- Soccer/Netball/Basketball
- (f) Sports field

XVII. Land:

- (a) Ownership is based on tribe
- (b) Women has the right
- (c) Important resource for sustaining community life

WEEK 3-DAY 13: Tuesday 17th September 2013

SIA Team Visits to:

I. Main Venue for the Meeting: Belaha

II. Targeted Communities: Belaha

III. In Attendance:

- (a) Israel Trevor Sibia
- (b) Members of the communities
- (c) SIA team-GF, KS, FP, LF & SP

IV. Program:

- (a) Began with Lawrence Foana'ota thanking the members of the communities who are able to attend the meeting on behalf of the SIA team
- (b) A brief introduction of the team members and their responsibilities
- (c) Followed by Kellington Simeon explaining the reason for the visit
- (d) Gerard Fitzgerald explaining the meaning of social and livelihood
- (e) Also explained steps to take in Hydro Project Development
- (f) Followed with discussions and questions

V. Steps to take in Project Development:

- (a) Planning includes lots of meetings, revisits to follow up
 - (b) Construction will disturb people, break custom, noise and river polluted
 - (c) Infrastructure good roads
 - (d) Completion will only employ a few
 - (e) Changes in the level of the water in the river
 - (f) Operating stage will cause long term changes
-

(g) Benefits should be positive for everyone

VI. Livelihood:

- (a) Milling
- (b) Cocoa
- (c) Betel nut
- (d) Marketing garden crops and vegetables
- (e) Pig
- (f) Shops for rice, taiyo, noodle
- (g) Bottle Shop selling SP beer
- (h) Poultry
- (i) Coconut
- (j) Fishing for eel, tilapia, river shells (leve) and shrimps
- (k) Hunting for wild pigs, opossum, lizards (iguana)
- (l) Formal employment c 20
- (m) Earth Mover (Logging Co.) between 10-20 workers
- (n) Small businesses-Canteens
- (o) Teachers - 20 (Kiddy, Primary and Secondary)
- (p) 50% make gardens for money
- (q) Crops grown for consumption and sale-Cassava, kumara, cabbages

VII. Marriage:

- (a) In order to maintain the proper cultural practice of marriage and to ensure landownership is sustained and kept within the tribe, a brother's son has to marry his sister's daughter.
- (b) To keep the family relationship strong and intact, X's son must marry Y's daughter.
- (c) If a woman marries outside of her tribe, the eldest daughter must marry someone within her tribe in order to maintain the right of use to the land

VIII. Where they get the fish and pigs:

- (a) Belaha River
- (b) Tina Catchment area
- (c) Usually spend 1 to 2 days hunting for pigs
- (d) If for special occasions they normally spend a week in the catchment area of the Tina River
- (e) During this time they hunt for pigs, fish and dive for fish, eel and shrimps
- (f) Where they normally come out after hunting or fishing is at Betiloga
- (g) They also have time to re-visit old settlement sites to maintain the connection

IX. Land Ownership:

- (a) In Guadalcanal landownership is handed down through women line
- (b) Stretches from Senge to Koeropa
- (c) Communities living in Belaha have the same right of landownership with those along the banks of the Tina River

X. Effects of the Hydro Project if Constructed:

- (a) Change to lifestyle
 - (b) Increase in drunkenness by men and women
-

- (c) Extra marital affairs will increase due to easy access to more money from the project
- (d) Plants used for medicine in Choro will disappear
- (e) Some of the livelihood activities connected to the Tina river will be affected
- (f) Royalties if not fairly distributed like they have already experienced with Gold Ridge Mining Company will cause disunity among community members
- (g) Timber will no longer be available for house building

XI. Benefits:

- (a) Improve access roads
- (b) Access to free power
- (c) Provide good water supply
- (d) Current source of water and quality not good
- (e) Improve standard of living for more than 2,000 living in the community
- (f) Provide employment
- (g) Training
- (h) Establish an institute and other schools improved
- (i) Provide scholarships (currently GRMC provides scholarships but not enough)
- (j) Light
- (k) Refrigerator
- (l) Operating small income generating businesses

XII. Health Issues:

- (a) A Provincial clinic is near the Belaha School
- (b) Improve sanitation
- (c) 5 villages have pit toilets

XIII. Main Diseases:

- (a) Malaria
- (b) Pneumonia
- (c) Diarrhea
- (d) Dengue Fever

XIV. Suggested Alternatives Needed:

- (a) Long term employment for members of the population
- (b) Proper management of any royalties
- (c) Change the leadership management
- (d) Build institutions that will sustain the population
- (e) Belaha school was built 30 years ago but not many go further so must be improved
- (f) Improve the only Health Clinic at Belaha
- (g) Most immediate need of the community is for water supply

XV. General Observations:

- (a) Those who spoke generally supported the hydropower project
 - (b) Express the fact that since this is new in the country no one knows it's good and bad effects at this stage
 - (c) The discussions went well and it ended with a peaceful atmosphere
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WEEK 3-DAY 14: Wednesday 18th September 2013**SIA Team Visits to:****I. Main Venue for the Meeting: Vera'ande (Roadside Communities)****II. Targeted Communities: Vera'ande, Verakweli, Niumahata****III. Attendance:**

- (a) Ruth Kao- Chief Joshua Kao's wife (Vera'ande)
- (b) Johnson Tadokata - Originally from Choiseul (Verkweli)
- (c) Charity Tadokata - Johnson's wife
- (d) Grace Paul - (Niumahata)
- (e) Saleem Stephen- Muslim follower -(Pululaha-South Malaita)
- (f) Women, youths and children

IV. Program:

- (a) Introduction by Lawrence Foana'ota
- (b) Explanation by Kellington Simeon of the reasons for the visit and how people live
- (c) 3 parts (i) story, (ii) household survey & (iii) interview with women
- (d) Sharon Para translated the information in the local language

V. History of the Villages:

- (a) Families moved from Tina to Vera'ane on April 3rd 2000 because they took up one of the cocoa blocks nearby left by Levers on land they owned
- (b) Niumahata community was established by families from the Weather Coast who moved in 1968 because of a major landslide and earthquake in that part of Guadalcanal Province
- (c) Verakweli was established by families who used to live at Veravolia. They moved because of easy access to the road

VI. Livelihood:

- (a) Market-pick coconut, kasume
- (b) Gardening-families main source for food
- (c) Cocoa-only during pick season from June to August
- (d) Sewing sago palm leaves and sell the panels at the market
- (e) Casual work around the villages
- (f) Milling timber
- (g) 6 employed by Lee Kwok Kuen- from Vera'ande
- (h) 8 employed by Lee Kwok Kuen- from Vermahata
- (i) 3 employed by Lee Kwok Kuen- from Verakwele
- (j) 1 employed by Gold Ridge Mining from Vera'ande
- (k) 1 employed by Guadalcanal Plains Palm Oil Ltd from Niumahata
- (l) Diving along the Tina River by young people for fish/no hunting

VII. Women's Roles:

- (a) Operate small income generating businesses like selling ring cakes, young coconuts, bans and other small items
 - (b) Washing clothes and dishes
 - (c) Fetching water from drinking and cooking, collecting food from the gardens
-

- (d) Women, men and youths harvest cocoa and young coconuts together

VIII. Church Groups in the 3 Communities:

- (a) Seventh Day Adventist (SDA)- Place of Prayer- Namanu
- (b) Church Of Melanesia (COM)- Place of Prayer- Ngalimera/Good Shepard
- (c) South Sea Evangelical Church (SSEC)- Place of Prayer- Veravinua
- (d) United Church (UC)- Place of Prayer-GPPOL/Town
- (e) Assembly Of God (AOG)- Place of Prayer- Verakabikabi

IX. Health Issues-Main Diseases/Clinics:

- (a) Malaria
- (b) Pneumonia
- (c) Diarrhea
- (d) Influenca
- (e) Namanu Health Clinic
- (f) Good Samaritan Mini Hospital/ Clinic near Ngovia School
- (g) Central Hospital at No.9

X. Main Source of Water for Drinking and Washing:

- (a) 3 wells (1 for drinking 2 for washing) at Vera'ande

XI. Main Concerns, Needs and Worries when the TH Project Actually started:

- (a) Not enough cash to pay for family needs
- (b) Generator to pump water
- (c) If road is constructed, it will be dusty
- (d) Children's safety will be at risk
- (e) Random visits by drunkard
- (f) Put up fence to protect children from running onto the road
- (g) Road should be tar seal to avoid dust
- (h) Have check points
- (i) Put in place speed humps
- (j) Security will be threatened and probably increase if development takes place
- (k) Main road use by children going to Rate and Namanu schools
- (l) Changes may be for good or bad
- (m) Heard houses might be moved if they are 1 meter within the perimeters of the road
- (n) Fear of losing their current way of life if they are to be relocated
- (o) Peace at night will be disturbed due to vehicles going up and down the road
- (p) Need Police Post
- (q) Emergency Post
- (r) School and Clinic at Namanu need to be moved because they are situated on someone else's registered land and relocate them on secure land elsewhere

XII. Benefits as Perceived by People from these Communities:

- (a) Easy access to transport
 - (b) Set up side road markets
 - (c) Light
 - (d) Water supply from own source will be improved
 - (e) Good road
-

- (f) Easy to get quickly to hospital in emergency cases
- (g) Fulltime and Part time employment
- (h) Good housing
- (i) Improve and upgrade the existing schools

XIII. Some General Observations and Comments:

- (a) People were basically satisfied with their present way of life
- (b) They are healthy and are generally easy going with not too much to worry about except when drunkards from other neighboring communities sometimes disturb them because their houses are located near the main road
- (c) Their feelings about the Tina Hydro Project and plans to expand and use the road as the main access to the location of the site were of a welcoming nature but at the same time of concern and fear for their communities' safety and security.

WEEK 3-DAY 14: Wednesday 18th September 2013

SIA Team Visits to:

I. Main Venue for the Meeting: Horohotu 1

II. Targeted Communities: Horohotu 1, 2, & 3

III. Attendance:

- (a) Village Chief- Seth Givu
- (b) Other Community members
- (c) SIA Team

IV. Program:

- (a) Brief welcome on behalf of the SIA team members and introduction
- (b) Chief's brief on the history of the communities
- (c) Discussions and questions regarding topics like livelihoods, health etc
- (d) The communities' thoughts about the benefits and effects of the Tina Hydro Project

V. History:

- (a) Originally came from the Weather Coast of Guadalcanal
- (b) First settled at Konga in 1974 while working for Foxwood Timber Milling Co based near Red Beach
- (c) From Konga they moved and started the settlement at Horohotu 1. They were already in Horohotu 1 before Cyclone Namu struck in 1986
- (d) Horohotu 2 was the second community to be established after Horohotu 1 followed by Horohotu 3

VI. Livelihood:

- (a) Marketing - 2 days a week - Mondays and Thursdays
 - (b) Gardening-potato or kumara, cassava, tomatoes, beans, pawpaw, banana
 - (c) Project involved in farming tomatoes, pawpaw and bananas for sale
 - (d) Youths employed by others to cut timber and paid
 - (e) 1 employed by World Vision
 - (f) 1 employed by Police as a Prison Warder
-

- (g) 1 employed by Gold Ridge Mining Co.
- (h) 6 employed by Guadalcanal Plains
- (i) 1 gone to work in Makira/Makira-Ulawa Province
- (j) Dig side of Tina River for drinking water
- (k) 1 rain water tank near the Church

VII. Health Issues: Diseases:

- (a) Malaria
- (b) Pneumonia
- (c) Diarrhea
- (d) Influenza or flu

VIII. Facilities:

- (a) Namanu Clinic
- (b) Clinics in Honiara
- (c) Project should make allowances for two more main markets

On the East and West sides of the Project

IX. Effects from Hydro Project as Communities Foresee:

- (a) Water from the river will be polluted
- (b) Clean drinking water will be scarce
- (c) Not be able to wash calico or dishes

X. Benefits from the Hydro Project:

- (a) Provide water tanks
- (b) Young people will work for the project
- (c) Easy access to transportation
- (d) Build clinic
- (e) Improve schools including Rate Primary and Secondary School
- (f) Borehole for water for the communities
- (g) Improve transportation
- (h) Improve road

XI. Church Organization:

- (a) Seventh Day Adventist or SDA

XII. General Comments:

- (a) Members did not come to SIA Meeting held at Vuramali
- (b) Some of the community members were away for a Church Meeting
- (c) The Pastor of the SDA Church is from Marovo area/Western Province
- (d) The Village Chief did not look healthy due to old age

Week 3-Day 15: Thursday 19th September 2013

SIA Field Visit to:

- I. Main Venue for the Meeting:** Ravu, Westside of Ngalibiu Bridge
 - II. Targeted Communities: Downstream-** (*East of Ngalibiu Bridge*): GPPOL 1,
-

Baravale – c7 houses 1 Church, Kadavu, Pokaso- c7 houses, Selaghohoro- 3 houses, Omba- c2 houses, Papaghu- c 10 houses (indigenous people from the Plains) (*West of the Bridge*): Ravu, Ngalimera (Yellow nut), Siroigha, Old Selwyn, Kolina- Popoloi 1 (Settlers from the Weather Coast), Pololoi 2- Lee Kwok Kuen Farm and gravel extraction site

III. Attendance:

- (a) Moses Karuku- Assistant Pastor, Church of the Living Word
- (b) Geoff Alexander- Originally from South Malaita but married to a Guadalcanal lady and is now living near GPPOL (His wife is Agnes Putu's sister)
- (c) Cathy Kakamo
- (d) Agnes Putu
- (e) James Laisa - Assistant Administration Officer – Guadalcanal Province
- (f) SIA Members
- (g) Community Leaders
- (h) Men, women & youths

IV Program:

- (a) Brief Introduction of SIA team members
- (b) Inform those present of the reason for the visit
- (c) Clarify the status of the SIA team that members are not from the Government or Project Office but are independent with sponsorship by the World Bank.
- (d) Explain nature of the SIA team's work
- (e) Asking questions and having general discussions

IV. General Discussions:

- (a) Most of the time was spent by those who spoke which seem to be dominated by three men complaining about their past experiences with Government and NGOs that did not keep their promises or assist them with programs like improvement of their school or building a nearby clinic
- (b) Examples they gave- Ngalibiu Primary School has 417 students, Grades 1-6 with two streams for each class a day which means that they have 12 class sessions per day in order to cater for the learning needs of the 417 kids
- (c) Government has already assisted Rate School but not their school at Ngalibiu
- (d) Ravu Community consists of about 16 villages
- (e) They use the water from the river for- drinking, swimming, washing and cooking
- (f) They raised the issue about not being included in the group that signed the agreement for the project to go ahead

V. Impacts:

- (a) If the dam is built it will have some social effects on the life of those who use the water from river.
 - (b) They feel the water might dry up during the dry season
 - (c) They dig the side of the river to get water for drinking and watering their gardens
 - (d) They are concerned about river pollution during the construction of the dam
-

- (e) Replacement of gravel which they depend on for cash will be affected
- (f) During the dry weather the level of the river will be low
- (g) Any plans to develop this hydro project must take into account the welfare of those using the river for the livelihood
- (h) Already they have been unfairly treated because of their exclusion from the initial discussions with the government and those who use the river for their livelihood
- (i) No water supply in the communities
- (j) Use old World War 2 drums for their water wells
- (k) If the dam will be safe because of fear that it might break if there is a storm or earthquake.
- (l) Fear is based on their experience during Cyclone Namu in 1986 when the river flooded and swept many of their homes which caused a huge disaster for the families
- (m) A woman expressed her concern that “culture” was not observed during this particular meeting because they always have refreshments when such gathering is held.
- (n) They will lose the income they generate from sale of gravel from the river
- (o) Use of the river for rubbish disposal from the upstream communities
- (p) Oil spill from Lee Kwok Kuen farm upstream as well
- (q) They are not happy with the way information is passed to the communities. For example, government initiates a project the information about it is then passed onto the Member of Parliament who in turn channels it to the Provincial Member who finally informs the communities. So far this system has not worked well in the country
- (r) Flooding of houses if dam breaks or during heavy rain
- (s) Arguments over unfair sharing of royalty payments
- (t) Government funding always given to Member of Parliament but never get to people in the communities in the rural areas
- (u) Employment by GPPOL mostly from other Provinces, very low from the village. 95% of the workforce from other Provinces only 5% local
- (v) Lack of money is a major issue of concern

VI. Possible Options or Solutions:

- (a) Need to form 3 representative groups- Upstream, Midstream and Downstream to sign agreements to ensure proper and fair sharing of benefits
 - (b) Help to build raised houses on stilts
 - (c) Provide water tanks, boreholes, water pumps, wells improved & water supply
 - (d) Government need to contact Solomon Island Water Authority
 - (e) Connect to main water supply from Honiara which is only 21.1 km away
 - (f) Set up alarm system to warn people of danger when the water level rises
 - (g) Improve already existing wells and provide water pumps
 - (h) Involve more men, women and youths in the workforce
 - (i) Relocate or identify place for communities to escape to during disasters on higher grounds
-

- (j) Wanted members of their communities to visit the proposed dam site since Tina communities already visited and seen it or in other countries with dams already exist. So government should include them in delegation in the future.
- (k) Women only heard about the dam but do not know how it works. So they need more information
- (l) Weather Division in Government should visit the lower parts of Ngalibiu River because when it rains the gardens and villages are always flooded
- (m) Should have good drainage system in place and proper designs for the settlements
- (n) All communities should have free electricity

VII. Livelihood:

- (a) Sale of gravel (Lee Kwok Kuen-Charge \$100 per load/use 15 ton truck) while Dalgro is charged \$390 per cubic
- (b) Gardening
- (c) Piggery
- (d) Poultry
- (e) Cocoa
- (f) Tourism-guided tours to tapu sites
- (g) Fishing for eel (paleo), kola, mamata, ghatubi, Kukuli (fish with poisonous fins), bagovu, lae, shrimps (ura), mathi, tilapia
- (h) Kasume, Water Lillie, kamau, pumpkin, pawpaw, banana, taro-swamp taro, tagolo-swamp taro or kakake
- (i) Aligeto

VIII. Health Issues:

- (a) Malaria (low)
- (b) Dengue Fever – (about 100 cases)
- (c) Bakua – skin disease (**Havole** vernacular name) (social effect people not married)
- (d) Pneumonia
- (e) Diarrhea
- (f) Diabetes – poor diet, sugar or fast food

IX. Clinics:

- (a) Goro Mini Hospital
- (b) Ngalibiu Clinic
- (c) No. 9 Central Hospital-Honiara

X. Benefits:

- (a) Have free electricity
- (b) Employment
- (c) Improved standard of living
- (d) Improved roads

XI. General Observations:

- (a) People were frustrated
 - (b) Young people not interested in working for GPPOL
-

- (c) At the end they wanted more information about the project and also others dams in other countries
- (d) Discussion took too long because those who spoke continue to repeat their frustrations and anger
- (e) The meeting ended with a prayer by the Assistant Pastor- Moses Karuku

Week 3-Day 16: Friday 20th September 2013

SIA Team Visit to:

I. Main Venue of the Meeting: Verakabikabi (Settlers from the Weather Coast)

II. Targeted Communities: Verakabikabi Community

III. Attendance:

- (a) Dominic Kusoli – Paramount Chief
- (b) Evens Seleso – Village Chief
- (c) SIA team –GF, KS, SP & LF
- (d) Ray Roberts – Engineer-Guadalcanal Province
- (e) Cathy Kakamo
- (f) Agnes Puti

IV. Program:

- (a) Opening Prayer and Introduction of SIA team by Ray Robert
- (b) Spoke's person on behalf of community was Stanley Veke

V. History concerning the Settlement:

- (a) 1965 big cyclone caused big flood forced the first families to move
- (b) Later other families came to join them from the Weather Coast in 1970 after a big flood and landslide.
- (c) They bought the land at Verakabikabi from the landowners in the custom way
- (d) The total number of households in the community is 43

VI. Livelihood:

- (a) Most of the family members away in Gold Ridge to dig for gold
 - (b) Marketing- Cabbage, banana, beans cassava, kumara, coconut
 - (c) Panning for gold and selling any finds
 - (d) Hunting for pigs
 - (e) Using eel trap to catch the eel at Betisasanga
 - (f) Hunting for opossum
 - (g) Gardening
 - (h) Diving
 - (i) Farming cocoa
 - (j) Grow swamp taro
 - (k) Fishing
 - (l) Collecting fern-kasume
 - (m) Collecting amau - a kind of leave of a shrub like sand-paper which they eat the young leaves and use the mature ones for washing pots and other cooking utensils
-

VII. Concerns:

- (a) Lack of own transport
- (b) When the road is constructed, it might cause dust
- (c) Children use the road to walk to school
- (d) Hydro dam might break causing huge damages
- (e) Need more information about the Project
- (f) Always arrange with landowners if want to make gardens
- (g) Main stream they draw their drinking water from at Ngongoti might be affected when the access road to the dam site is constructed
- (h) Gardening areas and 1 cemetery near the road might be destroyed
- (i) Split after family argument resulted in joining two separate churches (Roman Catholic & Assembly of God)
- (j) During construction of the road, families walking to Church in Marava might be affected
- (k) Main worries-Money and Food
- (l) Good clinics are in Honiara
- (m) School fees
- (n) Good houses
- (o) Land

VIII. Health Issues - Main Diseases:

- (a) Malaria
- (b) Pneumonia
- (c) Diarrhea
- (d) Worry/anxiety

IX. Clinics & Schools:

- (a) Namanu Clinic
- (b) Marava Kindergarten
- (c) Rate School

X. Churches:

- (a) Roman Catholic (Only one Church before 1990)
- (b) Assembly of God (Establish in 1990)

XI. Cultural & Historical Sites:

- (a) No cultural tapu sites
- (b) 3 Burial grounds

WEEK 3-DAY 16: Friday 20th September 2013**SIA Team Visit to:**

- I. Main Venue for the Meeting:** Old Selywn
 - II. Targeted Community:** Old Selwyn
 - III. Attendance:**
 - (a) Alifox Ulu- Chief
 - (b) Agnes Putu - Landowner & Her Home
 - (c) Cathy Kakamo
-

- (d) Ray Roberts-Engineer-Guadalcanal Province
- (e) SIA Team-GF, KS, SP & LF
- (f) Ronald Vosiu-Bougainville Christian Mission Fellowship
- (g) Community members

IV. Program:

- (a) Brief remarks and introduction of SIA team members by Ray Roberts (GP Rep)
- (b) Explanation concerning the Project visit of this independent team was by Kellington Simeon

V. History of the Community:

- (a) This place used to be called Nasilagu when the Anglican Church started a Primary School here
- (b) When the Church decided to upgrade it to a high school they changed the name to Selwyn College
- (c) In 1986 when the Cyclone Namu struck, the school was destroyed by flood from the Tina River and was abandoned and the School was relocated near Marovovo on the West side of the island
- (d) After the school moved out the members of the families that own the land moved in after 1986 and settled in the houses that were not destroyed by the floods and they use the name Old Selwyn and Popoloi to refer to their community
- (e) Before Cyclone Namu they used to live at Siroigha

VI. Livelihood:

- (a) Gardening
- (b) Plan cocoa, banana, etc
- (c) Coconut
- (d) Lease land for oil palm
- (e) 2 members work at Gold Ridge Mining
- (f) Sale of river gravel @\$500.00 (SBD) per cubic
- (g) Royalty payment from Guadalcanal Plains Palm Oil Ltd
- (h) Use Ngalibiu river side for gardening, drawing drinking water, washing when generator is not working
- (i) Use a well to draw water and only one tank at the Church Building
- (j) Use two boreholes and two wells

VII. Their Needs:

- (a) Solar power pump immediately needed
- (b) Old pipes needed replacing
- (c) Power needed to be re-connected

VIII. Concerns:

- (a) Their community is located on flat plains and so they fear if a big flood they will be badly affected
 - (b) During dry season the wells become dry
 - (c) Oil and fuel spill
 - (d) To build their houses they have to buy building materials
 - (e) Support for the Government = 0%
 - (f) Promises never been fulfilled
-

- (g) Only trustees benefit from any help
- (h) To have a plan in place in case of any disaster happening like the dam breaking
- (i) Interim Committee already in place but not legal
- (j) Access road still under negotiation
- (k) Upstream already well established with their organization
- (l) Lower stream/downstream still unorganized
- (m) Water boundary need chiefs to discuss and decide
- (n) Parts of the Tina and Ngalibiu are registered and customary owned
- (o) They need to be listened too and recognized also in any benefit sharing
- (p) Damming the water will affect the flow of gravel

IX. Benefits:

- (a) Still needed to be seen
- (b) Improve the road
- (c) Opportunity for employment
- (d) Connected to the main power grid

X. Health Issues:

- (a) Diarrhea
- (b) Malaria
- (c) Pneumonia
- (d) Dengue Fever -2-3 cases

XI. Schools & Clinics:

- (a) Ngalibiu Primary School-Guadalcanal Provincial School
- (b) Good Samaritan Mini-Hospital administered by the Roman Catholic Church
- (c) No. 9 at the Central Hospital

XII. Church:

- (a) Christian Mission Fellowship
- (b) Two Missionaries from Bougainville looking after the work of the Church

XIII. Alternatives:

- (a) Plan for any areas for safety during disasters
- (b) MOU with Project Office
- (c) During the period the work of the Project goes on they need power restored and pump repaired or provided with a new one
- (d) \$3 million a year should be shared equally amongst family members may be affected
- (e) Government to put in place clear guidelines on how trustees should distribute any benefits
- (f) Tribes should choose who should be a trustee

WEEK 4-DAY 17: Monday 23rd September 2013

SIA Team Visit to:

- I. Main Venues for the Meetings:** Ministry of Environment & Conservation & Guadalcanal Provincial Headquarter
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- II. Targeted Officials:** Permanent Secretary/ME&Con & Provincial Secretary/GP
- III. Present:**
 - (a) Permanent Secretary
 - (b) GF & KS
- IV. Program:**
 - (a) Main purpose of the visit was to update the Permanent Secretary of the work that have been done so far among those communities the SIA team members visited
 - (b) This was actually a courteous call
 - (c) Meeting with Guadalcanal Provincial Officials never materialized because the Provincial Government was having problems with its members
 - (d) Instead the SIA team decided to work on the plans for the writing up of their reports.

WEEK 4-DAY 18: Tuesday 24th September 2013

SIA Team Visit to:

- I. Main Venue of the Meeting:** Solomon Islands Development Trust or SIDT Office
 - II. Targeted Organization:** SIDT
 - III. Present:**
 - (a) Longden Mankdika- Director
 - (b) SIA team - Gerard Fitzgerald
 - (c) Kellington Simeon
 - (d) Lawrence Foana'ota
 - IV. Program:**
 - (a) Brief on the work of the SIA team
 - (b) Brief on the work of SIDT
 - V. Main purpose of SIA team visit:**

To hear if SIDT has any

 - (a) Current projects in the Tina Hydro Project area
 - (b) Plans for future projects
 - VI. SIDT's Involvement:**
 - (a) Has a project in Chichinge Community
 - (b) Aim at developing rural people
 - (c) Encourage more development at village level
 - (d) Introduction of malaria model to get rid of the disease
 - (e) Malaria projects already in place at Tinahulu, Chichinge and Ngalimera
 - (f) Facilitators of projects that help villages to be self reliance
-

- (g) Provision of drawn maps to locate village sites
- (h) Value their sites
- (i) Provide advice to communities on how to improve themselves

VII. Other SIDT's Activities:

- (a) Carry out work on Mining and Gender funded by World Bank
- (b) Involved with the rehabilitation of families from the Gold Ridge Mining area
- (c) Data collecting excise is all they do
- (d) Find out how involved are women in any development projects
- (e) Conducted research 3 years ago with Out-growers at GPPOL but initiative not working
- (f) Build capacity for a period of 9 months and then they should sustain themselves
- (g) Encourage all social groups or organizations to work together
- (h) Promote and encourage villages to involve in small solar and water projects

VIII. Projects that are still going:

- (a) Chichinge the project belongs to the people so it is still going
- (b) Roroni Kindergarten has become self reliance after SIDT assisted in establishing it in the community
- (c) Tina and Marava eco-tourism project, women's center and sanitation projects are going well especially Tina community's sanitation project

IX. Main Theme of their Approach to village improvement and sustainability is

“VILLAGE STAND UP SELEVA”

This was the last field visitation and consultation that the SIA team members carried out and on Wednesday 25th the SIA team spent in the office discussing their writing up plans and on Thursday 26th the International Expert, Gerard Fitzgerald left the country.

Morning meal	% of hhd	Midday meal	% of hhd
rice	43%	rice	41%
kasava	25%	cabbage (no detail)	34%
cabbage (no detail)	20%	kasava	25%
tea	20%	banana	14%
kumara	11%	kumara	14%
silver fern/fern/kasume	16%	water	11%
banana	9%	silver fern/fern/kasume	11%
bread	7%	taiyo (canned tuna)	14%
tea-coffee mix	7%	beans	5%
taiyo (canned tuna)	7%	noodles (instant)	5%
beans	5%	pig meat	5%
biscuits	5%	potato	5%
noodles (instant)	5%	tomato	5%
pig meat	5%	cabbage (wild taro leaf)	2%
potato	5%	cake	2%
tomato	5%	coconut	2%
water	5%	coconut milk	2%
slippery cabbage	5%	eggplant	2%
chinese cabbage	5%	fish (savutu)	2%
cabbage (wild taro leaf)	2%	chinese cabbage	2%
cake	2%	pawpaw	2%
coconut	2%	pumpkin	2%
garlic	2%	pumpkin soup	2%
milo	2%	pumpkin tops	2%
pumpkin	2%	slippery cabbage	2%
shallot	2%	taro	2%
		tea	2%

Evening meal	% of hhd	Snacks	% of hhd
rice	77%	none	43%
cabbage (no detail)	36%	banana	32%
kasava	23%	coconut	16%
kumara	22%	pawpaw	14%
silver fern/fern/kasume	16%	betelnut	7%
tomato	11%	cucumber	5%
water	11%	cutnut	5%
beans	9%	apple	2%
noodles (instant)	9%	biscuit	2%
taiyo (canned tuna)	9%	breadfruit (May)	2%
banana	7%	silver fern/fern/kasume	2%
pig meat	7%	cakes	2%
potato	7%	cassava	2%
tea	7%	guava	2%

Evening meal	% of hhd	Snacks	% of hhd
eel fish	5%	Malay apple	2%
chicken	2%	noodles (instant)	2%
coconut milk	2%	orange	2%
corned beef	2%	pig meat	2%
fish	2%	rice	2%
kaimosamosa (sand paper)	2%	ringcake (doughnuts)	2%
onions	2%	sugarcane	2%
pawpaw	2%	soft drink-soda	2%
prawns (ura)	2%	tea	2%
pumpkin	2%		
pumpkin top	2%		
sanage	2%		
savutu	2%		

The following table lists aquatic insects (water dependant) insects that thrive in Guadalcanal.

Table 1 List of aquatic insects in Guadalcanal

Name	Species particularity	Stations
Heteroptera		
Notonectidae		
Anisops browni	Endemic to the Solomon Islands	Data from previous surveys (mentioned in Polhemus et al., 2008)
Anisops capitata	Endemic to the Solomon Islands	
Anisops cheesmanae	Endemic to the Solomon Islands	
Anisops leucothea		
Anisops nasuta		
Anisops philippiensis		
Anisops sp.		Charebuma River (stations 64a & 64b)
Anisops tahitiensis		Downtown Honiara
Enithares gibbera	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
Enithares loria		Data from previous surveys (mentioned in Polhemus et al., 2008)
Enithares sp.		Tenaru River at Tenaru Falls (station 14)
Gerridae		
Halobates micans		Data from previous surveys (mentioned in Polhemus et al., 2008)
Halobates princeps		
Halobates proavus		
Limnogonus fossarum skusei		
Limnogonus luctuosus		Lungga River at mouth of gorge, Sasaa River at road bridge, Ndoma River at road bridge
Limnogonus sp.		Tenaru River at Tenaru Falls (station 14), Charebuma River (stations 64a & 64b)
Limnometra hysterema	Endemic to Guadalcanal	Tenaru River at Tenaru Falls (station 14)
Limnometra lipovskii		Lungga River at mouth of gorge, Ndoma River at road bridge, roadside pond in forest
Limnometra sp.		Charebuma River (stations 64a & 64b)

Name	Species particularity	Stations
<i>Metrobatopsis browni</i>	Endemic to the Solomon Islands	Tenaru River at Tenaru Falls (station 14), Tinahulu River (station 15), Lungga River at mouth of gorge, Ndoma River at road bridge, Charebuma River (stations 64a & 64b)
<i>Neogerris parvula</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
Mesoveliidae		
<i>Mesovelia</i> sp.		Sasaa River at road bridge, Ndoma River at road bridge, Charebuma River (stations 64a & 64b)
<i>Mesovelia subvittata</i>		Tenaru River at Tenaru Falls (station 14)
<i>Mesovelia vittigera</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
Ochteridae		
<i>Ochterus nigrinus</i>	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Ochterus</i> sp.		Tenaru River at Tenaru Falls (station 14)
Saldidae		
<i>Saldula parens</i>	Endemic to Solomon Islands	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Saldula solomonensis</i>	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Saldula</i> sp.		Tenaru River at Tenaru Falls (station 14), Lungga River at mouth of gorge, Sasaa River at road bridge
Veliidae		
<i>Microvelia</i> sp.		Tenaru River at Tenaru Falls (station 14), Tinahulu River (station 15), Lungga River at mouth of gorge, Sasaa River at road bridge, Ndoma River at road bridge, Charebuma River (stations 64a & 64b)
<i>Rhagovelia browni</i>	Endemic to Guadalcanal	Tenaru River at Tenaru Falls (station 14), Tinahulu River (station 15), Lungga River at mouth of gorge, Sasaa River at road bridge, Ndoma River at road bridge, Charebuma River (stations 64a & 64b)
<i>Rhagovelia</i> n. sp.	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
Corixidae		
<i>Micronecta ludibunda</i>		Lungga River at mouth of gorge, Charebuma River (stations 64a & 64b)
<i>Micronecta virgata</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
Gelastocoridae		

Name	Species particularity	Stations
<i>Nerthra gurneyi</i>	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Nerthra macrothorax</i>		
<i>Nerthra omani</i>	Endemic to Guadalcanal	
Leptopodidae		
<i>Valleriola</i> n. sp.		Lungga River at mouth of gorge
<i>Valleriola</i> "solomonensis"	Endemic to Solomon Islands	Data from previous surveys (mentioned in Polhemus et al., 2008)
Ochteridae		
<i>Ochterus</i> sp.		Lungga River at mouth of gorge
Hydrometridae		
<i>Hydrometra horvathi</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
Odonata		
Chlorocyphidae		
<i>Rhinocypha liberata</i>	Endemic to Solomon Islands	Tenaru River at Tenaru Falls (station 14), Charebuma River (stations 64a & 64b)
Coenagrionidae		
<i>Agriocnemis pygmaea</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Agriocnemis salomonis</i>	Endemic to Solomon Islands	Sasaa River at road bridge, Ndoma River at road bridge, roadside pond in forest
<i>Agriocnemis</i> sp.		Tinahulu River (station 15), Lungga River at mouth of gorge
<i>Ceriagrion erubescens</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Ischnura aurora aurora</i>		
<i>Pseudagrion incisurum</i>	Endemic to Guadalcanal	Tenaru River at Tenaru Falls (station 14), Charebuma River (stations 64a & 64b)
<i>Pseudagrion microcephalum</i>		Tinahulu River (station 15), Sasaa River at road bridge, Ndoma River at road bridge
<i>Pseudagrion</i> sp.		Lungga River at mouth of gorge
<i>Teinobasis bradleyi</i>	Endemic to Solomon Islands	Charebuma River (stations 64a & 64b)
<i>Teinobasis imitans</i>	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Xiphiagrion cyanomelas</i>		Sasaa River at road bridge, Tina river
Protoneuridae		
<i>Nososticta salomonis</i>		Tenaru River at Tenaru Falls (station 14), Lungga River at mouth of gorge, Charebuma River (stations 64a & 64b)
Libellulidae		

Name	Species particularity	Stations
<i>Aethriamanta subsignata</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Agrionoptera insignis similis</i>		
<i>Agrionoptera papuensis allogenes</i>		
<i>Brachydiplax denticauda</i>		
<i>Brachydiplax duivenbodei</i>		
<i>Crocothemis nigrifrons</i>		
<i>Diplacodes trivialis</i>		
<i>Hydrobasileus brevistylus</i>		
<i>Orthetrum sabina sabina</i>		
<i>Orthetrum villosovittatum bismarckianum</i>		
<i>Pantala flavescens</i>		
<i>Protorthemis woodfordi</i>	Endemic to Solomon Islands	
<i>Rhodothemis rufa</i>		
<i>Rhyothemis phyllis chloe</i>		
<i>Rhyothemis phyllis marginata</i>		
<i>Rhyothemis regia juliana</i>		
<i>Tapeinothemis boharti</i>	Endemic to Solomon Islands	
<i>Tramea liberata</i>	Endemic to Solomon Islands	
<i>Neurothemis terminata</i>		Tina river
<i>Neurothemys stigmatizans bramina</i>		Lungga River at mouth of gorge, Tina river
Platycnemididae		
<i>Lieftinckia lairdi</i>	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
<i>Lieftinckia salomonis</i>	Endemic to Solomon Islands	Data from previous surveys (mentioned in Polhemus et al., 2008)
<i>Salomonocnemis gerdae</i>	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
Isostictidae		
<i>Cnemisticta latilobata</i>		Data from previous surveys (mentioned in Polhemus et al., 2008)
Gomphidae		
<i>Ictinogomphus australis lieftincki</i>	Endemic to Solomon Islands	Data from previous surveys (mentioned in Polhemus et al., 2008)
Aeschnidae		

Name	Species particularity	Stations
Anasciaeschna melanostoma	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
Gynacantha rosenbergi		
Corduliidae		
Eusynthemis frontalis	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
Guadalca insularis	Endemic to Guadalcanal	
Coleoptera		
Dytiscidae		
Genus and species unknown		Tinahulu River (station 15), Sasaa River at road bridge, Ndoma River at road bridge, Charebuma River (stations 64a & 64b)
Gyrinidae		
Dineutes (Callistodineutus) pagdeni	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
Gyrinus sericeolimbatus		Data from previous surveys (mentioned in Polhemus et al., 2008)
Diptera		
Dolichopodidae		
Genus and species unknown		Lungga River at mouth of gorge
Simuliidae		
Morops kawagishii	Endemic to Guadalcanal	Data from previous surveys (mentioned in Polhemus et al., 2008)
Morops papuense		
Morops pohaense	Endemic to Guadalcanal	
Morops selwynense	Endemic to Guadalcanal	
Simulium (Gomphostilbia) hirosii	Endemic to Solomon Islands	
Simulium (Gomphostilbia) rhopaloides	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)
Simulium (Gomphostilbia) sherwoodi	Endemic to Guadalcanal	Charebuma River (stations 64a & 64b)

Source : Adapted from Polhemus et al., 2008, BRLi, 2013

The following list of tables present plants that were identified during on-field baseline.

Flora Transmission Line 1: Secondary vegetation on grassland next to Oil Palm plantation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, Widespread	Least concern
2 <i>Elaeis guineensis</i>	Oil palm	Common, Plantation	Least concern
3 <i>Mikania micrantha</i>	Mile-a-minute	Common	Least concern
4 <i>Euphorbia hirta</i>	Milky weed	Common	Least concern
5 <i>Mimosa invisa</i>	Sensitive grass	Common	Least concern
6 <i>Mimosa pudica</i>	Sensitive grass	Common	Least concern
7 <i>Hemigraphis reptans</i>	Hemigraphis	Few, Uncommon	Least concern
8 <i>Pueraria lobata</i>	Legume Cover crop	Common	Least concern
9 <i>Sida rhombifolia</i>	Sida	Few, Uncommon	Least concern
10 <i>Ipomoea illustris</i>	Ipomoea	Few, uncommon	Least concern
11 <i>Pennisetum polystachyon</i>	Mission grass	Common	Least concern
12 <i>Pennisetum purpureum</i>		Common	Least concern
13 <i>Brachiaria mutica</i>	Para grass	Common	Least concern
14 <i>Paspalum conjugatum</i>	T - grass	Common	Least concern

Flora Transmission Line 2: Secondary vegetation on grassland next to Oil Palm plantation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespred	Least concern
2 <i>Pennisetum polystachyon</i>	Mission grass	Common	Least concern
3 <i>Mimosa invisa</i>	Sensitive grass	Common	Least concern
4 <i>Mimosa pudica</i>	Sensitive grass	Common	Least concern
5 <i>Euphorbia hirta</i>	Milky weed	Common	Least concern
6 <i>Hemigraphis reptans</i>	Hemigraphis	Few, uncommon	Least concern
7 <i>Pueraria lobata</i>	Legume cover crop	Common, widespred	Least concern
8 <i>Phragmites karka</i>	Fi'l Rade	Common, widespred	Least concern
9 <i>Cucurbita sp?</i>	Cucurbita	Common, widespred	Least concern

Flora Transmission Line 3: Open grassland - Secondary vegetation on roadside			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Mimosa pudica</i>	Sensitive grass	Common	Least concern
2 <i>Pennisetum polystachyon</i>	Mission grass	Common	Least concern
3 <i>Sida rhombifolia</i>	Sida	Common	Least concern
4 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespread	Least concern
5 <i>Starchytapheta jamaicensis</i>	Blue Rat's tail	Rare, Uncommon	Least concern
6 <i>Brachiaria mutica</i>	Para grass	Common	Least concern
7 <i>Acacia auriculiformis</i>	Acacia	Planted near a house	Least concern, Exotic ornamental

Flora Transmission Line 4: Lowland forest - open vegetation - secondary regrowths			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Canarium indicum</i>	Ngali nut	Planted, Few trees	Threatened
2 <i>Intsia bijuga</i>	Kwila, Iron wood	Few trees	Threatened
3 <i>Pometia pinnata</i>	Pometia, Taun	Few trees	Threatened
4 <i>Vitex cofassus</i>	Vitex, Vasa	Few trees	Threatened
5 <i>Macaranga dioica</i>	Macaranga	Common	Least Concern
6 <i>Broussonetia papyrifera</i>	Paper mulberry	Common	Least Concern
7 <i>Premna corymbosa</i>	Premna	Few trees	Least Concern
8 <i>Solanum torvum</i>	Egg Plant	Planted, Garden crop	Least Concern
9 <i>Mikania micrantha</i>	Mile-a-minute	Common	Least Concern
10 <i>Starchytapheta jamaicensis</i>	Blue rat's tail	Common	Least Concern
11 <i>Acalypha grandis</i>	Acalypha	Few trees	Least Concern
12 <i>Calophyllum peekelli</i>	Calophyllum	Few trees	Least Concern
13 <i>Ficus septica</i>	Ficus	Common	Least Concern
14 <i>Alstonia scholaris</i>	Alstonia, Milky Pine	Few trees	Threatened
15 <i>Sida rhombifolia</i>	Sida	Common	Least Concern
16 <i>Alstonia spectabilis</i>	Alstonia	Few trees	Least Concern
17 <i>Merremia peltata</i>	Merremia	Common	Least Concern
18 <i>Trichospermum psilocladum</i>	Trichospermum	Few trees	Least Concern
19 <i>Cananga odorata</i>	Ylang ylang, Cananga	Few trees, Rare	Least Concern
20 <i>Macaranga similis</i>	Macaranga	Common	Least Concern
21 <i>Rhus taitensis</i>	Rhus	Few trees	Least Concern
22 <i>Ficus variegata</i>	Ficus	Few trees	Least Concern
23 <i>Carica papaya</i>	Pawpaw, Papaya	Garden crop	Least Concern
24 <i>Musa sapientum</i>	Banana	Garden crop	Least Concern
25 <i>Manihot esculenta</i>	Cassava, Tapioka	Garden crop	Least Concern
26 <i>Ipomoea batatas</i>	Potato	Garden crop	Least Concern

Flora Transmission Line 5: Secondary vegetation on open ridgetop overlapping grasslands			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespread	Least concern
2 <i>Nephrolepis hirsutula</i>	Fish tail Fern	Common, widespread	Least concern
3 <i>Cananga odorata</i>	Ylang ylang, Cananga	Few trees	Least concern
4 <i>Ficus longifolia</i>	Ficus	Few trees	Least concern
5 <i>Ficus septica</i>	Ficus	Few trees	Least concern
6 <i>Alpina purpurata</i>	Red Ginger	Common	Least concern
7 <i>Cyathea Vittata</i>	Tree Fern	Few Plants	Least concern
8 <i>Nephrolepis biserrata</i>	Fish tail Fern	Common	Least concern
9 <i>Merremia peltata</i>	Merremia	Common, widespread	Least concern
10 <i>Costus speciosus</i>	Costus	Few Plants	Least concern
11 <i>Pipturus argenteus</i>	Pipturus	Few trees	Least concern
12 <i>Mikania micrantha</i>	Mile-a-minute	Common, widespread	Least concern
13 <i>Pueraria lobata</i>	Legume cover crop	Common	Least concern
14 <i>Manihot esculenta</i>	Cassava, Tapioka	Garden crop	Least concern
15 <i>Pennisetum polystachyon</i>	Mission grass	Common, widespread	Least concern
16 <i>Solanum torvum</i>	Egg Plant	Common, Garden crop	Least concern
17 <i>Colocasia esculenta</i>	Taro	Common, Garden crop	Least concern
18 <i>Viola odorata</i>	Violet	Rare, Only a couple of plants	Least concern
19 <i>Ludwigia octovalvis</i>	primrose willow	Common	Least concern

Flora Access Roads 1: Lowland rainforest on ridgetop			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Pometia, Taun	Few trees	Threatened
2 <i>Canarium indicum</i>	Ngali, Canarium nut	Few trees, Planted	Threatened
3 <i>Uncaria appendiculata</i>	Water rope	Few plants	Least concern
4 <i>Pleomele angustifolia</i>	Pleomele	Few plants	Least concern
5 <i>Ptychosperma salomonense</i>	Ptychosperma palm	Few plants	Least concern
6 <i>Licuala lauterbachii</i>	Licuala palm	Few plants	Least concern
7 <i>Celtis philippinensis</i>	Celtis	Few trees	Least concern
8 <i>Alpinia oceanica</i>	Alpinia	Common	Least concern
9 <i>Heterospathe minor</i>	Heterospathe palm	Few plants	Least concern
10 <i>Heterospathe salomonensis</i>	Heterospathe palm	Few plants	Least concern
11 <i>Selaginella rechingeri</i>	Selaginella	Common, widespread	Least concern
12 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Few plants	Least concern
13 <i>Brownlowia argentata</i>	Brownlowia	Few trees	Least concern
14 <i>Schizostachyum tessellatum</i>	Bamboo	Few plants	Least concern
15 <i>Calamus vestitus</i>	Lawyer cane, Rattan	Few plants	Least concern
16 <i>Planchonella firma</i>	Planchonella	Few trees	Least concern
17 <i>Mangifera indica</i>	Native mango	Uncommon	Least concern
18 <i>Myristica fatua</i>	Myristica	Uncommon	Least concern
19 <i>Semecarpus forstenii</i>	Semecarpus	Common	Least concern
20 <i>Syzygium onesima</i>	Syzygium, wild local apple	Uncommon	Least concern
21 <i>Rhopaloblaste elegans</i>	Rhopaloblaste palm	Uncommon	Least concern

Flora Access Roads 2: Lowland forest on ridgetop			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Calophyllum peekelli</i>	Calophyllum	Uncommon	Threatened
2 <i>Syzygium onesima</i>	Syzygium	Uncommon	Threatened
3 <i>Syzygium tierneyana</i>	Syzygium	Uncommon	Threatened
4 <i>Syzygium myriadena</i>	Syzygium	Uncommon	Threatened
5 <i>Canarium salomonense</i>	Small Ngali nut, Canarium	Uncommon	Threatened
6 <i>Semecarpus forstenii</i>	Semecarpus	Common	Least concern
7 <i>Vitex cofassus</i>	Vitex, Vasa	Uncommon	Threatened
8 <i>Pometia pinnata</i>	Pometia, Taun	Uncommon	Threatened
9 <i>Mangifera indica</i>	Native mango	Uncommon	Least concern
10 <i>Intsia bijuga</i>	Kwila, Iron wood	Uncommon	Threatened
11 <i>Schizomeria serrata</i>	Schizomeria	Uncommon	Least concern
12 <i>Parinari glaberrima</i>	Tita tree	Uncommon	Least concern
13 <i>Heterospathe minor</i>	Heterospathe palm	Uncommon	Least concern
14 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Common	Least concern
15 <i>Calamus vestitus</i>	Lawyer cane, Rattan	Common	Least concern
16 <i>Calanthe longifolia</i>	Terrestrial Orchid	Rare, Uncommon	Vulnerable
17 <i>Celtis philippinensis</i>	Celtis	Uncommon	Least concern
18 <i>Sterculia conwentzii</i>	Sterculia	Uncommon	Least concern
19 <i>Calophyllum paludosum</i>	Calophyllum	Uncommon	Threatened
20 <i>Areca macrocalyx</i>	Wild Betel Nut	Common	Least concern
21 <i>Alpinia oceanica</i>	Alpinia	Common	Least concern
22 <i>Pterocarpus indicus</i>	Rose wood	Uncommon	Threatened
23 <i>Polyscias guilfoylei</i>	Polyscias	Common	Least concern

Flora Access Roads 3: Lowland forest on ridgetop			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Boerlagiodendron novoguineensis</i>		Common	Least concern
2 <i>Plerandra solomonensis</i>	Plerandra	Common	Least concern
3 <i>Hydriastele macrospadix</i>	Tall Palm	Uncommon	Least concern
4 <i>Cycas seemanii</i>	Cycad	Rare, Uncommon	Vulnerable
5 <i>Heterospathe minor</i>	Palm	Common	Least concern
6 <i>Heterospathe solomonensis</i>	Palm	Uncommon	Least concern
7 <i>Rhopaloblaste elegans</i>	Palm	Uncommon	Least concern
8 <i>Pterocarpus indicus</i>	Rose wood	Uncommon	Threatened
9 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened
10 <i>Pometia pinnata</i>	Pometia, Taun	Uncommon	Threatened
11 <i>Kleinhovia hospita</i>	Kleinhovia	Common	Least concern
12 <i>Ficus wassa</i>	Ficus	Common	Least concern
13 <i>Ficus longifolia</i>	Ficus	Common	Least concern
14 <i>Cominsia gigantea</i>	Cominsia	Common	Least concern

Flora Power Plant 1: Lowland forest - secondary and riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Cananga odorata</i>	Ylang ylang, Cananga	Uncommon	Least concern
2 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, Widespread	Least concern
3 <i>Samanea saman</i>	Rain tree	Common, Widespread	Least concern
4 <i>Merremia peltata</i>	Merremia	Common, Widespread	Least concern
5 <i>Mikania micrantha</i>	Mile-a-minute	Common, Widespread	Least concern
6 <i>Pueraria lobata</i>	Legume cover crop	Common, Widespread	Least concern
7 <i>Solanum torvum</i>	Egg plant	Uncommon	Least concern
8 <i>Alpinia purpurata</i>	Alpinia, Ginger	Common, Widespread	Least concern
9 <i>Nephrolepis hirsutula</i>	Fish tail fern	Common	Least concern
10 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
11 <i>Metroxylon salomonense</i>	Sago palm, Sagu	Uncommon	Least concern
12 <i>Areca catechu</i>	Betle nut	Common	Least concern
13 <i>Cocos nucifera</i>	Coconut	Common	Least concern
14 <i>Diplazium esculentum</i>	Edible fern	Uncommon	Least concern
15 <i>Musa sapientum</i>	Banana	Common	Least concern
16 <i>Commelina diffusa</i>	Herb	Uncommon	Least concern
17 <i>Dendrocnide inermis</i>	Poison or Stinging tree	Uncommon	Least concern
18 <i>Cyrtosperma johnstonii</i>	Wild taro	Uncommon	Least concern
19 <i>Barringtonia procera</i>	Cut nut	Uncommon	Least concern
20 <i>Theobroma cacao</i>	Cocoa	Uncommon	Least concern

Flora Power Plant 2: Lowland forest			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened
2 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
3 <i>Syzygium onesima</i>	Syzygium	Common	Threatened
4 <i>Canarium salomonense</i>	Small Ngali nut, Canarium	Uncommon	Threatened
5 <i>Barringtonia procera</i>	Cut nut	Common	Least concern
6 <i>Licuala lauterbachii</i>	Licuala palm	Common	Least concern
7 <i>Heterospathe minor</i>	Heterospathe palm	Common	Least concern
8 <i>Planchonella firma</i>	Planchonella	Uncommon	Least concern
9 <i>Celtis philippinensis</i>	Celtis	Uncommon	Least concern
10 <i>Elaeocarpus sphaericus</i>	Elaeocarpus	Common	Least concern
11 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
12 <i>Alpinia oceanica</i>	Alpinia, Ginger	Common	Least concern
13 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Uncommon	Least concern
14 <i>Dysoxylum excelsum</i>	Dysox	Uncommon	Least concern
15 <i>Ficus benjamina</i>	Ficus	Common	Least concern
16 <i>Heterospathe solomonensis</i>	Palm	Common	Least concern
17 <i>Vitex cofassus</i>	Vitex, Vasa	Uncommon	Threatened
18 <i>Cryptocarya medicinalis</i>	Cryptocarya	Uncommon	Least concern
19 <i>Ptychosperma salomonense</i>	Ptychosperma palm	Common	Least concern
20 <i>Macaranga dioica</i>	Macaranga	Common	Least concern

Flora Power Plant 2: Lowland forest			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
21 <i>Pandanus compressus</i>	Pandanus	Uncommon	Least concern
22 <i>Actinodaphne solomonensis</i>	Actinodaphne	Common	Least concern

Flora Reservoir 1: Lowland forest - Secondary regrowths and riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Vitex cofassus</i>	Vitex, Vasa	Uncommon	Threatened
2 <i>Semecarpus forstenii</i>	Semecarpus	Common	Least concern
3 <i>Dysoxylum excelsum</i>	Dysox	Common	Least concern
4 <i>Pometia pinnata</i>	Pometia, Taun	Uncommon	Threatened
5 <i>Drymophloeus salomonense</i>	Drymophloeus	Uncommon	Threatened
6 <i>Areca macrocalyx</i>	Wild betle nut	Common	Least concern
7 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
8 <i>Donax canniformis</i>	Donax	Common	Least concern
9 <i>Cyathocalyx petiolaris</i>	Cyathocalyx	Common	Least concern
10 <i>Cyathea brackenridgei</i>	Cyathea, Tree Fern	Common	Least concern
11 <i>Artocarpus altilis</i>	Bread fruit	Uncommon	Least concern
12 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened
13 <i>Schizostachyum tessellatum</i>	Small Bamboo	Common	Least concern
14 <i>Brownlowia argentata</i>	Brownlowia	Common	Least concern
15 <i>Stenochlaena palustris</i>	Climbing Fern	Common	Least concern
16 <i>Planchonella thyrsoidea</i>	Planchonella	Uncommon	Least concern
17 <i>Selaginella rechingeri</i>	Selaginella, Fern Ally	Common	Least concern
18 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
19 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
20 <i>Calophyllum paludosum</i>	Calophyllum	Uncommon	Least concern
21 <i>Leea indica</i>	Leea	Common	Least concern
22 <i>Euodia elleryana</i>	Euodia	Common	Least concern
23 <i>Elaeocarpus sphaericus</i>	Elaeocarpus	Uncommon	Threatened
24 <i>Syzygium tierneyana</i>	Syzygium	Common	Least concern
25 <i>Heterospatha minor</i>	Heterospatha palm	Common	Least concern
26 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Uncommon	Least concern
27 <i>Elatostema salomonense</i>	Elatostemon	Common	Least concern
28 <i>Hernandia peltata</i>	Hernandia	Common	Least concern
29 <i>Mucuna elegans</i>	Mucuna	Common	Least concern
30 <i>Flagellaria gigantea</i>	Flagellaria	Common	Least concern
31 <i>Polyscias sp?</i>	Polyscias	Uncommon	Least concern
32 <i>Macaranga similis</i>	Macaranga	Common	Least concern
33 <i>Tapeinochilus solomonense</i> Tapeinochilus	Ginger	Uncommon	Least concern

Flora Reservoir 2: Lowland forest overlapping secondary vegetation (old garden and village site)			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Spathodea companulata</i>	African Tulip	Uncommon, Introduced	Least concern
2 <i>Ficus longifolia</i>	Ficus	Common	Least concern
3 <i>Semecarpus forstenii</i>	Semecarpus	Common	Least concern
4 <i>Merremia peltata</i>	Merremia	Common	Least concern
5 <i>Artocarpus altilis</i>	Bread fruit	Uncommon	Least concern
6 <i>Ficus chrysochaete</i>	Ficus	Common	Least concern

Flora Reservoir 2: Lowland forest overlapping secondary vegetation (old garden and village site)			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
7 <i>Saurauia purgans</i>	Saurauia	Common	Least concern
8 <i>Areca macrocalyx</i>	Wild betel nut	Common	Least concern
9 <i>Areca catechu</i>	Betel nut	Uncommon	Least concern
10 <i>Ficus copiosa</i>	Ficus	Common	Least concern
11 <i>Alpinia purpurata</i>	Alpinia, Ginger	Common	Least concern
12 <i>Citrus limon</i>	Bush lime	Uncommon, Introduced	Least concern
13 <i>Costus speciosus</i>	Costus, Ginger	Common	Least concern
14 <i>Ficus septica</i>	Ficus	Common	Least concern
15 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespread	Least concern
16 <i>Dendrocnide inermis</i>	Poison or Stinging tree	Common	Least concern
17 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
18 <i>Canarium indicum</i>	Ngali nut, Canarium	Uncommon	Threatened
19 <i>Mikania micrantha</i>	Mile-a-minute	Common	Least concern

Flora Reservoir 3: Lowland forest - Secondary regrowths on a very steep slope			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Pometia, Tauna	Common	Threatened
2 <i>Astronidium salomonensis</i>	Astronidium	Uncommon	Least concern
3 <i>Astronidium novae-georgiae</i>	Astronidium	Uncommon	Least concern
4 <i>Cyathea vittata</i>	Tree Fern	Common	Least concern
5 <i>Cyathea brackenridgei</i>	Tree Fern	Common	Least concern
6 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
7 <i>Alpinia oceanica</i>	Ginger, Alpinia	Common	Least concern
8 <i>Rubus moluccanus</i>	Wild Raspberry	Uncommon	Least concern
9 <i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened
10 <i>Ficus septica</i>	Ficus	Common	Least concern
11 <i>Ficus copiosa</i>	Ficus	Common	Least concern
12 <i>Ficus wassa</i>	Ficus	Common	Least concern
13 <i>Ficus longifolia</i>	Ficus	Common	Least concern
14 <i>Ficus variegata</i>	Ficus	Uncommon	Least concern
15 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
16 <i>Macaranga similis</i>	Macaranga	Common	Least concern
17 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
18 <i>Macaranga fimbriata</i>	Macaranga	Common	Least concern
19 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Uncommon	Threatened
20 <i>Alstonia scholaris</i>	Milky Pine	Common	Threatened
21 <i>Calamus hollrungii</i>	Lawyer Cane, Rattan	Common	Least concern
22 <i>Ptychosperma salomonense</i>	Native Palm	Uncommon	Least concern

Flora Reservoir 4: Lowland forest - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened
2 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Uncommon	Threatened
3 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
4 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
5 <i>Ficus wassa</i>	Ficus	Common	Least concern
6 <i>Merremia peltata</i>	Merremia	Common	Least concern
7 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
8 <i>Cyathea vittata</i>	Tree Fern	Common	Least concern
9 <i>Vitex cofassus</i>	Vitex, Vasa	Uncommon	Least concern
10 <i>Hornstedtia lycostoma</i>	Hornstedtia, Sweet Ginger	Uncommon	Least concern
11 <i>Acalypha grandis</i>	Acalypha	Common	Least concern
12 <i>Piper betle</i>	Piper	Common	Least concern
13 <i>Calamus hollrungii</i>	Lawyer Cane, Rattan	Common	Least concern
14 <i>Calamus stipitatus</i>	Lawyer Cane, Rattan	Common	Least concern
15 <i>Saurauia purgans</i>	Saurauia	Common	Least concern
16 <i>Euodia solomonensis</i>	Euodia	Common	Least concern
17 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
18 <i>Trema orientalis</i>	Trema	Common	Least concern
19 <i>Dysoxylum excelsum</i>	Dysox	Common	Least concern
20 <i>Colocasia esculenta</i>	Wild Taro	Uncommon	Least concern
21 <i>Mikania micrantha</i>	Mile-a-minute	Common	Least concern
22 <i>Nephrolepis biserrata</i>	Fish tail fern	Common	Least concern
23 <i>Nephrolepis hirsutula</i>	Fish tail fern	Common	Least concern

Flora Dam 1: Riparian Vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Tapeinochilus solomonense</i>	Tapeinochilus, Ginger	Uncommon	Least concern
2 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
3 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespread	Least concern
4 <i>Ficus longifolia</i>	Ficus, Fig	Common	Least concern
5 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
6 <i>Artocarpus altilis</i>	Bread fruit	Uncommon	Least concern
7 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
8 <i>Schizostachyum tessellatum</i>	Bamboo	Uncommon	Least concern
9 <i>Heterospatha minor</i>	Palm	Common	Least concern
10 <i>Calamus vestitus</i>	Lawyer cane, Rattan	Uncommon	Least concern
11 <i>Selaginella rechingeri</i>	Selaginella	Common	Least concern
12 <i>Areca macrocalyx</i>	Wild betel nut	Common	Least concern
13 <i>Ficus variegata</i>	Ficus, Fig	Common	Least concern
14 <i>Ficus septica</i>	Ficus, Fig	Common	Least concern
15 <i>Ficus copiosa</i>	Ficus, Fig	Common	Least concern
16 <i>Flagellaria gigantea</i>	Flagellaria	Common	Least concern
17 <i>Elatostema salomonense</i>	Elatostema	Common	Least concern
18 <i>Cyathea vittata</i>	Tree Fern	Common	Least concern
19 <i>Cominsia gigantea</i>	Cominsia	Uncommon	Least concern
20 <i>Ficus chrysochaete</i>	Ficus, Fig	Common	Least concern
21 <i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened
22 <i>Barringtonia</i> sp?	Wild Cut nut	Uncommon	Least concern
23 <i>Leea indica</i>	Leea	Uncommon	Least concern

Flora Dam 1: Riparian Vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
24 <i>Nastus obtusus</i>	Bamboo	Uncommon	Vulnerable
25 <i>Hornstedtia lycostoma</i>	Sweet Ginger	Uncommon	Least concern
26 <i>Saurauia purgans</i>	Saurauia	Common	Least concern

Flora Dam 2: Secondary lowland forest			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
2 <i>Palaquium firmum</i>	Pencil Cedar	Uncommon	Threatened
3 <i>Calophyllum peekelli</i>	Calophyllum	Uncommon	Threatened
4 <i>Piper wichmanii</i>	Piper	Uncommon	Least concern
5 <i>Cominsia gigantea</i>	Cominsia	Common	Least concern
6 <i>Ficus wassa</i>	Ficus, Fig	Common	Least concern
7 <i>Ficus copiosa</i>	Ficus, Fig	Common	Least concern
8 <i>Ficus longifolia</i>	Ficus, Fig	Common	Least concern
9 <i>Ficus chrysochaete</i>	Ficus, Fig	Common	Least concern
10 <i>Cyathea brackenridgei</i>	Tree Fern	Common	Least concern
11 <i>Alpinia purpurata</i>	Alpinia, Ginger	Common	Least concern
12 <i>Heliconia salomonensis</i>	Heliconia	Uncommon	Least concern
13 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
14 <i>Dysoxylum excelsum</i>	Dysox	Common	Least concern
15 <i>Dendrocnide inerme</i>	Poison or Stinging	Common	Least concern
16 <i>Elatostema salomonense</i>	Elatostema	Common	Least concern
17 <i>Merremia peltata</i>	Merremia	Common	Least concern
18 <i>Flueggia flexuosa</i>	Flueggia	Uncommon	Least concern
19 <i>Areca macrocalyx</i>	Wild betel nut	Common	Least concern
20 <i>Leea indica</i>	Leea	Uncommon	Least concern
21 <i>Artocarpus altilis</i>	Bread fruit	Common	Least concern
22 <i>Semecarpus forstenii</i>	Semecarpus	Common	Least concern
23 <i>Ficus variegata</i>	Ficus, Fig	Common	Least concern
24 <i>Homalomena alba</i>	Homalomena	Common	Least concern

Flora Dam 3: Old Garden Area - Secondary forest			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Broussonetia papyrifera</i>	Paper mulberry	Common,widespread	Least concern
2 <i>Alstonia spectabilis</i>	Alstonia	Common	Least concern
3 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
4 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
5 <i>Musa sapientum</i>	Banana	Common	Least concern
6 <i>Ficus septica</i>	Ficus, Fig	Common	Least concern
7 <i>Ficus wassa</i>	Ficus, Fig	Common	Least concern
8 <i>Ficus copiosa</i>	Ficus, Fig	Common	Least concern
9 <i>Ficus longifolia</i>	Ficus, Fig	Common	Least concern
10 <i>Dioscorea alata</i>		Uncommon	Least concern

Flora Dam 4: Lowland forest and Riparian Vegetation on very steep cliff substrat			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Pometia, Taun	Common	Threatened
2 <i>Artocarpus altilis</i>	Bread Fruit	Common	Least concern
3 <i>Ficus virgata</i>	Ficus, Fig	Common	Least concern
4 <i>Ficus wassa</i>	Ficus, Fig	Common	Least concern
5 <i>Rhus taitensis</i>	Rhus	Uncommon	Least concern
6 <i>Trichospermum psilocladum</i>	Trichospermum	Uncommon	Least concern
7 <i>Neonauclea orientalis</i>	Nauclea	Uncommon	Least concern
8 <i>Ficus variegata</i>	Ficus, Fig	Common	Least concern
9 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Common	Threatened
10 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Common	Least concern
11 <i>Flagellaria gigantea</i>	Flagellaria	Common	Least concern
12 <i>Hornstedtia lycostoma</i>	Sweet Ginger	Common	Least concern
13 <i>Areca macrocalyx</i>	Wild betel nut	Common	Least concern
14 <i>Mussaenda cylindrocarpa</i>	Mussaenda	Common	Least concern
15 <i>Heterospathe minor</i>	Palm	Common	Least concern
16 <i>Paraserianthis falcata</i>	Albizia	Common	Least concern
17 <i>Elatostema salomonense</i>	Elatostema	Common	Least concern
18 <i>Selaginella rechingeri</i>	Selaginella	Common	Least concern

Flora Tunnel: Lowland forest - Secondary Vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
2 <i>Cananga odorata</i>	Ylang ylang, Cananga	Uncommon	Least concern
3 <i>Artocarpus altilis</i>	Bread fruit	Common	Least concern
4 <i>Premna corymbosa</i>	Premna	Uncommon	Least concern
5 <i>Ficus longifolia</i>	Ficus	Common	Least concern
6 <i>Dysoxylum excelsum</i>	Dysox	Common	Least concern
7 <i>Terminalia sp?</i>	Terminalia	Uncommon	Least concern
8 <i>Calamus stipitatus</i>	Lawyer cane, Rattan	Uncommon	Least concern
9 <i>Cyathea vittata</i>	Tree fern	Common	Least concern
10 <i>Areca macrocalyx</i>	Wild betel nut	Common	Least concern
11 <i>Drymophloeus salomonensis</i>	Drymo Palm	Uncommon	Least concern
12 <i>Schizostachyum tessellatum</i>	Bamboo	Common	Least concern
13 <i>Ficus Chrysochaete</i>	Ficus	Common	Least concern
14 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern

Flora Cliff 1: Uphill forest - Riparian vegetation on Very Steep Cliff Substrate			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
2 <i>Rhus taitensis</i>	Rhus	Common	Least concern
3 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
4 <i>Cyathea vittata</i>	Tree Fern	Common	Least concern
5 <i>Cycas seemanii</i>	Cycad	Uncommon	Vulnerable
6 <i>Timonius timon</i>	Timonius	Common	Least concern
7 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
8 <i>Phragmites karka</i>	Phragmites	Common	Least concern
9 <i>Ptychosperma salomonense</i>	Palm	Common	Least concern

Flora Cliff 1: Uphill forest - Riparian vegetation on Very Steep Cliff Substrate			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
10 <i>Rubus moluccanus</i>	Wild raspberry	Uncommon	Least concern
11 <i>Uncaria appendiculata</i>	Sweet Rope	Common	Least concern
12 <i>Pandanus</i> sp?	Pandanus	Uncommon	Threatened
13 <i>Pholidota</i> sp?	Orchid	Uncommon	Vulnerable
14 <i>Spathoglottis plicata</i>	Ground Orchid	Common	Vulnerable
15 <i>Hoya guppyi</i>	Hoya	Common	Least concern

Flora Cliff 2: Uphill forest - Riparian vegetation on very steep cliff substrate			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Common	Threatened
2 <i>Terminalia calamansanai</i>	Yellow Terminalia	Uncommon	Least concern
3 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
4 <i>Ficus variegata</i>	Ficus	Common	Least concern
5 <i>Broussonetia papyrifera</i>	Paper mulberry	Common, widespread	Least concern
6 <i>Khleinhovia hospita</i>	Khleinhovia	Uncommon	Least concern
7 <i>Ficus copiosa</i>	Ficus	Common	Least concern
8 <i>Ficus septica</i>	Ficus	Common	Least concern
9 <i>Ficus wassa</i>	Ficus	Common	Least concern
10 <i>Cyathea brackenridgei</i>	Tree Fern	Common	Least concern
11 <i>Paraserianthis falcata</i>	Albizia	Uncommon	Least concern
12 <i>Calamus hollrungii</i>	Lawyer cane, Rattan	Common	Least concern
13 <i>Calamus stipitatus</i>	Lawyer cane, Rattan	Common	Least concern
14 <i>Merremia peltata</i>	Merremia	Common	Least concern
15 <i>Uncaria appendiculata</i>	Sweet rope	Common	Least concern
16 <i>Pterocarpus indicus</i>	Rosewood	Common	Threatened
17 <i>Hornstedtia lycostoma</i>	Sweet Ginger	Common	Least concern
18 <i>Elaeocarpus sphaericus</i>	Elaeocarpus	Uncommon	Threatened
19 <i>Rhopaloblaste elegans</i>	Palm	Common	Least concern
20 <i>Heterospathes salomonensis</i>	Palm	Common	Least concern
21 <i>Dysoxylum excelsum</i>	Dysox	Common	Least concern
22 <i>Macaranga dioica</i>	Macaranga	Common	Least concern
23 <i>Macaranga similis</i>	Macaranga	Common	Least concern
24 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern

Flora Upper Stream 1: Lowland - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
2 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Common	Threatened
3 <i>Paraserianthis falcata</i>	Albizia	Common	Least concern
4 <i>Macaranga tanarius</i>	Macaranga	Common	Least concern
5 <i>Cassia alata</i>	Cassia	Uncommon	Least concern
6 <i>Diplazium esculenta</i>	Fern	Common	Least concern
7 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
8 <i>Mussaenda cylindrocarpa</i>	Mussaenda	Common	Least concern
9 <i>Ficus copiosa</i>	Ficus	Common	Least concern
10 <i>Ficus longifolia</i>	Ficus	Common	Least concern
11 <i>Ficus wassa</i>	Ficus	Common	Least concern

Flora Upper Stream 1: Lowland - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
12 <i>Crinum asiaticum</i>	Crinum, Lilly	Uncommon	Threatened
13 <i>Pterocarpus indicus</i>	Rosewood	Common	Threatened
14 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened

Flora Upper Stream 2: Lowland forest - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Alpinia purpurata</i>	Alpinia, Ginger	Common	Least concern
2 <i>Gymnostoma papuana</i>	Casuarina	Rare, Uncommon	Least concern
3 <i>Paraserianthis falcata</i>	Albizia	Common	Threatened
4 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
5 <i>Vitex cofassus</i>	Vitex, Vasa	Common	Threatened
6 <i>Cyathea brackenridgei</i>	Tree Fern	Common	Least concern
7 <i>Pandanus sp?</i>	Pandanus	Uncommon	Least concern
8 <i>Heliconia solomonensis</i>	Heliconia	Uncommon	Least concern
9 <i>Calophyllum paludosum</i>	Calophyllum	Uncommon	Least concern
10 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened
11 <i>Cominsia gigantea</i>	Cominsia	Common	Least concern
12 <i>Alstonia scholaris</i>	Alstonia, Milky Pine	Uncommon	Threatened
13 <i>Flueggia flexuosa</i>	Flueggia	Common	Least concern
14 <i>Costus speciosus</i>	Costus	Common	Least concern
15 <i>Trichospermum psilocladum</i>	Trichospermum	Common	Least concern
16 <i>Neonauclea orientalis</i>	Nauclea	Uncommon	Least concern
17 <i>Melastoma affine</i>	Melastoma	Uncommon	Least concern
18 <i>Syzygium onesima</i>	Syzygium	Common	Least concern
19 <i>Areca macrocalyx</i>	Wild Betel nut	Common	Least concern
20 <i>Saurauia purgans</i>	Saurauia	Common	Least concern
21 <i>Medinilla cauliflora</i>	Medinilla	Common	Least concern
22 <i>Selaginella rechingeri</i>	Selaginella	Common	Least concern
23 <i>Schizostachyum tessellatum</i>	Bamboo	Common	Least concern
24 <i>Rhus taitensis</i>	Rhus	Common	Least concern
25 <i>Ficus variegata</i>	Ficus	Common	Least concern
26 <i>Ficus chrysochaete</i>	Ficus	Common	Least concern
27 <i>Dendrocnide inerme</i>	Poison or Stinging tree	Common	Least concern
28 <i>Piper wichmanii</i>	Piper	Uncommon	Least concern
29 <i>Euodia elleryana</i>	Euodia	Common	Least concern

Flora Upper Stream 3: Lowland forest - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
1 <i>Terminalia brassii</i>	Brown Terminalia, Swamp Oak	Common	Threatened
2 <i>Calophyllum peekelli</i>	Calophyllum	Common	Threatened
3 <i>Pterocarpus indicus</i>	Rosewood	Common	Threatened
4 <i>Pometia pinnata</i>	Taun, Pometia	Common	Threatened
5 <i>Cyathea brackenridgei</i>	Tree Fern	Common	Least concerned
6 <i>Cyathea vittata</i>	Tree Fern	Common	Least concerned
7 <i>Ficus longifolia</i>	Ficus	Common	Least concerned

Flora Upper Stream 3: Lowland forest - Riparian vegetation			
Scientific Names	Common/Vernacular Names	Distribution Status	Protection Status
8 <i>Ficus wassa</i>	Ficus	Common	Least concerned
9 <i>Paraserianthis falcata</i>	Albizia	Uncommon	Threatened
10 <i>Boerlagiodendron novo-guineensis</i>		Common	Least concern
11 <i>Uncaria appendiculata</i>	Uncaria	Common	Least concern
12 <i>Alpinia purpurata</i>	Ginger, Alpinia	Common	Least concern
13 <i>Areca macrocalyx</i>	Wild Betel nut	Common	Least concern
14 <i>Hydriastele macrospadix</i>	Gulubia palm	Uncommon	Least concern
15 <i>Heterospathe minor</i>	Heterospathe	Common	Least concern
16 <i>Rhopaloblaste elegans</i>	Rhopaloblaste	Uncommon	Least concern
17 <i>Homalomena alba</i>	Homalomena	Common	Least concern
18 <i>Dendrocnide inerme</i>	Poison tree	Common	Least concern

Annex 9: Example of field maps

Here insert an example of field map

Annex 10: Regulatory analysis

CONSTITUTION OF SOLOMON ISLANDS

The preamble of the Constitution declares that the natural resources of Solomon Islands are vested in the people and government of the Solomon Islands.⁸ This declaration is significant in that it adopts the common law concept where the State owns the natural resources, in particular for example mineral resources, and the perception that natural resources, including water resources are owned by the people. The basic idea is that the natural resources of Solomon Islands (water included) are owned by customary landowners and the Government. Therefore, the customary landowners possess the property rights over their natural resources and accessing that will require their consent.

The right of customary landowners' over their land is recognized in the Constitution of Solomon Islands.⁹ The extent of this recognition and protection is argued to be comparable only to that formally given to private property under any Common Law system of land ownership.¹⁰ The concession to the special status of customary tenure is that the alienation or acquisition should be for as short a time as possible to achieve the public purpose being sought.¹¹ The access to resources also means access to land in which the resources is being sought, in the case of the TRHDP accessing the water resources also means accessing the land in which it is located. This means that the TRHDP requires registering the land under the Land and Titles Act. This will require two possibilities of processes to acquire the land. First compulsory land acquisition, which is often used for purposes of national interest, and land acquisition through a land acquisition officer. The option that the TRHDP will take require vigorous consultations which resources customary land resources owners and respecting the rights given to those customary owners under the Solomon Islands Constitution.

AGRICULTURE QUARANTINE ACT 1982

The Agriculture and Quarantine Act 1982 provide for preventing the introduction of disease into Solomon Islands through the importation or landing of animals, plants and other things and preventing the introduction of pests and undesirable plants; for requiring vessels and aircrafts to give notice of their arrival in Solomon Islands; and for connected purposes.¹² This Act grants regulation-making powers to the Minister in respect of the introduction or importation of plants and animals and substances or other material that may be the carrier of plant or animal pests and diseases.¹³ The Act further provides for the appointment of inspectors and defines their powers and prescribed list offences.¹⁴ An Order of the Minister may prohibit or regulate the importation or landing of: (a) animals and animal products; (b) plants; (c) earth; and (d) other things by, or by means of, which it appears to the Minister that any disease or pest might be introduced.¹⁵ The First Schedule sets out the matters which may be dealt with by Order made under this Act.¹⁶

ENVIRONMENT ACT 1998 AND ENVIRONMENT REGULATION 2008

The *Environment Act 1998* was passed by parliament in October 1998 and came into force (gazetted) on the 1st of September 2003.¹⁷ Its introduction is to provide a regulatory mechanism to address adverse environment impacts of major economic development projects in the country.

⁸ *Constitution of Solomon Islands*

⁹ *Ibid* s112.

¹⁰ *Ibid*.

¹¹ *Ibid*.

¹² *Agriculture Quarantien Act 1982*

¹³ *Ibid*.

¹⁴ *Ibid*

¹⁵ *Ibid*

¹⁶ *Ibid*

¹⁷ *The Environment Act 1998 (Solomon Islands)*

The Act emphasizes upon environmental management and protection, even at the expense of the development project.¹⁸ The Act tries to address this through the application of environmental impact statement (EIS) in order to include environmental considerations as a component of the project.¹⁹ The Act requires that an EIA should be carried out in the project planning stage prior to implementation.²⁰ As a planning and management tool, EIS is very important for decision making processes²¹

Any large scale development pursuant to the Environment Act is a 'prescribed development'.²² 'Development consent' is required by the developer from the Environment and Conservation Division in order for operations to begin. The development consent is the permit given by the Director of the Environment and Conservation Division after a developer submits an ESIA report and is approved. In the context of the TRHDP, once the ESIA is submitted and approved by the Director a development consent will then be issued for the development to occur. In 2008, the Environment and Conservation Division then developed the Environment regulations 2008 which outlines a set of criteria and specific guideline for the development of an EIS and a Public Environment Report (PER).

