Initial Environmental Examination

November 2014

SAM: Renewable Energy Development and Power Sector Rehabilitation Project

Prepared by MWH New Zealand Ltd on behalf of the Electric Power Corporation and the Government of Samoa for the Asian Development Bank.

ABBREVIATIONS

ADB	Asian Development Bank
CEAR	Comprehensive Environmental Assessment Report
CEMP	Construction Environmental Management Plan
COEP	Code of Environmental Practice
CPP	Consultation and Participation Plan
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ENSO	El Niño Southern Oscillation
EO	Environment Officer
EPC	Electric Power Corporation
EHSG	Environmental Health and Safety Guidelines (World Bank)
EU	European Union
GRM	Grievance Redress Mechanism
HSP	Health and Safety Plan
IEE	Initial Environmental Examination
IES	international environmental specialist
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
MAF	Mean Annual Flow
MAFF	Ministry of Agriculture, Forestry and Fisheries
MALF	Mean Annual Low Flow
MFAT	Ministry of Foreign Affairs and Trade
MSMP	Materials and Spoil Management Plan
MNRE	Ministry of Natural Resources and Environment
MWCSD	Ministry of Women, Culture and Social Development
MWTI	Ministry of Works, Transport and Infrastructure
NWAP	National Water Allocation Policy
PEAR	Preliminary Environmental Assessment Report
PMC	Project Management Consultant
PMU	Project Management Unit
PPE	Personnel Protective Equipment
PUMA	Planning and Urban Management Agency
RP	Resettlement Plan
SHP	Small Hydropower Plant
SPREP	Secretariat of the Pacific Regional Environment Programme
SWA	Samoa Water Authority
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
VMS	Village Managed Schemes
WMP	Waste Management Plan

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EXECUTIVE SUMMARY

1. **Introduction**. Samoa is heavily reliant on imported fossil fuels for power generation. The objective of the Renewable Energy Development and Power Sector Rehabilitation Project is to assist the efforts of Government of Samoa (GoS) to reduce the country's heavy reliance on fossil fuels by providing a secure, sustainable and environmentally sound source of electricity for consumers. The project includes the construction of four new Small Hydro Projects (SHPs) and the refurbishment of four existing SHPs. This report provides an environmental assessment of two proposed SHPs: the Tiapapata and Fuluasou schemes.

2. **Categorization**. The Tiapapata and Fuluasou schemes are classified as Category B in accordance with Asian Development Bank's Safeguard Policy Statement 2009 (SPS) as the potential adverse environmental impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed readily.

3. **Initial Environmental Examination**. As a requirement of the ADB SPS, an Initial Environmental Examination (IEE) has been undertaken part of project preparation, feasibility study of the proposed works has been undertaken. The feasibility studies include environmental assessment as per requirements of GoS and following ADB SPS. This IEE deals with development of two SHP schemes on Upolu: Tiapapata and Fuluasou.

4. **Policy, Legal and Administrative Framework**. The Project shall comply with requirements of the Planning and Urban Management Act 2004 and the Environmental Impact Assessment (EIA) Regulations 2007. For development of hydropower projects, development consent must be obtained from the Planning and Urban Management Agency (PUMA) within Ministry of Natural Resources and Environment (MNRE). The development consent application must include an environmental assessment which complies with the Act and Regulation requirements. The Project will also comply with the requirements of the ADB SPS. GoS environmental clearance and development consent (and other permits) must be obtained before any works commence.

5. The IEE is intended to meet the requirements of the ADB for Category B projects as described in the SPS as well as comply with the requirements of a Preliminary Environmental Assessment Report (PEAR) as required under the key environmental assessment requirements of GoS.

6. **Environmental Impacts**. The Fuluasou SHP is an existing derelict SHP which is to be rebuilt. The habitat is highly modified, and there is an existing dam, reservoir, penstock and powerhouse present. Effects of this project are considered to be minor. Mitigation measures contained in this EMP with ensure that environmental impacts are minimised and managed appropriately.

7. The Tiapapata SHP is a new SHP to be located on the Vaisigano River. The scheme will extract water from the Vaisigano west tributary and discharge to the Vaisigano central tributary. The site is secondary forest that provides habitat to two threatened birds: mao *Gymnomyza samoensis*) and manumea (*Didunculus strigirostris*). Approximately 70,000m2 of vegetation clearance will occur. This will be mitigated by planting 100,000 native plants in the catchment, undertaking pest control, and the proposal to create the new Vaisigano National Park linking to the adjacent O Le Pupu-Pue National Park.

8. While the Tiapapata site presents important biological values including endemic and/or threatened birds and fish, as well as some native trees, most of the potential impacts generated by the works like forest clearance for the opening of access roads, pollution, soil erosion, noise from engines and works, and riverbanks degradation, etc. can be reduced or avoided if the mitigation measures contained in the EMP are correctly implemented.

9. **Environmental flows**. Environmental flows have been developed for both SHP sites. The environmental flows proposed are based on the 95th percentile of the flow duration

curve and is consistent with MNRE recommendations. This equates to 0.36 m^3/sec at the Fuluasou SHP intake and 0.09 m^3/sec at the Tiapapata SHP intake.

10. Environmental flows account for abstraction by the Samoa Water Authority (SWA) upstream of the SHP intakes. Should additional abstraction occur downstream of the SHP intakes, the figures may need to be revised and increased to account for the additional water that is abstracted.

11. Adaptation of climate change is already included in the design in relation to the protection from flooding of the powerhouse, with the calculation of the occurrence, normally for a 50 years maximum climatic event, set now to 100 years

12. **Environmental benefits**. The operation of the SHPs will have beneficial effects through more efficient provision of electrical power from renewable resources and improved environmental management within EPC. These subprojects will achieve a net reduction of greenhouse gas emissions of around 3,806 tons of CO_2 per year. This corresponds to a fuel savings amount of 1420 litres for electricity generation.

13. **Implementation Arrangements.** The executing agency (EA) for the Project is the Ministry of Finance and the implementing agency (IA) is EPC. The Project Management Unit (PMU) established under the Power Sector Expansion Sector Project will be retained and strengthened to lead design and implementation of the Project. The PMU will be supported by a project management consultant (PMC) to assist with design and supervision.

14. **Environmental Management Plan**. Mitigation measures, environmental monitoring, and capacity development are required to minimize the environmental impacts in the pre-construction, construction and operation phases. The PMC and contractor will be tasked with finalizing the detailed design and compilation of updated EMP and the contractor will be responsible for implementing the EMP. The results of this IEE and the EMP will be updated if necessary at the detailed design by EPC's PMU.

15. Implementation of internationally recognized good construction environmental practices forms the basis of the EMP which covers issues such as erosion and sedimentation control, materials sourcing and spoil management, waste management, minimization of habitat disturbance, and worker and community health and safety. The EMP will form part of the construction contract documents and the contractor will be required to prepare a site-specific construction environmental management plan (CEMP) based on the approved IEE's EMP. The contractor will submit the CEMP to PUMA for approval prior to commencement of works.

16. **Information Disclosure, Consultation and Participation.** The stakeholder consultation process disseminated information to the general public, project affected communities and key environmental stakeholders. Information was provided on the scale and scope of the Project and the expected impacts and the proposed mitigation measures through consultation with government departments, local authorities and the general public in meetings. The process also gathered information on relevant concerns of the local community for the Project so as to address these in the project design and implementation stages. This IEE is submitted to ADB by the borrower and the final IEE report will be disclosed to the public by EPC and uploaded to ADB's website.

17. **Grievance Redress Mechanism.** A grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of affected people's concerns, complaints and grievances about the environmental and social performance of the Project. The GRM is based on accepted practices in Samoa including previous experience on ADB projects and provides an accessible, time-bound and transparent mechanism for the affected persons to voice and resolve social and environmental concerns linked to the Project.

1. INTRODUCTION

1.1. Project Background

1. The Asian Development Bank (ADB) is supporting the efforts of Government of Samoa to reduce the country's reliance on fossil fuels for power generation by providing a secure, sustainable and environmentally sound source of electricity. ADB Grant 0370/0371/0373-SAM: Renewable Energy Development and Power Sector Rehabilitation Project (the Project), is financing the repair and construction of several small hydropower plants (SHPs) in Samoa (ADB, 2014).

2. The Project was approved by the ADB Board of Directors on 15 November 2013 and became effective on 26 May 2014. The Project will have four outputs as follows (ADB, 2014):

(i) *Rehabilitation of damaged hydropower plants in Upolu*. The Project will rehabilitate and reconnect to the grid three SHPs damaged by Cyclone Evan with a total installed capacity of 4.69;

(ii) *Construct new hydropower plants in Upolu and Savai'i*. The Project will build and connect to the existing grid three new SHPs with a total preliminary capacity of 0.81 MW;

(iii) *Operation and Maintenance (O&M) Knowledge Transfer Program*. The Project will provide capacity development to EPC through an O&M knowledge transfer programme; and

(iv) *Efficient Project Implementation*. EPC will be assisted by the project owner's engineers (POE).

3. In August 2014, additional cofinancing for the project was sourced from the European Union (EU) and the New Zealand Ministry of Foreign Affairs and Trade (MFAT). The proposed co-financing will allow two additional grid connected SHPs to be built with a total additional capacity of 1.12 MW; the 0.68 Fuluasou SHP and the 0.43 MW Tiapapata SHP, both located on the island of Upolu.

4. Fuluasou and Tiapapata SHPs have been identified as priority sites for development based on (i) the largest capacity addition to the Samoa Electric Power Corporation, (ii) the best match with the available co-financing amount, (iii) the technical and financial feasibilities, (iv) the simplicity of land and environment issues, and (v) the readiness for ADB project processing (ADB, 2014).

1.2. Report Purpose and Scope

5. In accordance with ADB policies (ADB, 2010), when additional financing is required to fund an expansion in scale or changes in scope for a Project, due diligence will involve technical, economic, financial, safeguard, capacity, social and poverty aspects for the added and/or changed components.

6. Environmental and social safeguards due diligence for the Fuluasou and Tiapapata SHP was undertaken during September 2014. The purpose of this due diligence was to review and update the work completed under the existing loans, and to undertake new assessments required, in order to identify actual or potential adverse effects of the sub-project and to comply with ADB safeguards (ADB, 2009; ADB, 2010). This information has contributed to the preparation of the Initial Environmental Examination (IEE).

7. The purpose of this Initial Environmental Examination (IEE) report is to present the environmental impacts and risks associated with the sub-project. Specifically, the objectives of the IEE are to:

(i) Characterise the baseline environmental and socio-economic characteristics of the area surrounding the Fuluasou and Tiapapata SHPs.

(ii) Assess the potential environmental and social impacts of the construction and operation of the SHPs;

(iii) For the Tiapapata SHP, undertake a cumulative assessment of the Vaisigano River system;

(iv) Identify the presence of any critical habitat[1] within the project areas;

(v) Determine requirements for environmental flows for each site commensurate with impacts;

(vi) Provide avoidance, mitigation and management measures for the identified impacts; and

(vii) Document public and other stakeholder consultation regarding proposed works.

8. The IEE adheres to the requirements of the ADB Safeguards policy (ADB, 2009) and generally follows the form and content of the approved IEE for New SHPs on Upolu and Savai'i (ADB, 2013) that has been prepared the Project.

1.3. Methodology

9. The IEE involved a combination of literature reviews, meetings and informal interviews with key staff and stakeholders, as well as site visits and ecological investigations of the Fuluasou and Tiapapata SHP sites.

10. The methodology comprised:

(i) *Literature Review:* A review of existing reports and information on the two sites. This included reports and documents covering engineering design, stakeholder consultation, land ownership, ecology, threatened species, protected areas, and other relevant information. Documents were sourced from the Government of Samoa, ADB and MWH, as well as online sources.

(ii) *Meetings with Staff:* Meetings and interviews were held with key staff within the Electric Power Corporation, Ministry of Natural Resources and Environment, ADB, MWH, Secretariat of the Pacific Regional Environment Programme (SPREP), Samoa Conservation Society, and Atherton & Associates.

(iii) *Stakeholder Consultation:* Stakeholders have been consulted for both Fuluasou and Tiapapata SHPs. Meetings were held with the stakeholders in July 2013, with follow up meetings undertaken during September and October 2014. A total of four households and two government agencies will be affected by Fuluasou. Tiapapata will affect two households. Based on available information, it is understood that the components of the SHPs fall within government land, including the easements. Once topographical surveys have been carried and there is more information from the detailed design, the stakeholders will be updated on the effects of the projects.

(iv) *Site Visits:* Site visits to the Fuluasou and Tiapapata SHPs were undertaken between 11 and 18 September 2014.
The Fuluasou SHP is easily accessible and the entire scheme was assessed including the powerhouse, penstock route, dam and reservoir. The only part that was not accessed was a short section of the penstock route running through the golf course and an adjacent private property.

[1] As per the definition in the ADB Safeguard Policy Statement 2009 (Appendix 1 para. 28-30).

The Tiapapata scheme is located in forest away from roads and walking tracks. The intake, powerhouse location and transmission line route was assessed, and as much of the canal and penstock route as was possible was visited. The area around the headpond was not viewed due to difficulties in access, however the vegetation and habitat leading to the site was similar so that the additional effort to view this location was considered unnecessary.

(v) *Ecology Surveys:* During the site visits a qualitative assessment of vegetation and habitat was undertaken, with an emphasis on the quality of habitat for threatened avifauna, specifically mao (*Gymnomyza samoensis*) and manumea (*Didunculus strigirostris*).

Surveys for avifauna were conducted by way of five minute point counts (Dawson & Bull, 1975; FAO, 2007), in addition to roving surveys which recorded additional species that were not detected during point counts. A total of 14 fixed point counts were undertaken within the project footprints; three counts at Fuluasou, and 11 at Tiapatata.

Aquatic ecology surveys of fish and macroinvertebrate communities were undertaken previously in 2013 (Atherton et al., 2013a; Atherton et al., 2013b).

(vi) *IEE Analysis and Reporting:* The IEE report was prepared by assessing baseline conditions, identifying risks during site visit and desktop evaluation, evaluating potential Project impacts and benefits, and assessing mitigation and management mechanisms relative to ADB safeguards, and national and international statutory requirements.

2. INSTITUTIONAL, POLICY AND LEGAL FRAMEWORK

2.1. Institutional Framework

2.1.1. Executing and Implementing Agency

11. The project will be executed by the Ministry of Finance (MOF) and the implementing agency is the Electric Power Corporation (EPC). As the sole provider of electricity in Samoa, the EPC's mandate includes generation, transmission, distribution and sale of electricity.

2.1.2. Environmental Agency

12. The Ministry of Natural Resources and Environment (MNRE) is the environmental agency in Samoa. MNRE is comprised of a number of divisions including: Disaster Management; Environment and Conservation; Forestry; Land Management; Meteorology; Planning and Urban Management Agency (PUMA); Renewable Energy; and Water Resources.

13. The Environment and Conservation division is responsible for national parks, conservation and waste management. PUMA is the lead agency for implementation of the Planning and Urban Management Act 2004 and issuance of development consent for project development. The Water Resources Division of MNRE manages, protects and controls the allocation and use of water resources under the Water Resources Management Act 2008.

2.1.3. Other Agencies

14. The Ministry of Works, Transport and Infrastructure (MWTI) is responsible for drainage and storm water management, especially in relation to the development of road infrastructure and power lines. The MWTI also regulates the construction of buildings and issue building permits, to construct, maintain and manage the public assets, in the project case, the construction of access roads.

15. Any land acquisition needed under this project will have social implications and transformations and each case will have to refer to this Ministry. The Ministry of Women, Culture and Social Development (MWCSD) through its Internal Affairs Division, is facilitating in the provision and improvement of water supply and sanitation services in Village Managed Schemes (VMS), and assisting MNRE in water resources management at community level.

16. The Samoa Water Authority (SWA) is the national service provider of water supply and more recently for sanitation, sewerage and wastewater treatment. The SWA also monitor their own water supplies and have a water quality laboratory to support these activities. Because the drinking water is collected in the same river where SHPP will be or are installed it requires good coordination between EPC and SWA.

17. The Ministry of Agriculture, Forestry and Fisheries (MAFF) is responsible for the promotion, and sustainable development and management of irrigation services, and assists MNRE in the prevention and monitoring of uncontrolled clearance of forests for agriculture in watershed areas. It is related to the project for the conservation of the watershed through the control of the crop field's development

2.2. Legal and Policy Framework

18. The implementation of the Project will be governed by the environmental laws and regulations of Samoa and the safeguard policies of the ADB.

2.2.1. Environment Law and Regulations

19. *Lands, Surveys and Environment Act 1989:* This Act establishes the principal functions of the MNRE which include advising the Minister on all aspects of environmental management and conservation including: (i) the potential environmental impact of a public or private development proposal; and (ii) to act as the advocate of environmental conservation at Government, its agencies, and other public authorities with advice on procedures for the assessment and monitoring of environmental impacts.

20. *Planning and Urban Management Act 2004:* This Act sets out the framework for the planning, use, development, management and protection of land in Samoa. Under Section 34, all development needs consent, unless a sustainable management plan or regulations provides otherwise

21. Prior to undertaking certain activities development consent must be applied for. Section 42 describes the triggers for, and process to be followed, when an environmental assessment will be required. Under Section 42 of the Act PUMA may require an applicant under Section 37 to provide an environmental impact assessment (EIA) in relation to the proposed development to which the development application relates; and (ii) where PUMA decides that an environmental impact assessment shall be prepared, the format, structure, subject matter of any such assessment and any other related matter, shall be specified in writing by PUMA to the applicant and the applicant shall comply with the Agencies requirements under this section

22. The Act also outlines the process of notification of applications and also the submissions and hearings on development applications.

23. *Environmental Impact Assessment Regulations 2007*: The Regulations made under the Act are also administered by PUMA. The Regulations establish what level of EIA is required, the aspects that need to be included and the process for review and approval. Section 4 of the regulations prescribes two forms of EIA: (i) Preliminary Environmental Assessment Report (PEAR); and (ii) Comprehensive Environmental Assessment Report (CEAR). A PEAR is required when PUMA considers an activity requiring consent is not likely to have a significant adverse impact on the environment. A CEAR is required when a development is likely to have a significant adverse impact on the environment.

24. The Regulations also outline: (i) baseline and compliance monitoring (Section 8); (ii) reviews of the EIA (Section 9 and 10); and (iii) public consultation (Section 11). Schedules attached to the Regulations detail the content of the PEAR and CEAR.

2.2.2. Permits Required

25. Overall the project will need a number of permits:

(i) An application for a water permit under the Water Management Act should be lodged with the Water Resources Department of MNRE;

(ii) An application (with the environmental assessment report) submitted to PUMA;

(iii) If required, an application made to Forest Division of MNRE for a tree-harvesting permit

26. When a project belongs to the competency of several agencies and could have potentially significant environmental effects, Section 44 of the Act requires that PUMA will consult the appropriate agencies by sending a referral to them requesting comments. The answers should be received by PUMA within 10 days, unless more information is requested. The timeframe to obtain a permit for a project depends on its complexity and the number of Agencies involved.