The Tina Hydropower Development Project is a prescribed development under schedule 2 (section 16) of the *Environment Act 1998* and therefore required the formulation of an Environment Impact Statement through the Environment and Social Impact Assessment Process.²³ The EIS is required where a very large-scale development will be undertaken such as TRHDP and a PER for small-scale development such as logging or urban developments.

The scope of the Environment Act and Environment Regulations encompasses a number of processes, procedures and the establishment of an institution to regulate them. The following are the key components of the legislation:

It provides the guiding principles and definition for environment management.²⁴

Establish the Environment and Conservation as a key institution responsible for managing environmental issues in the country.²⁵

Sets out the procedures for undertaking and approval of Environment and Social Impact Assessments.²⁶

Develop requirements for robust stakeholder engagement process through public consultation as part of assessment and in the decision making process²⁷

Requires the formulation of appropriate environment and social safeguards as part of the environment and social impact assessment process (section 31)

Environment monitoring of the development (section 31)

Establish the Environment Advisory Committee as the appeal body where the developer or any person may within 30 days of the publication of the Director's decision, appeal against the Director's decision concerning the issuing of development consent.²⁸

FISHERIES ACT 1998

The Fisheries Act 1998 provides the legal basis for a comprehensive and responsive national fisheries management regime.²⁹ It promotes a precautionary approach to fisheries management and encourages the long-term sustainable management of fish stocks.³⁰ It provides that the Minister may make regulations for "carrying into effect the provisions of this Act in particular it focuses on :

¹⁸ *Ibid*

¹⁹ *Ibid*

²⁰ *Ibid*

²¹ *Ibid*

²² *Ibid* annex 1

²³ *Ibid* sec 16

²⁴ *Ibid* sec 3

²⁵ *Ibid* sec 5-7

²⁶ *Ibid* 15-23

²⁷ *Ibid* sec24

²⁸ *Ibid* sec 13

²⁹ *Fisheries Act 1998* (Solomon Islands).

³⁰ *Ibid* s3-4.

the licensing, regulation and management of any fishery and the conservation of particular species of fish or other aquatic organisms.³¹ (s59(1)(ii));

prescribing fisheries management conservation measures, including prescribed mesh size, gear standards, minimum and maximum species sizes, limitation on the amount of fish authorized to be caught by any vessel or person or from any fishery, closed season, closed areas, prohibited methods of fishing or fishing gear and schemes for limiting effort in all or any specified fisheries³² (s59(1)(iv)).

The powers vested to the provincial government under the Act could have implications for the Project. In particular, the provisions where each provincial government “is responsible for” the proper management and development of the reef, inshore, and freshwater fisheries within its provincial waters.³³ (FA s9). It empowers the province to take the lead on management of resources within reef and inshore waters and in freshwaters.³⁴

The Fisheries Act has no direct specific implications on the Project except with the provincial legislative provision earlier stated. There is a possibility that the fisheries sector could also be involved if compensation measures for the Project, such as development of aquaculture in the reservoir, arises.

FOREST RESOURCES AND TIMBER UTILIZATION ACT 1979

The Forest Resource and Timber Utilization Act 1979 (Cap 40) regulates the timber industry in the country through a license system issued by the Commissioner of Forest.³⁵ There are two types of timbers licenses that can be issued, one is for a milling license and the second one widely used for logging operations is a felling license. The Act made provision for logging operations to occur in customary land through the timber rights hearing process. It commences with an application to the Commissioner of Forest to grant consent to negotiate with the relevant Provincial Government Executive, and the owners of the customary land. If the Commissioner of Forest grants his consent then the Provincial government will organize a timber rights hearing meeting for the purposes of identifying the persons who have rights under customary land and are willing to dispose of their timber rights. A Timber Rights Agreement will then be entered into between the applicant and the persons having rights over the area. The Commissioner of Forest will be advised of the outcome and where a Timber Rights Agreement has been signed, he will issue a felling timber license.

The felling of trees under the act is for the purposes of commercial activity relating to the sale of logs or timber. Whilst the intention of law is not for vegetation removal for construction or other purposes, there is a possibility that a felling license could be required for a large amount of vegetation to be removed. Further consultation will be undertaken with the Ministry of forests if a reasonable amount of vegetation is to be removed during the construction phase of the Project.

³¹ *Ibid.*s59(1)

³² *Ibid* s59(1)(iv)

³³ *Ibid* s9

³⁴ Provinces may prepare ordinances regarding a wide range of issues, including:
 (b) registration or recording of customary fishing rights, their boundaries and the persons or groups of persons entitled under those rights;
 (c) open or closed seasons for fishing for all or any species of fish or other aquatic organisms in all or any areas of provincial waters based on scientific advice;
 (d) the closure of areas in which fishing for all or any species of fish or other aquatic organisms may be prohibited;
 (e) prescribing the minimum mesh sizes for nets employed, and minimum species sizes for all or any species of fish or other aquatic organisms caught and retained or collected in all or any fisheries management areas in provincial waters;
 (f) prescribing the number of fishing vessels, the types of fishing gear employed in any fishery or fishery management area in provincial waters;
 (g) prohibiting specified methods of fishing that are harmful to fisheries and the environment, or the use of specified types of fishing gear in provincial waters;
 (h) the establishment and protection of marine reserves;
 (i) regulating and prohibiting the destruction of mangroves;
 (j) authorising the use of specified natural poisons indigenous to Solomon Islands for fishing in, any specified area or areas of provincial waters (provided the provincial assembly has determined that the use of the natural poison is a customary practice in the area and that the continued use of such poison will not significantly impair the ecology of such area)(FA s10(3));
 and regulating the local use of explosives, poisons or other noxious substances in fishing s10,s30(1)

³⁵ *Forest Resources and Timber Utilization Act 1979 (Cap 40) (Solomon Islands).*

LABOR ACT 1996

The Labor Act 1996 makes provisions for the protection of the workers and their rights during employment. It establishes the office of the commissioner of labor to address all labor related issues. The legislation broadly covers the roles and powers of the office, identifies the commissioner as the administrative body, outline specific guidance on wages and hours of work and minimum wages for all workers in the country.³⁶ The minimum is set by the Minister of commerce from time to time, however minimum amount of time for work and overtime is clearly stated in the law as follows :

- (a) the normal weekly hours of any worker shall not exceed forty-five hours;
- (b) the normal daily hours of work of any worker in an industrial or agricultural undertaking shall not exceed nine hours;
- (c) a worker whose hours of work exceed six hours daily shall be given a break of at least thirty minutes arranged so that the worker does not work continuously for more than five hours;
- (d) hours of work and breaks from work shall be so arranged as not to require the worker's presence at the place of work for more than twelve hours daily;
- (e) a worker shall be given a weekly rest of at least twenty-four continuous hours, which shall, where practicable, include Sundays or other customary rest days; and
- (f) no worker shall be required to work on a gazetted public holiday or on more than six days in one week, unless such worker is employed in a service to which the Essential Services Act applies or in an occupation in which work on public holidays or customary rest days is expressly provided for in his contract of service.

It also made provision in the manner in which contracts for employment are made for both nationals and foreign workers. Part VI of the Act provide guidance on the treatment of women and their rights on conditions of employment, maternity leave and their protection from working during unusual hours.³⁷ Section 39 prohibits women from working at night, with night being defined as the period between 7 o'clock in the evening and 6 o'clock the next morning.³⁸

Part VII focus on the employment of child and young person to ensure that child labor is restricted. Section 46 states that "No child under the age of twelve years shall be employed in any capacity whatsoever"; Section 47 further state that "A person under the age of fifteen shall not be employed or work" - (a) in any industrial undertaking, or in any branch thereof, except in employment approved by the Minister; or (b) on any ship;

Part IX outlines the basic conditions for the general care of workers by any employer.³⁹ The Minister under the Act can make special exceptions on the provision of the act on the condition that it does not contravene the purpose and objective of the Act and does not result in abuse or the infringement of the individual workers rights.⁴⁰

³⁶ Labor Act 1996

³⁷ Ibid s 40

³⁸ Ibid.

³⁹ Ibid

⁴⁰ Ibid

The employment of foreign (to Solomon Islands) employees on the Project will be subjected to the requirements of the Immigration Act 1987.⁴¹ All entrants who wish to reside and work in the Solomon Islands must have two distinct authorizations; a valid permit that allows them to enter and reside in the Solomon Islands and a work permit that authorizes the holder to undertake employment or business in the Solomon Islands.⁴² The permit to enter and reside in the Solomon Islands is issued by the Ministry of Immigration and is valid for two years.⁴³ At the end of the two year period it can be renewed or extended by applying to the Director of Immigration two months prior to the expiry of the existing permits.⁴⁴ The work permit is issued by the Commissioner of Labour as set out in the Labour Act Part V Section 37.⁴⁵ Anyone wishing to work or operate a business while residing in the in the Solomon Islands must submit an application to the Commissioner of Labour.⁴⁶ Foreign nationals currently working in the Solomon Islands often enter the country on a visitor's permit or a 92B (business) permit and apply for a work permit after they have commenced work.⁴⁷ The practice is to avoid long delays in the process of getting work permits.

The provisions of both the labor act and the immigration act will be important during the construction phase if foreign workers are to be engaged.

LAND AND TITLES ACT

The issue of land is the most challenging in the modern development of Solomon Islands. This is due to the fact that landownership is related to customary practices and communal ownership of land and resources. Land ownership is attributed to tribes, clans and families rather than an individual. Land include vast majority of land, including forests, lagoons and reefs and that the clan or tribe, the chiefs or family heads decide over the deployment and use of the land for the benefit of the clan or community at large. This definition applies to everything on land and for the TRHDP includes the river itself, reservoir and the catchment areas. No person other than a Solomon Islander may hold or enjoy any interest of whatever nature over, or affecting, customary land. A Solomon Islander is defined under the Land and Titles Act as a person born in the Solomon Islands who has two grand-parents who were members of a group, tribe or line indigenous to the Solomon Islands. An exception is made to this rule - s.241 (2), for a person, not being a Solomon Islander, who:

is or has been married, whether according to current customary usage or otherwise, to a Solomon Islander and who according to current customary usage becomes entitled to acquire or enjoy the interest in question in right of his being or having been so married; or

acquires or becomes entitled to enjoy such interest by inheritance according to current customary usage.

The Lands and Titles Act provided two alternative mechanisms by which land can be acquired. Under Part V of the Lands and Titles Act, voluntary acquisition under Division 1 or compulsory acquisition under Division 2.

Under Division 1, when a customary owner wishes to transfer or lease his land, this must be done by a transfer or lease it to the national Government (through the Commissioner) or a Provincial Assembly (traditionally in the name of the Premier) and any customary usage prohibiting or restricting such transactions will be disregarded.

⁴¹ *Immigration Act 1987*

⁴² *Ibid.*

⁴³ *Ibid.*

⁴⁴ *Ibid.*

⁴⁵ above n 25

⁴⁶ *Ibid.*

⁴⁷ *Ibid.*

Part V Division 2 provides for a compulsory acquisition and compensation process is available in the case of both registered and unregistered land (including customary land). These provisions are subject to section 8 of the Constitution, which permits compulsory acquisition of property for specified public purposes, in particular where (i) the acquisition is necessary or expedient in the interests of town or country planning or for developing or utilizing the property to promote the public benefit, (ii) there is reasonable justification for any hardship caused and (iii) the acquisition is permitted by statute which provides for reasonable compensation and a right of access (direct or on appeal).

The Lands and Titles Act also made provision for preservation orders to be applied to land of “historic, architectural, traditional, artistic, archaeological, botanical or religious interest”, and permits the establishment of nature reserves.

The Tina Hydropower Development Project is located on customary land and therefore is required to adhere to processes under the Lands and Title Act through land acquisition. The most obvious process would be the voluntary land acquisition process. This will be done by undertaking a land identification process as a prelude to the acquisition process.

The current process undertaken by the TRHDP Project office is an internal process developed in consultation with customary landowners of the TRHDP. This process is called Land Identification (Land ID) process. Customary landowners organize themselves through the House Chiefs with respective tribes, clans and families in shorting out ownership and boundaries of the respective lands. The information is compiled by customary landowners after full agreement by all parties and provided to the project office. The TRHDP project office will then use the information to register the land either through land acquisition or compulsory acquisition as described above. The Land ID process is currently in progress and is expected to finish soon.

CUSTOMARY LAND RECORDING ACT

The Customary Land Record Act provides that the decision to apply for registration belongs to customary land holding group. Boundary disputes are to be settled by negotiation and in case no agreement or settlement is reached, the final and conclusive decision belongs to the traditional chiefs and no longer to the members of the Government. However, the determination of the chiefs is still subject to judicial review by the High Court and, on appeal, by the Court of Appeal. This Act is much more based on negotiation with customary land holding groups.

One of the strengths of the Act is that it differentiates between primary and secondary rights. By contrast, a weakness is that it does explain how a commercial investor can deal with landowning groups once they are recorded under the Act. In practice, the Customary Land Record Act has been applied only very rarely since 1994, and the provisions of the Land and Titles Act regarding the registration process remains in effect. Therefore the Project as discussed will require the land registration process under the lands and titles act rather than this particular law. As earlier stated, the house of chiefs are yet to be formally recognised and therefore whilst informal process of recording can occur formal recording will be done under the lands and titles act.

MINES AND MINERALS (AMENDMENT) ACT 2008

The Mines and Minerals (Amendment) Act 2008 provides the statutory framework for the mining sector. Section 2 states that no mining operations shall take place except in accordance with its provisions. Mining is defined as intentionally extracting any mineral which is itself defined as any substance found naturally in the earth except petroleum.⁴⁸ Several types of permits may be granted by the Minister responsible for mines and minerals: reconnaissance permits, prospecting licences, mining leases, alluvial mining, gold dealing and building materials permits.⁴⁹

⁴⁸ Mines and Minerals Act 1996

⁴⁹ Ibid.

The section of the Act most relevant to the Project is for material extraction from the site to be used as building material for the Project construction. Part VIII of the Act states that a permit is required for extraction of building materials.⁵⁰ Only the holder of such a permit may undertake mining or quarrying to obtain building materials. The Mines and Minerals (Amendment) Act 2008 defines building materials as "clay, gravel, sand and stone used for buildings, roads or other construction purposes"⁵¹. The building materials permit is not transferable and royalties must be paid at the prescribed rate per cubic meter for all building materials extracted. However, similar to many of the laws in the Solomon Islands the Minister under Section 69 of the Act can make an exemption to the building materials permit: "building materials for building or road construction for the personal use of the landowner or occupier, or for sale not exceeding a prescribed amount, may be mined without a building materials permit".⁵² The extraction of materials for the TRHDP will require seeking an appropriate permit from the Ministry of mines for quarry development to occur. However, the Minister of mines has powers to make exemption where a national project such as the TRHDP is involved.

NATIONAL PARKS 1954

The Act provides for the creation of national parks in Solomon Islands. The minister responsible at that time was the minister for cultural affairs and parks. The Minister can make a proclamation declaring certain area to be a national Park and purchase or acquire any land for such purpose. The rights of residence in Parks are restricted and there is a ban on hunting (other than fishing), carrying arms and making fires. The Queen Elizabeth II Park near Honiara was declared a National Park in 1965, today it exists in name only as it is highly degraded and squatters have long settled in the Park. The administration of the Act vests with the Minister and Park Rangers. These Park Rangers are appointed by the Minister. Park Rangers are empowered to ensure that national parks are well kept.

This Act would be important is the upper Tina catchment is to be declared a National Park, however it is outdated and lacks provisions to empower customary landowners to make decisions about their resources.

PROTECTED AREAS ACT 2010

The Protected Area Act 2010 is developed with the objective of establishing protected areas to conserve biological diversity.⁵³ To achieve these, the Act provided for the establishment of a Protected Areas Advisory Committee (PAAC) and made provisions for declaration of protected areas by the Minister of Environment from the advice of the Director of environment.⁵⁴ As a means to finance biodiversity protection, the Act established a protected area trust fund to be also managed by the PAAC.⁵⁵

In order for an area to become a protected area (PA), a community or organization will prepare an application to the Director of Environment for their site to be declared as a protected area. The application will need to include a PA management plan and scientific studies to show that the areas is of significance to biological diversity and to the community in terms of natural resources. The application will also include estimated budget for the PA and evidence of agreement by all customary landowners, map showing the boundary and size of the site. The director upon receiving the application will review the application and make recommendation to the Minister if the application have merits and should declared a PA. The basic requirements for considerations by the minister include:

- (a) the conservation objectives of the protected area are identified and are in accordance with sound conservation practices;
- (b) the boundaries of the area are accurately identified, or otherwise demarcated and surveyed;

⁵⁰ Ibid.

⁵¹ Ibid.s 3.

⁵² Ibid s 69.

⁵³ The Protected Area Act 2010 (Solomon Islands) s 3 objectives are: establish a system of protected areas where special measures need to be taken to conserve biological diversity, develop guidelines for selection, establishment and management of protected areas, regulate and management biological resources important for the conservation of biological diversity within or outside protected areas, promote the protection of ecosystems, natural habitats and maintenance of viable population for species in natural surroundings, promote environmentally sound and sustainable development in areas adjacent to protected areas and rehabilitate and restore degraded ecosystems and promote the recovery of threatened species through development for management plans and strategies.

⁵⁴ Ibid s 4-9 s 10-12.

⁵⁵ Ibid s 13-15.

(c) the consent and approval are obtained from persons having rights or interests in the area;

(d) an appropriate conservation, protection or management plan is developed for the area to ensure that the conservation objectives of the protected area will be achieved.

The Act then focused on the regulating research of biological diversity and bio-prospecting prohibiting biodiversity research unless a permit is issued by PAAC.⁵⁶

The PAAC assumes many powers under this Act. It consists of the chair, a deputy chair, four NGOs representative, four others appointed by Minister of Environment and a secretary.⁵⁷ The Act explicitly states their functions and their powers.⁵⁸ These include appointing management committee for protected areas, oversee the use of the protected area fund, provide technical support for protected areas management and approval of biodiversity research permits.⁵⁹ Although there is a provision for public officers or any person appointed by Minister of Environment to enforce the act as inspectors, the powers of the inspectors are also subject to directions issued by the PAAC.⁶⁰ Since its inception, no site has been declared as a formal protected area. The PAAC which has the responsibility of overseeing its implementation have not been formally appointed.

The legislation provides the opportunity for the Tina upper catchment area to be under formal protection. This is a process that has to start sooner rather than later as the issues relating to landownership over the catchment may take sometimes to resolve.

PROVINCIAL GOVERNMENT ACT 1997

The Provincial legislative authority derives from a combination of this Act and the accompanying Devolution Orders. The Devolution Orders enable each province to make legislative power over a range of matters of direct relevance to natural resource management and environment.

Power for making ordinances over wildlife and marine resources is also devolved under the Provincial Government Act 1997. "Provincial legislative authority derives from a combination of the Provincial Government Act 1997 (PGA) and the accompanying devolution orders (PGAs33). Regulatory or executive powers derive from valid provincial ordinances or may be delegated to the province under national statutes, devolution orders, or by negotiation between the province and responsible national authority (s31(1)).

The Devolution Orders made in respect of each province give them legislative competence over a range of matters of direct relevance to natural resource management."

The Provincial Government Act 1997 Schedule 3 provides a list of activities for which the provinces have responsibility and have the power to pass ordinances;

Trade and Industry - Local licensing of professions, trades and businesses, local marketing.

Cultural and Environment Matters - Protection of wild creatures, coastal and lagoon shipping,

Agriculture and Fishing - Protection, improvement and maintenance of fresh-water and reef fisheries.

Land and Land Use - Codification and amendment of existing customary law about land. Registration of customary rights in respect of land including customary fishing rights. Physical planning except within a local planning area

Local Matters - Waste disposal

Rivers and Water - Control and use of river waters, pollution of water,

⁵⁶ *ibid* s16-18.

⁵⁷ *ibid* s 4.

⁵⁸ *ibid* s 5 6.

⁵⁹ *ibid* .

⁶⁰ *ibid* s 20.

Corporate or Statutory Bodies - Establishment of corporate or statutory bodies for provincial services including economic activity. (Provincial services include "Conservation of the Environment" and "Fishing").

The Guadalcanal Province Wildlife Management Area Ordinance 1990 (GPWMAO) applies for the protection of wildlife. This ordinance applies to TRHDP to ensure that wildlife impacts are understood. The ESIA will study freshwater wildlife and biodiversity mitigation measures will sufficiently address the requirements of this ordinance. It also states that Management area may be established where the Guadalcanal Provincial Executive decides that an area requires management to protect, maintain, improve, or propagate any species that the area uses as habitat.

Other requirements also include business license during construction and approval for construction permit of buildings under the provincial planning board.

RIVER WATERS ACT 1964

The objectives of the Act are to provide for the control of river waters and for the equitable and beneficial use thereof. The Act however, only applies to rivers that are specifically designated. The Act devolves all ministerial functions to be exercised by the relevant provincial ministers.⁶¹ The inspector's power however remains with the national (central) Government inspectors. The River Waters Act 1964 clearly stated that it is an offence to interfere with a river except in accordance with the terms and conditions of a permit.⁶²

A permit may be granted for the following operations on a river :

"by means of a ditch, drain, channel, pipe or any other means whatsoever, diverts any water from a river;

fells any tree so that it falls into a river or river bed;

in any manner obstructs or interferes with a river or river bed;

builds any bridge, jetty or landing stage over or beside any river;

damages or interferes with the banks of any river; or

contravenes any order made under section 4 of this Act".⁶³ This means that a permit cannot be issued where a river is declared by order as being protected by the minister.

The legislation is applicable to the following rivers Mataniko River, White River, Mbalisuna River, Ngalibiu River, Lungga River and Mamara River. All these rivers are on Guadalcanal and Ngalibiu is downstream of the Tina river.

The law specifically applies to the section of the river called Ngalibiu referred to as the part of the Ngalimbiu River and the land adjoining within the area edged red on Plan number 2034 held in the office of the Commissioner of Lands, Honiara. The maps currently does not exist in the Commissioner of lands office and thus the requirement for a permit will be sought from the Minister for MMERE before constructions works occur.

The process for applying for a permit is by submitting details of the proposed construction and diversion that will occur including maps of the location in which construction will occur. The conditions for issuing of permit include the studies of the current use of the rivers and the potential impact of the river. Section 7 (2) states that "In granting any permit under this section the Minister shall have regard to the existing use of water and shall safeguard such existing use of water as far as appears to him to be practicable and consistent with the provisions and purposes of this Act". A practical application would be to submit the EIS and proposed development plan for a permit to be issued. The law does not provide for timeframe for the permit to be issued.

⁶¹ *Rivers and Water Act*

⁶² *Ibid.* s 5

⁶³ *Ibid.*

SAFETY AT WORK ACT 1982

The legislation codifies the duties of employers to their employees and others responsible in ensuring the safety of workers in various work environments. In particular safety of workers in dangerous and risky conditions. It provides for the civil and criminal liability of employers who are negligent to the safety of their workers. Part III of the legislation stipulates very specific duties relating to work environment that is dusty, have fumes, pressures and vacuum systems, machinery, electrical installations, fires and explosions, and other hazardous work environment. Part IV provides for the regulation of these conditions and powers given to the commissioner of labor to regulate working conditions, investigate offences and prosecution where there is breach.

Schedule I, II III and IV of the legislation provide for the duties of employers in terms of safety and outlines the expected standards that should be adhered to.

The legislation has a number of subsidiary legislation focusing on very specific areas as follows:

Code of practice for timber scaffolding – this section is for timber process and does not apply to the TRHDP.

Code of practice for flammable and combustible liquids

Safety at work first aid provision regulations – provides basically states that first aid kit should always be provided for labours on site.

Safety at work pesticide regulations.

TOWN AND COUNTRY PLANNING ACT 1980

The *Town and Country Planning Act 1980* provides for the regulation of planning at national and provincial level.⁶⁴ Although it has a national scope, the legislation can only be applied to urban areas. The Act empowered each province to have a town and country planning board.⁶⁵ Their responsibility is to prepare local planning schemes and control development of land within urban areas.⁶⁶ However, the definition of “development” under the legislation excludes agricultural activities, fisheries and forestry.⁶⁷ The Board members are appointed by the Minister⁶⁸ in accordance with the advice of the Provincial Executive. The board is responsible for making decision on certain developments according to local planning schemes for each provincial urban development. The board has no jurisdiction over customary land which is a significant limitation.⁶⁹

In the case of TRHDP, which is located on a customary land, this particular legislation does not apply. Although this could change if the site is to be declared as part of a local planning scheme for urban development.

WILD BIRDS PROTECTION 1914

This Act is repealed by the WildLife Protection and Management Act (Cap 10 of 1998).

WILDLIFE PROTECTION AND MANAGEMENT ACT 1998

The preamble to The Wildlife Protection and Management Act 1998 states that it is "An act to provide for the protection, conservation and management of wildlife in Solomon Islands by regulating the export and import of certain animals and plants; to comply with the obligations imposed upon Solomon Islands under the Convention on International Trade in Endangered Species of Wild Fauna and Flora and for other matters connected therewith or incidental thereto".⁷⁰

⁶⁴ *The Town and Country Planning Act 1979* (Solomon Islands).

⁶⁵ *Ibid.*

⁶⁶ *Ibid.*

⁶⁷ *Ibid.*

⁶⁸ The Act refers to the Minister charged with the responsibility for town and country planning. The relevant minister is the Minister of Finance, National Reform and Planning.

⁶⁹ *Ibid* s 13.

⁷⁰ *The Wildlife Protection and Management Act 1998* (Solomon Islands)

The object of the Act is to regulate the international trade in the country's wildlife resources including birds, reptiles, amphibians, mammals, insects, plants and marine organisms. In order for anyone to be involved in the wildlife trade that individual or organization needs to have an "approved management programme" and have its name entered into a specific "register".⁷¹ In regulating the export or import of plant or animal specimen, the Act prohibits any export or import of plant or animal specimen without the relevant permit. The procedure for application for a permit is set out in the Act. The export of live animals from Solomon Islands is also dealt with in the Act and a separate permit is required. The Director has the discretion to permit the export or import of specimen that is prohibited under the Act in exceptional circumstances. Schedule I lists the species that are prohibited to exports, Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required.

The legislation also has a list of protected species that will require attention if they or their habitat are at risk. These species are identified by the flora and fauna baseline sections.

ENVIRONMENTAL HEALTH ACT 1980

The Minister of Health is responsible for the administration of the environmental health services. The Minister may delegate this administration to the Provincial Government and the Honiara City Council that are designated as Enforcement Authority. There is provision in the Act that if the Enforcement Authorities do not perform their duties under the Act, then the Minister can arrange to have their functions carried out by others, and require the Enforcement Authority to reimburse the Ministry for the cost of doing so. The Enforcement Authority is given power to make its own by-laws under the Act to facilitate the efficient operation of environmental health services. The Enforcement Authority is required by the Act to carry out a program of health education and publicity in accordance with directions given by the Minister.

Environmental Health (Public Health Act 1970) Regulations

The Public Health Act, (No 2 of 1970) was repealed under this regulation. It was contemplated that a new Public Health would be enacted, however this did not happen, resulting in saving some parts of the Act. These regulations consist of Parts III to XII and section 2 of the repealed Act.⁷² These regulations deal with public health issues and how to deal with them when they occur. The regulations empowers the Minister and the Under Secretary of the Ministry of Health and Medical Services to take specific measures to prevent the occurrence of a public health disease or where such disease had already occurred, to take measures to contain and prevent the spread of the disease. The Minister establishes "local authorities" which are the Executive of the Honiara City Council and the Executive of the Provincial Assemblies, plus any others, which can include Area Councils.

The Minister also establishes public health areas. Any such areas can be exempted from some or all of the provisions of the regulations. The duty of every local authority is:

" to take all lawful, necessary, and, under its special circumstances, reasonably practicable measures for preventing the occurrence or dealing with any outbreak or prevalence of any infectious, communicable or preventable disease, to safeguard and promote the public health and to exercise the powers and perform the duties in respect of the regulations..."⁷³

⁷¹ Ibid

⁷² Environment Health Regulations

⁷³ Ibid.

In the case of the TRHDP, the Guadalcanal provincial health authorities has a duty to take necessary and reasonably practicable measures to enforce the law and request that at all time the Project site be in a clean and sanitary condition. When a local authority or health inspector becomes aware of a nuisance (pollution into environment from business activity or development), a notice to remove the nuisance must be served. There is a set procedure where the owner or person causing the nuisance fails to comply with the notice, the local authority or the health inspector shall cause a complaint relating to such nuisance to be made before a court. The court may by summons require that person to appear before it. The regulations spells out the actions that the court may take including the imposing of penalties and fines on the person that fails to comply with any order of the court. The regulations also deal with offensive trades (offensive trades are defined in the Second schedule of the regulations). It is an offence for any person to carry on any offensive trade (business activity that results in pollution into the environment) on any premises without the written consent of the local authority and the Health Director.

SOLOMON ELECTRICITY ACT

The Electricity Act was initially established 1969, and amended several times up to 1988. It establishes the Solomon Islands Electricity Authority ("SIEA") and sets out the overall rules regarding power production and supply. The Electricity Act is a very basic piece of legislation, which does not address issues relating to the power sector in any detail. The main subsidiary legislation on the matter has been drawn up by the Ministry in charge of the sector (currently the MMERE) and is as follows (in descending order of relevance for the Project):

Electricity (Tariff) Regulations;

Electricity (Tariff) (Amendment) Regulation 1999;

Electricity (Tariff) (Automatic Fuel Price Adjustment) Regulations ;

Electricity Regulations (Amendment) Regulation 1997;

Electricity (Exemptions) Order.

The SIEA is generally in charge of all matters related to electricity production and transmission/distribution in the Solomon Islands, including ensuring standards of safety, efficiency and economy. It also advises the Government on matters related to electricity and can make recommendations as to regulatory instruments.

The SIEA is set up as a "body corporate", with independent liability and the capacity to independently enter into contracts. The SIEA consists of a Chairman and four members (which together form its Board), as well as a general manager (acting ex officio). The general manager is appointed by the Authority, while the five members of the Board are all appointed by the Minister in charge of the electricity sector in the Government (the "Minister").

The definitions section of the Electricity Act distinguishes between "private" and "public" electrical installations, as follows:

"private installation" means an installation operated by a licensee or owner solely for the supply of electricity to and use thereof on the licensee's or owner's own property or premises; or, in the case of a consumer taking electricity from a public installation for use only on the property or premises of the licensee or owner;

"public installation" means an installation operated by a licensee for the supply of electricity to any person other than the licensee: provided that the licensee may use electricity for his own purposes where such use is consistent with the terms of the licence.

The Electricity Act sets out in very wide terms the functions and duties of the SIEA in this domain, as follows:

(a) to manage and work any electrical installations transferred to the SIEA by the Government and other installations and apparatus acquired by the SIEA (this mainly relates to the transfer to the SIEA of installations existing at the time the SIEA was established);

- (b) to establish, manage and work such electrical installations as the Minister may from time to time require or as the SIEA may from time to time deem it expedient to establish;
- (c) to secure the supply of electricity at reasonable prices;
- (d) to promote and encourage the generation of electricity with a view to the economic development of Solomon Islands;
- (e) to advise the Minister on all matters relating to the generation, transmission, distribution and use of electricity; and
- (f) to ensure standards of safety, efficiency and economy in respect of the production, transmission, distribution and use of electricity.

In particular, the Act empowers the SIEA to:

- (g) generate, transmit, transform, distribute and sell electricity either in bulk or to individual consumers;
- (h) purchase, construct, reconstruct, maintain and operate supply lines, generating stations, transformer stations and all other appropriate stations, buildings and works;
- (i) sell, hire or otherwise supply electrical plant and electrical fittings and apparatus, and install, repair, maintain or remove any electrical plant, fittings and apparatus;
- (j) acquire any property, real or personal, which the Authority deems necessary or expedient for the purposes of constructing or extending or maintaining any installation or otherwise for carrying out its duties and functions under the provisions of this Act.

GUADALCANAL HISTORIC PLACES ORDINANCE 1985

This Ordinance allows for protection of heritage sites. A heritage place can be declared protected by resolution by the Provincial Assembly. Consent of the representative of landowners is necessary. Prior to an activity, any developer has to undertake a site survey to identify and locate sites of historical, cultural and archeological significance.

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Annex 12: Minutes of Mitigation Workshops

Mitigation Workshop Team

BRLi Team; Eric Deneut, Gerard Fitzgerald, Lawrence Fonoata and Fred Patison
TRHDP Team; Fred Conning and Brally Jim Tavalia

Meeting and Workshops	Comments, issues , concerns and recommendations
03/02/2014	Preparatory Meeting – TRHDP Project Office
<ul style="list-style-type: none"> ▶ A general discussion with the project office of option 7c for the scheme. There is a number of discussion on technical issues related core land and its acquisition. ▶ Discussion was also held on the environmental flow for the section between the Dam and the power station. ▶ There is also a micro-scheme that will be set up for the environmental flow release. ▶ The meeting proper proceeded with Eric going through the power point presentations he prepared. The presentation covered a number of major themes as summary to the mitigation matrix. The focus of the discussion is to improve the presentation and its outline. 	<ul style="list-style-type: none"> ▶ Cultural heritage confidentiality ▶ Emphasis on community service and development ▶ Benefit sharing mechanism is currently being developed ▶ Avoid use of the word royalty ▶ Important that people understand the project, the impact and the measures being proposed.
4/02/2014, 9AM-12PM	Meeting with Tina Hydro Taskforce and PS's
<ul style="list-style-type: none"> ▶ Welcome and introduction by TRHDP Project Manager. ▶ Eric Deneut started presentations on the impacts and mitigation 	<ul style="list-style-type: none"> ▶ Discussions on the environmental flow and further explanation by the project office on the Dam design. ▶ Initial discussion on the fisheries above the dam as result of its development and the need for a fish pass. ▶ Questions were raised on how Fiji addresses the environmental flow and the fish pass. It is clarified that no such environmental consideration for fish pass has been reflected in the Fiji project ESIA ▶ A question was raised on the broader lesson learned from international experience and Asia-pacific region on fish passes. It's being clarified that further studies will be done and reflected in the ESIA report. ▶ It is being raised that specific species should be targeted to ensure that there is clear information on the species affected by the development. ▶ Clarification was being sought if non-native species of fish will be introduced and if so what kind of species. It is being clarified that this will not occur.

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> ▶ A question was raised if the fishery on the river is of economic scale. It is clarified that this not economical and also not significant for domestic use either. ▶ A question was raised on the impacts of gravel extraction downstream. It is clarified that no clear information exists on the status of gravel but there won't be any significant impact at least for another 50 years (short term). There is a need for more information on the deposition rate of the gravel for the whole river system. ▶ A concern was raised on the impact of population increase due to the development. This is in relation to the squatters and settlements. This will be further discussed. ▶ A concern was raised on the potential impact on floods during heavy rain falls. This was clarified by the BRL team. ▶ A concern was raised on the potential for labor camps being created. It is clarified that all external labors will be housed in Honiara and that on site accommodation not an option at this stage. ▶ A question was raised on the waste management issues for the project and a landfill site. This will be further explored by BRL. ▶ Another concern was raised on the health risks from water borne diseases considering the fact that the site is a hot spot for Malaria. This needs to be reflected in the ESIA. It is further stated that the whole of Guadalcanal plains will be affected by the risk of water diseases due to a large body of stagnant water inland. ▶ A concern was raised on the measures that are put in place as mitigation actions. The mitigation actions recommended needs to get the consent of local communities. The communities also need to be comfortable with the any proposed mitigation actions. ▶ The issues of security for the communities from intruders will need to be fully considered in the ESIA. ▶ A question was raised if the definition of impacts also includes those of the transmission lines. ▶ A question was raised on who will be responsible financially for the proposed mitigation actions. The important question is whether it is the SIG or the project investor. This was clarified by the Tina hydro project manager. ▶ A further clarification was sought if the assessments also include impacts of transmission line development. It's being clarified that the lines are included. ▶ A question was asked on the nature of the road access to the project site and current plans are for its development. Clarification was made that discussion are underway on the development of the road access. Further discussions were made on who owns the road, who will meet the cost of its development and also the expected nature of the development.

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> ▶ A concern was raised on how the ESIA process is informed by the Land Identification process, the benefit sharing mechanisms and the grievance mechanism. ▶ A final comment was made on the need for the work currently being done by the project office to be reflected in the ESIA process.
4/02/2014, 2PM-4PM	Government officials, NGOs and private sector
<ul style="list-style-type: none"> ▶ Welcome and Introduction of the project by the TRHDP Project Manager. ▶ The presentation of impacts and mitigation matrix by Eric Deneut. 	<ul style="list-style-type: none"> ▶ A question was raised on the impact of the dam on sediment deposit for downstream agricultural activities. ▶ The issue of water temperature is also being raised in relation to impacts on the biota within the river system ▶ A question was also raised on dissolved oxygen change due to the Dam. ▶ The impacts of vegetation on the reservoir will need to be investigated especially for biomass decomposition in the reservoir. ▶ The need to have in place the institutional arrangements for the river monitoring regime. ▶ A concern was made on the giant African snail and other invasive species. The BRL team stated that this will be dealt with in the report. ▶ The issue of giant African snail management after construction is being raised. A question if there is a map of the distribution of the snail. ▶ A question was raised on the rubber plant as an invasive and how the dam construction can exacerbate invasive species. ▶ It is stated that the Giant African snail is a French delicacy and should be considered as a management option. ▶ The risk of social upheaval in context of a post-conflict situation specific to the site is raised as a concern. ▶ A question was raised in relation to issues related to education and its importance. This was being clarified by the TRHDP project manager. A comment was raised on the need for education schemes to be done after a proper assessment is being done. ▶ A comment was made on the need for a comprehensive process of empowerment for leadership and also mechanism that facilitate community development activities. In particular the issue of trusteeship needs to be carefully navigated with agreements that will be negotiated and formulated. The cash hand out is an example of a very poor means of benefit. ▶ Project office made a clarification that mechanism currently being developed for education as a package of the benefit distribution system. ▶ It is further stated that the lessons from the global experience is that, cash hand out do not work and involvement of women in the consultation and engagement processes is critical.

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> ▶ A question was raised on seismic consideration in the feasibility studies. It is clarified that it is part of the geological studies. ▶ A comment was made on the need to ensure that grievance mechanism includes local communities in the implementation framework. ▶ A question was raised If there will be an emergency plan in the case of dam failure. It is clarified this is a standard operation procedure for Dams. ▶ A question was raised on the issue of social inconvenience usually raised by the project affected communities. This needs to be captured in the ESIA as it will certainly become part of future demands. Further concern was raised on the needs for caution on the kind language being used as well. ▶ A question was raised on the mechanism for cultural heritage and tabu site recording for the ESIA. ▶ Comments that for Gold Ridge, all taboo sites are being recorded and mapped by the national museum. This is something that can be replicated by the TRHDP. ▶ A question on the percentage of women being consulted out of the 500 people being met. There is a need to rethink of having women as focus group and thus there is a need for change on what issues are being discussed within the context of women's group. It is important that they are being consulted on major key issues as well. ▶ Gender is an important issue for the WB and therefore it is important that how they are being consulted is being documented. ▶ A comment was made on the fact that the project should not be a proxy government – it has to make the government see the need for things to happen.
05/02/2014, 3-6PM	Tina Village – Bahomea
<ul style="list-style-type: none"> ▶ Opening statement and Welcome by Brally from the project office ▶ Eric Deneut introduced the BRL team and started with presentation. Mr. Lawrence F. provided interpretation in pidjin with Mr. Fred P taking the minutes. ▶ At the end of the meeting a representative of the Tina and nearby communities presented 10 benefits that should part of any agreement negotiated with landowners and communities in the project affected area. The request are as follows; 	<ul style="list-style-type: none"> ▶ On the issues of alternative water supply there is a need for a committee to be established by the communities and the TRHDP to focus on water related issues. ▶ The water will be subject to construction and therefore there is potential for spillage from the heavy machines being used. Thus it is recommended that all villages downstream close to river including Tina village to be relocated to a new site. This new site should have access to clean water supply. ▶ A comment was made on the fact that women are dependent on river for daily subsistence activities. Therefore before any construction start the supply of alternative water sources is a pre-requisite. ▶ A question was raised on the actual timeframe on what exactly will happen for the project and the ESIA studies. ▶ A suggestion was made for the Solomon Island Government to establish a police post within the project area to help provide security.

Meeting and Workshops	Comments, issues , concerns and recommendations
<ul style="list-style-type: none"> • All affected communities to have access to free electricity • Water supply and alternative water sources to be installed before any construction start. • All access roads including those going to communities to be sealed. • A mini-hospital to be build within the project affected area (not clinic). • Communities near the river including Tina village to be relocated to a new site. • Scholarship scheme for all Bahomea communities • A representative body established to include current settlers • Rate School to be upgraded to Form 1-7 levels • A transport scheme to be established for land owners and project affected communities. 	<ul style="list-style-type: none"> ▶ A recommendation was made for the road that will be constructed to be sealed and four layered. This to ensure that it is not like the roads in Honiara which are easily damaged after heavy rain. ▶ On the issues recruitment of local workers, the suggested mitigation to have all recruitment in Honiara is not helpful to local workers. Therefore a recruitment office for all local workers must be established on site. ▶ A concern was raised on the risk of dam failure and therefore to avoid the risk relocation is best option that should be considered for the community of Tina village. ▶ A concern by women is that during the consultations, relocation is an issue that they have raised (option they would support) but was not reflected in the mitigation measure being proposed. ▶ A comment was made requesting that examples of dams that have failed to be presented to the community. This is because they are not convinced the dam will not fail as this cannot be fully guaranteed. ▶ A recommendation was therefore made that the Dam and Safety Panel visit the communities to further explain safety related issues. ▶ A recommendation was made that despite of the dam being safe they would like to be relocated to a new site to avoid any form of fear and risk. ▶ A request was made for copies of presentation by BRL to be provided. ▶ A request was made for a timetable of when agreements will be signed. ▶ A question was raised concerning why the landowner's council established is not functioning and not supported by the project office. Further clarification was sought as whether the landowner council will be re-established. ▶ A concern was made on the removal of taboo sites as it is culturally insensitive. ▶ The impact on current social structure of communities such as the church, women, youths and children needs to be reflected in the report. ▶ A concern was raised on the need to do awareness on the impacts of the project on their culture. In particular, it should focus on all the aspects of modernity and foreign cultures. ▶ A concern was raised on the need to rehabilitate youths who are affected by the recent civil unrest and also those involved in other anti-social behaviors'.
06/02/2014, 9-12 PM	Belaha Relocation School
<ul style="list-style-type: none"> ▶ Welcome and Introduction by Bally from the TRHDP office. 	<ul style="list-style-type: none"> ▶ A question was raised on the environmental flow and how it will be managed. The concern is related to fish and the ecology between the dam and the power station.

Meeting and Workshops	Comments, issues , concerns and recommendations
<ul style="list-style-type: none"> ▶ The presentation was made by Eric Deneut of BRL with interpretation by Lawrence and minutes taken by Fred Patison. ▶ Final Remarks at end of presentation; ▶ A general comment was made concerning the process in which the ESIA is being conducted. In particular where experts who understand the expected impacts and also solutions are continuously asking the community for solutions. The view shared was that the Solomon Islands Government and those participating in the ESIA process provide the environment and social solutions as experts. It is further stated that consideration to communities should focus on economic benefits and livelihood alternatives and for the people of Bahomea it is Cocoa farming. The Government should think seriously about enhancing Cocoa farmers' livelihood in the area. It is stressed that education is the key issues for many people on Guadalcanal and that investment and support should focus on community empowerment. 	<ul style="list-style-type: none"> ▶ A comment was made that fish will not actually be depleted but rather adapt and increase in numbers. This will need to be further studied. ▶ A comment was made of the need for a full comprehensive study of the cultural heritage sites. This will include their location, description and if they are going to be threatened as result of the development. ▶ A recommendation for alternative protein sources needs to be provided as an option for the communities. ▶ A concern was raise from the previous experience that explosions from dynamite may result in the death of fish in the river. This is in reference to the construction of the Dam and the tunnel. ▶ A question was raised whether consideration will also be given to the Belaha communities in terms of employment at the project site. ▶ A recommendation was made for consideration to fish farms as an alternative. ▶ A question was raised whether the people of Bahomea will have access to free power.
06/02/2014, 1-5PM	Malango – Mataruka, Job Varie's Residence
<ul style="list-style-type: none"> ▶ Welcome and Introduction by Brally from the TRHDP office. ▶ The presentation was made by Eric Deneut of BRL with interpretation by Lawrence and minutes taken by Fred Patison. ▶ Final Remarks at end of presentation were made purposely for the project office World Bank Representatives. 	<ul style="list-style-type: none"> ▶ A comment was made that there will be fish in the upstream of the Dam which will survive through adaptations and therefore the fish issues is not necessarily a serious issue. Further explanation was made by the BRL team on the migratory nature of the fish species studied at the river. ▶ A comment was made of the need for clear and precise example of the kind of fish pass that will be proposed for the Dam. ▶ A concern was raised on the oxygen level in the dam which will affect the biodiversity of the river in the Dam. This will need further clarification as to how this will be mitigated.

Meeting and Workshops	Comments, issues , concerns and recommendations
<p>▶ There is considerable concern on the manner in which the project is currently being implemented. The communities of both Bahomea and Malango have established the landowner's council as a representative body for all the tribes within the project affected area. This body although still exist is no longer recognized by the Government and the project office. Instead certain individuals were courted by the project office and excluded the representative of Malango. Whilst it is a fact we will not be directly affected by the project as communities we will be affected as primary landowners as we are members of tribes that are within Bahomea and the project affected area. Our recommendation is that the land owners' council be re-established as the representative body of landowning groups. We are aware of the fact that other groups such as women, youths and settler's needs representation and that will have to be facilitated as well. This should be reflected in the review of the TOR for the LOC before its re-establishment.</p>	<ul style="list-style-type: none"> ▶ A concern was raised on the removal of vegetation on the fringes of the lake and those that will be covered by the Dam. How will the mitigation measures address biomass decomposing in the lake which may affect the river systems for the first period of operation? ▶ The use of traditional knowledge and practice for the project site including the river needs to be documented and be reflected in the ESIA report. ▶ A question was raised in relation to the Monasavu Dam in Fiji. It has been observed that water quality remains very poor despite being operational for more than 20 years. The hydro dam was built in 1982 and the water quality remains very poor. The question is whether this dam will be the same? ▶ A question was raised with the people of Choro, Korepa and Senge will be relocated. ▶ A comment was made outlining the fact that the people of Bahomea and Malango actually came from same tribes that own land at the project site. Therefore equal involvement must be fully realized in order for the project to proceed successfully. ▶ A question was raised whether land acquisition will be made before the development. It is clarified that indeed that will have to occur. ▶ There are concerns that road access development also affected and therefore studies must be done to verify this. ▶ A concern was raised on ground water contamination from surface development activities. Also of concern is the surface run- off, the impacts on water bodies and other water tributaries. ▶ A major issue of concern is the Dam safety and associated risks. ▶ The guarantee of communities and landowners being given priority to work during the hydro development is a major concern. The experiences in the past have shown that this has not happen effectively. ▶ A woman expressed gratefulness that BRL presented the environment and social impacts of the project. The only concern is the need for alternative water supply to be provided for the communities in the project affected area. ▶ A recommendation was made that the Solomon Islands government seriously consider enacting an act of parliament to protect the interest of both the landowners and the project operator. This is in particular reference to the agreements made between landowners of the gold ridge mining area in which all agreements signed are not upheld by successive companies and the Government. The concern is that an Act of parliament will ensure that all parties are protected legally but also obligated legally. ▶ A question and concern was raised on how taboo sites in the middle of the river are going to be preserved.

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> ▶ A recommendation was made for a SWAT analysis to be done for all proposed impacts and mitigation measures. ▶ A recommendation was made that all taboo site destroyed be compensated by the developer or the Solomon Islands Government.
08/02/2014, 9-12PM	GPPOL 1 HALL – Downstream Ngalibiu communities
<ul style="list-style-type: none"> ▶ Welcome and Introduction by Brally and Fred Conning from the TRHDP office. ▶ The presentation was made by Eric Deneut of BRL with interpretation by Lawrence and minutes taken by Fred Patison. 	<ul style="list-style-type: none"> ▶ On the discussion on water quality monitoring and freshwater species studies. The downstream communities are concerned that the data collected is not independent and therefore it would be good if independent consultants representing downstream communities can be engaged. ▶ There is a need for the Ghaobata house of chief to be consulted in order for them to make their recommendations. In the regard it would be appropriate if a traditional ceremony (Chubu) be organized. ▶ There is concern that the project office have not been able to facilitate some of the request made by the Ghaobata house of Chiefs. ▶ A concern was raised on the safety of Dam and if it will stand cyclones and other severe weather conditions. This was clarified by the BRL team and also the project office. ▶ The downstream communities would like assistance to organize and undertake comprehensive awareness activities on the proposed project. ▶ A question was raised as whether the alternative water sources recommended would also include downstream communities. It is clarified that this will be part of the benefit sharing mechanism. ▶ A question was raised on the different fish species that are being studied. ▶ A concern was raised if chemicals such as lubricants will be used during operation for the generators. ▶ There is concern that gravel supply will be affected due to the Dam and also that the quality of gravel will be affected by siltation during construction. This will need further investigations. ▶ A concern was raised that fisheries will be affected due to the change in environment as result of the development. It is clarified that this has been considered and the option of a fish pass is being explored. ▶ A comment was made that the concerns of PE holders along the Ngalibiu river needs to be taken independently ▶ A question was raised on how long it will take for the Dam to be filled after construction. ▶ A request was made for representatives of landowners to attend a study tour of the similar projects. ▶ One of the concerns raised was the frequent change of PS and Minister within the Government which huge impediment to continuity in addressing outstanding issues.

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> ▶ A recommendation for was made for an “environment bond” to made in advance to a neutral account. This will only be accessed if there is an environment disaster. ▶ A question was raised if climate change factors are being considered in the studies of the ESIA. ▶ A concern was raised by a women representative on the need for alternative water sources to be provided. ▶ There are concerns that similar experience with Gold Ridge will occur especially with the SIG not fulfilling their commitments. ▶ A recommendation was made for a representative body other than the Ghaobata house of Chiefs that represent the interest of women groups, youth and children.
08/02/2014, 1:30pm – 5pm	Rate School – Bahomea
<ul style="list-style-type: none"> ▶ Welcome and Introduction by Brally and Fred Conning from the TRHDP office. ▶ A formal welcome and remarks was made by the Paramount Chief of Bahomea. ▶ The presentation was made by Eric Deneut of BRL with interpretation by Lawrence and minutes taken by Fred Patison. 	<ul style="list-style-type: none"> ▶ A recommendation was made on the need for an eco-tourism initiative to be part of the benefit package. ▶ A recommendation was made for the road access not to be acquired by the government or declared as a public road for access. This is to ensure that control of the road is managed by community to reduce any influx of settlers. Instead of declaring the road a public access road, the Bahomea house chief or a governing body should be establish to manage the access road. ▶ A recommendation was made for a gate to be established at the entrance of the project area and managed by both the company and landowners. ▶ A comment was made that the biggest threat to the project is the people and communities within the project area. They are the ones that invite settlers and intruders into the community and also are involved in illegal sale of land to those outside of the project area. ▶ A recommendation was made of the need to involve communities in landuse planning meetings and workshop in anticipation of the hydropower development. This should also involve the house of chiefs. ▶ The Bohomea house of chief capacity should be enhanced and supported so that they can support the project in planning and development phase. ▶ A recommendation was made that all access roads should sealed. ▶ A question was raised on the how many species of fish will be affected. A discussion was then made with photo of fish species observed being shown and local names were given to each of the species. Local communities have presented to the ESIA team the species that they would like to continue fishing upstream from the dam, as many villagers go to the upper catchment to fish for traditional events (the “upper catchment sampling area” as presented in the baseline is a fishing spots). Here are the results of communities opinion:

Meeting and Workshops	Comments, issues , concerns and recommendations
	<ul style="list-style-type: none"> • Gobiidae / Sicydiinae = Savutu et Vosu (in local language) • Eels = Mauvo (in local language) • Silver fish = Lae or Helu (in local language) <p>▶ A concern was raised on the voltage that the transmission line from the power house will carry towards Honiara. Further comments was made on the risk from vehicles accidently hitting the grid post as they are located along the access road. The suggestion was for alternative routes for the transmission lines to reduce the risk of being hit by vehicles and vandalism.</p> <p>▶ A question was raised on how wide the road will be and the potential impact on vegetation. The concern is the impact on medicinal plants and other use plant species.</p> <p>▶ It was recommended that the value of any medicinal plant and animal species within the road access area should be valued on monetary terms by local experts from the community.</p> <p>▶ A request was made of a clear timeframe be in place for activities that will be undertaken from now until the completion of the Dam. This is to ensure that the communities are prepared and that implementation of the mitigation measures is being monitored.</p> <p>▶ A comment was made regarding the need to address the economic issues related to the project. It was clarified that the benefit sharing workshops will also be part of the process.</p> <p>▶ A concern was again raised concerning the safety of dam and potential risk it poses.</p> <p>▶ A concern was raised on the fact that current laws and regulations for the environment and management of the project are very weak and not being effectively enforced. Therefore there is a need for the enactment of a law that specifically focuses on the Tina Hydro Project. The enactment of the Act would also mean that the hydropower company or government can be held accountable for environment damages. This also means that all negotiations on benefits will be made under the framework of the proposed Act.</p> <p>▶ A recommendation was made that all cultural heritage sites be compensated by monetary means if they are being disturbed or removed.</p>

Annex 13 : List of participants to the Mitigation Workshops

Feb 4th 2014, Heritage park, Ministries and Task force

Name	Organisation	Title	Email contact
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Feb 4th 2014, Heritage park, NGOs

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Feb 6th 2014, Ado

List of female participants		List of male participants	
1.	Lucia Jorrick	1.	John Batisi
2.	Anna Cheka	2.	Francis Maesi
3.	Pile	3.	Thomas Tona
4.	Anna Javen	4.	Fred Lani
5.	Vecho	5.	Kuki
6.	Bere	6.	Simon R
7.	Ellen	7.	Romando
8.	Uliana	8.	Kasiano
9.	Rita	9.	Peter Togovi
10.	Patricia E	10.	Samuel Sapu
11.	Salome Otary	11.	Jimmy P
12.	Jonita	12.	Morris Susa
13.	Hilda	13.	Devis D
14.	Odilia	14.	Leonsio
15.	Monica	15.	Philip Veke
16.	Sharon	16.	Peter Tanda
17.	Teresa	17.	Christopher L
18.	Esther	18.	Paul Bale
19.	Lydia	19.	George Dick
20.	Sololia	20.	Cypriano Vola
21.	Malina	21.	Peter Lale
22.	Francina	22.	Manuel
23.	Placinda	23.	Jovino
		24.	Jeffery
		25.	Kerry
		26.	Eddie
		27.	Robert Totolo
		28.	Mark Chuba
		29.	Grey
		30.	James
		31.	Makario Kulo
		32.	Anorld
		33.	Grey Bobo
		34.	Chris Sio
		35.	Peter Siosi
		36.	Bartholomew
		37.	Mevin

Feb 6th 2014, Mataruka

List of female participants	List of male participants
1. Vuvusi Patson	1. Mislam Soma
2. Mede Nesa	2. Justus Deni
3. Emu Amos	3. Thomas McKenzie
4. Abigail Job	4. Herman Pilo
5. Helen Clyde	5. Gerry Masedi
6. Eta	6. Erastus Kokoi
7. Enini Oko	7. Jethro Omi
8. Victoria Vare	8. Clodius rima
9. Cavu Pilosi	9. Lauvisu
10. Anita Riu	10. Urias Senge
11. Sepa Toni	11. Zibu Regeni
12. Vaelyn Timo	12. Job Vari
13. Sovea Toni	13. Jesmel Kesi
14. Selele Urias	14. Nelson Kepulu
15. Laga	15. Ashley Pengua
16. Jand O'so	16. Stephen Chiria
17. Rita Sae	17. Gigiano Lou
18. Ren Jeremiah	18. Michael Igi
19. Noela Gigiano	19. Jotham Kati
20. Bethy Jack	20. Genesis Oota
21. Joy Kiseni	21. Timothy Launi
22. Genda Riu	22. Nathaniel Obe
23. Sandra Obe	23. Malachi Rubo
24. Petrina Pilosi	24. Michael West
25. Beresia Jame	25. James Peku
26. Jocabeth Sammy	26. Clyde Maeni
27. Melda Steve	27. Aaron Hotai
28. Julan	28. Brian Lugu
29. Eileen Andrew	29. Japhet Racha
30. Pretty Lovo	30. John Adam
31. Mena Palo	31. Geoffrey Mak
32. Leanne Toki	32. Ziarah Geoffrey
33. Sophia Job	33. Peter Mover
34. Irene Hendry	34. Isaac Suhara
35. Elsie Wovick	35. Isaac Launigo
36. Elisah Lau	36. James Taniha
37. Fancy Liong	37. Josiah Frank
38. Aroma Clyde	38. Paul Branco
39. Mechol Warick	39. Kalona
40. Delilah Oko	40. William Manila
41. Ridah	41. Willy Taluga
42. Doris Asen	42. Amos Palo
43. Agaphe Amusiah	43. Jeremiah Matebasia
44. Teslin Julas	44. Juras Lobi
45. Joan Michael	45. Patson Kekegolo
46. Mercy Kila	46. Mangi Oro
47. Judith Raes	47. Philemon Mostyn
48. Gillian Obe	48. Dudley Pilo
49. Grace Teke	49. Bonny Saini
50. Janet Oota	50. Hagah Pilo
51. Charity Adam	51. Norman Amos
52. Lila Jeri	52. Asen Loni
53. Prudence Likona	53. Bredly Sade
	54. Elitoh Sae
	55. Lloyd Clyde
	56. Howard
	57. Wheatley Maeni
	58. Wigan Palo

List of female participants	List of male participants
	59. Zachariah Mete
	60. Vicky Toni
	61. Nicky Moni
	62. Billy Maesedi
	63. Gabriel
	64. Ben Ege
	65. Obed Ochele
	66. Steve Gauna
	67. Jordan Para

Feb 8th 2014, GPPOL community building

List of female and male participants	
1. Margaret Rava	38. Mose Karuku
2. Frances Bosauni	39. Isaac Gagau
3. Edlyn Lipa	40. John Nawei
4. Alifox Ulu	41. Allen Kigota
5. Baddley Lagatia	42. Leon Thugea
6. Coelins Sau	43. Samuel Bosawai
7. Henry Hinui	44. William Utuzia
8. Alfred Tora	45. Benedict Garimane
9. Floyed Talu	46. Stephen Oma
10. Andrew	47. Danny Nunuvia
11. Fredrick Manengelea	48. Frances Thugea
12. Miriam Vokia	49. Jacob Vuza
13. Brandie Tavake	50. Seai Keta
14. Pete Steve	51. Paul Vogithie
15. Philip Garimane	52. Dudley Gani
16. Charles Bunia	53. Philip Gusto
17. John Salo	54. Timothy Urobo
18. Patterson Ngelea	55. Stephen Luke
19. Michael kori	56. Jimmy Nollas
20. Pete	57. John Nunuvia
21. Simon Lumasa	58. John Kulu
22. Mattew Mole	59. Jude Kekea
23. Edmondson Tavea	60. Allen Tanasia
24. Peter Kakava	61. Ben Pilopuso
25. Daniel Poru	62. Steven Komopper
26. James Tiva	63. Joshua Halu
27. John Seketala	64. Silas Pirona
28. Nelson Matai	65. Nicholas Mekai
29. John Billy	66. Hoe Nanata
30. James Pogula	67. Martha Bako
31. Frames Garimane	68. Halida Tabala
32. Alfred Lova	69. Annie Leana
33. Selwyn Kulzar	70. Gwyneth Sekani
34. Joseph Kukale	71. Michael Su8klu
35. Miriam Kukale	72. Tome Koetevo
36. John Nemei	73. Charles Kakamo
37. Erick Ata	74. Nelson Ratu

Feb 8th 2014, Rate school

List of female and male participants	
1. Denson Dii	16. Alen kula
2. David Tabea	17. Michael Laosa
3. Peter Rocky	18. Enoch Mark

List of female and male participants

- | | |
|-------------------|-------------------------|
| 4. Michael Litani | 19. Asaraiah Sakeni |
| 5. Robert Para | 20. Rickson (Principal) |
| 6. Ovea Piuna | 21. Kathy Rickson |
| 7. Gravis Gesi | 22. Para Byce |
| 8. Chuba Garusi | 23. Luisa Mada |
| 9. Josiah Gesi | 24. Alick Lua |
| 10. Qurusu | 25. Selly Meki |
| 11. Gilbert Avoli | 26. FRed Tani |
| 12. Alfred Bua | 27. Sam Gasmate |
| 13. Muni Kau | 28. Yanny |
| 14. Sosimo Kapini | 29. Kevin |
| 15. Dipson Meki | 30. Paul Heti |

**Annex 14: Summary of community and
landowner engagement and
communication activities undertaken
by the Project Office**

REPORT FOR ALL COMMUNITY AND LANDOWNER CONSULTATIONS WITHIN BAHOMEA, MALANGO AND GHAOBATA CARRIED OUT BY THE TINA RIVER HYDRO DEVELOPMENT PROJECT FROM 2011 - 2016

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
1	2011: Overall Picture of Tina River Hydro	April	13 th - Women's 1-day workshop	Guadalcanal Women's Resource Centre	34	Benefits from the Hydro must be different from Gold Ridge	Women views on benefits
2		August :	18 th - CLA induction workshop	PO conference room	10	Introduced to the project and what it is	Introduction to work in the communities
3-14		Sept	14 th : 1 st awareness about the project in Bahomea and Malango	19 th : Namopila, 20 th : Verakuji 14 th :Marava 15 th : Tina 15 th : Vuramali Pamphylia Namoraoni 26 th : Mataruka 27 th : Belaha 26 th : Chichinge	35 73 20 33 53 34 50 64 75 55	Informed, updated, educated	Overall picture of the Project – history, rationale, ESIA, Benefits, timeline, Processes. Distributed copies of Tina Hydro booklet

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
15		October	4 th – quick meeting at Marava re drilling at Senge with Charana tribe members	Senge, Koropa, Choro	7	Voiced their views	Community views on the hydro being in their area
16			5 th – a follow up on the previous updates - Charana	Marava Hall	7	Informed/updated	Sort out details of drilling
17			6/7 th – Debriefing on major awareness - Charana	Marava Hall	5	Informed/updated	Evaluate the major awareness in Sept for Lessons Learnt
18			10 th – presented report of awareness to members of the LOC	Flamingo, Honiara Hotel	27	Update LOC members	Give a general idea about the first awareness To see how they feel Option 6e
19			10 th – Interviews with Senge Community leaders 12 th – Helicopter flies drilling gear into Senge	Various Homes	7	Get their views on record Start of drilling works	Asked about their views, where to move to if project was to be established

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
20			21 st : Drunken Roha men disturbed the drilling works	Riverbed drilling	Less than 10	Drilling stopped 2 days	Disagreed about the drilling, claiming they were the owners of the area
21			24 th – Reconciliation meeting, Roha and Charana	PO	11	Sorted out differences in peace	Drilling concerns between tribes reconciled
22		November	21 st : Briefing for G Province Executive	Burns Creek Hall	20+	Informed/updated	1 st briefing for G Province Exec
23			26 th 27 th :2 nd Benefits Workshop 1 st group	Rate Primary/High School	132	Communities updated/informed	Get views of all communities on whether or not the project should continue/benefits/carbon credits/benefits from conservation. All members signed to say the project should go ahead.
24			28 th 29 th :2 nd Benefits Workshop 2 nd group on same presentation	Rate Primary/High School	100+	Communities updated/informed	
25		December	4 th : Taskforce meeting	Kitano/Mendana	10+	Informed/updated	Briefed them about drilling

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
26			5 -8 th : 2 nd Phase Workshop	Kitano/Mendana	100+	Updated/informed	Inform landowners/stakeholders about the feasibility studies carried out in Oct/Nov
27	2012:	January:	25 th : Meeting with Downstream reps	COM church leaf hut, Ngalimbiu	20+	Updated/educated	First contact with downstream communities
28	.Extend to Downstream communities Geotech Studies Safeguards Team Visit Feasibility Studies		31 st :1 st awareness for Ghaobata communities	Guadalcanal Plains Plantations Ltd, GPPOL 1 Hall	100+	Communities updated/educated/aware	General picture of the Hydro Project , History, Location, Pre=feasibility studies, ESIA

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
29	SEP/Updates of progress	February:	1 st : SEP Consultations	Ado village	25	Discussed/agreed	Updates
30			2 nd : Collected and drew up a list of all tribes in the community	PO	10	Helpful for references	
31			3 rd : conducted awareness at Chichinge about an SEP for the Project	Chichinge	36	Most wanted more regular updates	Allow community put in ideas, if any
32			5 th : Drove Jean Williams into communities for assessment for her report	Bahomea Road	3	Seen/collected info	Consultant on Social and Resettlement Framework Plan
33			7 th : Developed list of downstream communities	PO	10	For records/information	

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
40			23 rd : Updates	Tina	72	Informed/updated	Same as above
41			24 th : Updates	Kairos Conf Centre	13	Discussed/updated	Clarified misunderstanding about launching the project downstream
42			27 th : Updates	Mataruka meeting hut	70+	“ “	“ “
43			28 th : Updates	Chichinge	45	“ “	“ “
44			29 th : Updates	Volovua	80	“ “	“ “
45		March:	8 th : Joint meeting between GHOC/Downstream CLAs	Compass Lounge, Honiara Hotel	13	Issues clarified/understood	Help chiefs and CLA understand issues and pass them on to their communities afterwards.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
46			10 th : Malango House of Chiefs Discuss land Id	Grassland	More than 10	Agreed on 7 criteria for land id process	MHOC and BHOC met separately to agree on the 7
47			19 th : Horohotu pilots Focus Group/mapping	Horohotu	9 men, 13 females	Empowered, learned new way of identifying issues	criteria for primary owners, 4 for land users Trial was held after a three-day training on Focus Group Discussions
48		April	9 th : Updates	Komuporo	100+	Informed/updated	General updates on latest progress of the project
49			19 th : Updates	Antioch	-20	Updated/informed	Land id, 3 rd feasibility study, ESIA studies, government support continues in classroom project, call for cooperation from communities; focus of awareness in Bahomea; benefit expert to arrive in the year
50		May	1 st : 1 st Updates for Katihana village	Katihana village	15	Updated/informed	Land Id, ESIA, Feasibility studies expected within the month; water supply, road improvement, school support through whole of govt support

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
51			7 th : 1 st update for Namanu Settlement village	Namanu School	30+	“	“ “
52			8 th : update for Namopila	Namopila church	-20	“	“ “
53			9 th : update for New Koleula Settlement	New Koleula village	20+	“	“ “
54			23 rd : Meeting with landowners to discuss land concerns	PO	15	Discussed/agreed	A group of LOs led by Chris Tabea visited the office to discuss land ID process
55			25 th : 1 st Benefits Workshop	Flamingo, Honiara Hotel	80+	Discussed/updated	General workshop on potential benefits for landowners and landowners given opportunity to indicate their top priorities

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
56			25 th : Land acquisition meeting with downstream CLAs	Papangu village, GPOOL 1	10	Discussed/updated	Explained what the issues were, how to go about acquiring for the power lines, who to sign.
57			29 th : Briefing for members of the Solomon Islands Chamber of Commerce and Industries, CC&I	Kitano/Mendana	100+	Briefed/updated	General info/updates about the project
58		June	5 th : Updates at Marava	Marava Hall	15	Informed/updated	PO to upgrade road from Marava to Managi; WB experts to visit Dam Site ;geological mapping to start in July; conduct geotech works in Aug; drilling in Sept
			6 th : Update for Antioch	Extension of Rate space	20+	Informed/updated	“ “
59			10 th : update for Managi	Managi	25	Informed/updated	“ “
			17 th : PO reps meet with Rocky/Litani about BLIC process	Sea King Restaurant	7	Briefed/informed	1 st briefing for PO staff about the progress of the BLIC Process
60			25 th : CLA assisted PO reps to map out communities on Google Earth	PO	12	Mapped all communities	The mapping was to help the PO develop an animated tour starting from the Airport to Blackpost going inland to all communities ending up at the dam site
61							

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
62							
63		July	30 th : Awareness	Burns Creek Hall		Briefed, updated	General presentation for the executive members of the G Province – 1 st one
64		August	13 th : updates for Verakuji	Managikiki	More than 20	Updated, aware	Informed about a Safeguards team to visit later in the Month
65			21 st : Safeguards Team visits	Namopila	Less than 30 men, women and children	Discussed, updated, aware	Visit followed team's flying to proposed dam area then discussions about their trip
66			21 st : Safeguards Team Visit	Antioch	40+	Discussed, updated, aware	"
67			21 st : Safeguards Team Visit	Marava	-20	"	"
68			21 st : Safeguards Team Visit	Tina	80+	"	"

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
69							
70			22 nd : Safeguards Team Visit	Belaha	70+	“	“ “
71			23 rd : Safeguards Team Visit	Mataruka 1	150+ (Chiefs 28; women 45;	“ “	“ “
			23 rd : Safeguards Team Visit	Vuramali	56	“ “	“ “
72		September	4 th : Driller meets Charana	Marava Hall	7	Briefing/update	First consultation about drilling on 6e
73			17 th : Land meeting	Saba village, Ngalibiu	8	Negotiation progressed	Consultation was led by acquisition Officer Jerry Tanito
74			20 th : Verakuji updates	Managikiki	73	Updated, aware	Updates on progress of project activities
75			27 th : CLA Training	PO	11	Informed/educated	Training was on Geospatial * Social mapping using Google earth to map out the different communities of Bahomea and Malango

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
76		October	8 TH : Helicopter flies equipment in	Chaunahue	3	Site ready for drilling	The first day in the geotech studies for option 6e.
77			9 th – 2 nd visit to see drilling	1 st hole on river bed	10	Started	1 st hole drilled on the riverbed.
78			15 th : another visit to see the drilling	Chaunahue riverbed		Drilling progressed	2 nd drill on the river bed; visited and interviewed residents of Senge, Koropa, Choro
79		November	22 nd & 23 rd : LOC Members extended Access Agreement	Kitano/Mendana	27	Discussed/agreed/signed	Discussion on extension to access agreement
80		December	16 th : first workshop on benefits	Flamingo, Honiara	60 (LOC, HOC, elite LOs, Women and youth)	Exchanged ideas on benefits	Discussion of landowner benefits

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
8`	2013: Land Id, Land Acquisit ion, Proces s Agreem ent	January	25 th : Updates for Tina Village	Tina meeting venue	30+	Informed/Updated	
82		February	8 th : Taskforce Team members visit	Marava, Managi, Antioch	3	Familiarized/informed	A familiarization trip
83			21 st : WB(SI) presentation	HP Hotel	30+	Presented/promoted	PO staff presented about the TRHDP in this one-day workshop hosted by the WB (S) office
84			23 rd : BLIC Meeting	Hilltop	7	Discussed/agreed	BLIC Members agreed they were on a good thing and should continue to the end
85		March	3 rd : Translation workshop for CLAs	Ngongoti	8	Educated/informed	This was to equip CLAs to translate difficult terms into the language

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
86			7 th : 3 Taskforce members visited communities	Managi, Antioch	5	Visited/discussed	This was the first such visit by members of the Taskforce (J Muria Jr, AG Chambers; S Wale, PS Lands and Acquisition Officer Jerry Tanito with PO staff). The team proceeded to Managi and Antioch to meet the communities and discuss the Project.
			8 th : Ngongoti CLA translation half day workshop	Ngongoti Kindy	10	Trained/empowered	Workshop to train the CLAs understand how to translate the big English terms used in the constant updates.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
90			21 st : Updates	Mataruka	30	Updated	Quick informal updates: road upgrading. Concentrated on water supply, road upgrades for Bahomea and status of land id process.
91							Informal updates: road upgrade, water supply, status of land id process.
92		April	8 th – Updates	Komuporo, downstream community	8	Updated	Seek the views of leaders about the need to install a river gauge at the mouth of Ngalmibiu, the downstream part of Tina River
93			22 nd : Updates	Managi	19	Informed/updated	Informal updates: road upgrade, . water supply, status of land Id process
			24 th : Updates	Antioch	19	Informed/updated	Informal updates: road, water supply, status of land id process

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
94							
95			25 th : Updates	Tina	20	Informed/updated	Informal updates about progress; residents expressed worry about the extension of SPL from Gold Ridge. They said they support the project, not Gold Ridge
96			30 th : Updates	Vuramali	11	Informed/updated	Quick informal updates about progress/activities
97			30 th : Updates	Marava	26	Informed/updated	Quick informal updates about progress of the project: Road improvement, water supply, status of land Id process update
98							
99		May	1 st : Updates	Katihana		Informed/updated	Updates for Katihana villagers who were very happy about the visit and updates.
100							

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
101			7 th : Updates	Areatakiki/Na manu	30+	Informed/updated	Informed settlers from the weather coast of Guadalcanal about the project.
			8 th : Updates	Namopila	17	Informed/updated	Quick informal updates about progress: road, water supply, status of land id process
102			9 th : Updates	New Koleula	55		Discuss project with settlers from the Weather coast of Guadalcanal.
103		June	6 th : Updates	Antioch village	20+	Informed/updated	Quick updates on progress
104			10 th : Updates	Managi village	25+	Informed/updated	Quick updates on progress

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
105		July	11 th : updates	Mataruka village	20+	Informed/updated	Members were happy about hydro as it may bring tourism.
106			17 th : updates	Antioch village	15+	Informed/updated	Community members very happy about the updates. They said they were tired of hearing updates – they want work.
107			18 th : Updates about ESIA	Mataruka village	20+	Informed/updated	Community happy to hear about the latest updates, looked forward to supporting the ESIA when it comes around their area.
108			24 th : Updates on ESIA	Hotohotu village	20+	Informed/Updated	Community members happy but most important point raised was benefits for the communities; BLIC land Id process. This is another settlement by weather coast people of Guadalcanal.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
109		August	1 st : Meeting of BLIC chiefs	Hilltop	10	Progressed work	CLO and Communications Officer called in to visit the BLIC team
110			7 th : updates	Hilltop	43	Informed/updated	Briefing about the BRL Environment Impact Assessments for leaders of the BLIC process. Pledged to support the project.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
111			Wed 21 st : BLIC Members Discussions	Doma	12	Brought to Doma/informed/updated	Chiefs were brought out of Bahomea to work with the PO and government agencies on the BLIC outcome to enable sensitive land discussions to take place. Met and discussed with J Muria Jr of the AG Chambers on 21 st to understand the land acquisition process. Phase 2 discussed in the afternoon after arrival; finalized criterions for primary owners
112			Thur 22 nd : BLIC members leave Bahomea	Doma – am;		Arrived/settled	Endorsed/agreed on criterions for Sister tribes. Chiefs returned to Bahomea.
113							

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
114			Fri 23 rd : Sister Tribe Criteria	Doma		Discussed/endorsed	
115			Sat 24 th : BLIC meeting	Doma		Met/discussed/educate	Tribal chiefs aware/informed about the Land Id process and its outcomes
116			Mon 26 th : Outcomes presentations to SIG	PO		Presented/discussed/agreed	Govt endorsed/agreed on outcomes of the Land Id process, prepared for next stage.
117			28 th : Road inspection	Bahomea road upgrades	2	Visited/seen	Hydrologist and CO driven to check on road upgrading at Bahomea
			30 th : Benefit Share workshop	Heritage Park Hotel	50+	Informed/updated	Benefit Share discussion by Raul of south America.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
118		September	2 nd : BLIC updates Chiefs	Guadalcanal Women's Resource Centre beside the Honiara International Airport	20+	Informed/updated	Members of the BLIC process informed/updated tribal chiefs about the land identification process. PO explained about the land acquisition and 50-50 ownership between SIG and core land tribes.
119			11 th : updates	Chichinge venue	27	Informed/updated	ESIA Feasibility Studies Land Acquisition Benefit Share
120				12 th : Updates	Mataruka	61	Informed/updated

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
121			17 th : Updates	Ado	70	Updated	“ “ (Note: While these updates were being carried out the Social Impact Assessment of the Bahomea region was being advanced, Malango area was to start two weeks after these updates for the Malango communities.
122		October	10 th : updates	Antioch	40	Updated	ESIA Feasibility Studies Land Acquisition Benefit Share
123	11 th : updates		Marava	17	Updated	“ “	
124	21 st : WB team visit		PO		Visited/discussed	Team visited and chatted with the Project Manager	
125	23 rd : Updates		Horohotu 2	44	“	“ “	

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed	
126		November	4 th : updates	Rate 1	100+	Informed/updated	Community partnership projects dam safety panel visit and work and gave advice about safety of the dam; ESIA.	
127			5 th : updates	Rate 2	100+	“ “		
128			6 th : meeting with Roha tribe reps	Hilltop	-10	“ “		BLIC Sec explained findings about land by their id process to Roha reps
129			7 th : meeting with Charana reps	Marava hall	10+	Discussed/updated		“ “
130			8 th : meeting with Buhu/Garo	Hilltop	-10	Discussed/updated		“ “
131			11 th : Meeting with core tribes	Ginger Beach, northwest Guadalcanal	19	Discussed/updated		Roha, Charana, Salasivo
132			14 th : presentation of outcomes of BLIC work to Core tribes	Kitano Mendana	-10	Discussed/agreed		Presented the details of the findings of BLIC to the potential core tribes

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
133			17 th : Core land tribe meeting	Antioch	-10	“ “	“ “
134			18 th : Roha Sign Drilling agreement	Kokonat Cafe	4	Agreed/signed	The Community Liaison Officer represented the PO in the closing of this community kindy as part of the outreach programs of the office.
135		21 st : Ngongoti Kindy closing	Ngongoti Kindy	1	Invited/attended		

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
136			22 nd : Clarification meeting	PO	8	Discussed/agreed	Meeting was to sort out confusions etc of Kochiabolo, Uluna/Sutahuri, Vatuviti and Lasi. The issues were in relation to a letter submitted by Vatuviti claiming it should be included in the Betigolo/Barahau Land. In the end the meeting agreed the claim was not correct and therefore dismissed.
137			24 th : Drilling started on new dam site	7C dam	10+	Almost a month long work started.	The work was supported by locals at the site
138			25 th : Buhu/Garo signs Process agreement	Volovua village	20+	Discussed/agreed/signed	The members signed after a meeting at Volovua village during which they asked questions and received clarifications from the PO.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
139			29 th : Land meeting	Parole Board Room	15+	Discussed/agreed	Meeting convened to discuss claims and disputes by Kaipalipali, Koenihao and Roha over the Nala land in the dam site being drilled at the time. Roha agreed to pay money to a family whose relative was buried on the site
140		December	1 st : final briefing for community champions	PO	7	Briefed/updated	Poster with different work streams of the project for community champions to take and update communities with.
			11 th : Drilling on 7c completed	7C	10+	Completed	Drilling completed and drill equipment flown out from site