2.3. Samoa Codes of Environmental Practice

27. The Codes of Environmental Practice (COEP) were prepared in 2006 to define methods and/or procedures to be applied in order to avoid or mitigate adverse environmental effects that may arise out of infrastructure development or maintenance work. The COEPs are to be implemented by all development works where development consent is required under the Act.

28. There are three implementation mechanisms for the COEPs: (i) use of the COEP is specified in the Terms of Reference for the design of works. The relevant design directives stated in the COEP should also be incorporated in the Terms of Reference; (ii) use of the COEP is specified in the specifications for the construction of physical works. The relevant suggested specifications stated in the COEP should also be incorporated in the specifications; and (iii) environmental approvals are granted with the condition that works proceed under the provisions of the COEP.

29. There are 14 COEP which have been prepared under the Act (refer to Annex 1), and though these COEP refers essentially to road construction, there is guidance on public consultation, land acquisition and slope and soil protection, campsites, archaeological discovery, drainage, earthworks plan, erosion and sedimentation measures, etc. which will be applicable to the project.

2.4. ADB Safeguard Policy

30. The ADB's Safeguard Policy Statement 2009 (SPS) has the objectives to (i) avoid adverse impacts of projects on the environment and affected people; (ii) where possible; minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The environment safeguard requires due diligence which entails addressing environmental concerns, if any, of a proposed activity in the initial stages of project preparation.

31. The SPS categorizes potential projects or activities into categories of impact (A, B or C) to determine the level of environmental assessment required to address the potential impacts. The Project is categorized as environment Category B because potential adverse environmental impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed readily. Accordingly this IEE/PEAR has been prepared as the requisite level of assessment to address the potential impacts in line with the SPS.

32. ADB's SPS applies pollution prevention and control technologies and practices consistent with international best practices as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines (EHSG). The EHSG provide the context of international best practice and contribute to establishing targets for environmental performance. The air and noise standards in the EHSG will be used in parallel with local standards (where they exist) throughout this document. Application of occupational and community health and safety measures, as laid out in the EHSG is required under the SPS.

3. PROJECT DESCRIPTION

3.1. Site Location

33. The Fuluasou and Tiapapata SHPs are located on the island of Upolu, Tuamasaga District, Samoa (Figure 1 and Figure 2).

34. The Fuluasou SHP is located five kilometres south-west of the capital city, Apia, close to the outskirts of the town and in the vicinity of Tuaefu and Ululoloa villages. The existing derelict powerhouse is located on Talimatau Road, Tuamasaga.

35. The Tiapapata SHP is located seven kilometres south of Apia and to the east of the Cross Island Road. Access is from Cross Island Road or Alaoa Road to the north.

Figure 1: Location of Fuluasou and Tiapapata SHPs, Upolu, Samoa

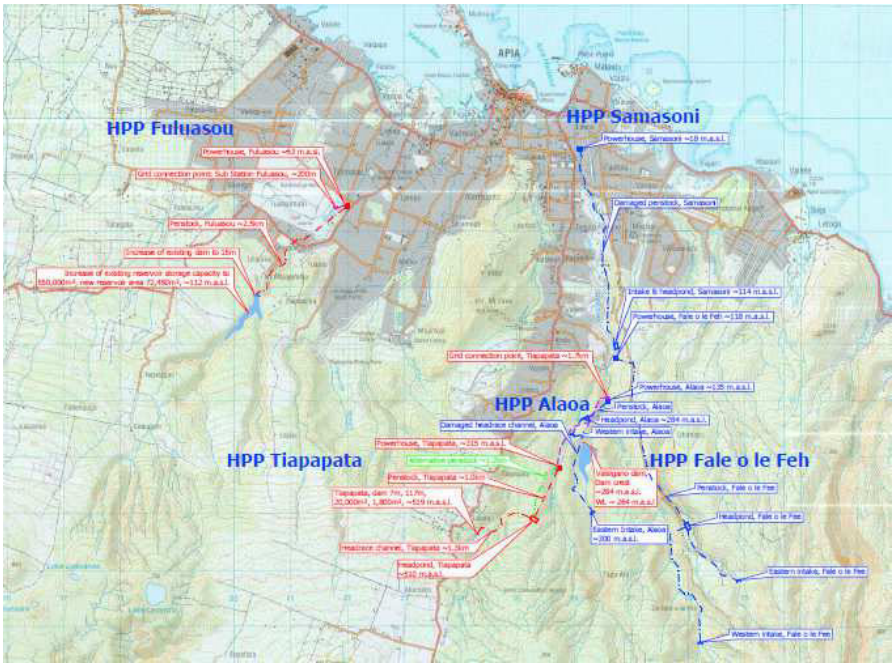

Figure 2: Location of Fuluasou and Tiapata in relation to existing SHPs near Apia

3.2. Fuluasou SHP

36. The proposed Fuluasou SHP will rehabilitate an existing SHP facility located on the Fuluasou River (Figure 3). The output of the scheme following rehabilitation is a nominal 0.68 MW (MWH, 2014).

37. The original Fuluasou plant was commissioned in the 1951 and upgraded in 1985. The plant has been out of service since May 1988 when the penstock was damaged in a cyclone. Further damage was caused in 1990 when part of the penstock was washed away during another cyclone.

38. The plant currently comprises of an existing dam and reservoir, damaged penstock and derelict powerhouse (Figure 4 to Figure 7). Parts of the penstock have been crushed by trees.

39. An engineering site inspection in 2014 (MWH, 2014) indicates that the existing dam has silted up and requires dredging to reactivate available storage. The intake structure and scour gates require rehabilitation, and the penstock and powerhouse needs to be rebuilt. Parts of the penstock route have been built on by residents, including a hotel, and a golf course. The new penstock will avoid these by diverting or undergrounding the pipe in these locations.

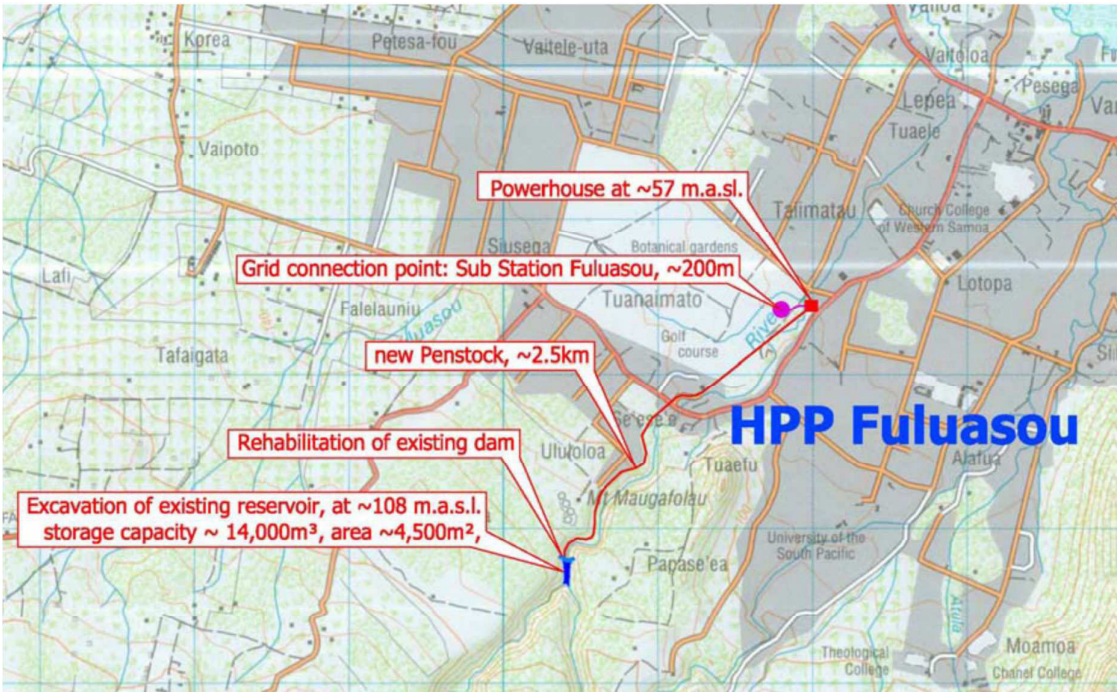

Figure 3: Fuluasoa SHP location plan (Posh and Partners, 2013)

Figure 4: The spillway at the existing dam

Figure 5: Existing derelict powerhouse

Figure 6: Penstock in private property

Figure 7: Existing, damaged penstock

40. The proposed Fuluasou SHP development involves the following components (MWH, 2014):

(i) Rehabilitation of the existing dam to abstract 1.8 m^3/sec. This will involve dredging of material from the dam and physical strengthening.

(ii) Installation of a new underground 2.5 km penstock along the existing alignment, subject to deviations around two private dwellings.

(iii) Construction of a new powerhouse with a single Turgo turbine at the site of the existing powerhouse next to the Fuluasou River.

(iv) Connection to an existing substation located approximately 200 m from the powerhouse site, using a transmission cable.

41. Water for the Fuluasou SHP will be abstracted from the Fuluasou River at the site of the existing dam and be returned to the river at the powerhouse, located approximately 2.5 km downstream. The proposed rate of extraction is 1.8 m^3/sec.

3.3. Tiapapata SHP

42. The proposed Tiapapata SHP is located in the Vaisigano River catchment (Figure 8). The intake will be located on the western branch of the river (Figure 9) and the powerhouse will be located on the middle branch (Figure 10), meaning that water will be diverted between these two tributaries via a proposed pipeline, headpond and penstock system. The Tiapapata SHP will be an entirely new development with a predicted power output of 0.48 MW.

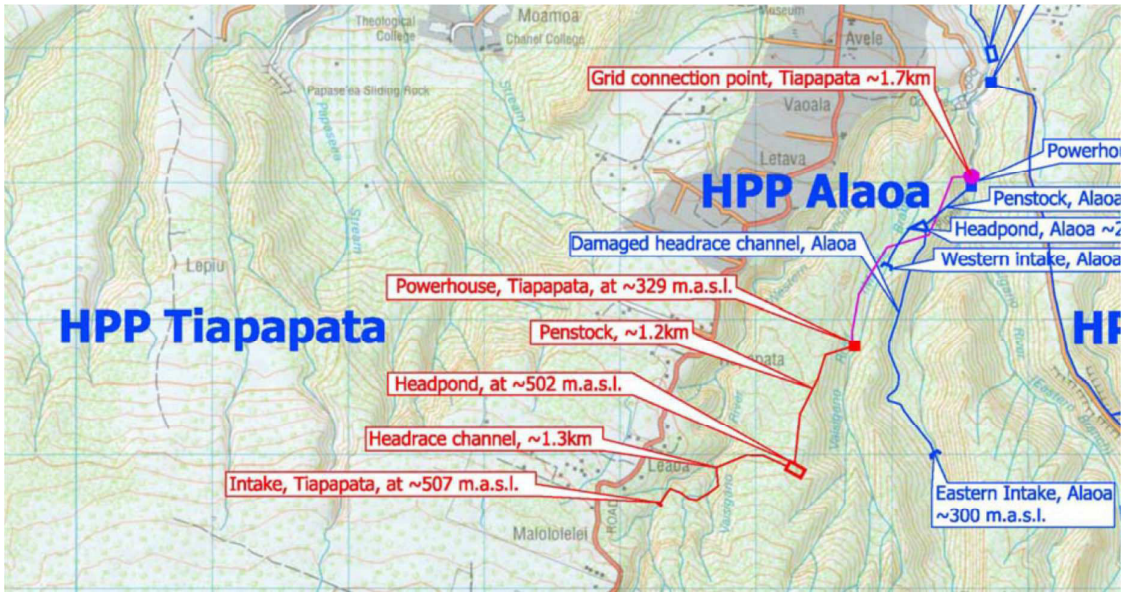

Figure 8: Tiapapata SHP location plan showing approximate route with original powerhouse location (Posh and Partners, 2013)

Figure 9: The proposed weir location on the Vaisigano west tributary

Figure 10: Existing road and plantation near the new (revised) powerhouse site

43. The proposed Tiapapata SHP development involves the following components (Posh and Partners, 2013):

(i) Installation of an in-stream weir to abstract 0.38 m^3/sec from the western branch of the Vaisigano River;

(ii) Construction of a 1.3 km buried 500 mm diameter pipeline (headrace) to transport water from the intake to a headpond located between the western and central tributaries of the Vaisigano River;

(iii) Construction of a headpond located on the eastern side of the ridge above the central branch of the river;

(iv) Installation of a 1.2 km underground penstock from the headpond to the powerhouse;

(v) Construction of a new powerhouse next to the Vaisigano River (central branch) with a short discharge canal to the river; and

(vi) Construction of a 1.7 km transmission line between the Fuluasou powerhouse and the existing Alaoa SHP powerhouse downstream.

44. Following ecological site visits and engineering investigations in September 2014, the location for the Tiapapata powerhouse was moved downstream closer to the existing Alaoa SHP. This location is modified habitat, requiring less vegetation clearance and provides increased head for the generation of electricity. Being closer to the Alaoa SHP also reduces the need for additional roads or maintenance buildings as the powerhouse can be managed by the existing staff at Alaoa.

45. Water for the Tiapapata SHP will be abstracted from the Fuluasou River at the site of the existing dam and be returned to the river at the powerhouse, located approximately 2.5 km downstream. The proposed rate of extraction is 0.38 m^3/sec.

46. The proposed Tiapapata SHP will be the fourth SHP to be located within the Vaisigano catchment. The Tiapapata powerhouse is located a short distance upstream of the Alaoa SHP which abstracts water from the central branch of the river and discharges to the eastern branch near the confluence with the main river. The Fale o le Fe'e SHP abstracts and discharges water to the eastern branch. The Samosoni SHP is located on the central branch of the river further downstream.

4. DESCRIPTION OF THE ENVIRONMENT

47. This section provides the baseline conditions of the physical, biological and socio-economic environment. The general description of Samoa-wide characteristics is sourced from the New SHP IEE (ADB, 2013). The descriptions of each subproject area are based on site visits and surveys in September 2014, and compilation of existing data.

4.1. Overview of Samoa's Socio-Economic Environment

4.1.1. Population

48. According to the 2011 Population and Housing Census, the total population of Samoa is 187,820 which comprised of 96,990 males, and 90,830 females. This is an increase of 3.9 percent of the population when compared with the population census in 2006 with 180,741 persons. The population is divided into four major statistical regions namely: Apia Urban Area (AUA), North West Upolu (NWU), rest of the Upolu and Savaii. The census 2011 shows that AUA region constituted 19 percent of the total population and 81 percent made up of rural population. The Samoan way of life is based on the traditional villages, managed and operated under the Village Council known as Pulega Mamalu a Aliii ma Faipule. The Village Council plays a significant role in the village such as establishing the village protocols and disciplinary actions to manage and maintain peace and harmony amongst the villagers.

49. Fuluasou and Tiapapata SHPs will provide the urban area of Apia with power. Fuluasou and Tiapapata SHPs are located within the peri-urban areas of Apia. Apia Urban Area (AUA) covers approximately 60 km2. Apia is characteristically urban with nonagricultural activities and is growing in population. Urbanization of the area is occurring with areas of Vaimauga East (comprising village settlements such as Laulii, Letogo, Vailele, Fagalii) and Faeata West (comprising village settlements such as Vaitele, Saina, Siusega, Ulululoa, Tuanaimato) with mixed land uses and less characteristic of the rural areas.

50. The 2011 census defines Apia as the districts of Vaigauga West and Faleata East with a population of 36,735 or 21% of the country's population. The census statistics show that the migration rate within Samoa to Apia was 17% (and North West Upolu was 19%) compared with the rest which is experiencing negative rates. This illustrates that the population of Samoa is becoming increasingly urban as people choose to move to Apia from other areas of Upolu and Savai'i.

51. Table 1 shows the four urban districts where the urban population has increased by more than 21 percent since 1981.

Table 1: Urban population change from 1981-2011 (PUMA, 2013)

Population Indicator	*1981 Pop.*	*1991 Pop.*	*2001 Pop.*	*2011 Pop.*	*Change*
Total Population	156,349	161,296	176,848	187,820	Growth
Apia Urban Area (two districts)	33,170	35,489	38,836	36,735	Decline
Greater Urban Apia (four districts)	45,881	48,616	60,872	73,470	Growth
% change (four districts)	NA 1971-1981	5.9% 1981-1991	25.2% 1991-2001	20.7% 2001-2011	Static
% share of national population (four districts)	29%	30%	34.4%	30%	Static

52. Within the villages of Apia, population growth rates vary widely with the most significant growth in the western parts of Apia. This change in the distribution of population towards the west has resulted in greater demand for services including power.

4.1.2. Economy and Infrastructure

Economy

53. Samoa's economy is dominated by subsistence agriculture and related activities, which support around three-quarters of the total population, including almost the entire rural population. The economy is also dominated by external aid and by remittances from Samoans residing and working abroad.

54. Samoa's economy has suffered from tropical cyclones. The destruction of tree crops, forests and infrastructure by cyclones has affected economic performance, especially primary production, and these impacts on the environment and the people could be felt for over three years after each cyclone. More recently, Cyclone Evan struck in December 2012. Its economic impact is still unknown but could be as significant as that which resulted from the 2009 Tsunami.

Transport

55. The two main islands of Samoa are well served by coastal ring roads and Upolu has three cross-island roads. The completion of the current road improvement program should see all the main roads upgraded and tar-sealed. The main international port is Apia, with an inter-island ferry service operating between Mulifanua at northwest Upolu and Salelologa at southeast Savai'i. The islands were once linked by air service between Faleolo near Mulifanua on Upolu and Maota near Salelologa on Savai'i, but this air service was discontinued in 2006. Another airport is located in North-West Savai'i at Asau. The main international airport is Faleolo Airport in northwest Upolu.

Water sources and supply

56. Historically, community water supplies from groundwater have been derived from coastal springs commonly found around the coastal villages. Groundwater is most readily available from freshwater lenses, but aquifer yields are constrained by the risk of inducing saline intrusion. With the high rainfall and virtually no drought period, the flows of such springs are sustained throughout the year. There are minor perched aquifers, held up by less permeable strata, which may be of local significance for inland springs.

57. Surface water is abstracted from catchment areas of the central highlands of Upolu and south-east of Savai'i. There are 28 surface water intakes on Upolu producing an average of 42.5 million m^3 of water per year and two on Savai'i (ADB, 2013). The Vaisigano catchment is the most critical catchment for Apia providing much of the water supply for the town. The SWA has a number of water supply intakes in the Vaisigano river and a main treatment works at Alaoa upstream from the damaged Fale o le Fe'e powerhouse.

Energy

58. The EPC operates 22kV transmission networks on Upolu and Savai'i and is in the process of completing staged upgrades to transmission and generation infrastructure through the ADB's Power Sector Expansion Project. While the bulk of Samoa's existing transmission network is via overhead cable, newer sections of the network include underground cabling.