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
141			12 th : meeting with tribes	Bisivotu Beach	10+	Discussed/briefed	Roha, Kaipalipali and Koenihao briefed about the BLIC outcome
142			13 th : meeting with additional tribes	“ “	4	“ “	Kochiabolo, Kaokao, Uluna get same briefing
143			14 th : PM Lilo flew over the dam site, visited Bahomea House of Chiefs in their meeting	7C, Marava,		Seen/discussed/informed	Prime Minister GD Lilo Minister Mines, Energy and Rural Electrification and Environment flew to the drilling site to see the work and landed at Marava to meet members of the Bahomea House of Chiefs who were having a meeting.
144	2014: Land Acquisition/ESIA consultations	January	22 nd : Updates for downstream CLAs/champions	Kairos Conf Centre	7	Informed/empowered	Feasibility Studies /Land Id and ESIA consultations to start in Feb

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
145			23 rd : Updates disturbed	Marava	6	Discussed/agreed	Discussion of BHOC election and role in land ID process
146							
147			24 th : updates	Najilaku (Old Selwyn College)	16	Updated/informed	Dam site confirmed; underground tunnel; 3.5km down to power house

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
148			25 th : sorted Marava grievances/disturbance , then updates for Tina Community	Marava	20	Reconciled/agreed	Before proceeding for an update at Tina village, the PO team including some Malango chiefs and supporters stopped at Marava and presented a chupu to the chiefs and people of Marava to allow updates at Tina village
149			25 th : Updates	Tin	50+	Updated/informed	Updates on progress of work : dam site confirmed; underground tunnel; road upgrades
150			27 th : Updates	Horohotu	25	Updated/informed	Dam site confirmed; underground tunnel to link powerhouse 3.5km downstream; road
151							

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
			28 th : discussion	PO	3	Discussed/informed	Reconciliation between Bahomea House of Chiefs and BLIC.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
152		February	10 th : Core Land discussion	PO	6	Discussed/updated	Meeting between F Conning, J Leua, E Gorapava,
153			11 th : Meeting between Eric, Jefferson and D Una	PO	3	Discussed/updated	Update meeting for Roha rep on the progress of a cabinet paper;a TOR for the BLIC
154			11 th : Roha senior tribe agree to register Roha				
155		May	14 th : Initial discussion of Process Agreement with Roha	Honiara Hotel Conference Room Jacob Kinai (lawyer from LALSU) with Jen Radford (JR), Jefferson Leua (JL), Eric Garopova (EG) from PO	8 tribal representatives (at least one woman)	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Process of landowner identification discussed. - Each clause of the draft process agreement read out and discussed in pijin. - Tribe requested that rain gauge, flow gauge and road sites be treated separately to Core land. - Some changes requested to draft including: - Increase in goodwill payment - Exclusion of secondary LO tribes and flow and rain gauge site tribes from agreement
156			15 th : Initial discussion of Process Agreement with Uluna Sutahuri	Honiara Hotel Conference Room	8 tribal representatives	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Process of landowner identification discussed. - Each clause of the draft process agreement read out and discussed in pijin.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
				Jacob Kinai (lawyer from LALSU) with Jen Radford (JR), Jefferson Leua (JL), Eric Garopova (EG) from PO			<ul style="list-style-type: none"> - Some changes requested to the draft. Other clauses supported. Changes requested included: - Change in ownership of TCLC from 51/49 to 50/50 - Greater clarity on benefit share clause - Assistance in compensation distribution – no good spendim lo quaso
157			16 th : Initial discussion of Process Agreement with Buhu Garo	Honiara Hotel Conference Room Jacob Kinai (lawyer from LALSU) with Jen Radford (JR), Jefferson Leua (JL), Eric Garopova (EG) from PO	6 representatives (4 men and 2 women)	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Process of landowner identification discussed. - Each clause of the draft process agreement read out and discussed in pijin. - Some clauses supported. Changes requested included: <ul style="list-style-type: none"> • Change Garo Buhu to Buhu Garo • More time is needed for tribes to consider and negotiate • Only 5 tribes are real LOs • Roha and Buhu Garo overlap to be resolved • Future payments from agreement should be paid by developer rather than SIG • LALSU support is good • Corporations will need training or support • Secondary LO tribes should not be in clause 13

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
							<ul style="list-style-type: none"> • 50/50 rather than 51/49 TCLC share • Need to hold tribal meetings before signing • Increase goodwill payments
158			19 th : Initial discussion of Process Agreement with Vuralingi	Honiara Hotel Conference Room	Small Group	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the draft process agreement read out and discussed in pijin. - Some changes requested to the draft. Other clauses supported. - Increase goodwill payment
159			19 th : Initial discussion of Process Agreement with Charana	Honiara Hotel Conference Room	7 tribal representatives including 1 woman	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the draft process agreement read out and discussed in pijin. - Some changes requested to the draft. Other clauses supported. - Tribe noted that they have only one block of land (Tulahi) and this is the block that would be given up for the project
160			20 th : Initial discussion of Process Agreement with Kochiabolo	Honiara Hotel Conference Room Jacob Kinai (lawyer from LALSU) with Jen Radford (JR), Jefferson Leua (JL), Eric Garopova (EG) from PO	6-8 tribal representatives	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the draft process agreement read out and discussed in pijin. - Some changes requested to the draft. Other clauses supported. - 51/49 TCLC shareholding not acceptable - Need to finalise tribes before acquisition - Increase goodwill payment - The number of tribes involved should not be allowed to increase, the three extras

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
							<p>should come out. Only tribes with proven claims should be included.</p> <ul style="list-style-type: none"> - PS and Ministers should conduct negotiations to show their status - Flow gauge land should be treated separately.
161			21 st : Initial discussion of Process Agreement with Kaipalipali	Honiara Hotel Conference Room Jacob Kinai (lawyer from LALSU) with Jen Radford (JR), Jefferson Leua (JL), Eric Garopova (EG) from PO	6 tribal representatives (and 4 observers)	Amendments to draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the draft process agreement read out and discussed in pijin. - Some changes requested to the draft. Other clauses supported. <ul style="list-style-type: none"> • Discussions related to the flow gauge land • Benefit share needs more detail • Trust the BLIC process
162			22 nd : Meeting with Wilson Suharu of Koenihao	Project Office	1	Discussion	Land ID: Evidence and claims for Nala Land discussed
163		June	3 rd : Meeting with Kochiabolo	Project Office	Tribal Representatives	Discussion	Discussion of Process Agreement terms
164			5 th : Meeting with all Core Land Tribes to discuss Process Agreement	Project Office	15+ Tribal Representatives	Amendments to Draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the Process Agreement was read through and discussed in pijin. - Changes made since last meeting emphasised

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
							<ul style="list-style-type: none"> - Request from tribes for a royalty payment - Agreement for compulsory acquisition to proceed subject to finalising terms of PA
165			12 th : Meeting with the 4 Core Land Tribes to discuss Process Agreement	Project Office	15+ tribal representatives	Amendments to Draft Process Agreement	<ul style="list-style-type: none"> - Each clause of the Process Agreement was read through and discussed in pijin. - Changes made since last meeting emphasised - Requested a minimum compensation value
166			18 th : Process Agreement and investment/management advice with Roha	Project Office PO and Martin Housanau	6-8 Tribal Representatives	Amendments to Draft Process Agreement and provision of management investment advice	<ul style="list-style-type: none"> - Martin Housanau discussed development and investment opportunities in other projects incl malaitia. - Discussed Process Agreement terms
167			18 th : Process Agreement and investment/management advice with Kochiabolo and Virulingi	Project Office PO and Martin Housanau	Tribal reps and PO	Process Agreement and provision of management investment advice	Discussion of Process Agreement with powerpoint
168			19 th : Process Agreement and investment/management advice with Buhu Garo	Project Office	Tribal reps and PO	Process Agreement	Discussion of Process Agreement with powerpoint
169			19 th (approx.): Process Agreement and Land ID discussion with Vuralingi	Project Office	Tribal Reps	Discussion	Discussed signing Discussed nature of Vuralingi ownership as trust arrangements

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
170			23 rd (approx.): Process Agreement discussion with 4 Core Land Tribes (Viurulingi, Kochiabolo, Buhu Garo and Roha)	Project Office	Tribal Reps	Amendments to Process Agreement Draft	Each clause of the Process Agreement read and discussed in pijin, emphasising amendments made based on previous negotiation
171			25 th : Discussion of Process Agreement and Land ID with Roha	Project Office	Tribal Reps	Discussion	<ul style="list-style-type: none"> - Discussing land ownership boundaries within the Core - Planning full tribe meeting to discuss Process Agreement
172			26 th : Full Roha Tribe meeting to confirm process agreement and land ID	Malango	70-100 including women, youth and men	Agreement to proceed with process agreement	<ul style="list-style-type: none"> - Power Point discussing terms of the agreement presented - Questions and answers - Consent of tribe sought to proceed
173			23 rd – 26 th : Roha Tribal Representatives signing Process Agreement	Project Office	7 Tribal Reps (5 men and 2 women)	Process Agreement signed	
174			23 rd – 26 th : Virulingi trustees signing Process Agreement	Project Office	4 named trustees and 3 witnesses (including 2 women)	Process Agreement signed	
175			28 th : Buhu Garo full tribe meeting to discuss Process Agreement	Don Bosco (near residence of	40-50 women, men and children		Power Point presentation of process agreement and land boundaries

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
				Sir Paul Tovua)			
176			29 th : Meeting with family and witnesses of Vuralingi trustee to discuss Process Agreement	Residence of Napter Noveti, Bahomea	40-50 men, women and children	Confirmation of Project Agreement signing and awareness of content and next steps	<ul style="list-style-type: none"> - Presentation of Power Point discussing terms of agreement - Questions and answers - Traditional feast
177			30 th : Meeting with Roha Tribal Reps to discuss boundary with Buhu Garo	Project Office	Approx 4	Discussion of internal land boundary location	<ul style="list-style-type: none"> - Land ID (internal boundary between Roha and Buhu Garo)
178		July	2 nd : Signatures to Process Agreement from Kochiabolo Trustees	Project Office	Tribal representatives (5 men and 2 women) – signed over differed dates leadin gup to 2/7	Signed Process Agreement	<ul style="list-style-type: none"> - Kochiabolo Reps signing Process Agreement
179			4 th : meeting between Roha and Buhu/Garo	Don Bosco Technical Institute	50+		Both tribes met to discuss a way forward on claims by Buhu/Garo parts of their land were included in those of Roha's. Both parties agreed to find their own time to settle the issue and then focused

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
							on when to sign the Process Agreement. After the meeting members of the Roha tribe presented a Chupu (traditional gift) to the chief and members of Buhu/Garo as a mark of respect.
180			9 th (approx.): Buhu/Garo Chief and leader Signed Process Agreement in PM's Residence		PM Gordon Darcy Lilo Residence, Vavaya Ridge	30+	
181			12 th : Updates	GP Women's Resource Centre, Henderson	30+	Discussed/agreed	Proposed updates for communities of Bahomea disturbed by individuals from Marava. However, many interested members of the community dropped by into the PO to get the updates.
182			14 th : Meeting between Roha and Buhu Garo tribal representatives, elders and story tellers to discuss land boundary	Bisivotu at Poha	25	Land boundary discussed and negotiated	<ul style="list-style-type: none"> - Old court cases and custom stories discussed - Agreement reached on part of boundary
183			22 nd , 23 rd : distributed updates	Various			

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
184		August	18 th : Discussion of compensation claim preparation with Virulingi Tribe	Project Office		Discussion of compensation claim boundaries	<ul style="list-style-type: none"> - Confirm customary boundaries for claim - Tribe confirmed no dispute as to boundary between Kochiabolo and Virulingi.
185			22 nd : Meeting with representatives of the 4 Core Land Tribes to discuss tribal awareness of acquisition process	Project Office		Discussion	<ul style="list-style-type: none"> - Need for awareness of acquisition and claims process to go down to community level - Jacob Kinai to assist tribes to prepare compensation claims
186		September	9 th : Meeting with all Core Land Tribes (date approx.)	LALSU/Hyundai Mall	Jacob Kinai from LALSU, PO and reps of 4 tribes	Discussion of compensation claim process and legal rights to appeal	<ul style="list-style-type: none"> - JK explained public purpose quashing appeal option - JK explained that he will assist Core Land Tribes to prepare claims but not competing tribes (conflict of interest) - Compensation claim process - How to prepare compensation claims - Right of appeal from COL to High Court
187			25 th : Meeting with representatives for Core Land Tribes to discuss compensation claim preparation	LALSU	Jacob Kinai, Chris Tabea, Paul Tovua, Jen Radford and Jefferson Leua	Discussion	<ul style="list-style-type: none"> - Tribes asked to start preparing claim evidence

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
188		November	3 rd : Meeting with Daniel Una to discuss compensation claim boundary for Roha	Project Office	1	Discussion of claim	Land boundaries (internal)
189			17 th : Meeting between Buhu Garo and Roha to discuss internal boundary	Project Office	13	Internal Boundary Resolution	Settlement discussion
190			20 th : Meeting with Daniel Una of Roha to assist with compensation claim preparation	Project Office	1	Completed claim	Discussion of draft claim and customary evidence
191		December	2 nd – 9 th : Team of 11 community reps carried out community consultations in Bahomea and Malango on behalf of the PO	2 nd : Namoraoni 3 rd : Kaimomosa 3 rd : Marava 4 th : Pamphyllia Mataruka 5 th : Chichinge 6 th : Namopila Managi 8 th : Antioch 8 th : Tina 9 th : Horohotu	30 39 34 25 29 21 27 39 72 42 67	Updated, Educated of project's progress	Project still progressing Benefits JSDF support Build confidence and trust for communities
	2015: Core Land Tribes	January					

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
	Cooperative Companies						
192		March	30 th : Update of claims process	Project Office	Reps from Core Land Tribes		<ul style="list-style-type: none"> - Option for land in place of monetary compensation - Strength of partnership - Core Land Tribes confirmed preference for compulsory acquisition process
193		June	10 th : Discussion with Uluna Sutahuri rep re protection of customary lands	Project Office		Discussion of catchment and Protected Area	<ul style="list-style-type: none"> - Protected areas on customary land need the approval of the tribes - Uluna could lead the way to setting up a PA on undisputed land - Benefit share discussed and the opportunity to focus it towards a PA
194		July	1 st : Meeting with representatives from Kochiabolo, Viurulingi and Buhu Garo (Roha not present). Date Approx.	Project Office		Compensation Officers discussed	<ul style="list-style-type: none"> - Valuation of land - Plan for transfer of title to joint venture company - Confirming timing of offer - Legal appeal options discussed
195			29 th : briefing for Tina Hydro Champions	PO	14	Briefed	Livelihood Restoration; Core land Company structure: Community Benefit Share Arrangement; Tribal Registration; PPA; JSDF – water/sanitation project

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
196		August	11 th : Meeting with Kochiabolo reps re compensation offers	Project Office	Tribal reps – 7 men, women reps requested but did not attend	Compensation offer discussed	<ul style="list-style-type: none"> - Terms of offer discussed - Land swap not accepted - Legal appeal options and timing discussed
197			11 th : Meeting with Roha reps re compensation offers	Project Office	Tribal reps – 4 men and 2 women	Compensation offer discussed	<ul style="list-style-type: none"> - Terms of offer discussed - Legal appeal options and timing discussed - Land swap not favoured - Process Agreement provisions for compensation discussed
198			11 th : Meeting with Buhu Garo reps re compensation offers		Tribal reps – women not available due to church camp	Compensation offer discussed	<ul style="list-style-type: none"> - Terms of offer discussed - Legal appeal options and timing discussed - Land swap not favoured. Tribe already has abundant land.
199			12 th : Meeting with Vuralingi reps re compensation offers		trustees	Compensation offer discussed	<ul style="list-style-type: none"> - Terms of offer discussed - Legal appeal options discussed - Land swap not favoured.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
200		August	13 th : two Senior WB Social Development officer and Environment Consultant visit communities	Manangi, Antioh	-20	Discussed briefly/informed/seen communities	First visit to familiarize themselves with the area and communities
201			13 th : “ “	Marava	11	“ “	
202			25 th : Roha meeting	Haimomosa			
203			28 th : Meeting with Uluna Sutahuri to discuss offer of compensation	Project Office	6-8 male reps	Compensation offer discussed	Update and responses to questions
204		September	7 th : Registration of Sarahi Members	Managi	35+	Discussed/registered	Sarahi now agreed to register all tribe members after Paramount Chief Peter Rocky had refused this earlier
205			9 th : updates for Uluna/Sutahuri	Red House, Grassland	80+	Informed/updated	Inform members about their being the 5 th tribe in the Core Land

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
206		October	8 th : Updates	Marava	20+	Updated/informed	Inform about the A Developer; Road and asset recording/payments; JSDF
207			7 th : Meeting with Roha rep re co-operative society	Project Office	1	Initial consultation on co-ops	<ul style="list-style-type: none"> - Overview of co-op ideas - Lifetime shareholding/ matrilineal committee for new members/possible spending allocations - A manager or administrator is essential. Tribe does not have accountants. - Not enough trust for people within the tribe to handle the money. Tribe can handle a milling operation if someone external handles money.
208			9 th : Meeting with Roha Reps for co-op formation consultation	Project Office	4	Consultation on tribal corporation	<p>Power Point presentation given on the proposed tribal corporation</p> <p>Comments:</p> <ul style="list-style-type: none"> - Rights to land have gone but we now see the benefits - Important that people understand the rules/finances/audit guidelines - Business is important to the future. But our understanding doesn't go beyond a small canteen. We need to leave money aside to grow this and we need rules that prevent people borrowing or taking money from

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
							the fund. Hard to say no in custom.
209			13 th : updates	Antioch	42	Updated/informed	Developer; Route, asset record/payments; JSDF
210			14 th : Updates	Zimri Launi House, top floor	18	Informed/updated	“ “
211			15 TH : Updates/Clarifications	Managi	35	Discussed/updated	Residents confused about pegs put by surveyors – anticipated relocation. PO stressed there wouldn't any relocation
212			20 th : updates	Namopila	55	Updated/informed	Developer/ Route, records, payments; JSDF
213			21 st : Meeting with Kochiabolo Reps for co-op formation consultation	Project Office	4	Consultation on tribal corporation	Power Point presentation given on proposed corporate structure Comments: - Need an appeal option for any tribal members not on register

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
214							<ul style="list-style-type: none"> - Could leaders have special shares/special provisions - Like the idea of a corporation based in custom - Directors need to change regularly. Too long and things go wrong - A corp will remove the pressure leaders receive from tribal members asking for money. Want this in place before we sign/receive compensation - Can't sign to accept offer without support of tribe. When we signed the process agreement our authority came from the tribe. Not from us. This needs to be the same.
			22 nd : Meeting with Uluna Sutahuri Reps for co-op formation consultation	Project Office	6-7	Consultation on tribal corporation	Power Point presentation given on proposed corporation structure Comments: <ul style="list-style-type: none"> - Core Area Committee had previously agreed to open an account with POB for the money. - Tribe previously divided Gold Ridge money as 50% dividends, 40% business, 10% administration costs. 40% for a business is still in the tribes term deposit account.
			27 th : Updates	Tina	53	Updated/informed	Developer/ Route, records, payments; JSDF

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
215							
216			30 th : Meeting with women of Roha Tribe	Project Office	20 women	Consultation on co-operative society	Power Point presentation given on proposed corporation structure
217		November	3 rd : Updates	Vuramali	28	Updated/informed	Developer/ Route, records, payments; JSDF
218			10 th : Updates	Horohotu	22	“ “	“ “
219			14 th : Updates	Marava	18	“ “	“ “
220			17 th : Updates	Horohotu 2	20+		
221			25 th : Meeting with Roha Tribe for co-op workshop	Anglican Church of Melanesia Hall, Honiara	10 male and 10 female representatives. Project Office team: FC, BT, LF, JM, JR	Consultation on Co-ops	Updated Power Point presentation by JR on proposed corporate structure. James from GPPOL discussed challenges and successes of the GPPOL LOs corporate business and social benefits entities. Small group break out activity with 2 groups of women and 2 of men to discuss objectives and outcomes for the corporation. Comments:

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
224	2016: Cooperative Societies for Core Landowners	January	19 th ; Banks meet Roha tribe members	Grassland	100+	Updated/informed	A first time ever for the ANZ and POB banks to get out to meet communities of Central Guadalcanal where they promoted themselves to the tribe members in readiness for the payment of their individual dividends into their personal accounts.
225			25 th : First Roha Tribe AGM/Id photo session	"	150+	Discussed/agreed/informed	Tribe members discussed about and elected an executive to lead their Cooperative Society and approved their method of sharing their money. Members also had their id photos taken by the PO team.
226			27 th : Awareness about sharing their dividends and funds/id photo session	"	100+	Discussed/agreed/informed	Members discussed and agreed on sharing of their money from the government. Those yet to get id photos had theirs taken.
227			28 th : Banks and Roha members meet/id photo session	"	100+	Discussed/agreed	Members listened and chose what bank to register with for their dividends.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
228		February	3 rd : 1 st Roha Coop Exec Meeting	PO	7	Discussed/agreed	Discussed about accounts, corrected names on the list, review of registration names, bank account and so forth.
229			4 th : Id photo session	Red House	100+	Photographed	Continuation of id photo sessions for individual bank accounts for the Cooperative Society
230			8 th : Uluna/Sutahuri exec meeting	"	11	Discussed/agreed	Discussion about tribal sharing of money from the government for their land
231			12 th : Michael Litani explained about land to Uluna/Sutahuri members.	Red House	160	Discussed/informed/educate	Mr Litani requested this meeting from the PO to explain about the handover of the Barahau Longa land to his mother by Labuchovi.
232							

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
233			16 th : Briefing for Uluna/S tribe members/id photo session	Red House	170	Discussed/updated/informed	Tribe members informed of how much money was coming to them from the government, sharing formula and other information about the Coop. Also done photo ids for members for their bank accounts.
234			19 th : Roha Exec meet Administrator	PO	7	Discussed/updated	Introductory meeting, constitution, distribution methods etc.
235			23 rd : Banks/ Id photo session for Uluna/Sutahuri 26 th : Id Photo sessions/Banks with Uluna/Sutahuri	Red House	100+	Ids photos taken	Continued to take Id photos for Uluna/Sutahuri tribe members
236		March	3 rd : Roha AGM	Red House	120+	Discussed/agreed	To allow members approve two new clauses and take 10 non tribe members out of the dividend list.
237			4 th : Roha given Chupu	Kaimomosa village	200+	Witnessed/recorded	Tribes gave and were given chupu to and from the members of the Roha Tribe in readiness for receiving their dividends.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
238			9 th : Roha Exec Meet	PO	7	Discussed/agreed	Culture Obligation Sharing formulae ANZ outstanding bills Verify final membership list
239			9 th : Roha Special Meeting with Administrator	Morris/Soj conference room			ANZ Arrears on individual members savings discussed. Familiarization with the Administrator by the 7 executive members. Commissioner of Lands was also present to sign and deliver the \$6.973m for distribution.
240		April	5 th : Una Meki Reconcile	Marava village	43	Apologised/reconciled	D Una provided record of this where Roha and Charana members reconciled on differences over Tulahi land.
241			7 th : Meki and sons apologize	PO	4	Discussed/agreed	Marava leaders to explain their involvement in an incident at Marava in March and offer their apologies and recommendations for a way forward.
242			9 th : Uluna/Sutahuri meeting	PO	10+	Discussed/agreed	List of tribal registration Awareness on what co-operation is and how it will administer money for the tribe

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
243							Customary obligation fund. Election of executive committee.
			10 th : Uluna/Sutahuri AGM	Red House	200+	Discussed/agreed/elected	Tribe elected its executive to manage their affairs in their Cooperative Society.
244			12 th : Gender Meeting	Tina Village	20	Updated/informed	Gender Consultant Jen Scott met and discussed about gender issues in the Project
245							
			20 th : Uluna/Sutahuri exec meeting	PO	7	Discussed/agreed	Their preparations to work on their members' bank accounts and other matters.
246			20 th : Water Survey team	PO	4	Discussed/agreed	Deputy Project Manager Fred Conning met/discussed with two appointed people to head the water project for the Malango/Bahomea communities.

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
247			20 th : Roha Exec committee meeting	PO	7	Discussed/agreed	The meeting was purposely to hear a presentation of a representative of the Value Added Timber Association to help the Roha Executive have a clear idea about how to proceed with their investment in timber milling.
248		May	06 th : Special Uluna/Sutahuri Meeting	Red House	150+	Discussed/agreed	To finalize outstanding issues that needed fixing so members could work on accounts for their money.
249			24 th : MID Awareness	Tina village	15+	Informed/updated	Update about 50m road concept design by Cardno of Australia. Team leader was Primo Chapa.
250		July	23 rd : Uluna/Sutahuri Meeting	Red House			Announcements; Review membership list; Breakdown of Cultural Obligation component

No.	Year	Month	Activity	Venue	No of Participants	Output	Issue discussed
251		August	22 nd : update for Community Champions	PO	10+	Updated/informed	To plan out a review of the project could be best displayed; Updated and mentored champions about Benefits for the Community through the JSDF. Preparing them for community consultations about this component that should happen before construction of the dam.
252			24 th : Community Champions meeting	PO	10+	Empowered/educated	A thorough discussion about the different components of the Benefit Share to empower the champions equipped for their community consultations later.

**Annex 15 : Local community
perceptions**

PROJECT IMPACT CONCERNS

Each village community surveyed for the SIA raised issues that could require attention. The following table presents the key points for each village community that relate to Option 7C ⁷⁴. These were recorded in the participatory workshops and in the follow-up mitigation workshops. [The villages within each community, and the clan affiliations of the households, are listed in the Baseline Report.]

Table 2 Tina catchment communities concerns relating to Option 7C

COMMUNITIES	PROJECT CONCERNS
SENGE COMMUNITY (DIA)	<p>Restricted access to fishing, hunting, and gardening areas in project area</p> <p>Decline in fishing in river if reduced flow.</p> <p>Impact on valuable wild plants (e.g. for food, medicine, magic, hunting etc) in project area.</p> <p>Loss of forest materials from project area, e.g., new access roads.</p> <p>Cultural sites permanently lost or damaged (tambu pool, sacred streams, grave sites, former habitation sites).</p> <p>Construction noise, vibration, etc from construction activities, e.g. tunnelling.</p> <p>Water pollution downstream of the dam construction.</p> <p>Reduction in river and stream water supplies for future use</p> <p>Possible disruption to culture, customs, and way of life by outside workers.</p> <p>Potential landowner and tribal conflicts over compensation, royalties etc.</p> <p>Fear of permanent loss of traditional cultural quiet way of life, income, and health.</p>
PACHUKI COMMUNITY (DSA)	<p>Loss of utility and amenity of the river due to reduced/unreliable river flow.</p> <p>Noise, dust etc from construction of powerhouse, and access road, especially for Habusi (approx. 500 metres away).</p> <p>Long term reduction in ability to transport float timber from upstream due to diversion of flow</p> <p>Dangers to river users from tailrace flow from the power station.</p> <p>Loss of clean water supply, washing places, recreation, and fishing during construction of dam and nearby powerhouse.</p> <p>Anxiety about danger of dam failure/earthquakes, and possible need to relocate.</p>
NAMOPILA COMMUNITY (DSA)	<p>Loss of utility and amenity of the river due to reduced/unreliable river flow ;</p> <p>Long term reduction in ability to float timber from upstream due to diversion of flow, with possible loss of income;</p> <p>Loss of fishing holes, and reduced access to hunting & gathering areas in upper catchment</p> <p>Loss of clean water supply during construction.</p> <p>Anxiety about danger of dam failure/earthquakes</p> <p>Few benefits to indigenous owners of the resources (river and land) being exploited by the project.</p> <p>Possible cumulative impacts with mining and logging</p> <p>Need for separate land and mitigation agreements for different communities and owners;</p> <p>Family problems arising from increased access to money.</p>
VERAKUJI /MANAGIKIKI COMMUNITY (ISA)	<p>Physical effects of road development (dust, noise , vibration) and road use</p> <p>Damage or disturbance to homes/buildings adjacent to road from roadworks and road use- may require re-siting of some buildings</p> <p>Disturbance to gravesites</p> <p>Danger to children, pedestrians and local traffic from project transport</p> <p>Loss of fishing holes, reduced access to hunting & gathering areas</p> <p>Damage to/loss of food gardens and forest resources from building damsite access road</p> <p>Possible damage to water supply sources from road building etc</p>

⁷⁴ The village workshops looked at the potential impacts of Option 6E and a notional design for Option 7C; the concerns that were specific to Option 6E have been omitted here.

COMMUNITIES	PROJECT CONCERNS
	Disturbances to way of life from outsiders.
ANTIOCH COMMUNITY (DSA)	<p>Reduced amenity of the river due to reduced/unreliable river flow and water quality; Long term reduction in ability to float timber from upstream of the power station, with possible loss of income; Loss of fishing holes, and reduced access to hunting & gathering areas in upper catchment Loss of clean drinking water supply during construction Inappropriate behaviour, social disorder, new diseases, changes in lifestyle and potential loss of culture and customs if outside workers live in the area.</p>
TINA COMMUNITY (DSA)	<p>Loss of utility and amenity of the river due to reduced/unreliable river flow and reduced water quality; Loss of drinking water supply during construction Long term reduction in ability to float milled timber from upstream of the power station Loss of fishing/diving holes Loss of access to fishing, hunting and gathering areas upstream of dam and reduced availability of bush materials Negative impact of outside workers – disrespect for culture and for women (as seen at Gold Ridge), and reduced personal and home security Potential water pollution from project facilities (sewerage etc) due to presence of outsiders Problems of rubbish disposal and sanitation (ref to Gold Ridge), and possible increased gastrointestinal infections. Cultural inappropriateness of female workers' clothing (shorts/trousers) Fear of dam failure or overtopping due to earthquake and landslide Distrust of government re agreements and promises of benefits to local people.</p>
VURAMALI COMMUNITY (DSA)	<p>Loss of utility and amenity of the river due to reduced/unreliable river flow and water quality; Long term reduction in ability to float milled timber from upstream of the power station Loss of fishing, hunting & gathering areas upstream of dam Pollution of drinking water supply Loss of forest resources in project area/s Lifestyle change / influence from construction-related outsiders and others Social and behavioural problems associated with outside workers (disrespect to locals and women), Safety of children from project traffic Increased risk to children from river level fluctuations Fear of devastation from dam failure – with possible need to relocate away from river. Contamination of hunting / fishing areas from oil & chemicals Fear of conflict over compensation and landowners' access to project benefits.</p>
MARAVALI COMMUNITY (ISA)	<p>Physical effects of road development (dust, noise, vibration etc.) and Negative impact on households of increased road use Disturbance to local gravesites and tambu areas. Damage or disturbance to homes, facilities, and gardens adjacent to road from roadworks Damage and/or loss of access to fishing, hunting & gathering areas upstream of dam. Reduced fish stocks in river generally Danger from traffic and heavy vehicles on Tina Road Possible damage to water supply streams from road building etc. Social and cultural problems from outside workers, including safety of women and children, increased drugs and alcohol in community etc., Damage to nearby riverside picnic & recreational areas</p>

COMMUNITIES	PROJECT CONCERNS
	Potential social problems among local families arising from increased availability of cash from projected-related employment.
VERA-ANDE COMMUNITY (ISA)	Dust, noise, and fumes from increased road use – with possible health effects Possible damage to water supply areas and wells from road building and road use Damage or disturbance to homes, facilities, and gardens adjacent to road from roadworks and road use. Possible need to re-site houses back from the road. Danger from traffic and heavy vehicles speeding past villages Disturbances to way of life from outsiders Fear of increased social disorder due to alcohol use.

Table 3 Bahomea Settler and Ghaobata Communities downstream communities concerns relating to Option 7C

COMMUNITIES	PROJECT CONCERNS
VERAKABIKABI COMMUNITY (ISA)	Physical effects of road development (dust, noise , vibration etc.) and increased road use on local households Potential for damage to gardens areas and a cemetery near road Risk of road accidents involving project vehicles - especially safety of school children Lack of own transport Fear of dam failure General concerns about negative impact on incomes and food security. Need more information on project.
HOROHUTU I (DSA)	Increased noise and dust from traffic/trucks on the road Social problems and bad influences from outsiders coming to the area, and from badly behaved drunk young people and associated disturbance Negative cultural influences from project workers
OLD SELWYN COMMUNITY (DSA)	Loss of utility and amenity of the river due to reduced/unreliable river flow and water quality; Fear of reduction in natural supply of river gravel, and associated loss of income from sales Fear of decrease in ground water levels, especially in dry season Fear of dam failure and its consequences Water pollution from oil and fuel spills Potential conflict with project and government over water ownership, royalties and compensation Lack of inclusion of downstream communities in project planning to date.
RAVU COMMUNITY (DSA)	Water pollution and reduced river flow, especially during construction and during dry season, with negative impact on all river water uses. Fear of reduction in natural supply of river gravel, and associated loss of income from sales Fear of decrease in ground water levels (wells), especially in dry season Water pollution from oil and fuel spills, especially during construction Fear of dam failure and flooding during big cyclone or earthquake. Potential conflict with government and other communities over water ownership, royalties, compensation , and access to project benefits Lack of inclusion of downstream communities in project planning to date.

Table 4 Indigenous Landowners outside Project area concerns relating to Option 7C

COMMUNITIES	PROJECT CONCERNS
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MATARUKA COMMUNITY	<p>Potential social and cultural problems from outsiders and expats working on the project or others coming attracted to the Bahomea and Malango area.</p> <p>Potential conflicts over ownership rights, royalties, compensation, and access to project benefits, including construction jobs.</p> <p>Loss of fishing spots and access to hunting areas etc in project area</p> <p>Damage to Tenaru River catchment from routing and construction of dam access road</p> <p>Conflicts over land identification and ownership</p> <p>Damage to/loss of cultural sites from construction and storage reservoir</p>
BELAHA COMMUNITY	<p>Loss of hunting / fishing areas (at dam site and above) to which they have access rights</p> <p>Loss of medicinal and cultural plants in project areas</p> <p>Reduced supply of timber from their own lands for building</p> <p>Demand on time for consultations and negotiations with developers</p> <p>Potential conflicts over compensation and access to project benefits, including construction jobs</p> <p>Potential social and cultural problems from outsiders and expats working on the project.</p>

PROJECT BENEFITS ANTICIPATED BY LOCAL COMMUNITIES

The anticipated or perceived local-level benefits or positive impacts of the TRHDP are presented below. Many of the anticipated benefits derive from (assumed) access and compensation payments, government benefit sharing programmes or projects, and TRHDP-related infrastructure development.

Table 5 Tina Catchment communities' views of project benefits

COMMUNITY	PROJECT BENEFITS
SENGE COMMUNITY (DIA)	<p>Electricity supply and associated benefits to quality of life, and small business opportunities.</p> <p>Protected forest area.</p> <p>Possible employment on the project.</p> <p>More accessible and improved health and educational facilities and services.</p> <p>New business opportunities involving the lake/reservoir (e.g. ecotourism, sightseeing)</p>
PACHUKI COMMUNITY (DSA)	<p>New houses, with road access and water supply (assuming relocation required for Habusi and Pachuki).</p>
NAMOPILA COMMUNITY (DSA)	<p>Income from royalties and compensation, with flow on benefits such as improved housing, consumer goods, and business creation.</p>
VERAKUJI /MANAGIKIKI COMMUNITY (ISA)	<p>Income from royalties and compensation, with flow on benefits.</p> <p>Electricity supply - with significant improvement in the quality of life e.g. lighting, refrigeration, entertainment, use of home appliances and creation of home industries such as sewing and joinery workshop).</p> <p>Improved road transport and associated access to services.</p>
ANTIOCH COMMUNITY (DSA)	<p>Creation of protected forest area (eliminating risk of mining and/or further logging in the catchment).</p> <p>Local electricity supply and associated opportunities.</p> <p>Improved water supply.</p> <p>Improved roads.</p> <p>Direct and indirect project employment opportunities.</p>
TINA COMMUNITY (DSA)	<p>Direct and indirect employment opportunities on the project for local men and women, with job training.</p> <p>Local electricity supply and associated livelihoods opportunities and improved quality of life</p>

COMMUNITY	PROJECT BENEFITS
	<p>New business opportunities involving the lake/reservoir. More income and investment opportunities from anticipated royalties/rents or other payments from the developer. Improved water supply Improved road and transport services Improved social and other services and facilities (e.g. schools & clinics) from government support programmes.</p>
VURAMALI COMMUNITY (DSA)	<p>Local electricity supply and associated livelihoods opportunities and improved quality of life. Improvement to water supply. Employment and small business opportunities for men & women. Improved roads and transport. Improved social and other services and facilities.</p>
MARAVA COMMUNITY (ISA)	<p>Local electricity supply and associated livelihoods opportunities and improved quality of life. Direct project and indirect employment and small business opportunities, and associated increased incomes Opportunity for job training Improved standard of living and services (e.g. schools). Potentially improved relationship between communities and central government.</p>
VERA-ANDE COMMUNITY (ISA)	<p>Local electricity supply and associated livelihoods opportunities and improved quality of life (e.g. water pumping, appliances, electrical equipment, lighting, entertainment). Improved roads and associated better access to public transport, health services, markets etc. Employment opportunities and Improved income. Government improvement to services and facilities.</p>

Table 6 Bhaomea Settler communities and Ghaobata Communities downstream views of project benefits

COMMUNITY	PROJECT BENEFITS
HOROHUTU I (DSA)	<p>Direct and indirect employment opportunities, especially for young people. Improved road and transportation, and associated better access to services. Alternative and better water supply. Electricity supply. Indirect improvement to standard of living.</p>
VERAKABIKABI COMMUNITY (ISA)	<p>Direct and indirect employment opportunities, and associated improvements in income. Improved roads and transportation and associated better access to services. Alternative and better water supply. Electricity supply Overall improvement to standard of living and economic circumstances.</p>
OLD SELWYN COMMUNITY (DSA)	<p>Direct and indirect employment opportunities. Electricity supply re-established. Assistance with improving village water supply or re-establishing reticulated supply improved roads.</p>
RAVU COMMUNITY (DSA)	<p>Possible better flood control for flood-prone Ravu area. Electricity supplies (free) and associated improvement in the quality of life. Employment opportunities with possible job training and capacity building. Participation in benefit sharing programmes.</p>

Table 7 Indigenous Landowners outside the Project area

COMMUNITY	PROJECT BENEFITS
MATARUKA COMMUNITY	Improvements to quality of life and standard of living for kinsmen in the Tina catchment Electricity supply to the landowners, and associated benefits. Improved water supply. Employment, small business, and training opportunities for the landowners. Income earning opportunities for women.
BELAHA COMMUNITY	Employment and training opportunities for the land owners. Electricity supply (free) to the land owning communities. Government improvement to services and facilities. Improved roads. Improved water supply local villages. Improved standard of living and quality of life.

**Annex 16: A summary of the situation
of women in the Solomon Islands and
the Project Area**

OVERVIEW OF KEY ISSUES

Reports of the situation of women since 2003 (i.e., the post-Tension period) paint a grim picture by international standards. In 2005, UNICEF summarised the situation as follows:

The status of women in Solomon Islands tends to be low, as are contraceptive prevalence levels. This contributes to high fertility levels that stretch the capacity of rural people engaged in subsistence to provide for their families. Domestic violence is widespread, as are sexually transmitted infections, and girl children and the disabled tend to be disadvantaged compared with healthy boys. . . . The major concerns for children, youth and women are under-resourced health services and schools, especially in rural areas, scarcity of cash earning opportunities for both men and women, and scarcity of employment opportunities and lack of career structures for youth. (McMurray, 2005,:viii)

Women have little say in family decision-making. Even where land is inherited matrilineally, as in Guadalcanal, decisions as to the management and allocation of the land still tend to be made by men, and female landowners are not expected to oppose the wishes of their menfolk (McMurray, 2005:40)

In the absence of village level data from the 2009 census, it is difficult to get the full picture of the social and economic situation of women in the project area. However, data is available at the provincial and ward level. The key indicators of women's situation and development in Guadalcanal (and Malango ward) are as follows:

- ▶ females make up 48% of Guadalcanal province's population;
- ▶ their life expectancy is 73 years (c.f. 66 years for males);
- ▶ the average annual female population growth rate is 4.5% (c.f. 4.3% for males)
- ▶ 14% of private households are headed up by females;
- ▶ the median age for females is comparatively low at 19.4 years (c.f. 19.1 years for males);
- ▶ the median age at first marriage is 23 (c.f. 27 for males), and 14% married as teenagers;
- ▶ The labour force participation rate for females is 63%, the same as for males, although only 28 % of the economically active females are in paid employment (32% in Malango ward). 46% of economically active females aged 14 and over are engaged in subsistence production (24% in Malango), and 14% produce goods for sale (18% in Malango);
- ▶ 25% of females aged 12 and over have either had no school or very limited primary education (c.f. 15% of males). Females have a lower literacy rate than males, and;
- ▶ In Malango Ward the majority of females and males-
 - live in houses that they own, and located on land that that they 'own' freehold or by custom. These houses typically have 1-2 rooms, traditional thatched roofs, wooden floors, and wooden or traditional bush material walls;
 - 30% rely on rivers and streams for their drinking water supply, 13% on wells, and 24% on community of individual tanks;
 - 57% rely on rivers, streams, ponds etc to do their washing, and
 - for sanitation, 44% use private or shared pit latrines, and 15% have no toilet facilities, and
 - over three quarters reply on kerosene lamps for lighting (although low wattage solar lighting has recently become available to most householders), and 90% rely for cooking on wood and coconut shells.

The data on household facilities is highly relevant when considering the workload of women in the villages of the project area (see below) and when considering potential impact mitigations and benefits sharing.

The 2007 national demographic and health survey provides basic indicators of the situation for women in the Solomon Islands:

- ▶ among women aged 15 to 49, 21% were recorded as not being able to read compared with 11% of men;
- ▶ in terms of paid employment only 42% of married woman had been employed in the previous 12 months compared with 87% of men. Over half of the woman who were employed were not paid in either in cash or kind;
- ▶ 21% of adult females are not able to read (of 11% of males), with illiteracy higher in rural areas;
- ▶ only 28% of married woman reported they were able to make their own healthcare decisions independently;
- ▶ only 20% reported they had the main decision-making power regarding their visits to their family and friends;
- ▶ only 55% of married woman usually participate in household decisions about major purchases, healthcare, and family relationships, and;
- ▶ 69% of women believe that physical violence against them by their partner is justified in some case. 63% of men believe that violence against women is justified for a range of reasons – with younger men more likely to justify such violence.

A 2012 report by the National Council of Women (in association with 10 national NGOs) confirmed the poor socio-economic situation for most women, noting that the critical issues for women are violence, corruption and its effects, and the lack of support and services for women with disabilities:

The conflict in Solomon Islands from 1999-2003 was a period of increased violence against women, both in public and private. Although there are many cultural taboos against women talking about sexual violence, the Women's Submission to the Solomon Islands Truth and Reconciliation Commission reports that a high number women and young women, married and single, were raped during the tension, resulting in physical and psychological trauma and unwanted pregnancies... Domestic violence also increased during the tension, with women reporting regular physical abuse resulting in fractured arms, legs and bodies and the destruction of personal belongings and clothing. Violence against children, including girls, also increased. Other women were forcibly detained. The levels of violence against women and girls have remained high following the tensions. (National Council of Women, 2012:9).

Such observations were confirmed during our discussions with women in the project communities.

With respect to women's status in decision making about land and resources, the 2012 report from the National Council of Women noted:

In all provinces, regardless of customary law, in practice men exercise decision-making rights over land use and over income generated from the land (e.g. royalties from logging and mining operations) ... Young women are particularly discriminated against in community decision-making processes about land use. In most communities, women and especially young women are not permitted to speak during community meetings about land use. Despite the fact that women are concerned about the impacts that unrestricted logging is having on traditional land, and that they have land ownership rights, women are prevented from participating in decision-making about the use of that land (National Council of Women, 2012:35)

Monson (2010) has researched the situation of women in matters of ownership and resource management in a northern Guadalcanal community, and summarised it as follows:

While it is common for Guadalcanal people to assert that "women are the real landowners of land on Guadalcanal", land records and court records generally record the names of a small number of male leaders thus solidifying their formal control over land. The state legal system tends to recognize the small number of individuals that have customary authority to speak about land inside a public arena, therefore turning the customary 'right to speak' into effective ownership. This has operated to the detriment of many landowners, particularly women, who often lack the formal education or customary authority required to speak in public arenas (Monson, 2010:5).

As seen in the SIA Baseline Report, the same issues for women and young people are present in the communities of the project area, and there seem to be few if any programmes designed to improve their situation.

WOMEN'S HEALTH

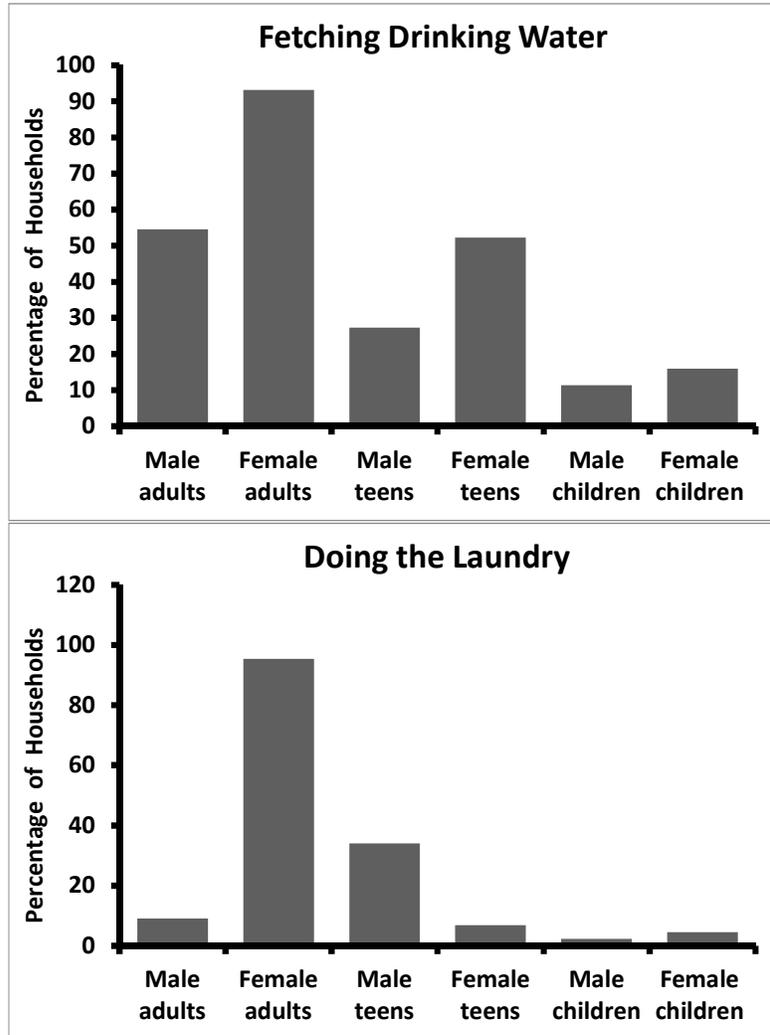
While national fertility levels have been decreasing over the past 20 years, rural Solomon Islands woman still have an average of 4.8 children in the course of their lives. Child bearing starts early, and in 2007, young woman from Guadalcanal were more likely than others to have begun child bearing in their teenage years. The median age for a woman having her first child is 21 years, compared with 22 years for Solomon Islands as a whole. Women in Guadalcanal were also more likely than others to have their children at home (29%) rather than at hospital, and only 69% of births were likely to be attended by skilled provider compared with 86% nationally. Among rural Guadalcanal women aged 15-49, 52% were found in 2007 to be anemic (Demographic and Health Survey, 2007). 97% of women Guadalcanal in the 2007 survey reported at least one serious problem in accessing health care, typically concern about having no provider, no transport, or not having sufficient money for treatment.

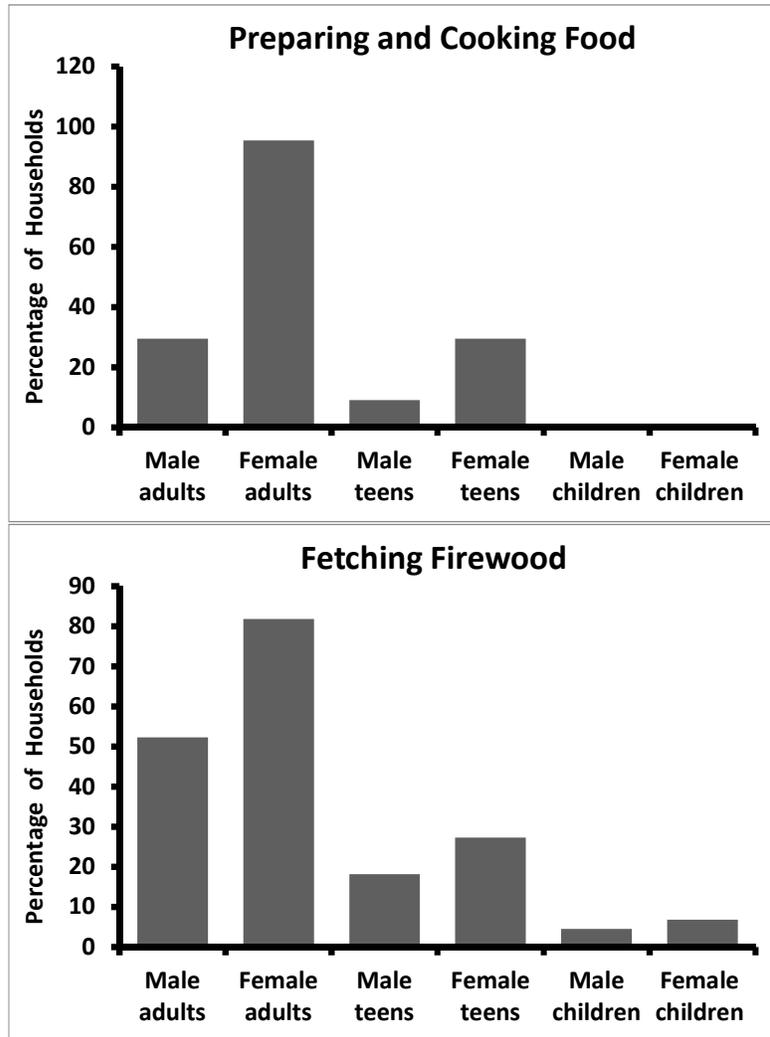
DIVISION OF LABOUR

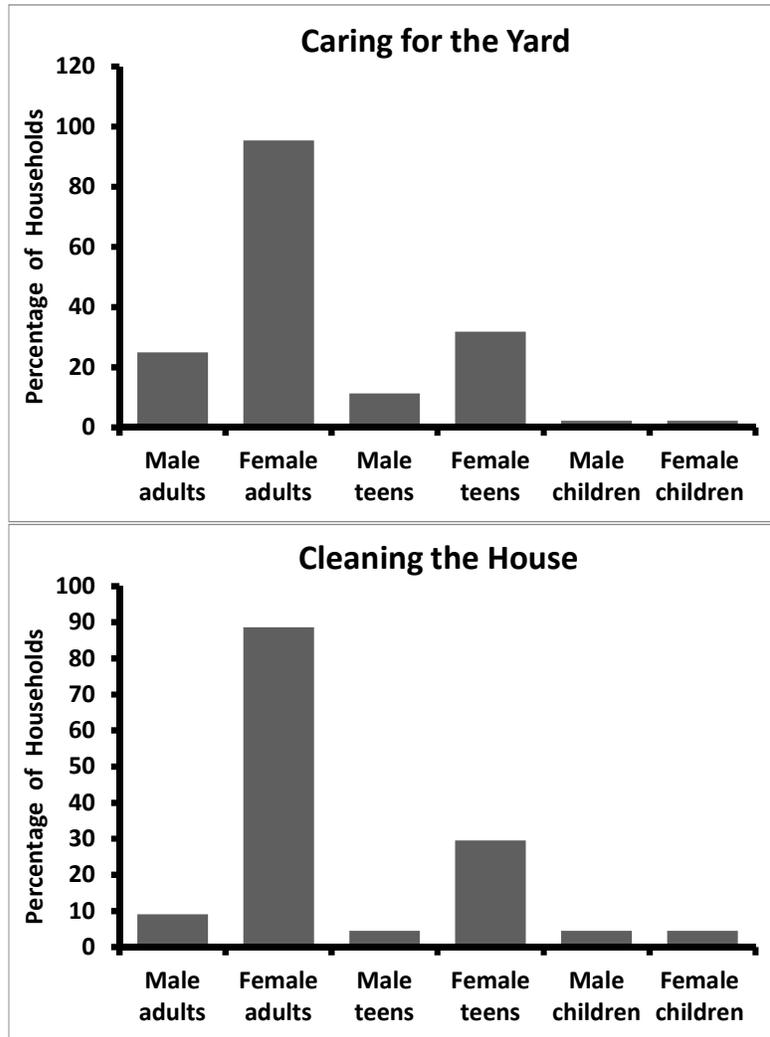
Table 8 Percentage of households in which each group is involved in the activity.

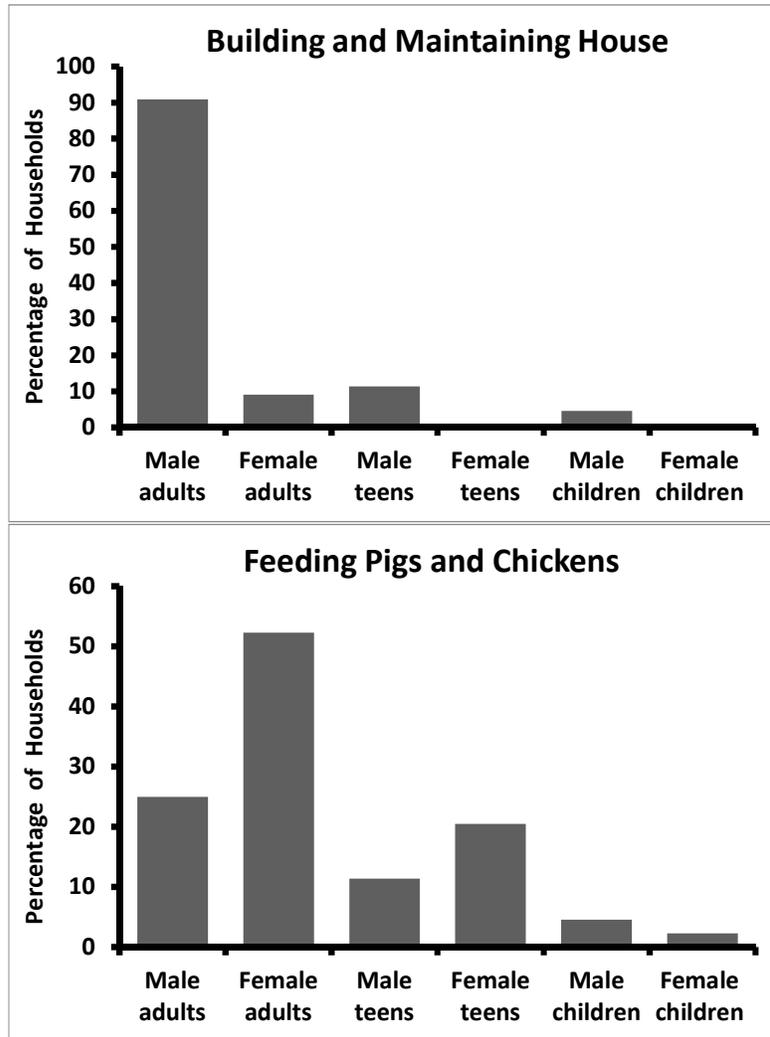
	Male adults	Female adults	Male teens	Female teens	Male children	Female children
Fetching Drinking Water	55%	93%	27%	52%	11%	16%
Doing the Laundry	9%	95%	34%	7%	2%	5%
Preparing and Cooking Food	30%	95%	9%	30%	0%	0%
Fetching Firewood	52%	82%	18%	27%	5%	7%
Caring for the Yard	25%	95%	11%	32%	2%	2%
Cleaning the House	9%	89%	5%	30%	5%	5%
Building and Maintaining House	91%	9%	11%	0%	5%	0%
Feeding Pigs and Chickens	25%	52%	11%	20%	5%	2%
Child Minding	45%	98%	14%	25%	2%	5%
Taking Children to School	11%	36%	0%	2%	5%	5%
Clearing Forest for Gardens	86%	50%	5%	2%	5%	5%
Cultivating the Gardens	66%	82%	9%	9%	2%	2%
Harvesting Planted Crops	48%	93%	5%	14%	2%	2%
Hunting	48%	2%	5%	0%	2%	0%
Catching Fish/Eels in the River	61%	32%	20%	9%	9%	2%
Collecting Wild Fruit etc.	45%	50%	18%	20%	5%	7%
Selling Produce/Cash Crops	18%	86%	5%	7%	0%	0%
Looking after Household Finances	50%	82%	0%	0%	0%	0%
Buying Food/Supplies	45%	82%	2%	5%	0%	0%
Attending Community Meetings	68%	93%	2%	2%	0%	0%
Deciding on Land Issues	75%	41%	0%	0%	2%	2%

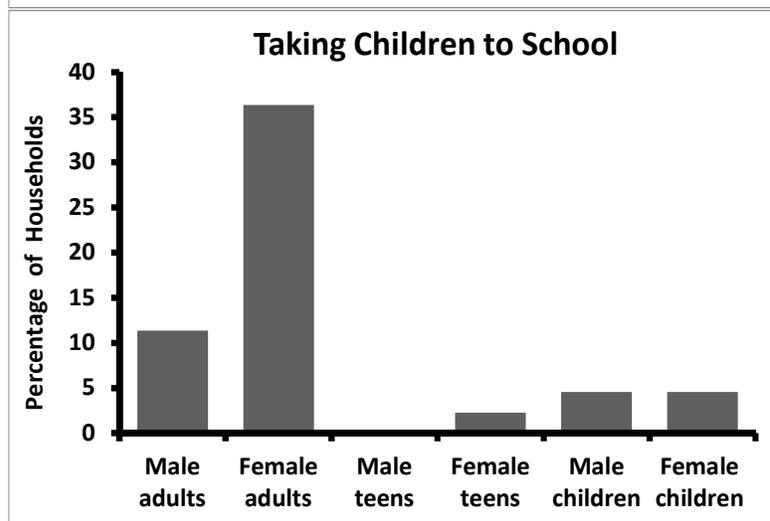
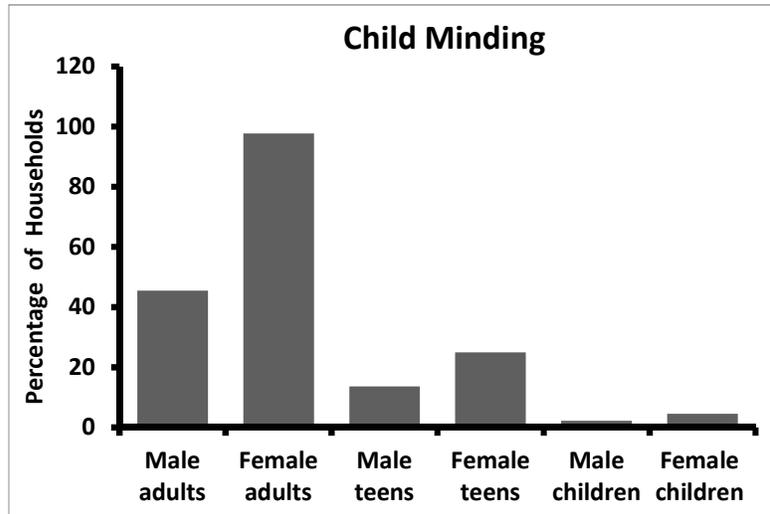
Figure 1 Division of Labour-Percentage of households in which each group is involved in the activity

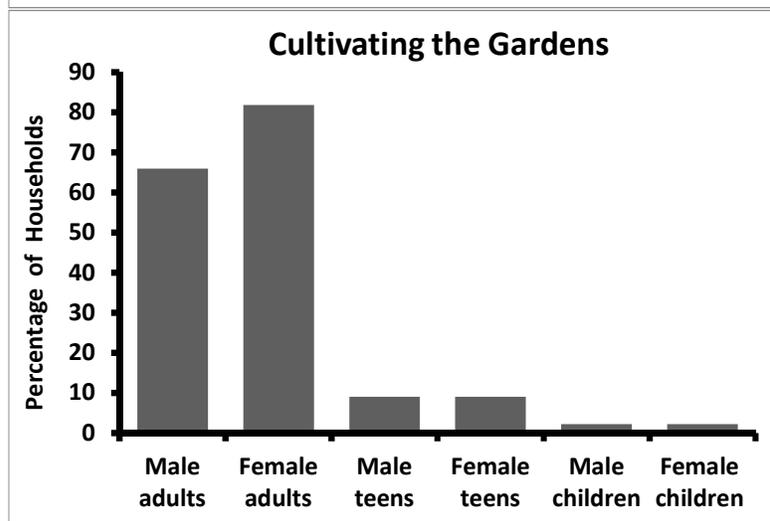
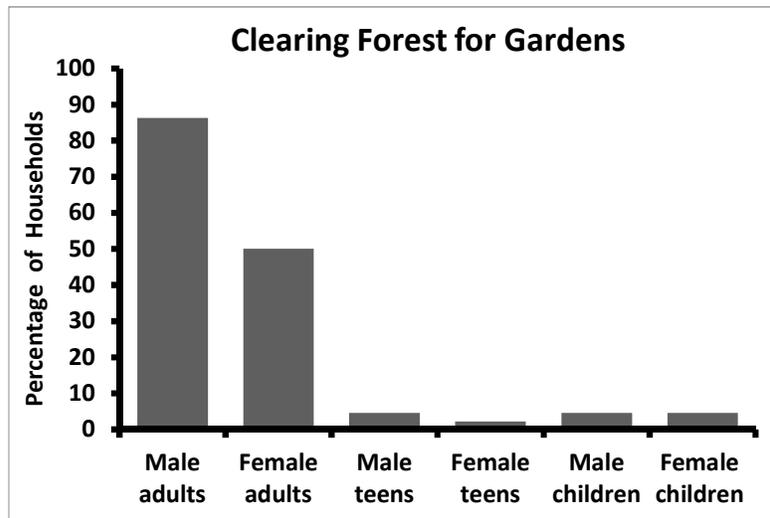


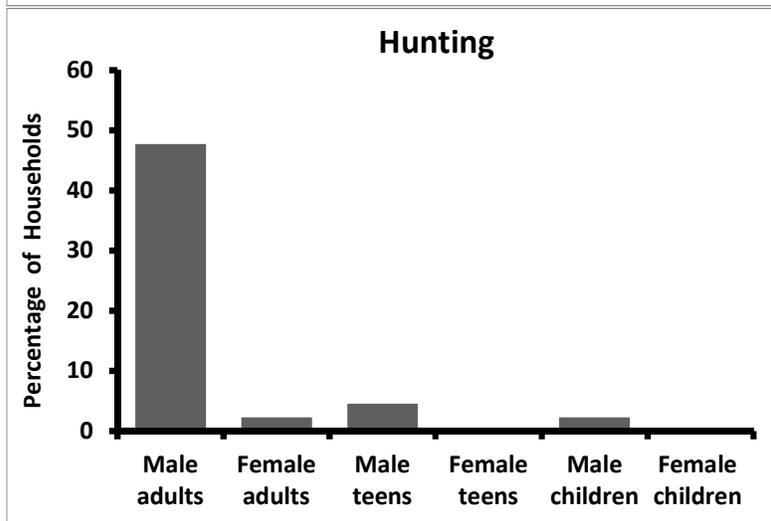
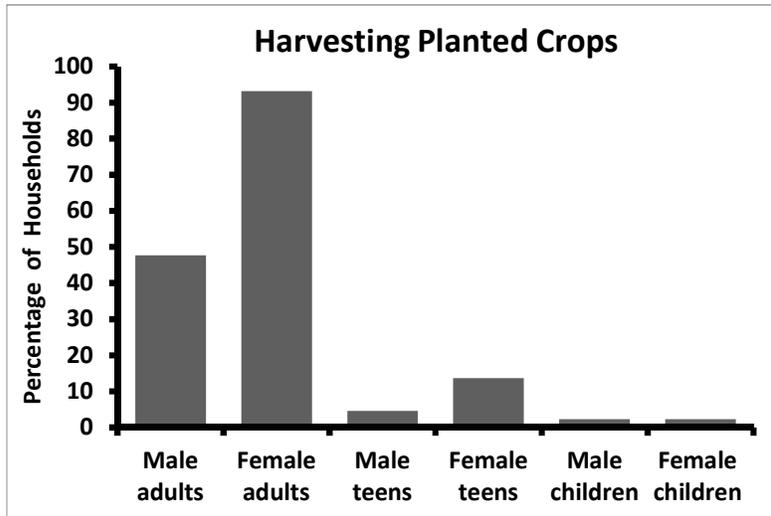


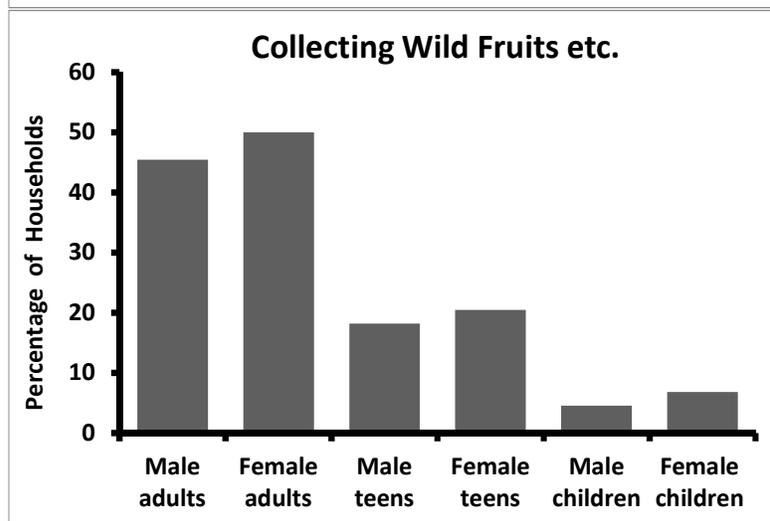
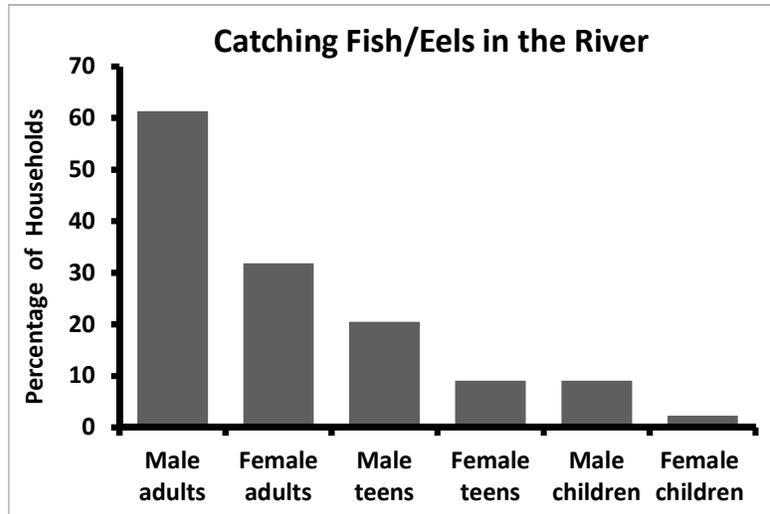


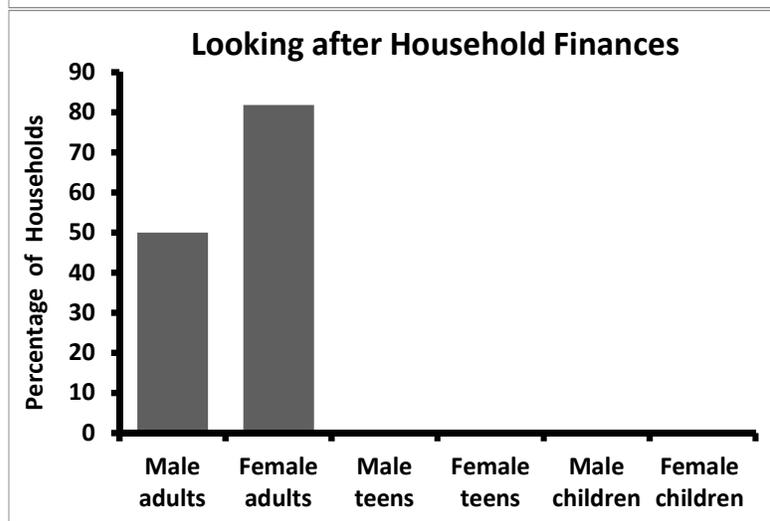
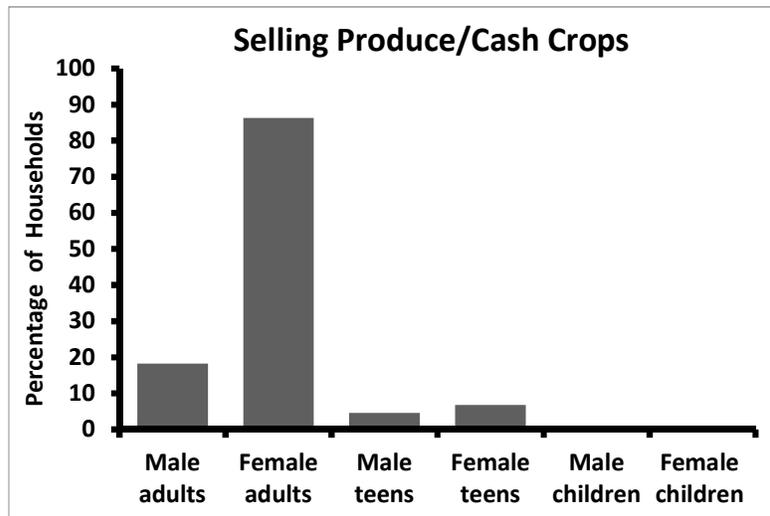


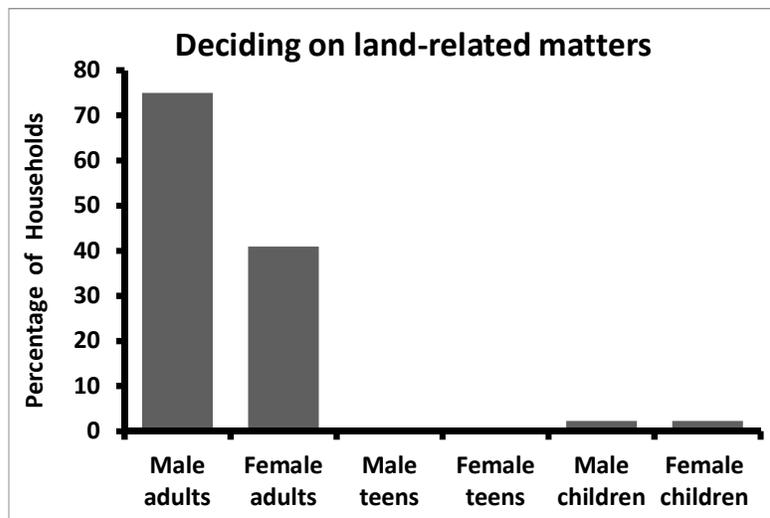
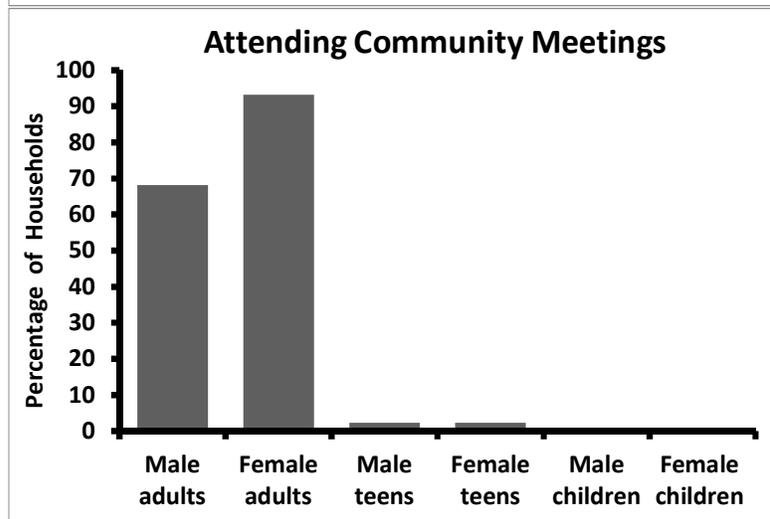
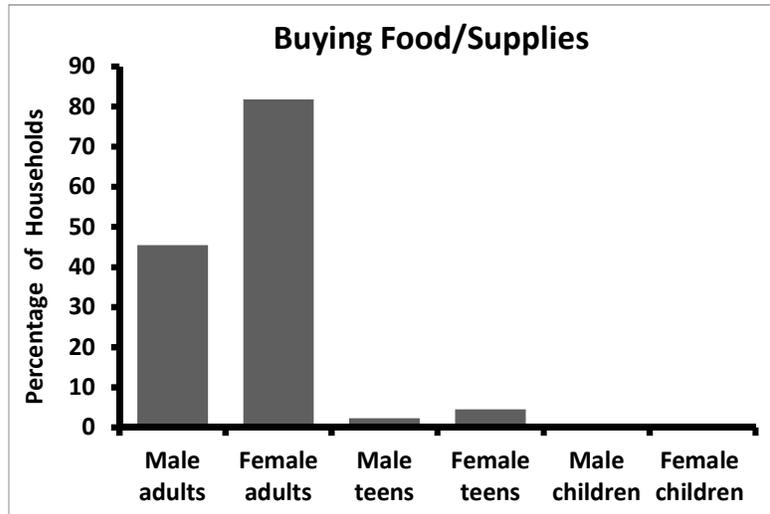






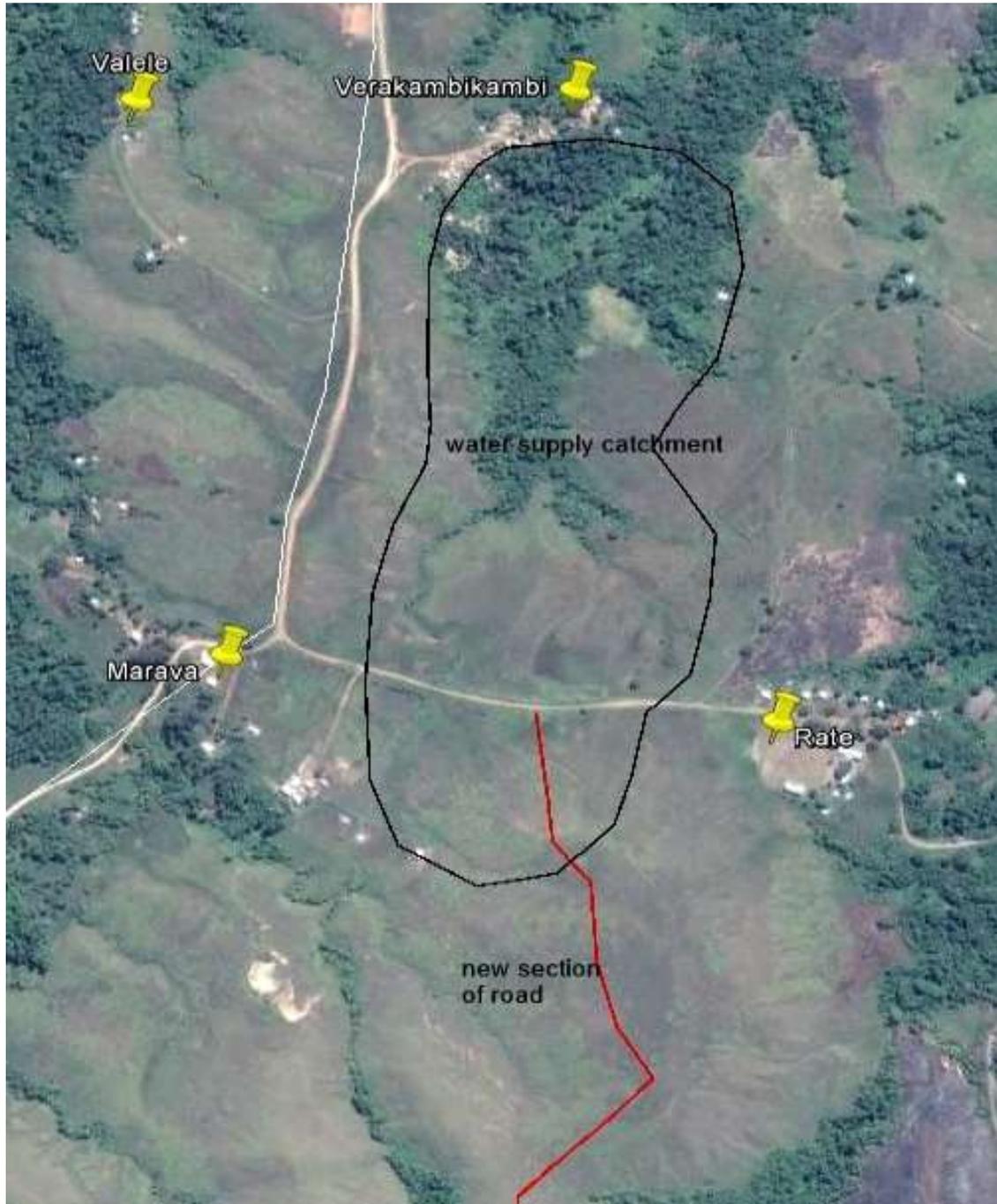






Annex 17 : Water supplies

Figure 2 The locations of the water supply for Verakabikabi and the proposed road at Rate



**Annex 18 : Protocol and Guidelines for
Cultural Heritage Management for the
TRHDP and code of conduct for
workers**

These Protocol and Guidelines Prepared by Lawrence Foana'ota, Solomon Islands National Cultural Heritage Expert.

PROTECTION OF TAMBU SITES PRIOR TO CONSTRUCTION

The following is provided by way of guidance in the preparation of a cultural heritage policy and procedure by the future TRHDP developer and contractor/s.

- i. First, talk with the members of the Landowners Core Group (LCG – the representatives of the landowners of the “core” project area) concerning the need to identify someone among them who has the knowledge of any tambu site(s) and their location(s) in the Project Impacted area(s).
 - ii. An expert with experience in recording the information associated with the tambu sites should be deployed from within or outside of the LCG to assist the knowledgeable person(s) they have identified and selected.
 - iii. Such knowledgeable and experience persons must be approved by the representatives from the LCG prior to involving them in this task.
 - iv. After the known tambu sites within the Project Impacted areas have been identified and the data collected and recorded, it must be stated clearly whether they will be completely or partly destroyed or only disturbed during the construction work on the Project.
 - v. It is of paramount importance that any tambu sites that are certain to be completely or partly destroyed should be prioritized for documentation while those that may be only disturbed could be clearly marked by using red and white painted posts erected around them to show that they are tambu sites and to be avoided.
 - vi. Any tambu sites located within the construction areas that the LCG really feels should not be destroyed should be demarcated with fence, and worked around where possible. This will help avoid any disagreements or demands for huge compensation payments which might delay the construction programme.
 - vii. Any decisions or agreements to move, relocate, or destroy any sacred objects from tambu sites must come either from the LCG or the heritage protection expert. This should be done before the construction work on the Project starts.
 - viii. For unknown tambu sites, it is important that, prior to construction, a clear understanding and written agreements (in the form of an accidental discovery protocol) between the LCG and the contractor should be made. This should specify how a contractor will act if a site is discovered , e.g., work will stop, the nominated LCG representative contacted (if not already on site supervising the work), the site owner identified, a scientific examination and/or cultural rituals performed, and any additional actions carried out to protect the rest of the site if required.
 - ix. The current compensation rates for disturbance or damage to tambu sites depend on the scale of destruction, and the distances between the sites and where the construction work is being carried out.
 - x. The following table provides some examples as a guide highlighting the different rates being paid by either loggers, miners or any development projects for the destruction of tambu sites:
-

Destruction or Disturbance of Tambu Sites	Compensation rates (Solomon Dollars)
Major Scale	\$50,000
Minor Scale	\$20,000
Disturbances: 50 meters from Sites	\$10,000
100 meters from Sites	\$15,000
Graves in Cemetery (per grave)	\$10,000

Note that disturbances are caused when trees fall into nearby tambu sites, and machines or employees pass through these sites during construction work even though they might not cause any physical damage to them.

CODE OF CONDUCT FOR LOCAL AND NON-LOCAL PROJECT WORKERS

The project developer and construction contractors will be expected, in advance of any construction work commencing on the project, to prepare and promulgate a code of conduct for its workers (and related visitors), including locals, other Solomon Islanders, and immigrants/expats. Induction training should include a cultural induction, delivered with the help of local knowledgeable elders.

WORKERS CODE OF CONDUCT FOR LOCAL AND NON-LOCAL PROJECT WORKERS

The project developer and construction contractors will be expected, in advance of any construction work commencing on the project, to promulgate this code of conduct for its workers (and related visitors), including locals, other Solomon Islanders, and immigrants/expats. Induction training shall include a cultural induction, delivered with the help of local knowledgeable elders.

The following is the code of conduct :

- ▶ Prior to entering a village or hamlet for the first time, the Chief, a leader from a church, or the head of a family (usually the father) shall be met for the construction contractor to show his respect.
- ▶ All workers must always consult the Chiefs, and community leaders (such as a church pastor or an elder) about any issues that may not be clear in the local culture.
- ▶ If no male members of the community are present, the outsider/visitor must not enter and talk to women, especially young girls and married women. This will help avoid any unnecessary arguments arising between a man and his wife or parents with their daughters.
- ▶ When talking or shaking hands with someone (whether a man or woman) do not look straight at them in the eyes or press their hands strongly because to some it is disrespectful, shameful or could mean something different, especially to a woman.
- ▶ Custom requires that women visitors who enter a village publically are suitably attired, that is, in clothing traditionally associated with women. Male-style work clothing (overalls, trousers, boots, and shorts) on women is not acceptable to many. This does not apply to female construction workers where safety is prevailing.
- ▶ Do not criticize someone openly but always call the person aside and talk to him or her separately to avoid any ill feelings. Such incidents may even escalate to a stage where other relatives may become involved.
- ▶ Saturdays and Sundays are days when some people in the communities go to Church and so there will be no work. Death and funerals are also times when work and other activities stop in the community. Always seek advice and clearance from the Chiefs or community leaders in such cases whether work should continue on or temporarily stop.

- ▶ No alcohol or any form of drugs shall be consumed in the communities by any project employees. The contractor/developer should have and enforce an alcohol and drug-free policy (in the work place, while driving vehicles, or use of the access roads). The company policy should develop a position on the use of betel nut in the workplace.
- ▶ All employees should respect the local custom or culture of the people. For example one must always ask before taking any produce growing in the area, such as bananas, kumara, cassava/root crops, nuts, fruits from trees, and coconuts etc. There is always someone in the community who owns them. Picking something without asking first is regarded as disrespect for the owner, or stealing, and may require payment of compensation to the owner.
- ▶ Workers and visitors should not make any disrespectful gestures or use any swearing words to anyone either in the community, or along the access road, especially to women or co-workers in the company workforce. These may lead to demand for compensation fees from communities.
- ▶ No unlicensed person shall drive work vehicles. Drivers shall be tested prior to starting work on the project, and have a valid license.
- ▶ Construction Company vehicles or trucks shall not be permitted to pick up anyone who is not an employee of the Project, except in case of an emergency.
- ▶ Heavy machinery shall only be operated by those who have the license and proven skills to use those types of machines. This shall be embedded in the recruitment and other policies of the contractor/s. This will help avoid health and safety problems and the unnecessary destruction of property, resources, and tambu sites.
- ▶ Workers and visitors shall drive slowly when passing villages that are very close to the access roadside or a pedestrian walking along the side of the road.
- ▶ Drivers and passengers shall watch out for domesticated animals or people crossing the access road.
- ▶ Take Prior Consultation, Careful Listening, and Paying Respect (PC-CL-PR) seriously because they are the key to avoiding conflict. Such incidents can easily escalate into company-community conflicts..

IMPLICATIONS OF THE PROJECT FOR THE MORO FOLLOWERS IN THE HAMLETS IN THE IMPACT AREA

The Moro (or Gaena'alu) Movement's has two main ongoing objectives:

- ▶ the establishment of a socio-political organization (initially headed by Moro) based on their traditional belief, and;
- ▶ the launching of a number of co-operative economic enterprises aimed at elevating the standard of living of the movement's followers.

The followers of the Moro/Gaena'alu Movement in the hamlets located in the project area regard the TRHDP as fulfilling these objectives. Today, even though they still keep some of their traditional way of life, they also depend on outside material goods such as money, clothes, cooking utensils, medicines, and some imported foods. They are also members of one of the Christian churches. They only wear the traditional attire when visitors call in their hamlets.

The general view the Movement's followers, including those in these hamlets in the Project Impact Area, is that such development should proceed as long as their traditional beliefs, practices, lifestyle, tambu sites, and personal property and resources are respected, and the impacts, if any, are mitigated or compensated for.

It is important that, along with other communities in the project area, that:

- ▶ this particular cultural minority are well informed of the consequences and impacts of this kind of development in their area prior to the project proceeding;
 - ▶ that the Government and the Developer must keep all of the promises they make with the people, regarding any form of assistance they decide to provide;
-

- ▶ that the Government and the Developer must respect local culture, and;
- ▶ respond quickly to any grievances that may arise due to the construction and operation of the project.

The project needs to take into consideration the wish of those followers who are present in the Impact Area for having alternative income generating activities that will mitigate or compensate some of the losses they may have because of the project. One example would be to assist them with ecotourism or home-stay type operations (such as at Senge). When they see there is something good coming out of such development that will benefit them, they would certainly be happy because this will be in line with their Movement's objectives.

The late Moro, who founded this movement, regarded development as a means through which the people can improve and raise their living standard but only in accordance to their culture and beliefs. Any development that goes against these they will not accept. The Moro people in the project area strongly believe, from their founders' teaching, that if people can get the material goods they need, they can bring together the two customs (the Western and the island Melanesian) in a new unity of prosperity and progress.

The implication for the Project of the followers of the Moro/Gaena'alu Movement residing in the Impact Area would be that the project could offer a path to an improved standard of living, including better schools, health facilities and material wealth. The Project Office/developer should continue to brief local Moro followers and consult on the kinds of benefit they would derive from the TRHDP when it is completed and operating. This will require a targeted awareness raising and ongoing consultation by the developer.

Annex 19 : Impact significance method for environmental components

Impacts significance is studied using a standardized method based on the integration of 6 criteria:

1. identification of impact sources
2. determination of affected components' value
3. Impact duration
4. Impact extent
5. Impact intensity
6. Impact occurrence probability

Criteria #1 Impact sources

An impact identification matrix presents activities (in lines) as well as components (in columns) and identifies all sources of impacts.

Criteria #2 Environmental and Social Components value

Each component of the natural environment will be analysed according to their value in the study area. Value assessment will be based on Experts' knowledge on the component, field surveys, public consultation, etc.

Value analysis does not take into account foreseen impacts, it is purely based on the component intrinsic value.

Three threshold levels are defined : Low, Moderately and Highly valued components.

Criteria #3 Impact duration

Each impact is identified according to its duration. Temporary and permanent impacts can be distinguished based on their reversibility: temporary are reversible and permanent are irreversible (or will last all through the Project lifespan).

Criteria #4 Impact extent

Each impact is defined by its geographical extent. Three levels are established: point source impact (punctual), local impact and regional impact.

Point source impacts affect a component on a very small scale of the study area, i.e. a small proportion of the study area species population.

Local impacts affect a component on the entire or the majority of the detailed study area in opposition to regional impacts that affect a component on a larger scale such as the entire extended study area or outside its boundaries.

Criteria #5 Impact intensity

Impact intensity refers to level of disruption on the component. Disruption of natural component refers to death of species, displacement, fragmentation and loss of habitats.

Three threshold levels of intensities are defined: Minor, Moderate and Major.

Impact significance determination

Impact significance is based on the four previous criteria. The following table presents the impact significance determination.

Positive impact are assessed using the same four criteria.

Intensity	Extent	Duration	Environmental and Social Component value		
			Low	Moderate	High

Major	Regional	Permanent			
		Temporary			
	Local	Permanent			
		Temporary			
	Punctual	Permanent			
		Temporary			
Moderate	Regional	Permanent			
		Temporary			
	Local	Permanent			
		Temporary			
	Punctual	Permanent			
		Temporary			
Minor	Regional	Permanent			
		Temporary			
	Local	Permanent			
		Temporary			
	Punctual	Permanent			
		Temporary			
Impact significance	Major				
	Moderate				
	Minor				
	Negligible				

Major impacts represent high level of perturbation of the component, these impacts are seldom mitigable and most of the times require compensation or offsets, followed by measurable monitoring measures.

Moderate impacts represent noticeable perturbation of the component, however these impacts can be mitigated and need to be monitored.

Minor impacts most of the time only require mitigation measures without the need for monitoring.

Negligible impacts do not require any particular measures.

Criteria #6: Impact occurrence probability

Assessment of the probability that an impact will take place will be based on the expert's experience on similar assignments.

Three thresholds will be used.

High probability	Analysis of the baseline coupled with Project characteristics concludes that the impact will take place
Potential occurrence	Based on previous experiences, it is possible that the impact will occur.
Risk (low probability)	Analysis of baseline coupled with Project characteristics only reveals a risk of impact occurrence.

Residual impact

After the implementation of measures, residual impact is assessed and impact significance reevaluate.

Annex 20 : Land Acquisition Process



SOLOMON ISLANDS GOVERNMENT
Ministry of Mines and Energy
and Rural Electrification
Tina River Hydropower Development Project
(TRHDP)

MEMO: Summary of the Land Acquisition Process and FPIC

The land needed for the Tina River Hydropower Development Project was compulsorily acquired by the Commissioner of Lands under Division 2, Part V, of the *Land and Titles Act*. The land acquired is referred to as the Core Land. It includes all of the land needed for the construction and operation of the project including the access road.

Although the process used was a 'compulsory' process under the legislation, the acquisition was contingent on first obtaining the consent of all identified landowning tribes. This consent was obtained through the negotiation of a written 'process agreement'.

The steps involved in the acquisition process are discussed in more detail below.

Bahomea Land Identification Committee

Before starting negotiations for the process agreement, the Project Office needed to identify the customary landowners of the land. Land is owned by tribes and as such negotiations for land cannot be done on a community/village level in the same way as general project awareness. Villages and communities are made up of a mixture of tribes.

Landowner identification was principally carried out by the Bahomea Land Identification Committee (**BLIC**). This Committee was made up of traditional knowledge holders (known as story tellers), chiefs and elders from different tribes and communities within the Bahomea and Malango regions of Central Guadalcanal. BLIC members are highly regarded in their own communities and tribes, and are considered to possess historical and traditional knowledge about land ownership, tribal groupings, and evidence of ownership (including tabu sites, boundaries, devils, migration routes and genealogies).

The Committee used traditional Central Guadalcanal methods to determine land ownership. This process took more than 12 months and involved more than 50 meetings between different elders, chiefs and tribal representatives. The Permanent Secretary of the Ministry of Lands, Housing and Survey and the Permanent Secretary of the Ministry of Mines, Energy and Rural Electrification formally endorsed the BLIC process and findings.

The Project Office discussed BLIC's findings through a series of discussions with representatives from different tribes. Representatives from several tribes came to the Project Office to discuss written and verbal landownership claims. Claims included customary evidence, Court decisions, surveyed boundaries, and the support of neighbouring tribes.

This process resulted in the identification of a number of tribes as holding primary interests within the area of land known as the Core Land.

Process Agreement

The Project Office negotiated the process agreement from 14 May 2014 to 11 July 2014.

A series of meetings were held between project office and representatives of each tribe identified as owning land within the Core Land. Representatives constituted between 6 to 10 individuals. Tribes were asked to bring male and female representatives.

The project engaged a lawyer for the Landowner's Advocacy and Legal Support Unit (**LALSU**) to represent the tribes during the negotiations.

Six to seven rounds of negotiations were held with each tribe. After each round, further amendments were made to the text of the process agreement ahead of the next round. Some negotiations took place with each tribe separately, and others with representatives of all tribes together.

When the final text was agreed by representatives of all tribes, Project Office staff held community awareness meetings inviting all members of each tribe. At the meetings the Project Office presented on the key clauses of the process agreement, explained the acquisition, and showed and provided maps of the Core Land to be acquired. Tribal members were given an opportunity to comment and to ask questions. No tribal members spoken to at these meetings objected to the project or to the acquisition of the land.

Four tribes signed the Process Agreement. These tribes were Buhu Garo, Vuralingi, Roha and Kochiabolo. The Process Agreement provided for later inclusion of any additional tribe identified through the statutory land acquisition process. Each of the four tribes chose seven representatives, including 2 women, to sign the final agreement. The final signing ceremony took place at a public function with Prime Minister Gordon Darcy Lilo.

Statutory Land Acquisition Process

The process agreement provided the written consent of the identified Core Land Tribes to proceed with a statutory acquisition process. The statutory land acquisition process included the following key steps:

- The Core Land was acquired by publication of a notice, from the Minister of Lands and Housing, in the Government Gazette. The notice acquiring the Core Land was published on 21 August 2014.
 - The Project Office took the following steps to bring awareness of the acquisition process and rights to claim compensation to potential Core Land interest holders:
 - Publishing a full page notice, map and FAQs in the Island Sun and the Solomon Star (the two largest of Solomon Islands' newspapers);
 - Posting A3 notices and maps at the boundary to the Core Land and in key locations in villages in Bahomea and Malango;
 - Posting A3 notices and maps at Guadalcanal Provincial headquarters;
-

- Training community educators to speak in villages in and around the area about the acquisition process and providing educators with A3 laminated graphic information sheets;
- Delivering letters to representatives of each of the 27 tribes registered in Bahomea and Malango setting out the acquisition and compensation claim process (statutory requirement).
- Tribes claiming an interest in the land were given 3 months to submit written claims for compensation for the value of their interest in the land. The statutory process provides that claimants may seek assistance from the Provincial Secretary for Guadalcanal Province. The Project Office provided the following assistance for compensation claimants:
 - Legal assistance for the identified Core Land Tribes through LALSU;
 - Legal assistance for all other claimants through the Project Office funding an independent private lawyer, chosen and engaged by the Provincial Secretary for Guadalcanal Province; and
 - Funds for an independent valuer, engaged by the Core Land Tribes, to value the compensation payable for primary ownership interests in the Core Land.
- The Commissioner of Lands received nine claims from eight tribes. Four of these claims were prepared by the tribes who were signatories to the Process Agreement, of which three sought assistance from LALSU. Five claims were prepared by four tribes who were not identified through the BLIC process. These tribes received assistance from an independent private lawyer engaged through the Provincial Secretary for Guadalacanal.
- In accordance with the statutory process, the Commissioner of Lands assessed each claim and determined:
 - (a) the customary owners of interests in the acquired land; and
 - (b) the value of each interest.
- The Commissioner of Lands assessment provided an offer of compensation to five tribes. These tribes were the four process agreement signatory tribes, as well as one additional claimant, Uluna Sutahuri.
- In accordance with the statutory process, Claimants were provided with notice of their offer of acceptance or rejection. Notices set out the Claimants rights to accept or reject the determination, and of the three month High Court appeal period.
- No tribes elected to appeal the Commissioner of Lands' determination.
- Process complete 1 January 2016.

Uluna Sutahuri

Extensive consultations were held with the Uluna Sutahuri tribe following their statutory endorsement and offer of compensation under the statutory process. Uluna Sutahuri were also customary owners of a rain guage monitoring site and were extensively involved in the Project for many years. Uluna Sutahuri representatives signed the Process Agreement in December 2015.

APPENDICES

This report includes all Appendices to the ESIA Main Report. It contains valuable information such as analysis of mitigation measures, analysis of protected area opportunities, and a review of the adoption of community feedback, etc. Appendix sequence in this report is classified in a chronological order and reflect the time at which information was gathered or obtained.

APPENDICES

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Appendix A

Terrestrial Ecosystem Sampling Stations

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Appendix A

Terrestrial Ecosystem Sampling Stations

A.1 General Description of Habitats Along Sampling Stations

Coordinates of each terrestrial ecology sampling station are described herein, and coincide with the map below - Location of Aquatic, Fauna and Flora sampling Stations. Station numbers are related to their spatial distribution. Station #1 is the most upstream station and station #24 is the farthest from the TRHDP.

A.1.1 Upper Stream Sampling Area

Upper Stream areas were primarily covered by undisturbed forests; most terrain was quite steep.

Fauna & Flora #1: Primary lowland forest - Riparian vegetation; site is located adjacent to a cliff area and is surrounded by undisturbed forest and the river.

Fauna & Flora #2: Primary lowland forest - Riparian vegetation; site is located at a confluence of Vohara and Mbeambea rivers; surrounding areas were forested however there is evidence of past village settlement.

Fauna & Flora 3: Primary lowland forest - Riparian vegetation; site is located close to Njarimbisu River.

Conditions during the sampling of these stations were wet to cloudy and were deemed not optimal for observing fauna as the conditions would limit the movement of species.

A.1.2 Middle Tina River Sampling Area

Fauna & Flora #4: Lowland forest - Riparian vegetation; site is located in forest with slight disturbance and evidence of timber extraction.

Fauna & Flora #5: Lowland forest - Secondary regrowth; site is located on a steep slope and covered by forest, with evidence of disturbance through timber harvesting and past garden use.

Fauna & Flora #6: Lowland forest overlapping secondary vegetation; site is located adjacent to a village area and is surrounded by gardens and remnant forest.

Fauna & Flora #7: Lowland forest - Secondary regrowth and riparian vegetation; site is located on a flat area that is forested. However, there is evidence of disturbance through timber harvesting.

Fauna & Flora #8: Lowland forest and riparian vegetation; site is located in a very steep area that is forested, with evidence of past timber harvesting.

Fauna & Flora #9: Secondary lowland forest; is located in forested areas, with disturbance due to current timber harvesting.

Fauna & Flora #10: Cliff areas are mainly covered in distinct cliff vegetation that lacked larger canopy trees but covered with smaller plants such as ferns and shrubs. The site is located on a very steep slope adjacent to the water.

Fauna & Flora #11: Old Garden Area - Secondary forest; site is located on a slight slope and covered with gardens and fallow brush land from past garden use.

Fauna & Flora #12: Lowland forest on ridge top; site is located on a ridge adjacent to a steep slope to the Tina River. It is surrounded by relatively undisturbed forest with the presence of large canopy trees.

Fauna & Flora #13: Riparian Vegetation; site is located on a steep slope that is forested. However, there is evidence of disturbances through past timber harvesting.

Fauna & Flora #14: Cliff areas are mainly covered in distinct cliff vegetation that lacks larger canopy trees. It is covered with smaller plants such as ferns and shrubs. The site is located on a very steep slope adjacent to the water.

Fauna & Flora #15: Lowland forest on ridge top; site is located in Sengue old Tina meander.

Fauna & Flora #16: Lowland forest - Secondary Vegetation; site is located in disturbed forest, with evidence of past and current timber harvesting.

Fauna & Flora #17: Lowland forest; site is located on a small hill covered by forest with evidences of timber harvesting and some relatively undisturbed areas.

Fauna & Flora #18: Lowland forest - secondary and riparian vegetation; site is located on a flat areas that is surrounded by gardens with crops of betelnut, banana and coconut. Fallow brush land is also evident.

Fauna & Flora #19: Lowland rainforest on ridgetop; site is located on a hill slope surrounded by forest with evidence of disturbance such as past timber harvesting.

Conditions during sampling were clear to cloudy and were deemed optimal for observing fauna.

A.1.3 Transmission Line Sampling Area

Fauna & Flora #20: Secondary vegetation on open ridgetop overlapping grasslands; Site is located in remnant forest.

Fauna & Flora #21: Lowland forest - open vegetation - secondary regrowths; site is located between grassland, gardens and remnant forest dominated by Canarium nut trees. Site is located along the future transmission line.

Fauna & Flora #22: Open grassland - Secondary vegetation; site is located on roadside. Site located along the future transmission line.

Fauna & Flora #23: Secondary vegetation on grassland; site is located between oil palm plantations and grassland inter-mixed with gardens. Site is located along the future transmission line.

Fauna & Flora #24: Secondary vegetation on grassland; Site is located between oil palm plantation and fallow bush dominated by paper mulberry trees. Site is located along the future transmission line.

Conditions during sampling were clear to cloudy and were deemed optimal for observing fauna.

A.1.4 Previous Stations: Site A, B, C

Fauna and Flora was also characterized in the ESIA Scoping Study prepared by Entura (2013) during a rapid flora assessment. Results were obtained for the current ESIA. The following station description comes from the ESIA Scoping.

Site A: The vegetation cover in this site is comprised of lowland primary forest trees, riparian species and elements of steep ridge forests decorated by different species of palms, grass and shrubs. The overall forest canopy cover is about 80%.

Site B: This site appears to be disturbed by human activities such as gardening and is located next to Koropa village. As such, the vegetation cover is mainly lowland secondary forest with some big, old trees, colonized with ferns and palms. The overall forest canopy cover is about 60%.

Site C: Contains a thin riparian forest belt about ten metres wide next to a very steep ridge with recent land slide on the lower part of Sengue village. The site appears to be a flood plain and is occupied by secondary regrowth of small to medium size trees. The overall canopy cover is about 50%.

The ESIA Scoping report provides a list of plant species identified at these three sites. These plants were added to the ESIA flora survey list (see table next section). However, it did not specify in which plants were observed by sample site, in the flora table next section they are all gather under “ES stations” (ESIA Scoping Stations).

A.1.5 Coordinates

The following table lists all stations coordinates. Since these stations are terrestrial, river chainage is not shown

Table 1 Station Coordinates

Full name	Short name	Coordinate*	Full name	Short name	Coordinate*
Fauna & Flora 24	F&F24	S09,44763 E160,10069	Fauna & Flora 10	F&F10	S09,55326 E160,07375
Fauna & Flora 23	F&F23	S09,46438 E160,10502	Fauna & Flora 9	F&F9	S09,55332 E160,08220
Fauna & Flora 22	F&F22	S09,48518 E160,11072	Fauna & Flora 8	F&F8	S09,55342 E160,07919
Fauna & Flora 21	F&F21	S09,52470 E160,09351	Fauna & Flora 7	F&F7	S09,55546 E160,07742
Fauna & Flora 20	F&F20	S09,53821 E160,08854	Fauna & Flora 6	F&F6	S09,55573 E160,07180
Fauna & Flora 19	F&F19	S09,54159 E160,08024	Fauna & Flora 5	F&F5	S09,55717 E160,06947
Fauna & Flora 18	F&F18	S09,54177 E160,08936	Fauna & Flora 4	F&F4	S09,55823 E160,06667
Fauna & Flora 17	F&F17	S09,54286 E160,08677	Fauna & Flora 3	F&F3	S09,59459 E160,03574
Fauna & Flora 16	F&F16	S09,54466 E160,08835	Fauna & Flora 2	F&F2	S09,59487 E160,03055
Fauna & Flora 15	F&F15	S09,54511 E160,08156	Fauna & Flora 1	F&F1	S09,59513 E160,03469
Fauna & Flora 14	F&F14	S09,54994 E160,08048	Station Site C	Station Site C	S9,32.812 E160,05.060
Fauna & Flora 13	F&F13	S09,55086 E160,08124	Station Site B	Station Site B	S9,33.557 E160,03.805
Fauna & Flora 12	F&F12	S09,55143 E160,07822	Station Site A	Station Site A	S9,35.487 E160,01.802
Fauna & Flora 11	F&F11	S09,55270 E160,08060			

Appendix B

List of Amphibian Species Occurring in TRHDP Study Area

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Appendix B

List of Amphibian Species Occurring in TRHDP Study Area

Amphibians of the Study area

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local Uses	River Dependent
Bufonidae TRUE TOADS											
<i>Bufo marinus</i>	Cane Toad	F&F24, F&F7, F&F6, F&F5, F&F4, F&F9, F&F1	PP	-	I	LC	-	-	I	-	-
Ceratobatrachidae											
<i>Batrachylodes vertebralis</i>	Fauro Sticky-toed Frog	F&F6, F&F5, F&F4, F&F9, F&F11	PP	-	-	LC	-	II	S	-	-
<i>Batrachylodes elegans</i>	Elegant Sticky-toed Frog		SSa, SSb	-	-	LC	-	-	S	-	-
<i>Ceratobatrachus guentheri</i>	Solomon Islands Eyelash Frog	F&F5, F&F9	PP, GR	-	-	LC	-	II	S	-	-
<i>Discodeles guppyi</i>	Giant Webbed Frog		PP, SSa, SSb, GR, LK	-	-	LC	-	-	S	F	X
<i>Discodeles malakuna</i>	Malakuna Webbed Frog	F&F1	SSa, SSb	-	SI	DD	-	-	S	-	-
<i>Platymantis guppyi</i>	Solomon Islands Giant Treefrog	F&F1	SSa, SSb, GR, PP	-	-	LC	-	-	S	-	-
<i>Platymantis solomonis</i>	Solomon Wrinkled Ground Frog		SSa, PP	-	-	LC	-	I	S	-	-
<i>Platymantis weberi</i>	Weber's Wrinkled Ground Frog	F&F6, F&F9	SSa, PP	-	-	LC	-		S	-	-
Hylidae TREEFROGS											
<i>Litoria lutea</i>	Solomon Island's Treefrog		SSa	-	-	VU	-	-	S	-	-
<i>Litoria thesaurensis</i>	Treasury Island Treefrog	F&F6	PP	-	-	LC	-	-	S	-	-
<i>Litoria sp.</i>		F&F5	SS, GR	-	-	-	-	-	S	-	-

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local Uses	River Dependent
Ranidae TRUE FROGS											
<i>Hylarana krefftii</i>	San Cristobal Treefrog	F&F1	GR, PP	-	-	LC	-	-	S	-	X

Potential Species: TRHDP ESIA Scoping Study = SSa=site A, SSb=site B, SSc=site C; Frogs of the SI = PP, Gold Ridge Report = GR, Local Knowledge = LK

Endemic: Guadalcanal = G, Solomon Islands = SI, Introduced = I

IUCN Red List Category: Least Concern = LC, Vulnerable = VU & Data Deficient = DD

Population Trend: Increasing =I & Stable =S (according to IUCN Red List Category)

Local Uses: Food =F (bush meat)

1998 Act = Wildlife Protection and Management Act 1998 Schedule I lists the species that are prohibited to export, Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required

Appendix C

List of Reptile Species Occurring in the TRHDP Study Area

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Appendix C

List of Reptile Species Occurring in the TRHDP Study Area

Reptiles of the Study area

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses / Venomous	River Dependent
Gekkonidae GECKOS											
<i>Cyrtodactylus salomonensis</i>	Solomons Bent-toed Gecko		MM, GR	-	SI	NT	-	II	S	-	-
<i>Cyrtodactylus biordinis</i>	Guadalcanal Bow-fingered Gecko		MM, LK	-	G	LC	-	-	S	-	-
<i>Gehyra oceanica</i>	Oceanic Gecko		MM,	-	-	LC	-		S	-	-
<i>Gekko vittatus</i>	Sago Gecko		MM	-	-	LC	-	II	S	-	-
<i>Nactus multicaudatus</i>	Solomons Slender-toed Gecko	F&F4, F&F9	MM	-	-	LC	-	-	S	-	-
Scincidae SKINKS											
<i>Corucia zebrata</i>	Prehensile-tailed Skink		SSa, SSb, MM, LK	-	SI	NT	II	II	D	F	-
<i>Emoia cyanogaster</i>	Green-Bellied Tree Skink		MM, SSa, SSb	-	-	LC	-	-	S	-	-
<i>Emoia cyanura</i>	Brown-tailed Copper-striped Skink	F&F21, F&F19	MM, SSa, SSb, SSc, GR	-	-	LC	-	II	S	-	-
<i>Emoia nigra</i>	Pacific Black Skink	F&F24, F&F19, F&F1, F&F13, F&F9	MM, SSa, SSb, SSc, GR, LK	-	-	LC	-	-	S	-	-
<i>Emoia pseudocyanura</i>	Solomons Blue-tailed Skink	F&F20, F&F19, F&F18, F&F17, F&F13, F&F2, F&F1	MM, SS, GR	-	SI	LC	-	-	S	-	-
<i>Eugongylus albobasiliatus</i>	White-banded Giant Skink		MM	-	-	LC	-	-	S	-	-
<i>Lipinia noctua</i>	Moth Skink		MM	-	-	LC	-	-	S	-	-
<i>Lamprolepis smaragdina</i>	Emerald Tree Skink		MM, SSb, SSc	-	-	LC	-	II	S	-	-
<i>Prasinohaema virens</i>	Green-blooded Skink		MM, GR	-	-	LC	-	II	S	-	-

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses / Venomous	River Dependent
<i>Sphenomorphus bignelli</i>			MM	-	SI	LC	-	-	S	-	-
<i>Sphenomorphus concinnatus</i>	Elegant Forest Skink		MM, GR	-	-	LC	-	II	S	-	-
<i>Sphenomorphus solomonis</i>			MM, GR	-	-	LC	-	II	S	-	-
<i>Sphenomorphus cranei</i>	Crane's Skink		MM, GR	-	-	LC	-	-	S	-	-
<i>Tribolonotus schmidti</i>	Schmidt's Crocodile Skink		MM, GR	-	G	LC	-	-	S	-	-
Boidae BOAS											
<i>Candoia paulsoni</i>	Solomons Ground Boa		MM, SS, GR, LK	-	-	LC	II	-	S	-	-
Colubridae COLUBRID SNAKES											
<i>Boiga irregularis</i>	Brown Tree Snake		SSa, GR	-	-	LC	-	-	S	V	-
<i>Dendrelaphis salomonis</i>	Solomons Tree Snake	F&F20	MM, GR, LK	-	-	LC	-	-	S	-	-
Elapidae ELAPID SNAKES											
<i>Salomonelaps par</i>	Solomons Red Krait		MM, SSa, GR, LK	-	-	LC	-	-	S	V	-

Potential Species: TRHDP ESIA Scoping Study = SSa=site A, SSb=site B, SSc=site C;
 Reptiles of the Solomon Islands = MM, Gold Ridge Report = GR, Local Knowledge = LK

Endemic: Guadalcanal = G, Solomon Islands = SI

IUCN Red List Category: Least Concern = LC, Near Threatened = NT

CITES Appendix for international trade of species: II = may be authorized by the granting of an export permit

Population Trend: Decreasing =D & Stable =S (according to IUCN Red List Category)

Local Uses / Venomous, Food =F (bush meat), V= Venomous

1998 Act: Wildlife Protection and Management Act 1998. Schedule I lists the species that are prohibited to exports, Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required

Appendix D

List of Bird Species and Subspecies Occurring in the TRHDP Study Area and Their Status / Vulnerability

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Appendix D

List of Bird Species Occurring in the TRHDP Study Area and Their Status / Vulnerability

Birds of the Study area

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
Ardeidae HERONS. Diet: mainly fish, but also amphibian, reptile, small mammal, insect											
<i>Nycticorax caledonicus mandibularis</i>	Nankeen Night Heron	F&F6, F&F5, F&F4, F&F10	SSa, SSb, SSsc, GD, MT	-	-	LC	-		S	-	R
<i>Egretta s. sacra</i>	Pacific Reef Heron	F&F22	GD	-	-	LC	-		S	-	R
Phalacrocoracidae CORMORANTS. Diet: mainly fish, but also amphibian and aquatic insects											
<i>Microcarbo m. melanoleucos</i>	Little Pied Cormorant	F&F7, F&F6, F&F5, F&F4, F&F2	SSa, SSb, SSsc, GD	-	-	LC	-		S	-	R
Anatidae DUCKS. Diet: detritivores											
<i>Anas superciliosa</i>	Pacific Black Duck		SSa, SSb, SSsc, MT, GD	-	-	LC	-		S	F	R
Accipitridae HAWKS and EAGLES. Diet: fish, large insects, birds, mammals, amphibians											
<i>Haliastur indus flavirostris</i>	Brahminy Kite	F&F5, F&F12	SSb, SSsc, MT, GD, GR	-	SI	LC	II		D	-	U
<i>Aviceda subcristata proxima</i>	Pacific Baza		MT, GD, LK	-	SI	LC	II		S	-	U
<i>Accipiter novaehollandiae pulchellus</i>	Variable Goshawk	F&F2	MT, GD	-	G	LC	II		D	-	U

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Accipiter meyerianus</i>	Meyer's Goshawk	F&F22	MT, GD, GR	-	-	LC	II	I	D	-	U
<i>Haliaeetus sanfordi</i>	Solomon Sea-Eagle	F&F20, F&F2	MT, GD	-	SI	V U	II	I	D	-	U
Megapodiidae MEGAPODES. Diet: fruits, seeds, insects and other invertebrates											
<i>Megapodius eremita</i>	Melanesian Scrub Fowl		SSa, SSb, MT, GD, LK	-	-	LC	-		D	F	F
Turnicidae BUTTONQUAILS. Diet: invertebrates											
<i>Turnix maculosa salomonis</i>	Red-backed Button-Quail		MT, GD	-	SI	LC	-		D	F	-
Rallidae RAILS. Diet: herbivores, omnivores											
<i>Gallirallus philippensis christophori</i>	Buff-banded Rail	F&F22	MT, GD, LK	-	SI	LC	-		S	F	-
<i>Nesoclopeus w. woodfordi</i>	Woodford's Rail	F&F24, F&F22	MT, GD, LK	-	G	N T	-	I	D	F	F
<i>Amaurornis moluccanus sp.</i>	Pale-vented Bush-hen	F&F6	MT, GD, LK	-	SI	LC	-		S	F	F
<i>Porphyrio p. samoensis</i>	Purple Swamp hen	F&F22	GD, SSb, SSc, LK	-	-					F	R
Scolopacidae SANDPIPERS and CURLEWS. Diet: Small fish, crustaceans, frogs											
<i>Actitis hypoleucos</i>	Common Sandpiper	F&F7, F&F5, F&F4	MT, GD, LK	X	-	LC	-		D	CI	R
Columbidae PIGEONS. Diet: Seeds and fruits											
<i>Ptilinopus s. superbus</i>	Superb Fruit-Dove		MT, GD, GR	-	-	LC	-		S	F	F

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Ptilinopus solomonensis ocularis</i>	Yellow-bibbed Fruit-Dove		MT, GD, GR	-	G	LC	-	I	S	F	F
<i>Ptilinopus viridis lewisii</i>	Claret-breasted Fruit-Dove		MT, GD, GR	-	-	LC	-		S	F	F
<i>Ducula rubricera rufigila</i>	Red-knobbed Imperial Pigeon	F&F21, F&F19, F&F12, F&F18, F&F17, F&F6, F&F5, F&F9, F&F16	SSa, SSb, MT, GD, GR, LK	-	SI	N T	-		D	F	F
<i>Ducula p. pistrinaria</i>	Island Imperial Pigeon		MT, GD	-	-	LC	-		S	F	F
<i>Gymnophaps solomonensis</i>	Pale Mountain Pigeon		MT, GD	-	-	LC	-		S	F	F
<i>Macropygia mackinlayi arossi</i>	Mackinlay's Cuckoo-Dove	F&F8, F&F2, F&F1	SSa, SSb, MT, GD	-	-	LC	-		S	F	F
<i>Reinwardtoena crassirostris</i>	Crested Cuckoo-Dove	F&F16	SSa, MT, GD	-	-	N T	-		D	F	F
<i>Chalcophaps stephani mortoni</i>	Stephan's Dove		SSb, SSb, MT, GD, GR	-	SI	LC	-		S	F	F
Cacatuidae COCKATOOS. Diet: seeds and fruits											
<i>Cacatua ducorpsi</i>	Ducorp's Cockatoo	F&F20, F&F19, F&F2, F&F1	SSa, SSb, SSb, MT, CD, GR	-	-	-	II	II	S	-	U
Psittacidae PARROTS. Diet: seeds, nuts, fruits											

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Chalcopsitta cardinalis</i>	Cardinal Lory		SSa, SSb, SSc, MT, GD, GR, LK	-	SI	LC	II	II	S	-	U
<i>Trichoglossus haematodus massena</i>	Coconut Lorikeet	F&F21, F&F16, F&F2, F&F1	SSa, SSb, SSc, MT, GD, LK	-	-	LC	II	II	D	-	U
<i>Lorius chlorocercus</i>	Yellow-bibbed Lory	F&F18, F&F17, F&F7, F&F5, F&F9, F&F1	SSa, SSb, MT, GD, GR, LK	-	SI	LC	II	II	S	-	F
<i>Chamosyna margarethae</i>	Duchess Lorikeet		MT, GD, GR	-	-	NT	II	I	D	-	F
<i>Micropsitta finschii aolae</i>	Finsch's Pigmy Parrot	F&F16	MT, GD, GR, LK	-	SI	LC	II	I	S	-	F
<i>Eclactus roratus solomonensis</i>	Eclactus Parrot	F&F1	SSa, SSb, MT, GD, GR, LK	-	-	LC	II	II	D	-	U
<i>Geoffroyus h. heteroclitus</i>	Song Parrot		MT, GD, GR	-	-	LC	II	I	S	-	U
Cuculidae CUCKOOS. Diet: insect											
<i>Cacomantis variolosus addendus</i>	Brush Cuckoo		MT, GD, GR	-	-	LC	-		S	-	U

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Centropus m. milo</i>	Buff-headed Coucal	F&F22, F&F21, F&F20, F&F19, F&F18, F&F9	SSa, SSb, MT, GD, GR	-	SI	LC	-		S	-	F
Strigidae OWLS. Diet: insect and small mammal											
<i>Ninox jacquiniti granti</i>	Guadalcanal Boobook		MT, GD, GR	-	G	LC	II		S	-	U
Apodidae SWIFTS. Diet: insect											
<i>Aerodramus vanikorensis lugubris</i>	Uniform Swiftlet	F&F24, F&F22, F&F9, F&F1,	MT, GD	-	-	LC	-		S	-	U
<i>Collocalia esculenta becki</i>	Glossy Swiftlet	F&F6, F&F5, F&F4, F&F9, F&F8, F&F14, F&F10, F&F2, F&F1	SSa, SSb, SSc, MT, GD, GR,	-	SI	LC	-		S	-	U
Hemiprocnidae TREESWIFTS. Diet: insect											
<i>Hemiprocne mystacea woodfordiana</i>	Moustached Tree-Swift		MT, GD, GR	-	-	LC	-		S	-	G
Coraciidae ROLLERS. Diet: insect											
<i>Eurystomus orientalis solomonensis</i>	Dollar Bird		MT, CD, GR	-	-	LC	-		D	-	U
Bucerotidae HORNBILLS. Diet: fruits (figs) and small animals											
<i>Aceros plicatus mendanae</i>	Blyth's Hornbill	F&F7, F&F5, F&F18, F&F9, F&F11, F&F8, F&F2, F&F1	SSa, SSb, SSc, MT, GD, GR, LK	-	SI	LC	II		D	-	F
Alcedinidae KINGFISHERS. Diet: mainly fish but also wetland insects											

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Alcedo atthis salomonensis</i>	Common (River) Kingfisher	F&F1	SSa, SSb, SSc, MT, GD, GR	-	-	LC	-		S	-	R
<i>Ceyx lepidus nigromaxilla</i>	Variable Dwarf Kingfisher	F&F5, F&F8	MT, GD, GR	-	G	LC	-		D	-	R
<i>Todiramphus chloris alberti</i>	Collared Kingfisher		MT, GD, GR	-	-	LC	-		D	-	R
<i>Todiramphus leucopygius</i>	Ultramarine Kingfisher		MT, GD, GR	-	-	LC	-		S	-	R
Hirundinidae SWALLOWS. Diet: insect											
<i>Hirundo tahitica subfusca</i>	Pacific Swallow		SSb, SSc, MT, GD	-	-	LC	-		I	-	G
Campephagidae CUCKOOSHRIKES and TRILLERS. Diet: insect											
<i>Coracina lineata pusilla</i>	Barred Cuckoo-shrike		MT, GD, GR	-	-	LC	-		S	-	U
<i>Coracina papuensis elegans</i>	White-bellied Cuckoo-Shrike	F&F21	SSb, SSc, MT, GD, GR	-	SI	LC	-		I	-	U
<i>Coracina h. holopolia</i>	Solomon Cuckoo-Shrike		MT, GD, GR	-	-	N T	-		D	-	U
<i>Coracina tenuirostris erythropygia</i>	Common Cicadabird	F&F6	MT, GD, GR	-	SI	LC	-		S	-	F
Rhipiduridae FANTAILS. Diet: insect											

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Rhipidura leucophrys melaleuca</i>	Willie Wagtail	F&F5, F&F4, F&F8, F&F14, F&F2, F&F1	SSa, SSb, SS _c , MT, GD, GR	-	-	LC	-		I	-	G
<i>Rhipidura c. cockerelli</i>	Cockerell's Fantail		MT, GD, GR	-	G	N T	-		D	-	F
<i>Rhipidura rufifrons rufifrons</i>	Rufous Fantail		MT, GD, GR	-	G	LC	-		D	-	F
Monarchidae MONARCHS. Diet: insect											
<i>Monarcha c. castaneiventris</i>	Chestnut-bellied Monarch	F&F5, F&F8	SSa, SSb, MT, GD, GR, LK	-	SI	LC	-		D	-	U
<i>Monarcha b. barbatus</i>	Solomons Monarch	F&F5, F&F9	MT, GD, GR, LK	-	SI	N T	-		D	-	F
<i>Myiagra f. ferrocyanea</i>	Steel-blue Flycatcher	F&F5, F&F1	MT, GD, GR	-	SI	LC	-		S	-	U
Pachycephalidae WHISTLERS. Diet: insect											
<i>Pachycephala pectoralis cinnamomea</i>	Golden Whistler	F&F17, F&F6, F&F4, F&F9	SSa, SSb, MT, GD, GR, LK	-	G	LC	-		S	-	F
Dicaeidae FLOWERPECKERS. Diet: insect and fruits											
<i>Dicaeum aeneum becki</i>	Midget Flowerpecker	F&F12, F&F7, F&F5, F&F4, F&F9, F&F14, F&F10, F&F1	MT, GD, GR	-	G	LC	-		S	-	U
Nectariniidae SUNBIRDS. Diet: nectar and insect											

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	Habitat
<i>Nectarinia jugularis flavigastra</i>	Olive-backed Sunbird	F&F21, F&F2	SSa, SSb, SSc, MT, GD	-	-	LC	-		S	-	U
Meliphagidae HONEYEATERS. Diet: nectar											
<i>Myzomela melanocephala</i>	Black-headed Myzomela	F&F9, F&F8, F&F1	MT, GD, GR	-	G	LC	-		D	-	U
Sturnidae STARLINGS. Diet: insect and fruits											
<i>Aplornis cantoroides</i>	Singing Starling		SSa, SSb, MT, GD, GR	-	-	LC	-		S	-	U
<i>Aplornis grandis macrura</i>	Brown-winged Starling	F&F6, F&F5, F&F10	MT, GD, GR	-	G	LC	-		S	-	U
<i>Aplornis metallicus nitida</i>	Metallic Starling	F&F5, F&F9	SSa, SSb, MT, GD	-	-	LC	-		S	-	U
<i>Aplornis brunneicapilla</i>	White-eyed Starling		MT, GD, GR	-	SI	EN	-		D	-	U
<i>Acridotheres tristis</i>	Common Myna	F&F22	MT, GD	-	I	LC	-		I	-	U
<i>Mino kreffti sanfordi</i>	Long-tailed Myna	F&F21, F&F20, F&F19, F&F17, F&F5	SS, MT, GD, GR	-	SI	LC	-		S	-	U
Corvidae CROWS. Diet: omnivores											
<i>Corvus woodfordi</i>	White-billed Crow	F&F12, F&F18, F&F16, F&F1	SSa, SSb, MT, GD, GR, LK	-	SI	LC	-		S	-	F

Potential Species: TRHDP ESIA Scoping Study = SSa=site A, SSb=site B, SSc=site C; Birds of Melanesia = GD, Guadalcanal Island Bird Checklist = MT, Gold Ridge Report = GR, Local Knowledge = LK

Endemic: Guadalcanal = G, Solomon Islands = SI, Introduced = I

IUCN Red List Category, Least Concern = LC, Near Threatened = NT, Vulnerable = VU, Endangered = EN & Data Deficient = DD

CITES Appendix for international trade of species, II = may be authorized by the granting of an export permit

Population Trend: Increasing =I, Decreasing =D & Stable =S (according to IUCN Red List Category)

Local Uses: Food =F (bush meat) & Cultural Importance = CI

1998 Act: Wildlife Protection and Management Act 1998. Schedule I lists the species that are prohibited to exports, Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required

Habitat: R: river dependent, U : Ubiquist (forest edge, grassland, riverine), F : forest interior, G :Grassland

The most important bird species and subspecies based on their CITES or IUCN (Red List) status, or endemcity, are identified below, along with their relative vulnerability to the Project:

Nankeen Night Heron (*Nycticorax caledonicus mandibularis*) - This bird is deemed ecologically important because of its dependence on the river system, where it feeds on small fish and shrimp, and because the sub-species is also a Solomon Islands endemic (Dutson, 2011). This heron is found close to water, especially along rivers with forested margins, such as the Tina River, and is found in riparian habitats. The following photo of a heron footprint was observed during the field sampling. Loss of habitat for breeding and feeding for this species may occur due to Project construction activities. However, the creation of a reservoir may increase micro-habitats for feeding.

Nankeen Night Heron footprint



Little Pied Cormorant (*Microcarbo m. melanoleucos*) - This bird is deemed ecologically important because of its dependence on the river system, where it feeds on small fish and shrimp. It is found along large rivers and nests in large trees beside water (Dutson, 2011). This cormorant is found in riparian habitats. Loss of habitat for breeding and feeding for this species may occur due to project construction activities. However, the creation of a reservoir may increase micro-habitats for feeding.

Pacific Black Duck (*Anas superciliosa*) - This bird is deemed ecologically important because of its dependence on the river system for feeding and breeding (Dutson, 2011). This duck is also hunted opportunistically as a source of food by inhabitants of local communities. It is found in riparian habitats. Loss of habitat for this species may occur due to project construction activities. However, the creation of a reservoir may create micro-habitats for feeding.

Brahminy Kite (*Haliastur indus flavirostris*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and because it is also a Solomon Islands endemic (Dutson, 2011). It is the commonest raptor in the Solomon Islands and is found throughout a wide range of habitats, including the entire study area. This raptor feeds mainly on smaller birds. It is not threatened. The Project will likely have only minimal impact on this species of bird.

Pacific Baza (*Aviceda subcristata proxima*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013) and because it is also endemic to the Solomon Islands (Dutson 2011). It is a common species found in forest habitats, but may also be observed throughout the entire range of the study area. This raptor feeds mainly on smaller birds and lizards. It is not threatened. The Project will likely have only minimal impact on this species of bird.

Variable Goshawk (*Accipiter novaehollandiae pulchellus*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and because it is also endemic to Guadalcanal (Dutson, 2011). The commonest hawk in the region, it is found in forest habitats, and is often be seen throughout the entire range of the study area. This raptor feeds mainly on smaller birds and lizards. It is not threatened. The Project will likely have only minimal impact on this species of bird.

Meyer's Goshawk (*Accipiter meyerianus*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013). It is an uncommon species found in forest habitats (Dutson, 2011) but is can be seen throughout the entire range of the study area (see photo). This raptor feeds mainly on smaller birds and lizards. It may be locally threatened. The Project will likely have only minimal impact on this species of bird.

Meyer's Goshawk

Solomon Sea-Eagle (*Haliaeetus sanfordi*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013) and its vulnerability based on the IUCN Red List assessment (IUCN 2013). It is also important due to it being endemic to the Solomon Islands (Dutson, 2011). This eagle is wide ranging, from coast to upland forests, and is found throughout the entire study area. It feeds mainly on pigeons, doves, fish, possums and lizards. It is considered to be rare. The Project will likely have only minimal impact on this species of bird.

Red-backed Button-Quail (*Turnix maculosus salomonis*) - This species of quail is found in grassland (Dutson, 2011). It is locally common, but may also be locally threatened due to habitat disturbance and opportunistic hunting by inhabitants of local communities for food. The Project will likely have only minimal impact on this species of bird.

Guadalcanal Rail (*Hypotaenidia woodfordi*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011), and is classified as being Near Threatened by IUCN's Red List (IUCN, 2013). It is opportunistically hunted by inhabitants of local communities as a source of food. The impacts of the hydropower project on this rare and threatened rail should be minimal due to minimal impacts that project is expected to have on the grassland habitat where this species occurs.

Common Sandpiper (*Actitis hypoleucos*) - This bird is deemed very ecologically important because it is a migratory species, and also because it is dependent on the river system (Dutson, 2011). It breeds in the northern hemisphere from May to June, when it is absent from the Solomon Islands. Possible breeding destinations for this species of bird include Russia, Korea and Japan (BirdLife, 2013). This sandpiper is water dependent and feeds on larval insects, spiders, mollusks, snails, crustaceans, annelids, frogs, toads, tadpoles and small fish, as well as plant material, including seeds). This bird is also a culturally important as its feathers are believed to give extra strength or luck if obtained. This common species is usually solitary and is also territorial (see photo). Loss of habitat for this species may occur due to the Project. However the creation of a reservoir may increase micro-habitats for feeding.

Common Sandpiper

Yellow-bibbed Fruit-Dove (*Ptilinopus solomonensis ocularis*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). It is also opportunistically hunted by inhabitants of local communities as a source of food. This dove is found in upland habitats and feeds on fruits and nuts. It is not threatened. The Project will likely have only minimal impact on this species of bird.

Ducorp's Cockatoo (*Cacatua ducorpsi*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and also because it is endemic to the Solomon Islands (Dutson, 2011). This common cockatoo is found in most areas where large trees are found, so all habitats except grassland and oil palm plantations should contain this species. This cockatoo feeds on fruit, nuts and seeds of trees. It is not threatened. The Project will likely have only minimal impact on this species of bird.

Cardinal Lory (*Chalcopsitta cardinalis*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and also because it is endemic to the Solomon Islands (Dutson, 2011). This common lory is found throughout all habitat types in the study area, and has a preference for large flowering or fruiting trees. This bird is not threatened. The Project will likely have only minimal impact on this species of bird.

Coconut Lorikeet (*Trichoglossus haematodus massena*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013) (Dutson, 2011). This abundant lorikeet is found throughout all habitat types in the study area, and has a preference for large flowering or fruiting trees. This bird is not threatened. The Project will likely have only minimal impact on this species of bird.

Yellow-bibbed Lory (*Lorius chlorocercus*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and also because it is endemic to the Solomon Islands (Dutson, 2011). This common lory is found throughout all habitat types in the study area, and has a preference for large flowering or fruiting trees. This bird may be threatened by logging, and possible impacts from the hydropower project could result from forest clearing along the access roads.

Duchess Lorikeet (*Charmosyna margarethae*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013) (Dutson, 2011). This species is also listed as Near Threatened by IUCN's Red List (IUCN, 2013). This lorikeet is common in upland habitats especially on flowering trees. Therefore, it may be affected by forest clearing along the access roads.

Finsch's Pygmy Parrot (*Micropsitta finschii aolae*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and also because it is endemic to the Solomon Islands (Dutson, 2011). This parrot is found in forest habitats and feeds on small termites found in the bark of large forest trees. This common species is not threatened. The Project will likely have only minimal impact on this species of bird.

Eclectus Parrot (*Eclectus roratus solomonensis*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013). This is a common parrot that can be found in a wide variety of habitats, from forests to gardens, and feeds on wild and cultivated fruits, such as banana's (Dutson, 2011). It is not threatened. The Project will likely have only minimal impact on this species of bird.

Song Parrot (*Geoffroyus h. heteroclitus*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013). This is an uncommon parrot that can be found in a wide variety of habitats from forests to gardens, and feeds on fruits and seeds of trees (Dutson, 2011). It is not threatened. The Project will likely have only minimal impact on this species of bird.

Guadalcanal Boobook (*Ninox granti*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC, 2013), and also because it is endemic to Guadalcanal (Dutson, 2011). This owl is common in forest habitats, where it feeds on insects. It is globally vulnerable. The Project will likely have only minimal impact on this species of bird.

Blyth's Hornbill (*Aceros plicatus mendanae*) - This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), and also because it is endemic to the Solomon Islands (Dutson 2011). This common hornbill is found in forest habitats and is not considered as threatened. It feeds on forest fruits and nuts. The Project will likely have only minimal impact on this species of bird.

Common (River) Kingfisher (*Alcedo atthis salomonensis*) - This bird is deemed ecologically important because of its dependence on the river system for feeding on fish (Dutson 2011). This kingfisher is relatively uncommon and can be found beside streams and large rivers in the riparian habitat. It is not threatened. Loss of micro-wetlands downstream of the dam due to project operation, and loss of fish productivity upstream of the dam if fish passage is not maintained, may result in the disappearance of this kingfisher from the upper catchment, since its diet is mainly comprised of fish.

Variable Dwarf Kingfisher (*Ceyx lepidus nigromaxilla*) - This bird is deemed ecologically important because of its dependence on the river system and also because it is endemic to Guadalcanal (Dutson, 2011). This kingfisher is relatively common and can be found beside streams in riparian habitats (see photo). It is not threatened. Loss of micro-wetlands downstream of the dam due to project operation, and loss of fish productivity upstream of the dam if fish passage is not maintained, may result in the disappearance of this kingfisher from the upper catchment, since its diet is mainly comprised of fish.

Variable Dwarf Kingfisher



Cockerell's Fantail (*Rhipidura c. cockerelli*) - This bird is deemed ecologically important because it is endemic to Guadalcanal island (Dutson, 2011). This uncommon fantail requires undisturbed forest habitat, where it feeds on insects. It is threatened by habitat degradation. Therefore, impacts arising from project construction activities are possible.

Rufous Fantail (*Rhipidura rufifrons rufifrons*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). This fantail is common in forested habitats, where it feeds on insects. It appears not to be threatened. However, impacts from project construction activities are possible.

Oriole Whistler (*Pachycephala orioloides cinnamomea*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). The whistler is common in forest habitats, where it feeds on insects. It may be threatened due to habitat loss. Impacts from project construction activities are possible.

Midget Flowerpecker (*Dicaeum aeneum becki*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). This bird is very common in forest habitats especially on flowering plants and "ant" plants, where it feeds on insects living in the ant plants. It is not threatened. Impacts from project construction activities are possible.

Black-headed Myzomela (*Myzomela melanocephala*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). It is common in forest habitats, especially on flowering plants and “ant” plants, where it feeds on nectar from flowers. It is not threatened. Impacts from project construction activities are possible.

Brown-winged Starling (*Aplornis grandis macrura*) - This bird is deemed ecologically important because it is endemic to Guadalcanal (Dutson, 2011). This common starling is found in a wide range of habitats, from gardens and settlements, to forest habitats, where it feeds on insects, flowers and fruits. It is not threatened. Possible impacts accruing due to the Project are likely minimal, since it is a widely distributed species.

White-eyed Starling (*Aplornis brunneicapilla*) - This rare bird is deemed ecologically important, based on its classification as Endangered by IUCN’s Red List (IUCN, 2013). It is also a Solomon Islands endemic (Dutson, 2011), where it is found in forested habitats, feeding on insects, flowers and fruits. It is threatened by habitat loss and will be affected by project construction activities, especially forest clearing.

Appendix E

List of Mammal Species Occurring in the TRHDP Study Area and Their Status / Vulnerability

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Appendix E

List of Mammal Species Occurring in the TRHDP Study Area and Their Status / Vulnerability

Mammals of the Study area

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	River Dependent
Pteropodidae FRUIT BATS											
<i>Macroglossus minimus</i>	Northern Common Blossom Bat		GR, SSa, SSb, SSs	-	-	LC	-	-	S	F	-
<i>Melonycteris fardoulisi</i>	Fardoulis's Blossom Bat		GR	-	SI	LC	-	-	D	F	-
<i>Nyctimene major</i>	Island Tube-nosed Fruit Bat	F&F6, F&F5, F&F4	GR	-	-	LC	-	-	S	F	-
<i>Pteropus rayneri</i>	Solomon's Flying Fox	F&F5, F&F11	SSa, SSb, LK	-	-	NT	II	I	D	F	-
<i>Pteropus admiralitatum</i>	Island Flying Fox		SSa, SSb, LK	-	-	LC	II	I	D	F	-
<i>Rousettus amplexicaudatus</i>	Rousette Bat	F&F5, F&F4	GR	-	-	LC	-	-	S	F	-
Hipposideridae LEAF-NOSED BATS											
<i>Aselliscus tricuspis</i>	Trident Leaf-nosed Bat		GR	-	-	LC	-	-	S	F	-
<i>Hipposideros cervinus</i>	Fawn Leaf-nosed Bat	F&F5		-	-	LC	-	-	S	F	-
<i>Hipposideros diadema</i>	Diadem Leaf-nosed Bat		GR	-	-	LC	-	-	S	F	-
Muridae RODENTS											

Species name	Common name	Observed at station	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	River Dependent
<i>Rattus exulans</i>	Polynesian Rat		GR	-	I	LC	-	-	S	-	-
<i>Rattus rattus</i>	House Rat		GR	-	I	LC	-	-	S	-	-
<i>Uromys rex</i>	King Rat		SSa, LK	-	G	EN	-	I	D	-	-
<i>Uromys imperator</i>	Emperor Rat		LK	-	G	CR	-	I	D	-	-
Suidae PIGS											
<i>Sus scrofa</i>	Wild Pig	F&F17, F&F16, F&F5	LK	-	-	LC	-	-	S	F	-
Phalangeridae NOCTURNAL MARSUPIALS											
<i>Phalanger orientalis</i>	Northern Common Cuscus		LK	-	-	LC	-	-	S	F	-

Potential Species: TRHDP ESIA Scoping Study = SS, SSa=site A, SSb=site B, SSc=site C; Local Knowledge = LK, Gold Ridge Report = GR

Endemic: Guadalcanal = G, Solomon Islands = SI, Introduced = I

IUCN Red List Category: Least Concern = LC, Near Threatened = NT, Endangered = EN & Critically Endangered = CR

CITES Appendix for international trade of species: II = may be authorized by the granting of an export permit

Population Trend: Decreasing =D & Stable =S (according to IUCN Red List Category)

Local Uses: Food =F (bush meat)

1998 Act: Wildlife Protection and Management Act 1998. Schedule I lists the species that are prohibited to exports, Schedule II lists the regulated and controlled species for which a valid permit to export such specimen is required

Appendix F

Habitat Value Analysis

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Appendix F Habitat Value Analysis

The following table provides an analysis of habitat value by habitat type, defines the habitat vegetation and characteristics, and provides photographs to illustrate how habitat typically appears in Guadalcanal.

Habitat value analysis

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
<p>Grassland</p>	<p>Moderate</p>	<p>Grassland refers to habitats that are dominated by grasses and cover the lower lying hills toward the plain. These are natural habitats formed from the locally dryer climate and less fertile soils. Since human density is higher in grassland, and plant species of concern are rarer, they have moderate ecological value. However, they support unique wildlife and bird species that are adapted to open spaces not found in forests.</p> <p>The most common species (indicator species) identified during plant survey were <i>Pennisetum polystachyon</i>, <i>Pueraria lobata</i>, <i>Sida rhombifolia</i> and <i>Mimosa pudica</i>. The invasive species <i>Mikania Micanthra</i> is also present.</p> <p>Grassland dominates the landscape along the existing Black Post road, future access road to the Project site and where the transmission line will be installed. In the Tina River catchment, this habitat is however only present at its Northernmost end.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
<p>Undisturbed forest (primary lowland forest)</p>	<p>High</p>	<p>Refers to forested areas that have undergone relatively no disturbance by human activities. These forest areas are in pristine condition and have a high ecological value. They are home to a wide variety of species and the intactness of the forest supports great biodiversity.</p> <p>From Sengue upstream, the Project area is solely made of lowland forests. Primary forest (undisturbed forest) becomes increasingly important moving upstream as logging company encroachment becomes scares. Primary forest is characterized by tall canopy trees. However, regrowth species are also common due to occasional cyclones which make canopy uneven. Most fruit trees are found in lowland forests (FAO, 2009). Indicator species include: <i>Ficus</i> sp., <i>Dysoxylum excelsum</i> and <i>Cyathea</i> sp. (Tree Fern).</p> <p>As shown in the previous section, plant survey stations carried out in undisturbed forests, have a high proportion of plant species of concern.</p> <p>This habitat covers the majority of Tina River's catchment at altitude below 600 m.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
<p>Undisturbed forest, montane forest</p>	<p>High</p>	<p>Montane forest refers to habitats further inland and of a higher altitude (starting at 600masl). Upland areas are usually of a pristine nature due to the distance from human habitation and influence. They also are home to many unique and rare species and this habitat is therefore of high ecological value.</p> <p>Recent studies in Malaysia suggest that montane forests in the region are better at sequestering carbon than lowland forest since montane forests have moister and richer organic soils due to higher rainfall. This gives montane forests an additional ecological value (Jeyanny et al., 2013). Indicator species include: <i>Syzygium</i> sp, <i>Metrosideros</i> sp., <i>Ardisia</i> sp., <i>Ficus</i>, <i>Rhododendron</i>, <i>Dacrydium</i> spp ,<i>Podocarpus pilgeri</i> (WWF, 2005)</p> <p>There is no montane forest that will be directly impacted by the Project.</p> <p>In Tina River's catchment, this habitat is the most important one in terms of surface coverage.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
<p>Disturbed forest (secondary lowland forest)</p>	<p>Moderate</p>	<p>Refers to forested areas that have undergone relatively recent disturbance by human activities, such as timber extraction. These forest areas are not in pristine condition and have a moderate ecological value mainly because of logging disturbances.</p> <p>Secondary forest (disturbed forest that have regenerated) were affected by logging activities in the study area. These forests are dominated by regrowth species such as <i>Ficus</i> sp., <i>Pometia pinnata</i> and <i>Calophyllum</i> sp. Shrubs include the <i>Macaranga</i> species. Common non-ligneous species include <i>Alpinia purpurata</i>, <i>Calamus</i> sp. These are indicator species. This habitat becomes important from Choro moving downstream.</p> <p>Regeneration in the Solomon Islands is fast as long as soil remains available. In disturbed forests, logging roads are quickly colonized by regrowth species of shrubs, plants and trees. However, in such forests some of the key functions of primary forest are degraded due to deforestation:</p> <p>Forests are guardian of water catchment integrity: forested areas protect water sources and ensure water quality by providing soil stability. Unfortunately, deforestation brings erosion, and soil losses in watercourses.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
		<p>Forests are important for biodiversity conservation. Deforestation opens the canopy and fragmentize habitats, locally increasing temperature and reducing humidity which reduces the attractiveness for many species that thrive in moist habitat such as amphibians. Fragmentation also exposes wildlife to predators and feral animal, exposes soils to erosion, etc. Degraded lowland forests have lower bird diversity and other "strict-interior species" as shown in fauna surveys and scientific articles (Hossein et al., 2009)</p> <p>Forests are important nutrient pools not only for tree regeneration but for all plants regeneration through topsoil recycling and tree decaying. Unfortunately, deforestation deplete soil from its nutrients as well as its capacity to sequester carbon (Imai et al. 2010, Lal, 2005).</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
<p>Remnant forest (secondary forest colonized by pioneer species)</p>	<p>Moderate</p>	<p>This habitat refers to forested areas that have undergone extensive disturbance with remaining large trees such as Canarium nut trees left on purpose. These forest areas are not in pristine condition and have moderate ecological value. They are home to a variety of species but are highly modified landscapes by people. Increasing light has modified plant composition under the canopy.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Riparian	High	<p>Riparian refers to habitats along and adjacent to Tina River and other waterways. These habitats are of high ecological value because they are home to many unique species that are dependent on the water ecosystems such as aquatic insects and amphibians. Riparian habitats at a greater distance from settlement areas are in pristine conditions.</p> <p>This habitat is typical along rivers such as Tina River. It is made of many epiphytic plants and orchids, vines (climbers and creepers shrubs) as well as fern trees that are indicator species. Many medium sized trees and shrubs are present.</p> <p>The natural water regime of rivers allows many microwetlands to be created, trapped by large boulders or sand bars, which add value to riparian habitat. Their extent and location regularly change with Tina flows.</p> <p>Along Tina River, riparian habitats only cover limited areas due to the rivers steep slopes.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Cliffs	High	<p>Cliff refers to habitats on and adjacent to very steep areas (vertical slopes), usually adjacent to the river as well. Cliffs seem to be habitats that are created by the river systems and are fed by many small waterfalls (small tributaries). They are of high ecological value because they house unique species that may use the cliffs as feeding and breeding habitats. They are of a relatively pristine nature because cliff areas are hard to be modified by local peoples.</p> <p>Tree fern (Cyathea), ficus, palm, epiphytic orchids and ferns are common on cliffs. Other indicator species include : Pholidota sp., Macaranga sp., Timonius timon, Alpinia purpurata, etc.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Garden	Low	Garden refers to human cultivated habitats such as food crops. These habitats are of low ecological value as they are human created landscapes. However, they do provide certain feeding habitats for some species, mainly opportunistic species, insects and reptiles.	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Fallow brush land	Low	Refers to habitats that were cultivated in the past but have been left to fallow in recent years. These are areas similar to remnant forest however, they have undergone complete cultivation as in the form on a garden and have been left to fallow/regrow. They are of a weak ecological value because they host a minimal number of species.	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Oil palm	Low	<p>Refers to habitats that are homogenously cultivated with oil palm. These areas are of low ecological value as they are human created landscapes and are dominated by introduced palms. However, some wildlife species have learned to adapt and take advantage of this habitat such as bats and birds.</p> <p>Plant composition under palm plantation are uniform and made of several heliophilous plants.</p>	

Habitat	Ecological value	Explanation	Photograph of the habitat in the study area
Settlements	Low	<p>Refers to habitats in and around village areas. These areas are of a low ecological value and the presence of domesticated animals such as cats, dogs and pigs threaten wildlife native species.</p> <p>Opening in the canopy allows for invasive plant species to settle such as the <i>Mikania micrantha</i> and colonize nearby natural habitats.</p>	

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Appendix H

Mitigation Measures for Protecting Downstream Migrating Fish

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Appendix H

Mitigation Measures for Protecting Downstream Migrating Fish

H.1 Rationale for Installing a System for Protecting Downstream Migrating Fish

Gobies spawn on substrate in the area in which they live. When the eggs hatch the larvae are carried passively downstream. It is not clear whether goby spawning is seasonal, or occurs all through the year. It is possible that spawning seasonality varies between species. Larval fish return to the estuary during the dry season and this indicates that spawning and downstream migration takes place early in the wet season. Thus, it is likely that hatching and downstream movement occurs during floods and freshes with the high flows ensuring rapid and safe transport to the sea. If so, the dam may be spilling and larval fish will pass over the spillway.

Although there are very few studies of larval survival through turbines, it is well known that the length of fish is the primary determinant of survival (e.g., Larinier and Travade 2002) and with larval fish potential mortality caused by striking the turbine blades or wicket gates will be low. Morris et al. (1985) describe quantitative data on entrainment mortalities that were gathered at the Ludington Hydro Plant on Lake Michigan, which has a head of 110m. Survival tests on 9 species of larval fishes indicated that passage through the Ludington turbines decreased survival rates by an average of 15%. Large smelt larvae (15-42 mm) experienced much greater mortality than did smaller (<15 mm) smelt larvae. Some larvae were apparently robust and seemed to survive turbine passage (i.e., ninespine stickleback, lake whitefish, turbot larvae). Goby larvae are small (<10mm) and there is unlikely to be significant mortality through the turbines.

Although the gobies in the Solomon Islands are generally considered diadromous, large numbers of 10 mm gobies were observed in the shallow low velocity margins of the river between the dam and power house sites on 11-15 July 2016. It is unlikely that fish of this size have the swimming ability to make the 25 km journey from the sea and this suggests that these fish are rearing in the river rather than the sea. Shallow low velocity margins are the type of rearing habitat used by non-diadromous bullies in New Zealand.

Adult eels migrate to the sea at the beginning of the wet season. They are likely to migrate on the first fresh so that the deeper swift flowing water facilitates their passage to the sea, similar to the migration of New Zealand eels. The mortality of adult eels through turbines is significant, and there does not seem to be any easy way of screening or diverting adult eels. However, if they are migrating during a flood, a proportion of the migrating population may be carried over the spillway rather than through the turbines. Consideration should be given to increasing the normal operating level to near full supply level, during the first month of the wet season, to facilitate the downstream movement of adult eels over the spillway during floods. The loss of generation resulting from increasing spill would be partially offset by the increased generation from the extra head on the turbines. Consideration could be given to the possibility of 15-25 mm screens in front of the intake structure to prevent the ingress of large eels.

H.1.1 The TRHDP: a Barrier to the Downstream Migration of Silver Eels and Amphidromous Larvae

As mentioned above, all native fish species in the Tina River are migratory species with a life cycle that shifts between the sea and the river.

All species that utilise the Tina River enter into the river mouth as juveniles and undertake upstream migration to colonize the whole watershed and mature to adults.

The downstream migration follows two patterns:

- ▶ For catadromous species (eels *Anguilla marmorata*, *A. megastoma* and *A. reinhardtii*), the adults at a certain stage of their cycles (silver eels) return to the sea to spawn in deep marine areas, after which they die.
- ▶ For amphidromous species (Syciinidae and other Gobiidae, Eleotridae, Paleomonidae), spawning occurs in the river. After hatching, the larvae are passively flushed down to the sea within a few days of hatching, where they grow for a period of several weeks/months before migrating back upstream.

Unlike salmonids, these species do not follow a homing behavior. Juveniles can colonize any river, not only their natal stream.

Assuming that an efficient fish trap and haul system is employed for the Project (see Appendix A) allowing upstream migration of juvenile eels and target amphidromous species (Syciinids, other Gobiids, prawns), thereby ensuring that fish grow to adulthood upstream of the dam, the ecological continuity for these species would be fully achieved if silver eels and gobiidae/prawn larvae are able to successfully migrate back to the sea.

In the absence of appropriate mitigation measures, the TRHDP facilities will potentially impair the downstream migration. A proportion of fish will be entrained into the power intake tunnel and passed through the turbines. The passage through the turbines is likely to cause mortalities due to pressure fluctuation, turbulence and cavitation (affecting both silver-eels and larvae) plus physical damage when struck by the runner blades. However, Francis turbines, which are less damaging than Pelton turbines, have been proposed by Entura (March 2014).

H.1.2 Facilitating Downstream Migration of Silver Eels and Amphidromous Larvae

To move achieve full ecological continuity for target species by balancing upstream and downstream migrations, different mitigation measures can be considered for protecting outward migrating fish. This includes physical barriers (i.e., fish screens), behavioral barriers (i.e., light, acoustic, electric or hydrodynamic fields) and fish-friendly turbines. These are presented in the following sections with a discussion on their suitability for the Tina River context.

H.1.2.1 Fish Screens in the context of reservoir spills

Mature eels, also referred to as silver eels, may reach more than 1m in length and 10kg in weight for the most common species *A. marmorata*. Other species may grow to be larger.

One solution considered to prevent eels from being entrained into the power intake and thereby passed through the turbines, is to install fish screens on the power intakes. The screens should have a mesh size or inter-bar spacing of a 2cm to 5cm. In this scenario, attention would need to be paid to: (i) selecting a sufficiently wide mesh to prevent fish from being stuck against the screen; (ii) a bypass outlet to allow fish to swim away from the screen covered power intake, and (iii) an automatic cleaning system to keep the screens free from fouling.

The efficacy and impact of this option has been considered in relation to the fact of reservoir spills occurring regularly in the context of river freshes, which silver eel migration has been observed to occur timed to coincide with.

During such events of silver eel migration, the reservoir level at a level to spill water over the spillway, thereby providing a route for eels to migrate downstream, and reduce the need for screens.

It is considered preferable to permit this spill option to be relied on for the downstream migration of the eel species.

H.1.2.2 Behavioral Barriers

These systems are based on the response of fish to visual, auditory, electrical or hydrodynamic stimuli. Many systems have been experimented with, including light screens, bubble screens, and other methods. However, these systems are usually specific to a particular fish species or taxa.

Prawn larvae are known to be attracted by light (phototaxis). Fievet *et al.* (2000), inspired from works in Japan, implemented a pilot system on a dam in the French West Indies, which consisted of streetlights on the bank opposite to the power intake structure to entice the larvae to the downstream fish pass. The results appear promising, though they vary widely in relation to natural light (moonlight / sunlight), turbidity, and waves on the reservoir. However, the most attractive wave-length may differ according to prawn species. Unfortunately, phototaxis has not been highlighted for Goobidae larvae, and light has a repellent effect on eels.

Therefore, implementing behavioral screens would need to be preceded by technical studies on the targeted species to estimate the most effective system.

H.1.2.3 “Fish Friendly” Turbines

As mentioned above, fish passing through hydraulic turbines are subject to various forms of stress and physical damage that is likely to cause high mortality.

A new type of turbine (Alden) conceived as “fish-friendly” has undergone pilot stage testing in North America and Europe. This system has a lower rotation speed than other types of turbines, thereby reducing the risk of mortality from physical contact shocks or overpressure.

However, fish friendly turbines are at an early stage of field application and have been mainly tested on salmonids. Their effects on eels and fish / prawn larvae are unknown. Furthermore, fully installed equipment price is roughly 35% to 40% higher than with conventional Francis turbines.

H.1.2.4 Conclusions Regarding Downstream Fish Barrier Systems

Even if several solutions exist to prevent mortality during the downstream migration, the only method recommended is reliance on the high frequency of uncontrolled reservoir spills to provide regular down migration opportunities to the eel species.

Notwithstanding that measures aimed at reducing mortality to eels and fish larvae in the turbines may not be readily achievable with current technologies, considering the absence of homing behavior in native fish species, the Tina River watershed will be continuously stocked by upstream migration of juveniles that have spent part of their life cycle in other coastal rivers in the Solomon Islands.

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Appendix J

Free, Prior and Informed Consent

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Appendix J

Free, Prior and Informed Consent

There is no single internationally agreed definition of FPIC and “no single, nor a one-size fits all mechanism for its implementation” (UN Collaborative Program on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, 2013). International development agencies define FPIC as follow:

- ▶ “Free” - implies the absence of coercion, intimidation or manipulation (including bribery or rewards).
- ▶ “Prior” - implies that sufficient time is provided to indigenous communities and stakeholders during consultations and decision-making processes. This allows community members and stakeholders to receive adequate information, come together, discuss the proposal, and make decisions prior to providing any formal response (e.g., consent).
- ▶ “Informed” - implies that the affected communities and stakeholders have access to relevant information on the project to engage in consultations and decision-making processes. Providing ‘access’ to information implies that the information is:
 - in a form and language that is suitable for the particular communities and stakeholders;
 - accurate;
 - delivered in a culturally appropriate and inclusive way; and
 - made available to every member of the community.
- ▶ “Consultation” refers to an inclusive and fair process of interaction, engagement, and dialogue between various stakeholders with respect to a proposed development or activity. The intention is to achieve a clear shared understanding of the proposal, the issues and concerns of all parties, and of any future actions and decisions. It does not imply common agreement or consensus as an outcome.
- ▶ “Consent”, in the context of IFC PS, refers to a “broad agreement” within and between the affected communities and stakeholders that the proposed project or activity can proceed, as determined through local customary decision-making practice. It does not imply universal agreement amongst stakeholders or all members of a community.

Appendix K

Analysis of Opportunities to Improve Conservation of the Upper Tina River Catchment

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Appendix K

ANALYSIS OF OPPORTUNITIES TO IMPROVE CONSERVATION OF THE UPPER TINA RIVER CATCHMENT

K.1 Protection of the Upper Tina River Catchment

The upper catchment area is defined as the area upstream of the proposed TRHDP dam. It covers an area of 125km², and represents 83% of the total Tina/Ngalimbiu catchment area. The Tina River upper catchment is characterized by mountainous terrain, with peaks ranging from 800masl to 2300masl.

Approximately 60% of the catchment is higher than 800masl. The Tina River headwaters (270masl), are comprised of the junction of two main rivers: Vohara River (1) and Mbeambea River (2) and a minor tributary: Njarimbisu River (3). Becho River (4), a tributary of the Vohara is located further upstream.

Protection of the Upper Tina River Catchment would create one of the largest, if not the largest, terrestrial protected area in Solomon Islands. Protection of the area would provide conservation support to a key portion of the highlands of Guadalcanal identified as a Key Biodiversity Area by the IUCN and Bird Life International.

The highest reaches of the Tina catchment back onto the highest parts of Solomon Islands, and the most extensive cloud forests in the country. Unlike the directly impacted area of the project, which is heavily affected by logging and human encroachment, these parts of the catchment are relatively intact and are thought to harbour significant unique biological and ecological diversity.

K.2 Protection Avenues

There are two potential avenues to conserve the upper catchment. The first is to create a formal Protected Area, changing the existing rights of customary landowning groups to consent to commercial activities on the land. As the catchment is owned by customary landowners these groups rather than SIG or the Project Company have powers to consent to a formal PA under the *Protected Areas Act*. A formal PA would serve as a biodiversity and customary land use reserve and could start upstream from the dam, including the reservoir and the entire upper Tina River catchment, which covers 125km².

The second is to use the Project as an opportunity to increase awareness and supervision and to improve the enforcement of existing laws for the protection of the upper catchment. This latter option could be used in conjunction with informal customary protection. The two options are not exclusive and there is benefit to pursuing the latter while the former is explored.

A third option, creating a formal protected area under the *National Parks Act* without the consent of landowners, is not considered feasible. The Act provides inadequate safeguards for customary land users and owners and while not repealed has been effectively replaced by the *Protected Areas Act*. The Act has been used only once in 1973 to designate a registered area of land as a National Park (the largely degraded and unmanaged Queen Elizabeth National Park). The Act is not in current usage. Any restrictions on the use of customary land without the consent and participation of owners is anticipated to lead to a backlash against protection efforts.