59. Upolu currently has a combination of hydro-generation and diesel generation as the primary source of electricity. The main Upolu power station, located at Tanugamanono, has been in operation since the mid-1970s. EPC operates four run-of-river and one dam-based hydroelectric power stations with a total capacity of around 12 MW. Hydro generators on

Upolu generated a total of 35.248 GWh in 2010/11, representing 36% of Samoa's total electricity. This was slightly less than typical due to the prevailing drought conditions at the time.

60. Under the EPC Expansion Plan, a new diesel power station has been constructed at Fiaga to replace the existing Tanugamanono power station. The Fiaga power station consists of four new diesel engines (5.78MW each) all-generating at 11kV. Also, three existing diesel units will be relocated from Tanugamanono to Fiaga generating at 6.6kV.

61. New transmission lines of 33kV connect Fiaga Power Station to the new Fuluasou Substation, which supplies 22kV feeders. Tanugamanono will continue to operate as a substation serving distribution feeders and terminating transmission line from five existing hydro projects. A new underground transmission cable will connect Fuluasou to Tanugamanono. There will be a total of 10 feeders fed from three major substations supplying on Upolu.

62. The overwhelming majority of Upolu's load is located in the Apia area, with the remainder spread out around the coastal ring and the cross-island road. Some sections of the network experience poor power quality. Upolu had a peak demand of 13.5 MW in 2000.

4.1.3. Land Use

63. The landscape on Upolu generally consists of a narrow coastal plain, with rocky, rugged, volcanic terrains making up the inner parts of the islands. The vegetation in these areas is primarily composed of lowland and montane rain forests, with small areas of riverine, swamp, mangrove, and beach forest. The islands have undergone extensive deforestation, as a consequence of timber operations and clearance of land for agriculture. A large proportion of the lowland forest on Upolu has been cleared or highly modified, but the montane forests are less disturbed and have a rich variety of endemic flora and fauna.

64. Land use capability assessments in 1990 categorized Samoa's land into four main classes:

(i) Land with few limitations for agricultural use (39,600 ha);

(ii) Land with moderate limitations for agricultural use and few limitations for forestry use

(iii) Land with severe limitations for agricultural use and moderate to severe limitations for forestry use (59,400 ha); and

(iv) Land unsuitable for agricultural or forestry use (69,000 ha).

4.1.4. Land Ownership

65. There are four types of land ownership in Samoa with over 80% of total land being in customary ownership. The rest is divided between freehold, Government, and land vested in Samoa Trust Estates Corporation and Samoa Land Corporation. About 15% of land in Samoa is publicly owned and is generally known and recognized as Government land. Under statutory law, access to Government land is through lease or exchange of either freehold land or customary land. Freehold land takes up 4% of the total land area.

66. Landowners independently manage their own lands. These can be alienated in any manner desired by the owner, be it through sale, gifting, leasing, licensing or exchange. However, alienation to no citizens or overseas residents is prohibited under the Alienation of Freehold Land Act 1972 unless granted consent by the Head of State.

67. Customary land vested in accordance with Samoan custom and usage, are primarily managed by the matai who is the head of an extended family. As trustee for his/her family, the matai is responsible for the management and allocation of the land for various uses by

family members. These lands are protected from alienation by sale by the Constitution of the Independent State of Samoa 1960, except by way of lease or license in accordance with the Alienation of Customary Land Act 1965.

68. An emerging form of land tenure is leased land, which is land under lease arrangements between the lessor (landowner) and the lessee (applicant). All types of land, whether Government, freehold or customary, can be leased out to individuals, corporations and community or to private investors. In this regard, leasing can provide a viable option to access the land necessary for private sector growth. Ideally, leasing allows the use of land without alienating it from traditional landowners.

69. The Government closely controls the leasing of customary land. The Minister of MNRE, as the trustee of customary lands, is vested with the power to manage and administer lease arrangements between the leasor and the leasee. The Minister's involvement in land leasing is designed to ensure that landowners are protected from entering into inappropriate land deals or making unwise decisions, and to prevent alienation of customary land or ownership from the landowner.

4.1.5. Cultural Heritage and Resources

70. MNRE is responsible for the implementation of the Cultural Heritage Law. This law has not been revised as the Samoan Law Reform proposed to create a separate body, the Samoan Heritage Authority.

71. No cultural heritage sites are known to exist at the Fuluasou SHP site.

72. No cultural heritage sites are known to exist at the Tiapapata SHP site. The location of the intake is used as a swimming hole by local people. Fishermen catch and sell fish and freshwater prawns from the Vaisigano west tributary. Downstream of the Tiapapata powerhouse, the Alaoa east intake used to be used for waterfall hiking tours. The walks ceased when the intake was damaged in a cyclone.

73. The Samoan Code of Environmental Practices (2006) states that should any archaeological sites be discovered during gravel extraction works such work shall cease immediately and MNRE notified. On no account shall extraction work continue until authorized by MNRE. MNRE shall arrange an evaluation of the site in association with archaeologists before making any decision as to whether or not extraction works may proceed.

4.2. Overview of Samoa's Physical and Biological Environment

4.2.1. Climate

74. Samoa has a wet tropical climate with temperatures ranging between 17°C and 34°C and an average temperature of 26.5°C. Average humidity for the capital Apia is 83%. The average annual rainfall is about 2,000 mm with about three-quarters of the precipitation occurring during November- March.

75. Due to the predominance of moisture-bearing southeasterly trade winds, the northwest parts of the main islands, as well as the southeast side of Savai'i, are rain shadow areas, receiving about half the rainfall of the highland areas.

76. Samoa is affected by tropical cyclone patterns with the cyclone season in November to March. Cyclone Evan struck Upolu in December 2012. A weather monitoring mast at Mt. Fiamoe measured wind at a peak of 46m/s at 28m above ground, in a ten-minute average, with a maximum three-second gust of 59m/s being recorded in the same 10-minute interval. Cyclone Evan was thought to be the worst to hit Samoa in over two decades.

4.2.2. Geography

77. The topography of Samoa is rugged and mountainous with about 40% of Upolu and half of Savai'i is characterized by steep slopes descending from volcanic ridges. The interior of both main islands is still covered with mountain forests and, in the case of the highest peaks on Savai'i, covered in cloud forest.

78. These areas also contain volcanic peaks with the Upolu crestal ridge rising to 1,100m. Savai'i has more and younger volcanic cones with the highest peak reaching 1,848m at Mt. Silisili. Western Savaii and northwest Upolu are almost devoid of surface streams, corresponding to the rain shadow and sub-surface drainage.

4.2.3. Geology

79. The Samoan islands are composed almost wholly of basic volcanic rocks such as olivine basalt, picrite basalt and olivine dolerite. Most of the soils are formed from weathered basaltic volcanic flows, including lava, scoria and volcanic ash. Soils are generally clay in texture, free draining, porous and relatively shallow.

80. A coral reef surrounds the islands for nearly half of the coastline, except where there are steep cliffs and where young lava flows have filled the lagoon. Coral sand is found along most of the coastline, up to 5m above sea level. Alluvium is not common, but forms the parent material for the most versatile soils.

81. Earth tremors continue on a frequent basis in Samoa (as measured by the MNRE Meteorology Division at Mulinuu, Apia) and Samoa remains vulnerable to future volcanic activity. The last recorded eruptions were on Savai'i in 1902 and 1905-1911. The Samoa islands are subject of violent earthquakes. The last one occurred in 2009. While the epicenter was located far offshore, the tsunami resulting from this earthquake affected the south-western part of Upolu, destroying land along the coast and killing 115 people.

4.2.4. Biodiversity

82. Samoa's unique biodiversity is a result of its geographic isolation, which has led to the evolution of unique species and communities of plants and animals, many of which are indigenous to only one island or island group within the Pacific region. These species usually have small population sizes, making them particularly vulnerable to loss from over-exploitation and habitat degradation.

83. Some 11 terrestrial and 65 marine species found in Samoa are listed as globally threatened on the 2009 IUCN Red List of Threatened Species. It is thought that the true number of threatened species in Samoa is significantly higher than this.

Flora

84. It is estimated that Samoa supports 775 native vascular plant species of which approximately 30% of the angiosperms are endemic. There are about 280 genera of native angiosperms. In addition, there are about 250 introduced plant species and 47 threatened plants. A 1992 survey classified Samoa's vegetation into 19 plant communities within five broad categories, as follows:

(i) Littoral vegetation: Four communities of vegetation situated on the seashore were recognised: herbaceous strand or beach; littoral shrub-land; Pandanus scrub; and littoral forest whereby much of these types have been lost or degraded. The best remaining examples are at Aleipata Islands, O Le Pupu-Pue National Park and sites on the South (central) coast of Savai'i.

(ii) Wetland vegetation: Four communities are recognised: coastal marsh; montane marsh; mangrove scrub/forest; and swamp forest. There has been a very serious loss of wetlands, particularly in the lowlands, and only a few intact areas of each type remain.

(iii) Rainforest: Four communities are recognised on an altitudinal gradient: coastal; lowland; montane; and cloud forest. Cloud forests are restricted to Savai'i with the summit reaching over 1800 m. The few remaining significant areas of coastal forest are at the Aleipata Islands, Apolima and possibly Tafua Crater. The montane habitat is considered to have the richest flora of any forest community in the country. On Upolu, no montane sites were found that had good forest or were recovering (from cyclone damage) and there was substantial impact from several weeds. On Savai'i, the forests are recovering faster at higher elevations where there is little human activity, whereas the process is much slower at lower areas where forest cutting has added to the problem.

(iv) Volcanic vegetation: Two communities, lowland volcanic scrub and upland volcanic scrub, are recognized and these occur only on recent lava flows on Savai'i.

(v) Disturbed vegetation: Four communities, derived from a combination of human activities and weather, are recognized: managed land; secondary scrub; secondary forest; and fern-lands.

85. About 25% of the plants found in Samoa are endemic and 32% are endemic to the Samoan archipelago. A further 500 or so species of plants have been introduced to the islands since the first Samoans brought the coconut, taro and other species for cultivation about 3,000 years ago. Currently about half the plants in Samoa are exotic. While some of these plants are beneficial for agriculture, others are considered destructive weeds.

Fauna

86. Samoa's fauna consists of 21 butterfly species, 11 species of reptiles, 43 resident bird species eight of which are endemic, and three flying fox species.

87. **Avifauna**. Bird Life International records 81 bird species in Samoa. This includes 31 breeding native land birds, one possibly extinct native land bird (the Samoan Moorhen), 4 breeding introduced birds, approximately 10 breeding seabirds and 35 migrants or vagrants. Nine of the land birds are endemic to Samoa and another seven are regional endemics or near endemics.

88. Twelve species are globally considered to be Restricted Range species, but not classed as of immediate conservation risk. Six species are considered to be of national conservation concern as determined through the National Biodiversity Strategy and Action Plan.

89. **Sea and Shore Birds**. There is a gap in the knowledge of population numbers and breeding status of seabirds in Samoa making it difficult to review and update the existing list of seabird species of conservation concern. Based on the available literature, approximately 12 seabird and shorebird species that are of global or national conservation concern have been recorded in Samoa. Several seabird species of global concern are either migrants, visitors or status unknown in Samoa. These include the Phoenix Petrel (*Pterodroma alba*); Tahiti Petrel (*Pseudobulweria rostrata*); Collared Petrel (*Pterodroma brevipes*) and Polynesian Storm Petrel (*Nesofregetta fuliginosa*). The globally threatened Bristle-thighed Curlew (*Numenius tahitiensis*) is a regular northern winter migrant in small numbers.

90. **Land Mammals**. There are four species of native mammal present in Samoa, in addition to introduced pests. The Tongan or white-necked flying-fox (*P. tonganus*) is the most widespread. The Samoan flying fox (*Pteropus samoensis*) is relatively common but is thought to be in slow decline. A small insectivorous bat, the sheath-tailed cave bat (*Emballonura semicaudata*) is now believed to be extinct in Samoa. Another bat species, *Insular myotis* may be present. Flying foxes are important for the long-term survival of the forests as they pollinate the flowers of many species and also disperse the seeds of the fruits that they eat throughout the forest. It has been estimated that almost one in three Samoan forest trees depend on flying foxes in some way.

91. **Reptiles.** There are at least nine species of terrestrial reptiles in Samoa including geckos and skinks.

4.2.5. Protected Areas

92. Samoa has three National Parks and 22 reserves and conservation areas totalling 10,794 ha or 5% of the total land area (MNRE, 2009). All forest area outside protected forest is by definition considered production forest. In the marine environment, Samoa has one marine reserve, two marine protected areas and an estimated 71 village fisheries marine reserves. The entire Samoan EEZ is a declared sanctuary for whales, dolphins, turtles and sharks (MNRE, 2009).

93. The first National Park established in Samoa was the O Le Pupu-Pue National Park in Togitogiga, in 1978. Two new National Parks were established in 2003; Mauga o Salafai, the first to be located on Savai'i, and Lake Lanoto'o which is the first Ramsar Convention Wetland site in Samoa, and is located at the center of the volcanic ridge on Upolu.

94. Key Biodiversity Areas (KBA) support the regular occurrence of one or more globally threatened species assessed as critically endangered, endangered, or vulnerable according to the IUCN Red List. The eight terrestrial KBAs identified in Samoa cover a total of 940 km^2 or approximately a third of the total land area of Samoa, including representation of 12 of the 13 native terrestrial vegetation communities in the country. The seven marine KBAs cover approximately 173 km^2 or 23% of the inshore reef area of Samoa.

95. Currently, six of the eight terrestrial KBAs and three of the seven marine KBAs have been completely or partially established as conservation areas by the GoS or by local village communities, two additional KBAs have small community based fisheries sites within their boundaries.

4.3. Fuluasou SHP Site

96. The Fuluasou SHP is an existing scheme which is to be rebuilt. The environment around the scheme is highly modified by urban development, water abstraction and previous SHP construction.

4.3.1. Protected Areas

97. The Fuluasou SHP is located on land owned by the Government of Samoa, excluding one private property that has an easement for the penstock route. The site of the Fuluasou SHP has no legal protection for conservation purposes. The closest legally protected area is the Mount Vaea Scenic Reserve located on the summit of Mount Vaea approximately four kilometres to the east. This area includes the Stevenson Memorial Reserve which is the burial ground of author Robert Louis Stevenson.

98. The Fuluasou dam is located on the edge of the Apia Key Biodiversity Area (KBA). The dam and beginning of the penstock route is contained within the KBA, although the powerhouse and the majority of the penstock route sites outside of the KBA boundary.

99. The Apia KBA totals 8,335 hectares and supports seven globally or nationally threatened species: Samoan bush palm, tooth-billed pigeon, ground dove, mao, Samoan broadbill, Samoan flying fox and the land snail *Thaumatodon hystrucelloides*. The KBA is threatened by invasive species, hunting and development (Conservation International et al., 2010).

4.3.2. Catchment and Hydrology

100. The Fuluasou SHP is located on the Fuluasou River. The Fuluasou River catchment arises in the forested central mountains of Upolu around Lake Lanoto'o. There are two unnamed branches of the river which converge above the site of the dam. The eastern branch of the river has a water intake for the Samoa Water Authority (SWA). A second SWA intake is located at the existing dam.

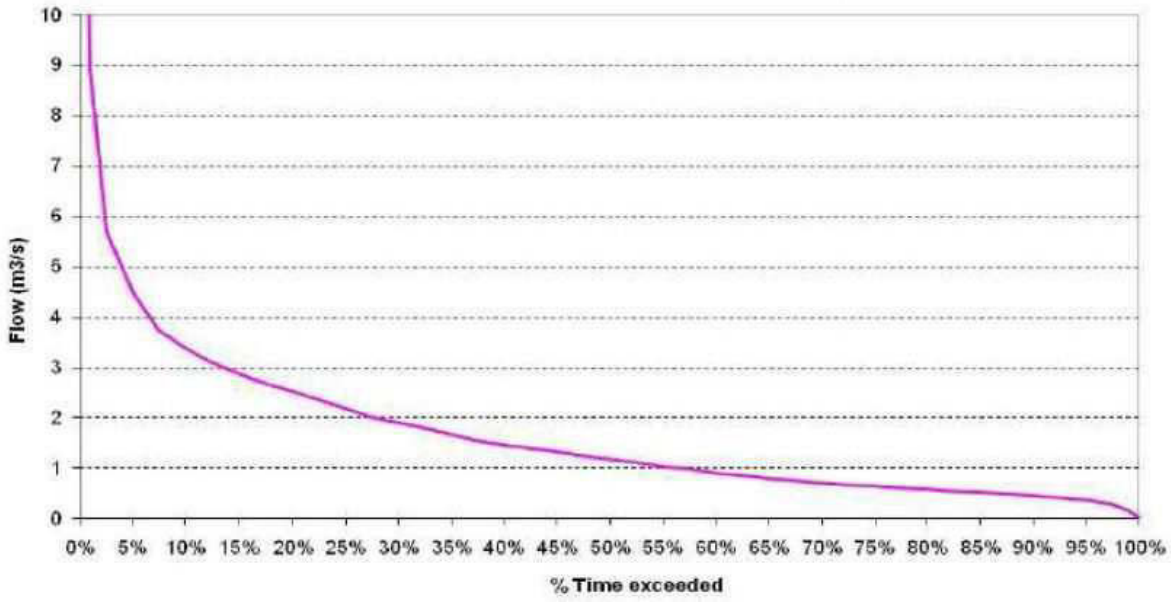

Figure 11: Fuluasou flow duration curve (Egis International, 2011)

101. The catchment of the existing Fuluasou dam is 17.2 km2 (Egis International, 2011). Flows range from 0.04 m3/sec to over 10 m3/sec, with a median discharge rate of 1.18 m3/sec (Figure 11).

102. During the site visit in September 2014 the river was flowing at the dam (Figure 12) but became dry from upstream of Papaseea Road to the coast (Figure 13).

Figure 12: Fuluasou dam reservoir

Figure 13: Dry riverbed at the powerhouse

4.3.3. Fish and Aquatic Macroinvertebrates

103. A survey of freshwater ecology at the Fuluasou reservoir and powerhouse location was conducted in August 2013 (Atherton, Jenkins, & Stirnemann, 2013).

104. Two introduced pest fish were found, *Poecilia mexicana* in the reservoir and *Gambusia affinis* at the powerhouse. No native species were found during this survey, although in September 2014 an unidentified native goby (possibly *Sicyopterus sp.*) was observed in the river near Papaseea Road (K. Hall, MWH, pers. obs.).

105. A total of three crustacean species were found, comprising of two species at each of the two monitored sites (Atherton, Jenkins, & Stirnemann, 2013). All crustacea recorded were common indigenous species.

106. No aquatic snails were recorded at either site.

107. During the August 2013 survey the Fuluasou River at the powerhouse was 15 cm deep, had a lot of rubbish and smelled of faecal contamination (Atherton, Jenkins, & Stirnemann, 2013). During September 2014 the river at this location was completely dry (Figure 13). At the dam site, the river was flowing on both occasions.