K.1.1 Previous Activities

In October 2015, an international expedition, known as 'Islands in the Sky', was conducted by the University of the South Pacific (USP) and the American Museum of Natural History (AMNH), to explore the biodiversity of the upper catchment. This region, recognised as a Key Biodiversity Area (KBA) has received very little scientific attention. Expedition access to the key locales within the upland regions was made possible through the reliance on the existing relationships established between the TRHDP and landowning tribes, particularly the Uluna-Sutahuri tribe which has a guardianship status with the highest regions of the catchment. The expedition was conducted with the funding of Critical Ecosystem Partnership Fund (CEPF) and involved collaborations with the Solomon Islands National University (SINU) as well as other academic and conservation organisations.

The social pathway for the planning and implementation of the expedition was aligned with the behaviours and expectations that TRHDP has developed amongst indigenous peoples of the area, providing a stable association between tribal members and the members of the expedition.

K.1.2 ESMP Measures for Upper Catchment Protection

The Project is expected to have no direct impact on the terrestrial upper catchment. Initially indirect risks of increased access facilitated by the road to the dam site were considered. However, a new logging road on the right bank of the Tina River constructed in 2015/2016 provides unrestricted vehicular access to the same elevation. Unlike the logging road, the project road will be gated above Mengakiki (the end point of the existing usable road) and will have restricted vehicular access from Mengakiki onwards. 24 hours security guards will monitor access. This section of road is to remain a private road, owned by the TCLC and leased to the SPC during the BOOT period. As recorded in the social baseline assessments, part of the catchment is currently used in traditional hunting and fishing expeditions undertaken on foot by local communities. This use will continue to be permitted. Under no circumstances will SPC provide commercial logging operations access to the private road. In these circumstances, the TRHDP is anticipated to have negligible impacts on upper catchment access.

Notwithstanding this, the ESMP proposes a number of key measures to protect the upper catchment:

- SPC and PO to regularly monitor forest coverage in the upper catchment through satellite or aircraft imagery, and to monitor and report any logging trucks or logging operations operating in the Tina or Toni catchments. Reporting should be made to the WB, Ministry of Environment, Climate Change, Disaster Management and Meteorology, and Ministry of Forests and Research. SPC and PO to coordinate with Ministry of Forests and Research to enforce existing law preventing commercial logging above 400 metres; and

- SIG to provide assistance, information and seed funding to an NGO to conduct community consultations and studies contributing to the potential establishment of a protected area.

K.1.3 Activity Restriction

The key element in declaring the upper Tina River catchment as a PA is to establish a prohibition on commercial logging and mining activities, and ban infrastructure development, including road construction into the area. Traditional activities would be recognised such as small-scale logging by local communities, fishing and hunting.

Activity restrictions would need to be approved by customary landowners and the SIG since timber, prospect and mining licenses are approved by landowners and granted by the SIG. .

Sustainable funding schemes are key to the ongoing protection of the catchment. There will be pressure to monetarise the area and to receive royalties from logging or mining enterprises. The key to combatting this will be to provide opportunities for income streams and paid employment. Without the support of customary landowning groups, PA designation would be meaningless.

K.1.4 Staged Proposal

If protected, the Upper Tina Catchment would become the largest terrestrial protected area in the country. Examples of other, technically «informal», protected areas include the Arnavon Islands, Choisseul, supported by The Nature Conservancy, Tetepare Island, Western Province, managed by the Tetepare Descendants Association and supported by Solomon Islands Community Conservation Partnership (SICCP), and Kolombangara, managed by the Kolombangara Island Biodiversity Conservation Association (KIBCA).

Each of these sites involved several years of development and continue to receive ongoing external support. A successful protected area will need significant funding and long term commitment to establish and implement.

The support of customary landowners, SIG and donors will be key to the successful protection of the upper catchment. A potential staged process is contemplated, as set out in the table below.

	Activitiy	Actor
Stage 1	Monitoring and reporting of upper catchment forest coverage and logging activities	SIG and SPC
	Engagement with Ministry of Forests and Resoures to support their prevention of illegal commerical logging above 400 metres	PO/SIG
	Restricting use of the Project's access road above Mengakiki Village	SPC and HEC
Stage 2	Engagement of partner NGO to faciliate studies and consultations towards protected areas status	NGO/PO

Protected Area Feasibility		
	Supporting and facilitating NGO activities, including providing data and support to work with landowning groups	PO
	Consultation with landowning groups to seek in principle support for protection and proceed with preliminary studies	NGO
	Mapping and forestry studies undertaken with support of landowning groups. Studies to include potential opportunities for sustainable financing. Options will include a mix of eco-tourism, supporting scientific expeditions and voluntary carbon trading.	NGO
	Consultation and sharing of study findings with landowners and communities Consultations with SIG, including Ministry of Forests and Resources, Ministry of Environment, Climate Change and Disaster Management and Ministry of Mines, Energy and Rural Electrification	NGO
Stage 3 Establishment of an « informal » protected area through donor funded project with support of landowners and SIG	Agreement of customary landowners to prevent commercial logging and mining.	Donor/NGO with PO support where funding available
	Public signing of an MOU or equivalent with SIG and landowners Agreement marked by public declarations, cultural ceremony and media	Donor/NGO
	Option for SIG to provide 'legal' support to the informal protection of the area through designation of the area as a 'reserved area' under section 4 of the Mines and Minerals Act, prohibiting mining activities. It is not proposed to designate the area as a forest reserve under the FRTU Act due to compensation payment requirements and wide exemptions.	Donor/NGO

<p>Stage 4</p> <p>Formal Protection under the Protected Areas Act</p>	<p>Completion of all steps to create a formal protected area. This includes :</p> <ul style="list-style-type: none"> - Establishment of a management committee - Consultation, agreement and support of customary landowning groups - Preparation of management plans - Mapping of area - Support of neighbouring customary landowning groups (as protection includes a buffer zone) - Preparation of a budget - Submission of formal application for approval <p>Full summary of steps is available in the Protected Areas Toolkit prepared by the Landowners' Advocacy and Legal Support Unit.</p>	<p>Donor/NGO with PO support where funding available</p>
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K.3 Challenges

Like all projects in Guadalcanal, one challenge that arises is customary land ownership and the need to identify land owners and boundaries to approve the protected area and to share in any financial benefits. The upper catchment is owned by a number of Malango Tribes . Boundaries and ownership have not been mapped, and as a pristine environment, the ownership of land has not been the subject of previous court cases for logging or acquisition.

This challenge is reduced in an informal protected area as opposed to a formal area where the support of all potential landowning groups can be obtained without the need to articulate land boundaries. A number of groups can sign an MOU for protection. For this to work, benefits would need to be provided by way of employment opportunities and activities rather than as cash payments to be divided between groups. Where possible, it is recommended that any formal protected area also avoid identifying landownership boundaries and adopt a principle of inclusion of groups where disputes arise. Again, the extent to which this is possible will depend on the form of benefits and their distribution.

As PAs remain under customary ownership, the role of the SIG is to declare the area a PA and to enforce a strict prohibition on issuing resource exploration and exploitation licenses, granting logging licences or allowing infrastructure development. Working with SIG to agree to designate a PA will be a lengthy process, since it has already issued prospecting licences in the upper Tina River catchment. These existing licences need to be reviewed to determine their expiration dates (and lawful extensions) and discussions held with MMERE towards agreeing that no further licences will be issued as the PA is formalised.. The support of customary landowners will be the key to SIG's support.

The PA project will require the cooperation of villages and customary landowners before any protection is possible. NGOs and consultant firms could be involved in training and capacity building of both communities and government officials and development of community awareness and community participation. The concept of carbon trading might not be fully understood by communities. If carbon credits are pursued, training sessions will need to be provided to all beneficiary communities.

Long term protection will be dependent on sustainable financing opportunities. Securing these on Guadalcanal is a significant challenge. Experience of other protected areas in SI suggests that a mix of financing should be pursued. This may include small scale eco-tourism (assisted by the area's proximity to Honiara), paid support of scientific expeditions in the form of guides and logistics, NGO funded activities including rangers, and potential sales in the voluntary carbon trading market.

By prohibiting logging activities, landowners could potentially use the area to generate income through a voluntary carbon trading scheme. Benefits of "forest carbon rights" on customary land would be owned by customary landowners, which could represent a small financial benefit to local communities. UNDP is currently supporting the preparation of a REDD+ program in Solomon Islands to establish a monitoring and reporting mechanism at the national level. This mechanism when complete will assist to establish the forest monitoring and legal frameworks required to attract a voluntary trading scheme. However, carbon trading opportunities in Solomon Islands are still many years away, as the ongoing SI REDD+ project continues to prepare frameworks and monitoring.

One issue raised by the SPC/GIZ Regional REDD+ Project in the Solomon Islands (2012), is that "there are currently no suitable mechanisms for customary land owners to join together as a legally recognized entity, to hold and manage forest carbon rights and to distribute benefits in an open and transparent way". This issue has been overcome in other components of the TRHDP, in particular the design of co-operative societies for the open and transparent sharing of the land purchase price and royalty benefits within each Core Land Tribe. The lessons learned from that exercise can contribute to the benefit sharing mechanisms for any protected area.

To summarize, there are currently three major challenges associated with designating the upper Tina River catchment as a PA. These include:

- ▶ Identifying customary landownership and boundaries, if this step cannot be avoided
- ▶ Providing sustainable benefits to achieve and maintain customary landowner support in competition with pressure and payments from logging or mining companies. Any income from carbon trading is likely to be small, and while UNDP's REDD+ preparation project is ongoing, may be some years away.
- ▶ Establishing and enforcing a prohibition on mining and logging when there are already existing prospecting licences in the Tina River catchment and significant political pressure asserted on Ministry of Forestry and Research by foreign logging companies.

K.4 Process for Formal Protection

The Ministry of Environment, Conservation and Meteorology is responsible for the protection and conservation of biodiversity and designation of the PA network in the Solomon Islands.

As mentioned in the Environmental Baseline, the *Protected Areas Act 2010* presents the process to designate a protected area. For an area to become a PA, a community or organization should prepare:

- ▶ An application to the Director of Environment for the site to be declared as a PA. The application will need to include a PA management plan and scientific studies to show that the area is of significance to biological diversity, and to the community in terms of natural resources. The application will also need to include an estimated budget for the PA and evidence of agreement by all customary landowners, a map showing the boundaries and size of the site.
- ▶ The Director, upon receiving the application, will review it and make recommendations to the Minister, if the application is deemed to have merit and should be declared a PA. The basic requirements for an application and for considerations by the Minister include:
 - Conservation objectives of the PA identified in accordance with sound conservation practices;
 - Boundaries of the area accurately identified, or otherwise demarcated and surveyed;
 - Consent and approval obtained from persons having rights or interests in the area; and
 - Appropriate conservation, protection or management plan developed for the area to ensure that the conservation objectives of the PA would be achieved.

K.6 Conclusion Regarding Upper Tina River Protected Area

Establishing the upper Tina River catchment PA will require significant funding and a dedicated project team with expert assistance.

Neither SIG nor the SPC have the power to create a protected area without the consent and support of customary landowners. As a large area covering 125 km², protection will require the consent of a large number of landowning groups with disparate ideas about the value of conservation, and for many, a history of sometimes lucrative involvement in logging and mining. A dedicated and well resourced project team will be required to conduct the consultations and negotiations necessary to make the protected area a reality.

Expert assistance will also be required for studies and mapping, and preparation of a management plan. Funding for a project team and expert assistance will need to be obtained from international environmental NGOs or donor agencies such as the Green Climate Fund, Conservation International or the World Bank.

Once established, the protected area will need to leverage sustainable benefits to landowners to maintain landowner support, which in turn is crucial to maintaining SIG support. Sourcing and managing benefits will be a key component of the project team's work.

Based on this analysis, the declaration of a PA for the upper Tina River catchment should adopt a staged approach, the later stages of which will depend on the outcomes of Stage 2 feasibility assessments.

In the absence of a formal protected area, the role of TRHDP will be crucial to shining a spotlight on activities in the upper catchment. The Project provides an opportunity for the SPC to monitor and report on any deforestation activities. This will include reporting any illegal logging activities above the 400 metre contour, which covers the vast majority of the upper catchment area. The PO is well placed to secure SIG support to enforce existing laws and shut down illegal operations. Satellite monitoring of forestation through the SPC and SIG will provide essential data both to support future donor funding proposals as well as to provide baseline data for any carbon trading application.

Appendix L

Ian Jowett Report on Environmental Flow Requirements and Fish Passage Mitigation Measures

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Jowett Consulting Limited

**Tina River Hydropower
Development – environmental flow
requirements and fish passage
mitigation measures**

Client Report: IJ1601

July 2016

Tina River Hydropower Development - environmental flow requirements and fish passage mitigation measures

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Executive Summary

The Tina River drains in a north-westerly direction from some of the highest peaks (2000+ m) on the island of Guadalcanal. It was selected as a potential site for an hydroelectric project because it has a relatively high flow and is close to Honiara.

This report assesses the effects of the proposed hydro-electric operation on the aquatic physical environment, including environmental flow requirements, potential effects on fish, fish passage requirements, hydro-peaking, morphological changes resulting from reduced sediment load, and possible mitigation measures.

Hydroelectric project description

The project comprises a 55 m high dam located at an elevation of approximately 123 m amsl, and roughly 30 river km from the sea, a 3.3 km tunnel to a powerhouse and tailrace at elevation 73 m amsl. The reservoir formed by the dam will extend upstream approximately 2.6 km and will have a surface area of about 0.28 km² at an elevation of 175 m amsl. The operating range of the reservoir formed by the dam will be 5 m but the reservoir will normally be held about 3 m below the full reservoir level to increase utilisation by storing water during floods and freshes and reducing the number of spill events.

Initially, the powerhouse will have 3 turbine/generator units, each with a capacity of 5MW, allowing a maximum discharge of about 18 m³/s, and a minimum discharge of about 2.4 m³/s.

An environmental flow will be maintained between the dam and power house tailrace. The river distance between the dam and tailrace is 5.4 km.

Hydrology and power station operation

A water level recorder was operated on the Tina River upstream of the dam between 16 June 2010 and 03 April 2014. The mean and median river flow at the dam site derived from this record is 14.85 m³/s and 11.87 m³/s, respectively. Entura derived 30 years of synthetic flows from rainfall record and estimated the long-term mean and median flows to be 13.1 m³/s and 10.78 m³/s, respectively. The maximum generating flow of 18 m³/s was exceeded 22% of the time in the short-term record, and 18% of the time in the long-term record.

Power station operation was simulated using both the shorter recorded flow record and the longer synthetic flow record. These simulations showed spill flows would occur on average every 5.5 weeks and would usually be of 4-6 days duration. The mean spill flow for the short and long term flow record was 2.3 m³/s and 1.3 m³/s, respectively, and resulted in generation utilisation of 82% and 89%, respectively. Using the short flow record, the estimated energy generated at the power house and at a generator on the environmental flow outlet was 86 GWh/a for a 1 m³/s environmental flow. Without a generator on the environmental flow, the estimated energy output was 82.2 GWh/a. Using the 30 year synthetic flow record, the estimated energy was 83 GWh/a or 79.2 GWh/a without any generation from the environmental flow. Transmission losses to Lungga are about 1.2 GWh/a.

Fish community and habitat preferences

The fish community in the Tina River is diverse and comprises about 20 species of goby, two eel species, two kuhlia species and two species of grunthers. All species are reported to be diadromous in that they must have access to the sea to complete their life cycles (ESIA). All species, except for kuhlia and grunthers, are excellent aquatic climbers and are able to negotiate rapids and waterfalls. All species occur in other Solomon Island rivers, and most are found in the wider area of the western Pacific. The gobies spawn in their adult locations and when the larvae emerge they are carried to the sea by floods during the wet season. The larvae rear in the sea and return to rivers as juveniles that then migrate upstream. Adult eels migrate downstream during wet season floods to spawn in the ocean. The adults die after spawning and the juvenile eels return to freshwater and migrate upstream. Adult kuhlia and grunthers migrate to the Tina River estuary to spawn and, after spawning, the adults return upstream. Their young rear for a while in the estuary or coastal waters before migrating upstream.

Although the gobies in the Solomon Islands are generally considered diadromous, numerous juvenile gobies 10 mm in length were observed in the shallow low velocity areas of the river between the dam and power house sites on 11-15 July 2016. The number and size of these juvenile fish suggests that these fish are rearing in the river rather than the sea because it is unlikely that fish of this size have the swimming ability to make the 25 km journey from the sea.

As part of this study, measurements of fish numbers, water depth, velocity, and substrate composition were made at 70 locations across transects in the Toni and Tina rivers in a variety of habitat types (riffle, run and pool). A total of 18 species were either caught or observed on 11 March 2016 by electro-fishing and on 13-14 July 2016 by snorkel observation. Eight of these species were relatively common (present in more than 3 sampling locations).

These fish observations showed that coarse substrates with minimal sand movement were the preferred habitat of most fish species. In general, most species were found in shallow water (0.2-0.3 m) with moderate velocities (0.45-0.65 m/s) and coarse substrate. Eels and the two *Sicyopterus* species were found in the swiftest water and kuhlia were found in the lowest water velocities. Shallow water (<0.3 m) with a velocity of up to 0.7 m/s and boulder/cobble substrate contained the greatest density of fish and the greatest number of species.

Fish density and diversity was higher in the Toni River than in the Tina River, with an average of 60.4 ± 81.7 fish/12m² in the Toni River compared to 6.7 ± 17.1 fish/12m² in the Tina River.

Habitat suitability and generalised additive models (Jowett & Davey 2007) were developed for the eight most common species (*Stiphodon semoni*, *Stiphodon pelewensis*, *Stiphodon rutilaureus*, *Belobranchus sp.*, *Anguilla marmorata*, *Sicyopterus cyanocephalus*, *Sicyopterus lagocephalus*, *Kuhlia marginata*), as well as models for overall fish density and species richness.

Instream habitat

The Tina River gradually increases in gradient from its confluence with the Toni River to the head of the proposed reservoir. The average gradient between the Tina/Toni confluence and the power house site is 5.3 m/km, increasing to 9.3 m/km between the power house and dam. The morphology reflects the change in gradient with the substrate size and frequency of swift water habitat

increasing with gradient. The river is characterised by runs and riffle, with relatively few rapids/torrents and pools.

Surveys of the river were carried out on 6-9 March 2016 and 11-15 July 2013. During the first survey, the proportion of the different habitat types was measured and cross-sections were identified in each of the habitat types. A large flood that occurred on the second day of the survey and removed more than half of the temporary staff gauges that had been installed. This meant that only 3 cross-sections were surveyed in March, one pool, one run and one riffle. Water levels were measured at flows of 8.7 m³/s and 19.7 m³/s and these were used to develop rating curves at each cross-section. The second survey (11-12 July 2013) comprised cross-sections in 2 pools, 5 runs, 5 riffles and 2 rapids; a total of 14 cross-sections. The flow was 9.91 m³/s on the 11 July and 9.66 m³/s on the 12 July. Water level and flow measurements were taken on 15 July and 25 July for rating calibration when the flows were 8.28 m³/s and 5.39 m³/s, respectively.

These surveys showed that the river between the dam and powerhouse comprised 46% run, 36% riffle, 13% pool and 5% rapid habitats. The average water surface width at a flow of 9 m³/s was 23.6 m and the average depth and velocity were 0.58 m and 0.66 m/s, respectively.

Variability of flows

The river downstream of the dam will require some flow variability, particularly floods and freshes to flush algal accumulations. Because the maximum capacity of the powerhouse and the amount of storage in the reservoir are not large, there will be frequent periods of spill between the dam and tailrace. Simulation of the hydro operation indicated that floods or freshes would occur on average every 6 weeks and their average duration would be between 4-6 days. This frequency is probably sufficient to prevent prolific periphyton (algae attached to substrate) accumulation in this low nutrient river. Therefore, it should not be necessary to provide for flushing flows or any other seasonal pulses to stimulate spawning, migration or other biotic activities.

Large scale hydro-peaking can severely affect fish and benthic invertebrates. In the Tina River during the dry season, it is intended to generate at full discharge during the day and reduce to zero power station discharge during the night leaving only the environmental flow in the river. This means that the flows could fluctuate between 18 m³/s and the environmental flow on an almost daily basis. Flows of 18 m³/s or more presently occur for about 20% of the time. Fluctuating flows from 1 m³/s to 18 m³/s would inconvenience local inhabitants but would not prevent them from crossing the river on foot.

The maximum flow from the generators is relatively low compared to the magnitude of floods and freshes during the wet season, so that it is unlikely that fish habitat and fish populations will be affected by hydro-peaking. However, depending on the mobility of the species, there is the possibility of fish stranding.

Sediment

Entura (2014) estimated that it would be about 65 years before it became necessary to flush deposited sediment from around the power station intake. Thus, the dam will trap all bed load sediment (sand and coarser material) and a proportion of suspended sediment, and reduce the amount of bed load in the river downstream of the dam.

At present, a large amount of sediment is transported through the steep, relatively narrow section of river between the dam and powerhouse sites. The movement of sediment during floods and in the deeper swifter areas of the river at normal flows reduces algal growth, benthic invertebrate production and fish habitat. The creation of a dam will prevent much of this sediment movement and will gradually coarsen the substrate. This will improve the fish habitat considerably, as the habitat observations showed a clear preference for coarse substrate and avoidance of deep swift water where sand was being transported along the river bed.

The reduction in sand supply will tend to deepen pools and improve habitat for the pool dwelling species kuhlia and grunTERS. Any beneficial effect of sediment removed by the reservoir will gradually reduce with distance downstream, as sediment is entrained for the sands and gravels on existing river banks and introduced from tributaries.

Observations downstream of New Zealand hydro dams on gravel bed rivers (Waitaki, Clutha) indicate that the river bed will not degrade (erode) to any noticeable degree because the surface will be armoured by cobbles and larger gravels once the surface fines are removed.

Water temperature and quality

Because there is little diurnal and seasonal temperature variation and little wind mixing, tropical reservoirs often become stratified (Barrow 1988). Shallow lakes with high inflow are least at risk of stratification. The low residence time (7 days), relatively narrow sinuous reservoir, combined with floods that can occur at any time of year, suggest that stratification is unlikely.

During the rainy season, spot temperatures measured in the Tina River were 24.5°C at the Tina Village. Water temperatures in the Toni River were higher at 28.4-29.4°C. Water temperatures were also measured in the Toni River and in the Tina River between the Toni River confluence and approximately 1.5 km below the dam site over the period 11-15 July 2016. The daily maximum water temperature was 26°C at all sites over the 5 days with a diurnal variation of about 3°C. The lack of any downstream increase in temperature and the similarity of the water temperatures in the Toni and Tina rivers suggests that during July the water temperature was in equilibrium with the physical and climatic conditions and therefore a change in flow would have minimal effect on daily mean water temperature.

A reduction in flow generally does not change the daily mean water temperature significantly, but it does increase the daily maximum and decrease the daily minimum temperature. However, during the wet season at least, water velocities are high and river water temperatures may be below the equilibrium temperature, so that a reduction in flow would increase the daily maximum water temperature and may increase the daily average water temperature in the river between the dam and powerhouse. With a flow of 1 m³/s in the river between the dam and powerhouse, water temperatures are likely to be similar to those in the Toni River. This will not affect fish and benthic invertebrates as the aquatic community in the Toni River is similar to, if not better than, that in the Tina River.

The formation of a lake or reservoir is unlikely to have any effect on seasonal water temperatures because there is little variation in the annual air temperature in the Solomon Islands.

Environmental flow requirements

The environmental flow requirements were determined by modelling ten habitat suitability criteria (8 species -*Stiphodon semoni*, *Stiphodon pelewensis*, *Stiphodon rutilaureus*, *Belobranchus sp.*, *Anguilla marmorata*, two *Sicyopterus* species, *Kuhlia marginata*, and two fish community measures fish density and species richness) for flows of up to 11 m³/s. The analysis of habitat variation with flow suggested that a flow of 2-4 m³/s would provide maximum habitat for most of the common species, fish density and species richness. However for the species that live in very swift water (*Sicyopterus cyanocephalus* and *S. lagocephalus*), habitat suitability is greatest at flows greater than 10 m³/s.

The standard of environmental protection provided by an environmental flow can be assessed by comparing the amount of habitat (m²/m of river length) at the environmental flow with the amount of habitat at median flow. A flow of 1 m³/s would provide more habitat than is available at median flow for *Stiphodon semoni*, *Belobranchus sp.*, *Stiphodon pelewensis* and *Kuhlia marginata* and a similar amount for *Stiphodon rutilaureus*. Fish density and species richness would both be greater with a flow of 1 m³/s than with the median flow of 11.1 m³/s. The estimated fish density at an environmental flow of 1 m³/s is approximately 50 fish per 12 m². This is slightly less than the average of 60.4 fish/12m² observed in the Toni River and considerably higher than the 6.7 fish/12m² observed in the Tina River. Similarly, the estimated number of species per quadrat with an environmental flow of 1 m³/s was 2.1 compared to the observation of 2.61 and 1.17 in the Toni and Tina rivers, respectively.

The selection of an environmental flow depends on the balance between environmental effects and loss of generation and the relative values placed on the environment and generation. Provision of a 1 m³/s environmental flow between the dam and powerhouse should maintain or improve fish and benthic invertebrate densities and total numbers for most species. An environmental flow of 1 m³/s would maintain the riffle habitats that appear to be used by most fish species, although there would be a reduction in habitat for the *Sicyopterus* species, which can live in very swift water. Pools will also be maintained for *kuhlia* and grunTERS. Moreover, trapping of sediment in the dam and subsequent coarsening of substrate in the river below the dam will improve habitat for all aquatic species and overall productivity and this improvement with an environmental flow of 1 m³/s should result in fish densities that are similar to that in the Tina and Toni rivers at present.

A possible increase in water temperature will not affect fish populations, as the predicted increase is small and the same fish community is present in the Toni River where water temperatures are similar or slightly higher than in the Tina River. There is little likelihood of any change in biotic interactions, such as predation, although the lower flow will make it easier for humans to spear fish.

The fish and invertebrate community in the Toni River is an example of the fish community that would probably develop between the dam and tailrace with an environmental flow of 1 m³/s. The flow in the Toni River is approximately one fifth of that in the Tina River, yet the average fish density in the Toni River was almost 10 times higher than that in the Tina River. Fish diversity was also higher in the Toni River. This is probably because the Toni River provides a more stable aquatic environment than the Tina River, where the velocities were higher and amount of sand movement greater.

Fish passage

The suggested environmental flow will not be an impediment to fish passage between the power house and dam. The fish in the river are either swimming species or climbing species. It does not appear to be feasible to provide passage facilities for the swimming species (kuhlia and grunTERS), because such facilities would be prohibitively expensive and the success of any design would be uncertain. However, it is relatively easy to provide upstream passage for the gobies and eels by installing a trap and haul system. This would comprise a simple ramp into a trap. The fish in this trap would be transferred into the reservoir at intervals of 3-7 days. The advantages of a trap and haul system are that it is simple and inexpensive, it can be operated by local people and it would provide a record of fish migrations. If kuhlia and/or grunTERS accumulate at the powerhouse or base of the dam, it will be possible to net them and transfer them to other locations.

Downstream passage for adult eels could be facilitated by spilling water at the start of the wet season when adult eels are observed congregating at the dam face. In addition, it would be possible to operate the reservoir at a slightly higher level, to increase the probability of spill early in the wet season.

Mitigation measures

The environmental flow is one mitigation measure, and probably the most important, as this will maintain the aquatic habitat and fish populations.

Provision of fish passage is another measure that will sustain fish communities in the upper river. Sudden increases in water level can be dangerous to people in the river bed and it might be advisable to ramp up generation from minimum to maximum load over a period of 1 to 1.5 hours to give people sufficient warning of increasing flows. Sudden reductions in water level can strand fish. Therefore, it is recommended that an adaptive management approach be taken to determining whether ramping flows are needed to mitigate potential fish stranding. This would involve carrying out studies during initial operation to determine whether fish are stranded on sudden reductions in flow. If necessary, the rate of flow reduction (i.e., ramping rate) could then be reduced to see if that prevents stranding.

Part of the river upstream of the dam will change from a river to a lake. Lakes are rare on Guadalcanal, so this provides the potential for improved access, and recreational activities.

1 Introduction

The Tina River was selected as a possible river for hydropower development because it is close to Honiara and, because it drains from the highest region of Guadalcanal, is a relatively large river with a substantial flow.

The Tina River Hydropower development has been studied in some detail since 2006, and various options for dam sites and dam heights have been investigated. The preferred option is known as phase 3 option 7c, and is described by Entura (2014).

A study of the aquatic ecology of the Tina River catchment (Environmental and Social Impact Assessment ESIA) has been carried out. This comprised a review of existing information on fish species in the catchment, a fisheries field survey in the dry season from 20 July to 06 August 2013, plus discussions with fisherman and other river users regarding their observations of fish. A second fish and water quality survey was carried out in the wet season (February 2014), which included the sampling sites used in the 2013 dry season survey, as well as measurements and observations obtained at the dam site (option 7c).

These fish surveys provide good information on the fish species and their distribution within the Tina River catchment, as well as a description of the physical environment at sampling sites. However, the ESIA report acknowledged that there is limited knowledge about habitat use, life history, time of migration, and the ability or willingness of fish species to pass potential barriers, such as waterfalls and rapids. Consequently, Measurements were made of fish numbers, water depth and velocity, and substrate in the Toni and Tina rivers and these data were used to derive habitat suitability models for common species.

The potential effects of the Tina River hydropower development on fish are discussed in Annex 1 of the ESIA and in the engineering report by Entura (2014). Both reports considered that further work should be carried out to determine ecological effects, environmental requirements and possible mitigation measures.

An instream habitat survey of the Tina River was carried out to develop an instream habitat model that predicts how physical habitat in the river between the dam and powerhouse locations varies with flow. This model, in conjunction with habitat suitability models, was used to determine the effects of flow changes on fish habitat in the Tina River.

This report uses the results of the instream habitat modelling plus information in the ESIA and Entura report, to assess potential impacts in three areas: downstream of the powerhouse tailrace, between the tailrace and the dam, and upstream of the dam. In particular, the study addresses:

- the issues of environmental flow requirements between the dam and tailrace, as well as downstream of the tailrace;
- the potential effects of hydro-peaking on fish;
- the effect of reduced sediment load downstream of the dam on river morphology; and
- the potential effects of the dam on fish distribution and possible fish passage options.

Although the report considers changes to river morphology, changes in water temperature, and effects on algal accumulation, the focus is on fish because maintenance of the fish community at an acceptable level is considered an appropriate management goal for an environmental flow.

2 Methods of determining environmental flow requirements

Long-term solutions to river flow management need to take a holistic view of the river system, including geology, fluvial morphology, sediment transport, riparian conditions, biological habitat and interactions, and water quality, both in a temporal and spatial sense.

The instream flow incremental methodology (IFIM; Bovee 1982) is an example of an interdisciplinary framework that can be used in a holistic way to determine an appropriate flow regime by considering the effects of flow changes on instream values, river morphology, physical habitat, water temperature, water quality, and sediment processes (Fig. 1). Its use requires a high degree of knowledge about seasonal and life-stage requirements of species and inter-relationships of the various instream values or uses.

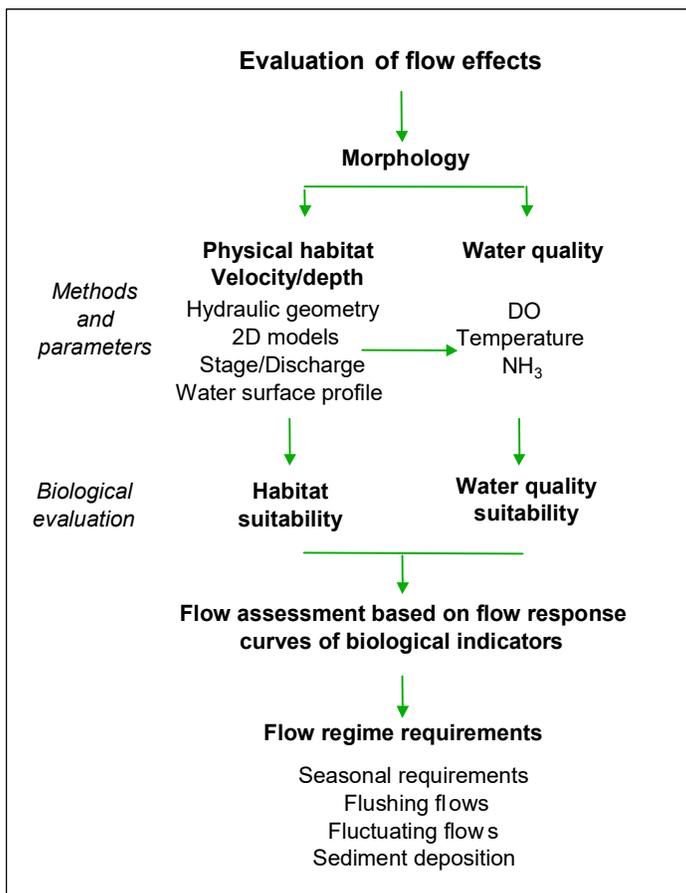


Figure 1: A framework for the consideration of flow requirements.

Other flow assessment frameworks are more closely aligned with the “natural flow paradigm”, a concept that emphasises the need to partially or fully maintain or restore the range of natural intra- and interannual variation of hydrologic regimes in order to protect native biodiversity and the

evolutionary potential of aquatic, riparian and wetland ecosystems (Poff et al. 1997). The range of variability approach (RVA) and the associated indicators of hydrologic alteration (IHA) allow an appropriate range of variation, usually one standard deviation, in a set of 32 hydrologic parameters derived from the 'natural' flow record (Richter et al. 1997). The implicit assumption in this method is that the natural flow regime has intrinsic values or important ecological functions that will be maintained by retaining the key elements of the natural flow regime. Arthington et al. (1992) described a holistic method that considers not only the magnitude of low flows, but also the timing, duration and frequency of high flows. This concept was extended to the building block methodology (BBM), which "is essentially a prescriptive approach, designed to construct a flow regime for maintaining a river in a predetermined condition" (King et al. 2000). It is based on the concept that some flows within the complete hydrological regime are more important than others for the maintenance of the river ecosystem, and that these flows can be identified and described in terms of their magnitude, duration, timing, and frequency.

A holistic consideration of every aspect of flow and sediment regime, river and riparian morphology, and their associations with the life cycles of the aquatic biota requires a degree of knowledge about individual rivers that is rarely available. The aim of the minimum flow is to retain adequate water depths and velocities in the stream or river for the maintenance of the critical values. Most flow assessments and habitat suitability criteria consider physical habitat at a meso- to macro-habitat level rather than microhabitat. In this way, suitable average depths and velocities can be maintained in the main habitats, with a degree of habitat diversity that is generated by the morphology of the river, and is largely independent of flow. The geomorphological and flow-related ecological processes that are associated with low to median flows are generally taken into consideration in instream flow methods. However, fish passage or seasonal flow requirements may need to be investigated in situations where fish passage may be an issue or where the species has distinct seasonal habitat requirements. Consideration should also be given to downstream effects. The effect of an abstraction is usually greatest immediately below the abstraction site, but diminishes as the river flow is supplemented by contributions from tributaries and the proportional change in flow reduces.

Instream flow methods can be classified into two basic types; historic flow and hydraulic-habitat methods. Historic flow methods are coarse and largely arbitrary. An ecological justification can be argued for the mean annual low flow (MALF) and retention of the natural flow regime, and the concept of a low flow habitat bottleneck for large brown trout has been partly justified by research (e.g., Jowett 1992), but setting flows at lower levels (e.g., the 5 year 7 day low flow — $Q_{7,5}$) is rather arbitrary. Hydraulic-habitat methods have a direct link to habitat use by aquatic species. They predict how physical habitat (as defined by various habitat suitability models) varies with flow, and the shapes of these curves provide the information that is used to assess flow requirements. Habitat based methods allow more flexibility than historic flow methods, offering the possibility of allocating more flow to out-of-stream uses while still maintaining instream habitat at levels acceptable to other stakeholders (i.e., the method provides the necessary information for instream flow analysis and negotiation).

The ecological goal of habitat methods is to provide or retain a suitable physical environment for aquatic organisms that live in the river. Habitat methods tailor the flow assessment to the resource needs and can potentially result in improved allocation of resources. The consequences of loss of

habitat are well known; the environmental bottom line is that if there is no suitable habitat for a species it will cease to exist. It is essential to consider all aspects such as food, shelter, and living space (Orth 1987; Jowett 1995) and appropriate habitat suitability curves are the key to the successful application of habitat based methods.

The procedure in an instream habitat analysis is to select appropriate habitat suitability curves or criteria (e.g., Fig. 2), and then to model the effects of a range of flows on the selected habitat variables in relation to these criteria. The habitat suitability index (HSI) at each point was calculated as a joint function of depth, velocity and substrate type using the method shown in Figure 2. The area of suitable physical habitat, or weighted usable area (WUA), was calculated by multiplying the area represented by each point by its joint habitat suitability. Using the example in Figure 2, a given point in the river (representing an area of reasonably uniform depth and velocity) where the depth is 0.1 m, depth suitability is only 65% optimal, according to knowledge of the depth requirements of the fish. Similarly, the velocity recorded at the point is 0.25 m/s, which is optimal (suitability weighting of 1), and the substrate is fine gravel (sub-optimal, with a weighting of 0.4) and cobbles (optimal with a weighting of 1). Multiplying these weighting factors together we get a joint habitat suitability weighting of 0.455 for that point in the river for the selected fish species. If the depth had been 0.2 m and there had been only cobbles, then that point in the river would have been optimal (i.e., 1 for depth \times 1 for velocity \times 1 for substrate = 1). This exercise was repeated within the habitat assessment model for the depth/velocity/substrate types in every grid square across the river, and the area covered by each square was multiplied by the point suitability. These areas, which have been weighted by their respective point suitability values, were then summed to give a measure of total area of suitable physical habitat for the given species at the given flow. This process was then repeated for a series of other flows with the depths, velocities, and habitat suitability being modelled for the new flows as described above. The total area of suitable physical habitat was then plotted as a function of flow to show how the area of suitable physical habitat for a given species changes with flow. Variations in the amount of suitable habitat with flow are then used to assess the effect of different flows for target organisms. Flows can then be set so that they achieve a particular management goal, such as an objective in a regional plan.

The flow related habitat metrics used to quantify instream habitat are weighted useable area (WUA m^2/m) and the average habitat suitability index (HSI) (Bovee 1982; Stalnaker et al. 1995). HSI is numerically equivalent to WUA divided by the wetted river width.

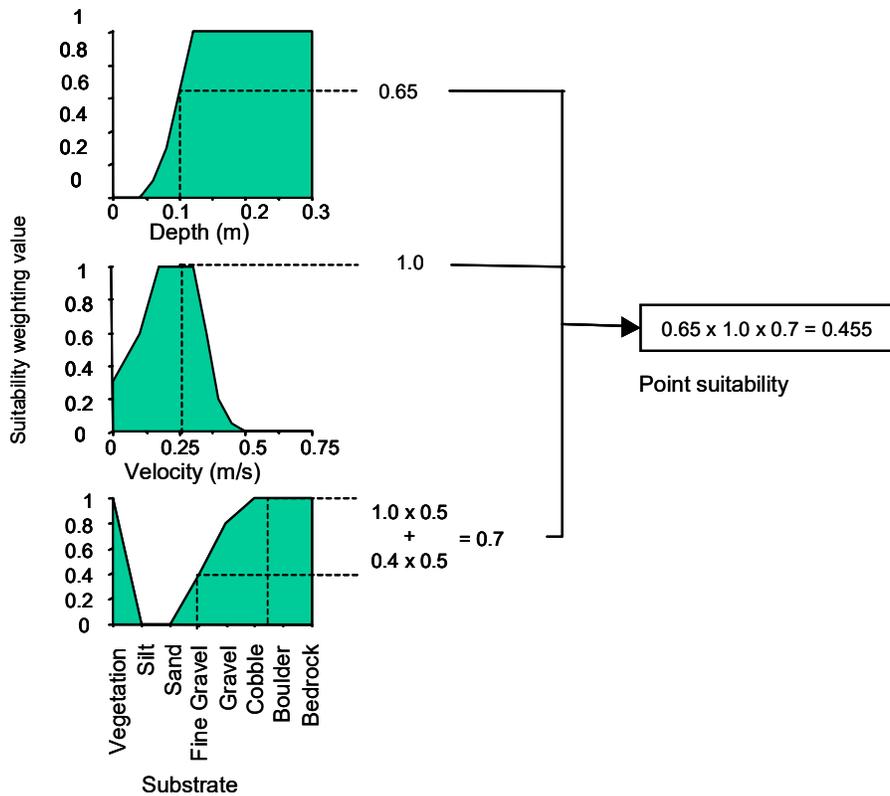


Figure 2: Calculation of habitat suitability for a fish species at a point with a depth of 0.1 m, velocity of 0.25 m/s, and substrate comprising 50% fine gravel and 50% cobble. The individual suitability weighting values for depth (0.65), velocity (1.0), and substrate (0.7) are multiplied together to give a combined point suitability of 0.455.

Various approaches to setting levels of protection provided by a minimum flow have been used, from maintaining a maximum amount of habitat, a percentage of habitat at median flow, or using a breakpoint (or “inflection point”) on the habitat/flow relationship (Jowett 1997). While there is no percentage or absolute value associated with a breakpoint, it is a point of diminishing return, where proportionately more habitat is lost with decreasing the flow than is gained by increasing the flow.

Habitat methods can also incorporate flow regime requirements, in terms of both seasonal variation and flow fluctuations. Flow fluctuations are an important component of the habitat of most naturally flowing streams. Such fluctuations remove excess accumulations of silt and accumulated organic matter (e.g., from algal mats) and rejuvenate stream habitats. Extended periods without a flow disturbance usually result in a shift in benthic community composition, such as a reduction in diversity and an increase in biomass of a few species.

3 Tina River

The Ngalimbui River is a large river draining in a northerly direction from some of the highest peaks (2000+ m) on the island of Guadalcanal. The river has two main tributaries, the Tina and Toni rivers. The Tina River catchment is more than three times larger than the Toni River. The catchment area of the Tina River is about 150 km² compared to 45 km² for the Toni River. The Tina River contains a diverse fish community and is unaffected by human development in its upper reaches. The gradient of the river increases with distance upstream (Table 1). Downstream of the Tina/Toni confluence the gradient is 2.3 m/km. This increases to about 5 m/km between the Tina/Toni confluence and the powerhouse site. Upstream of this the gradient continues to increase and is an average of about 9.3 m/km through the reach between the dam and powerhouse, and is steep (19 m/km) between the dam and the head of the proposed reservoir.

Table 1: Distance, elevation and gradient of key sections of the Tina River.

Location	Distance from sea (km)	Elevation (m amsl)	Gradient (m/km)
Estuary	0	0	0.0
Tina/Toni confluence	19	43	2.3
Powerhouse site	24.7	73	5.2
Dam site	30.1	123	9.3
Proposed reservoir reach	32.7	172	18.8

The changes in gradient with distance upstream are reflected in the substrate and morphology. In the lower reaches downstream of the Tina/Toni confluence, the river is relatively wide and the substrate is dominated by sand and gravel. The bars and braiding are evidence of bedload movement during floods. From the Tina/Toni confluence to approximately 1 km upstream of Tina Village the river gradient is low, and the river unconfined with a substrate comprised of cobble, gravel and sand. The aquatic habitat comprises mainly wide runs and riffles. Upstream of this, the river becomes steeper and more confined and boulders are present, as well as cobbles, gravel and sand. The runs and riffles are generally narrower, with occasional rapids and places where the river splits into two channels. There are also pools which form where the river flows against a bedrock bank and changes direction. Upstream of the powerhouse site, the river becomes even more confined and steeper (50 m in 5.4 km).

On 6 March 2016, habitat types were identified and their lengths estimated between Tina Village and a point about 1.5 km downstream of the dam site. The flow on that day was measured at 8.7 m³/s. The habitat types were classified into pools, runs, riffles and rapids according to their surface characteristics. The water surface in pools was smooth and the water was relatively deep (>1.5 m). At high flows (>8 m³/s) the water velocity in the pools was noticeable (Fig. 3). The water surface of runs was usually wavy and broken by boulders (Fig. 4). Riffles were shallower than runs and contained more broken water (Fig. 5) and rapids were steep torrents over boulders (Fig. 6).



Figure 3: Pool formed against cliff



Figure 4: Run



Figure 5: Run transitioning into riffle



Figure 6: Rapid and riffle habitat

Overall, the swift water habitat types were more frequent upstream of the powerhouse site than downstream of it, but the average length of each habitat type tended to be shorter because the river was more constrained by its steep banks (Table 2).

Table 2: Percentage of habitat types between Tina Village, powerhouse site and dam site on 6 March 2016.

Habitat type	1 km upstream of Tina Village to powerhouse site	Upstream of powerhouse to 1.5 km downstream of dam site
Rapid	5%	5%
Riffle	31%	36%
Run	55%	46%
Pool	9%	13%

3.1 Hydrology

A flow measurement and rainfall station was established at the commencement of the Phase 1 study in the upper Tina River catchment to provide flow data for the river. The flow station was operational from 15 June 2010 to 3 April 2014, providing approximately 4 years of river flow data. The water level recorder was located about 7 km upstream of the dam site and recorded flow data were multiplied by the ratio of the catchment areas (125/115) to provide a flow record at the dam site (Entura 2015a). The derivation of the river flows used in this report is described in detail by Entura (2015a).

Table 3: Flow statistics for Tina River at Dam site (for period 16 June 2010-3 April 2014) derived from daily mean flows.

Mean flow	14.85 m ³ /s
Mean annual flow (for complete years only)	15.87 m ³ /s
Median flow	11.87 m ³ /s
Coefficient of Variation	0.89
Fre3 (frequency of flows > 3 x median per year)	6.3
MALF (mean annual 1-day low flow for complete years)	4.83 m ³ /s
MALF (mean annual 7-day low flow for complete years)	5.27 m ³ /s

The recorded (2010-2014) median flow of the Tina River at the dam site (Option 7c) was approximately 11.9 m³/s (Table 3) with higher mean and median flows during the wet season (October-May) than the dry season (Figure 7). The annual minimum daily flow varied from 2.9 m³/s in 2010 to 5.8 m³/s in 2012, and can occur between June and September.

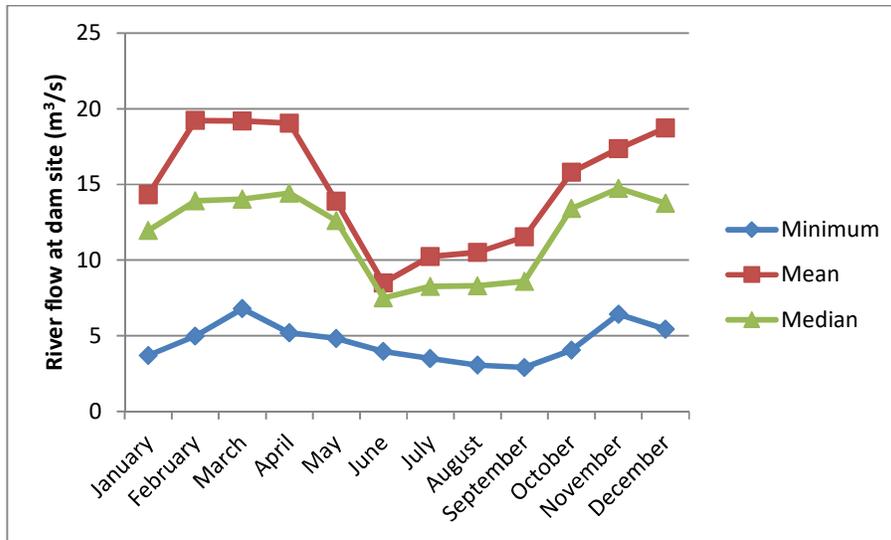


Figure 7: Monthly average flows in the Tina River at dam site (2010-2014)

To estimate the long-term flow statistics, Entura (2015a) simulated 30 years of rainfall and flow data from rainfall data recorded at Henderson Field, and showed that the statistical characteristics of the simulated rainfall series were similar to those of the rainfall recorded in the Tina River catchment (Chupukarma). Entura fitted a hydrological model to the 4 years of flow and rainfall data, and used this model to produce 30 years of simulated flow record. This showed that the period 2010-2014 was probably a period of slightly higher than normal flows (Table 4). The median flow was 10.78 m³/s compared to 11.87 m³/s for the short-term flow record. A flow of 18 m³/s was exceeded for 18% of the time with the long-term record, and for 22% of the time for the short-term record (Fig. 8).

Flows at the dam site were obtained by scaling the recorded flows by the proportion of the catchment area at the dam site (125 km²) by the catchment area at the recorder site (115 km²). With the strong south to north rainfall gradients that probably exists, there is a risk that this scaling might slightly over-estimate flows at the dam site.

Table 4: Simulated flow statistics for Tina River at Dam site (January 1975-24 December 2003)

Mean flow	13.10 m ³ /s
Mean annual flow (for complete years only)	12.91 m ³ /s
Median flow	10.78 m ³ /s
Coefficient of Variation	0.69
Fre3 (frequency of flows > 3 x median per year)	4.83
MALF (mean annual 1-day low flow for complete years)	4.56 m ³ /s
MALF (mean annual 7-day low flow for complete years)	5.09 m ³ /s

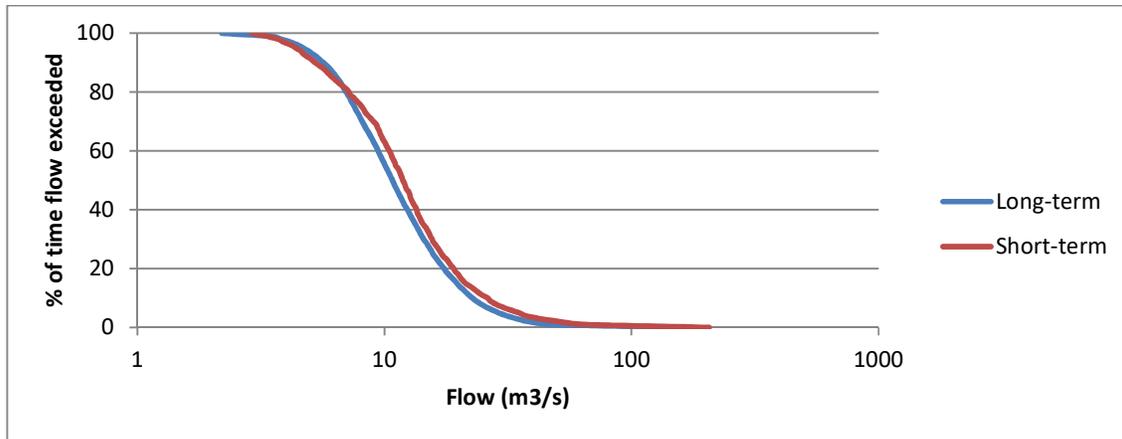


Figure 8: Flow duration curves for long-term synthetic flows in the Tina River at dam site (2010-2014) and short-term recorded flows (16 June 2010 to 3 April 2014).

4 Description of power scheme

The preferred option, known as Phase 3 - Option 7c, is described by Entura (2014). The proposed dam is located approximately 30 km upstream of the mouth of the river and about 11.7 km upstream of the Toni River confluence. The development comprises an approximately 55 m high dam with a 3.3 km headrace tunnel leading to a powerhouse and tailrace from which the water is discharged back into the Tina River.

The operating range of the reservoir formed by the dam will be 5 m. However, the reservoir will normally be held about 3 m below full stage to increase utilisation by storing water during floods and freshes. Initially, the power house will have three generator/turbine units, each with a capacity of 5MW, allowing a maximum discharge of about 18 m³/s and a minimum discharge of about 2.4 m³/s. Provision will be made for a fourth unit, should it be required in the future.

At the dam site the river elevation is approximately 123 m amsl and the catchment area is about 123 km². At the tailrace location the elevation is about 73 m amsl, and the catchment area is about 133 km². The river distance between the dam and tailrace is 5.4 km.

4.1 Power station operation

The power station will be operated to maximise power generation, so that during periods of high flow the station will be at full generation for much of the time. However, during low flows in the dry season, the river flow will be considerably less than the maximum generating capacity. During these periods, the station will operate on a daily/weekly cycle, generally following the load demand with maximum generation up to 18 m³/s on weekdays during working hours, then shutting down during the night, as shown in Fig. 9. From an environmental perspective, it would be preferable for the night generation to reduce to minimum machine discharge (2.4 m³/s) rather than zero flow. This will reduce the magnitude of fluctuations in flows, and better meet environmental flow requirements in the Tina River between the tailrace and Toni River confluence.

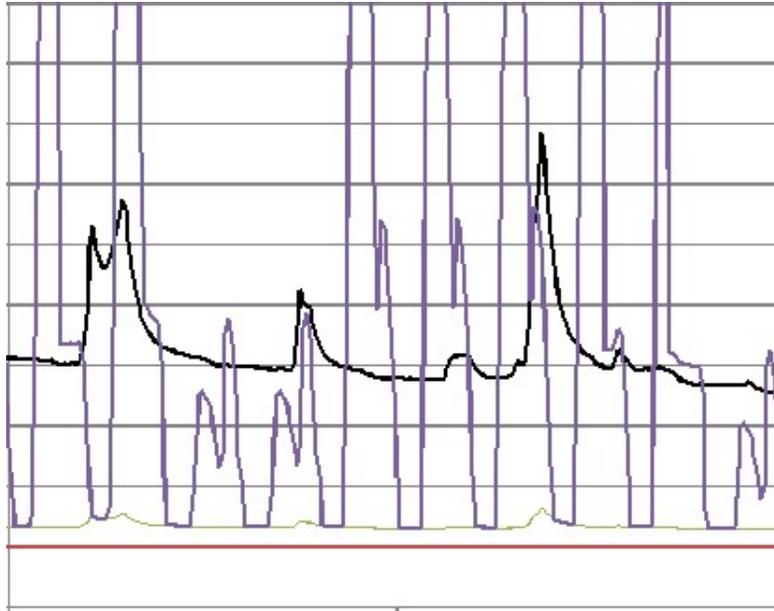


Figure 9: Likely operation of power station during low flows showing inflow in black and power station discharge in blue (Entura 2014)

4.1.1 Operation modelling

Power station operation was simulated for the 3.3 years of hourly flow data (15 June 2010 to 21 September 2013) that were available. The simulation assumed that generation was maximised with a maximum generation rate of 18 m³/s, and that the minimum generation was 2.4 m³/s. The environmental flow downstream of the dam was assumed to be 1 m³/s. The normal operating level was assumed to be 172 m amsl, with the spillway invert at 175 m amsl. This provides 3 m of water storage during floods and freshes to reduce the incidence of spill events. The reservoir area is relatively small and was assumed to be 0.284 km². The ogee spillway width was taken as 45 m, with a discharge formula of $2.03 \cdot 45 \cdot (\text{Reservoir level of 175 m amsl})^{1.5}$, calculated assuming the spill capacity at 185.9 m amsl is 3300 m³/s (Entura 2014).

The simulation of power station operation showed that spill flows could occur in any month (Fig. 10). The mean inflow over the simulation period was 14.8 m³/s and mean flow of the river between the dam and the powerhouse would be about 3.5 m³/s, comprising 1 m³/s environmental flow and 2.5 m³/s of spill (Table 5). Tributary flows, between the dam and powerhouse, would increase the mean environmental flow by up to 8%, but this would mainly be during, and just after, storms. Flows in the river would be 1 m³/s for about 88% of the time. The average reservoir level would be about 172.8 m amsl, and the average flow through the powerhouse would be approximately 11.3 m³/s, giving utilisation of about 82% of the available water, excluding the environmental flow.

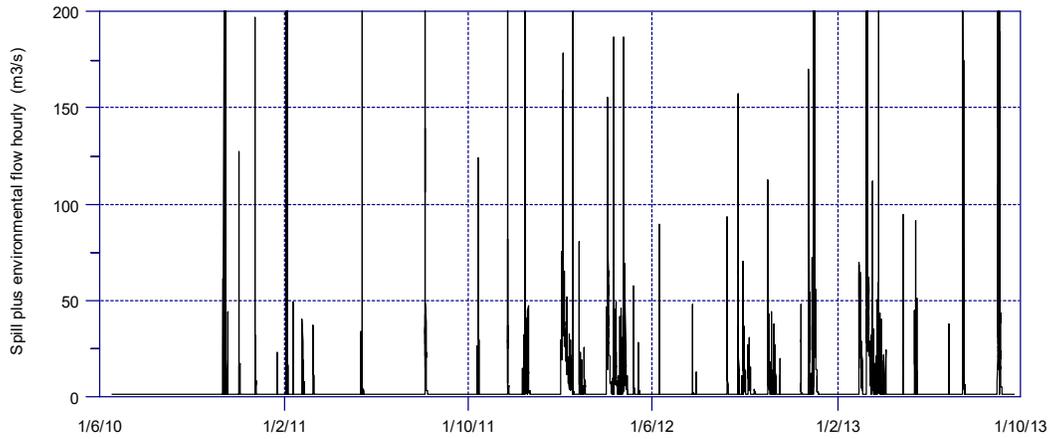
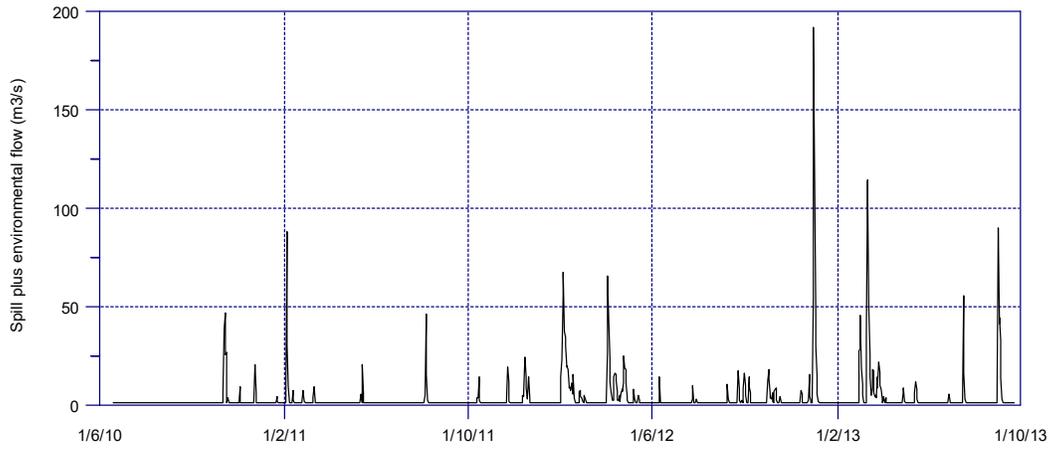
For the period simulated assuming a 1 m³/s environmental flow, it is estimated that the annual energy generation from the powerhouse and environmental flow generator could be about 82.2 GWh/a and 3.8 GWh/a, respectively, for a total of 86 GWh/a. When reduced for transmission losses of about 1.2 GWh/a, the annual output is close to Entura's estimate of 84.7 GWh/a (Table 11.14

Entura 2014). If the environmental flow were increased to 3 m³/s, the annual energy generation from the powerhouse and environmental flow generator could be about 71.5 GWh/a and 11.3 GWh/a, respectively, or a decrease of about 3.7%. For the environmental flow generator at the dam, it was assumed a tailrace level of 123 m amsl and a generation efficiency of 88%. At the powerhouse, it was assumed a tailrace level of 73 m amsl, an efficiency of 89%, and total hydraulic losses of $0.02179 \cdot Q^2$ (Entura 2014).

The median and mean flows for the period 15 June 2010 to 21 September 2013 were 11.1 m³/s and 14.8 m³/s, respectively (Table 5), compared to the estimated long-term median and mean flows of 10.78 m³/s and 13.1 m³/s, respectively (Entura 2015a).

To check the long-term energy generation, generation for the 30 years of synthetic daily flows was simulated on an hourly time step. The use of daily data for the simulation was checked by converting the short-term record for the period 15 June 2010 to 21 September 2013 to daily means, and then using these daily means to simulate operation. This showed that simulation with hourly and daily data produced similar results. The mean inflow over the 30-year simulation period was 13.1 m³/s, and mean flow of the river between the dam and the powerhouse was about 2.3 m³/s, comprising 1 m³/s environmental flow and 1.3 m³/s of spill. The average reservoir level was approximately 172.55 m amsl, and the average flow through the powerhouse was about 10.8 m³/s, providing utilisation of about 89% of the available water, excluding the environmental flow. The average generation was reduced by 3.5% from 86 Gwh/a for the 2011 to 2013 period, to 83.0 Gwh/a for the synthetic 30-year record. This is a slightly less than the reduction of 5% calculated by Entura (Table 3.9, Entura 2015b).

According to Entura (2014), in the early years of operation (2018), average Honiara power demand will range from 8.2MW to 15.8MW. However, in 2035, average power demand is expected to range from 15.4MW to 29.7MW. For the purposes of the present analysis, it was assumed that generation was maximised, i.e., by 2035 there will likely always be demand for the power generated .



Period analysed 3 years and 4 months

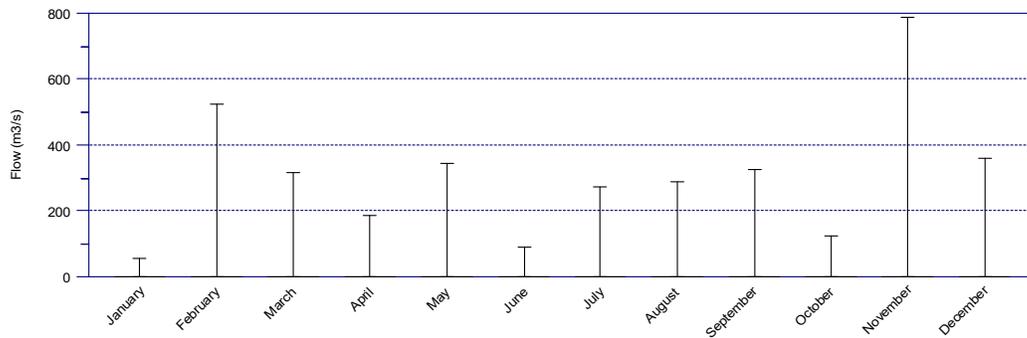


Figure 10: Simulated daily mean spill flows (upper), hourly flows (middle) and monthly maximum hourly spill flows (lower).

Table 5: Simulated flow statistics for the period (15 June 2010 to 21 September 2013 for the river between dam and powerhouse

	Environmental flow	Natural flow
Mean flow	3.5	14.8
Median flow	1.0	11.1
Coefficient of Variation	4.6	1.2
MALF (mean annual 1-day low flow for complete years)	1.0	4.2
MALF (mean annual 7-day low flow for complete years)	1.0	4.3

4.1.2 Occurrence of floods and freshes (spill events) in the residual river

Hydroelectric operation was simulated using hourly data, and daily means were calculated from the hourly flows. Spill events, that would flush the channel and remove any fine sediment deposits and algal accumulations (Table 6), would occur relatively frequently, with 9.5 events per year (every 5.5 weeks on average). These would be of relatively short duration (4 to 6 days), but 5% of the spill events could last for longer than 23 days. A spill event of 6 days means that there will be spill on 6 successive days, but without necessarily spilling continuously for 6 days. An examination of hourly spill showed that a spill event of 6 days could be made up of a number of spills that were shorter duration than a day. This happens when flows are high, the reservoir is at full control level, and afternoon thunderstorms requiring spill releases cease early the next day, as shown in Fig. 11.

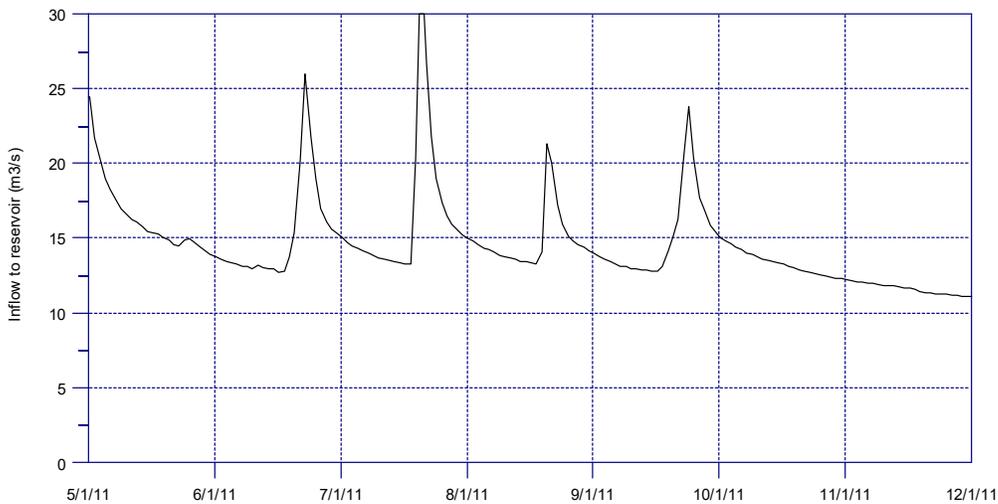


Figure 11: Example of inflow sequence that triggers short duration spill events over a number of days.

Table 6: Frequency and duration of spill events in the residual river

Number of days that the flow > 1 m ³ /s per year	58
Average number of contiguous events per year	9.5
Mean duration	6.1
Maximum duration	30
Duration equalled or exceeded by 5% of events	23.4
Duration equalled or exceeded by 25% of events	6.0
Median duration	4.0
Duration equalled or exceeded by 75% of events	3.0
Duration equalled or exceeded by 95% of events	1.4

5 Fish species in the Tina River

5.1 Diversity

The fish fauna of the Solomon Islands is diverse, with the total number of species potentially numbering as high as 100. Polhemus, et al (2008), report a total of 43 species from 31 sites in the Solomon Islands and Jenkins & Boseto (2007) report 60 species from 15 sites in lakes and rivers of Tetepare Island. Surveys of the Tina River (ESIA) report 76 fish species. However, many of these species are predominantly marine species that are found in the estuaries. No fish species are believed to be endemic to the Tina River, although it is possible that some gobies are endemic to the Solomon Islands (ESIA). Tilapia have been found in still water of the Lower Toni River (Robson Hevalao 14 July 2016) and it is likely that they would be in similar habitats in the lower Tina River. It is unlikely that tilapia or gambusia would be found in the swift flood-prone water of the upper Tina River catchment.

5.2 Distribution and species richness

The distribution of fish species observed during ESIA surveys in the Tina River catchment (Table 7) is described in the ESIA report. A total of 44 species were identified in the middle reaches (site 7c, Koropa, Sengue) and 32 species were identified upstream of the dam site (recorder site, plus 2 sites further upstream). The 44 species identified were 1 species of eel, 38 species of goby, 2 mullet species, 2 kuhlia species, 1 grunter and 1 pipefish. All of these species are reported to be migratory and require access to the sea to complete their life cycles.

Of the species observed in the middle and upper reaches of the Tina River catchment, 4 species were found in the upper catchment that did not occur in the middle catchment, and 16 species were found in the middle catchment that did not occur in the upper catchment. This suggests that some of the species in the middle catchment do not migrate to the upper part of the catchment.

Fish observations were also made in the Ngalimbui River downstream its confluence with the Toni River. The average number of species found in the Ngalimbui River (10) was less than in the Tina River (19). This difference was statistically significant in the wet season (Kruskal-Wallis, P=0.02, N=11) but not in the dry season (Kruskal-Wallis, P=0.28, N=10). The finer and less stable substrate of

the Ngalimbui River is probably the reason for the reduced species richness. However, fish were sampled using nets and snorkelling observation in the wet season, and only snorkelling observation in the dry season.

The ecological value of the Tina catchment is high because of its species richness, area and unmodified nature. However, the catchment is not unique and studies (Boseto 2016) have been carried out that show that the Tina River is similar to nearby catchments in terms of fish species composition. The river provides some food for the local people who spear the larger fish species (>70 mm) and catch the freshwater shrimps.

The amount of sediment transported, particularly sand, is an important ecological characteristic of the Tina River. Where the river is relatively narrow, such as between the dam and powerhouse sites, the river is steep and flow is concentrated in a relatively narrow cross-section. This results in considerable substrate mobility during floods and some movement of sand along the bed of the river at most flows. From a biological point of view, this creates an inhospitable environment in the deeper swifter areas of the river where there is virtually no algal growth or benthic invertebrate production and few fish.

Table 7: Distribution of fish species observed in Tina River. This table is from the ESIA and is subject to review by D. Boseto.

Species Scientific name	Common name	Reach in which species was observed		
		Both upper and middle	Upper alone	Middle alone
<i>Anguilla marmorata</i>	Eel	X		
<i>Allamogurna sp.</i>	Goby			X
<i>Belobranchus spp.</i>	Goby			X
<i>Butis amboinensis</i>	Goby	X		
<i>Ophieleotris hoedti</i>	Goby			X
<i>Ophieleotris sp.1</i>	Goby	X		
<i>Ophieleotris sp. 2</i>	Goby	X		
<i>Bunaka gyrinoides (Eleotris gyrinoides)</i>	Goby			X
<i>Awaous guamensis</i>	Goby	X		
<i>Awaous melanocephalus</i>	Goby	X		
<i>Awaou ocellaris</i>	Goby	X		
<i>Awaous sp.</i>	Goby		X	
<i>Bathygobius andrei</i>	Goby	X		
<i>Glossogobius celebius</i>	Goby			X
<i>Lentipes multiradiatus</i>	Goby	X		
<i>Lentipes sp.1(Solomonensis)</i>	Goby	X		
<i>Lentipes sp. 2(Solomonensis)</i>	Goby	X		
<i>Redigobius bikolanus</i>	Goby	X		
<i>Schismatogobius ampluvinculus</i>	Goby			X

Species	Common name	Reach in which species was observed		
		Both upper and middle	Upper alone	Middle alone
<i>Schismatogobius roxasi</i>	Goby			X
<i>Sicyopterus lagocephalus</i> *	Goby	X		
<i>Sicyopterus longifilis</i>	Goby		X	
<i>Sicyopterus ouwensi</i>	Goby	X		
<i>Sicyopterus sp.</i>	Goby			X
<i>Sicyopus discordipinnis</i>	Goby	X		
<i>Sicyopus mystax</i>	Goby			X
<i>Sicyopus sp.1</i>	Goby	X		
<i>Sicyopus sp.2</i>	Goby			X
<i>Sicyopus zosterophorum</i>	Goby	X		
<i>Stenogobius hoesei</i>	Goby			X
<i>Stiphodon pelewensis</i> **	Goby	X		
<i>Stiphodon autopurpureus</i>	Goby	X		
<i>Stiphodon birdsong</i>	Goby	X		
<i>Stiphodon multisquamus</i>	Goby	X		
<i>Stiphodon ornatus</i>	Goby	X		
<i>Stiphodon rutilaureus</i>	Goby			X
<i>Stiphodon semoni</i>	Goby	X		
<i>Stiphodon sp.1</i>	Goby		X	
<i>Stiphodon sp.2</i>	Goby			X
<i>Rhyacichthys aspro</i>	Loach goby	X		
<i>Kuhlia marginata</i>	Spotted flagtail	X		
<i>Kuhlia rupestris</i>	Jungle perch	X		
<i>Liza vaigiensis</i>	Mullet			X
<i>Chelon macrolepis</i>	Mullet			X
<i>Microphis sp.</i>	pipe fish			X
<i>Mesopristes argenteus</i>	Silver grunter		X	
<i>Mesopristes cancellatus</i>	Grunter	X		
Total number of species		27	4	16

* probably includes *Sicyopterus cyanocephalus*

** previously called *Stiphodon atratus*

5.3 Migration

Species of gobies probably spawn on stable substrate in the habitats they occupy as adults. When the larvae hatch, they are carried downstream to the sea or estuary, where they rear for 2-3 months,

before returning as juveniles to freshwater, in the dry season. The return of these juvenile fish supports a subsistence and commercial fishery. The juveniles swim upstream, sometimes in shoals, using low velocity areas, such as river margins, due to their poor swimming ability. The life cycle of gobies and the fishery for juveniles is similar to that of juvenile galaxiids (whitebait) in New Zealand (McDowall 1990).

None of the fish species whose larvae rear in the sea (e.g., eels and gobies) are believed to return to their natal habitats. The goby larvae rear in near shore environments and are attracted by freshwater plumes when they move into freshwater as juveniles. However, numerous small (10 mm) gobies were observed in the margins of the Tina River between the dam and powerhouse sites in July 2016. The distance upstream and the number and size of these fish suggest the possibility that not all species of gobies require access to the sea to complete their life cycles. Unreported otolith studies also suggest that not all larvae of Sicydiinae gobies reared in the sea (Boseto 2016).

Eels, kuhlia and possibly grunters migrate downstream as adults to spawn and the juveniles migrate upstream to the adult habitats. Eels migrate downstream in late November, at the start of the wet season, spawn in the ocean, and die after spawning. Adult eels probably migrate to a spawning location in the Pacific Ocean. The larvae (Leptocephali) feed in the ocean until they develop into glass eels (juveniles), at which time they move into freshwater. Juvenile eels begin their upstream migration at the start of the dry season in May and, because they are excellent climbers, are able to migrate to high elevation reaches. Conversely, kuhlia are a swimming species with no climbing ability, but have been found up to 300 m above sea level. They can spawn several times, migrating downstream to the estuary at the start of the wet season (December). The extent and timing of the return of post-spawning adults is unknown. After rearing in the estuary or near-coast, juvenile kuhlia migrate upstream in the dry season (April/May).

Mullet are essentially a marine swimming species that rarely travel upstream past passage barriers such as rapids. Grunters and pipefish are swimming species that probably spawn in the estuary. Little is known about the timing of their migrations but the grunters negotiate rapids to high elevation reaches.

Most of the species found upstream of the dam site (option 7c) will have good climbing abilities. The kuhlia and grunters (Mesopristes) are probably the only swimming species that are found upstream of the dam site.

5.4 Habitat use

There is little published information about the types of habitat used by Tina River fish species. No specific information is available on the water depths, velocities and substrates in which they are found. Gobies are usually found in riffles, where coarse substrate (boulders, cobbles and large gravels) provide both shelter from the current, and a food resource. Pools provide habitat for large eels, grunters and kuhlia. Measurements of fish species and number, water velocity and depth and substrate composition in small areas (2-4 m²) were made on 11 March 2016 and 13-14 July 2016 to determine habitat suitability for common fish species in the Tina River.

Very little is known about the factors controlling fish populations in the Solomon Islands. As in New Zealand, most Solomon Island fish species will have evolved to cope with the conditions they experience. Eels and most gobies are capable climbers and can penetrate to the headwaters of most

ivers. The diadromous life history protects their early life stages from the vagaries of the riverine environment, such as strong and variable currents caused by floods and freshes. The overwhelming influence of diadromy suggests that total fish numbers and diversity in a given reach will depend on access to the sea, with instream habitat controlling the density of fish within a given reach.

6 Method for determining environmental flow requirements

6.1 Habitat modelling

Modelling of instream habitat availability for selected species, over a range of flows, is a valuable tool when assessing potential effects of flow changes and making decisions about environmental flow requirements. This method is one of the most commonly used methods of assessing flow requirements (Tharme 2003). The background to methods used here is discussed in Jowett et al. (2008).

Habitat modelling entails measuring water depths and velocities, as well as substrate composition, across a number of stream cross-sections at a given flow (referred to as the survey flow). Points on the banks, above water level, along the cross-sections are also surveyed to allow model predictions to be made at flows higher than the survey flow. Calibration data for fitting rating curves are obtained from additional measurements of water level at each cross-section, relative to flow, on subsequent visits. The stage (water level) with no flow in the river (stage of zero flow) is also estimated at each cross-section to help fit rating curves. These data allow calibration of a hydraulic (instream habitat) model to predict how depths, velocities and the substrate types covered by the stream will vary with discharge in the surveyed reach.

The habitat suitability at each point in the reach is calculated from modelled depth, velocity and substrate from habitat suitability curves¹ (HSC). Habitat suitability weighted by the area represented by each point is summed over the reach to give area weighted suitability (AWS previously known as WUA weighted usable area) with units of m²/m. The average habitat suitability of a given reach is the AWS divided by the wetted area of the river and is a dimensionless number between 0 (totally unsuitable) and 1 (ideal). Habitat modelling is undertaken over a range of flows to predict how habitat availability (AWS) and average habitat suitability will change with flow.

6.1.1 Habitat mapping

The first step in the process is to carry out habitat mapping along the length of the reach between the dam and tailrace locations. The habitat types are assessed in the field after traversing the affected reach. The habitats would typically be classified as riffle, run, pool, and rapid. The length and location of each habitat type is recorded. The habitat mapping between Tina Village and the dam site was carried out on 6 March 2016 and is presented in Table 2.

6.1.2 Cross-section selection

The number of cross-sections required depends on the morphological variability within the river, with homogenous stretches of river requiring fewer cross-sections than stretches that are highly varied morphologically. Studies have shown that relatively few cross-sections can reproduce the

¹ HSC describe the suitability of different depths, velocities and substrate sizes for given species of interest.

results from a survey in which a large number of cross-sections were sampled (see Jowett et al. 2008 for details).

The total number of cross-sections needed to generate a robust result should be proportional to the complexity of the habitat hydraulics, with 6 to 10 sampled for simple reaches and 18 to 20 for diverse reaches.

Each cross-section is given a percentage weighting based on the proportion of the habitat type in the reach that it represents. The underlying assumption is that the cross-sections measured provide a reasonable representation of the habitat throughout the reach. Reach results can be extended to longer sections of river, if the flows, river gradient and morphology do not change significantly.

Surveys of the river were carried out on 6-9 March 2016 and 11-15 July 2013. During the first survey, the proportion of the different habitat types was measured and cross-sections were identified in each of the habitat types. A large flood that occurred on the second day of the survey and removed more than half of the temporary staff gauges that had been installed. This meant that only 3 cross-sections could be surveyed. One cross-section was a wide riffle at the proposed powerhouse location and the other two were in a pool and run further upstream. Water levels were measured at flows of 8.7 m³/s and 19.7 m³/s and these were used to develop rating curves at each cross-section. The cross-section at the powerhouse site was selected to evaluate the effect of flow on water level between the powerhouse and Tina Village where the valley is wider than between the dam and powerhouse. Because the powerhouse cross-section was unrepresentative of the habitat between the dam and powerhouse it was excluded from the habitat analyses.

The second survey (11-12 July 2013) comprised cross-sections in 2 pools, 5 runs, 5 riffles and 2 rapids; a total of 14 cross-sections. The flow was 9.91 m³/s on the 11 July and 9.66 m³/s on the 12 July. Water level and flow measurements were taken on 15 July and 25 July for rating calibration when the flows were 8.28 m³/s and 5.39 m³/s, respectively.

6.2 Habitat suitability

It is the quality of the habitat that is provided by the flow that is important to density of stream biota, rather than the magnitude of the flow, per se. In many streams, flows less than the naturally occurring low flow are able to provide good quality habitat and sustain stream ecosystems. The magnitude of this flow will vary with the requirements of the species and with the morphology of the stream.

Water velocity is probably the most important characteristic of a stream. Without it, the stream becomes a lake or pond. In New Zealand gravel bed rivers, an average velocity of at least 0.2-0.3 m/s tends to provide for most stream life. Velocities lower than this are unsuitable habitat for a number of fish species and stream insects, and allow deposition of sand and finer materials which is also unsuitable habitat. In large rivers, water depth of more than 0.4 m provides habitat for swimming species, but benthic fish are often found in shallower water. Gobies feed either on algae or small invertebrates associated with algae growing on the stable cobbles and boulders.

The flow at which limiting conditions of depth and velocity occurs varies with stream morphology. Generally, minimum flow increases with stream size, because stream width increases with stream

size. However, the relationship is not linear. In general, small streams require a higher proportion of the natural stream flow to maintain minimum habitat than do large rivers.

6.2.1 Method for determining habitat suitability

Fish densities were sampled across transect across transects in the Toni River in a variety of habitat types (riffle, run and pool) on 11 March 2016. Thirteen quadrats of between 2 m² and 6 m² were sampled by electro-fishing using an EFM300 (NIWA Instrument Systems, Christchurch, New Zealand) electro-fishing equipment. Flooding and turbidity prevented sampling in the Tina River. The quadrats were situated at regular intervals across each transect, with a distance of at least 1 metre between quadrats to avoid fish disturbance. The quadrats were selected so that there was minimal variation in water depth, velocity and substrate composition within the quadrat. Electro-fishing was conducted using a downstream stop net and a dip net to catch any fish that missed the stop net. Captured fish were placed in a bucket for subsequent identification and recording. The species of fish, and estimated length of fish caught were recorded after which the fish were released at their capture point.

A further 57 quadrats were sampled by snorkelling on the 13-14 July 2016; 23 in the Toni River and 33 in the Tina River. A total of 18 species were either caught or observed and 8 of these species were relatively common (present in more than 3 quadrats).

After fish sampling, measurements were made of water depth and velocity (at 0.4 times depth above the bed) in each quadrat. The percentage of five substrate size categories (bedrock, boulder, cobble, gravel, and fines) was estimated visually. Potential cover, such as banks with overhanging vegetation or large logs, was also noted and sampled.

The average depth and velocity was calculated in each quadrat from the measurements taken within the quadrat. For substrate, substrate index (s) was calculated from the visual percentage estimates using the formula (Jowett & Richardson, 1990)

$$s = 0.08 * \text{bedrock} + 0.07 * \text{boulder} + 0.06 * \text{cobble} + 0.05 * \text{gravel} + 0.04 * \text{fine gravel} + 0.03 * \text{sand}.$$

The most suitable habitat was determined by the density of fish. For example, if the highest average density of fish occurred in riffles, and the lowest density in pools, riffles would be the most suitable habitat and pools the least. A similar procedure was followed to determine habitat suitability for depth, velocity and substrate. The methods used for determining habitat suitability are described in Jowett & Davey (2007) and Jowett & Richardson (2008).

Some size-related habitat selection was observed with smaller fish found in lower velocity water than the larger individuals of the same species. A preference for margins and avoidance of the swift deep water in the thalweg of the Tina River was noted. The margins usually provide a more stable environment than the centre of the river where the high velocities carry sand that either embeds or covers the larger substrate.

This sampling showed that coarse substrates with minimal sand movement were the preferred habitat of most fish species. Based on the snorkelling observations, the average fish density where the substrate index was less than 5 (i.e. gravel) was 7.3 ± 16.5 fish/12 m² compared to an average of 34.7 ± 65.7 fish/12m² when the substrate index was 5 or higher (Mann-Whitney non-parametric test,

$P=0.066$). No fish were found in association with log or bank cover, although fish were found against a bedrock bank in a pool.

Fish density and diversity was higher in the Toni River than in the Tina River (Mann-Whitney non-parametric test, $P<0.001$), with an average of 60.4 ± 81.7 fish/12m² in the Toni River compared to 6.7 ± 17.1 fish/12m² in the Tina River and an average number of species per quadrat of 2.61 ± 1.44 in the Toni River compared to 1.17 ± 1.09 in the Tina River. There were no significant differences between rivers in sampling depth or substrate composition (Mann-Whitney non-parametric test, $P>0.1$) but sampling velocities were higher in the Tina River than in the Toni River (Mann-Whitney non-parametric test, $P=0.001$).

Habitat suitability and generalised additive models (Jowett & Davey 2007) were developed for the eight most common species (*Stiphodon semoni*, *Stiphodon pelewensis*, *Stiphodon rutilaureus*, *Belobranchus sp.*, *Anguilla marmorata*, *Sicyopterus cyanocephalus*, *Sicyopterus lagocephalus*², *Kuhlia marginata*), as well as models for overall fish density and species richness (Fig. 12).

In general, most species (Table 8) were found in shallow water (0.2-0.3 m) with moderate velocities (0.45-0.65 m/s) and coarse substrate. Eels and the two *Sicyopterus* species were found in the swiftest water and *Kuhlia* were found in the lowest water velocities (Table 8). The two *Sicyopterus* species have a sucker or disc on their underside that allows them to attach to large substrate in high velocities. Shallow water (<0.3 m), a velocity of up to 0.7 m/s, and boulder/cobble substrate contained the greatest density of fish and the greatest number of species (Fig. 12).

Table 8: Depths and velocities used by fish species in the Tina and Toni Rivers

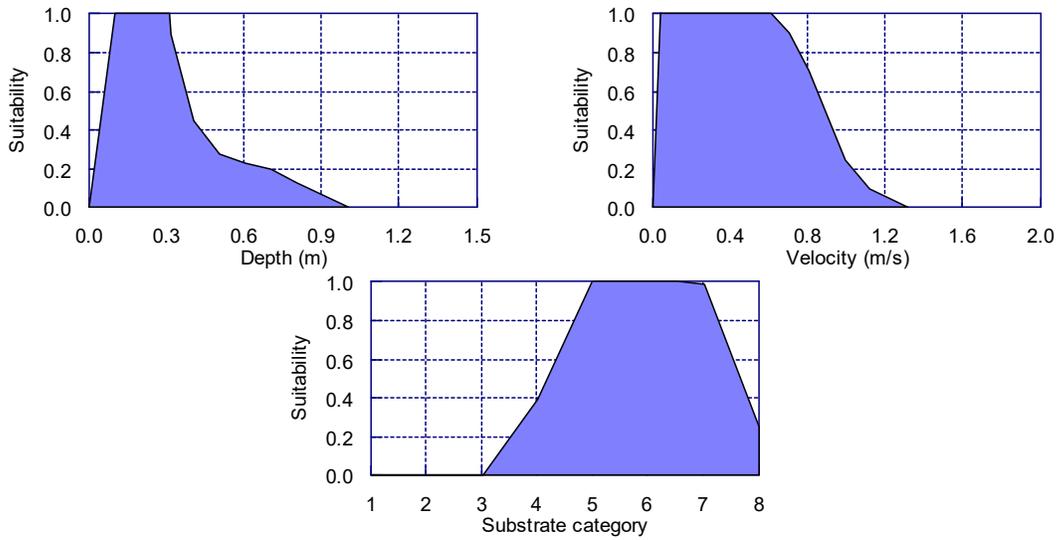
Species	N	Depth \pm s.d. (m)	Velocity \pm s.d. (m/s)
Quadrats sampled	70	0.35 \pm 0.18	0.64 \pm 0.33
<i>Stiphodon semoni</i>	2408	0.2 \pm 0.11	0.46 \pm 0.25
<i>Stiphodon pelewensi</i>	1002	0.18 \pm 0.1	0.5 \pm 0.25
<i>Stiphodon rutilaureus</i>	345	0.24 \pm 0.11	0.55 \pm 0.26
<i>Belobranchus sp.</i>	48	0.21 \pm 0.08	0.49 \pm 0.16
<i>Sicyopterus cyanocephalus</i>	50	0.4 \pm 0.26	0.85 \pm 0.21
<i>Sicyopterus lagocephalus</i>	74	0.29 \pm 0.19	0.72 \pm 0.3
<i>Anguilla marmorata</i>	15	0.34 \pm 0.2	0.93 \pm 0.56
<i>Kuhlia marginata</i>	71	0.39 \pm 0.12	0.38 \pm 0.15

The preferred habitat of the goby species *Sicyopterus stimpsoni* in Hawaii (Fig. 13) was similar to the preferred habitat of the Solomon species *Stiphodon semoni*, *S. pelewensis*, *S. rutilaureus* and *Belobranchus sp.*, in that they preferred shallow water, low to moderate velocities and coarse substrate. However, the other Guam and Hawaii species (*S. elegans* and *Awaous stamineus*) seemed to prefer lower velocities than the Solomon *Stiphodon* species and the Solomon *Sicyopterus* species

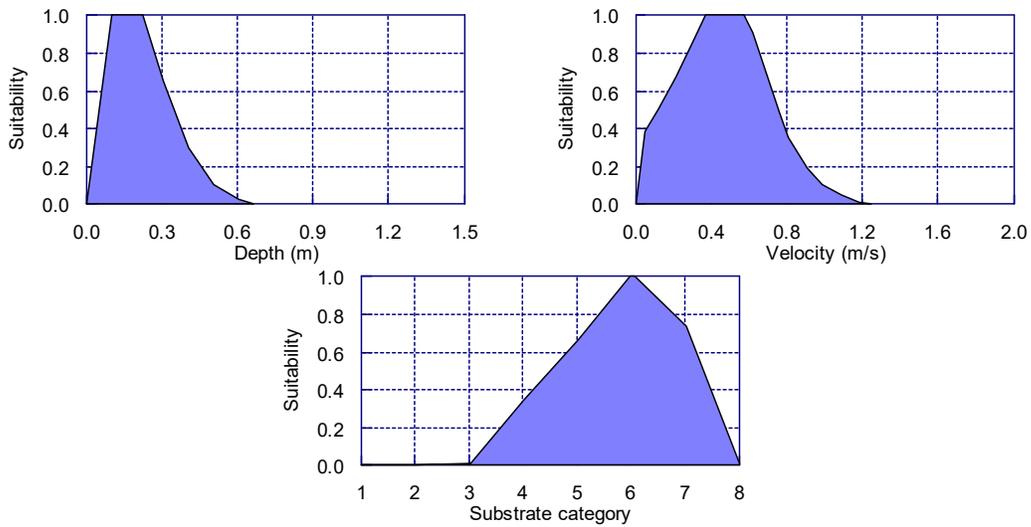
² These species are similar in morphology and habitat use

were found in higher velocity water than indicated by the suitability curves for the Hawaiian *Sicyopterus stimpsoni*.

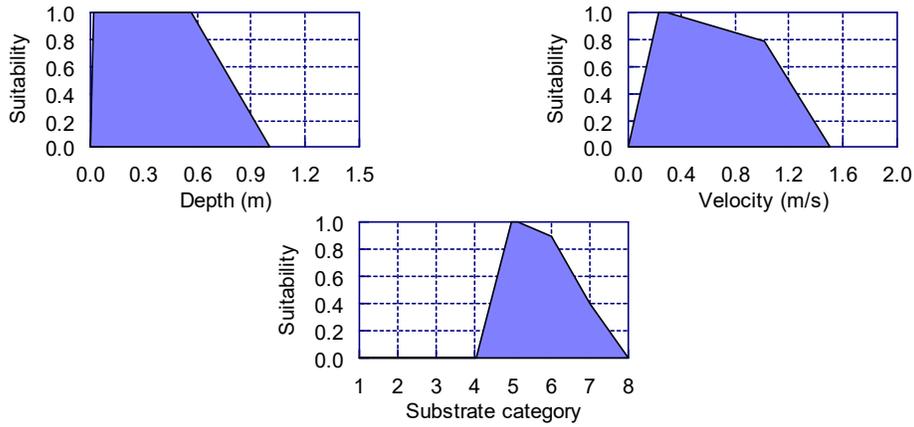
Stiphodon semoni



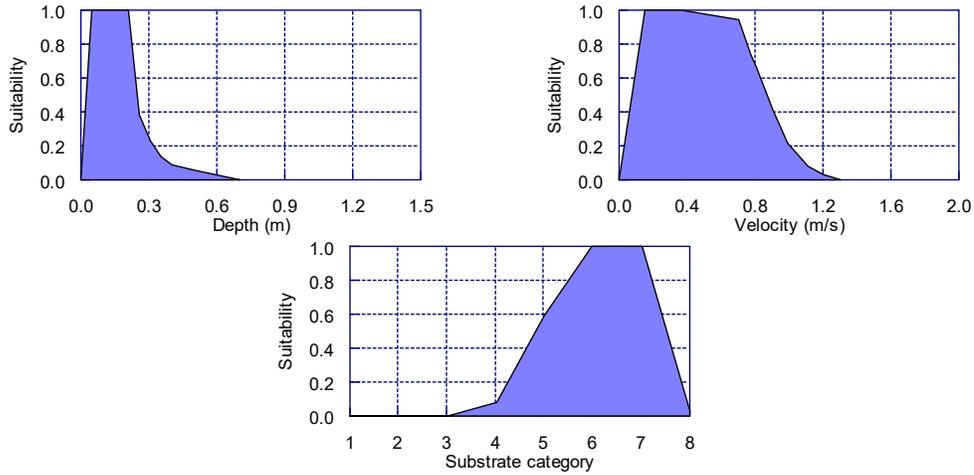
Belobranchus sp.



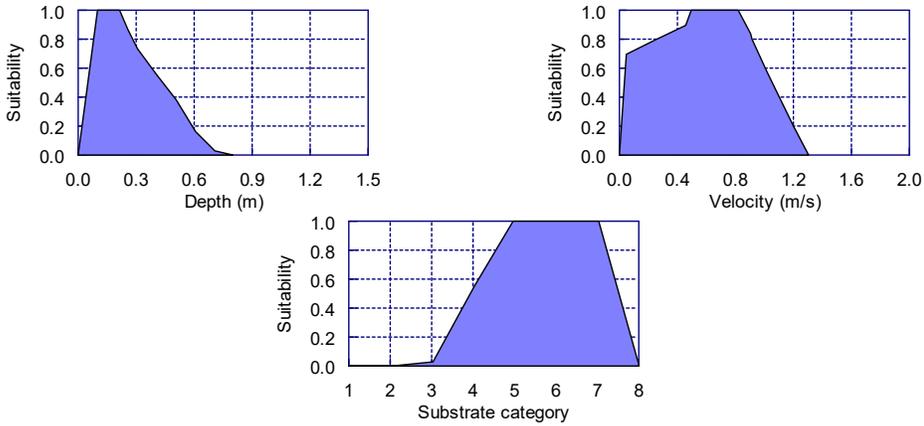
Anguilla marmorata (<150mm)



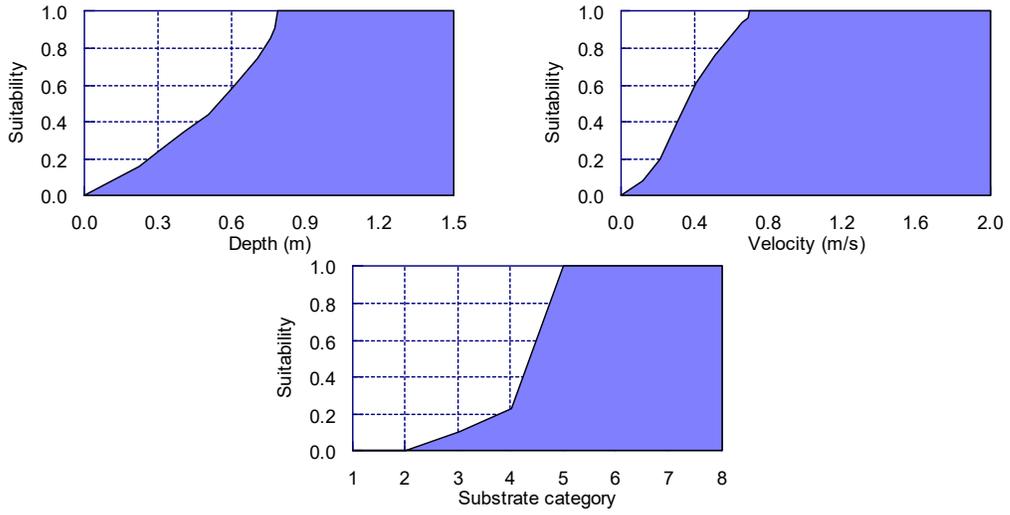
Stiphodon pelewensis



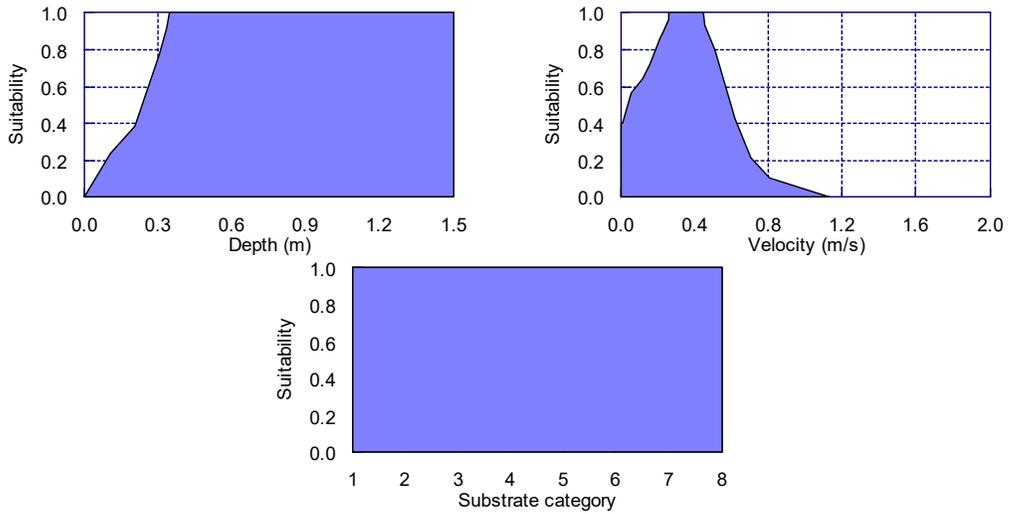
Stiphodon rutilaureus



Sicyopterus sp.



Kuhlia marginata



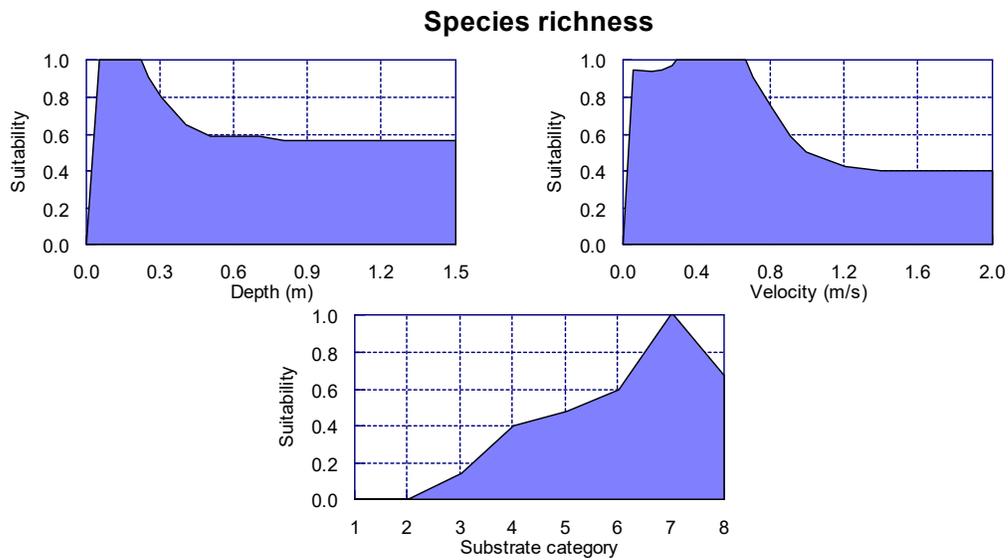
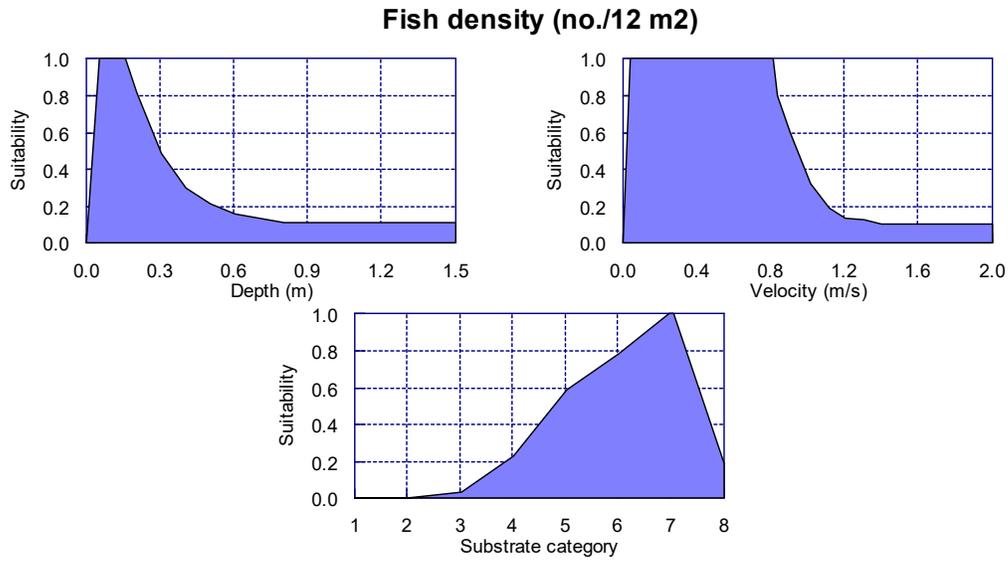


Figure 12: Habitat suitability curves for *Stiphodon semoni*, *Stiphodon pelewensis*, *Stiphodon rutilaureus*, *Belobranchus sp.*, *Anguilla marmorata*, two *Sicyopterus* species, *Kuhlia marginata*, fish density and species richness. The substrate categories are 1=vegetation, 2=mud/silt, 3=sand, 4=fine gravel, 5=gravel, 6=cobble, 7=boulder, 8=bedrock.

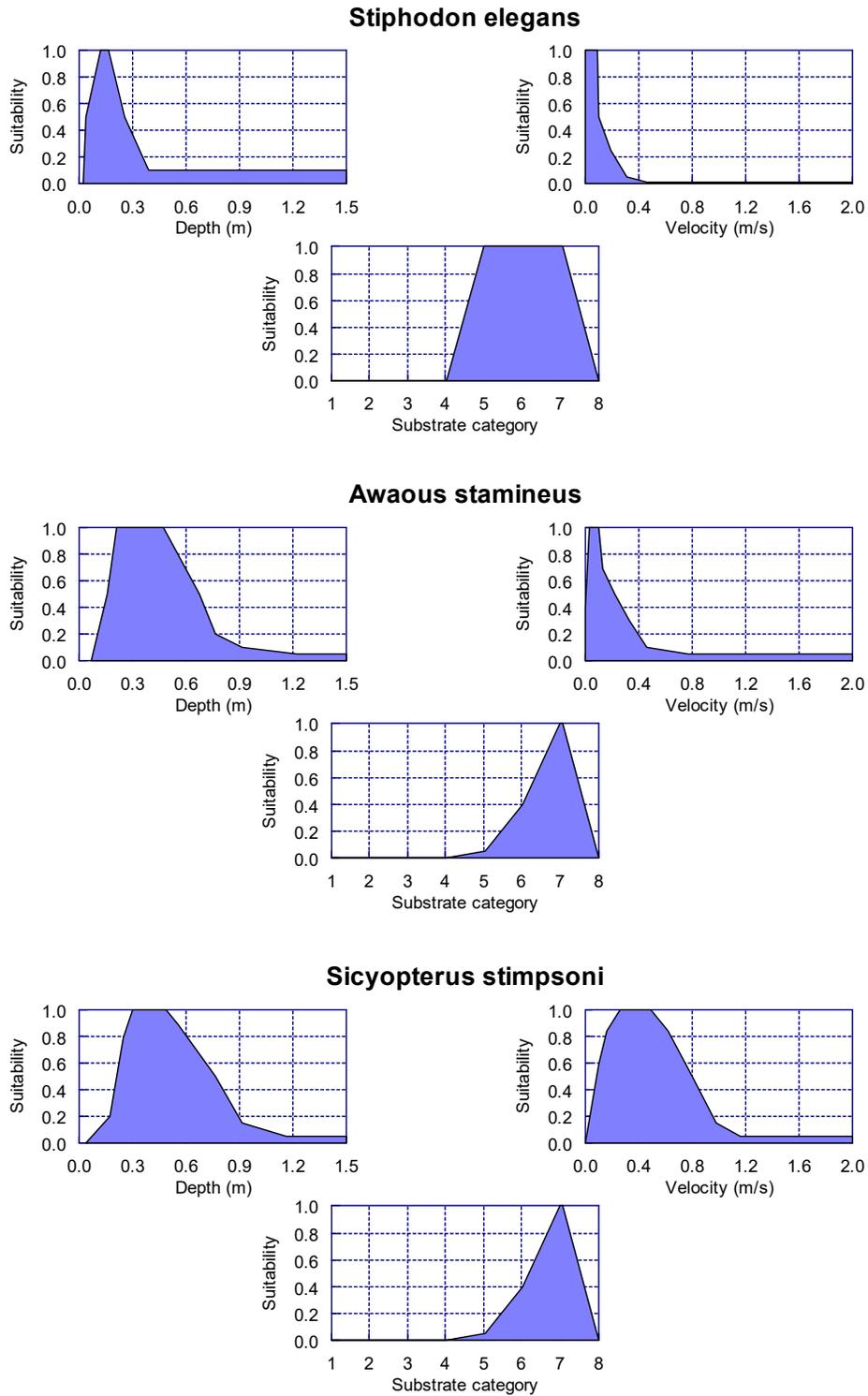


Figure 13: Habitat suitability curves for goby species from Guam and Hawaii from Thomas R Payne & associates. The substrate categories are 1= vegetation, 2=mud/silt, 3=sand, 4=fine gravel, 5=gravel, 6=cobble, 7=boulder, 8=bedrock.

7 Assessment of effects on aquatic ecology

7.1 Reduced flows

The potential effects of hydroelectric dam developments are mostly related to the change in flows. Where there are large flow reductions, an environmental flow will usually be provided to prevent or mitigate potential detrimental effects of low or zero flow.

For the Tina River Hydropower Development Project, environmental flows will be required for the river reach between the dam and tailrace and downstream of the tailrace. The magnitude of the environmental flow will be the flow that provides an adequate amount of suitable habitat for the fish species in the river, as determined from an instream habitat survey and information of habitat use by the various fish species. The necessary information on habitat use is gathered from a field survey to determine the relative densities of fish in the various habitats, depths and velocities present in the Tina River, in the vicinity of the tailrace. The instream habitat analysis uses a hydraulic model based on cross-sections surveyed in each of the habitat types, and habitat suitability models for the various species, as well as fish density and species richness. The model predicts how habitat suitability for the various species varies with flow.

A reduction in flow from the median flow of 11.1 m³/s to an environmental flow of 1 m³/s reduces the water surface width by 27%, the average depth by 41%, and the average velocity by 68% (Table 9).

Table 9: Predicted variation of water surface width, average depth and width weighted average velocity with flow in the Tina River between the dam and powerhouse.

Flow (m ³ /s)	Width (m)	Depth (m)	Velocity (m/s)
1	18.0	0.36	0.23
2	20.1	0.40	0.29
3	21.0	0.44	0.35
4	21.4	0.47	0.42
5	21.8	0.50	0.47
6	22.3	0.53	0.52
7	22.7	0.55	0.57
8	23.1	0.57	0.61
9	23.5	0.58	0.65
10	23.9	0.60	0.69
11	24.6	0.60	0.72

The analysis of habitat variation with flow suggested that a flow of 2-4 m³/s would provide maximum habitat for most of the common species, fish density and species richness (Fig. 14). However for the species that live in very swift water (*Sicyopterus cyanocephalus* and *S. lagocephalus*), habitat suitability is greatest at flows greater than 10 m³/s.

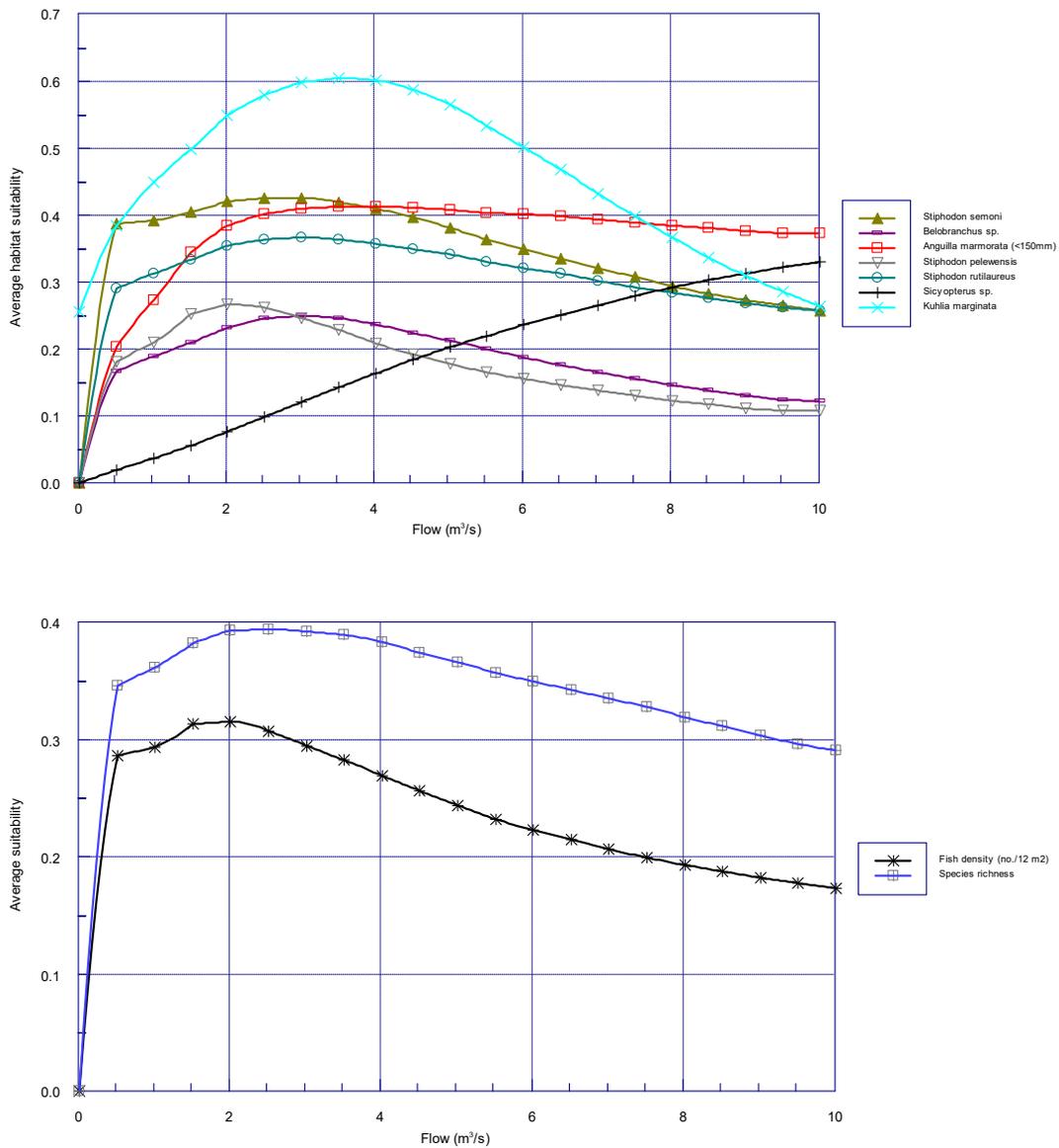


Figure 14: Variation in average habitat suitability with flow for the 8 common fish species (upper) and for fish density and diversity (lower) in the reach between the dam and powerhouse.

The standard of environmental protection provided by an environmental flow can be assessed by comparing the amount of habitat (m²/m of river length) at the environmental flow with the amount of habitat at median flow.

A flow of 1 m³/s would provide more habitat than is available at median flow for *Stiphodon semoni*, *Belobranchus sp.*, *Stiphodon pelewensis* and *Kuhlia marginata* and a similar amount for *Stiphodon rutilaureus* (Fig. 15). Fish density and species richness are likely to be greater with a flow of 1m³/s than with the median flow of 11.1 m³/s. The estimated fish density at an environmental flow of 1 m³/s is approximately 50 fish per 12 m². This is slightly less than the average of 60.4 fish/12m²

observed in the Toni River and considerably higher than the 6.7 fish/12m² observed in the Tina River. Similarly, the estimated number of species per quadrat with an environmental flow of 1 m³/s was 2.1 compared to the observation of 2.61 and 1.17 in the Toni and Tina rivers, respectively.

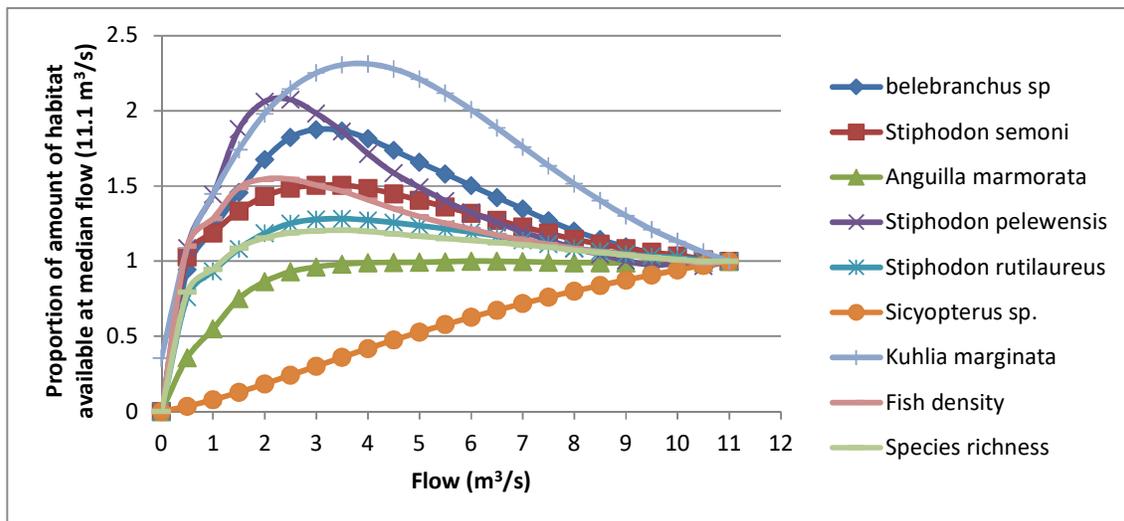


Figure 15: Relationship between flow and the proportion of the amount of habitat available at the median flow of 11.1 m³/s.

At present, a large amount of sediment is transported through the steep, relatively narrow section of river between the dam and powerhouse sites. The movement of sediment during floods and in the deeper swifter areas of the river at normal flows reduces algal growth, benthic invertebrate production and fish habitat. The creation of a dam will prevent much of this sediment movement and will gradually coarsen the substrate. This will improve the fish habitat considerably, as the habitat observations showed a clear preference for coarse substrate and avoidance of deep swift water where sand was being transported along the river bed.

The selection of an environmental flow depends on the balance between environmental effects and loss of generation, and the relative values placed on the environment and generation. Based on the available data, the amount of habitat provided by a 1 m³/s environmental flow is similar to the amount of habitat at a median flow of 11.1 m³/s for most of the common fish species. Predicted overall fish density should be higher than at present and should be similar to that in the Toni River. A 1 m³/s flow would provide for fish passage and would maintain pool habitat for the pool dwelling species and good riffle habitat for the riffle dwelling species that comprise the majority of fish in the river. In addition, there would be an improvement in habitat quality resulting from a reduction in the amount of fine gravel and sand in the river channel.

The gradient of the Tina River between the tailrace and its confluence with the Toni River is less than the gradient between the dam and tailrace. Environmental flow requirements tend to increase as the gradient decreases, so that the flow requirement downstream of the tailrace will probably be higher than the flow requirement upstream of the tailrace.

As suggested by Entura (2014), the loss of generation resulting from an environmental flow can be partially offset by installing a generator on the environmental flow discharge point at the dam.

Entura (2015b) estimated that with a 1 m³/s environmental flow, potential long-term generation (powerhouse plus generator on environmental flow, less transmission losses) would be about 80.6 Gwh/a with 3 turbine/generator units compared to this report's estimate of 81.8 GWh/a (i.e., 83 Gwh/a less 1.2 Gwh/a transmission loss)

7.2 Variability of flows

The river between the dam and powerhouse requires some flow variability, particularly for floods and freshes. The maximum capacity of the powerhouse and the amount of storage in the reservoir are not large compared to the flow in the river, and the size of floods and freshes. Thus, it is likely that there will be frequent periods of spill between the dam and tailrace. Simulation of the hydro operation indicated that floods or freshes would occur on average every 6 weeks, and their average duration would be between 4 to 6 days. This frequency is probably sufficient to prevent prolific periphyton (algae attached to substrate) accumulation in this low nutrient river. Therefore, it should not be necessary to provide for flushing flows, or any other seasonal pulses, to stimulate spawning, migration or other biotic activities.

7.3 Hydro-peaking

Large scale hydro-peaking can severely affect fish and benthic invertebrates. During the dry season, the intention is to generate electricity at full discharge during the day and reduce to zero power station discharge during the night, leaving only the environmental flow in the river. This means that the flows could fluctuate between 18 m³/s and the environmental flow on an almost daily basis. The maximum flow from the generators is relatively low compared to the magnitude of floods and freshes during the wet season, so that it is unlikely that fish habitat will be affected by hydro-peaking. However, depending on the mobility of the species, there is the possibility of fish stranding and a reduction in benthic invertebrate and periphyton abundance. It is unlikely that a reduction in benthic invertebrate abundance will substantially affect gobies. This is because the fish are small and benthic invertebrate abundance is probably in excess of their trophic requirements. A reduction in periphyton is also unlikely to affect fish, because there is no evidence of a reduction in species richness during the wet season when there are frequent floods and freshes that reduce periphyton and benthic invertebrate abundance.

Local people make considerable use of the river, and sudden increases in water level can endanger people if they are caught in the river bed. Usually, a rate of rise of 0.3 m per hour is considered safe. Safe rates of change in flow were calculated from data collected at a wide riffle at the powerhouse tailrace site during the instream habitat survey. Water levels at this cross-section were measured at flows of 8.7 m³/s and 19.7 m³/s and a rating curve (relationship between water level and discharge) was developed. This indicated that a flow change from minimum generation (2.4 m³/s) to maximum generation (18 m³/s) will increase the water level by about 0.38 m. This is likely to be conservative since much of the river downstream of the tailrace is less confined than at the powerhouse tailrace location. Thus, it might be advisable to ramp up generation from minimum to maximum load over a period of 1 to 1.5 hours.

As well as endangering people in the river bed, sudden reductions in water level can strand fish. Therefore, it is recommended that an adaptive management approach be taken to determining whether ramping flows are needed to mitigate potential fish stranding. This would involve carrying out studies during initial operation to determine whether fish are stranded on sudden reductions in

flow. If necessary, the rate at which flow is reduced (i.e., flow ramping) could then be decreased to see if that prevents stranding.

7.4 Sediment

The reservoir volume up to the invert of the sediment scour outlet (155m) is $2344 \times 10^3 \text{ m}^3$, and $6900 \times 10^3 \text{ m}^3$ up to Full Supply Level (175 m). Entura (2014) estimated that the annual suspended sediment load would be about $500 \text{ t/km}^2/\text{year}$, which would deposit about $45000 \text{ m}^3/\text{year}$ of sediment in the reservoir. They estimate that it would take approximately 65 years before it became necessary to flush deposited sediment from around the power station intake. Thus, the dam will trap all bed load sediment (sand and coarser material) and a proportion of suspended sediment, and reduce the amount of bed load in the river downstream of the dam. This will result in a coarsening of the substrate within the river downstream of the dam, as reduced sediment input, combined with high flows that wash the sand and fine gravel component from the substrate, will leave coarser gravels and cobbles. An increase in the amount of coarse substrate will improve habitat for eels, gobies and benthic invertebrates that live around and under coarse substrates. In addition, the reduction in sand supply would tend to deepen pools and improve habitat for the pool dwelling species like kuhlia and grunters. Any effect of sediment removed by the reservoir will gradually reduce with distance downstream, as sediment is entrained for the sands and gravels on existing river banks and introduced from tributaries.

Observations downstream of New Zealand hydro dams on gravel bed rivers (Waitaki, Clutha) indicate that the riverbed will not degrade (erode) to any noticeable degree because the surface will be armoured by cobbles and larger gravels once the surface fines are removed.

7.5 Water quality

Because there is little diurnal and seasonal temperature variation and little wind mixing, tropical reservoirs often become stratified (Barrow 1988) and there is a risk that dissolved oxygen concentration is reduced in the lower layers (hypolimnion). Shallow lakes with high inflow are least at risk of stratification.

The residence time of the proposed reservoir when full is approximately 7 days at median flow of $11.1 \text{ m}^3/\text{s}$ and the average flow depth is approximately 10 m (Entura 2014). The shallow depth and short residence time suggests that stratification is extremely unlikely. Relationships between temperature differential thermal (stratification) and residence time (Jorgenson et al. 2005) that show virtually no thermal stratification with a residence time of 7 days, and thus it is very unlikely that there will be any stratification and development of a hypolimnion with a low dissolved oxygen concentration.

The discharge of surface water from the reservoir through the spillway, tailrace and environmental flow outlet is unlikely to cause any measurable change in dissolved oxygen.

7.5.1 Water temperature

As water flows down a river, it is heated by solar radiation and cooled by evaporation until a thermal equilibrium is reached. If the amount of shade and radiation or ambient air temperatures changes, the water temperature adjusts towards thermal equilibrium. Usually, this will mean that water temperature will increase in a downstream direction.

In the Tina River during the rainy season, measured spot temperatures increased from 24.5°C at the Tina Village to 32.0°C at the Ngalimbiu River Bridge. The Toni River flows into the Tina River just downstream of Tina Village. Water temperatures in the Toni River were 28.4 to 29.4°C so that the Ngalimbiu River water temperature downstream of the Tina/Toni confluence was 26.4 to 27.2°C.

Water temperatures were also measured in the Toni River and in the Tina River between the Toni River confluence and approximately 1.5 km below the dam site over the period 11-15 July 2016. There was no rain over the period 11-15 July 2016. The daily maximum water temperature was 26°C at all sites over the 5 days. The daily minimum temperature was 23°C indicating diurnal variation of about 3°C. The lack of any downstream increase in temperature and the similarity of the water temperatures in the Toni and Tina rivers suggest that the water temperature was in equilibrium and therefore a change in flow would have minimal effect on daily mean water temperature.

The formation of a reservoir will generally alter the seasonal thermal characteristics of the river immediately downstream of the outlet. Since the thermal capacity of a reservoir is greater than that of a river, the reservoir tends to store heat resulting in smaller daily temperature fluctuations, lower summer temperatures, and higher winter temperatures. However, there is little variation in the annual air temperature in the Solomon Islands, so seasonal variation in water temperature is unlikely. Measurements in other lakes suggest that the reservoir water temperature is likely to be less than 28 °C (pers. comm., Robson Hevalao).

A reduction in flow generally does not change the daily mean water temperature significantly, but it does increase the daily maximum and decrease the daily minimum temperature. However, during the wet season at least, water velocities are high and river water temperatures may be below the equilibrium temperature, so that a reduction in flow would certainly increase the daily maximum water temperature and may increase the daily average water temperature in the river between the dam and powerhouse. With a flow of 1 m³/s in the river between the dam and powerhouse, water temperatures are likely to be similar to those in the Toni River. The fish community in the Toni River is similar to, or better than, that in the Tina River. Thus, an increase in water temperature in the Tina River is unlikely to have any effect on the fish community in the Tina River.

7.6 Fish passage

The dam will create a barrier to the passage of migratory fish species to the catchment upstream of the dam. It is possible to provide fish passage past the dam for most species. The options include a natural stream fish pass (if there is sufficient space), or a trap and haul system. These systems are used in New Zealand for a variety of climbing species and in UK, France, and the US for eels (Paterson & Boubée 2010, Solomon & Beach 2004). Fish pass systems developed in Europe and North America for salmonids and similar species are expensive and will not necessarily suit the Tina River species. The 5 m operating range of the reservoir would necessitate a complicated system of hydraulic structures at the upstream end of a conventional fish pass to maintain a constant flow under the range of reservoir levels.

7.6.1 Upstream passage

Because of their climbing ability, it is relatively easy to provide effective upstream passage for gobies and eels using either a natural stream channel³ pass, or trap and haul system. It is likely that a trap and haul system will be the least costly and most practical option for fish passage. A simplified diagram of the trap is shown in Fig. 16. Fish from the trap can and should be released in or upstream of the reservoir at a location that will avoid the possibility of fish being entrained by spillway or power station flows. The ramp allows migratory fish to climb to the trap, where they remain until transferred to an upstream location.

One advantage of a trap and haul system is that fish caught in the trap can be identified and counted before they are transferred to areas upstream of the dam. Thus, a trap system will provide very useful monitoring data on the state of the goby and eel populations which is very difficult, if not impossible to obtain by other means.

Neither a trap and haul system, or natural fish pass, is likely to provide passage for kuhlia and grunTERS, both of which are a swimming species. Kuhlia appear to be reluctant to use fish passes (Lewis & Hogan 1987). However, if kuhlia and/or grunTERS accumulate at either the powerhouse tailrace or the base of the dam, it will be possible to net them and transfer them to a more suitable environment such as the Toni River or upstream Tina River. The former would be more preferable because some mortality would occur when the adult fish migrate from the upper Tina River to the estuary area to spawn.

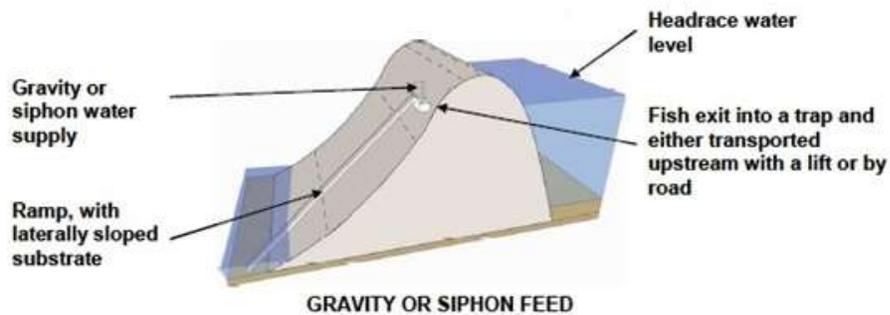


Figure 16: Principle of trap and transfer system

³ A gravel/cobble channel similar to a riffle which would zig-zag up the dam face or abutments with resting pools at the changes of direction.



Figure 17: Example of trap installation at dam.

Figure 17 shows the trap system with ramp leading to a holding tank and piped water supply installed at Waitaki Dam, New Zealand. The ramp can be lined with bristles, gravel or a drainage product called Miradrain or Cordrain (Patterson & Boubee 2010). The optimum slope is about 15 degrees.

While bristles appear to best for eels, gravel or drainage products suit both gobies and eels. New Zealand traps have been used to collect eels, galaxiids, redfin bully (*Gobiomorphus huttoni*) and to a lesser degree torrentfish (*Cheimarrichthys fosteri*). The ramp should also have a transverse slope to provide deep water on one side and shallow water on the other to provide a choice of velocities and depths for the fish that move up the ramp. The climbing abilities and modes of locomotion of these New Zealand species are the same as those used by crawling and climbing species in the Solomon Islands, as described in the ESIA.

7.6.2 Downstream passage

Gobies spawn on substrate in the area in which they live. When the eggs hatch the larvae are carried passively downstream. It is not clear whether goby spawning is seasonal, or occurs all through the year. It is possible that spawning seasonality varies between species. Larval fish return to the estuary during the dry season and this indicates that spawning and downstream migration takes place early in the wet season. Thus, it is likely that hatching and downstream movement occurs during floods and freshes with the high flows ensuring rapid and safe transport to the sea. If so, the dam may be spilling and larval fish will pass over the spillway. Although there are very few studies of larval survival through turbines, it is well known that the length of fish is the primary determinant of survival (e.g., Larinier and Travade 2002) and with larval fish potential mortality caused by striking the turbine blades or wicket gates will be low. Morris et al. (1985) describe quantitative data on entrainment mortalities that were gathered at the Ludington Hydro Plant on Lake Michigan, which has a head of 110m. Survival tests on 9 species of larval fishes indicated that passage through the Ludington turbines decreased survival rates by an average of 15%. Large smelt larvae (15-42 mm) experienced much greater mortality than did smaller (<15 mm) smelt larvae. Some larvae were

apparently robust and seemed to survive turbine passage (i.e., ninespine stickleback, lake whitefish, turbot larvae). Goby larvae are small (<10mm) and there is unlikely to be significant mortality through the turbines.

Although the gobies in the Solomon Islands are generally considered diadromous, large numbers of 10 mm gobies were observed in the shallow low velocity margins of the river between the dam and power house sites on 11-15 July 2016. It is unlikely that fish of this size have the swimming ability to make the 25 km journey from the sea and this suggests that these fish are rearing in the river rather than the sea. Shallow low velocity margins are the type of rearing habitat used by non-diadromous bullies in New Zealand.

Adult eels migrate to the sea at the beginning of the wet season. They are likely to migrate on the first fresh so that the deeper swift flowing water facilitates their passage to the sea, similar to the migration of New Zealand eels. The mortality of adult eels through turbines is significant, and there does not seem to be any easy way of screening or diverting adult eels. However, if they are migrating during a flood, a proportion of the migrating population may be carried over the spillway rather than through the turbines. Consideration should be given to increasing the normal operating level to near full supply level, during the first month of the wet season, to facilitate the downstream movement of adult eels over the spillway during floods. The loss of generation resulting from increasing spill would be partially offset by the increased generation from the extra head on the turbines. Consideration could be given to the possibility of 15-25 mm screens in front of the intake structure to prevent the ingress of large eels.

8 Mitigation measures

Mitigation can take the form of reducing the detrimental effect to an acceptable level by modifying the operation of the proposed scheme. The following sections describe possible options for this form of mitigation. Mitigation can also take the form of providing some facility or service that is valued by the local community and substitutes for the loss caused by the construction of the power scheme.

8.1 Uniqueness of upper Tina catchment fish community

The upper Tina catchment is a valuable fish resource because the high elevation catchment is unmodified and has high water quality and minimal disturbance. Although the fishes found in the upper catchment are reportedly diadromous species that require access to the sea to complete their life cycles, there is a high possibility that some are non-diadromous and will establish self-sustaining populations upstream of the dam. There are also other similar catchments with unmodified high elevation catchments nearby and the fish communities in these appear to be the same as those in the Tina River catchment (Boseto 2016).

The river between the dam and powerhouse will experience reduced flows. Likewise, the river downstream of the tailrace will experience reduced flows during non-generation hours when the reservoir is being filled. Fish communities and densities present in rivers smaller than the Tina River are likely to be indicative of the aquatic community that would be present in the environmental flow between the dam and tailrace. The fish community in the Toni River is an example of the fish community that would probably develop between the dam and tailrace. The average fish density and diversity in the Toni River was significantly higher than that in the Tina River, probably because

the Toni River provides a more stable aquatic environment than the Tina River, where the velocities were higher and amount of sand movement greater.

8.2 Change from riverine to lacustrine (lake) habitat

The creation of the reservoir will replace about 2.6 km of riverine habitat with a reservoir (Entura 2014). The average width of the reservoir would be about 118 m at a FSL of 175 m amsl. There are very few lakes on Guadalcanal, so it is not known what riverine fish species will take up residence in the newly formed lake with its lacustrine environment. Non-native fish species could be introduced into the lake, but generally this is not considered desirable because of potential effects on native species.

8.3 Environmental flow

Provision of a 1 m³/s environmental flow between the dam and powerhouse will maintain or improve fish and benthic invertebrate densities and total numbers for most species. An environmental flow of 1 m³/s would maintain the riffle habitats that appear to be used by most fish species, although there would be a reduction in habitat for the *Sicyopterus* species, which can live in very swift water. Pools will also be maintained for kuhlia and grunters. However, trapping of sediment in the dam and subsequent coarsening of substrate in the river below the dam will improve habitat for all aquatic species and overall productivity and this improvement with an environmental flow of 1 m³/s should result in fish densities that are similar to that in the Tina and Toni rivers at present.

8.4 Fish passage and species diversity

A suitable trap and haul system will maintain the diadromous species in the streams and river upstream of the dam. Downstream passage for adult eels could be facilitated by spilling water at the start of the wet season when adult eels are observed congregating at the dam face. In addition, it would be possible to operate the reservoir at a slightly higher level early in the wet season to increase the probability of spill. In addition, there is a high possibility that one or more of the goby species are non-diadromous and therefore live their entire lives in freshwater and do not require passage to the sea .

A trap and haul system would not provide for swimming species (kuhlia and grunters). Therefore, the provision of passage for these species is probably impractical, as described earlier. However, if these species accumulate at the powerhouse or base of the dam, it will be possible to net them and transfer them to other locations.

Kuhlia and grunters are widespread. *Kuhlia rupestris* is widely distributed from the western Indian Ocean, north to Japan (Ryukyu Islands), south to Queensland, Australia and east to the Federated States of Micronesia (the Caroline Islands), Fiji and Samoa. *Kuhlia marginata* is widespread throughout the Indo-Pacific, from Japan to Australia and east to the Federated States of Micronesia (Caroline Islands).

The Indo-Pacific species *Mesopristes argenteus* is fairly widespread from Indonesia and the Philippines, north to Japan (the Ryukyu Islands), south to Australia (Queensland) and east to Melanesia (Papua New Guinea, Vanuatu and Solomon Islands). The distribution of *Mesopristes cancellatus* is slightly more restricted than *M. argenteus* but is still fairly widespread from Indonesia

and the Philippines to East Timor), Papua New Guinea, north to Taiwan and into Melanesia (Vanuatu and the Solomon Islands).

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Appendix M
Fauna Report

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Appendix M

Fauna Report

Edgar Pollard

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1. FAUNA CHARACTERISATION

In each sampling station a general habitat description is carried out. The polygons and points of habitat areas and important species areas will be drawn using Google Earth. Species tables will then be created with the following information for fauna, specifically amphibians, birds, mammals, and reptiles: species name (including scientific and common name), migration routes of wildlife in the project areas of impacts (if any), population trends of species (population declining increasing or stable), species status (CITES, IUCN, endemism), description of wildlife role for local populations (bush meat and cultural significance) as sources of livelihood and series of photographs to help describe each station and species (if possible). Potential species that were not observed will also be presented in order to have a complete overview of the area. This series of potential species can be gathered from other sources such as previous studies (see scoping reports, Gold Ridge reports, scientific journals or field guides).

1.1 METHOD FOR THE ON FIELD CHARACTERIZATION

Method for inventory descriptions will be described in this section: they include direct observations, species identification, species traces, netting and interviews, the date of field visit will be provided.

Methods used to identify terrestrial vertebrate inventories include visual and auditory encounter surveys (diurnal and nocturnal) consisting of 1) point and 2) plot counts primarily for birds, reptiles and amphibians and 3) mist nets primarily for birds and mammals. Informal interviews were also carried out with locals to determine important species presence. The field visits and sampling occurred on the dates 05/08/13 to 17/08/13.

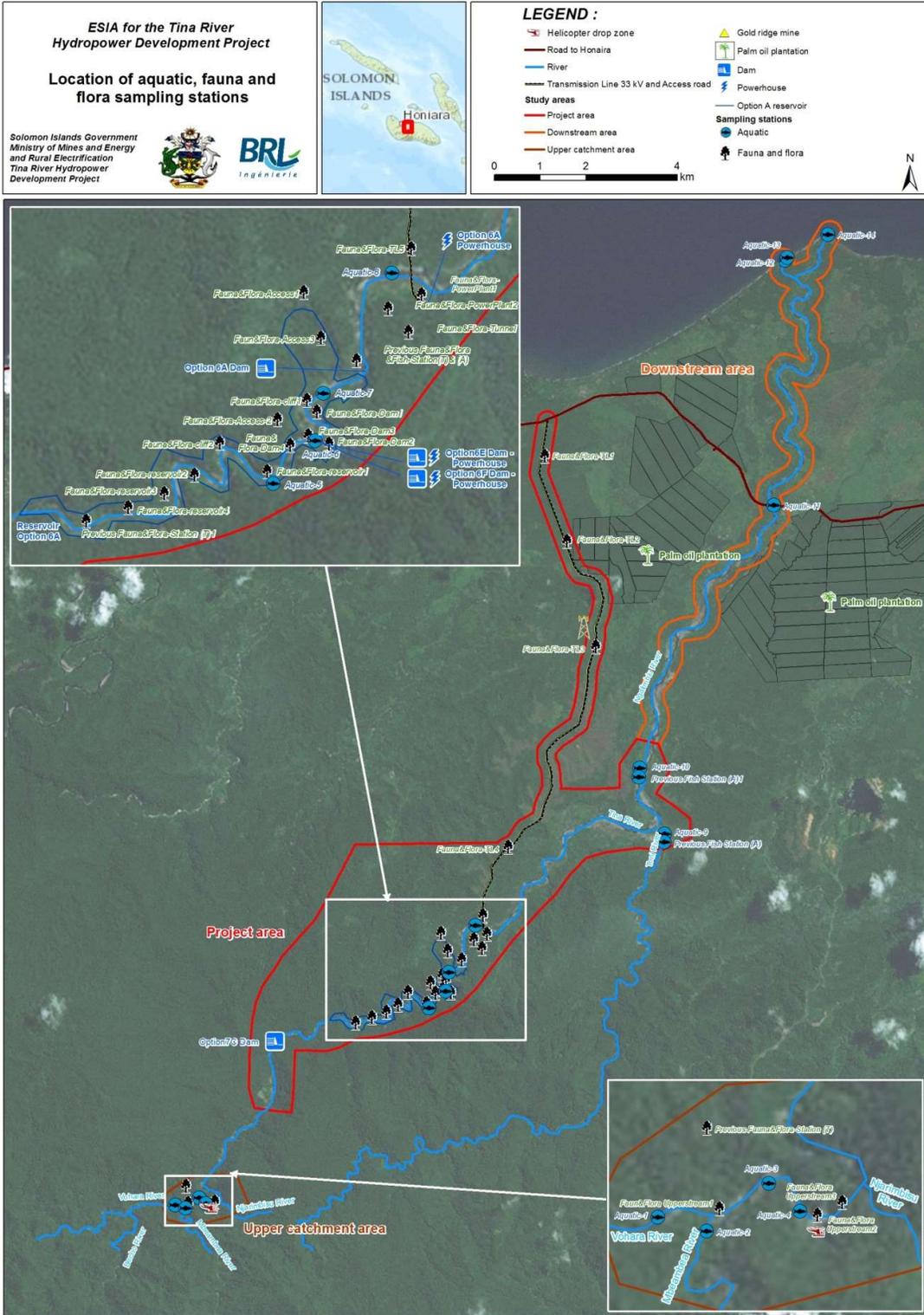
Point counts involved visual and auditory surveying from a set location (sampling station) for the duration of 20min. Visual aids in the form of binoculars were also used. All faunal species (amphibians, birds, mammals and reptiles) observed (seen or heard) during the sampling period were recorded.

Plot counts involved the movement (where possible) and visual and auditory surveying in and around a 10x10m plot to sample for fauna (amphibians, birds, mammals and reptiles). Visual aids in the form of binoculars were also used. All faunal species (amphibians, birds, mammals and reptiles) observed (seen or heard) during the sampling period were recorded.

Mist netting involved the placement of 8 mist nets (15m x 2m, 20mm mesh size) in sampling stations to capture and record birds and mammals. Nets were placed in forested areas and also in locations adjacent to waterways.

Informal interviews involved the discussion with locals of important fauna and associated uses of associated species, these informal interviews also resulted in the significant recording of local knowledge (LK).

1.2 SAMPLING STATIONS



1.2.1 Fauna Transmission Line (TL1, 2, 3, 4 & 5)

Transmission Line areas were mainly covered in grassland, garden, oil palm plantation, remnant forest and fallow brush land habitats. TL1 is located between oil palm plantation and fallow bush dominated by paper mulberry trees. TL2 is located between oil palm plantations and grassland inter-mixed with gardens. TL3 is located in grassland and TL4 is located between grassland, gardens and remnant forest dominated by Canarium nut trees. TL5 is located in remnant forest. Conditions during the sampling of the TL sites were clear to cloudy and were deemed optimal for faunal sampling.

1.2.2 Fauna Access Road (Acc.1 & 2)

Access Road areas were mainly covered in forested habitats. Acc.1 is located on a hill slope surrounded by forest with evident signs of disturbance such as past timber extraction. Acc.2 is located on a ridge adjacent to a steep slope to the Tina river, it is surrounded by relatively undisturbed forest with the presence of large canopy trees. Conditions during the sampling of the Acc. sites were clear to cloudy and were deemed optimal for faunal sampling.

1.2.3 Fauna PowerPlant (PP1 & 2)

PowerPlant areas were mainly covered garden, fallow brush land habitats and disturbed forest. PP1 is located on a flat areas that is surrounded by gardens with crops of betelnut, banana and coconut, fallow brush land is also evident. PP2 is located on a small hill and is covered by forest with evidence of timber extraction and some relatively undisturbed areas. Conditions during the sampling of the TL sites were clear to cloudy and were deemed optimal for faunal sampling.

1.2.4 Fauna Reservoir (Res.1, 2, 3 & 4)

Reservoir areas were mainly covered in forest, though there were certain areas that were garden, and disturbed forest habitats. Res.1 is located on a flat area that is forested however there is evidence of disturbance through timber exploitation. Res.2 is located adjacent to a village area and is surrounded by gardens and remnant forest. Res.3 is located on a slope and covered by forest with evidence of disturbance through timber extraction and past garden use. Res.4 is located in forest with slight disturbance and evidence of timber extraction. Conditions during the sampling of the Res. sites were wet to cloudy and were deemed not optimal for faunal sampling as the conditions would limit the movement of species.

1.2.5 Fauna Dam (Dam1, 2, 3 & 4)

Dam areas were mainly covered in disturbed forest and gardens. Dam1 is located on a steep sloping area that is forested however there is evidence of disturbance through past timber exploitation. Dam2 is located in forested areas with disturbance due to current timber extraction. Dam3 is located on a slight slope and covered gardens and fallow brush land from past garden use. Dam4 is located in a very steep area that is forested with evidence of past timber extraction. Conditions during the sampling of the Dam sites were wet to cloudy and were deemed not optimal for faunal sampling as the conditions would limit the movement of species.

1.2.6 Fauna Tunnel (Tun.)

The Tunnel (Tun.) area was mainly covered in disturbed forest, with evidence of past and current timber extraction. Conditions during the sampling of the TL sites were clear to cloudy and were deemed optimal for faunal sampling.

Bufonidae TRUE TOADS												
<i>Bufo marinus</i>	Cane Toad	TL1, Res.1, Res.2, Res.3, Res.4, Dam2, Upp.2	PP	-	I	LC	-		I	-	-	
Ceratobatrachidae												
<i>Batrachylodes vertebralis</i>	Fauro Sticky-toed Frog	Res.2, Res.4, Dam3,	Res.3, Dam2,	PP	-	SI	LC	-	II	S	-	-
<i>Batrachylodes elegans</i>	Elegant Sticky-toed Frog			SS	-	SI	LC	-		S	-	-
<i>Ceratobatrachus guentheri</i>	Solomon Islands Eyelash Frog	Res.3, Dam2,		PP, GR	-	SI	LC	-	II	S	-	-
<i>Discodeles guppyi</i>	Giant Webbed Frog			PP, SS, GR, LK	-		LC	-		S	F	X
<i>Discodeles malakuna</i>	Malakuna Webbed Frog	Upp.2,		SS	-	SI	DD	-		S	-	-
<i>Platymantis guppyi</i>	Solomon Islands Giant Treefrog	Upp.2		SS, GR, PP	-	SI	LC	-		S	-	-
<i>Platymantis solomonis</i>	Solomon Wrinkled Ground Frog			SS, PP	-	SI	LC	-	I	S	-	-
<i>Platymantis weberi</i>	Weber's Wrinkled Ground Frog	Res.2, Dam2,		SS, PP	-	SI	LC	-		S	-	-
Hylidae TREEFROGS												
<i>Litoria lutea</i>	Solomon Island's Treefrog			SS	-	SI	VU	-		S	-	-
<i>Litoria thesaurensis</i>	Treasury Island Treefrog	Res.2,		PP	-	SI	LC	-		S	-	-
<i>Litoria sp.</i>		Res.3		SS, GR	-	-	-	-		S	-	-
Ranidae TRUE FROGS												
<i>Hylarana krefftii</i>	San Cristobal Treefrog	Upp.2		GR, PP	-	SI	LC	-		S	-	X

(Potential Species, TRHDP ESIA Scoping Study = SS, Frogs of the SI = PP, Gold Ridge Report = GR, Local Knowledge = LK), (Endemic, Guadalcanal = G, Solomon Islands = SI, Introduced = I), (IUCN Red List Category, Least Concern = LC, Vulnerable = VU & Data Deficient = DD), (1998 Act, Prohibited Species = I, Regulated Species = II), (Population Trend, Increasing = I & Stable = S), (Local Uses, Food = F), (X = Dependent on the river).

1.2.9.2 Birds

A total of 41 bird species were observed from a total of 67 potential species from 28 families. This is around 61 percent of all birds expected to be found along the Tina River study area. Table 2 (below) lists bird species by family including scientific and common nomenclature. The sampling stations that the species is present in are noted as well as the 'Potential Presence' of the species in the Tina River study area based on species observed in areas in close vicinity to the study site in literature (TRHDP ESIA Scoping Study (Sherwood 2012) = SS, Birds of Melanesia (Dutson 2011) = GD(Dutson 2011)(Dutson 2011), Guadalcanal Island Bird Checklist (Tarburton 2007) = MT, Gold Ridge Report (NL 1996) = GR and Local Knowledge = LK). Species migratory and endemic status (Guadalcanal = G, Solomon Islands = SI, Introduced = I) were also stated based on Dutson (2011). Each species Red List category (IUCN 2013) as a value of vulnerability is also specified (Least Concern = LC, Near Threatened = NT, Vulnerable = VU and Data Deficient = DD). Each species CITES category (UNEP-WCMC 2013) where possible, of protection is also stated, as well as the status of local protection based on the Wildlife and Protection Act (1998). The 'Population Trend' (where possible, Increasing = I, Decreasing = D & Stable = S) is based on the IUCN (2013) Red List and 'Local Uses' is based on information regarding the species from locals (Food = F and Cultural Importance = CI). Each species dependence on the river based on literature (Dutson 2011) and in-field observations is also stated.

Table 2 Bird Species Inventory of Tina River

Species name	Common name	Station Presence	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	River Dependent
Ardeidae HERONS											
<i>Nycticorax caledonicus mandibularis</i>	Nankeen Night Heron	Res.2, Res. 3, Res.4, Clif.2	SS, GD, MT	-	-	LC	-		S	-	X
<i>Egretta s. sacra</i>	Pacific Reef Heron	TL3	GD	-	-	LC	-		S	-	-
Phalacrocoracidae CORMORANTS											
<i>Microcarbo m. melanoleucos</i>	Little Pied Cormorant	Res.1, Res.3, Upp.1, Res.2, Res.4,	SS, GD	-	SI	LC	-		S	-	X
Anatidae DUCKS											
<i>Anas superciliosa</i>	Pacific Black Duck		SS, MT, GD	-	-	LC	-		S	F	X
Accipitridae HAWKS and EAGLES											

<i>Haliastur indus flavirostris</i>	Brahminy Kite	Res.3, Acc.2,	SS, MT, GD, GR	-	SI	LC	II		D	-	-
<i>Aviceda subcristata proxima</i>	Pacific Baza		MT, GD, LK	-	SI	LC	II		S	-	-
<i>Accipiter novaehollandiae pulchellus</i>	Variable Goshawk	Upp.1	MT, GD	-	G	LC	II		D	-	-
<i>Accipiter meyerianus</i>	Meyer's Goshawk	TL3	MT, GD, GR	-	-	LC	II	I	D	-	-
<i>Haliaeetus sanfordi</i>	Solomon Sea-Eagle	TL5, Upp.1,	MT, GD	-	SI	VU	II	I	D	-	-
Megapodiidae MEGAPODES											
<i>Megapodius eremita</i>	Melanesian Scrub Fowl		SS, MT, GD, LK	-	-	LC	-		D	F	-
Turnicidae BUTTONQUAILS											
<i>Turnix maculosa salamonis</i>	Red-backed Button-Quail		MT, GD	-	G	LC	-		D	F	-
Rallidae RAILS											
<i>Gallirallus philippensis christophori</i>	Buff-banded Rail	TL3	MT, GD, LK	-	SI	LC	-		S	F	-
<i>Nesoclopeus w. woodfordi</i>	Woodford's Rail	TL1, TL3	MT, GD, LK	-	G	NT	-	I	D	F	-
<i>Amauornis moluccanus sp.</i>	Pale-vented Bush-hen	Res.2,	MT, GD, LK	-	SI	LC	-		S	F	-
<i>Porphyrio p. samoensis</i>	Purple Swamphen	TL3,	GD, LK	-	-					F	
Scolopacidae SANDPIPERS and CURLEWS											
<i>Actitis hypoleucos</i>	Common Sandpiper	Res.1, Res.3, Res.4	MT, GD, LK	X	-	LC	-		D	CI	X
Columbidae PIGEONS											
<i>Ptilinopus superbus</i>	Superb Fruit-Dove		MT, GD, GR	-	-	LC	-		S	F	-

<i>Ptilinopus solomonensis ocularis</i>	Yellow-bibbed Fruit-Dove		MT, GD, GR	-	G	LC	-	I	S	F	-
<i>Ptilinopus viridis lewisii</i>	Claret-breasted Fruit-Dove		MT, GD, GR	-	-	LC	-		S	F	-
<i>Ducula rubricera rufigila</i>	Red-knobbed Imperial Pigeon	TL4, Acc.1, Acc.2, PP1, PP2, Res.2, Res.3, Dam2, Tun.,	SS, MT, GD, GR, LK	-	SI	NT	-		D	F	-
<i>Ducula pistrinaria</i>	Island Imperial Pigeon		MT, GD	-	-	LC	-		S	F	-
<i>Gymnophaps solomonensis</i>	Pale Mountain Pigeon		MT, GD	-	SI	LC	-		S	F	-
<i>Macropygia mackinlayi arossi</i>	Mackinlay's Cuckoo-Dove	Dam4, Upp.1, Upp.2	SS, MT, GD	-	-	LC	-		S	F	-
<i>Reinwardtoena crassirostris</i>	Crested Cuckoo-Dove	Tun.	SS, MT, GD	-	SI	NT	-		D	F	-
<i>Chalcophaps stephani mortoni</i>	Stephan's Dove		SS, MT, GD, GR	-	SI	LC	-		S	F	-
Cacatuidae COCKATOOS											
<i>Cacatua ducorpsi</i>	Ducorp's Cockatoo	TL5, Acc.1, Upp.1, Upp.2	SS, MT, CD, GR	-	SI	LC	II	II	S	-	-
Psittacidae PARROTS											
<i>Chalcopsitta cardinalis</i>	Cardinal Lory		SS, MT, GD, GR, LK	-	SI	LC	II	II	S	-	-
<i>Trichoglossus haematodus massena</i>	Coconut Lorikeet	TL4, Tun., Upp.1, Upp.2,	SS, MT, GD, LK	-	SI	LC	II	II	D	-	-
<i>Lorius chlorocercus</i>	Yellow-bibbed Lory	PP1, PP2, Res.1, Res.3, Dam2, Upp.2,	SS, MT, GD, GR, LK	-	SI	LC	II	II	S	-	-

<i>Chamosyna margarethae</i>	Duchess Lorikeet		MT, GD, GR	-	SI	NT	II	I	D	-	-
<i>Micropsitta finschii aolae</i>	Finsch's Pigmy Parrot	Tun.	MT, GD, GR, LK	-	SI	LC	II	I	S	-	-
<i>Eclectus roratus solomonensis</i>	Eclectus Parrot	Upp.2	SS, MT, GD, GR, LK	-	-	LC	II	II	D	-	-
<i>Geoffroyus heteroclitus</i> h.	Song Parrot		MT, GD, GR	-	-	LC	II	I	S	-	-
Cuculidae CUCKOOS											
<i>Cacomantis variolosus addendus</i>	Brush Cuckoo		MT, GD, GR	-	SI	LC	-		S	-	-
<i>Centropus milo</i> m.	Buff-headed Coucal	TL3, TL4, TL5, Acc.1, PP1, Dam2,	SS, MT, GD, GR	-	SI	LC	-		S	-	-
Strigidae OWLS											
<i>Ninox jacquiniti granti</i>	Guadalcanal Boobook		MT, GD, GR	-	G	LC	II		S	-	-
Apodidae SWIFTS											
<i>Aerodramus vanikorensis lugubris</i>	Uniform Swiftlet	TL1, TL3, Dam2, Upp.2,	MT, GD	-	SI	LC	-		S	-	-
<i>Collocalia esculenta becki</i>	Glossy Swiftlet	Res.2, Res.3, Res.4, Dam2, Dam4, Clif.1, Clif.2, Upp.1, Upp.2,	SS, MT, GD, GR,	-	SI	LC	-		S	-	-
Hemiprocnidae TREESWIFTS											
<i>Hemiprocne mystacea woodfordiana</i>	Moustached Tree-Swift		MT, GD, GR	-	SI	LC	-		S	-	-
Coraciidae ROLLERS											
<i>Eurystomus orientalis solomonensis</i>	Dollar Bird		MT, CD, GR	-	SI	LC	-		D	-	-
Bucerotidae HORN BILLS											

<i>Aceros plicatus mendanae</i>	Blyth's Hornbill	Res.1, Res.3, PP1, Dam2, Dam3, Dam4, Upp.2,	SS, MT, GD, GR, LK	-	SI	LC	II		D	-	-	
Alcedinidae KINGFISHERS												
<i>Alcedo atthis salomomensis</i>	Common (River) Kingfisher	Upp.2,	SS, MT, GD, GR	-	SI	LC	-		S	-	X	
<i>Ceyx lepidus nigromaxilla</i>	Variable Dwarf Kingfisher	Res.3, Dam4,	MT, GD, GR	-	G	LC	-		D	-	X	
<i>Todirhamphus chloris alberti</i>	Collared Kingfisher		MT, GD, GR	-	SI	LC	-		D	-	-	
<i>Todirhamphus leucopygius</i>	Ultramarine Kingfisher		MT, GD, GR	-	SI	LC	-		S	-	-	
Hirundinidae SWALLOWS												
<i>Hirundo tahitica subfusca</i>	Pacific Swallow		SS, MT, GD	-	-	LC	-		I	-	-	
Campephagidae CUCKOOSHRIKES and TRILLERS												
<i>Coracina lineata pusilla</i>	Barred Cuckoo-shrike		MT, GD, GR	-	SI	LC	-		S	-	-	
<i>Coracina papuensis elegans</i>	White-bellied Cuckoo-Shrike	TL4,	SS, MT, GD, GR	-	SI	LC	-		I	-	-	
<i>Coracina holopolia h.</i>	Solomon Cuckoo-Shrike		MT, GD, GR	-	SI	NT	-		D	-	-	
<i>Coracina tenuirostris erythroptigia</i>	Common Cicadabird	Res.2	MT, GD, GR	-	SI	LC	-		S	-	-	
Rhipiduridae FANTAILS												
<i>Rhipidura leucophrys melaleuca</i>	Willie Wagtail	Res.3, Dam4, Upp.1, Upp.2,	Res.4, Clif.1,	SS, MT, GD, GR	-	-	LC	-		I	-	-
<i>Rhipidura cockerelli c.</i>	Cockerell's Fantail			MT, GD, GR	-	G	NT	-		D	-	-

<i>Rhipidura rufifrons rufifrons</i>	Rufous Fantail		MT, GD, GR	-	G	LC	-		D	-	-
Monarchidae MONARCHS											
<i>Monarcha castaneiventris</i>	Chestnut-bellied Monarch	Res.3, Dam4,	SS, MT, GD, GR, LK	-	SI	LC	-		D	-	-
<i>Monarcha barbatus</i>	Solomons Monarch	Res.3, Dam2,	MT, GD, GR, LK	-	SI	NT	-		D	-	-
<i>Myiagra ferrocyanea</i>	Steel-blue Flycatcher	Res.3, Upp.2,	MT, GD, GR	-	SI	LC	-		S	-	-
Pachycephalidae WHISTLERS											
<i>Pachycephala pectoralis cinnamomea</i>	Golden Whistler	PP2, Res.2, Res.4, Dam2,	SS, MT, GD, GR, LK	-	G	LC	-		S	-	-
Dicaeidae FLOWERPECKERS											
<i>Dicaeum aeneum becki</i>	Midget Flowerpecker	Acc.2, Res.3, Dam2, Upp.2, Res.1, Res.4, Clif.1, Clif2,	MT, GD, GR	-	G	LC	-		S	-	-
Nectariniidae SUNBIRDS											
<i>Nectarinia jugularis flavigastra</i>	Olive-backed Sunbird	TL4, Upp.1,	SS, MT, GD	-	-	LC	-		S	-	-
Meliphagidae HONEYEATERS											
<i>Myzomela melanocephala</i>	Black-headed Myzomela	Dam2, Upp.2, Dam4,	MT, GD, GR	-	G	LC	-		D	-	-
Sturnidae STARLINGS											
<i>Aplornis cantoroides</i>	Singing Starling		SS, MT, GD, GR	-	-	LC	-		S	-	-
<i>Aplornis grandis macrura</i>	Brown-winged Starling	Res.2, Res.3, Clif.2,	MT, GD, GR	-	G	LC	-		S	-	-
<i>Aplornis metallicus nitida</i>	Metallic Starling	Res.3, Dam2,	SS, MT, GD	-	-	LC	-		S	-	-

<i>Aplornis brunneicapilla</i>	White-eyed Starling		MT, GD, GR	-	SI	EN	-		D	-	-
<i>Acridotheres tristis</i>	Common Myna	TL3	MT, GD	-	I	LC	-		I	-	-
<i>Mino kreffii sanfordi</i>	Long-tailed Myna	TL4, TL5, Acc.1, PP2, Res.3,	SS, MT, GD, GR	-	SI	LC	-		S	-	-
Corvidae CROWS											
<i>Corvus woodfordi</i>	White-billed Crow	Acc.2, PP1, Tun., Upp.2,	SS, MT, GD, GR, LK	-	SI	LC	-		S	-	-

(Potential Species, TRHDP ESIA Scoping Study = SS, Birds of Melanesia = GD, Guadalcanal Island Bird Checklist = MT, Gold Ridge Report = GR, Local Knowledge = LK), (Endemic, Guadalcanal = G, Solomon Islands = SI, Introduced = I), (IUCN Red List Category, Least Concern = LC, Near Threatened = NT, Vulnerable = VU, Endangered = EN & Data Deficient = DD), (CITES Appendix for international trade of species, II = may be authorized by the granting of an export permit), (1998 Act, Prohibited Species = I, Regulated Species = II), (Population Trend, Increasing =I, Decreasing =D & Stable =S), (Local Uses, Food =F & Cultural Importance = CI), (X = Dependent on the river).