108. The Fuluasou dam is a barrier to non-climbing fish species.

109. The dam has silted up over time and was partially dug out by the SWA in 2013, causing significant turbidity downstream (Atherton, Jenkins, & Stirnemann, 2013). More extensive excavation is required to regain storage for the new Fuluasou SHP (MWH, 2014).

4.3.4. Vegetation

110. An aerial photograph and map of vegetation types at the Fuluasou SHP is shown in Figure 14 and Figure 15, respectively.

111. The powerhouse and lower portion of the penstock route consist of urban land use, crossing the Faleata Golf Course (Figure 16), a private estate called the Riverside Complex and single residential house built on government land. This area consists of open ground, dwellings, roads, mown grass and some mature exotic trees and crops. The small area around the powerhouse consists of exotic grasses, weed trees (primarily *Castilla elastica*) and climbers, however the SWA has recently planted some native seedlings (Figure 17). These are spaced about 2-5 metres apart and are less than a metre tall.

112. Upstream of Papaseea Road an unformed EPC access road follows the existing penstock route to the dam. The road follows the river bank and penstock with adjacent secondary vegetation, dominated by exotic grasses, groundcovers and weeds with Panama rubber trees (*Castilla elastica*), African rubber tree (*Funtumia elastica*) and albizia (*Falcataria moluccana*). Occasional crops and wild ornamental species also occur.

113. The higher sides of the valley immediately west of the access road include mixed lowland forest dominated by exotic trees, but with a small portion of native species such as tava (*Pometia tomentosa*), maota mamala (*Dysoxylum samoense*), lopa (*Adenanthera pavonina*), fu'afu'a (*Leinhovia hospita*), tavai (*Rhus taitensis*) and giant fern (*Angiopteris evecta*). The valley-side vegetation has been modified or felled in some places (Figure 19).

114. Lowland rainforest occurs upstream of the dam. This is still dominated by exotic trees including Panama rubber tree, albizia, African rubber tree, African tulip (*Spathodea campanulata*), with lower growing giant taro (*Colocasia gigantea*) and ornamentals. Native trees include tava, maota mamala, fu'afu'a, malili (*Terminalia richii*), moso'oi (*Cananga odorata*) and magele (*Trema cannabina*) with perching lilies (*Asplenium nidus*) and ferns, including giant fern.

115. Riparian vegetation in the two tributaries upstream is partially modified. The downstream portion of the western tributary is occupied by the reservoir, and crops have been planted along the banks (Figure 20). The eastern tributary (Figure 21) has a SWA reservoir with road access, and there was eviednece of human habitation, walking and hunting tracks.

116. No rare or endangered plants have been recorded in the project area (Atherton, Jenkins, & Stirnemann, 2013).

Figure 14: Aerial photograph of the Fuluasou SHP (MWH, 2014)

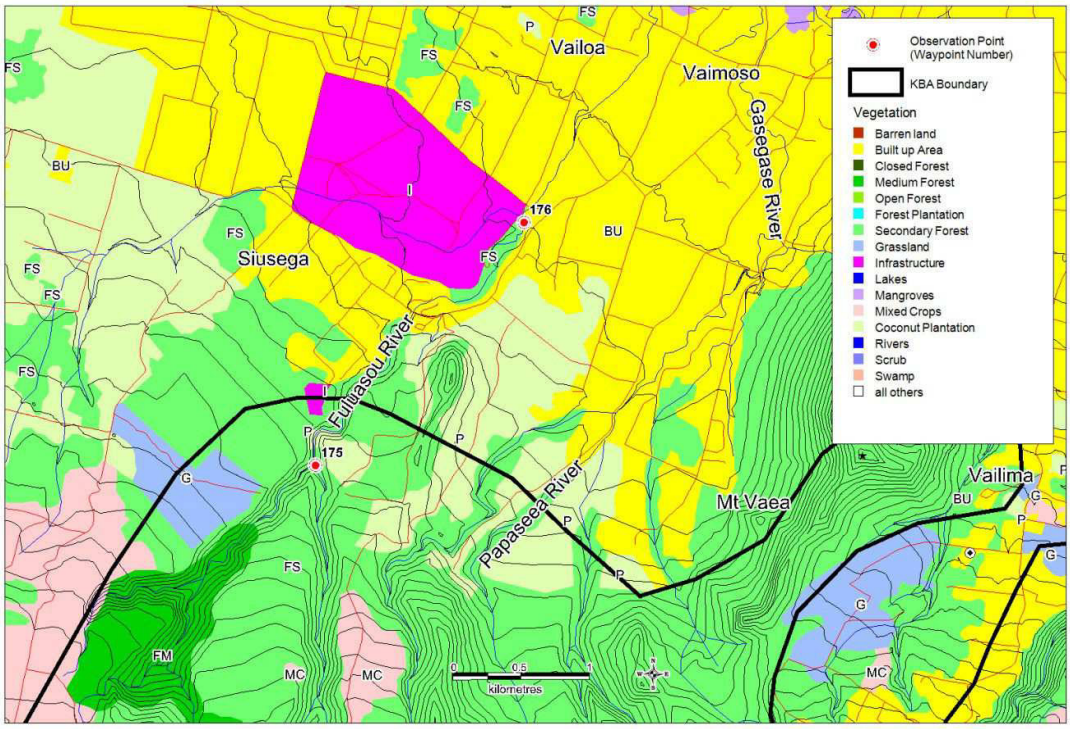

Figure 15: Fuluasou SHP vegetation map (Atherton, Jenkins, & Stirnemann, 2013)

Figure 16: Faleata Golf Course fairway viewed from the Fuluasou river bank

Figure 17: One of the buildings at the powerhouse site with SWA plantings

Figure 18: Existing penstock overgrown by rubber trees

Figure 19: Felled trees at Samoa Tradition Resort above the river and access road

Figure 20: Fuluasou reservoir and true left tributary looking upstream

Figure 21: True right tributary near SWA intake showing mainly exotic canopy

4.3.5. Avifauna

117. An avifauna survey at the Fuluasou SHP site in August 2013 identified two exotic and 12 native bird species (Atherton, Jenkins, & Stirnemann, 2013).

118. A total of 20 avifauna species were identified in the September 2014 field work, consisting of three exotic and 17 native bird species (Table 2).

119. Ten avifauna species were recorded in 2014 that were not observed in 2013: brown noddy, crimson-crowned fruit dove, domestic chicken, great frigatebird, Pacific pigeon, reef heron, white-tailed tropic bird, white-rumpted swifted, white tern and white-throated pigeon. Four species were observed in 2013 that were not recorded in 2014: scarlet robin, Samoan fantail, Polynesian triller and blue-crowned lorry. The difference in species is likely to be the result of differing survey times and methodologies, rather than changes in habitat type or quality.

120. One near-threatened species, the Samoan triller (*Lalage sharpei*) is present and occurred during both surveys. This endemic species occurs in forested areas, forest edges and clearings. It is relatively uncommon on Upolu but more widespread and common on Savai'i (Watling, 2004).

121. No birds of special conservation interest have been recorded at this site (Atherton, Jenkins, & Stirnemann, 2013).

Table 2: Avifauna species detected during surveys at Fuluasou SHP, September 2014

Scientific Name	English Name	Samoan Name	Threat Status (IUCN)	Power-house 11/09/14 9:10 GPS 001	Penstock 11/09/14 9:59 GPS 002	Reservoir 11/09/14 11:03 GPS 004	Other - - -	Total
Acridotheres tristis	Common mynah	Maina fanua	Introduced		X		X	**X**
Aerodramus spodiopygius	White-rumpted swiftlet	Pe'ape'a	Least concern			X	X	**X**
Anous stolidus	Brown noddy	Gogo	Least concern			X		**X**
Aplonis atrifusca	Samoan starling	Fuia	Least concern	X	X	X		**X**
Aplonis tabuensis	Polynesian starling	Fuia vao	Least concern	X				**X**
Columba vitiensis	White-throated pigeon	Fiaui	Least concern				X	**X**
Dacula pacifica	Pacific pigeon	Lupe	Least concern				X	**X**
Egretta sacra	Reef heron	Matu'u	Least concern				X	**X**
Erythrura cyaneovirens	Red-headed parrotfinch	Segaula	Least concern					
Foulehaio carunculata	Wattled honeyeater	Iao	Least concern	X	X			**X**
Fregata minor	Great Frigatebird	Atafa	Least concern				X	**X**
Gallirallus philippensis	Banded rail	Ve'a	Least concern				X	**X**
Gallus gallus	Domestic chicken	Moa	Introduced	X				**X**
Gygis alba	White tern	Manusina	Least concern		X	X		**X**
Gymnomyza samoensis	Mao	Ma'oma'o	Endangered					
Lalage sharpei	Samoan triller	Miti	Near threatened	X	X			**X**

Myiagra albiventris	Samoan broadbill/flycatcher	Tolaifatu	Near threatened					
Myzomela cardinalis	Cardinal honeyeater	Segasegamau'u	Least concern			X	X	**X**
Pachycephala flavifrons	Samoan whistler	Vasavasa	Least concern				X	**X**
Petroica multicolor	Scarlet robin	Tolaiula	Least concern					
Phaethon lepturus	White-tailed tropic bird	Tava'e	Least concern				X	**X**
Porphyrio porphyrio	Purple swamphen	Manuali'i	Least concern					
Ptilinopus porphyraceus	Crimson-crowned fruit dove	Manutangi	Least concern	X	X	X	X	**X**
Pycnonotus cafer	Red-vented bulbul	Manu palagi	Introduced	X	X			**X**
Rhipidura nebulosa	Samoan fantail	Se'u	Least concern					
Todirhamphus sp.	Kingfisher	Ti'otala	Least concern			X		**X**
Turdus poliocephalus	Island thrush	Tutumalili	Least concern					
Vini australis	Blue-crowned lorry	Sega vao	Least concern					
			TOTAL:	**7**	**7**	**7**	**11**	**20**

4.3.6. Other Fauna

122. Pacific black skinks (*Emoia nigra*) and azure tailed skinks (*Emoaia impar*) were present in the project area (Figure 22).

123. No introduced pests were observed during the 2013 and 2014 site visits.

Figure 22: Azure-tailed skink basking on rocks in the dry Fulusou riverbed

4.4. Tiapapata SHP Site

4.4.1. Protected Areas

124. The proposed Tiapapata SHP partially located on land owned by the Government of Samoa and partially located on private land. The site has no legal protection. The closest legally protected area is the Mount Vaea Scenic Reserve located on the summit of Mount Vaea approximately three kilometres to the north (Figure 23). This area includes the Stevenson Memorial Reserve which is the burial ground of author Robert Louis Stevenson. The O le Pupu Pue National Park is located approximately five kilometres to the south-east and is immediately adjacent to the Vaisigano catchment.

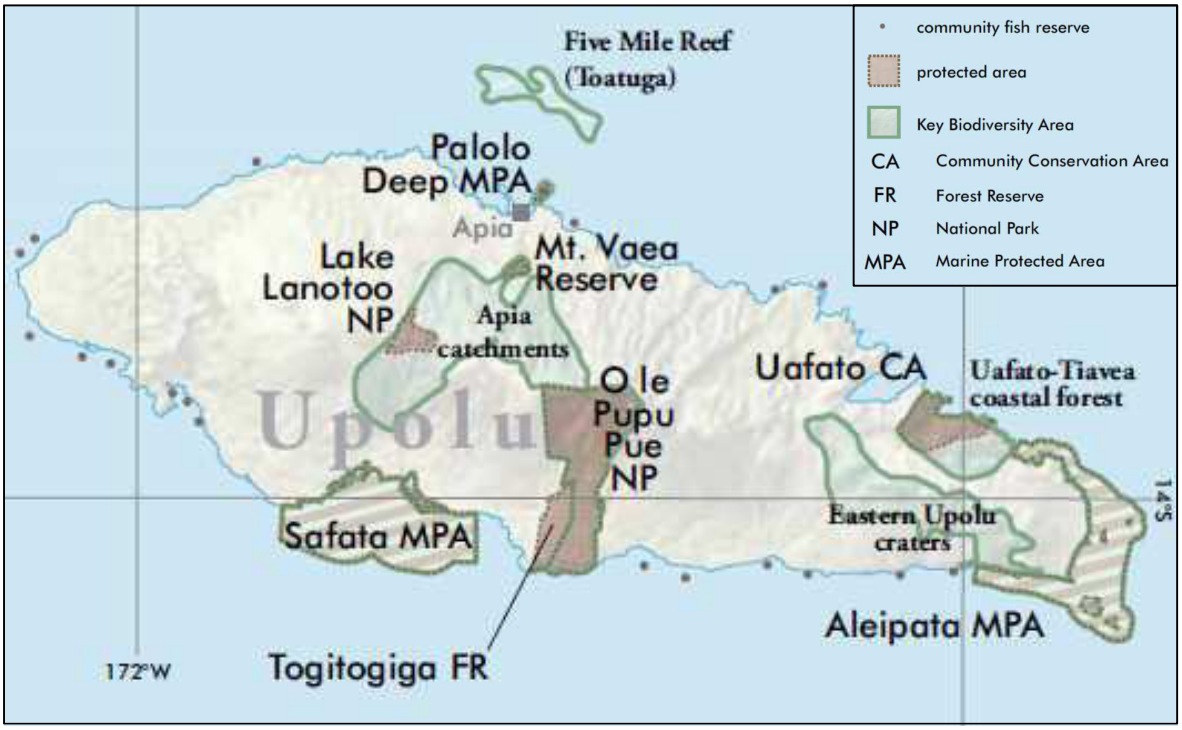

Figure 23: Protected areas and Key Biodiversity Areas on Upolu (Conservation International et al., 2010)

125. The Tiapapata SHP is located within the Apia Catchments Key Biodiversity Area (KBA). A KBA is a site of critical importance for the conservation of globally important biodiversity (Conservation International et al., 2010). KBAs support the regular occurrence of one or more globally threatened species.

126. The Apia KBA totals 8,335 hectares and includes the mid to high elevation portions of catchments that drain to Apia, including the Vaisigano River. There are seven globally or nationally threatened species found within this KBA: Samoan bush palm, tooth-billed pigeon, ground dove, mao, Samoan broadbill, Samoan flying fox and the land snail *Thaumatodon hystrucelloides*. The area is threatened by invasive species, hunting and development.

127. The Samoa Water Authority is looking to protect the upper Vaisigano catchment for water supply purposes, above the site for the SHP. It is understood that the government is looking to conduct a land swap with local landowners in order to secure the area (Niualuga Evaimalo, MNRE, pers. comm. 09/09/14).

4.4.2. Catchment and Hydrology

128. The proposed Tiapapata SHP is located on the western branch of the Vaisigano River. The Vaisigano catchment is 37.18km^2 in area (Figure 24) and arises in the mountains of Upolu around Mount Le Pue and Mt Fito (Atherton, Jenkins, & Stirnemann, 2013). The upper catchment is forested, grading to clearings for cattle grazing (SPC et al., 2012), with the city of Apia in its lower reaches. The catchment is used for reticulated water supply and electricity generation, and is known to be prone to flooding (SPC et al., 2012).

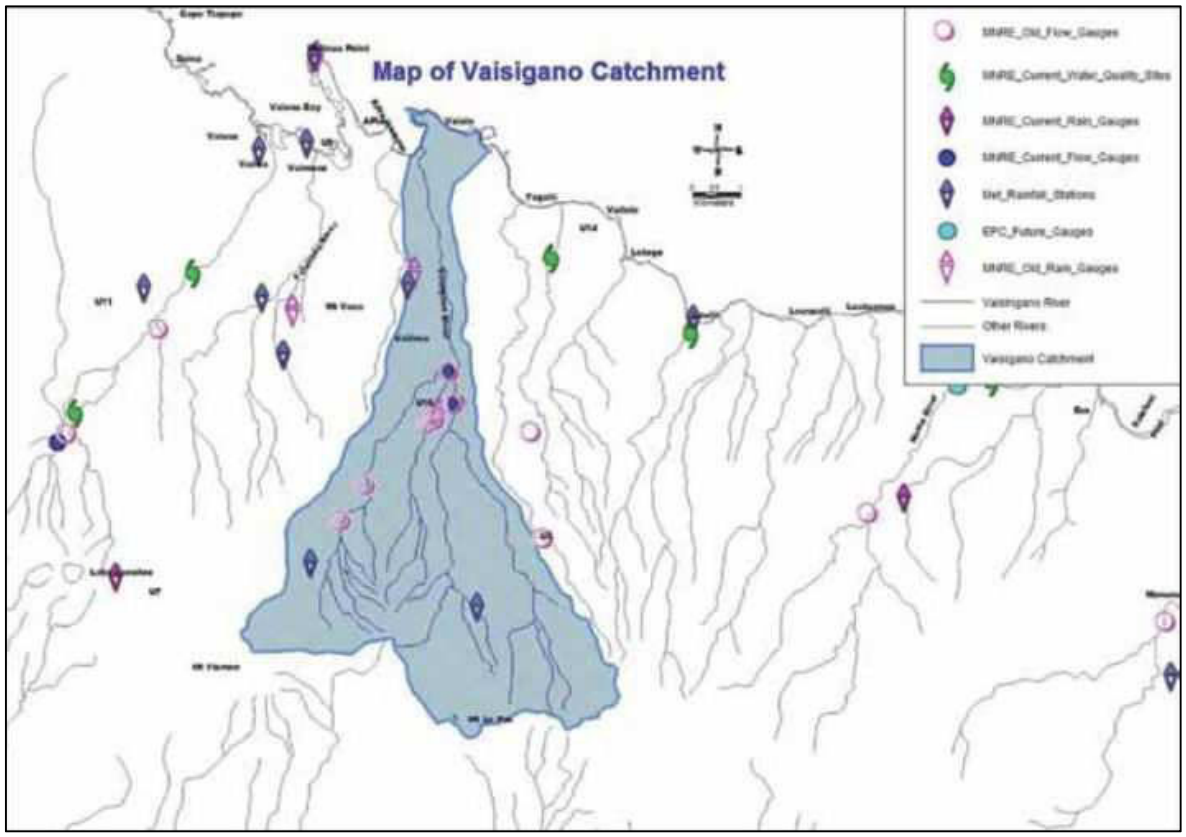

Figure 24: Vaisigano catchment, Upolu (SPC et al., 2012)

129. The Vaisigano catchment has three main river branches; eastern, middle and western. The MNRE Water Resources Unit has installed hydrological stations at seven locations in the Vaisigano catchment, three of which are currently monitored (SPC et al., 2012). The closest guage to the proposed Tiapapata SHP is Alaoa West, located downstream of the Tiapapata intake and a short distance above where the western branch converges with the central branch of the river (3°52'22.897056''S 171°45'20.0304''E).

130. Hydrological data from the site of the proposed Tiapapata SHP intake indicate flows range from 0.00 m^3/sec to over 4.44 m^3/sec, with a median discharge rate of 0.24 m^3/sec (Figure 11: Fuluasou flow duration curve).

131. During the site visit in September 2014, the river was flowing for the entire observed length from the SHP intake location to the coast.

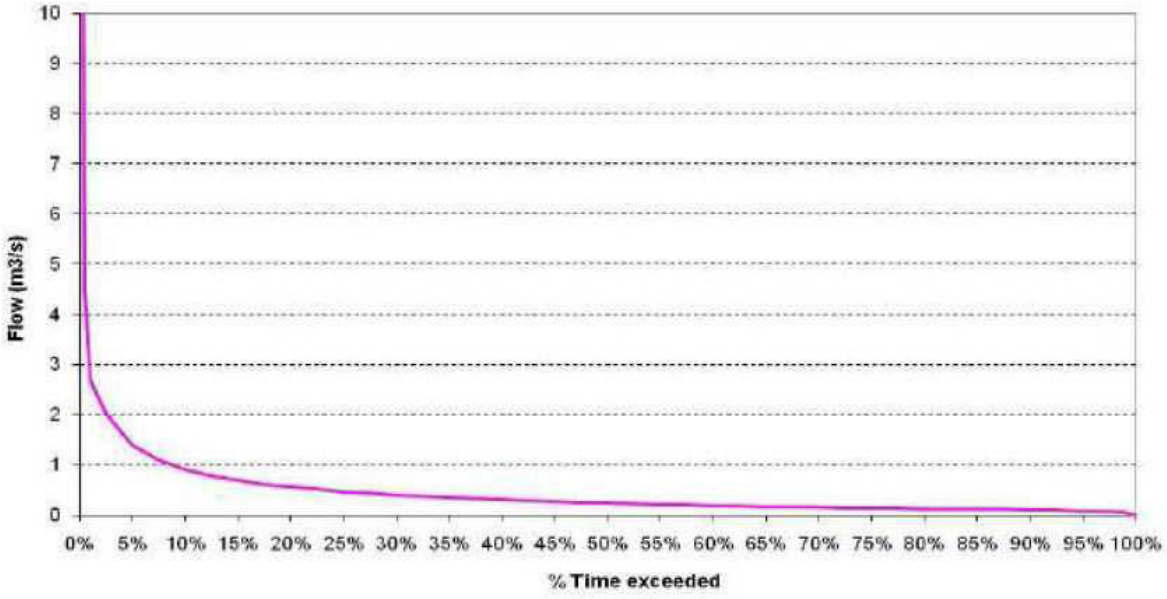

Figure 25 : Tiapapata flow duration curve (Egis International, 2011)

132. The proposed Tiapapata SHP would be the fourth hydroelectric power station to be installed in the Vaisigano catchment. The three existing stations are Alaoa on the central branch (1MW), Fale o le Fe'e on the eastern branch (1.7MW), and Samasoni on the main river near the coast (1.7MW) (Figure 26). Tiapapata SHP would direct water from the western branch and discharge to the central branch, effectively increasing the generation capacity of the Alaoa SHP downstream.

133. The Alaoa SHP is the oldest SHP in Samoa and it extracts the entire river flow of the Vaisigano central branch under normal flows. Excess water discharges downstream via an engineered chute, however there is no natural stream connection and little or no ability for fish passage. Flood flows are designed to bypass the scheme downstream via an artificial channel and dam which is currently damaged.

134. The Vaisigano catchment also provides much of the water supply for the city of Apia. The Samoa Water Authority (SWA) has a number of water supply intakes in the Vaisigano river including one upstream from the proposed intake for the Tiapapata HPP. The main water treatment plant is at Alaoa, downstream from the proposed powerhouse for the Tiapapata SHP (Atherton, Jenkins, & Stirnemann, 2013). The SWA is looking to protect land in the upper catchment in order to preserve the water quality in the river (Niualuga Evaimalo, MNRE, pers. comm. 09/09/14).

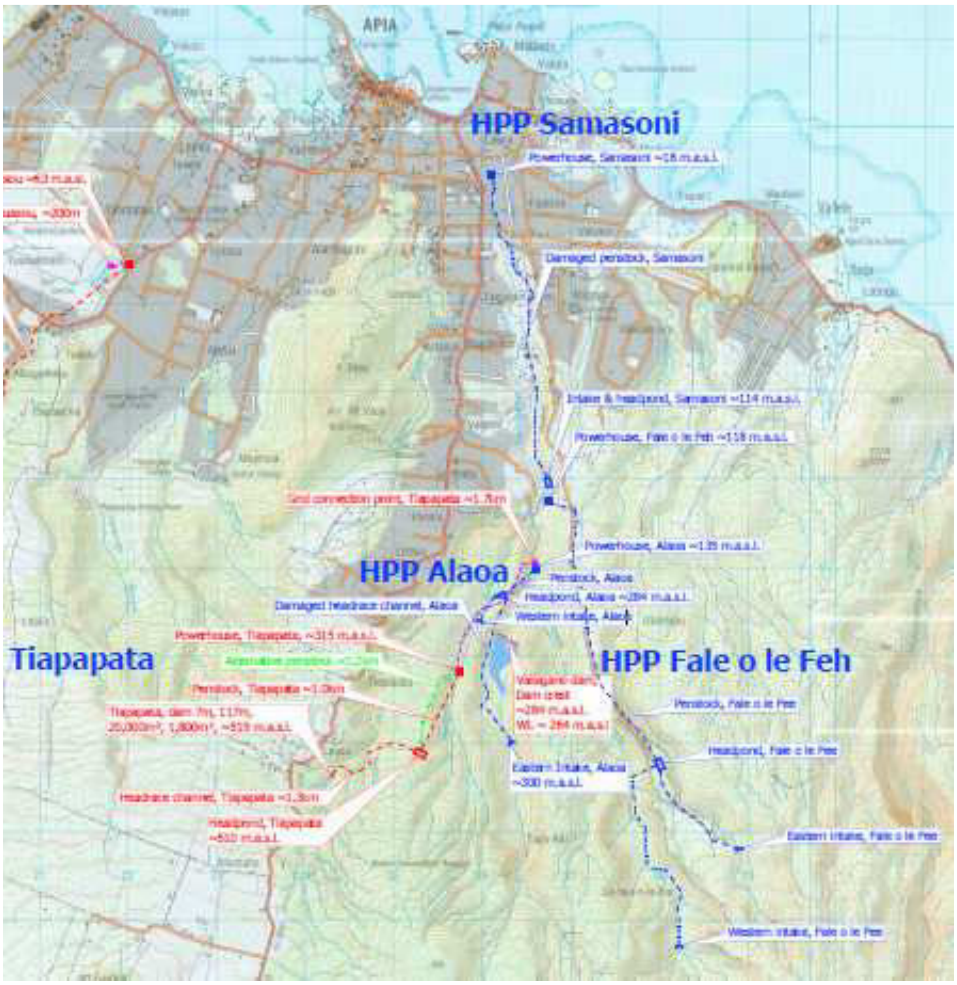

Figure 26: Location of existing and proposed SHPs in Vaisgano catchment

4.4.3. Fish and Aquatic Macroinvertebrates

135. A survey of freshwater ecology at the Tiapapata intake and powerhouse location was conducted in 2013 (Atherton, Jenkins, & Stirnemann, 2013). The intake is located on the Vaisigano western branch and the powerhouse is located on the Vaisigano central branch.

136. Two species of fish were found in the stream near the intake location: the red-tailed goby (*Sicyopterus lagocephalus*) and *S. pugnans* (Atherton, Jenkins, & Stirnemann, 2013). Red-tailed gobies are diadromous meaning that they migrate between fresh and salt water as part of their life cycle, requiring adequate fish passage (www.iucnredlist.org/details/196371/0). *S. pugnans* may also be migratory (www.iucnredlist.org/details/196368/0). Both fish are common indigenous species that inhabit fast-flowing streams with rock and gravel substrates. A series of waterfalls downstream of the proposed intake location are barriers to non-climbing fish, but passable for climbing species. Fish biodiversity at this site was considered to be low (*ibid.*).

137. No fish were found at the Tiapapata powerhouse location on the central branch (Atherton, Jenkins, & Stirnemann, 2013). It is uncertain if this is because of a lack of fish, or possibly due to the shallower, rockier substrate which is more difficult to fish via netting. An alternative method, such as electric fishing, may yield higher diversity at this site. It is also likely that the downstream Alaoa SHP is adversely affecting fish recruitment into this tributary as it is a barrier to fish passage.

138. A total of seven crustacean species were found during the surveys, comprising of five species at each of the two monitored sites (Atherton, Jenkins, & Stirnemann, 2013). All crustacea recorded were common indigenous species. Crustacea biodiversity at both sites was considered to be high (*ibid.*).

139. No aquatic snails were recorded at either site.

140. The red-tailed goby and *S. pugnans* are small fish which are unlikely to be key food sources, but may be harvested as juveniles during upstream migrations (www.iucnredlist.org). Freshwater prawns occur in both tributaries and are often harvested for food. Prawns are caught from the Vaisigano western branch and sold commercially by several fishermen (P. Anderson, SPREP, pers. comm. 16/09/14).

Figure 27: The Vaisigano western branch near the proposed intake

Figure 28 : The Vaisigano central branch near the proposed powerhouse

4.4.4. Vegetation

141. An aerial photograph and map of vegetation types at the Tiapapata SHP is shown in Figure 29 and Figure 30, respectively.

142. Vegetation within the project footprint is mainly regenerating (secondary) forest with areas of open forest and clearings at the southern and northern end. Evidence of human modification is present near to the Alaoa SHP which is more accessible on foot, and at the intake site where there is a SWA access road. In addition, a section of the proposed penstock route was once used as a coffee plantation.

143. The northern end of the Tiapata SHP footprint is a proposed transmission line and road to connect the Alaoa SHP to the Tiapapata powerhouse. There is an existing road that runs from the Alaoa SHP to the river and this previously crossed the river via a culvert (long since destroyed). Vegetation across the river is already cleared and modified with exotic weeds and food crops. Plant species comprise invasive groundcovers, grasses and shrubs, including mile-a-minute (*Mikania micrantha*), *Ipomoea* spp., black-eyed susan (*Thunbergia alata*), queen of the night (*Cestrum nocturnum*), prickly solanum (*Solanum torvum*) and native merremia (*Merremia peltata*), along with coconuts, taro and breadfruit.

144. Riparian vegetation along the Vaisigano central tributary comprises of open forest with clearings and sparse wild and cultivated crops, including taro, banana and coconut trees (Figure 31). Trees consist of Panama rubber trees, African tulip, albizia, and wild bush banana, with occasional tava and *Dysoxylum spp.*. Away from the river on steeper valley

slopes and ridges the vegetation is dense and has higher species diversity. The area along the Vaisigano central tributary will be unaffected by the proposed development.

145. At the original proposed powerhouse site (Figure 33), the vegetation is dense lowland rainforest, but is still dominated by exotic species. The site includes dense wild ginger, bush banana, queen of the night, black rubber tree, and cinnamon (*Cinnamomum verum*), with native trees tava, lau fatu (*Macaranga stipulosa*), asi (*Sysygium inophylloides*), ‘atone (*Myristica hypargyraea*), moso’oi (*Canaga odorata*), ferns and climbers.

146. The revised powerhouse site is located further downstream and closer to the Alaoa SHP headpond (Figure 29 and Figure 37). This area is an open clearing discussed in paragraph 143 above. The vegetation consists of exotic groundcovers and weeds with emergent coconut trees and very little native vegetation.

147. Between the proposed Tiapapata powerhouse and intake the vegetation is less accessible and less modified by people. MNRE staff report that the area is used for hunting. A shotgun shell was found during the site visit.

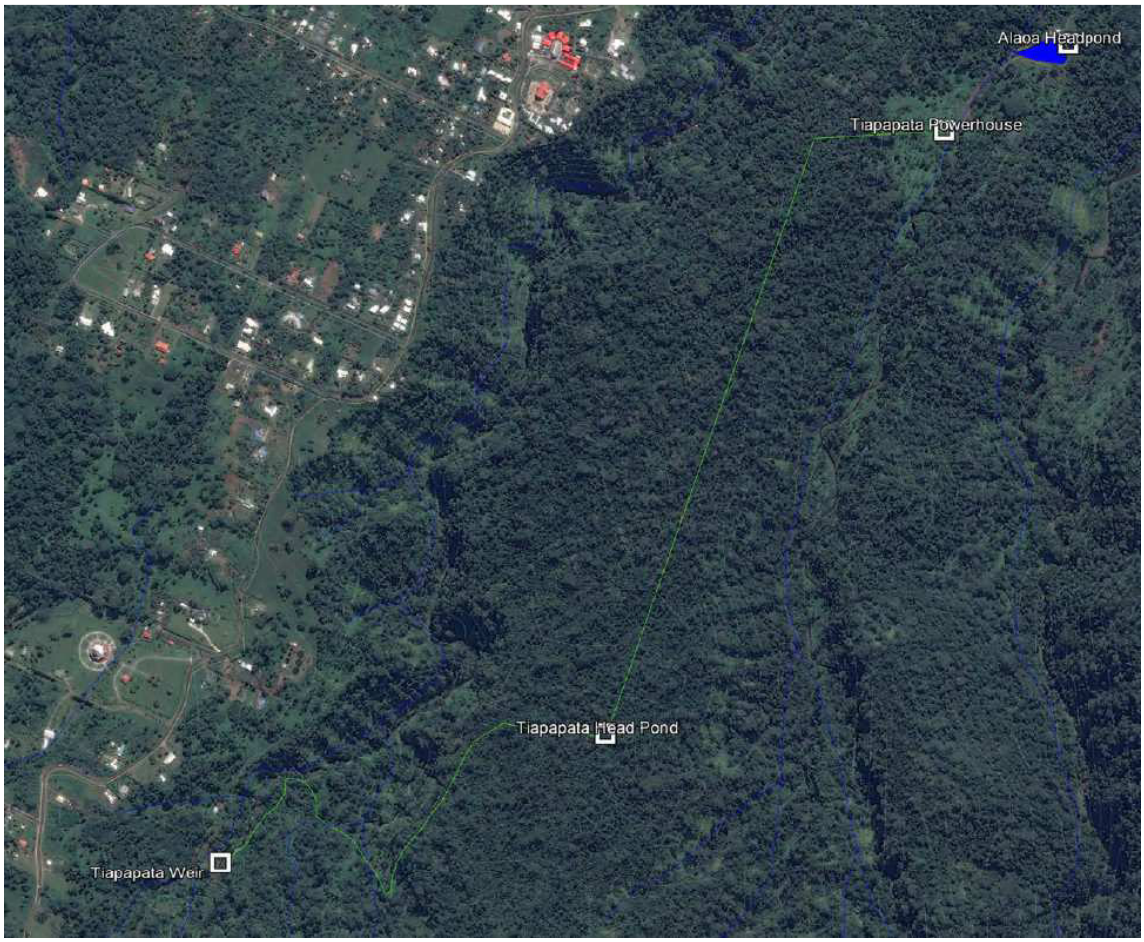

Figure 29: Aerial photograph of the Tiapapata SHP route showing the revised powerhouse location

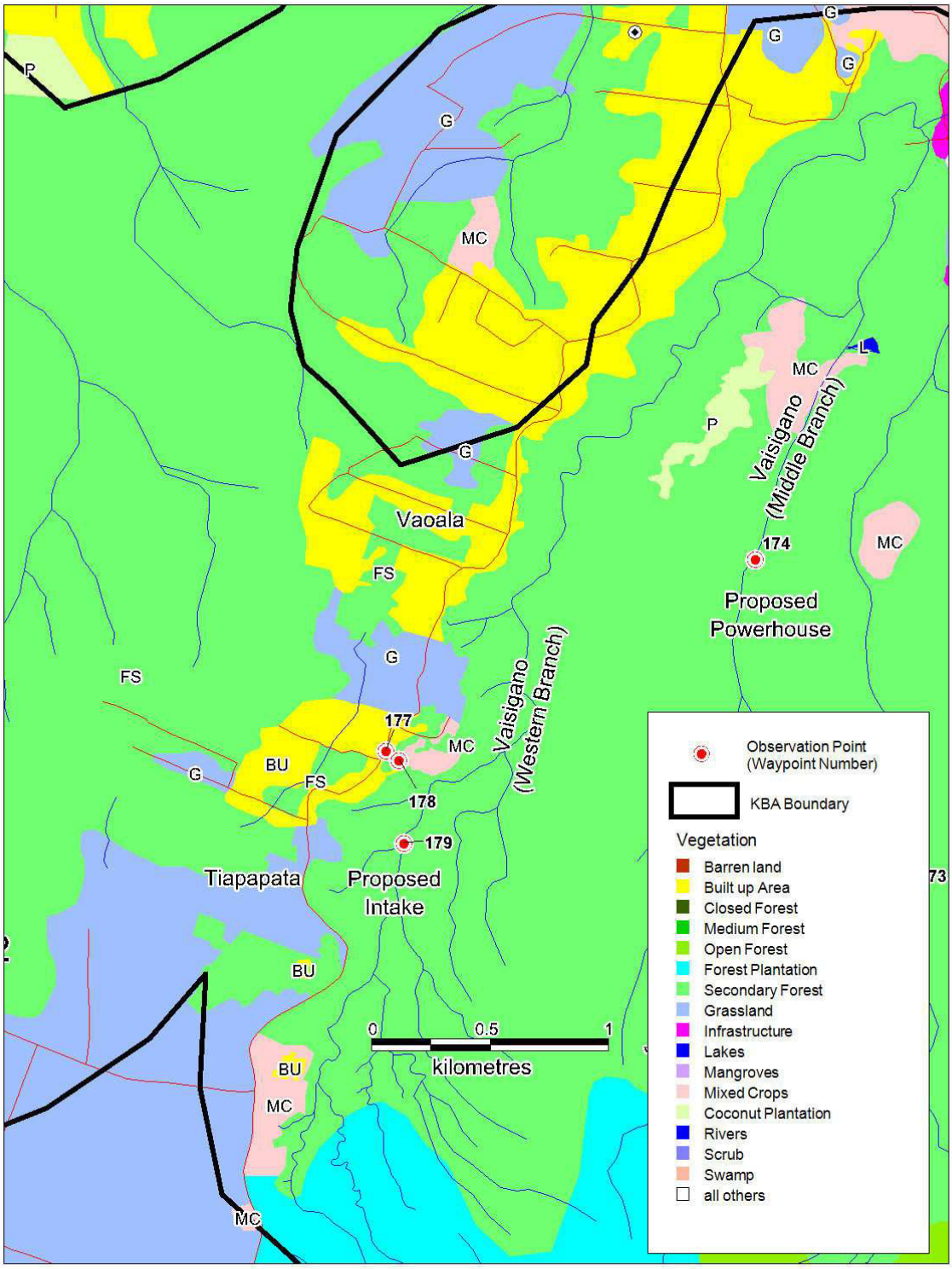

Figure 30: Tiapapata SHP vegetation map (Atherton, Jenkins, & Stirnemann, 2013)

148. Between the powerhouse and the headpond the vegetation consists of secondary forest which has regenerated after past cyclone damage and a portion of land that was cleared for a coffee plantation. The sub-canopy and groundcover tier is almost exclusively exotic (Figure 34), dominated by dense black rubber saplings, Panama rubber samplings, and coffee (*Coffea sp.*). Queen of the night (*Cestrum nocturnum*) mile-a-minute (*Mikania micrantha*), *Ipomoea* spp., and merremia (*Merremia peltata*) colonise small clearings.