1.2.9.3 Mammals

A total of 5 mammals were observed from a total of 14 potential species from 4 families. This is around 36 percent of all mammals expected to be found along the Tina River study area. Table 3 (below) lists mammal species by family including scientific and common nomenclature. The sampling stations that the species is present in are noted as well as the 'Potential Presence' of the species in the Tina River study area based on species observed in areas in close vicinity to the study site in literature (TRHDP ESIA Scoping Study (Sherwood 2012) = SS, Gold Ridge Report (NL 1996) = GR and Local Knowledge = LK). Species migratory and endemic status (Guadalcanal = G, Solomon Islands = SI, Introduced = I) were also stated based on IUCN (2013). Each species Red List category (IUCN 2013) as a value of vulnerability is also specified (Least Concern = LC, Near Threatened = NT, Endangered = EN, Critically Endangered = CR and Data Deficient = DD). Each species CITES category (UNEP-WCMC 2013) where possible, of protection is also stated, as well as the status of local protection based on the Wildlife and Protection Act (1998). The 'Population Trend' (where possible, Increasing =I, Decreasing =D & Stable =S) is based on the IUCN (2013) Red List and 'Local Uses' is based on information regarding the species from locals (Food =F). Each species dependence on the river based on in-field observations is also stated.

Table 3 Mammal Species Inventory of Tina River

Species name	Common name	Station Presence	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	River Dependent
Pteropodidae FRUIT BATS											

<i>Macroglossus minimus</i>	Northern Common Blossom Bat		GR, SS	-	-	LC	-		S	F	-
<i>Melonycteris fardoulisi</i>	Fardoulis's Blossom Bat		GR	-	SI	LC	-		D	F	-
<i>Nyctimene major</i>	Island Tube-nosed Fruit Bat	Res.2, Res.3, Res.4	GR	-	-	LC	-		S	F	-
<i>Pteropus rayneri</i>	Solomon's Flying Fox	Res.3, Dam3,	SS, LK	-	SI	NT	II	I	D	F	-
<i>Pteropus admiraltatum</i>	Island Flying Fox		SS, LK	-	-	LC	II	I	D	F	-
<i>Rousettus amplexicaudatus</i>	Rousette Bat	Res.3, Res.4	GR	-	-	LC	-		S	F	-
Hipposideridae LEAF-NOSED BATS											
<i>Aselliscus tricuspidatus</i>	Trident Leaf-nosed Bat		GR	-	-	LC	-		S	F	-
<i>Hipposideros cervinus</i>	Fawn Leaf-nosed Bat	Res.3		-	-	LC	-		S	F	-
<i>Hipposideros diadema</i>	Diadem Leaf-nosed Bat		GR	-	-	LC	-		S	F	-
Muridae RODENTS											
<i>Rattus exulans</i>	Polynesian Rat		GR	-	I	LC	-		S	-	-
<i>Rattus rattus</i>	House Rat		GR	-	I	LC	-		S	-	-
<i>Uromys rex</i>	King Rat		SS, LK	-	G	EN	-	I	D	-	-
<i>Uromys imperator</i>	Emperor Rat		SS, LK	-	G	CR	-	I	D	-	-
Suidae PIGS											
<i>Sus scrofa</i>	Wild Pig	PP2, Tun., Res.3	LK	-	-	LC	-		S	F	-
Phalangeridae NOCTURNAL MARSUPIALS											
<i>Phalanger orientalis</i>	Northern Common Cuscus		LK	-	-	LC	-		S	F	-

(Potential Species, TRHDP ESIA Scoping Study = SS, Local Knowledge = LK, Gold Ridge Report = GR), (Endemic, Guadalcanal = G, Solomon Islands = SI, Introduced = I), (IUCN Red List Category, Least Concern = LC, Near Threatened = NT, Endangered = EN & Critically Endangered = CR), (CITES Appendix for international trade of species, II = may be authorized by the granting of an export permit), (1998 Act, Prohibited Species = I, Regulated Species = II), (Population Trend, Decreasing =D & Stable =S), (Local Uses, Food =F).

1.2.9.4 Reptiles

A total of 5 reptiles were observed from a total of 23 potential species from 5 families. This is around 22 percent of all reptiles expected to be found along the Tina River study area. Table 4 (below) lists reptile species by family including scientific and common nomenclature. The sampling stations that the species is present in are noted as well as the 'Potential Presence' of the species in the Tina River study area based on species observed in areas in close vicinity to the study site in literature (TRHDP ESIA Scoping Study (Sherwood 2012) = SS, Reptiles of the SI (McCoy 2006) = MM, Gold Ridge Report (NL 1996) = GR and Local Knowledge = LK). Species migratory and endemic status (Guadalcanal = G, Solomon Islands = SI, Introduced = I) were also stated based on McCoy (2006). Each species Red List category (IUCN 2013) as a value of vulnerability is also specified (Least Concern = LC, Near Threatened = NT and Data Deficient = DD). Each species CITES category (UNEP-WCMC 2013) where possible, of protection is also stated, as well as the status of local protection based on the Wildlife and Protection Act (1998). The 'Population Trend' (where possible, Increasing =I & Stable =S) is based on the IUCN (2013) Red List and 'Local Uses' is based on information regarding the species from locals (Food =F). Each species dependence on the river based on literature (McCoy 2006) and in-field observations is also stated.

Table 4 Reptile Species Inventory of Tina River

Species name	Common name	Station Presence	Potential Presence	Migratory	Endemic	IUCN Red List Category	CITES Appendix	1998 Act	Population Trend	Local uses	River Dependent
Gekkonidae GECKOS											
<i>Cyrtodactylus salomonensis</i>	Solomons Bent-toed Gecko		MM, GR	-	SI	NT	-	II	S	-	-
<i>Cyrtodactylus biordinis</i>	Guadalcanal Bow-fingered Gecko		MM, LK	-	G	LC	-		S	-	-
<i>Gehyra oceanica</i>	Oceanic Gecko		MM,	-	-	LC	-		S	-	-
<i>Gekko vittatus</i>	Sago Gecko		MM	-	-	LC	-	II	S	-	-
<i>Nactus multicaudatus</i>	Solomons Slender-toed Gecko	Res.4, Dam2,	MM	-	-	LC	-		S	-	-
Scincidae SKINKS											
<i>Corucia zebrata</i>	Prehensile-tailed Skink		MM, LK	-	SI	NT	II	II	D	F	-
<i>Emoia cyanogaster</i>	Green-Bellied Tree Skink		MM, SS	-	-	LC	-		S	-	-

<i>Emoia cyanura</i>	Brown-tailed Copper-striped Skink	TL4, Acc.1,	MM, SS, GR	-	-	LC	-	II	S	-	-
<i>Emoia nigra</i>	Pacific Black Skink	TL1, Acc.1, Upp.2, Dam1, Dam2,	MM, SS, GR, LK	-	-	LC	-		S	-	-
<i>Emoia pseudocyanura</i>	Solomons Blue-tailed Skink	TL5, Acc.1, PP1, PP2, Dam1, Upp.1, Upp.2,	MM, SS, GR	-	SI	LC	-		S	-	-
<i>Eugongylus albofasciolatus</i>	White-banded Giant Skink		MM	-	-	LC	-		S	-	-
<i>Lipinia noctua</i>	Moth Skink		MM	-	-	LC	-		S	-	-
<i>Lamprolepis smaragdina</i>	Emerald Tree Skink		MM, SS	-	-	LC	-	II	S	-	-
<i>Prasinohaema virens</i>	Green-blooded Skink		MM, GR	-	-	LC	-	II	S	-	-
<i>Sphenomorphus bignelli</i>			MM	-	SI	LC	-		S	-	-
<i>Sphenomorphus concinnatus</i>	Elegant Forest Skink		MM, GR	-	SI	LC	-	II	S	-	-
<i>Sphenomorphus solomonis</i>			MM, GR	-	-	LC	-	II	S	-	-
<i>Sphenomorphus cranei</i>	Crane's Skink		MM, GR	-	SI	LC	-		S	-	-
<i>Tribolonotus schmidti</i>	Schmidt's Crocodile Skink		MM, GR	-	G	LC	-		S	-	-
Boidae BOAS											
<i>Candoia paulsoni</i>	Solomons Ground Boa		MM, SS, GR, LK	-	-	LC	II		S	-	-
Colubridae COLUBRID SNAKES											
<i>Boiga irregularis</i>	Brown Tree Snake		SS, GR	-	-	LC	-		S	-	-
<i>Dendrelaphis salomonis</i>	Solomons Tree Snake	TL5	MM, GR, LK	-	-	LC	-		S	-	-
Elapidae ELAPID SNAKES											
<i>Salomonis par</i>	Solomons Red Krait		MM, SS, GR, LK	-	SI	LC	-		S	-	-

(Potential Species, TRHDP ESIA Scoping Study = SS, Reptiles of the Solomon Islands = MM, Gold Ridge Report = GR, Local Knowledge = LK), (Endemic, Guadalcanal = G, Solomon Islands = SI), (IUCN Red List Category, Least Concern = LC, Near Threatened = NT), (CITES Appendix for international trade of species, II = may be authorized by the granting of an export permit), (1998 Act, Prohibited Species = I, Regulated Species = II), (Population Trend, Decreasing =D & Stable =S), (Local Uses, Food =F).

1.3 IMPORTANT SPECIES DESCRIPTIONS

This section will describe species observed that are deemed ecologically important because of their migratory patterns, endemic status, threatened status and protected status and water dependence. Species that will be described include species that are migratory, are Guadalcanal island endemics, are IUCN red listed as Vulnerable, Endangered or Critically Endangered, are protected CITES species and have a dependence on the river water system.

Literature regarding specific life cycle, breeding and feeding habits of most fauna in the Solomon Islands is lacking. There is lack of human and financial resources to carry out research at a species specific level. Due to this lack of information there is therefore a limitation regarding in the impact that development activities may have on such species. Therefore care must always be taken to err on the side of caution when assumptions are being made.

1.3.1 Amphibians

Amphibians are sensitive animals and often seen as good indicators for forest health. This is due to their dependence on certain moisture regimes and sensitivity for pollutants as they are able to 'breathe' through their skin. Therefore amphibians require moist environments that are relatively pollutant free.

Discodeles guppyi

Giant Webbed Frog

This frog is deemed ecologically important because of its dependence on the river system and is usually found along smaller rivers and streams (Pikacha *et al.* 2008). This is the largest frog in the Solomon Islands and locals report eating this species. This species belongs to the riparian habitat. Possible impacts of the hydro project on this species is the loss of habitat for breeding and feeding.

Litoria lutea

Solomon Island's Treefrog

This frog is deemed ecologically important because of its vulnerability based on the IUCN Red List assessment (IUCN 2013). This is a rare forest frog in the Solomon Islands and little information about this species is available (Pikacha *et al.* 2008). This species belongs to the upland, forest habitats. Possible impacts of the hydro project on this species is minimal.

Hylarana krefftii

San Cristobal Treefrog

This frog is deemed ecologically important because of its dependence on the river system and is an aquatic breeder that lays eggs in pools of water (Pikacha *et al.* 2008). This is the only Solomon Islands frog that has a tadpole stage as opposed to direct development evident in the Ceratobatrachidae frogs (See egg and tadpole pictures in appendix). This species belongs to the riparian habitats. Possible impacts of the project on this species is the loss of habitat for feeding, however the creation of a dam may increase micro-habitats for breeding.

1.3.2 Birds

There is a wide variety of birds that occupy different ecological niches in various habitats from grasslands to waterways to upland forests. Birds play an important ecological role in the dispersal of plant seeds, the control of insects and the pollination of plants amongst other things. Specialist birds that occupy very narrow niches (such as the common sandpiper) are very good indicators as their disappearance can easily signify a degraded habitats.

Nycticorax caledonicus mandibularis **Nankeen Night Heron**

This bird is deemed ecologically important because of its dependence on the river system for feeding (such as on little fish and shrimp) and the sub-species is also a Solomon Islands endemic (Dutson 2011). This heron is found close to water and especially along forested rivers such as the Tina and is found in riparian habitats (see picture of footprint in appendix). Loss of habitat for breeding and feeding for this species may occur, however the creation of a dam may increase micro-habitats for feeding.

Microcarbo m. melanoleucos **Little Pied Cormorant**

This bird is deemed ecologically important because of its dependence on the river system for feeding (such as on little fish and shrimp). It is found along large rivers and nests in large trees beside water (Dutson 2011). This cormorant is found in riparian habitats. Loss of habitat for breeding and feeding for this species may occur, however the creation of a dam may increase micro-habitats for feeding.

Anas superciliosa **Pacific Black Duck**

This bird is deemed ecologically important because of its dependence on the river system for feeding and breeding and is found along waterways such as rivers (Dutson 2011). This duck is also opportunistically hunted by locals as a food source. This species is found in riparian habitats. Loss of habitat for this species may occur, however the creation of a dam may increase micro-habitats for feeding.

Haliastur indus flavirostris **Brahminy Kite**

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), this sub-species is also a Solomon Islands endemic (Dutson 2011). It is the commonest raptor in the Solomon's and if found throughout a wide range of habitats, it is found throughout the entire study area. This raptor feeds mainly on smaller birds. This bird is not threatened and possible impacts of the hydro project on this species is minimal.

Aviceda subcristata proxima **Pacific Baza**

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013) and this sub-species is also a Solomon Islands endemic (Dutson 2011). This common species has small numbers and is found in forest habitats but is able to be seen throughout the entire range of the study area. This raptor feeds mainly on smaller birds and lizards. This bird is not threatened and possible impacts of the hydro project on this species is minimal.

Accipiter novaehollandiae pulchellus **Variable Goshawk**

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), this sub-species is also a Guadalcanal island endemic (Dutson 2011). The commonest hawk in the region and is found in forest habitats but is able to be seen throughout the entire range of the study area. This raptor feeds mainly on smaller birds and lizards. This bird is not threatened and possible impacts of the hydro project on this species is minimal.

Accipiter meyerianus **Meyer's Goshawk**

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013). It is an uncommon species found in forest habitats (Dutson 2011) but is able to be seen throughout the entire range of the study area (see picture in appendix). This raptor feeds mainly on smaller birds and lizards. This species may be locally threatened and possible impacts of the hydro project on this species is minimal.

Haliaeetus sanfordi

Solomon Sea-Eagle

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013) and its vulnerability based on the IUCN Red List assessment (IUCN 2013), this sub-species is also a Solomon Islands endemic (Dutson 2011). This eagle is wide ranging, from coast to upland forests and is found throughout the entire study area (see picture in appendix). This eagle feeds mainly on pigeons, doves, fish, possums and lizards. It is rare but possible impacts of the hydro project on this species is minimal.

Turnix maculosa salomonis

Red-backed Button-Quail

This bird is deemed ecologically important because this sub-species is a Guadalcanal island endemic (Dutson 2011). This quail is locally common but may also be locally threatened due to habitat disturbance and opportunistic hunting for food. This species is found in the grassland habitat. Possible impacts of the hydro project on this species is minimal.

Nesoclopeus w. woodfordi

Woodford's Rail

This bird is deemed ecologically important because this sub-species is a Guadalcanal island endemic (Dutson 2011), it is classed as Near Threatened by IUCN's Red List (IUCN 2013) and it is also opportunistically hunted by locals for food. The possible impacts of the hydro project on this rare and threatened rail should be minimal due to minimal impacts to the grassland habitat that this species is located in.

Actitis hypoleucos

Common Sandpiper

This bird is deemed very ecologically important because it is a migratory species and it is also dependent on the river system (Dutson 2011). This species breeds in the northern hemisphere from May to June and would be absent from the Solomon Islands, possible breeding destinations for these migrants include Russia, Korea and Japan (BirdLife 2013). This sandpiper is water dependent and feeds on larval insects, spiders, molluscs, snails, crustaceans, annelids, frogs, toads, tadpoles and small fish, as well as plant material (including seeds). This bird is also a culturally important species as its feather is believed to give extra strength or luck if obtained, to further signify the migratory status of this species, locals recall never observing the nest or egg of this bird. This common species is usually solitary and is also territorial (see picture in appendix). Loss of habitat for this species may occur, however the creation of a dam may increase micro-habitats for feeding.

Ptilinopus solomonensis ocularis

Yellow-bibbed Fruit-Dove

This bird is deemed ecologically important because this sub-species is a Guadalcanal island endemic (Dutson 2011) and it is also opportunistically hunted by locals for food. This dove is found in upland habitats and feeds on fruits and nuts. This bird is not threatened and possible impacts of the hydro project on this species is minimal.

Cacatua ducorpsi

Ducorp's Cockatoo

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), also this species is also a Solomon Islands endemic (Dutson 2011). This common cockatoo is found in most areas that have large trees so all habitats except grassland and oil palm plantations should have this species. This cockatoo feeds on fruit, nuts and seeds of trees. This species is not threatened and possible impacts from the hydro project are minimal.

Chalcopsitta cardinalis

Cardinal Lory

This bird is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), also this sub-species is a Solomon Islands endemic (Dutson 2011). This common hornbill is found in forest habitats and is thought not to be threatened it feeds on forest fruits and nuts. Possible impacts from the hydro project are minimal.

Alcedo atthis salomomensis

Common (River) Kingfisher

This bird is deemed ecologically important because of its dependence on the river system for feeding on fish and this sub-species is also a Solomon Islands endemic (Dutson 2011). This kingfisher is relatively uncommon and can be found beside streams and large rivers in the riparian habitat. It is not threatened and loss of habitat is possible, however the creation of a dam and reservoir may increase micro-habitats for feeding.

Ceyx lepidus nigromaxilla

Variable Dwarf Kingfisher

This bird is deemed ecologically important because of its dependence on the river system and this sub-species is also a Guadalcanal island endemic (Dutson 2011). This kingfisher is relatively common and can be found beside streams in riparian habitats (see picture in appendix). It is not threatened and loss of habitat is possible, however the creation of a dam and reservoir may increase micro-habitats for feeding.

Rhipidura c. cockerelli

Cockerell's Fantail

This bird is deemed ecologically important because it's sub-species is a Guadalcanal island endemic (Dutson 2011) and it is also classed as Near Threatened by the IUCN Red List (IUCN 2013). This uncommon fantail requires undisturbed forest and is threatened by habitat degradation, however possible impacts from the hydro project are minimal. It feeds on insects.

Rhipidura rufifrons rufofronta

Rufous Fantail

This bird is deemed ecologically important because it's sub-species is a Guadalcanal island endemic (Dutson 2011). This fantail is common in forested habitats and feeds on insects and appears not to be threatened with possible impacts from the hydro project are minimal.

Pachycephala pectoralis cinnamomea

Golden Whistler

This bird is deemed ecologically important because it's sub-species is a Guadalcanal island endemic (Dutson 2011). This whistler is common in forest habitats and feeds on insects and may be threatened due to habitat loss. Possible impacts from the hydro project are minimal.

Dicaeum aeneum becki

Midget Flowerpecker

This bird is deemed ecologically important because it's sub-species is a Guadalcanal island endemic (Dutson 2011). This bird is very common in forest habitats especially on flowering plants and ant-plants (see picture in appendix) that it feeds on insects living in the ant plants. It is not threatened and possible impacts from the hydro project are minimal.

Myzomela melanocephala

Black-headed Myzomela

This bird is deemed ecologically important because it is a Guadalcanal island endemic (Dutson 2011). This bird is common in forest habitats especially on flowering plants and ant-plants where it feeds on nectar from flowers. It is not threatened and possible impacts from the hydro project are minimal.

Aplornis grandis macrura

Brown-winged Starling

This bird is deemed ecologically important because it's sub-species is a Guadalcanal island endemic (Dutson 2011). This common starling is found in a wide range of habitats from gardens and settlements to forest habitats and feeds on insects, flowers and fruits. It is not threatened and possible impacts from the hydro project are probably minimal.

Aplornis brunneicapilla**White-eyed Starling**

This bird is deemed ecologically important because it is classed as Endangered by IUCN's Red List (IUCN 2013) and is also a Solomon Islands endemic (Dutson 2011). This is a rare bird and is found in forested habitats and feeds on insects, flowers and fruits. It is threatened by habitat loss, however possible impacts from the hydro project are minimal.

1.3.3 Mammals

Guadalcanal is home to some of the most cryptic and rare mammals in the Pacific including flying foxes and giant native rats. These animals are also very threatened and some have not been seen for over 100 years and may be extinct, however in depth searches for these animals have not been carried out and there is a possibility that they may occur in the study vicinity.

Pteropus rayneri**Solomon's Flying Fox**

This bat is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), this species is also classed as Near Threatened by the IUCN's Red List (IUCN 2013) and is a Solomon Islands endemic, this species is also opportunistically hunted by locals for food. This large bat is found over a wide variety of habitats though uses forests for roosting, especially large trees and caves and feeds on fruits. This species is threatened by habitat loss and hunting however, possible impacts from the hydro project are minimal.

Pteropus admiralatum**Island Flying Fox**

This bat is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), this species is also opportunistically hunted by locals for food. This large bat is found in forest habitats and feeds on wild and cultivated fruits, it may be threatened and possible impacts from the hydro project are minimal.

Uromys rex**King Rat**

This rat is deemed ecologically important because it is classed as Endangered by IUCN's Red List (IUCN 2013) and it is also a Guadalcanal island endemic. This native tree-rat is believed to be found in upland forest habitats and feeds on fruits, nuts and seeds, it is highly threatened from habitat loss and predation from cats. This species is very rare however it is unlikely to come into contact with the hydro project direct impact area. The establishment of the catchment area into a conservation area may prove beneficial to this species, though more surveying for this species is recommended.

Uromys imperator**Emperor Rat**

This rat is deemed ecologically important because it is classed as Critically Endangered by IUCN's Red List (IUCN 2013) and it is also a Guadalcanal island endemic. This native tree-rat is believed to be found in upland forest habitats and feeds on fruit, nuts and seeds, it is highly threatened from habitat loss and predation from cats. This species may be extinct as no species has been encountered since 1880, it is unlikely to come into contact with the hydro project direct impact area. The establishment of the catchment area into a conservation area may prove beneficial to this species, though more surveying for this species is recommended.

1.3.4 Reptiles

Reptiles are important animals of the forest and provide a large proportion of faunal biomass, thus playing an important role in the food web of the ecosystem. Reptiles are ectotherms and therefore require body heat from the sun and also their body heat is regulated externally similar to amphibians, therefore they can also be susceptible to changes in the micro-habitats.

Cyrtodactylus biordinis**Guadalcanal Bow-fingered Gecko**

This gecko is deemed ecologically important because it is a Guadalcanal island endemic (McCoy 2006). It is commonly found on smaller trees and tree hollows where it lays its eggs, in forested habitats and feeds on insects especially moths. It is believed not to be threatened and possible impacts from the hydro project are minimal.

Corucia zebrata

Prehensile-tailed Skink

This skink is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013), this skink is also a Solomon Islands endemic (McCoy 2006) and is classed as Near Threatened by the IUCN Red List (IUCN 2013), it is also opportunistically hunted for food. This species is probably the largest skink in the world and prefers large trees with dense foliage in forest habitats, it is a vegetarian and feeds on leaves from vines and fruits and flowers. This species may be threatened by habitat loss, however possible impacts from the hydro project are minimal.

Tribolonotus schmidti

Schmidt's Crocodile Skink

This skink is deemed ecologically important because it is a Guadalcanal island endemic (McCoy 2006). This skink is relatively common and prefers moist areas under fallen and rotting timber in forest habitats, it feeds on insects. It is not threatened and possible impacts from the hydro project are minimal.

Candoia paulsoni

Solomons Ground Boa

This snake is deemed ecologically important because of its CITES protection status (UNEP-WCMC 2013). This common snake occurs in a wide variety of habitats from forests to gardens and feeds on frogs to skinks and smaller snakes. It is not threatened and possible impacts from the hydro project are minimal.

1.4 HABITAT DELINEATION AND VALORIZATION

General habitats were localized and delineated on a Google Earth map. This section describes the value of the general habitat types for terrestrial wildlife (highly valued, moderately valued, weekly valued). The report defines what is considered "critical" in the study area in a strictly biological point of view: areas with protected species colonies, areas with endemic species, areas with migratory species and areas with endangered species. Critical natural habitats described and delineated include grassland, riparian, upland and forests. However certain important species have ranges that cover the entire project area and can be found in all areas.

1.4.1 Habitat Types

Refer to pictures in appendix and delineated areas on Google Earth. All the habitats described are common on Guadalcanal and there are no unique habitats that are found in the project that cannot be found elsewhere on the island of Guadalcanal. Most habitats found in the project area are not in a pristine state and have been used and degraded to a certain extent by local populations.

1.4.1.1 Grassland

Refers to habitats that are dominated by grasses and cover the lower lying hills that are not so steep. These are natural habitats formed from the dryer climate and less fertile soils. They have moderate ecological value mainly because they support fewer species but they do support unique species that are not found in forests.

1.4.1.2 Forest

2.4.1.2.1 Undisturbed forest

Refers to forested areas that have undergone relatively no disturbance by human activities. These forest areas are in pristine condition and are on a high ecological value. They are home to a wide variety of species and the intactness of the forest supports greater biodiversity.

2.4.1.2.2 Disturbed forest

Refers to forested areas that have undergone relatively recent disturbance by human activities, such as in the form of timber extraction. These forest areas are not in pristine condition and are on a moderate ecological value. They are home to a small variety of species because of the disturbed nature.

2.4.1.2.3 Remnant forest

Refers to forested areas that have undergone extensive disturbance with remaining large trees such as *Canarium* nut trees left on purpose. These forest areas are not in pristine condition and are on a moderate ecological value. They are home to a small variety of species but are highly modified landscapes by people.

1.4.1.3 Upland

Refers to habitats further inland and of a higher altitude and usually of a forest nature. Upland areas are usually of a pristine nature due to the distance from human habitation and influence. They also are home to many unique and rare species and this habitat is therefore of a high ecological value.

1.4.1.4 Riparian

Refers to habitats along and adjacent to the Tina river and other waterways. These habitats are of high ecological value because they are home to many unique species that are dependent on the water ecosystems. Riparian habitats of a greater distance from settlement areas are also of the most pristine conditions.

1.4.1.5 Cliff

Refers to habitat on and adjacent to very steep areas, usually always adjacent to the river as well. Cliffs seem to be habitats that are created by the river systems that they are adjacent to. They are of a moderate ecological value because they house unique species that may use the cliffs as feeding and breeding habitats. They are of a relatively pristine nature because cliff areas are hard to be modified by local peoples.

1.4.1.6 Garden

Refers to human cultivated habitats that contain food crops. This habitats are of a weak ecological value as they are human created landscapes. However they do provide certain feeding habitats for some species.

1.4.1.7 Fallow brush land

Refers to habitats that were cultivated in the past but have been left to fallow in recent years. These are areas similar to remnant forest however they have undergone complete cultivation as in the form on a garden and have been left to fallow/regrow. They are of a weak ecological value because they host a minimal number of species.

1.4.1.8 Oil palm plantation

Refers to habitats that are homogenous cultivated with oil palm. These areas are of a weak ecological value as they are human created landscapes and are dominated by a foreign species. However certain species have learned to adapt and take advantage of this habitat such bats.

1.4.1.9 Settlement

Refers to habitats in and around village areas. These areas are of a weak ecological value and threaten native species especially through domesticated animals such as cats, dogs and pigs.

1.5 RECOMMENDATIONS AND CONCLUSIONS

- Field study time should be increased for this report, to increase the accuracy and credibility of information on faunal species.
- The establishment of a protected area for the catchment area may benefit the conservation of most biodiversity of the island, especially the endangered native rats.
- The formation of a dam system may favour some water dependent species such as birds by providing extra micro-habitats for feeding and breeding.

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3. APPENDIX

3.1 SAMPLING STATION PHOTOGRAPHS

Refer to folder in FTP

3.2 SPECIES PHOTOGRAPHS

Refer to folder in FTP

3.3 HABITAT PHOTOGRAPHS

Refer to folder in FTP

Appendix N

Treatment of Community Feedback

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Appendix N

Treatment of Community Feedback

Table N-1 provides a summary of the community feedback received in the 15 ESIA mitigation workshops undertaken in 2014 and the manner in which feedback has been incorporated into project design and key safeguard documents. Minutes of the relevant mitigation workshops can be found in Annex 12.

Table N-2 provides a summary of community feedback arising during community consultations of the revised ESIA in October and November 2016 and Project responses to issues raised.

Table N-1 – Resolution of Community Concerns ESIA Mitigation Workshops 2014

Consultation Feedback	Project Outcome
Grievance Mechanism required for local communities	Grievance mechanisms for local communities provided for land acquisition in the LALRP and for project impacts in the ESIA
Need for a fish pass and protection of key fish species	Further fish study undertaken by Ian Jowett to consider protection of nominated fish species (Gobi, eel, silver fish). Trap and Haul system adopted as more effective fish pass for true swimmer species. ESIA disclosure in November 2016 included presentation of photographs of trap and haul systems and mechanism details.
Concern about impact of dam on downstream commercial gravel activities and request for further investigation	Communities informed in November 2016 ESIA disclosure meetings: - Initial drill hole studies suggest a minimum of 30-50 years of river-bed gravel. - Further and ongoing investigations to monitor gravel quantity will be undertaken on a regular basis through the hydro operations period
Provision of alternative water supplies pre-construction for river dependent communities	Accommodated. Provision of alternative water supplies for Project affected river users downstream of the dam site provided for in ESMP. SPC to prepare a Water Supply Feasibility Study for approval by PO and WB prior to installation of supplies.
Safety of the dam during cyclones and extreme weather conditions a series concern for communities.	Dam design complies with dam safety panel requirements. Dam safety panel visited communities in 2012. Under the ESMP, the TRHDP-PO will run a village level consultation program on modern day dam engineering, construction and operation complemented by community briefings from the World Bank's dam safety panel.
Tambu site protection to be considered and compensation paid for damage	Accommodated. The ESMP's Cultural Heritage Plan Framework provides for tambu sites to be confidentially identified prior to construction, protected where possible, and provided with monetary compensation where damage occurs.
Consideration to be given to protecting community benefit agreements where companies change to avoid difficulties experienced with Gold	To accommodate this concern, the community benefit share payment regime once finalised shall be enforceable through contracts between SPC and Solomon Power (PPA), and between SPC and SIG (Implementation Agreement). Any novation or transfer of the contracts will require consent. Consideration will be given to recommending an Act of Parliament to reflect the contractual agreements once

Consultation Feedback	Project Outcome
Ridge. Suggestion that this be done by way of an Act of Parliament.	implementation confirms success of community benefit share financing arrangement.
Guarantee for communities and landowners to be given priority employment	Accommodated. The Implementation Agreement provides for communities and landowners to receive preferential employment. JSDF funded Community Benefit Share Pilot provides for pre-employment training for landowners and communities.
Malango people as landowners need equal involvement in the Project with Bahomea	Accommodated. Malango people will be included in the community benefit share arrangements, and as landowners, were key players in the negotiation of the Process Agreement for land acquisition. They are also included in the PO's ongoing consultation program.
Traditional use of the river to be documented in the ESIA	Accommodated. ESIA and LALRP include assessment of river uses including fishing, drinking, washing, bathing, and swimming.
Mitigation measures to address removal of vegetation and biomass from the reservoir	Accommodated. ESMP includes measures for reservoir vegetation to be stripped (without pesticides) and mulched, to reduce biomass.
Consideration to be given to oxygen levels in the dam	Accommodated. Investigation of reservoir stratification included in ESIA.
Information needed on how environmental flow will be managed	Accommodated. ESIA community awareness in Nov 2016 provided information on environmental flow requirements and management. Requirements will also form part of the Reservoir Management Plan to be prepared by the SPC.
Overseas study visits needed to show other hydros	Accommodated. Two overseas study visits facilitated by PO, including visits to hydro power stations in Fiji and Australia.
Relocation request for riverside villages even if dam is deemed safe	Not Accommodated. Relocation not compliant with WB Indigenous Peoples safeguards. Village level dam safety workshops, involving the dam safety panel, instead proposed in ESMP.
Impacts of dam on social structures of communities, churches, women and youth to be included in ESIA	Accommodated. Social impact assessment in ESIA accommodates issues raised. Key mitigation measures include compulsory cultural induction training for workers, workers code of conduct, prohibition on a construction worker's camp in the area, and priority job access and job training for local communities.
Request for a police post to be installed in the Tina area	Not Accommodated. RSIPF arrangements are out of scope of the TRHDP. However, extensive security will be provided during construction and operations and there is an opportunity for the Community Benefit Share Fund to consider accommodating police infrastructure needs as a supported project if determined to be a priority.
Request for re-opening of clinics and a high level health service (mini hospital)	Partly Accommodated. SPC/EPC are to open and operate a clinic in or near the Project Area before construction commences. Community Benefit Share Fund is anticipated to support the re-opening of the Konga Clinic in Bahomea in consultation with the Guadalcanal

Consultation Feedback	Project Outcome
	Ministry of Health. Opening of a clinic in Malango is also a likely priority for the fund. Ministry of Health planning for Guadalcanal provides for a referral system to the National Referral Hospital (NRH) in Honiara (30-40 minutes drive). Providing requisite staff, expertise and supplies to a second hospital is not consistent with Ministry of Health policy. Road upgrades will improve transport times to NRH.
Studies should take into account social inconvenience and use of bad language	Accommodated. ESMP requires all new workers to participate in cultural induction training and adhere to a Worker's Code of Conduct
Need to consider seismic events in dam design	Accommodated Dam design built to withstand a 1 in 500 year Operating Base Earthquake (OBE) and a 1 in 10,000 year Maximum Design Earthquake (MDE). A seismic risk assessment was undertaken and incorporated into design requirements as the PPA's 'Minimum Functional Specifications'. The Dam Safety Panel will continue to review dam design in accordance with the WB's Dam Safety Plans under OP 4.37. Seismic event design communicated to Bahomea, Malango and Ghaobata communities in November 2016 ESIA disclosure consultations and will form a key component of dam safety village workshops required under the ESMP.
Emergency plan for dam failure needed	Accommodated Developer to prepare an Emergency Preparedness Plan under the ESMP including disaster/extreme event modelling, dam failure and responses.
Importance of education	Accommodated Community Benefit Share Fund is proposed to focus primarily on education outcomes, including improvements to existing schools, teacher housing, electrification of schools and computer classes. Final priorities will be determined in accordance with the decision making processes of the final fund design.
Information requested on Project timeframes	Accommodated Ongoing community awareness has updated communities on Project activities and timeframes. See Annex 14.
Rehabilitation needed for youths involved in anti-social behaviour during the tensions	Partly Accommodated Community Benefit Share Fund to provide improvements to education from kindergarten to Form 7 to increase employment and further studies opportunities for youth. JSDF Community Benefit Share Pilot to provide pre-employment training to youth, and Implementation Agreement to prioritise local community for employment opportunities. If specific rehabilitation programs are a community priority, these will be incorporated into the Community Benefit Share program. Community consultation will inform the focus on the Community Benefit Share Fund.
Suggestion that fish will not be depleted but may increase in number. Further study requested.	Accommodated. Further fish study by Ian Jowett commissioned. Results confirm feedback and suggest that fish numbers likely to increase in lower flow conditions.
Alternative protein sources to be provided to communities	Accommodated. LALRP provides for 3 x SBD \$20,000 annual community payments for the purchase of alternative proteins for

Consultation Feedback	Project Outcome
	feasts/celebrations to compensate for loss of pig hunting grounds/fishing sites during construction years. Households identified as obtaining more than 10% of their livelihood from impacted fishing or hunting activities (vulnerable households) to receive equivalent comparable foods or store vouchers to the value of SBD \$25,000 (being 50% of the average income of Bahomea households). (LALRP Entitlements Matrix)
Fish farms to be considered as an alternative if fish depleted	Accommodated. LALRP to provide for a feasibility study of a reservoir fish farm if annual fish studies along the river suggest depletion over baseline studies (NB: clarification on this will be part of the next round of amendments)
Whether people of Bahomea will have access to free power	Not Accommodated. Further consultations with communities raised concerns that free power will attract unwanted settlers and squatters to the area.
Clear example of the fish pass proposed for the dam needed	Accommodated. ESIA disclosure consultations in Nov 2016 included indicative photographs of the proposed trap and haul measure and information on its application
Will people of Choro, Senge and Korepa need to be relocated?	Accommodated. No relocation required, and confirmed to communities in a number of consultations including ESIA disclosure consultations in Nov 2016.
Downstream communities in Ghaobata to be included in alternative water supplies	Accommodated. All river dependent downstream communities to be provided with alternative water supply systems commiserate with affected river use. EPC contractor to prepare Water Supply Feasibility Plan for WB and PO approval. Ngalimbiu community informed of measure at ESIA workshops in 2014 and 2016.
Information needed on the dam fill time after construction	Accommodated. Information on dam fill time provided during ESIA disclosure workshops in November 2016.
Suggestion of an environmental bond to ensure developer compliance	Environmental bond requirements will be a decision of the MECDM as part of the development consent conditions under the <i>Environment Act</i> .
Gate to be established at entrance of Project area managed by both the developer and landowners	Accommodated. ESMP provides for access above Mengakiki to be restricted and for the road to remain a private road. SPC operational budget includes a budget for security.
Voltage of power lines and safety concerns of vehicles hitting poles	ESMP requires Solomon Power to carry out educational programs on electricity safety including safety around transmission lines.
Width of road and potential damage and compensation needed for any plants damaged	Accommodated. LALRP includes an asset survey of all plants within the infrastructure corridor.
Enforcement of Environmental laws ordinarily very weak. Additional measures required.	Accommodated. In addition to <i>Environment Act</i> compliance, ESMP requires monitoring and oversight of all environment and social measures by Project Office. ESMP compliance forms a key term of the Implementation Agreement. World Bank Project Agreements with SPC will also incorporate monitoring and compliance.

Table N2 – Resolution of Community Concerns ESIA Consultations Oct 2016

	Consultation Feedback	Project Outcome
.Ngalimbiu Communities	Concerns of reduction in gravel available for commercial extraction	Gravel monitoring by a river geomorphologist provided in the ESMP in section 13.2.2. Drill holes demonstrate areas of deep gravel depth, suggesting sufficient gravel for a significant number of years.
	Dam safety concerns for downstream villages. Dam will 'answer to nature's call'	Dam design complies with dam safety panel requirements. Dam safety panel visited communities in 2012. ESMP section 13.2.2 requires a village level consultation program on modern day dam engineering, construction and operation complemented by community briefings from the World Bank's dam safety panel.
	Concern that environment and safety measures discussed will not be implemented or overseen.	Environment and safety measures to be incorporated into all project agreements. New contractual arrangements section 13.7.3 added to ESMP. Project Finance to include funding for TRHDP-PO and MMERE to provide oversight of SPC and HEC E&S implementation.
Bahomea and Infrastructure Corridor Communities	Concerns of dam safety and question regarding possibility of relocation	Dam design complies with dam safety panel requirements. Dam safety advisory panel (DSAP) visited communities in 2012. ESMP section 13.2.2 requires a village level consultation program on modern day dam engineering, construction and operation complemented by community briefings from the World Bank's dam safety panel. Relocation not advised by DSAP. WB safeguards do not support unnecessary relocation.
	Could the dam be used to provide a water supply for communities and Honiara	Not a component of the current hydropower project.
	Village water supplies to be built before construction starts	Section 13.2.2.6 revised to clarify that all downstream communities whose use is affected by the Project will receive alternative water supplies before construction commences.
	Employment to prioritise host communities. Concerns of influx of people and workers from other islands.	Project related employment to prioritise host communities, ESMP section 13.2.2.2. Requirement incorporated into Implementation Agreement between SIG and SPC.
	Will downstream fish migration be impacted by the dam once upstream migration measures are implemented	Downstream fish migration predicted to follow freshes and small floods and make use of spillway.
	Electrification for villages	Electrification for priority infrastructure a component of the JSDF Community Benefit Share Pilot, at section 13.5.1.1.

	Consultation Feedback	Project Outcome
	Important that dust reduction and malaria prevention plans are properly implemented	Air Quality Management and Dust Control Plan and Community Health and Disease Vector Management Plan to be provided by the Developer. Further information on these plans, and details of timeframes and approvals inserted in section 13.4.
	Will there be improvements to education and clinics? Education is priority.	Funding for education and clinics are expected to be key priorities for the Community Benefit Share Fund. Fund priorities to be determined with reference to community consultations as part of fund design and ongoing operations. Discussion of the Benefit Share Fund updated in section 13.5.1.

Appendix O

Construction Environment and Social Management Plan Specifications

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Appendix O

Construction Environmental and Social Management Plan Specifications

This Appendix provides an outline of environmental specifications for assistance of implementation actors in preparing construction contracts in the TRHDP. This document is provided for guidance only and is not intended to create any additional obligations on the Developer in addition to those provided in the ESMP. In the event of any inconsistency the ESMP shall prevail.

1. GENERAL

2. ENVIRONMENTAL DUTIES OF THE CONTRACTOR

The duties of the Contractor(s) include but not limiting to:

- a. Compliance with relevant environmental legislative requirements in Solomon Islands
- b. Work within the scope of contractual requirements and other tender conditions;
- c. Prior to construction commencement, the contractor shall submit to the Project Company a Contractors Health, Safety and Environment Plan (HSE) showing its organization and methods for implementation of the Construction Environmental and Social Management Plan (CESMP) and related management and monitoring plans issued by the Project Company.
- d. Organize representatives of the construction team to participate in site inspections undertaken by the Project Company, MMERE Project Office, the independent monitoring agent, and undertake any corrective actions instructed by the Supervision Engineer;
- e. Provide and update information to the Project Company regarding works activities which may contribute, or be continuing to the generation of adverse environmental conditions;
- f. Stop construction activities which generate adverse impacts upon receiving instructions from the Supervision Engineer and propose and carry out corrective actions and implement alternative construction method, if required, in order to minimize the environmental impacts;
- g. Submit Contractor's Compliance Reports on the dates specified in the Contract.
- h. Establish a Grievance Redress Mechanism according to the GRM associated with the Project Company's ESMP.

3. CONTRACTOR'S PROGRAM FOR IMPLEMENTATION OF EMP

The Contractor is required to submit a CESMP Implementation Program (CEMPIP) as part of his proposed Construction Method Statements during construction phase. The Contractor's CEMPIP shall provide details such as Contractor's commitment to environmental protection; methodology of implementing the project CSEMP; detailed designs for mitigation measures; environmental monitoring program during different stages of the construction period, and the contractor's proposed resources for the implementation of the CSEMP.

4. CONTRACTOR'S WORKPLACE SAFETY AND ENVIRONMENTAL AND SOCIAL OFFICERS (SESO)

Three Workplace Safety and Environmental/Social Officers (SESO) working full time on-site will be appointed by the Contractor. Each of the SESOs is expected to have at least 7 years relevant working experiences. One shall be specialized in environmental management, training and monitoring in infrastructure construction projects; one shall be specialized in workplace health and safety in infrastructure construction projects; and one shall be responsible for community liaison, including public information, consultations, interactions on community development projects and mitigation measures such as replacement water supplies, and grievances. The SESOs should be familiar with relevant requirements of Solomon Islands legislation and regulations. The Contractor shall assign a sufficient number of inspectors and assistants to provide adequate coverage of the workplace.

The SESOs shall be responsible overall for implementation and management of the CSEMP program. The roles and responsibilities of SESOs are, but not limited to, the followings:

- a. Assist in environmental awareness and health and safety training for the contractor's workers within two weeks since mobilization and refresh training at every six months. Conduct additional training as advised by the Environmental Manager of the Project Company
- b. Carry out environmental site surveillance to investigate the Contractors' site practice, equipment and work methodologies with respect to pollution control and adequacy of environmental mitigation implemented;
- c. Carry out safety inspections, investigate and report on incidents, administer a permit to work system, enforce compliance with workplace safety rules.
- d. Monitor the implementation of environmental and social mitigation measures and the contractor' compliance with environmental protection, pollution prevention and control measures, and contractual requirements; Advice to the Contractor(s) on environment improvement, awareness, proactive pollution prevention measures;
- e. Carry out investigation and submit proposals on mitigation measures to the Contractor(s) in the case of non-compliance / discrepancies to CESMP are identified. Participate in the monitoring and implementation of remedial measures to reduce environmental impact
- f. Review the success of the CSEMP to cost-effectively confirm the adequacy of mitigation measures implemented
- g. Prepare Contractor's Compliance Reports to be ready on the dates specified in the contract.
- h. Incorporate CESMP implementation progress into contractor's construction progress report
- i. Complaint investigation, evaluation and identification of corrective measures.
- j. Carry out the monitoring programs issued by the Project Company within the specified timeframe instructed by the Supervision Engineer and/or Project Company and participate in any SIG or World Bank monitoring programs; and
- k. Brief the Independent Environmental Monitoring Agent (IEMA), who will carry out environmental sampling and monitoring quarterly, on all environmental-related issues regarding the contractor's works. Provide the IEMC one copy of each environmental document the SEO prepared during and between visits of the IEMC.

The Contractor(s) shall ensure adequate resources are available to the SEO for the implementation of the CESMP throughout the construction phase.

5. CONSTRUCTION ACTIVITIES AND ENVIRONMENTAL RULES FOR CONTRACTOR

The Contractor will prepare and enforce a Workers Code of Conduct based on the model in the ESMP issued by the Project Company to reflect the followings.

5.1 PROHIBITIONS

The following activities are prohibited on or near the project site:

1. Cutting of trees for any reason outside the approved construction area;
2. Hunting, fishing, wildlife capture and poaching, or plant collection;
3. Buying of wild animals or their meat for food or any other purposes;
4. Disturbance to anything with architectural or historical value other than in compliance with the Physical Cultural Resources Management Plan;
5. Building fires outside workers' housing areas without authorization;
6. Use or possession of firearms;
7. Use of alcohol by workers during working hours;
8. Washing car or machinery in streams or creeks.
9. Doing maintenance (change of oils and filters) of cars and equipment outside authorized areas
10. Littering of the site and disposing trash in unauthorized places
11. Workers driving motorbikes without wearing helmets
12. Control construction plants or vehicles by unauthorized person.
13. Driving at speeds exceeding set safety limits.
14. Having caged wild animals (especially birds) in camps.
15. Working without safety equipment (including gloves, boots and masks)
16. Creating nuisances and disturbances in or near communities
17. Disrespecting local customs and traditions
18. The use of rivers and streams for washing of clothes.
19. The use of welding equipment, oxy-acetylene torches and other bare flames where fires constitute a hazard.
20. Indiscriminate disposal of rubbish or construction wastes or rubble.
21. Spillage of potential pollutants, such as petroleum products.
22. Collection of firewood.
23. Latrining outside of the designated facilities.
24. Burning of wastes and/or cleared vegetation.

5.2 TRANSPORT

The Contractor shall use selected routes to the project site, as agreed with the Supervision Engineer, and appropriately sized vehicles suitable to the class of roads in the area. The contractor shall restrict loads to prevent damage to local roads and bridges used for transportation purposes. The Contractor shall be held responsible for any damage caused to local roads and bridges due to the transportation of excessive loads, and shall be required to repair such damage to the approval of the Supervision Engineer.

The Contractor shall not use any vehicles, either on or off road with grossly excessive, exhaust or noise emissions. In any built up areas, noise mufflers shall be installed and maintained in good condition on all motorized equipment under the control of the Contractor.

Adequate traffic control measures shall be maintained by the Contractor throughout the duration of the Contract and such measures shall be subject to prior approval of the Supervision Engineer.

5.3 WORKFORCE AND WORKERS' FACILITIES

The Contractor should, whenever possible, locally recruit the majority of the workforce, including all unskilled and semi-skilled labour, and shall provide appropriate training as necessary. The contractor shall prioritise workers from the local Bahomea and Malango areas.

Minimum Facilities required:

The construction site shall be provided with the following minimum facilities:

- Warning signs at the perimeter of construction areas to restrict public access to hazardous areas.
- Sanitary arrangements, latrines and urinals shall be provided on the following scale:
- Where female workers are employed, there shall be at least one latrine for every 25 females or part thereof.
- Where males are employed, there shall be at least one latrine for every 25 males or part thereof.
- Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.
- Each latrine or urinal must be lockable from inside, and outside of each block there must be a notice in the language understood by the majority of the workers "For Men" or "For Women" as the case may be.
- The latrines and urinals shall be adequately lighted and shall be maintained in a clean sanitary condition at all times and
- Water shall be provided in or near the latrines and urinals by storage in drums.
- A sick bay and first aid station. First aid box shall be provided at every construction campsite and under the charge of a responsible person who shall always be readily available during working hours of the work place. He shall be adequately trained in administering first aid-treatment. Formal arrangement shall be prescribed to make motor transport available to carry injured person or person suddenly taken ill to the nearest clinic or hospital.
- Waste disposal facilities shall be provided:
- Disposal of sanitary wastes and excreta shall be into septic tanks.
- Kitchen wastes shall be disposed into soak pits. Wastewater from campsites will be discharged and disposed in a kitchen sump located at least 15 meters from any body of water. Sump capacity should be at least 1.3 times the maximum volume of wastewater discharged. The bottom of the pit should be filled with coarse gravel and the sides shored up with board, etc. to prevent erosion and collapse of the pit.
- Solid wastes generated in the construction site shall be reused if recyclable or disposed off in land fill sites
- Fire breaks are important, together with an effective fire prevention policy.

Workers' Camp

The contractor undertakes not to establish a workers' camp. Workers are to be recruited from local communities of Malango and Bahomea as a priority. Foreign and non-local national workers shall be housed in existing townships such as Honiara and Henderson.

Activities in Construction Camp

The following precautions need to be taken in construction of camps:

- Measures to ensure that no leaching of oil and grease into water bodies or underground water takes place
- Wastewater should not be disposed into water bodies
- Regular collection of solid wastes should be undertaken and should be disposed of safely
- All consumables of first aid equipment, cleaning equipment for maintaining hygiene and sanitation should be recouped immediately

The Contractor shall ensure that site offices, storages and workshops are located in appropriate areas as approved by the Supervision Engineer and not within 200 meters of existing residential settlements. Explosive materials storage must be away from residential areas, administrative areas or other public areas, the location of the storage must be accepted, approved by the Ministry of Environment in consultation with the Tina Hydro Project Office and comply with existing Solomon Islands legislation.

The Contractor shall comply with all point source pollution requirements of the Project Company's ESIA and ensure that site offices and particularly storage areas for diesel fuel and bitumen are not located within 100meters of watercourses, and are operated so that no pollutants enter watercourses, either overland or through groundwater seepage, especially during periods of rain. This will require bund walls to be constructed around the area with a settling pond/oil trap at the outlet.

Site Restoration

At the completion of the construction work, the Contractor shall comply with the Post Construction Rehabilitation Plan. Including, all construction camp facilities shall be dismantled and removed from the site unless retention of a facility is requested by the Project Company for use during operation, and the whole site restored to a similar condition to that prior to the commencement of the works or to a condition agreed to with the Project Company in consultation with the owner of the land. Various activities to be carried out for site restoration are:

- Oil and fuel contaminated soil shall be removed and transported and buried in waste disposal areas approved by the Supervision Engineer.
- Construction campsite shall be grassed and trees cut replaced with similar tree species.
- Trees planted shall be handed over to the Project Company for maintenance
- Soak pits and septic tanks shall be covered and effectively sealed off.

5.4 CLEARING THE RIGHT-OF-WAY

The Contractor shall ensure that vegetation clearing of right of way is carried properly.

- Before clearing, a botanical survey will be carried out in accordance with the Forest Clearing Plan to identify trees and plants to be avoided or transplanted. Whenever possible, communities should be allowed to benefit from this vegetation for firewood and other uses.
- Trees should be cut in such a way that they fall longitudinally and not transversally to the right of way alignment. Extra care should be taken to avoid tress from falling down slope with potential risk for communities or traffic below.
- Make use of any usable timber (after community uses) before construction starts.
- The Contractor shall remove and store the organic layer of the soil to be used for revegetation and restoration of affected sites in accordance with the Topsoil and Spoil Management Plan.

5.4 WASTE MANAGEMENT AND EROSION

Solid, sanitation, and, hazardous wastes must be properly controlled, through the implementation of the following measures:

Waste Management:

- Shall be undertaken in accordance with the Waste Management Plan issued by the Project Company

Erosion Control:

- Shall be undertaken in accordance with the Erosion and Sedimentation Control Plan issued by the Project Company

Maintenance:

- Identify and demarcate equipment maintenance areas (>15m from rivers, streams, lakes or wetlands). Fuel storage shall be located in proper areas and approved by the Supervision Engineer.
- Ensure that all equipment maintenance activities, including oil changes, are conducted within demarcated maintenance areas; never dispose spent oils on the ground, in water courses, drainage canals or in sewer systems.
- All spills and collected petroleum products shall be disposed of in accordance with standard environmental procedures/guidelines, and the Point Source Pollution requirements of the Project Company's ESMP. Fuel storage and refilling areas shall be located at least 100m from all cross drainage structures and important water bodies or as directed by the Supervision Engineer.

5.5 EARTHWORKS, CUT AND FILL SLOPES

All earthworks shall be properly controlled, especially during the rainy season.

The Contractor shall maintain stable cut and fill slopes at all times and cause the least possible disturbance to areas outside the prescribed limits of the works.

The Contractor shall complete cut and fill operations to final cross-sections at any one location as soon as possible and preferably in one continuous operation to avoid partially completed earthworks, especially during the rainy season.

In order to protect any cut or fill slopes from erosion, in accordance with the drawings, cut off drains and toe-drains shall be provided at the top and bottom of slopes and be planted with grass or other plant cover. Cut off drains should be provided above high cuts to minimize water runoff and slope erosion.

Any excavated cut or unsuitable material shall be disposed of in designated disposal areas as agreed to by the Supervision Engineer and in accordance with the Topsoil and Spoil Management Plan.

5.6 STOCKPILES AND BORROW PITS

Operation of a new borrowing area, on land, in a river, or in an existing area, shall be subject to prior approval of the Supervision Engineer, and the operation shall cease if so instructed by the Supervision Engineer. Borrow pits shall be prohibited where they might interfere with the natural or designed drainage patterns. River locations shall be prohibited if they might undermine or damage the river banks, or carry too much fine material downstream.

The Contractor shall ensure that all borrow pits used are left in a trim and tidy condition with stable side slopes, and are drained ensuring that no stagnant water bodies are created which could breed mosquitoes.

The location of crushing plants shall be subject to the approval of the Engineer, and not be close to environmentally sensitive areas or to existing residential settlements, and shall be operated with approved fitted dust control devices.

In any borrow pit and disposal site, the Contractor shall:

- Identify and demarcate locations for stockpiles and borrow pits, ensuring that they are 15 meters away from critical areas such as steep slopes, erosion-prone soils, and areas

that drain directly into sensitive water bodies (except the sites designed with rock wall to cover the surroundings)

- Limit extraction of material to approved and demarcated borrow pits.
- Stockpile topsoil when first opening the borrow pit. After all usable borrow has been removed, the previously stockpiled topsoil should be spread back over the borrow area and graded to a smooth, uniform surface, sloped to drain. On steep slopes, benches or terraces may have to be specified to help control erosion.
- Excess overburden should be stabilized and re-vegetated. Where appropriate, organic debris and overburden should be spread over the disturbed site to promote re-vegetation. Natural re-vegetation is preferred to the extent practicable.
- Existing drainage channels in areas affected by the operation should be kept free of overburden.
- Once the job is completed, all construction -generated debris should be removed from the site.

The Contractor shall present a quarry or borrow pit exploitation plan. The operation of the quarry or borrow pit should follow the following practices: should include aspects like:

- Operations must be conducted in discrete stages with all valuable material fully extracted so that progressive rehabilitation can be carried out.
- It is most important that operators plan for progressive rehabilitation while operations are ongoing. Planning of final rehabilitation of a pit should occur well before the cessation of operations. Any plan for the rehabilitation of a site should include a brief description of the site prior to the commencement of operations, including: soils, landform, flora and fauna, drainage and conservation values.
- Deposits should be worked in a systematic manner, generally across or down the slope, so that worked out sections can be rehabilitated and left to revegetate without further disturbance.
- Where substantial volumes of waste rock or overburden will be produced by the operation of the quarry, this material should be placed in properly designed dumps, which are located and shaped to blend in with the surrounding landscape. Costly reshaping of dumps during the rehabilitation phase is then avoided.
- Minimization of the total disturbed area is the best method of reducing erosion caused by storm water run-off and weed invasion. Use boundary markers, such as stakes and flagging tape, to indicate to machinery operators the extent of areas to be cleared.
- The Contractor shall submit a blasting plan for each site following the Drill and Blast Management Plan issued by the Project Company for review and approval by the Supervision Engineer prior to implementation.
- Avoid blasting in overcast and other adverse weather conditions. A regular blasting time should be adhered to and notified to communities.
- Quarrying should be carried out in a series of working benches if the material is stable. Orientation of benches should take into account the underlying geology and vantage points from which the quarry is visible. All benches should be self-draining. Each bench should act as a table drain, carrying water along the bench to a suitable discharge point or settling pond. If drainage is allowed to flow down the face from one bench to the next, erosion will occur and the benches may be lost.
- Topsoil is usually the darker, upper soil layers. Though only 10 - 30 cm deep, it contains nutrients, minerals, seed, and organic matter which helps bind it all together. Wherever possible, stripped topsoil should be placed directly onto an area being rehabilitated. This avoids stockpiling and double handling of the soil.
- If topsoil must be stockpiled, remember that it does deteriorate in quality while stockpiled. The following practices will help maintain soil quality:
 - Topsoil should be kept separate from overburden, gravel and other materials; if possible, windrows of topsoil should not exceed one metre in height to reduce "souring";
 - topsoil stockpiles should be protected from erosion;
 - Growing vegetation on the stockpiles (shrubs or grasses) reduces erosion and will maintain biological activity in the soil;

- Topsoil should not be buried or driven on, as this will damage soil structure.
 - Soil should be stored somewhere out of the way; and
 - Excessive handling of topsoil should be avoided.
- Sites should be regularly inspected for the presence of noxious weeds, their presence should be recorded, and if necessary a control program implemented.
- All run-offs from working areas, which contains sediment, should be collected in settling ponds before being discharged from the premises. Water from washing, screening, or dust reduction plants should be treated in a like manner. Accepted methods for removal of sediment from run-off include settling ponds, hay bale filters, aggregate filters, wetlands (shallow ponds planted with suitable swamp plants). For quarries in vegetated areas, run-off should be directed through vegetation prior to reaching any watercourse to enable further filtering of sediment.
- Management of noise impact can be achieved through:
 - Confining operations to reasonable operating hours is the simplest means of avoiding unreasonable noise impacts. Another effective means is to provide appropriate separation distance to enable the noise to decay to acceptable levels.
 - Enclosures may be required around crushing and screening plants. Solid barriers, such as bund walls and topographical features, provide the most effective 'in line' reduction of sound levels. Reliance on a barrier of vegetation alone will result in only marginal reduction in noise levels.
 - Hydraulic rock breakers produce less noise than secondary blasting with explosives. In general, operators should avoid using surface detonating cord for charge initiation. Sufficient stemming and appropriate delays between shot holes should always be used. Use of non-electric detonators has won widespread approval as the quietest delay system for initiating blasts.
- The following practices shall be considered to minimize environmental impact on air quality:
 - The direction of the prevailing winds and the placement of the stockpile on the site should be considered during the planning stage. Trees should be planted for windbreaks or topography and/or embankments utilized, to shield stockpiles and working areas from prevailing winds. As conveyors and transfer points can be major sources of dust, enclosures, mist sprays, or approved dust extraction equipment may be required. Drop distance between discharge point and top of the stockpile should be kept to a minimum.
 - The speed of vehicles is an important factor in the generation of dust. The speed of vehicles on site may need to be restricted. In addition, where transport routes are along unsealed roads, it may be advisable to slow down in the vicinity of residents along these routes.
 - Stockpiles and roads can be sprayed with chemicals such as magnesium chloride to produce an impermeable layer, which reduces dust development. Alternatively, regular spraying with water can also be used to suppress dust. Waste oil must not be used as a dust suppressant.
 - The nature of the material being transported and its potential to emit dust should be considered in the loading of trucks. Generally, the highest point of the load should not exceed the height of the tray walls, unless the load is covered. Environmental factors play a large role in the nature of air pollution and dust emissions. Extra care should therefore be taken at times of high wind speed, or during other adverse weather conditions, to minimize dust emissions. Decreased vehicle speeds, increased watering of roads and stockpiles and reduction of the amount of product transported per load, may be appropriate in adverse weather conditions.
- Visual impact shall be minimized through:
 - Natural vegetation is a valuable resource that should be employed for screening purposes. Vegetation may needlessly be destroyed by brief activities with heavy machinery at the pit boundary. Clearing should be kept to the minimum absolutely necessary for efficient operations. Planting of vegetation will also provide additional screening.
- Quarry faces should be screened from frequently used roads and commonly visited vantage points. Existing topographic features may be utilized as effective screens and

any landscaping undertaken should be designed to be visually compatible with the surrounding natural landscape. Where practical, working faces should be oriented away from vantage points and neighbors and the direction of working should be carefully chosen so that the working face is hidden from the most critical view. Where possible, uppermost benches should be worked out and rehabilitated as soon as possible.

- New premises should not be opened adjacent to roads frequently used by the public, unless adequately screened by topography and/or vegetation. Access tracks should be aligned to avoid continuous line of sight from vantage points.

5.7 DISPOSAL OF CONSTRUCTION AND VEHICLE WASTE

The Contractor shall establish and enforce daily site clean-up procedures, including maintenance of adequate disposal facilities for construction debris

All arrangements for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary, will be considered incidental to the work and should be planned and implemented by the contractor as approved and directed by the Supervision Engineer.

5.8 SAFETY DURING CONSTRUCTION

The Contractor's responsibilities include the protection of every person and nearby property from construction accidents. The Contractor shall be responsible for complying with all national and local safety requirements as well as the Health and Safety Plan issued by the Project Office, and any other measures necessary to avoid accidents, including the following:

- Carefully and clearly mark pedestrian-safe access routes;
- If school children are in the vicinity, include traffic safety personnel to direct traffic during school hours;
- Maintain supply of supplies for traffic signs (including paint, sign material, etc.), road marking, and guard rails to maintain pedestrian safety during construction;
- Conduct safety training for construction workers prior to beginning work;
- Provide personal protective equipment and clothing (gloves, dust masks, boots, etc.) for construction workers and enforce their use;
- Post Material Safety Data Sheets for each chemical present on the worksite;
- Require that all workers read, or are read, all Material Safety Data Sheets. Clearly explain the risks to them and their partners, especially when pregnant or planning to start a family. Encourage workers to share the information with their physicians, when relevant;
- Ensure that the removal of asbestos-containing materials or other toxic substances be performed and disposed of by specially trained workers;
- During heavy rains or emergencies of any kind, suspend all work and mobilise resources for mitigation actions.
- Brace electrical and mechanical equipment to withstand seismic events during the construction.
- Setting up nets, fences or traps to prevent rocks, trees, and soil from falling down slope and put communities or traffic at risk. Specific high risk points are identified in the Information Sheet.

5.9 ENVIRONMENT PROTECTION AND SAFETY DURING BLASTING

Due to the narrow characteristics of construction site and the presence of population along the right-of-way, mine exploding for road bed only inner exploding method will be allowed in order to limit soil and stone to be pushed away to fill up river/stream and effect to surrounding houses. The Contractor shall present for approval Blasting Plan for each site. The Plan should include the following methods to be applied to ensure safety and minimize environmental impacts:

- A blasting plan for each exploding point. The Plan must be available during construction period)
- Procedures for management on non-exploding mines or missing exploding points. □ All the safety precautions that will be applied during blasting such as:
Radius of dangerous area must be calculated based on site condition (for example: to small exploding the minimize radius of dangerous area is from 300m to 400m)
- If , practical conditions at the site does not allow the application of standard method to ensure safety for blasting the Contractor shall prepare and submit to the Supervision Engineer and PMB a detail blasting plan for each of the blasting sites that satisfy: (i) create a barrier made of suitable materials to ensure safety, (b) temporary evacuate people and animals before blasting; and (c) blasting using inner exploding method.
- Exploding site must be far away from resident as required by regulations
- Exploding direction must be towards mountain sides or non residential areas and far from traffic road.
- Information systems such as signboards and setting warning surrounding exploding area to local people and traffic.
- Information campaigns to alert local government and communities about blasting schedules and safety measures.
- Provision for lead times (at least 15 min) before actual blasting with sirens that can be heard far away
- Evacuation people out of exploding area.
- Check safety of equipment and workers before returning to normal operations

5.10 NUISANCE AND DUST CONTROL

To control nuisance and dust the Contractor should:

- Maintain all construction-related traffic at or below 15 mph on the road within 500 m of the site;
- Maintain all on-site vehicle speeds at or below 10 mph.
- To the extent possible, maintain noise levels associated with all machinery and equipment at or below 90 db.
- In sensitive areas (including residential neighborhoods, hospitals, rest homes, etc.) more strict measures may need to be implemented to prevent undesirable noise levels.
- Minimize production of dust and particulate materials at all times, to avoid impacts on surrounding families and businesses, and especially to vulnerable people (children, elders).
- Phase removal of vegetation to prevent large areas from becoming exposed to wind.
- Spray water at the site, and on dirt roads, cut areas and soil stockpiles or fill material as needed to ensure that dust level at areas close to housing, commercial areas, and recreational areas meets the existing Vietnam air quality standard.
- Apply proper measures to minimize disruptions from vibration or noise coming from construction activities.
- Heating bitumen should be carried out at least 50 m from any residential area, the heating areas must be at the end of wind direction, be appropriately covered so as the impacts of smoke, dusts and odour onto the surrounding areas are minimised.

5.11 COMMUNITY RELATIONS

To enhance adequate community relations the Contractor shall:

- Inform the population about construction and work schedules, blasting schedules, interruption of services, traffic detour routes and provisional bus routes, and demolition, as appropriate.
- Limit construction activities at night. When necessary ensure that night work is carefully scheduled and the community is properly informed so they can take necessary measures.
- Inform local community as early as possible and repeat at least one day in advance of any service interruption (including significant changes to the river or the use of roads) the community must be advised through postings at the project site, and key community locations including churches, schools and clinics.
- All community infrastructures such as roads, bridges, water supply systems, micropower generators, boat landings, irrigation systems, etc. affected during construction must be restored to the satisfaction of the communities and approved by the Supervision Engineer.
- All local roads used or by-passed by the Contractor will need to be rehabilitated to their original conditions, and Black Post Road to be rehabilitated to its post-reconstruction condition.
- Establish and maintain a unit to receive, process and reach resolution on community complaints arising from construction activities. This mechanism will be overseen by the Contractor's SEO. Records of such complaints and their resolution must be kept and be available for review by the Supervision engineer and PMB in accordance with the Grievance Redress Mechanism.

5.13 PHYSICAL CULTURAL RESOURCES CHANCE-FINDS PROCEDURES

If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall follow the Chance Finds Procedure set out in the Project Company's ESMP.

5.14 HAZARDOUS MATERIALS

The Contractor undertakes not to use hazardous building materials, including asbestos, in any construction.

5.15 HEALTH SERVICES, HIV/AIDS EDUCATION

The Contractor shall provide basic first aid services to the workers as well as emergency facilities for work related accidents including as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital.

The Contractor shall be responsible for implementing a program for the detection screening of sexually transmitted diseases, especially with regard to HIV/AIDS, amongst laborers is actually carried out.

The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay and ambulance service are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics.

The Contractor shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority.

The Contractor shall send, to the Supervision Engineer, details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Engineer may reasonably require.

The Contractor shall conduct an HIV-AIDS awareness program via a third party service provider, and shall undertake such other measures as are specified in this Contract to reduce the risk of the transfer of the HIV virus between and among the Contractor's Personnel and the local community, to promote early diagnosis and to assist affected individuals.

The Contractor shall throughout the contract (including the Defects Notification Period): (i) conduct Information, Education and Consultation Communication (IEC) campaigns, at least every six monthly, the first one should be within three weeks from construction commencement, addressed to all the Site staff and labor (including all the Contractor's employees, all Sub-Contractors and Consultants' employees, and all truck drivers and crew making deliveries to Site for construction activities) and to the immediate local communities, concerning the risks, dangers and impact, and appropriate avoidance behavior with respect to of Sexually Transmitted Diseases (STD)-or Sexually Transmitted Infections in general and HIV/AIDS in particular; (ii) provide male or female condoms for all Site staff and labor as appropriate; and (iii) provide for STI and HIV/AIDS screening, diagnosis, counseling and referral to a dedicated national STI and HIV/AIDS program, (unless otherwise agreed) of all Site staff and labor.

5.16 ENVIRONMENTAL EMERGENCY PROCEDURES

Prior to construction commencement, the contractor shall submit to the Environmental Supervising consultant and Project Company an Emergency Response

In the event that accidental leakage or spillage of diesel/chemicals/chemical wastes takes place, the following response procedures shall be followed immediately by the Contractor(s): The person who has identified the leakage/spillage shall immediately check if anyone is injured and shall then inform the Contractor(s), Supervision Engineer and PMB.

- The Contractor(s) shall ensure any injured persons are treated and assess what has spilled/leaked;
- Should the accidents / incidents generate serious environmental pollution (e.g. spillage / leakage of toxic or chemicals, large scale spillage / leakage, or spillage / leakage into the nearby water bodies which are used for irrigation / portable water), the SEO immediate inform PMB;
- In such cases, the Contractor(s) shall take immediate action to stop the spillage / leakage and divert the spilled / leaked liquid to nearby non-sensitive areas;
- The Contractor(s) shall arrange maintenance staff with appropriate protective clothing to clean up the chemicals/chemical waste. This may be achieved through soaking with sawdust (if the quantity of spillage/leakage is small), or sand bags (if the quantity is large); and/or using a shovel to remove the topsoil (if the spillage/leakage occurs on bare ground); and
- Depending on the nature and extent of the chemical spill, evacuation of the activity site may be necessary.
- Spilled chemicals must not be flushed to local surface drainage systems. Instead, sawdust or sandbags used for clean-up and removed contaminated soil shall be disposed

of by following the procedures for chemical waste handling and disposal already described.

The possibility exists for environmental emergencies of an unforeseen nature to occur during the course of the construction and operational phases of the project. By definition, the nature of such emergencies cannot be known. Therefore, the Contractor(s) shall respond on a case-by-case basis to such emergencies and shall initiate event-specific measures in terms of notifications and reactions.

The Contractor(s) shall prepare a report on the incident detailing the accident, clean-up actions taken, any pollution problems and suggested measures to prevent similar accidents from happening again in future. The incident report shall then be submitted to the Supervision Engineer and PMB for review and keep in the records. The incident report shall also be submitted to DONRE, if required.

5.17 ENVIRONMENTAL TRAINING AND AWARENESS

The Contractor should ensure that all concerned staff are aware of the relevant environmental requirements as stipulated in local environmental legislation and the Contract specifications. The Contractor(s) is responsible for providing appropriate training to all staff. This should be tailored to suit their level of responsibility for environmental matters. The Contractor(s) should also ensure that all site staff members are aware of the emergency response procedures. All staff should receive environmental induction training and managerial staff should receive additional training. The training materials should be reviewed by the SES and submitted to the PMB for approval.

Additional refresher training may be provided and this should be scheduled following periodic internal review of requirements for the Project activity concerned. Records should be maintained for staff environmental training and submitted to the IEMC upon request. Records should be kept on site where possible for each project activity for easy access during site audits or enquiries. Environmental training records (e.g. attendance records for environmental awareness training, topics covered) should be kept.

REMEDIAL ACTIONS

Remedial actions which cannot be effectively carried out during construction should be carried out on completion of the works (and before issuance of the acceptance of completion of works:

- (a) All affected areas should be landscaped and any necessary remedial works should be undertaken without delay, including grassing and reforestation;
- (b) water courses should be cleared of debris and drains and culverts checked for clear flow paths; and
- (c) All sites should be cleaned of debris and all excess materials properly disposed; (d) Borrow pits should be restored.

Appendix P

Biodiversity Management Plan Preparation TOR

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Appendix P

BIODIVERSITY MANAGEMENT PLAN PREPARATION TOR

1. BACKGROUND

Tina River Hydropower Development Project Office (TRHD PO), the Solomon Islands State-owned project delivery entity, is in the final stages of negotiating a loan agreement with International Financial Institutions (IFIs) to construct the 15MW run-of-river hydropower peaking facility on the Tina River, Guadalcanal Province.

The Project will consist of a 53 meter high Roller Compacted Concrete dam in an uninhabited area of Malango Ward at an elevation of approximately 123 masl and roughly 30 river km from the sea. It also incorporates a 3.3 km tunnel to a powerhouse and a tailrace at elevation 73 masl. The reservoir formed by the dam will extend upstream approximately 2.6km and will have a surface area of about 0.28km² at an elevation of 175 masl. The powerhouse will be located 3 to 4 km kilometers downstream from the dam directly alongside the left bank of the Tina River, and water will be diverted to the powerhouse from the reservoir through an underground tunnel. Initially, the powerhouse will have 3 Francis turbine/generator units, each with a capacity of 5MW, allowing a maximum discharge of about 18m³/s and a minimum discharge of 2.4m³/s. The powerhouse will be designed with an extra bay to accommodate another 5 MW unit when the demand grows further. An environmental flow of 1m³/s will be maintained between the dam and the powerhouse tailrace, a distance of 5.7km.

A 23 km, 66 kV transmission line system will evacuate the power from the hydropower facility to the Honiara grid, connecting to the existing Lungga Power Station. The transmission lines will extend southward from the Lungga Power Station and then eastward, on the south side of several villages, until reaching the access road and following it to the power station.

Construction activities will last 3 years and all construction activities will take place in the recently acquired "Core Area" and Black Post Road. The Tina Core Land Company (TCLC), a joint venture between customary landowners and government, will hold rights to the lands on which the Project will be constructed and operated (Core Area), including the access road from the power station to the dam site. This land shall be leased to the Independent Power Producer (IPP).

The footprint of the 72m high dam, reservoir, transmission lines, powerhouse, access road, quarry and other ancillary activities will result in the permanent loss of 115.49 ha due to construction activities, although the area of influence of the project is much wider.

Construction on the access road from its current terminus at the end of Black Post Road, and upgrading Black Post Road, is expected to start in late 2017. The main construction works (dam, power house, tunnels, etc.) will start in 2018 once the road is completed.

An ESIA for the Tina River Hydropower Development Project (TRHDP) has been completed in accordance with good international industry practice, and includes an Environmental and Social Management Plan (ESMP).

1.1. KEY TERRESTRIAL ECOSYSTEM FEATURES

A total of 161 plants species were identified during field surveys. Among them 5 species are listed as being vulnerable, and 19 are listed as being threatened.

The primary habitats of the study area are comprised of forested and non-forested ecosystems, which represent a mix of modified and natural habitats. The level of disturbance increases from upstream to the downstream in the catchment. The upper Tina River catchment, upstream of the dam site, is dominated by highly valued, undisturbed lowland forests, whereas, the area downstream of the dam site is dominated by disturbed forests. This is mainly the result of anthropogenic activities (e.g., logging, settlements, garden, trails, etc.). Disturbed areas such as Black Post Road, and the proposed access road and transmission line corridor, are colonized by invasive plant species. There is a concern that the Project may facilitate improved access for loggers into the upper Tina River catchment, thereby accelerating the rate of timber removal from upland forest areas outside of, but immediately adjacent to, the Project.

The fauna baseline study has shown that wildlife species thrive in pristine forests of the upper Tina River catchment, but also in the more anthropogenically altered areas in the middle and lower reaches of Tina River. A total of 60 wildlife species were observed by the ESIA team in the study area, including: 9 amphibian, 5 reptile, 41 bird, and 5 mammal species. Approximately 45% of which are endemic. This includes: 1 endemic amphibian, 1 endemic reptile, and 25 endemic bird species and subspecies.

The project, including areas of inundation during operation, access and construction activity, will be located in those parts of the study area that are largely disturbed forest and modified grassland with extensive and ongoing anthropogenic change.

The pristine montane forests found in the upper Tina River catchment will not be directly affected by the Project.

Invasive faunal species, including the Giant African Snail, cane toad, Norway rat, and feral cats, are found on Guadalcanal Island. The Giant African Snail can be found in lowland areas, adjacent to, but not yet within, the project area. Whereas, the cane toad, Norway rate and feral cats are all found within both lowland areas and the project area, where pose an ongoing threat to local native species that contribute to Guadalcanal's biodiversity.

1.2. KEY AQUATIC ECOSYSTEM FEATURES

Current water quality in the Tina River does not appear to be a limiting factor for aquatic life, given the low level of pollution.

The Tina River is a relatively pristine, low nutrient watercourse originating from bedrock-controlled substrate in the undisturbed montane forests found on the higher elevation slopes of Guadalcanal. Lower trophic level aquatic organisms, such as algae and macro-invertebrate species support many of the fish species found within the Tina River. Species assemblages and populations can be used as an index of aquatic ecological health.

Field studies conducted in support of the ESIA involved only limited sampling of aquatic macro-invertebrates, primarily aquatic dependent insect species, mostly in their emergent adult forms. In the interest of monitoring potential impacts of TRHDP construction and operation on the health of the aquatic habitat, a program of algae and macro-invertebrate monitoring is required. Baseline algae and macro-invertebrate data collection should be undertaken pre-construction during a typical low flow period, when it is safe to enter the river

to collect samples. Periodic algae and macro-invertebrate sampling should be subsequently carried out to measure potential changes to these lower trophic levels that may result from construction and operation of the Project.

Fifty-nine species of fish were recorded within the Tina/Ngalimbiu River system, from the upstream catchment area to the mouth of the river.

In the Solomon Islands, as with other mountainous islands of the Indo-Pacific Region, Gobioid fishes are the dominant fresh water fauna, and are mainly represented by members of the Gobiidae and Eleotridae families. Baseline fish surveys showed that the Gobioid group was represented by 34 species (25 Gobiidae, 8 Eleotridae and 1 Rhyacichthidae).

Like other tropical islands of the Indo-Pacific Region, all native species encountered in inland fresh water are migratory species with a life cycle that alternates between ocean and river. Two main migration patterns are followed: catadromous and amphidromous.

Fishing is a significant source of livelihood only at the mouth of the Ngalimbiu River, where semi-commercial fishing occurs using mosquito seine net, gill net, and other methods.

The upper Tina River catchment plays an important role in fish life cycle but not a critical one since:

- ▶ fish within the Solomon Islands do not show natal stream homing behavior. Rather, juveniles will colonize any rivers for which they can gain access; and
- ▶ the mouth of the Ngalimbiu River is more critical to the life cycle of most fish species than upstream areas, as it is the only entry point to all fish that live within the catchment.

Based on current knowledge, the upper Tina River catchment is a highly valued aquatic habitat but not a “critical habitat” for fish species present in Guadalcanal. This remains under assessment, as a number of fish found during ESIA surveys are awaiting confirmation of identification. Notwithstanding, the Project has elected to provide for upstream and downstream fish passage.