149. Tall emergent trees do occur, principally Panama and black rubber trees, with African tulips and albizia, the latter are more common on ridges and at higher elevations which presumably were hit hardest by cyclones. (Albizia colonises open ground quickly, and African tulips easily sprout from fallen branches.) Windblown trees are common. Occasional native trees occur including tava (*Pometia pinnata*) and maota mea (*Dysoxylum huntii*). The latter is a key food source for manumea or tooth-billed pigeon (*Didunculus strigirostris*).

150. As much of the canal route was accessed as possible. The sub-canopy east of the intake was mixed vegetation but dominated by exotic species. Sub-canopy and groundcover species included cinnamon, coffee, guava (*Psidium guajava*), *Plectranthus*, wild banana, as well as native ferns and shrubs such as ti (*Cordyline sp.*). Trees included albizia, cinnamon, with native lau fatu, tamanu (*Calophyllum neo-ebudicum*) and toi (*Alphitonia zizyphoides*).

151. The site of the Tiapapata intake is at the base of a steep valley (Figure 36). The soil is thin and erodible with a cover of mainly exotic shrubs and groundcovers including ginger, mile-a-minute, impatiens, bush banana, occasional tree ferns and young albizia. A small banana and taro plantation has been established on the true right bank of the river downstream of the intake.

152. Two unformed roads occur within the Tiapapata SHP project area. A rough road has been built from Cross Island Road to the site of the proposed Tiapapata intake by the Samoa Water Authority. SWA has a water intake and small dam upstream the proposed SHP intake. The road is very steep and eroding in places, but is an obvious access route for construction vehicles for the SHP. An old road is also present from the Alaoa headpond to an old house and former coffee plantation located near the new powerhouse and penstock route. The road is overgrown with grasses, shrubs and some trees, but provides evidence of habitat modification that has occurred in the past.

153. No rare or endangered plants have been recorded in the project area (Atherton, Jenkins, & Stirnemann, 2013).

Figure 31: Open vegetation on the central tributary upstream of Alaoa SHP

Figure 32: Sione and family collecting taro and lau fatu leaves above Alaoa SHP

Figure 33: Vegetation at the original (old) Tiapapata powerhouse site

Figure 34: Dense black rubber sub-canopy on the penstock route

Figure 35: Exotic albizia canopy on the ridgeline overlooking the canal route

Figure 36: Tiapapata intake site (centre) showing gorge and adjacent vegetation

Figure 37: Existing overgrown road and plantation near the new powerhouse

Figure 38: Existing SWA access track leading to the Tiapapata intake site

4.4.5. Avifauna

154. An avifauna survey at the Tiapapata SHP in August 2013 identified one exotic and 20 native bird species. The area was identified as having high bird diversity (Atherton, Jenkins, & Stirnemann, 2013).

155. A total of 23 avifauna species were identified in the September 2014 field work, consisting of one exotic and 22 native species (Table 4).

156. Five avifauna species were recorded in 2014 that were not observed in 2013: Pacific pigeon, red-headed parrotfinch, kingfisher, island thrush and red-vented bulbul. Three species were observed in 2013 that were not recorded in 2014: Samoan triller, Polynesian triller and common myna. The difference in species is likely to be the result of differing survey times and methodologies, rather than changes in habitat type or quality.

157. Three species present within the Tiapapata project area are classified as endangered or near threatened in the IUCN Red List of Threatened Species: the mao (*Gymnomyza samoensis*), Samoan triller and Samoan flycatcher (Table 3).

158. The manumea or tooth-billed pigeon (*Didunculus strigirostris*) was not identified during either survey but has been observed flying in and out of the upper Vaisigano catchment across Cross Island Road (R. Stirnemann, pers. comm. 16/09/14). An unconfirmed sighting of the manumea was also reported in December 2013 from near the Bahai'i temple, a short distance from the Tiapapata SHP intake (Niualuga Evaimalo, MNRE, pers. comm. 09/09/14).

Table 3: Endangered, threatened and near-threatened bird species at Tiapapata SHP

Scientific Name	Common Name	Samoan Name	IUCN Threat Status
*Didunculus strigirostris**	Tooth-billed pigeon	Manumea	Critically endangered
Gymnomyza samoensis	Mao	Maomao	Endangered
Lalage sharpei	Samoan triller	Miti	Near threatened
Myiagra albiventris	Samoan flycatcher / broadbill	Tolaifatu	Near threatened

*Reported in the area

159. During the September 2014 field work one male mao was found near the original (old) Tiapapata powerhouse location. This site had several ginger plants which are a favoured food source. At other times, mao have been observed at the derelict house site west of the penstock route (P. Anderson, SPREP pers. comm. 16/09/14) and other places in the catchment (R. Stirnemann, pers. comm. 16/09/14). Empirical evidence from a local suggests that mao are more common on the Vaisigano east branch (Sione, pers. comm. 12/09/14).

160. The mao is endemic to Samoa and was formerly found in American Samoa (Watling, 2004). The species occurs in foothill and montane forest, being found in greatest densities in craters at high altitude in the least disturbed forest, although is now largely absent from the lowlands (Figure 39: Distribution of mao in surveys 2005-2006Figure 39). The IUCN lists an estimated population of 375-1,499 individuals (www.iucnredlist.org/details/22704317/0), however the recovery plan indicates that mao may be present in smaller numbers than the manumea (MNRE, 2006), a bird which has recently been classified as critically endangered.

Table 4 : Avifauna species detected during surveys at Tiapapata SHP, September 2014

Scientific Name	English Name	Samoan Name	Threat Status (IUCN)	Intake Track 11/09/2014 13:20 GPS 006	Intake Site 11/09/2014 14:41 GPS 007	Canal Ridge 11/09/2014 15:25 GPS 008	AlaoaW Canal 12/09/2014 9:38 GPS 009	DS Powerhouse 12/09/2014 10:19 GPS 010	Powerhouse 12/09/2014 10:43 GPS 011	DS confluence 12/09/2014 11:37 GPS 012	Old House Site 17/09/2014 10:00 GPS 016	Penstock ridge + gully 17/09/2014 10:53 GPS 017	Penstock blk rubber trees 17/09/2014 13:17 GPS 019	Penstock clearing 17/09/2014 13:57 GPS 020	Other - - -	Total
Acridotheres tristis	Common mynah	Maina fanua	Introduced													
Aerodramus spodiopygius	White-rumpted swiftlet	Pe'ape'a	Least concern	X		X	X	X						X	X	X
Anous stolidus	Brown noddy	Gogo	Least concern		X	X		X	X	X	X			X	X	X
Aplonis atrifusca	Samoan starling	Fuia	Least concern	X		X	X		X		X			X	X	X
Aplonis tabuensis	Polynesian starling	Fuia vao	Least concern			X					X				X	X
Columba vitiensis	White-throated pigeon	Fiaui	Least concern			X									X	X
Dacula pacifica	Pacific pigeon	Lupe	Least concern			X		X						X		X
Egretta sacra	Reef heron	Matu'u	Least concern													
Erythrura cyaneovirens	Red-headed parrotfinch	Segaula	Least concern	X											X	X
Foulehaio carunculata	Wattled honeyeater	Iao	Least concern	X		X	X	X			X	X	X	X	X	X
Fregata minor	Great frigatebird	Atafa	Least concern													
Gallirallus philippensis	Banded rail	Ve'a	Least concern												X	X
Gallus gallus	Domestic chicken	Moa	Introduced													
Gygis alba	White tern	Manusina	Least concern				X		X		X				X	X
Gymnomyza samoensis	Mao	Ma'oma'o	Endangered												X	X
Lalage sharpei	Samoan triller	Miti	Near threatened													
Myiagra albiventris	Samoan broadbill/flycatcher	Tolaifatu	Near threatened									X			X	X
Myzomela cardinalis	Cardinal honeyeater	Segasegamau'u	Least concern		X	X		X						X	X	X
Pachycephala flavifrons	Samoan whistler	Vasavasa	Least concern		X	X		X					X			X
Petroica multicolor	Scarlet robin	Tolaiula	Least concern							X					X	X
Phaethon lepturus	White-tailed tropic bird	Tava'e	Least concern		X					X	X				X	X
Porphyrio porphyrio	Purple swamphen	Manuali'i	Least concern												X	X
Ptilinopus porphyraceus	Crimson-crowned fruit dove	Manutangi	Least concern			X	X				X	X	X		X	X
Pycnonotus cafer	Red-vented bulbul	Manu palagi	Introduced	X							X					X
Rhipidura nebulosa	Samoan fantail	Se'u	Least concern		X					X		X			X	X
Todirhamphus sp.	Kingfisher	Ti'otala	Least concern				X									X
Turdus poliocephalus	Island thrush	Tutumalili	Least concern												X	X
Vini australis	Blue-crowned lorry	Sega vao	Least concern												X	X
			TOTAL:	**5**	**5**	**10**	**6**	**6**	**3**	**4**	**8**	**4**	**3**	**6**	**19**	**23**

161. Since the mid-2000s, mao have been consistently present in the Vaisigano catchment, Tiapapata, and Mt Le Pue / Mt Fito (MNRE, 2006). During a survey of Samoa's National Parks, mao were only recorded at one site near Lake Lanoto'o (R. Stirnemann, pers. comm. 16/09/14).

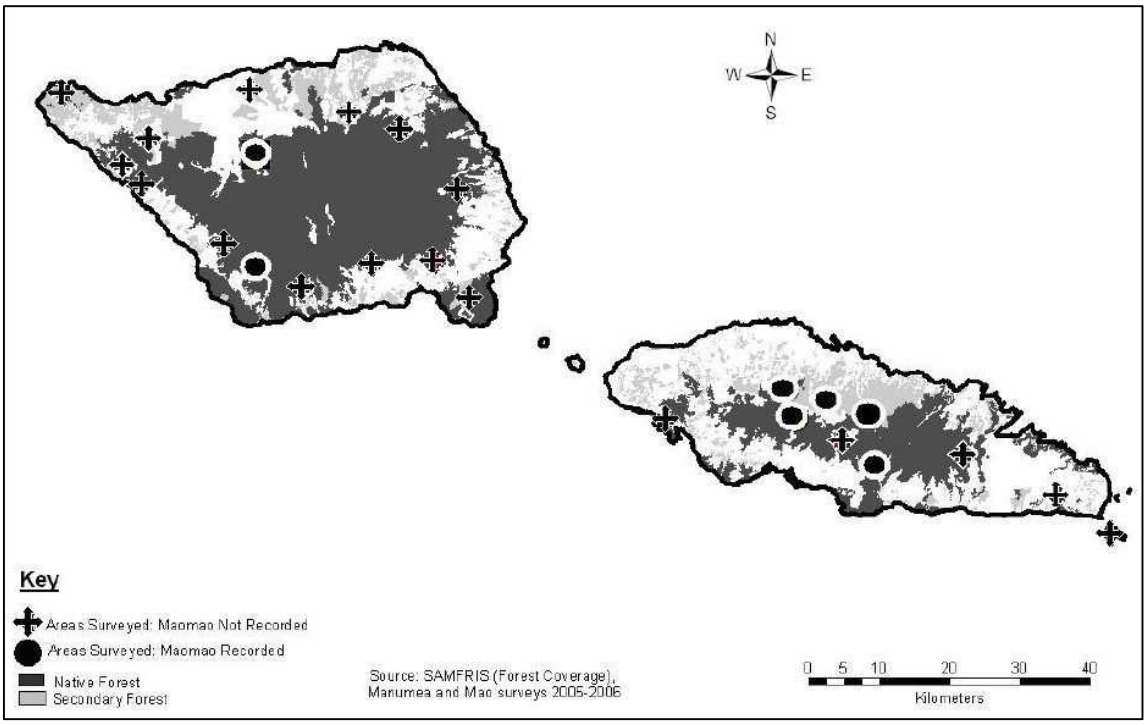

Figure 39: Distribution of mao in surveys 2005-2006 (MNRE, 2006)

162. The manumea is endemic to Samoa where it inhabits mature and secondary forest (Watling, 2004). The species occurs in primary forest from sea-level to 1,600m, also occurring in forest edge, along forest roads and sometimes visiting clearings where native trees remain. It is specialised to feed on the seeds of *Dysoxylum* spp. using its unusual bill to saw through the tough, fibrous pericarp, and also feeds on other fleshy fruit (www.iucnredlist.org/details/summary/22691890/0).

163. The manumea is listed as critically endangered by the IUCN. This is the highest threat ranking for an extant species in the wild. The threat ranking for manumea was raised in 2014 from a former classification of endangered because the population is estimated to be smaller than previously thought (www.iucnredlist.org/details/summary/22691890/0). The population was estimated to be 4,800-7,200 birds in the mid-1980s, but a low number of recent records and lack of sightings by local people strongly suggest that the population is now extremely small. The current population is decreasing with no more than 50 mature individuals thought to exist in each of the two presumed sub-populations, on Upolu and Savai'i (www.iucnredlist.org/details/summary/22691890/0).

164. The manumea is endemic to Samoa where it inhabits mature and secondary forest (Watling, 2004). The species occurs in primary forest from sea-level to 1,600m, also occurring in forest edge, along forest roads and sometimes visiting clearings where native trees remain. It is specialised to feed on the seeds of *Dysoxylum* spp. using its unusual bill to saw through the tough, fibrous pericarp, and also feeds on other fleshy fruit (www.iucnredlist.org/details/summary/22691890/0).

165. A study of the manumea has recently commenced, led by Rebecca Stirnemann, founder of the Samoa Conservation Society. The aim of the study is to focus conservation action by determining the core locations and migratory requirements of manumea and to also collect any local knowledge on this species. This work will engage local villagers and will have a conservation education component to ensure local support. In 2014, the study hopes to find and radio tag manumea to assist in understanding nesting and spatial requirements of the species (Stirnemann R. , 2014).

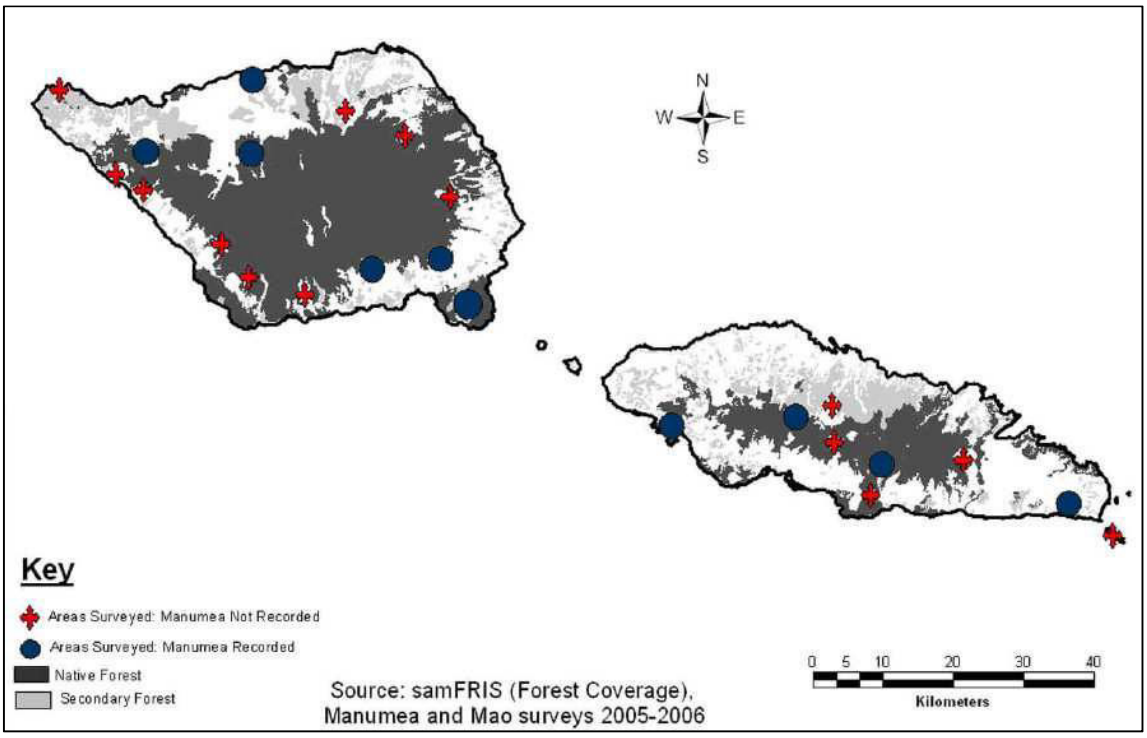

Figure 40: Range of the tooth-billed pigeon or manumea

166. The Samoan triller and inhabits primary and secondary forest and forest edge habitat. It is endemic to Samoa and is relatively uncommon on Upolu (nominate *sharpei*) but more widespread and common on Savai'i (race*tenebrosa*) (Watling, 2004). It is most frequently observed at the forest edge and forest clearings in upland areas where it feeds on caterpillers and other insects (Watling, 2004).

167. The Samoan flycatcher or broadbill is endemic to Samoa and occurs on the islands of Upolu, Savai'i and Nu'utele (Watling, 2004). The species was considered common before the 1990s when it underwent a population decline following severe cyclones, but more recent surveys indicate that there has been a at least a moderate and localised recovery (www.iucnredlist.org/details/22707393/0). The species is found in open forest and forest edges (Watling, 2004) predominantly in the lowlands. It feeds on insects (www.iucnredlist.org/details/22707393/0).

4.4.6. Other Fauna

168. A Tongan fruit bat (*Pteropus tonganus*) roost is present on the Vaisigano central tributary upstream of the powerhouse (Figure 41). This will not be directly impacted by the SHP development, however this species is hunted for food.

169. Pacific black skinks (*Emoia nigra*) are relatively common in river valleys and forest in the Vaisigano catchment, and "brown skinks"[2] (*Emoaia sp.*) also occur.

170. Two species of insects have been recorded at the Tiapapata intake and powerhouse, the grass yellow butterfly (*Eurema hecabe sulphurata*) and blue tiger butterfly (*Tirumula hamate melittula*) (Atherton, Jenkins, & Stirnemann, 2013).

171. Giant African land snails (*Achatina fulica*) are common in the catchment. This is a highly invasive pest species classified as one of the 100 world's worst invaders by the IUCN (http://www.issg.org/database/species/ecology.asp?si=64&fr=1&sts=&lang=EN).

172. Wild pig sign (*Sus scrofa*) was common on the ridgeline near the penstock route. This is another highly invasive species listed by the IUCN (http://www.issg.org/database/species/ecology.asp?si=73&fr=1&sts=sss&lang=EN).

Figure 41: Bat roost in tamaligi palagi trees on the Vaisigano central branch

[2] Tag name from MNRE staff. Likely to be *Emoia cyanura*.

5. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1. Screening and Categorisation

173. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts (ADB, 2009). Projects are assigned to one of the following four categories:

(i) **Category A:** A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An Environmental Impact Assessment is required.

(ii) **Category B:** A proposed project is classified as Category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An Initial Environmental Examination is required.

(iii) **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

(iv) **Category FI:** A proposed project is classified as category FI if it involves investment of ADB funds to or through a financial intermediary.

174. The ADB checklist for hydropower projects was used to screen for any potential environmental impacts during the project inception stage. The Fuluasou and Tiapapata SHPs were provisionally allocated as Category B by ADB, subject to additional site visits and ecological surveys.

175. Additional ecological studies were undertaken in September 2014 and the results are presented in this report and an initial summary report (MWH, 2014). The environmental categorisation was confirmed as Category B for both projects (MWH, 2014, p. 9):

(i) The proposed Fuluasou SHP is a highly modified environment. No significant adverse environmental impacts that are irreversible, diverse, or unprecedented have been identified. An Environment Safeguard Category of B is appropriate.

(ii) The proposed Tiapapata SHP is located in habitat that has been modified by human and natural disturbance. The site includes habitat for the endangered mao and possibly the critically endangered manumea. With careful mitigation and environmental management the habitat for these species can be maintained and possibly enhanced. No significant adverse environmental impacts that are irreversible, diverse, or unprecedented have been identified. Therefore, an Environment Safeguard Category of B is appropriate.

176. The following section provides an assessment of the Project's likely impacts on physical, biological, socio-economic, physical and cultural resources, and identifies mitigation measures to ensure all such environmental impacts will be avoided or managed/reduced to acceptable levels.

177. The mitigation measures identified below will be implemented in accordance with the environmental management plan (EMP) presented in Section 6.

5.2. Issues Addressed During Design and/or Pre-Construction

5.2.1. Obtaining Consents and Disclosure

178. The EPC will consult MNRE and submit the IEE (or re-formatted as a PEAR and then submitted) and development consent applications as part of the statutory process.

179. The IEE and EMP, approved by MNRE, along with any conditions of the development consent will be integrated into the contract documents including:

- A requirement for Contractor to seek MNRE approval and update the EMP in the case of significant changes to the design;
- The Contractor will prepare a Construction Environmental Management Plan (CEMP) based on EMP for approval of PUMA before commencement of construction. The CEMP will demonstrate the manner (location, responsibilities, schedule/ timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP and any additional measures required by MNRE as part of the development consent; and
- Grievance redress mechanism (GRM) as described in the IEE.

180. Project documents will be disclosed and made available to public and communities in an appropriate form and manner and kept in an accessible place as per the project's consultation and participation plan (CPP). Appropriate measures from CPP and GRM shall be included in the tender documents.

5.2.2. Climate Change Adaptation

181. There have been several well-documented events that show the increase of extreme weather events such as tropical storms and typhoons in the Pacific. Most climate change modelling shows that tropical typhoons will increase in frequency and severity, and will be characteristic of the project area in the future. Many of these extreme weather events can be linked to the El Niño/La Niña-Southern Oscillation (ENSO) pattern, but ENSO is predicted to also have an effect in modifying trade winds in the Pacific, strengthening of tropical deep convection, and alteration of monsoon flow. Cyclone Evan was the strongest typhoon in 50 years with strong winds and heavy rain.

182. Key civil infrastructure components associated with SHP of the project including intake structure, canal, penstock, powerhouse and access road are located away from the coast in hilly areas. These components are therefore somewhat less exposed to climate driven extremes than most of the other infrastructure. Distribution lines and their receiving infrastructure including schools, clinics, airstrips and community households are located mainly on the coast and are thus more exposed to extremes such as intense storms, tropical cyclones and flash floods including storm surges.

183. Some of the identified risks posed by climate change and natural hazards in the Pacific, specific to the energy sector are described in Table 5.1. This table is adapted from ADB's report Climate Risks and Adaptation in the Power Sector (2012). It includes various adaptation options that could be considered for the risks identified in respect of the small run-of-river type hydropower projects.

Table 5 : Summary of impacts and adaptations on hydroelectricity infrastructure (ADB, 2013)

Climate change/hazard	Potential Impact	Potential Resilience Measure	Complementary Measures
Sea-level rise	Most hydro is located inland and not directly affected by sea-level rise, possibly increased rate of deterioration of concrete structures due to increased salinity from sea-level penetration upstream	Materials substitution for less corrosive materials	Coastal zone protection to protect estuaries and watersheds
Increase/decrease in rainfall	Energy from hydropower relies on rainfall and reduced river flow over a period of time could reduce or disrupt entirely energy generation.	Where flow is expected to increase, modify the number and type of turbines that are better suited for expected water flow rates, reduce expected turbine lifetime due to higher suspended sediment loads, modify canals to better handle changes in water flows, modify spillway capacities	Develop improved hydrological forecasting techniques and adaptive management operating rules; develop basin-wide management strategies that take into account the full range of downstream environmental and human water uses; restore and better manage upstream land including afforestation to reduce floods, erosion, silting, and mudslides. Improved watershed modeling to inform
Cyclones/hurricanes and frequent strong storms	Flooding of riverbanks could adversely affect stream flow particularly where hydropower is generated. Transmission/distribution lines and poles are damaged.	Design more robust infrastructure for heavier flooding and extreme events	
Increased temperatures	Higher evaporation rates, reduced turbine efficiency	Water cooling systems in turbines	
Earthquakes	Damage to infrastructure, oil spills and fire hazards.	Use design standards applicable to high earthquake risk areas.	

184. Integrating climate change adaptation measures into the design of the hydropower scheme needs to be based on the economic considerations associated with the relatively small-scale nature of the scheme. The expected increase in extreme weather events and rainfall days in terms of both frequency and duration is the prime climate change issue in respect to the upgrades completed at the Fuluasou scheme. Therefore design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change.

185. In order to survive a cyclone damage, the SHPs need to be designed to cope with extreme conditions, especially to avoid submersion. Penstocks will be buried (except for pipe bridges) to minimise any future destruction from falling trees. Climate change issues have therefore been appropriately addressed by the project.

186. Critical structures that need to be considered for possibly increased peak floods include:

(i) Penstock – undergrounding where possible and practical;

(ii) Intake weir - suitable erosion protection to prevent scour around the intake weir's training walls;

(iii) Powerhouse - level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment; and

187. Other measures to mitigate the effect of an increase in intensity and frequency of extreme rainfall and consequent floods on the project components centre on enhanced erosion protection. Such measures could include: (i) additional river bank protection / rock armor placed around the intake structures and powerhouse tailrace; and (ii) enhanced slope protection works along steep sections of the headrace canal routes (benching, cut off drains, masonry etc).

188. The extent to which such climate change adaptive measures are employed for erosion protection needs to be balanced against the marginal economics of small scale hydropower projects. For example, for project components that are repairable and any resulting outage not significant, normal best practice design criteria should apply. Any additional erosion protection measures such as benching of headrace canal slopes (over and above normal design criteria for such works), can be implemented during project operation if required. On the other hand if there is a plentiful supply of nearby rock material able to be utilized for erosion protection it might be that a small incremental cost for enhanced erosion protection for climate change adaptation purposes during construction may have a significant economic benefit.

189. In principle, it is suggested that the project only makes climate change design decisions on structures that cannot be practically modified or adapted later during the project's operational life. This includes the critical structures that need to be protected against peak flood size and levels as indicated above. However, if the incremental cost of providing enhanced river bank and/or slope protection as a climate change adaptation measure is low, this should also be incorporated into the project design.

190. **Reduction of gas emissions**. Fuluasou will achieve a net reduction of greenhouse gas emissions of around 1,729 tons of CO_2 per year. Tiapapata will achieve a net reduction of greenhouse gas emissions of around 2,077 tons of CO_2 per year. This corresponds to fuel savings of 645 and 775 litres per year, respectively.

Table 6: Energy savings and greenhouse gas emission (ADB, 2013)

Subprojects	Renewable electricity production/year (MWh)	Equivalent of fossil fuel saving (ltr)	Equivalent tons of CO_2 emissions (0.670 Ton CO_2/MWh)
Fale o le Fe'e	3340	835	2238
Alaoa	4780	1195	3203
Samasoni	3870	967	2593
Fulouasou	2580	645	1729
Tiapapata	3100	775	2077
Faleaseela	1060	265	710
Faleata	500	125	335
Tafitoala	1820	455	1219
Total	**20,110**	**5262**	**13,469**

5.2.3. Environmental Flows

191. Environmental flows, also known as ecological flows, is water that is left in a river ecosystem, or released into it, for the specific purpose of managing the condition of that ecosystem (World Bank, 2005).

192. There is no set method or international standard to calculate environmental flows (World Bank, 2005). A large number of methodologies exist, some more complex than others. Some methods set fixed standards while others vary according to the season, flow regime of the river, sensitivity of the receiving environment, or catchment changes monitored over time.

193. Hydrological parameters that have been adopted as environmental flows internationally include, *inter alia* (MWH, 2009):

(i) Mean Annual Low Flow (MALF)

(ii) Percentage of the Mean Annual Low Flow (MALF) for example 80% MALF

(iii) Seven-day five-year Average Recurrence Interval (ARI) low flow

(iv) Percentage of Mean Annual Flow (MAF) for example 95% of MAF

194. **Samoan Standard.** The National Water Allocation Policy 2008 (NWAP) of Samoa provides for the sustainable management of water resources in Samoa and establishes the principles on which water will be allocated for all purposes, including the environment.

195. The NWAP operates a licence system that grants a volumetric entitlement for water from specific water sources. All public and private water users who take water from surface water or groundwater require a water licence, with the exception of surface water takes for individual dwellings, firefighting and emergency response needs (NWAP s8.2.8.2).

196. The NWAP establishes the following principles to maintain healthy rivers (NWAP s7.4.1.8):

- The important role of rivers is recognised in supporting native flora and fauna of Samoa, and their important influences on estuarine and coastal ecosystems;
- A river should not be dried up completely by water abstraction at times when the river would naturally be flowing;
- Water abstraction should not cause serious deterioration in the quality of water in rivers;
- The natural variability of flow in rivers should be retained as far as feasible.

197. The NWAP proposes to develop a “safe yield” for all important rivers and aquifers in Samoa. As part of this process, an in-stream flow regime is to be developed for each of the five highest priority rivers in Upolu, including Fuluasou and Vaisigano. Once this is done, flow regimes for other rivers will be developed on a site-specific as needed basis.

198. The GoS has not yet developed environmental flow requirements for rivers and streams within Samoa. The MNRE currently recommends that environmental flows are calculated at 95% of the flow duration curve, and the agency is currently working to transform this figure into a national standard (ADB, 2013).

199. Flow data for the Fuluasou River is available at the Fuluasou dam (Figure 11 and Appendix A; Egis International 2011a). Under the MNRE standard, 95% of the flow duration curve equates to 0.36 m^3/sec. This means that all flows above 0.36 m^3/sec would be available for the hydro scheme, up to a (yet to be designed) maximum level. During storm events, flows would exceed the capacity of the hydro scheme and would discharge to the river.

200. Flow data for the Vaisigano River is available at the proposed Tiapata intake (Figure 25 and Appendix A; Egis International 2011b). For Tiapapata, 95% of the flow duration curve equates to 0.09 m^3/sec. This means that all flows above 0.09 m^3/sec would be available for the hydro scheme, except during storm events when high flows would discharge to the river.

201. **10% of Annual Median Flow.** Egis International has recommended that 10% of the annual median flow be provided for environmental flows at Fuluasou and Tiapapata SHP (Figure 42 and Figure 43). This figure is based on French regulations. For Fuluasou, this equates to 0.17 m^3/sec (Egis International, 2011). For Tiapapata, the figure is 0.04 m^3/sec. This is much lower environmental flows than the MNRE recommendation.

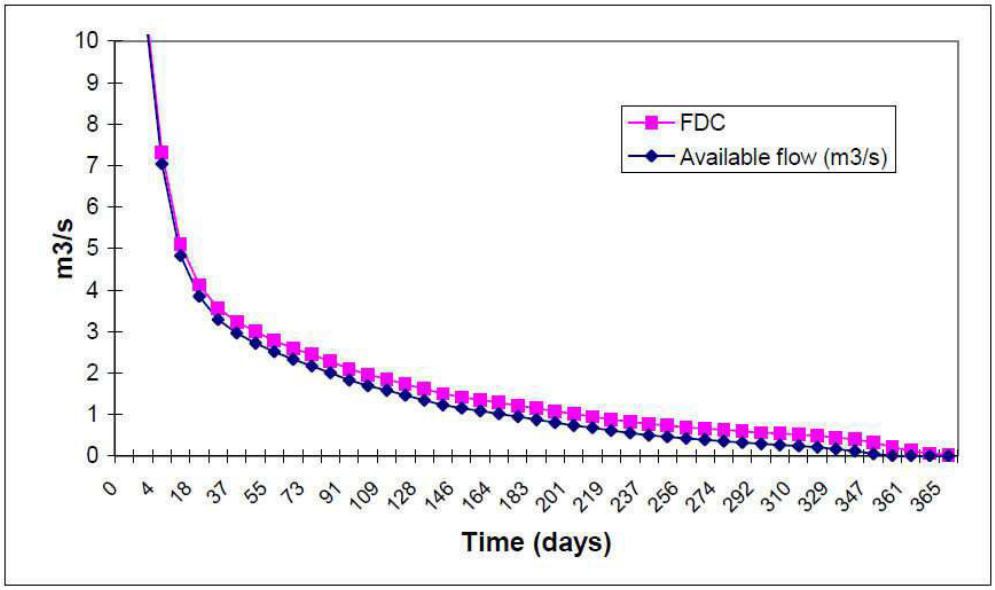

Figure 42: Fuluasou flow duration curve with 10% of the annual median flow provided as environmental flows (Egis International, 2011)

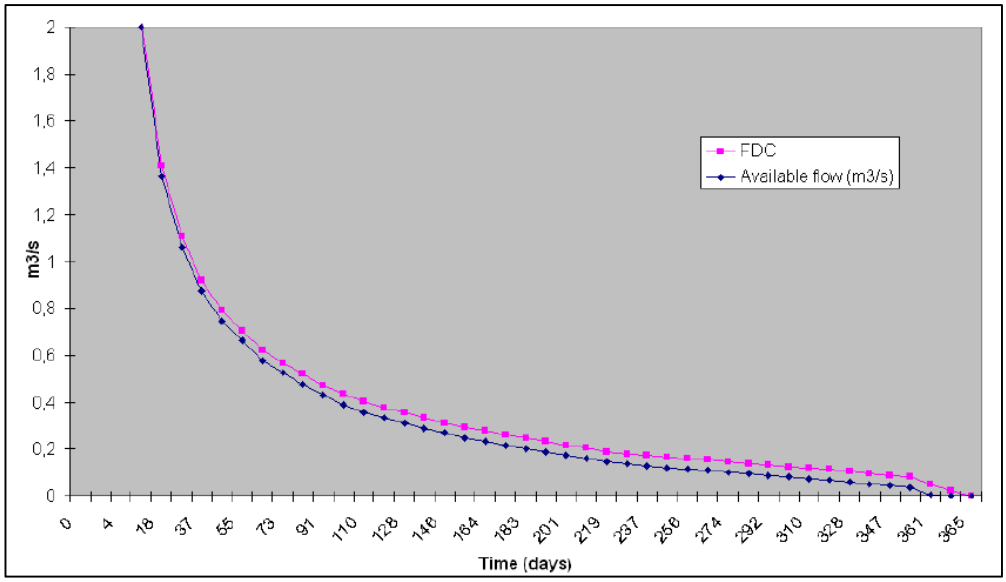

Figure 43: Tiapapata flow duration curve with 10% of the annual median flow provided as environmental flows (Egis International, 2011)

202. **80% MALF.** The IEE for New SHPs (ADB, 2013) and Rehabilitation of SHPs (ADB, 2013) recommend that environmental flows be at least 80% of the seven day Mean Annual Low Flow (MALF). This figure was recommended to maintain steady populations of fish in upper catchment areas. Calculations of 80% of MALF were not provided, presumably due to lack of hydrological data.

203. The figure of at least 80% MALF at Fuluasou and Tiapapata was supported by Atherton et al. (2013a; 2013b).

204. Full hydrological data is unavailable and therefore the seven day MALF cannot be calculated accurately. Using the flow duration data from Egis International (2011a; 2011b) as a proxy, the estimated 80% MALF calculations are as follows: Fuluasou SHP = 0.06 m^3/sec; Tiapapata SHP = 0.22 m^3/sec. These are lower flows than the MNRE recommendation, but higher than the flows recommended by Egis International (2011a; 2011b).

205. **Recommended Approach for Environmental Flows.** In the absence of a single international standard for environmental flows and incomplete hydrological information at these sites, it is recommended that the environmental flows at the Fuluasou and Tiapapata SHP be set at the 95th percentile of the flow duration curve. This is consistent with the MNRE guideline and interim national standard. This figure is also more conservative than 80% of the seven day MALF and 10% of annual median flow.

206. The 95th percentile of the flow duration curve is as follows:

(i) Fuluasou = 0.36 m^3/sec

(ii) Tiapapata = 0.09 m^3/sec.

207. It is understood that the above figures account for the existing SWA intakes located upstream of the SHP intake structures. Should additional abstraction occur downstream of the SHP intakes, these figures will need to be revised and increased to account for the additional water that is abstracted.

208. The above figures have been derived from existing flow data (Egis International 2011a; 2011b). It is assumed that this data is accurate however this data has not been verified.

5.2.4. Fish Passage

209. Many indigenous fish in Samoa are diadromous, moving between fresh and salt water as part of their lifecycle. For this reason, limiting barriers to fish passage assists in the maintenance of these fish populations.

210. For Fuluasou, the existing dam constitutes a barrier to non-climbing fish species. It is surmountable for climbing species. Given that this is an existing structure and aquatic ecology values are low, there is little justification to provide a fish pass at this structure.

211. At the Tiapapata intake, the intake should be designed to provide for climbing fish passage to the upstream catchment. Ideally, the intake should be offline or adjacent to the main flow and a fish screen installed to prevent entrainment. No passage for non-climbing species is necessary given the abundance and severity of existing waterfalls downstream.

212. Downstream of the Tiapapata powerhouse, the bypass channel for the Alaoa west SHP needs to be upgraded to provide for fish passage into the Vaisigano central tributary.

213. Some structures, particularly hanging culverts and long, enclosed pipes may hinder fish passage. An ideal fish-way where a culvert crosses a stream (Kapitzke, 2010) should allow for:

- Slope: as flat as possible; should not exceed 1:100.

- Water depth: minimum 0.2-0.5 m.
- Velocity: maximum 1 m/s preferred 0.3 m/s.
- Length: maximum 6 m without resting areas.
- Width: to width of stream.
- Bottom roughness should simulate natural streambed morphology.
- The outlet of the pipe should be at or below stream bed level.