The trap-and-haul method of affecting upstream fish passage was selected as the preferred means for moving fish up and over the dam, as it offers potentially greater effectiveness, better opportunity for adaptive management, lower capital cost, and provides ongoing social benefits in the form of employment to operators of the facility.

Consideration has been given to include two forms of trap-and-haul, an engineered trap-and-haul system to accommodate climbing fish species, plus, a system involving netting and hauling for swimming species, as part of an adaptive management approach to monitor their migrations and congregations with a view to designing an effective but inexpensive engineered structure, should the results of monitoring support this. Each type of system will need to be monitored during operation to determine whether changes to design or operation are required to ensure fish passage over the dam.

Spilling flows will be used to move adult eels downstream during migration periods.

1.3. LAND ACQUISITION AND LIVELIHOODS ISSUES

There will be no physical relocation of homes or settlements resulting from the Project. Instead, the principal effects will be a reduction on the availability and loss of access to the natural capital available on 428ha of land acquired for Project construction and operation (core land), the Tina River, and the infrastructure corridor. A further important livelihood effect will be the potential damage to physical capital in the form of private and community structures, such as homes, huts, and tracks.

1.4. PROXIMITY OF PROTECTED AREAS AND CRITICAL NATURAL HABITAT

There are no formal protected areas or proposed protected areas that could be affected by the TRHDP. However, there are nearby areas that are considered to be of great landscape and biodiversity value, and are either protected or official protection status is pending. Informal protection of many small, natural sites called “Tambu” is provided by the local population, which protects these areas in a traditional manner.

At least two authoritative sources recognised by the World Bank, the IUCN and Birdlife International, have identified the upper watersheds on Guadalcanal as Critical Natural Habitat. Within the Tina River catchment, this area is within undisturbed montane forest located above 400masl to the south, west and east of the dam site and reservoir. Below this elevation the habitat has been either moderately or significantly anthropogenically altered. Therefore, the TRHDP will not significantly impinge directly on the Critical Natural Habitat of the upper Tina River catchment.

2. OBJECTIVES

A Biodiversity Management Plan (BMP) is required as one of the sub-plans under the ESMP. Preparation of a BMP is also an appropriate (and in some cases necessary) approach to meet the requirements of World Bank Performance Standard 6 *Biodiversity Conservation and Sustainable Management of Living Natural Resources*, which is applicable to TRHDP. The BMP needs to be completed and implemented prior to mobilisation of the EPC contractor to the site.

The goals of the Biodiversity Management Plan include:

1. Protecting and, if possible, enhancing remaining significant habitats within, and particularly adjacent to, the project area, in particular, reducing pressure on the upper Tina River catchment area, upstream of the Project. In particular, achieve no net loss of biodiversity, in areas of natural habitat, where feasible.
2. Protecting and, if possible, improving the chances of survival of listed species in the project area. □The plan must provide clear guidance on how to protect and restore habitats in the project site, to protect and manage listed species and to prevent the further incursion of invasive species. However, the approach to biodiversity management is expected to be ‘adaptive’. This means there should be continuous monitoring of success, and the plan should be flexible to allow changes to the approach, depending on the on-going achievements or setbacks in the field.

According to the ESMP timetable, the Biodiversity Management Plan shall be in place at least one month prior to the EPC mobilising to the field, and will remain operative through the pre-construction, construction, inundation and operational phases of the project. □

The BMP will be implemented by the SPC, and it is anticipated that SPC will require support from expert ecologists / biologists and possibly community groups from the project area.

4. RESPONSIBILITIES

Organisation	Responsibility
BMP Consultant	As described in this scope of work.
SPC	Oversee the scope of work □ Ensure that the plan is undertaken in accordance with the ESMP. Attend training. □ Supervise BMP implementation. Update the ESMP to be consistent with the Biodiversity Management Plan. Update the relevant sub-plans, for which they are responsible, that have links with the Biodiversity Management Plan. Operate in accordance with the Biodiversity Management Plan.
TRHDP PO	Review draft plan. Ensure that the plan is undertaken in accordance with the ESMP. Attend training. Monitor BMP implementation.
HEC	Update the relevant sub-plans they are responsible for that have links with the final Biodiversity Management Plan. □ Attend training. □ Operate in accordance with the Biodiversity Management Plan.
Solomon Power	Participate in stakeholder meetings. □ Receive copies of the Biodiversity Management Plan.

5. □ SCOPE OF WORK

There are five key outputs in this scope of work as follows:

1. Complete an Issues and Options report based on a site visit and review of previous studies and other background materials. □
2. Prepare a Biodiversity Management Plan based on good international industry practice and strengthened through stakeholder and community consultation. □
3. Provide detailed information in a technical report to update the ESMP and other relevant environmental and social protection sub-plans so that they are consistent with the Biodiversity Management Plan. □
4. Deliver training on the Biodiversity Management Plan, and provide training materials for future training events. □
5. Provide materials to support awareness raising and community engagement.

5.1. ISSUES AND OPTIONS REPORT

Complete an “Issues and Options Report” that is based on the following activities:

- Review background documents and raw data from previous flora and fauna surveys and studies in the project area, and the ESIA. In particular analyse data and recommendations made in the ESIA (TRHD PO 2016) and fish habitat evaluations (Jowett 2016). □
- Project site visit (2 – 3 days) – At least one field trip to site by relevant members of the team is anticipated to become familiar with the environmental setting. No additional field-work or primary data gathering is anticipated. □
- Stakeholder consultation – with the support of TRHD PO’s Community Liaison Assistant, identify and meet with key stakeholders, including relevant agencies, and conservation and wildlife NGO’s. The purpose is to gather information, identify relevant skills and resources in the Government and NGO sector and to establish a

multi-sector stakeholder group (or work with TRHDP-PO's existing stakeholder groups). □

- Prepare a list of issues and options for biodiversity management, and the rationale, costs, complications and benefits of each option. □
- Prepare clear recommendations on practical, achievable approaches to meet the objectives of the Biodiversity Management Plan. □

5.2. BIODIVERSITY MANAGEMENT PLAN

Prepare a BMP based on the recommendations of the Issues and Options Report, including:

- Community consultation – assist SPC/TRHDP PO to run a series of meetings with interested community groups and leaders to inform them of the BMP, seek their input into biodiversity management, and consider development of a community group that could be engaged in the implementation of the plan. □
- Forest mapping using satellite imagery where appropriate to link the BMP to the Forest Clearance Plan and/or to monitor changes in forest cover in the upper catchment.¹ This measure should be implemented in close consultation with SIG.
- Minimum required mitigation measures – should be equal to, or have higher standards than, the mitigation measures listed in the TRHDP ESMP. A table providing an overview of minimum measures applicable during the operations period is provided at Annex 1. This table should be read together with the ESIA and ESMP.
- Establish an invasive species management program.
- Consideration for whether reservoir-operating rules in the Reservoir Management Plan need to be adjusted to consider biodiversity issues, given the size and volume of the proposed reservoir.
- Provide clear instructions as to how the BMP will be monitored, evaluated and updated, since it represents an 'adaptive management' approach. □
- Using the Adaptive Management process as a guide, develop an appropriate and detailed methodology and program for managing the key biodiversity issues. This should include (but is not limited to):
 - A clear strategy for biodiversity management, with objectives and policies. □
 - Organisation of the stakeholder group – who will be involved, their roles and responsibilities, how the group will work, etc.
 - A detailed plan and methodology for consultation and engagement with locals and the construction workforce. □
 - Restoration plan and 'no net loss biodiversity plan' for areas to be returned to their natural state, with maps, planting plans (species, program of planting, source of plants), budgets, etc. □
 - Methodologies for protecting the 'species of interest' and 'habitats of interest'. Detailed methods for translocation (if relevant), protection measures during construction and operation, including a program, required expertise and resources, schedules and budgets for each species / habitat. □
 - Detailed design of trap and haul system for upstream migration
 - Detailed monitoring programmes and budgets, including Algae Macro-invertebrate and Fish Monitoring Plan. □
 - Scope of works for completing further studies, including baseline and follow-up algae and macro-invertebrate studies, study of the efficacy of fish passage during

¹ Imagery with 10-m resolution may be available from the European Space Agency.

operation and potential need to adjust operation of fish passage facilities or redesign, etc. □

- An overall program showing critical paths and key milestones, acknowledging the project's overall construction and operational program. □

As a minimum, the BMP should be structured as follows:

- Executive Summary
- Methodology
- Biodiversity Context
- Priority Biodiversity Features
- Biodiversity Objectives and Targets
- Recommended Management Actions (legal requirements; biodiversity actions; responsible parties; etc.)
- Implementation Mechanism
- Monitoring and Surveillance (including adaptive management process)
- Budgets and Timelines
- Internal and External Reporting
- References
- Appendices (maps; photo documentation; etc.)

5.3. INSTRUCTIONS / INFORMATION FOR UPDATING ESMP AND SUB-PLANS

Provide instructions and / or detailed information necessary to update relevant sections in the TRHDP ESMP framework, and related sub-plans, and to the overall project plan that may affect, or relate to, the BMP, such as:

- Key milestones and critical paths for the project program (particularly with regard to land clearance, significant earthworks, and reservoir filling). □
- Monitoring data, methodologies, and programs. □
- Construction mitigation measures that relate to biodiversity management. □

Tasks may include:

- Preparing a technical report with clauses and sections to be inserted into the ESMP framework and sub-plans. □
- Meetings, presentations and / or workshops with TRHD PO, KWater (EPC Contractor) and construction contractors to explain and discuss the cross-overs with the ESMP and sub-plans. □

The relevant sub-plans which may be influenced by the BMP include:

- Operation and Maintenance Plan
- Emergency Preparedness Plan
- Cultural Heritage Management Plan
- Community Health and Disease Vector Management Plan
- Construction Environmental and Social Management Plan (CESMP)
- Influx Management Plan
- Waste Management Plan

- Hazardous Materials Management Plan
- Spill Prevention and Emergency Response Plan
- Forest Clearance Plan
- Watercourse Crossing Management Plan
- Spoil and Topsoil Management Plan
- Drainage, Erosion and Sediment Control Plan
- Reservoir Preparation Plan
- Drill and Blast Management Plan
- Accidents and Malfunctions Plan
- Air Quality Management and Dust Control Plan
- Stormwater Management Plan
- Point Source Pollution Management Plan
- Post-construction Rehabilitation and Revegetation Plan
- Operations Environmental and Social Management Plan (OESMP)
- Reservoir Management Plan
- Suspended Sediment Monitoring Plan
- Water Quality Monitoring Plan

5.4. TRAINING

Provide training and materials for a training program, including:

- Deliver at least four training sessions as follows:
 - TRHDP PO and KWater (EPC Contractor) environmental staff and senior project managers
 - Contractors' environmental staff and senior project managers
 - Two 'Training the trainers' workshops
- Develop a training module (presentation slides, hand outs, notes for the trainers, etc.) for TRHDP PO, KWater and the Contractors to use to train their staff on the issues and how to implement the BMP.

5.5. COMMUNITY CONSULTATION AND ENGAGEMENT

Prepare community consultation and engagement materials. Develop an ongoing awareness and community engagement campaign for SPC to deliver. Written materials, methodology, communication methods and delivery program.

6. DELIVERABLES

The following deliverables will be provided under the BMP contract:

- Issues and Options report.
- Biodiversity Management Plan

- Training module for Biodiversity Management Plan
- Three training workshops completed
- Technical report recommending relevant changes to the ESMP and other sub-plans.

NOTE: The BMP report should be presented by the Consultants in a draft form to a meeting of SPC and TRHD PO staff (which may also be attended by World Bank representatives) within two weeks of submission of the report. A final report shall be prepared based on comments and recommendations received during the meeting.

7. INDICATIVE PROGRAM

There is some urgency with the timeframe to ensure that the BMP is operative prior to mobilization of the EPC Contractor, and especially before mobilization of the contractor that will construct the access road. An indicative program is provided below:

Indicative deliverable / output	Details	Estimated timeline from engagement
Kick off meeting	Meet with SPC, TRHD PO and World Bank representatives to confirm the program, deliverables, outputs, information requirements, site visit logistics, etc.	1 week
Stakeholder consultations	As required throughout the program, but at least one to be completed prior to the Issues and Options Report.	2 weeks
Site visit	Familiarity site visit to project area.	2 weeks
Issues and Options report	Report discussing issues and options for biodiversity management, and clear recommendations for the BMP.	3 weeks
Community consultation	Engage with community leaders and local groups and consult about the BMP, if required.	4 weeks
Draft BMP and technical report	A draft BMP with detailed program and methodology and draft budgets. □ Draft technical report outlining recommendations for updates to the ESMP framework and other sub-plans.	2 months
Draft training module materials	Proposed training method, list of potential attendees, location, logistics, training materials (draft slides, hand outs, notes for trainers, etc.)	2.5 months
Final BMP and technical report	Final BMP encompassing comments from SPC, TRHD PO, World Bank, and other key stakeholders.	3 months

Four training workshops completed.	Training environmental staff and senior project managers. Training trainers.	4 months
Awareness campaign	Develop an ongoing awareness and community engagement campaign for SPC to deliver, including preparation of materials and delivery program.	4.5 months

8. EXPERTISE REQUIRED

Experts must have international experience in the protection and restoration of forest habitats, in particular experience with the species listed in this TOR, and with the lowland and montane forest habitats of Guadalcanal, Solomon Islands. The consultants will form a team they consider appropriate for the tasks in the TOR. **One individual may have the expertise to carry out more than one role or all roles.** The following table is intended to be a guide of the possible core team.

Team member	Minimum experience	Role
Lead ecologist (1) / Project Manager	15 years of ecological assessment and / or conservation ecology; □Project Management experience; experience preparing Biodiversity Management Plans; experience working in the Solomon Islands; at least 10 years' experience working internationally.	Manage the team. □Control the preparation of the reports. Lead contact with SPC. □Coordinate meetings. □Coordinate training workshops. Manage quality reviews.
Terrestrial fauna biologist / forest ecologist (1)	7 years' experience in the conservation of terrestrial fauna ecosystems found in tropical forests of South Pacific Islands. Experience with invasive fauna management.	Provide advice and recommendations on the management and protection of terrestrial fauna (amphibians, reptiles, mammals), and forest habitats.
Avifuna biologist / ecologist (1)	7 years' experience in the conservation of birds in tropical ecosystems of South Pacific Islands.	Provide advice and recommendations on the management, protection and restoration of bird habitat.
Aquatic biologist / ecologist (1)	7 years' experience in the conservation of aquatic ecosystems of South Pacific Islands	Provide advice and recommendations on the management of riverine ecosystems, fish passage facilities using adaptive management processes.

Annex 1 – Overview of ESMP Biodiversity Management Measures during Operations

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
1	All	All	Preparation of Operational E&S Plans (to be finalised pre COD). Many plans will have been developed by EPC Contractor and can be amended for operations. This will comprise the Operations Environment and Social Management Plan (OESMP) and a number of sub-plans.	O&M Contractor	PO, MECDM, WB and ADB	Plans finalised	n/a	n/a	Plans available to and understandable by all project staff and contractors two months prior to COD.
2	All	All	Implement adaptive management, using data from monitoring to revise Action and Management Plans over time as necessary. Review of Plans necessary where any KPIs in this BMP or other Plans are not met.			Records of review and adaptive management	At least annual	Report on review of Plans and any changes made	Each unmet KPI addressed by review and change of relevant Plans within four weeks

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
3	All	All	Environmental and social safeguards management specialist with relevant experience engaged by the SPC (SPC ESS Specialist) to ensure that all general mitigation measures are implemented	SPC	TRHDP PO	Appointment of qualified SPC ESS Specialist; records and reports of that specialist	Audits by PO ESS Specialist three times/year	Incident reporting log of SPC ESS Specialist; monthly reports; audit reports by PO ESS Specialist	SPC ESS Specialist appointed. Audits reveal no significant non-compliances
4	All	All	Environmental and social safeguards specialist with relevant experience engaged by the Project Office (PO ESS Specialist) to audit implementation of mitigation measures three times/year	TRHDP PO		Appointment of qualified PO ESS Specialist. Audits conducted three times/year	n/a	Audit reports	PO ESS Specialist appointed.

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
5	All	All	New Employee Induction Training (undertaken on average once per year, this will vary depending on staff turnover), including Wildlife Protection			Training records	At least annual	Training records	Every employee undergoes induction within six months of hiring; induction tests demonstrate new employees learning key wildlife rules
6	All	All	Community Consultation and Grievance - Community Liaison Committee meetings and management - Community Awareness and Consultation Meetings These consultations will cover ESMP communication requirements including encroachment of invasive flora and fauna			Records of consultations	At least quarterly initially, at least bi-annually after first year of operations or more often as grievances require	Consultation records	All biodiversity-related grievances fully addressed within six months

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
7	Aquatic	Aquatic	Fish, algae and macro-invertebrate monitoring (both upstream and downstream, with at least eight consistent sample stations in the Tina, Toni and Ngalimbiu areas)			Monitoring reports		Monitoring reports	Monitoring of sufficient depth and quality to provide information needed for other KPIs (e.g., activities 11-12)
8	Aquatic	Aquatic	Water quality monitoring: - at the environmental flow outlet of the dam - in the by-passed river reach (i.e., upstream of the powerhouse), and - downstream of the powerhouse, for the key pollution indices. Weekly for the first 2 to 3 months following commissioning, then quarterly for the first year, followed by annually when annual testing is conducted of the project electro-mechanical systems.			Monitoring reports		Monitoring reports	Monitoring of sufficient depth and quality to provide information needed for other KPIs

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
9	Aquatic	Aquatic	Flow monitoring			Monitoring reports	At least monthly	Monitoring reports	Monitoring of sufficient depth and quality to provide information needed for other KPIs (e.g., activities 11-12)
10	Potential for project impacts on White-eyed Starling	Potential for project impacts on White-eyed Starling	Low-level surveillance monitoring for presence of White-eyed Starling, via posters offering reward for confirmed live sightings and awareness raising with local community			Monitoring records of SPC ESS Specialist	Ongoing	Monitoring records of SPC ESS Specialist	Community aware of SPC's interest in species' presence

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
11	Reduced Flow Between Dam and Powerhouse	Impacts of changes of flow downstream of dam on aquatic life	Maintain a minimum environmental flow of 1 m ³ /s at all times in the bypassed section of river between the dam and power station, in line with Environmental Flows Management Plan	Developer	TRHDP PO	Flow, fish, algae and macro-invertebrate monitoring	At least annually; monthly in early stages of project	Project and consultant monitoring reports	Environmental flow of 1 m ³ /s maintained at all times in bypassed section; Fish in the Tina River remain at >90% of original quantity, all original species are retained, and diversity does not change by >10%

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
12	Reduced Overnight Flow	Impacts on aquatic life of reduced flow	Maintain a minimum flow of 3.4 m ³ /s flow below the power station during overnight reservoir refill. One option for achieving this is to maintain the 1m ³ /s environmental flow and continue to run 2.4m ³ /s through the power generators. Actions to be in line with Environmental Flows Management Plan	Developer	TRHDP PO	Flow, fish, algae and macro-invertebrate monitoring (both upstream and downstream, with at least eight consistent sample stations in the Tina, Toni and Ngalmibi areas)	At least annually; monthly in early stages of project	Project and consultant monitoring reports	Minimum flow of 3.4 m ³ /s maintained below power station overnight; Fish in the Tina River remain at >90% of original quantity, all original species are retained, and diversity does not change by >10%

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
13	Reduced Sediment Transport	Impact of reduced sediment transport on aquatic life	Flushing to be undertaken periodically. An outlet of 3x3m is proposed near the power intake at 160masl. Once sediments reach this level, the outlet will be used either for local flushing or for lowering the reservoir to permit dredging/excavating of accumulated sediments. Any flushing should be within the bounds of flows associated with natural flash floods in this river	Developer	TRHDP PO	Water quality monitoring, including for suspended solids downstream	At least annually; monthly in early stages of project	Project and consultant monitoring reports	Fish in the Tina River remain at >90% of original quantity, all original species are retained, and diversity does not change by >10%

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
14	Introduction of invasive species to the reservoir	Accidental or deliberate introduction of non-native plants, fish or other species to the reservoir, with potential to affect all aquatic biodiversity	Monitoring for, and immediate removal of, all non-native species to avoid their spread			Monitoring of invasive plant and animal species (inc. Water Hyacinth) to assess presence in the reservoir and quick response if found	Twice-yearly	Monitoring records of SPC ESS Specialist, and records of any necessary removal actions taken	No invasive species persist within reservoir for more than a month

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
15	Barrier to Fish Passage	Barrier to passage of migratory fish species	Implement a trap and haul system in accordance with Appendix G of the ESIA and Fish Passage Plan	Developer	TRHDP PO	Fish monitoring in accordance with a fish monitoring plan to be prepared by the Developer in accordance with section 13.3.3.3.	According to fish monitoring plan	Project and consultant monitoring reports	Migratory fish above and below dam remain at >90% of original quantity, all original species are retained, and diversity does not change by >10%

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
16	Fish Entrainment	Barrier to passage of migratory fish species	Increase the normal operating level to near full supply level, during the first month of the wet season, to facilitate the downstream movement of adult eels over the spillway during floods. The loss of generation resulting from increasing spill would be partially offset by the increased generation from the extra head on the turbines	Developer	TRHDP PO	Fish monitoring in accordance with a fish monitoring plan to be prepared by the Developer in accordance with section 13.3.3.3; flow monitoring during first month of wet season.	At least quarterly (according to fish monitoring plan).	Project and consultant monitoring reports	Migratory fish above and below dam remain at >90% of original quantity, all original species are retained, and diversity does not change by >10%
17	Fish Entrapment	Barrier to passage of migratory fish species	Install 15-25 mm screens in front of the intake structure to prevent the ingress of large eels	Developer	TRHDP PO	Screens installed; maintenance records	At least annually	Monitoring records of SPC ESS Specialist	Screens maintained in fully working order

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
18	Road Access	Induced increases in human access upstream, with potential for increased degradation/loss of all biodiversity	Extension of Black Post Road from Mangakiki to dam site to remain a private access road that will be gated. Access will be restricted by the Project Company and the TCLC to local population and hydropower facility operator. Commercial logging trucks will be prohibited.	SPC and Tina Core Land Company	TRHDP PO	Register of permissible vehicles; gate access logbook	Ongoing	Register of permissible vehicles; gate access logbook	Zero vehicles beyond access gate, other than those registered as permissible
19	Road Access	Induced increases in human access upstream, with potential for increased degradation/loss of all biodiversity	A settlement policy will be developed and implemented with the assistance of the TCLC. The settlement policy will include enforcement measures to prevent the use of the land for a workers camp. It will also address restrictions on the use of the private project road through the Core Area by people seeking to build new settlements beyond the Core Area.	SPC	TRHDP PO	Settlement policy	n/a	n/a	Settlement policy established.

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
20	Road Access	Induced increases in human access upstream, with potential for increased degradation/loss of all biodiversity	The TCLC and Developer will not permit anyone to live or construct housing within the land leased for the project, except where strictly necessary for project activities, including housing for rangers or security staff.		TRHDP PO	Monitoring records of SPC ESS Specialist; incident reporting systems	At least monthly	Monthly mitigation monitoring reports; incident reporting logbook	Zero violations of settlement policy
21	Road Access	Spread of invasive species along project roads	Regular live trapping and removal of non-native rats and feral cats from the project area; incidental monitoring of project area for other invasive species by SPC ESS Specialist		TRHDP PO	Reports of consultants	Monthly live trapping sessions; ongoing monitoring	Consultant reports of trapping sessions; incident recording system	No increase in occurrence of non-native rats or feral cats over time

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
22	Road Access	Direct mortality of wildlife from vehicles	Vehicle speed limits will be controlled along the access roads, to ensure that drivers are able to prevent running over wildlife that may be lying on, or crossing, the access road	Developer	TRHDP PO				Zero incidents of vehicles exceeding speed limit or of wildlife mortality on project roads
23	Vegetation and Forest Clearance during Transmission Line Maintenance	Spread of invasive species	Training will be conducted for Solomon Power or its contractors to ensure workers clearing the transmission line identify and leave low-level native vegetation to prevent spread of invasive weeds	Solomon Power	TRHDP PO	Monitoring records of SPC ESS Specialist; training records	At least quarterly	Quarterly mitigation monitoring reports; training records	Complete adherence to established guidelines on maintaining native vegetation

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
24	Workers Affects on Fauna	Harm to wildlife (e.g. killing of snakes)	Workers and contractors prohibited from harming wildlife. Workers to receive wildlife awareness training informing them of the requirement to request the project's environmental specialist capture and remove animals that are either in danger or are dangerous to construction workers	Developer	TRHDP PO	Monitoring records of SPC ESS Specialist and incident reporting system; training records	Patrols of project area at least monthly	Monthly mitigation monitoring reports; incident reporting logbook; training records	Zero incidents of harm to wildlife by workers/contractors
25	Lighting Disturbance	Disturbance to, and disorientation of, wildlife	Regular use of artificial lights during operational period shall be avoided	Developer	TRHDP PO	Monitoring records of SPC ESS Specialist	At least monthly	Monthly mitigation monitoring reports	No lights regularly used during operational period

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
26	Transmission Line Operation	Collision and electrocution risk for bats, birds and marsupials	Metal shields to be installed on wooden power poles in forested areas to prevent Cuscus from climbing poles and becoming electrocuted. Best-practice design and mitigation (e.g., APLIC or BirdLife) to be applied for the powerline	Solomon Power	TRHDP PO	Monitoring records of SPC ESS Specialist	At least quarterly	Quarterly mitigation monitoring reports; incident reporting logbook	All mitigation still installed and intact; zero incidents of animal collisions or electrocutions as a result of the powerline
27	Harvesting by Workers	Overfishing, overhunting, and overcollecting	Workers and contractors prohibited from fishing in the Tina River, hunting in the watershed, and collecting plants (other than at personal traditional levels out of work hours)	Developer	TRHDP PO	Monitoring records of SPC ESS Specialist and incident reporting system	At least monthly	Monthly mitigation monitoring reports; incident reporting logbook	Zero incidents of fishing, hunting and collecting of plants by workers/contractors (other than at personal traditional levels out of work hours)
28	Temporary loss of habitat	Terrestrial	Post-construction rehabilitation			Gains in extent and quality of forest, measured by monitoring	At least annually	Rehabilitation monitoring reports	Gains in extent x quality of forest sufficient to compensate for temporary project impacts

No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
29	Permanent loss of habitat	Terrestrial	Offset through rehabilitation of at least 9.5 ha of modified habitat within the Project Area			Gains in extent and quality of forest, measured by monitoring	At least annually	Offset monitoring reports	Gains in extent x quality of forest on track to meet defined rehabilitation targets (e.g., gain of 5 Quality Hectares over 20 years)
30	Permanent loss/ degradation of forest	Terrestrial	Offset of 12,500 ha in upstream watershed (details on second tab)			Averted losses of forest, measured by monitoring in comparison to control areas	At least annually	Offset and control site monitoring reports and audits	Averted loss of forest extent / quality sufficient to compensate for residual project impacts
31	Potential for permanent loss/ degradation of Tina River	Aquatic	Offset on the Toni River if monitoring demonstrates residual project impacts on the Tina River (details on third tab)			Gains in quality of Toni River, measured by monitoring	At least annually	Offset monitoring reports and audits	Restoration of aquatic extent x quality sufficient to compensate for residual project impacts

1	All	All	<p>Preparation of Operational E&S Plans (to be finalised pre COD). Many plans will have been developed by EPC Contractor and can be amended for operations This will comprise the Operations Environment and Social Management Plan (OESMP) and include the following subplans:</p> <ul style="list-style-type: none"> • Biodiversity Action Plan • Emergency Preparedness Plan • Disease Vector Management Plan • Stormwater Management Plan • Project Decommissioning Plan • Hydrocarbon Management Plan • Health and Safety Plan • Stakeholder Engagement Plan • Accidents and Malfunctions Plan • Grievance Mechanism Plan • Spill Prevention and Emergency Response Plan • Traffic Management Plan • Waste Management Plan • Hazardous Materials Management Plan 			Plans finalised	n/a	n/a	Plans available to and understandable by all project staff and contractors by DATE .
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No	Impact	Key Biodiversity impact	Measure or Activity	Implementing Actor	Oversight Actor	Means of Verification	Timing and Frequency of Monitoring	Reporting Requirements	KPIs
			<ul style="list-style-type: none"> • Safety Management Plan • Wildlife Management Plan 						
2	All	All	Implement adaptive management, using data from monitoring to revise Action and Management Plans over time as necessary. Review of Plans necessary where any KPIs in this BMP or other Plans are not met			Records of review and adaptive management	At least annual	Report on review of Plans and any changes made	Each unmet KPI addressed by review and change of relevant Plans within four weeks

Appendix Q

Critical Habitat Assessment

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Appendix Q

Critical and Natural Habitat assessment, impacts, mitigation, and monitoring

John Pilgrim

May 2017

1 Executive Summary

This rapid review addresses the specific concerns of the Asian Development Bank (ADB) Safeguard Policy Statement (2009) in relation to Critical Habitat and Natural Habitat, so far as these are not already dealt with in the main ESIA.

A Critical and Natural Habitat assessment, based on information in the ESIA, finds that **the project is situated within a watershed containing substantial Natural Habitat**, comprising both undisturbed and disturbed/remnant forests as well as the Tina River and its tributaries (Section 2.4 & Figure 1).

The undisturbed (both lowland and montane) forests in the watershed are globally restricted as an ecosystem type and hold a particularly unique assemblage of species. This, their recognition as part of a Key Biodiversity Area, Important Bird Area and proposed World Heritage Site, and their importance in providing ecosystem services for local communities, mean that **the upper and outer forests of the Tina watershed qualify as Critical Habitat** (Section 2.3.4 & Figure 1). **Two restricted-range bird species (Guadacanal Boobook and Black-headed Myzomela) and one reptile (Guadacanal Bow-fingered Gecko) also appear to qualify the Tina watershed as Critical Habitat** (Section 2.3.2).

Direct impacts on this Critical Habitat appear to be non-significant, given the remaining extent of high quality forest on Guadalcanal (Section 3.1.1 & Table 1). **Nonetheless, significant risks remain of induced increases in clearing of upper watershed forest.** These will need to be carefully managed.

It is possible that the Endangered King Rat and White-eyed Starling might also remain undetected in the area (Section 2.3.1) and – if present – would also qualify it as Critical Habitat (Section 3.1.2). Further, the identification of a number of fish species remains in question (Section 2.3.2). These might possibly represent restricted-range species or species new to science, both of which are likely to qualify the Tina River as Critical Habitat. **It is a priority to resolve identification of unidentified fish species collected during ESIA surveys, to assess whether the project impacts Critical Habitat for those species and – if so – to plan additional mitigation** (Section 3.3) and, if necessary, offsets (Section 4.3).

Direct and indirect impacts on Natural Habitat are small, but not insignificant (Section 3.2 & Table 2). Mitigation has been systematically identified in order to minimize impacts, but residual impacts will necessarily require offsets. An ambitious offset program has been proposed, in order to compensate for project residual direct and indirect impacts (Section 4.1 & Table 2) on terrestrial Critical and Natural Habitat. Despite considerable uncertainties and major (albeit largely precautionary) assumptions, **it appears very likely that the proposed offset would – if successfully implemented – allow the project to achieve No Net Loss for terrestrial biodiversity** (Section 4.2). The proportion of the costs of establishment and implementation of this conservation program covered by the project will need to be sufficient

to generate and sustain biodiversity gains necessary to offset residual project impacts. These costs are likely to be high relative to the overall project budget (ESIA Section 2.4).

Key areas of monitoring necessary to assess changes in the state of biodiversity, changes in threats to this biodiversity, and progress of project mitigation/offsets are outlined in Table 3 (Section 5).

2 Critical and Natural Habitat Assessment

2.1 Summary of Results of Critical and Natural Habitat Assessment

The ADB Safeguard Policy Statement (ADB 2009) requires assessment of whether the project is planned in an area that may qualify as Critical Habitat or Natural Habitat. This assessment followed more detailed guidance in International Finance Corporation Performance Standard 6 and its accompanying guidance note (IFC 2012a, 2012b). A broad terrestrial area and a relatively long freshwater area were considered, to incorporate all potential project impacts (Figure 1).

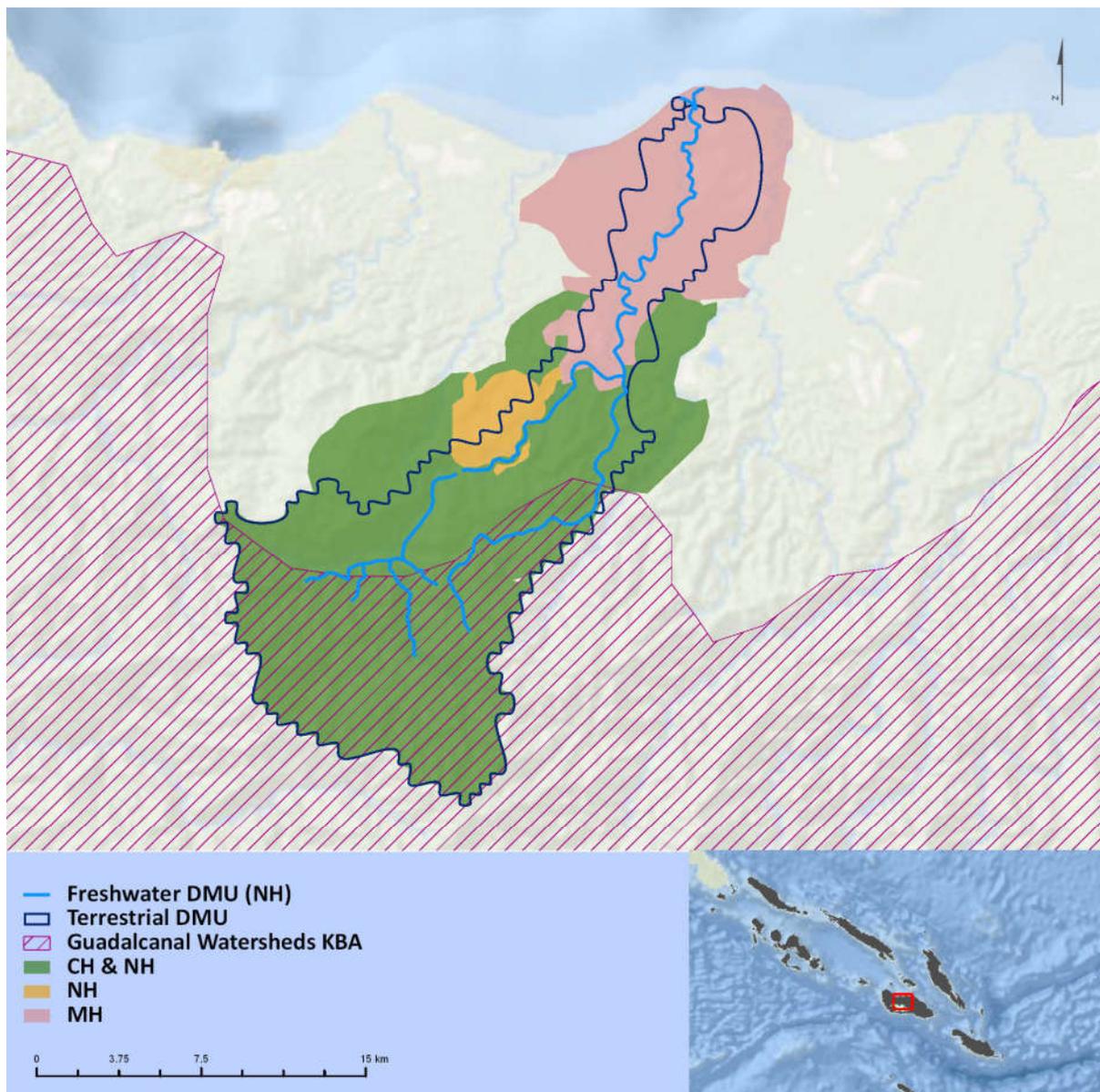


Figure 1. Map of discrete management units, showing areas of Critical, Natural and Modified Habitat (based on land use mapped in ESIA Figure 6-12)

Downstream from the project, large areas of Modified Habitat exist, owing to intensive logging and small-scale agriculture – as well as widespread incursion of invasive species. Despite some logging, the project area and surrounds have retained forest cover and basic ecological integrity, and can be considered to largely comprise Natural Habitat. The upper and outer watershed, upstream from the proposed dam location and further down away from the river itself, remain largely undisturbed and represent Critical Habitat. The freshwater area appears to have retained most of its original ecological functionality, despite extensive fishing and household use by communities, and the Tina River and its tributaries can thus be considered Natural Habitat.

There is not currently evidence that any species present in the project area or surrounds qualify the area as Critical Habitat. It is, nonetheless, apparent that some threatened species might remain undetected in the area and – if present – would qualify it as Critical Habitat. The project should thus continue low-level monitoring for these species (King Rat and White-eyed Starling). On a precautionary basis, the project can best manage these unknown risks by acting as though the area might be Critical Habitat for these two species, and so ensuring that appropriate mitigation and offset measures are in place. Further, concern remains that some fishes collected during the ESIA may represent undescribed species which could qualify the project area as Critical Habitat. These represent a significant risk to the project, and the project should pursue accurate identification of collected fish specimens as soon as possible, in order to verify the situation.

More broadly, as well as providing a number of important ecosystem services to local communities, natural forests in the Tina Watershed can be considered Critical Habitat owing to the limited global extent of this forest ecosystem type and the particularly unique nature of the species' assemblage it supports.

2.2 Discrete management units

Critical Habitat and Natural Habitat assessment ideally takes place across sensible ecological or political units that are sufficiently large to encompass all direct and indirect impacts from the project. These areas of assessment, referred to as 'discrete management units' (DMUs) are thus often much broader than the direct project footprint. DMUs may be separate or combined, depending on the ecology of the biodiversity concerned.

As outlined in Section 2.3, the species of concern in this area are freshwater fish, birds and mammals. Birds and mammals are likely to be impacted by a hydropower project in similar ways (e.g., direct terrestrial footprint, induced clearance) and so are considered together. The Tina River watershed (including the Toni) forms a relatively discrete ecological unit, and is likely to be the focus of any project-related direct and indirect impacts. This watershed was thus taken as an appropriate terrestrial DMU, covering approximately 243 km². Given the potential for project impacts both upstream (e.g., blocked fish migrations) and downstream (e.g., owing to altered flows) of the dam, and the interconnected nature of freshwater ecosystems, the whole Tina River and its tributaries were considered together as one freshwater DMU. These two discrete management units, with mapped areas of Critical, Natural and Modified Habitat, are outlined on Figure 1.

Identification of these 'discrete management units' does not mean that the project has management obligations across them. The aim of this Critical and Natural Habitat Assessment is to identify whether the broad units qualify as Critical Habitat and, if so, for what biodiversity features. This information helps to prioritise impact assessment and to focus mitigation efforts.

2.3 Assessment of biodiversity which may qualify the area as Critical Habitat

Each of the following sections considers candidate Critical Habitat-qualifying biodiversity identified within the ESIA as actually or potentially present. In each case, reasons are identified for each biodiversity feature likely meeting or not meeting Critical Habitat. Two categories of biodiversity that might qualify the area as Critical Habitat were only considered briefly here, and should be assessed further by social experts – specifically areas that provide key ecosystem services and areas with biodiversity that has significant social, cultural or economic importance to local communities.

2.3.1 Critically Endangered and Endangered species

Only species assessed globally by IUCN are included here, since there is no national Red List. Species are included if they were found during surveys, or there is indication of their presence from literature.

Emperor Rat (*Uromys imperator*)

This globally Critically Endangered species is only known from northern Guadalcanal. There have been no confirmed sightings since the last specimen was collected in 1888, although local sightings reported by Flannery (1995) suggest that the species' range receded to higher mossy forest and that it persisted there until at least the early 1960s. It appears that this species was largely terrestrial, and so invasive species (e.g., predation from feral cats or disease from introduced rats) may thus have had significant impacts on the species' range and distribution. Even if the species is not yet globally Extinct, it seems unlikely that the project area continues to hold this species, given that it is partially degraded and already significantly impacted by invasive species. The discrete management unit thus does not qualify as Critical Habitat for Emperor Rat.

King Rat (*Uromys rex*)

This species is globally Endangered, and only known from a small number of records. In contrast to the Emperor Rat, this species is arboreal and thus more likely to be able to resist impacts from (more terrestrial) invasive species. Although likely to prefer primary forest, it has been recorded relatively recently (in 1988) even from a patch of remnant forest close to Honiara (Flannery 1995). In 1989, two individuals were captured at 600m elevation at Gold Ridge, very close to the project. A local hunter (per Kevin Jeanes, December 2016) reported the species was last seen in the Tina catchment in the 1980s. Relatively recent records in and near the project area, and some apparent tolerance of the species to forest fragmentation and invasive species, suggest that the King Rat may still persist in the project area. The absence of records on project surveys should not be taken as evidence of the species' absence, since it is extremely difficult to survey for rare, nocturnal, arboreal rodents.

The species' area of occupancy is considered to be less than 500 km² (Helgen *et al.* 2016). The discrete management unit includes about 192 km² of forest which might be considered Natural Habitat and thus potentially suitable for this species. On a precautionary basis, and given that the population distribution of this species is not well understood, this watershed could thus potentially be considered of significant importance to the King Rat, and the loss of the area could potentially impact the long-term survivability of the species. On such a precautionary basis, the area would qualify as Critical Habitat for King Rat (IFC 2012, Criterion 1d). In the absence of any evidence of its presence, however, it seems over-precautionary to treat the area as Critical Habitat for the species. It is thus recommended that the area should not be considered as Critical Habitat for the species, but ***the project should act as though the area might be Critical Habitat for King Rat and so ensure that appropriate mitigation and offset measures are in place.***

White-eyed Starling (*Aplornis bruneicapillus*)

This Endangered bird occurs rarely and patchily on at least Guadalcanal, Choiseul, Rendova and Bougainville, but is very poorly-known and may occur more widely. While the species does appear to have some reliance on primary forest for nesting (in colonies in trees with high epiphyte cover), it also regularly feeds in semi- and heavily-degraded areas, where small fruit trees provide abundant food (Guy Dutson, *in litt.* 2017; Chris Filardi, pers. comm. 2017). While project surveys did not detect the species, it is not always easy to find during field surveys even when present (Chris Filardi, pers. comm. 2017), is most regularly observed nearby (at Mount Austen, around five miles from the project site), and appears to have seasonal or interannual movements which are not yet understood. There is thus potential for the species to use the project area, for example on a seasonal or periodic basis in response to fruit availability. In the absence of any evidence of its presence, it is recommended that the area should not be considered as Critical Habitat for the species. It would, however, be advisable to put in place some adaptive management by implementing low-level monitoring for the species over the project lifetime, and help to protect nesting colonies should they be located in the project area.

2.3.2 Endemic or restricted-range species

Following the IFC PS6 Guidance Note (IFC 2012b), species were considered restricted-range if their global extent of occurrence was 50,000 km² or less (for terrestrial vertebrates) and 20,000 km² or less (for freshwater fish). Species are included if they were found during surveys, or there is indication of their presence from literature. 'Endemism' *per se* was not considered – this can be a useful approach for species such as plants for which distributions are poorly known, but is less useful for better-known vertebrate species (many of which, in the Solomon Islands, are endemic to just several islands). Based on current knowledge, none of the plant species observed during ESIA surveys appear to have a restricted-range (the most restricted being *Palaquium firmum*, potentially endemic to the Solomon Islands, and *Syzygium onesima*, which appears to be restricted to the eastern Papua New Guinea islands and the Solomon Islands).

Solomons Flying Fox (*Pteropus rayneri*)

This Near Threatened bat species has an extent of occurrence of 29,500 km². It is known from the project area, and occurs more widely across the Solomon Islands – as well as on Bougainville and Buka in Papua New Guinea (Hamilton & Leary 2008). While this is a restricted-range species, it is still relatively widespread and the project DMU is too small in its entirety to hold 1% of the species' global population. This species thus does not qualify the project area as Critical Habitat.

Guadalcanal Rail (*Hypotaenidia woodfordi*)

Guadalcanal Rail is a Near Threatened bird known only from Guadalcanal, with an estimated range of 6,500 km² (BirdLife International 2017a). It occupies grassland and thickets up to c. 600 m elevation (Dutson 2011). The project DMU contains c. 51 km² of Modified Habitat, of which a subset (and some degraded Natural Habitat) is likely to be suitable for this species. It thus seems unlikely that the DMU holds more than 1% of the species' global range or population, and thus this species does not qualify the project area as Critical Habitat.

Buff-headed Coucal (*Centropus milo*)

Buff-headed Coucal has a range of almost 47,000 km² and also occurs on several other islands, including New Georgia, Vella Lavella and Rendova (BirdLife International 2017a). It has been observed in the project area, but the Tina Watershed as a whole is too small in comparison to the species' distribution to be likely to hold more than 1% of the population of this species. It thus does not qualify the project area as Critical Habitat.

Guadalcanal Boobook (*Ninox granti*)

Guadalcanal Boobook has been recently recognized as a bird species separate from *Ninox jacquinoti* (BirdLife International 2017a). It is considered Vulnerable and is known only from forests up to 1,500 m elevation on Guadalcanal (BirdLife International 2017a). The project DMU contains c. 180 km² of forest within this elevational range, representing about 3% of the known range of this species. It thus seems quite possible that the DMU holds more than 1% of the species' global range or population, and therefore **it is quite possible that Guadalcanal Boobook qualifies the Tina River watershed as Critical Habitat**. Without further information on the distribution and ecology of this species in the project area, higher quality forest within the project DMU is preliminarily assessed as Critical Habitat for this species (Figure 1).

Black-headed Myzomela (*Myzomela melanocephala*)

This fairly common restricted-range species occurs only on Guadalcanal, including in the project area, and nearby Nggela Sule. It has a range estimated at 10,200 km² (BirdLife International 2017a) and occurs up to 1,550 m elevation (Dutson 2011). The project DMU contains c. 180 km² of forest within this elevational range, representing about 1.7% of the known range of this species. As such, **it is quite possible that Black-headed Myzomela qualifies the Tina River watershed as Critical Habitat**. Without further information on the distribution and ecology of this species in the project area, higher quality forest within the project DMU is preliminarily assessed as Critical Habitat for this species (Figure 1).

Other potentially restricted-range birds

White-eyed Starling is considered a restricted-range species and has the potential to occur in the project area. This species is already assessed in Section 2.3.1.

Another set of observed species were considered restricted-range by Stattersfield *et al.* (1998) but current information (BirdLife International 2017a) clarifies that their extents of occurrence exceed 50,000 km², and they can thus no longer be considered restricted-range. These species comprise Sanford's Sea-eagle (*Haliaeetus sanfordi*); Red-knobbed Imperial-pigeon (*Ducula rubricera*); Crested Cuckoo-dove (*Reinwardtoena crassirostris*); Solomons Corella (*Cacatua ducorpsii*); Yellow-bibbed Lory (*Lorius chlorocercus*); Green Pygmy-parrot (*Micropsitta finschii*); Chestnut-bellied Monarch (*Monarcha castaneiventris*); Solomons Pied Monarch (*Symposiachrus barbatus*); Midget Flowerpecker (*Dicaeum aeneum*); Brown-winged Starling (*Aplonis grandis*); White-billed Crow (*Corvus woodfordi*). A further set of such species were considered potentially present in Appendix D of the ESIA: Melanesian Scrubfowl (*Megapodius eremita*); Yellow-banded Fruit-dove (*Ptilinopus solomonensis*); Pale Mountain-pigeon (*Gymnophaps solomonensis*); Cardinal Lory (*Chalcopsitta cardinalis*); Duchess Lorikeet (*Charmosyna margarethae*); West Solomons Boobook (*Ninox jacquinoti*); Solomon Cicadabird (*Edolisoma holopolium*); White-winged Fantail (*Rhipidura cockerelli*).

Guadalcanal Bow-fingered Gecko (*Cyrtodactylus biordinis*)

This fairly common restricted-range species occurs only on Guadalcanal. It is known from elevations of 300-500 m, rarely lower, and mainly lives on smaller trees and vines in the

understorey of forest (Allison 2013). It appears to have been recorded from the project area, on the basis of local knowledge (ESIA Appendix C). Within the project DMU, there is only about 33 km² of suitable habitat. Nonetheless, given the limited range of this species, this is likely to represent more than 1% of the species' global distribution and population. As such, pending confirmation that the species does occur in the project area, ***it is quite possible that Guadalcanal Bow-fingered Gecko qualifies the Tina River watershed as Critical Habitat.*** Pending further information on the distribution and ecology of this species in the project area, higher quality forest between 300-500 m elevation within the project DMU is preliminarily assessed as Critical Habitat for this species.

Solomons Bent-toed Gecko (*Cyrtodactylus salamonensis*)

This Near Threatened species is stated to have an extent of occurrence of less than 10,000 km² (McCoy 2013), and so qualifies as a restricted-range species. It has not yet recorded from the project area, but does appear to occur nearby (ESIA Appendix C) and so may yet be found in the project area. It is a lowland species, being found in undisturbed and moderately disturbed forests up to 400 m elevation. As such, the Tina Watershed offers relatively little remaining habitat of suitable quality for this species, and is unlikely to hold more than 1% of its population or distribution. This species thus does not qualify the project area as Critical Habitat.

Schmidt's Crocodile Skink (*Tribolonotus schmidti*)

This restricted-range species is listed as potentially present in the project area by the ESIA, based on occurrence nearby (ESIA Appendix C). It is considered very common in forest on Guadalcanal between sea level and 1,500 m (Harlow 2013), so it is surprising that it was not recorded during ESIA surveys. If it does occur in the Tina River watershed, the area may well hold more than 1% of its population or distribution (given that the watershed holds c. 180 km² of Natural Habitat within its elevation range, representing about 3% of the known range of the species). In the absence of any evidence of its presence, however, it is recommended that the area should not be considered as Critical Habitat for the species. In any case, the species does not face any particular threats other than habitat loss, so impacts and necessary mitigation measures would very much reflect those for the forest as a whole. It is thus unclear whether this species qualifies the area as Critical Habitat but, even if it does so, no additional mitigation or offset measures are foreseen to be necessary.

Malukuna Webbed Frog (*Cornufer malukuna*)

This species, sometimes known as *Discodeles malukuna*, is stated by Richards & Parker (2004a) as known only from the vicinity of the type locality, which lies in the upper Tina River catchment. It has since, however, been found on several islands throughout the New Georgia group and may potentially be patchily more widespread in the Solomon Islands (Scott Travers, *in litt.* 2017). It is thus unlikely to qualify as a restricted-range species, or to qualify the area as Critical Habitat.

Faro Island Treefrog (*Litoria lutea*)

This is also considered a restricted-range species by Richards & Parker (2004b) and is listed as potentially present in the project area by the ESIA. It is not clear, however, that this species' extent of occurrence is <50,000 km², and thus whether it actually qualifies as restricted-range. It is thus not considered to qualify the area as Critical Habitat

San Cristobal Treefrog (*Papurana krefftii*)

This species, sometimes known as *Hylarana krefftii*, is stated by Richards & Parker (2004c) as likely to have an extent of occurrence of <20,000 km². It would thus qualify as a restricted-range species. However, as well as being widespread in the Solomon Islands it is known from New Ireland and Buka in Papua New Guinea. While it has a small overall area of occupancy, it thus has an extent of occurrence exceeding 50,000 km² and does not qualify the project area as Critical Habitat.

Restricted-range fishes

Three *Schismatogobius* (*S. cf. ampluvinculus*, *S. cf. marmoratus* and *S. cf. roxasi*) and three *Stiphodon* (*S. cf. atropurpureus*, *S. cf. multisquamus* and *S. cf. ornatus*) were found, but not conclusively identified, by ESIA surveys (R. Hevalao, *in litt.* 2017). This is understandable, given the paucity of information available to draw from in identifying freshwater fish in the Solomon Islands. The known range of the six species which these specimens resembled (e.g., *S. ampluvinculus*) suggests that these actually represent other species.. Knowledge of *Schismatogobius* taxonomy and distribution is advancing rapidly, with many new species described to science recently from the Pacific – including three that occur in the Solomon Islands (Keith *et al.* 2017). It is quite possible that some of these unidentified fishes represent species described by Keith *et al.* (2017), or described by those authors as now known from the Solomon Islands. An alternate possibility is that these represent undescribed species. Fish from some other genera (*Apogon*, *Caranx*, *Scomberoides*, *Gerres*, *Polydactylus*, *Redigobius*, *Stenogobius*, *Lentipes* and *Sicyopus*) were not identified to species, leading to similar concerns. All of these fish species urgently need identification. If any are identified as *Schismatogobius* or *Stiphodon* species known from the Solomon Islands, many of these are known to be **restricted-range species and would be likely to qualify the Tina River and its tributaries as Critical Habitat. Any undescribed fish species would inherently likely be restricted-range and thus qualify the Tina River and its tributaries as Critical Habitat**, and represent a significant risk to the project. As such, the project should pursue accurate identification of collected specimens of these fishes as soon as possible.

2.3.3 Migratory or congregatory species

Common Sandpiper (*Actitis hypoleucos*)

This is the only species identified in the ESIA which is migratory. It is globally common and widespread, and winters regularly in the Solomon Islands. The population of the species in the project area is likely to be quite considerably less than 1% of the species' global population. This species thus does not qualify the project area as Critical Habitat.

Solomons Flying Fox (*Pteropus rayneri*)

This restricted-range bat species often roosts in large colonies. As assessed in Section 2.3.2, the project DMU is too small in its entirety to hold 1% of the species' global population. This species thus does not qualify the project area as Critical Habitat.

Admiralty Flying Fox (*Pteropus admiralitatum*)

The ESIA considers this poorly-known colonial bat species as possibly present in the project area. It may actually comprise several different species, of which one would be restricted to

the islands of Western Province, Guadalcanal and Malaita. In the absence of any evidence of its presence, it is recommended that the area should not be considered as Critical Habitat for the species. Even if the species was found to be present, the species' extent of occurrence is more than 67,000 km², and so the project area would not contain a significant enough proportion of its population to be considered Critical Habitat.

Geoffroy's Rousette (*Rousettus amplicaudatus*)

This colonial bat species may ultimately be found to contain more than one species (Csorba *et al.* 2008). However, as currently understood, it has a very wide range across South-East Asia and Melanesia. Given this wide distribution, the project area is very unlikely to hold more than 1% of the species' global population. This species thus does not qualify the project area as Critical Habitat.

2.3.4 Unique assemblages of species that are associated with key evolutionary processes

The Solomon Islands are notable for their high levels of bird and mammal endemism, because their fauna has a continental origin, but many of the islands – including Guadalcanal – have experienced long-term isolation owing to deep marine trenches between islands.

IFC (2012b) takes a view that unique assemblages of species can often be identified by their association with 'highly threatened and/or unique ecosystems' (GN90-93). Martin *et al.* (2015) make a first, global-level assessment of which marine ecosystems might qualify as Critical Habitat under this criterion, and a similar effort is ongoing for terrestrial ecosystems.

In the current absence of an assessment of which terrestrial ecosystems might qualify as Critical Habitat, it is necessary to assess whether any ecosystems in the project area might be considered 'highly threatened' or 'unique'. The most useful ecosystem classification, while imperfect, is that of the WWF ecoregions, since it has achieved global coverage and thus allows global comparison. This is thus used here as a basis for assessment.

Solomon Islands Rainforest

Most of the project area was originally covered by forest, classified by WWF as one ecoregion, 'Solomon Islands Rainforest' (Wikramanayake *et al.* 2001). This has a small global extent (c. 36,000 km²) and holds a particularly unique assemblage of species (e.g., 90 endemic or near-endemic bird species). The value of this ecosystem on Guadalcanal is acknowledged by other authorities. For example, CEPF (2012) and BirdLife International (2017b) recognize the 'Guadalcanal Watersheds' area as a Key Biodiversity Area and Important Bird Area, respectively. Further, the interior forests of Guadalcanal around Mount Popomanaseu – including the upper reaches of the Tina River watershed – were proposed in 2008 by the Government of the Solomon Islands as the 'Tropical Rainforest Heritage of Solomon Islands' World Heritage Site. For all of these reasons, **Solomons Islands Rainforest qualifies the project area as Critical Habitat** (Figure 1). This ecosystem can be considered to comprise those forest types identified in the ESIA as relatively intact, namely 'undisturbed forests', 'montane forests' and 'riparian' (per, e.g., Table 10-2 and Figure 6-12), totaling about 184 km² in the DMU. The riparian ecosystem is naturally more disturbed and less forested than the other two, but is included here on a precautionary basis. It is clear that actual project impacts on high quality areas of Solomon Islands Rainforest will be small (c. 32 ha of direct footprint and increased access with potential to induce additional clearance), as discussed further in Section 3.1. Direct project impacts on this ecosystem are

not considered significant, given the small scale of project residual impacts (Table 2) compared to the extent of the ecosystem.

2.3.5 Areas having biodiversity of significant social, economic, or cultural importance to local communities (including ecosystem services)

Section 8.1.6.2 of the ESIA discusses local livelihood strategies, including – relying on biodiversity – small-scale timber-milling and a fishery at mouth of the Tina River. Sections 8.1.11.5-7 expand on local use of natural resources.

Section 8.1.11 of the ESIA discusses Natural Capital, noting that the forests of the project area and Tina Watershed are important to local communities for:

- timber and non-timber materials for housing (i.e., timber, loya cane, thatch, bamboo, and bark);
- game wildlife for hunting, such as wild pigs, possums, flying foxes, lizards, skinks, frogs, hornbill, pigeons, and ducks;
- plants used for medicinal purposes and magic;
- wild foods such as fruits, wild palm, wild yam, various nuts, and ferns, megapode eggs, and emergency foods when required;
- materials for handcrafts, such as baskets;
- regulation of run-off from the heavy rains that occur on Guadalcanal especially around the high mountains, and climate regulation; and
- aesthetic appeal, and places for recreation and relaxation.

It is beyond the scope of this assessment to delve more deeply into which of these ecosystem services may qualify the project area as Critical Habitat, and there is little previous precedent for doing so. It is clear, however, that the forests of the Tina Watershed are important not only in their own right (Section 2.3.4), but also in providing ecosystem services for local communities living in the area.

Section 8.2.3 of the ESIA discusses cultural heritage sites. Little information was obtained on these sites, but they appear to be site- or history-based, rather than biodiversity-based.

2.4 Assessment of Natural Habitat

Guadalcanal as a whole would originally have been largely forested. Across the lower reaches of the project discrete management unit, forest has been degraded and/or removed by logging and small-scale agriculture, and a number of invasive species are now prevalent in the area. These degraded and deforested areas in **the lower Tina watershed can thus be considered Modified Habitat** (covering 51 km² of the DMU). These comprise the potentially-impacted ecosystems identified in the ESIA (e.g., ESIA Table 10-2) as ‘garden’, ‘fallow brush land’, ‘grasslands’, as well as areas of farmland and oil palm nearer the coast. Although this is a coarse classification, grasslands in lowland Melanesia are, for the most part, not natural ecosystems and are comprised largely of non-native or widespread generalist species.

Despite some degradation of forest and some incursion of invasive species – particularly in the mid-reaches and closer to the river – the majority of the discrete management unit away from the coast remains largely forested and ecologically functional. Therefore, **the forests of the majority of the Tina watershed can be considered Natural Habitat** (covering 192 km² of the DMU). It is more challenging to assess the current level of functionality in the

freshwater ecosystems. There has clearly been some level of degradation from gravel mining and fishing, as well as general household use, but it appears that these ecosystems retain the majority of their original ecological functionality and thus that **the Tina River and tributaries can be considered Natural Habitat.**

Many of the terrestrial areas of Natural Habitat within the DMU (covering 184 km²) are also considered Critical Habitat, owing to the intact nature of their restricted ecosystems and the unique assemblages of species they contain (Section 2.3.4), including two very restricted birds and one reptile (Section 2.3.2).

3 Impacts on Critical and Natural Habitat

Direct project impacts on the various ecosystems in the project area are summarized in Table 10-2 of the ESIA, and reinterpreted below in Table 1.

Table 1. Summary quantitative estimation of direct project impacts on terrestrial Critical, Natural and Modified Habitat.

Habitat type	Ecosystem (from Table 10-2)	Direct impact area (ha; from Table 10-2)
Critical Habitat	Undisturbed forests	9.54
	Montane forests	0
	Riparian	21.62
Sub-total (Critical Habitat)		31.16
Natural Habitat	Disturbed forests	29.65
	Remnant forests	21.87 (of which 10 ha is temporary)
	Cliffs	16.12
Sub-total (Natural Habitat, including Critical Habitat)		98.80
Modified Habitat	Grasslands	6.09
	Garden	0
	Fallow brush land	6.40
Sub-total (Modified Habitat)		12.49
Total		111.29

3.1 Impacts on terrestrial Critical Habitat

3.1.1 Solomons Island Rainforest

Solomons Islands Rainforest is considered to represent Critical Habitat (Section 2.3.4). ESIA Table 10-2 clarifies that direct project impacts on undisturbed forests represent <0.2% of the

extent of this forest type in the Tina catchment, with further impacts on riparian forest. Project direct impacts on Critical Habitat total just over 31 ha (Table 1), or about 0.3% of Critical Habitat within the catchment. Moreover, the majority of Guadalcanal remains forested, with much of that area still in a good condition and thus representing Critical Habitat for similar reasons. Direct project impacts on Critical Habitat are thus not considered significant, and will not impair the Critical Habitat's high biodiversity value or ability to function. Induced project impacts present more of a risk.

Through construction of an access road, and development of a reservoir, the project will increase the potential for access by local people and visitors to the upper, less disturbed, reaches of the Tina watershed in order to take advantage of forest resources such as fruits, nuts, medicinal plants, wild game, timber for construction, fuel wood or aggregates at the upstream end of the reservoir (ESIA Section 10.8.1.2.1). Mitigation has been outlined for the risk of induced increases in access by non-local people (ESIA Section 10.8.1.2.2). This will involve declaring the Black Post Road extension a private road, and gating it to allow access only to the company and local people. The Tina TCLC will not permit anyone to live or construct housing within the land leased for the project, except where strictly necessary for project activities. Further, a settlement policy will be developed and implemented with the assistance of the TCLC, to restrict the use of the private project road through the Core Area by local people seeking to build new settlements beyond the Core Area. However, it will not be accepted by local communities that this road be strictly prohibited to new settlements (ESIA Section 10.8.2.2.1). The details of access restrictions remain to be resolved, and implementation of such restrictions requires substantial awareness raising (briefly mentioned in ESIA Section 10.8.2.2.2) and a complex level of coordination among various stakeholders. There thus remains a significant risk of indirect project impacts on Critical Habitat owing to induced increases in access to less disturbed forests in the Tina watershed, particularly by local people, and consequent small-scale logging or other destructive activities. Nonetheless, the improved/extended access road is relatively short and largely surrounded by already degraded (though Natural) forest (ESIA Figure 6-12). With appropriate restrictions on access, impacts on Critical Habitat of deforestation and degradation from project-induced access are likely to remain low in the short-medium term. These are very unlikely to impair the Critical Habitat's high biodiversity value or ability to function at any meaningful scale (compared to the current extent of Solomon Islands Rainforest across the island).

No estimates of the scale of indirect impacts on Critical Habitat are available in the ESIA, and are difficult to predict with the changing socio-economic situation in the area as a result of this project. As a first estimate, it is estimated that induced residual impacts on terrestrial Critical Habitat will be of a similar scale to direct impacts (e.g., complete loss of another 32 ha of forest; or a halving in condition of a wider area of 64 ha of forest). This estimate is likely precautionary, and can likely be refined and reduced by assessment of historic change in the project area or by review of induced impacts in similar previous situations (such as the nearby Gold Ridge mine).

3.1.2 Species

Two bird species were identified as qualifying forests in the Tina River watershed as Critical Habitat. These have the potential to be impacted by the project in similar ways, mostly related to loss and degradation of forest habitat. Induced access from the Black Post Road extension could lead to small-scale logging, degradation or fragmentation of forests. The project ESMP (ESIA Table 13-7) already contains a set of good practice mitigation measures which have the potential to benefit both species, including: minimizing footprint; preventing disturbance from construction workers; preventing access along this road by non-local people; and restrictions on settlement along the road by local people. Project impacts on these species are not considered likely to differ significantly from those on forest more

generally. Mitigation and offset measures already designed for forests are thus appropriate and sufficient to achieve No Net Loss for these species (Sections 3.2 and 4.2).

It also remains possible – if unlikely – that some species (King Rat and White-eyed Starling) have remained undetected in the project area, or will use it at some times, and these species would qualify the area as Critical Habitat (Section 2.3.1). On a precautionary basis, the project should act as though the area might be Critical Habitat for these species. If present, these have the potential to be impacted by the project in similar ways to the birds listed above, but also by induced increases in access leading to increased hunting or spread of invasive species which may compete with, predate or spread disease to these species. The project ESMP (ESIA Table 13-7) already contains good practice mitigation measures which have the potential to benefit both species, including: preventing hunting from construction workers; preventing access along this road by non-local people; restrictions on settlement along the road by local people; and setting up an invasive species management program (see also ESIA Appendix P). It would be advisable for the project to establish a low-level surveillance program for these species, in order that mitigation can be adapted/enhanced should the species be found in the area during the project life. Such surveillance could be achieved at low cost by, for example, developing simple posters with small rewards for anyone who finds these species in the area and can take project staff to see them.

3.2 Impacts on terrestrial Natural Habitat

ESIA Table 10-2 clarifies that direct project impacts on undisturbed forests represent <0.2% of the extent of this forest type in the Tina catchment, with further impacts on riparian forest. Project direct impacts on Natural Habitat total almost 100 ha (Table 1), or about 0.5% of Natural Habitat within the catchment. The majority of Guadalcanal remains forested Natural Habitat, with much of that area still in a good condition. Direct project impacts on Natural Habitat might thus not be considered significant at the scale of Guadalcanal, or even at the scale of the Tina River watershed. Nonetheless, the project is committed to achieving no net loss of Natural Habitat.

As is the case for Critical Habitat, induced project impacts present more of a risk to Natural Habitat than direct impacts. As the Black Post Road extension runs through Natural Habitat, and local use and settlement will be restricted but not prohibited, it can be expected that significant degradation or loss of this habitat will occur over time. No estimates of the scale of these impacts are available in the ESIA, and are difficult to predict with the changing socio-economic situation in the area as a result of this project. As a first estimate, which can be refined by assessment of historic change in the project area or by review of induced impacts in similar previous situations (such as the nearby Gold Ridge mine), it is estimated that induced residual impacts on terrestrial Natural Habitat will be of a similar scale to direct impacts (e.g., complete loss of another 100 ha of forest; or a halving in condition of a wider area of 200 ha of forest).

3.3 Impacts on freshwater Critical or Natural Habitat

The Tina River and its tributaries represent Natural Habitat (Section 2.4). The project is expected to result in unavoidable short-term impacts on water quality during construction and long-term impacts on flow regimes (e.g., ESIA Section 11.4.4.4.1). Mitigation has been planned to avoid and minimize these impacts as much as possible, based on current information (e.g., ESIA Appendix L).

With a number of fish identifications remaining uncertain, and a high likelihood that at least some of these refer to restricted-range species and/or species new to science, there also remains significant potential that the Tina River and its tributaries represent Critical Habitat (Section 2.3.2). Just as the identification of these fish species remains uncertain, so does their ecology, and thus project impacts upon them. ESIA Appendix L thus assesses

environmental flow requirements and fish passage mitigation requirements based upon modelled habitat suitability criteria for eight more common species and an understanding of the broad ecological requirements and life history strategies of the genera of fish present in the river. This represents good practice given available data, but falls short of a precautionary plan to ensure no net loss for any habitat required by any fish species which may prove to qualify the area as Critical Habitat.

It is a high priority to obtain expert identification (likely by the French National Museum of Natural History in Paris, given the concentration of expertise on relevant fish species in that institution) of unidentified fish collected during the ESIA. Once these fish are identified, it will be necessary to assess whether the Tina River and tributaries represent Critical Habitat for these species. If so, further studies will be urgently required to better understand the species' ecology, habitat requirements and life history, and thus whether the project is likely to have a significant impact on these species and whether current planned mitigation is sufficient to avoid a net residual loss to these species' populations or habitats.

4 Offsets for residual impacts on Critical and Natural Habitat

4.1 Estimates of the magnitude of residual terrestrial impacts

The developer has committed to development of a Biodiversity Management Plan (BMP), with the objective of achieving no net loss of biodiversity as a result of natural habitat conversion. This BMP will be in place at least one month prior to the Engineering Procurement and Construction mobilising to the field. The BMP will include an offset comprising measures to protect the remaining Natural Habitat in the Core Area (ESIA Appendix P) and a program to rehabilitate at least 9.5 ha of Modified Habitat (ESIA Section 10.7.1.1.2; ESIA Appendix P). This 9.5 ha of rehabilitation is not factored into estimates of residual impacts in this section.

Direct impacts on Natural Habitat are likely to affect c. 100 ha, of which c. 32 ha comprise Critical Habitat (Section 3). Given the absence of quantitative spatial estimates of the scale of indirect impacts on forest ecosystems, first estimates here are that these will be at a similar scale to direct impacts, i.e. another 100 ha of Natural Habitat, of which c. 32 ha comprise Critical Habitat (Sections 3.1.1 and 3.2). Given these preliminary assumptions, the project is assumed to result in residual impacts of c. 200 ha of Natural Habitat (including c. 64 ha of Critical Habitat). Refined estimates are presented in Table 2.

Assessment of project offset needs requires quantification of the scale and severity of project impacts. No significant residual impacts are currently expected for species, beyond those for which their habitat already represents a useful proxy. Offset estimates regularly use 'extent × condition' metrics¹ (e.g., Quality Hectares or QH) to account for variable quality of impacted ecosystems and varying severity of impacts. A pristine or 'benchmark' ecosystem would be judged to be 100% quality. Few data are available in the ESIA to enable estimation of the current condition of the Critical and Natural Habitat. In general, the Critical Habitat areas are described as essentially in natural/undisturbed/pristine condition (e.g., ESIA Appendix F) and may thus – for the purposes of this exercise – be taken as a 100% benchmark condition. ESIA Appendix F and Section 6.3.5 note that many non-Critical Natural Habitat areas of 'disturbed' forest in the project area have been affected by logging and only have a moderate ecological value, although they still show rich plant diversity, and

¹ e.g., see Parkes *et al.* (2003) Assessing the quality of native vegetation: The 'habitat hectares' approach. *Ecological Management and Restoration* 4, supplement.

rapid vegetation regeneration. For the purposes of this assessment, these are classed as of 60% condition. Some ('remnant forest') areas are stated to have undergone extensive disturbance, with few large remaining trees. For the purposes of this assessment, these are classed as of 30% condition. All of these forest condition estimates could be refined by in-field measurement of relevant condition variables such as canopy cover and canopy height.

Table 2. Preliminary quantitative estimation of residual direct and indirect project impacts on terrestrial Critical and Natural Habitat.

Habitat type	Ecosystem (ESIA Table 10-2)	Impact area (ha)			Ecosystem condition ('quality')	Impact (Quality Hectares)
		Direct (ESIA Table 10-2)	Indirect (estimated)	Total		
Critical Habitat	Undisturbed forests	9.54	9.54	19.08	100%	19.08
	Riparian	21.62	21.62	43.24	100%	43.24
Sub-total (Critical Habitat)		31.16	31.16	62.32	-	62.32
Natural Habitat	Disturbed forests	29.65	29.65	59.30	60%	35.58
	Remnant forests	11.87 ²	11.87	23.74	30%	7.12
	Cliffs	16.12	16.12	32.24	100%	32.24
Sub-total (Natural Habitat, including Critical Habitat)		88.80	88.80	177.60	-	137.26

4.2 Estimates of the magnitude of terrestrial offset gains

ESIA Appendix K outlines the opportunity for protection of an extensive area of Critical Habitat in the upper watershed of the Tina River. This opportunity is at a very early stage of consideration, and considerable engagement with stakeholders, including customary landowners, will be necessary before it is clear whether this is a realistic option.

The area under consideration covers about 12,500 ha. An offset as proposed would represent an 'averted loss' offset in which offset gains comprise the area of forest which would have been expected to have been lost in the absence of the offset action. In the Solomon Islands, particularly at higher altitudes, the most likely reason for forest loss is logging. At a national level, annual deforestation rates have been estimated at about 0.2%/year (FAO 2015). Real rates are likely to be higher, but to disproportionately impact

² An additional 10 ha represents temporary footprint for topsoil storage. The project plans to restore this area afterwards. It is likely that restoration will be able to restore this area to the previous low condition ('30%'), so this 10 ha is omitted from calculations here.

more accessible area at lower elevations nearer coasts. In the absence of any data specific to the project area, a precautionary baseline to estimate offset gains might be 0.1%/year, and that this would relate to heavy deforestation (resulting in an ecosystem of lower quality than that considered 'remnant forest' in the ESIA, assumed here to be of only 10% quality). The life of the project, and its accompanying offset, is expected to be very long-term. However, for the purposes of no net loss assessments, a reasonable timescale such as 25 years is usually taken.

An offset as proposed might thus be expected to produce 11.25 QH of gains in its first year (0.001 [deforestation rate averted] \times 0.9 [quality loss averted] \times $12,500$ [offset area]). Over 25 years, this would equate to approximately 300 ha, more than double the necessary level to compensate for project residual impacts of c. 138 ha (Table 2, Section 4.1). Despite considerable uncertainties and major (albeit largely precautionary) assumptions, it thus appears very likely that the proposed offset model would – if fully funded and successfully implemented – be sufficient to allow the project to achieve No Net Loss with regard to terrestrial impacts.

The project is only planning to support a proportion of the costs of establishment and implementation of this conservation program, but it will be important to ensure that the proportion covered remains sufficient to generate and sustain biodiversity gains necessary as an offset for residual project impacts. Present, very preliminary calculations in this section suggest that the project would thus need to contribute almost half of the costs, which are likely to be very high. Further efforts by the project to refine assumptions and estimates in this preliminary calculation are likely to reduce costs (as estimates here are largely precautionary).

4.3 Freshwater offsets

The ESIA does not currently identify the need for any freshwater offsets, on the basis that identified mitigation (particularly minimum environmental flows) will not result in any significant residual project impacts on freshwater ecosystems. As outlined in Section 3.3, it may be too early to be confident of this conclusion. If residual project impacts are identified upon freshwater Critical (or Natural) Habitat, and no further adjustments to mitigation or HPP operation are feasible to eliminate these impacts, an opportunity may exist to offset such impacts in the Toni River. While smaller, the Toni River is connected to the Tina River and likely to contain a very similar set of species. Further, it has experienced some degradation as a result of the (now non-operational) Gold Ridge mine in the neighbouring catchment (C. Filardi pers. comm. 2017). There is thus an opportunity to restore some ecological functionality of the Toni River.

5 Biodiversity monitoring

Section 13.3 of the ESIA outlines project monitoring activities, and a process for independent auditing of monitoring. ESIA Section 13.3.2 lists monitoring plans to be developed, including on 'Aquatic Life' and 'Flora and Fauna' (the latter to include monitoring of invasive species). Physical environmental monitoring is elaborated for suspended sediments (ESIA Section 13.3.3.1) and water quality (ESIA Section 13.3.3.2). ESIA Section 13.3.3.3 outlines plans for fish, algae and macro-invertebrate monitoring. Each monitoring plan will identify the parameter being monitored, how it will be monitored, how frequently and who will be responsible for monitoring.

To assist development of future monitoring plans, Table 3 briefly outlines key areas of monitoring necessary to assess changes in the state of potentially Critical Habitat-qualifying ecosystems and species, changes in threats to this biodiversity, and progress of project mitigation/offset actions. Together, these approaches to monitoring 'state', 'pressure' and

'response' for Critical Habitat-qualifying biodiversity will enable the project to assess progress towards No Net Loss.

Aquatic monitoring outlined in Table 3 will be important not only for any Critical Habitat-qualifying fish species, but more broadly given current limited knowledge of the ecology of the Tina River, and thus limited confidence in the effectiveness of proposed environmental flows and fish passage methods. Results of aquatic monitoring will thus inform adaptive management through project life.

For all aspects of monitoring, it will be necessary to establish higher and/or lower thresholds which outline the expected natural variation within indicators. Should monitoring show indicators above/below these safe boundaries, adaptive management of project mitigation or operation will need to be considered.

Table 3. Key areas of monitoring necessary to assess changes in the state of important ecosystems and species, changes in threats to this biodiversity, and progress of project mitigation/offset actions

	Solomon Islands Rainforest (including Guadalcanal Boobook, Black-headed Myzomela and Guadalcanal Bow-fingered Gecko³)	King Rat and White-eyed Starling	Aquatic biodiversity, including potentially restricted-range fish species
State monitoring (to assess the ongoing extent/distribution and condition/population of important biodiversity)			
Surveillance to assess presence in area	N/a	Necessary	N/a
Remote sensing to assess direct and induced forest loss and degradation	Necessary	Necessary if confirmed in area	N/a
Measurement of regrowth (habitat condition) in areas restored after temporary topsoil storage	Necessary	Necessary if confirmed in area	N/a
Water dissolved oxygen, temperature, river sedimentation and geomorphology (already in ESIA Table 13-7)	N/a	N/a	Necessary during both construction and operation, at decreasing frequency over project life
Species richness and population density, at least for key species (from both a Critical Habitat and livelihood perspective)	N/a	N/a	Necessary, both upstream and downstream of the dam (including control monitoring on the Toni River). Baseline yet to be established. Very regular monitoring required to inform

³ It is not anticipated that these species will be affected by the project in any way that is not closely related to that of the forest and its species assemblage as a whole, thus no specific monitoring is proposed for, e.g., any of these species' populations.

			adaptive management.
Number of individuals per species using trap and haul system	N/a	N/a	Necessary. Very regular monitoring required to inform adaptive management.
Pressure monitoring (to verify the scale of direct and indirect project impacts in relation to those predicted in the ESIA)			
Ambient noise	Necessary during construction	Necessary if confirmed in area	N/a
Spread of invasive species beyond ESIA baseline	In particular, cats, rats and cane toads	Cats and rats	In particular, water hyacinth and non-native fishes
Ground-truthed mapping of project-cleared areas within forest	Necessary	Necessary if confirmed in area	N/a
Presence of non-local people (except project staff) beyond end of current Black Post Road	Necessary	Necessary if confirmed in area	Necessary
Extent of new local settlements beyond end of current Black Post Road	Necessary	Necessary if confirmed in area	Necessary
Workers identified/reported harming or purchasing wildlife (including fish) (already in ESIA Table 13-7)	Necessary	Necessary if confirmed in area	Necessary
Response monitoring (to verify the occurrence and effectiveness of project mitigation and offset measures in comparison to predictions in the ESIA)			
Progress of program to control/remove non-native species	In particular, cats, rats and cane toads	Cats and rats	In particular, water hyacinth and non-native fishes
Maintenance of environmental flows at all times (already in ESIA Table 13-7)	N/a	N/a	Necessary

Operation of trap and haul system at regular intervals (already in ESIA Table 13-7)	N/a	N/a	Necessary
Progress of restoration for temporarily disturbed areas after construction period	Necessary	Necessary if confirmed in area	N/a
Progress of offset conservation program	Necessary	Necessary if confirmed in area	Likely necessary if restricted-range fishes are identified

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