214. In addition, some general ecological principles to be applied during detailed design include:

- Prevention of adverse flow turbulence through the structure and ensure water surface drops are not excessive;
- Ensuring fish are not obstructed from downstream migration;
- Maintenance of natural flow and sediment processes in the waterway;
- Protection of riparian and in-stream habitat, terrestrial and aquatic ecosystems;
- Ensuring stream water quality is not degraded;
- Installation of fish screens on intake and outlet structures; and
- Where possible, using bridges in preference to culverts for stream and river crossings (to limit piping of streams and loss of aquatic habitat).

5.3. Construction Impacts on Physical Environment

5.3.1. Noise

215. Noise impacts may occur from the operation of machinery at the site and construction site traffic transporting materials and equipment. This will be temporary and sporadic over the construction period. Implementation of good practice construction methods such as using well maintained powered mechanical equipment equipped with silencers will ensure impacts are minimized and acceptable.

216. Mitigation measures include:

- Application of the national noise standard3
- Advance information to close residents (sign close to the entrance of the access road, announcements in papers and distributing of leaflet information related to the works or contacting them individually);
- Adherence to legal working hours to avoid disturbance early in the morning, at night, on Sundays or public holidays and restricting noisy activities to between 0900 and 1700[4]; and
- Checking construction vehicles and machinery are in good working order.

[3] PUMA; Noise Policy (October 2011)
[4] Day period is defined as 0700 to 1800, evening period is defined as 1800 to 2200 and night period is defined as 2200 to 0700. Construction activities conducted at times not specified in the table above will require special approval from relevant authorities. These may include the night period, Sundays and all other times within residential and education compounds or close to other sensitive receivers.

5.3.2. Air Quality and Dust

217. Construction activities and vehicle movements can generate dust and affect air quality. As with noise, this will be temporary and sporadic over the construction period. Implementation of good practice construction methods such as watering of access roads adjacent to residential areas during dry spells will reduce this nuisance.

218. Mitigation measures include:

- Reduce speed through settlement areas;
- Cover stockpiles and flatbeds of trucks when carrying materials that could create dust;
- Utilize vehicles with low emissions; and
- Regularly cleaning construction vehicles and watering/damping of roads to prevent dust.

5.3.3. Erosion and Loss of Top Soil

219. Erosion could occur during construction of access roads, and headrace canals, especially where they cross steep slopes, and in the river channel adjacent to the intake/sand trap and tailrace. Erosion could also be caused by extraction of material (such as sand and gravels) during construction.

220. Erosion could result in:

(i) loss of top soil and the forest it supports due to landslides, and

(ii) increased siltation/sedimentation of the river and its tributaries.

221. Mitigation measures include:

- Application of COEP 6 – road construction and erosion control, COEP 7 – slope stability, COEP 8 – quarry development and operations, and COEP 9 – gravel extraction, as relevant;
- Contractor to prepare Erosion and Sedimentation Control Plan as part of CEMP;
- Construction materials, such as sand needed for concrete should come from existing quarries, in compliance with Ministry of Works recommendations;
- As much as practicable, aligning the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors;
- Minimizing the vegetation clearance corridor for all components;
- Installing cut-off drains when excavating on steep slopes;
- Ensuring slope cuts are appropriately designed and engineered for the prevailing conditions (geotechnical, climate etc.);
- Cut slopes to be re-vegetated as soon as practicable to minimize the exposure of bare surfaces;
- Re-vegetation of cut slopes to incorporate appropriate bioengineering practices utilizing local native species as much as possible;
- Masonry bank protection in the river channel adjacent to the weir/intake and sand trap and adjacent to the tail race; and
- Scheduling the construction in the dry season.

222. The scale of the construction activities and limited footprint of the Project means there will be limited direct loss of top soil. However, indirect loss of topsoil could occur through

erosion as described above. Following site clearance top soil will be stockpiled for later use in landscaping or made available to the local community for their use. The relatively small scale nature of the Project coupled with rigorous implementation of the above mitigation measures will ensure that the potential impact of erosion and loss of topsoil due to the project will be minimized to acceptable levels.

5.3.4. Sedimentation and Water Quality

223. There is potential for localized and short term water contamination from runoff of suspended sediment from exposed surfaces, slope erosion and concrete residues into the river during various construction activities. Activities which will require sediment control during works at Tiapapata include clearance of vegetation and construction of access roads as well as construction of the main components of the scheme.

224. Construction activities will involve some use of powered mechanical equipment in particular during excavation works for the access roads and some sections of the headrace canal however it is envisaged that the majority of the construction activities will be undertaken using manual labour. This should help in minimizing the potential for erosion and sediment runoff into the river and tributaries.

225. The contractor will need to implement sediment control devices in areas of steep gradients and areas of high disturbance where possible when rehabilitating or constructing the weir, penstock and powerhouse to avoid spillage of chemical substances, construction material, sand etc. into the river waters. It may be necessary to sample and analyse water quality before, during and after in-stream works.

226. A range of proven mitigation measures normally associated with good construction practice will be implemented during construction work to avoid or minimize sedimentation impacts on the river and its tributaries. As a minimum these mitigation measures will include:

- Application of COEP 6 – road construction and erosion control and COEP 13 – earthworks, as relevant;
- Contractor to prepare Erosion and Sedimentation Control Plan as part of CEMP;
- As much as practicable, aligning the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors thereby minimizing the excavation footprint;
- Minimizing the vegetation clearance corridor or footprint for all components;
- Re-vegetate and/or cover/stabilize exposed surfaces and excavated materials
- Installation of sediment control devices (silt traps and the like) and implementing effective construction site drainage such that runoff is directed to sediment traps before discharge to water courses;
- If the waterway has continuous flow, other control measures, such as flotation sediment curtains, should be used to minimise the effects of sediment downstream;
- Use of cut-off drains above excavated areas on steep slopes to reduce erosion;
- Close construction supervision to ensure the above measures are implemented; and
- Scheduling of earthworks to be conducted in the drier months.

227. Effective implementation of the above mitigation measures will ensure that the potential short term impacts on water quality due to construction of the Project will be of relatively minor significance.

5.3.5. Materials and Spoil Management

228. Moderate amounts of sand and cement and other equipment and materials will be required for construction. It is envisaged that a dedicated borrow pit /quarry will not be required for the Project and that aggregates could be obtained from existing quarries.

229. Material sources will be identified by the contractor and will be detailed in Materials and Spoil Management Plan (MSMP) as part of the CEMP. Excavation activities will be limited with a corresponding limited volume of excess spoil needing to be disposed of. The aim of access road design will be to balance cut and fill as much as possible to reduce requirements for import of material.

230. The contractor will be required to prepare and implement a MSMP to minimize the use of non-renewable resources and provide for safe disposal of excess spoil. As a first priority, where surplus materials arise from the removal of the existing surfaces these will be used elsewhere on the project for fill (if suitable) before additional rock, gravel or sand extraction is considered. The MSMP will include as a minimum consideration of the following:

- Required materials, potential sources and estimated quantities available;
- Impacts related to identified sources and availability;
- Excavated material for reuse and recycling methods to be employed;
- Excess spoil to be disposed of and methods proposed for disposal;
- Endorsement from MNRE and Ministry of Works, and local landowners for use of sources and disposal of excess spoil; and
- Methods of transportation to minimize interference with normal traffic.

231. The contractor will be responsible for; i) identifying suitable sources and obtaining all agreements associated with the sources and preparing a MSMP; ii) balancing cut and fill requirements to minimize need for aggregates from other sources; iii) managing topsoil, overburden, and low-quality materials so they are properly removed, stockpiled near the site, and preserved for reuse; and, iv) arranging for the safe disposal of any excess spoil including provision for stabilization, erosion control, drainage and re-vegetation provisions at the disposal site.

232. Mitigation measures include:

- Application of COEP 8 – quarry development and operations and COEP 9 – gravel extraction, as relevant;
- Contractor to prepare Materials and Spoil Management Plan as part of CEMP; and
- Construction materials, such as sand needed for concrete should come from existing quarries, in compliance with Ministry of Works recommendations.

233. Effective implementation of the MSMP by the contractor as outlined above will ensure that potential environmental impacts associated with the management and disposal of construction materials will be negligible.

5.3.6. Waste Management and Pollution Control

234. Uncontrolled waste disposal during construction can cause impacts including water and land pollution and effects on public safety. Mitigation measures for the waste arising from the Project will seek to reduce, recycle and reuse waste as far as practicable and dispose of residual waste in an environmentally sustainable way.

235. As part of the CEMP prepared by the contractor waste management measures will be included in a Waste Management Plan (WMP) to cover all matters related to solid

and liquid waste disposal arising from construction related activities (including storage, disposal and accidental spills).

236. Mitigation measures include:

- Preparation of the Waste Management Plan as part of the CEMP;
- Expected types of waste and volumes of waste arising;
- Designation of waste disposal areas agreed with local authorities;
- Segregation of wastes to be observed. Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (no burning is allowed on site);
- Recyclables to be recovered and sold to recyclers;
- Residual waste to be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams;
- Disposal of solid wastes on site, agricultural fields and in public areas shall be prohibited; and
- All solid waste will be collected and removed from work sites and disposed in designated local waste disposal sites.

237. The contractor's WMP, as part of the CEMP, will need to be approved in writing by PUMA prior to start of construction.

Hazardous Materials and Hazardous Waste Disposal.

238. Use of hazardous substances during construction, such as oils and lubricants can cause significant impacts if uncontrolled or if waste is not disposed correctly. Mitigation measures will aim to control access to and the use of hazardous substances such as oils and lubricants and control waste disposal.

239. The contractor's mitigation measures in the hazardous materials section of the WMP will include but not necessarily be limited to the following measures. The contractor shall ensure implementation of such measures.

- Ensure that safe storage of fuel, other hazardous substances and bulk materials are agreed by PUMA and follow internationally recognized good practice;
- Hydrocarbon and toxic material will be stored in adequately protected sites consistent with national and local regulations and codes of practice to prevent soil and water contamination;
- Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and is undertaken as outlined in national regulations and code of practice;
- Ensure all storage containers are in good condition with proper labelling;
- Regularly check containers for leakage and undertake necessary repair or replacement;
- Store hazardous materials above possible flood level;
- Discharge of oil contaminated water shall be prohibited;
- Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the PUMA;
- Adequate precautions will be taken to prevent oil/lubricant/hydrocarbon contamination of drainage channel beds;

- Spill clean-up materials will be made available before works commence (e.g., absorbent pads, etc.) and be specifically designed for the hazardous substances stored on site; and
- Spillage, if any, will be immediately cleared with utmost caution to leave no traces.

240. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations complying with all the applicable statutory stipulations.

241. Provided the WMP is prepared, approved and implemented in accordance with the above recommendations the environmental impacts associated with waste management are expected to be negligible.

5.4. Construction Impacts on Biological Environment

5.4.1. Removal of Vegetation

242. Vegetation clearance for the construction zone will impact on secondary forest and modified habitat values.

243. Loss of forest habitat can be minimized by reducing the width of the clearance corridors for the access roads, headrace canal and penstock route and adjusting the alignments to minimize the need to remove large trees wherever possible. This will require close construction supervision to ensure clearance corridors are clearly marked and adhered to by construction workers.

244. Replanting following completion of construction will mitigate for some of the vegetation removal. All areas will be replanted excluding access roads and infrastructure.

245. Mitigation measures include:

- Prior to construction commencement, an Environmental Specialist is to identify and mark mature native trees that are not to be removed. If any trees cannot be avoided, at least 10 trees of the same species shall be replanted as a replacement;
- Vegetation clearance is to be conducted at the beginning of the dry season and outside of the main nesting period for mao from June to October (Stirnemann, Potter, Butler, & Minot, in press);
- Minimize damage to, or the removal of, riverbank vegetation, particularly vegetation that shades the low-flow channel
- Hand clear riverbanks and slopes wherever possible; and
- Replant riverbanks and cleared areas with native trees and plants that are present within the catchment. Invasive species shall not be used for replanting.
- 100,000 native trees are to be planted within the upper Vaisigano catchment to replace the vegetation that is to be felled, and be maintained for three years.

5.4.2. Impacts on Threatened Avifauna

246. Construction activities at Fuluasou SHP are unlikely to adversely impact threatened avifauna.

247. Construction of the Tiapapata SHP has the potential to adversely impact the breeding and/or feeding habitat of two threatened birds: the mao and manumea. Careful environmental management and mitigation will be required to ensure that adverse effects on avifauna habitat will be avoided, minimized, or mitigated.

248. Adverse impacts on these species during construction and operation of the Tiapapata scheme potentially include:

(i) Direct loss of habitat and food trees through 70,000m^2 vegetation clearance;

(ii) Killing of individuals, eggs or nestlings during vegetation clearance;

(iii) Disturbance during construction causing stress and reduced breeding success;

(iv) Fragmentation of habitat;

(v) Increased predation from pest species due to increased disturbance;

(vi) Increased hunting pressure by people caused by accessibility through new roads and tracks;

(vii) Further vegetation clearance and habitat loss through logging and crop cultivation caused by increased accessibility;

249. Standard environmental management and replanting of cleared areas is insufficient to mitigate for the loss of habitat for threatened species. To enable the clearance of habitat known to be used by the mao and manumea, the remaining habitat must be protected and enhanced to increase the carrying capacity for these birds.

250. For this reason, it is recommended that the EPC, SWA and MNRE work together to create the Vaisigano National Park.

251. The proposed Vaisigano National Park is located in the upper Vaisigano catchment on land owned by the GoS (Appendix B). The land has been acquired for water supply purposes (Ordinance No. 18, 1921) but currently has no formal protection. The proposed Vaisigano National Park would encompass a large area of the Apia Catchments KBA that is already proposed for protection (Conservation International et al., 2010), including most of the Vaisigano central and eastern tributaries. The proposed National Park would adjoin the existing O Le Pupu Pue National Park and create a corridor of protected habitat across Upolu.

252. To create a National Park, the MNRE needs to prepare a cabinet submission with supporting documents for the Parliament's approval (MNRE, pers. comm.). Once approved by Parliament the area is declared a National Park.

253. Alternatively, to create a Reserve, the MNRE announces the site during Environment Week in November each year (MNRE, pers. comm.). There is no formal (political) declaration process for reserves.

254. This creation of the Vaisigano National Park would require the support and backing from the GoS, including cooperation between the MNRE and EPC. Involvement and buy-in from the local community and NGOs would also be necessary. The purpose of the Park would be to improve and protect habitat for mao and manumea whilst also securing the watershed for water supply and electricity generation. The Park would also provide eco-tourism opportunities.

255. If managed correctly, the Tiapapata SHP project could provide opportunities to improve habitat for threatened and endangered species through the Vaisigano National Park, and planting of native vegetation, particularly fruit bearing trees including *Dysoxylum* spp, and other species used as food sources by the mao and manumea. Pest control would also be beneficial to increase breeding success of these birds in the catchment.

256. If implementation of the above recommendation is not undertaken, the Tiapapata SHP has the potential to adversely impact the range and population of both the mao and manumea at one of the few sites where the occur on Upolu.

257. Mitigation measures recommended for Tiapapata SHP include:

- Threatened species monitoring. The location and distribution of mao and manumea within the Vaisigano catchment will be monitored prior to, during, and post-construction. If adverse effects are identified, adaptive management will be required;
- Prior to construction commencement, an Environmental Specialist is to identify and mark mature native trees along the route that are not to be felled. If any trees cannot be avoided, at least 10 trees of the same species shall be replanted as a replacement;
- Vegetation clearance is to be conducted at the beginning of the dry season and outside of the main nesting period for mao from June to October (Stirnemann, Potter, Butler, & Minot, in press);
- Prior to, during construction and after completion of construction, gates and security measures will be required to restrict access for people and vehicles to ensure that there is no hunting, tree felling or crop cultivation along the route.
- 100,000 native trees are to be planted within the upper Vaisigano catchment to replace the vegetation that is to be felled, and be maintained for three years.
- During and after completion of construction, pest control for rats and cats is to be conducted along the route to minimise the spread of introduced mammalian predators. Predator control is to continue for at least five years after completion of construction.
- EPC is to work together with the MNRE Environment and Conservation division and MNRE Water Resources Division to proect the Vaisigano catchment and create the Vaisigano National Park on land owned by the Government of Samoa.

5.4.3. Impacts on Other Terrestrial Fauna

258. Construction activities, noise and presence of workers can affect birds and other wildlife in the area. Trees, such as maota (*Dysoxylum* species), are key food supplies for the Manumea and other native pigeons and are important breeding sites for seabirds. Implementation of above mitigation measures will reduce impacts on fauna and birds.

259. Additional mitigations include:

- Workers being prohibited from poaching or hunting any birds or wildlife from within the Project area or adjacent catchment, and
- Prohibition on use of invasive species in replanting.

260. The construction of access roads may result in future impacts in these areas by improving access for plantation development or small-scale timber removal affecting habitat for birds and wildlife. Over the last few years the land use of the water catchment area of this site has been increasingly modified with large areas of land, formerly covered with forest, now being converted to plantations. Such impacts will need to be managed carefully in collaboration with local communities. Official designation of the KBA (as a reserve of National Park) and monitoring and enforcement of conservation requirements would support retaining biodiversity values of the area.

5.4.4. Impacts on Aquatic Ecology

261. During construction, impacts on the river ecosystem can occur through construction activities in rivers, damming and diverting flows, piping of streams, and sediment runoff from land-based construction activities.

262. At Fuluasou, dredging of the reservoir is to occur which has the potential to release silt-laden water downstream.

263. Mitigation measures include:

- All petrol and hazardous materials are to be stored in a bunded area at least 20m from any watercourses;
- Ensure that all stormwater runoff from earthworks and stabilised surfaces are diverted away from watercourses through the use of bunds and trenches;
- Diversions and dammingvof river flow minimized as far as practicable, except during in-stream works;
- In-stream work should be scheduled for the driest time of the year to minimize erosion and silt generation. This will also minimize conflict with the majority of fish migration patterns[5];
- In-stream construction be completed as quickly as possible to lessen the impact on fish and habitats;
- Design and installation of structures and fish screens to minimise restrictions on fish passage;
- Aquatic ecology monitoring of fish and macroinvertebrate communities prior to, during and post-construction.
- Water quality monitoring of pH, total suspended solids, TPH, and heavy metals, prior to, during and post-construction;
- At completion of works disturbed areas should be stabilised and replanted with native vegetation.

264. Mitigation for the dredging works at Fuluasou are to include:

- Work is to be conducted during the dry season;
- Dredging is to be staged, working from upstream to downstream of the reservoir;
- Use of silt curtains around the area of staged works to prevent sediment discharges;
- Dredged material to be stockpiled on land to be dewatered naturally before being trucked off site. This area is to be bunded with silt curtains;
- Dredged material is to be disposed of off-site to landfill or to an existing cleared area (no vegetation clearance is to occur as a result of dredging disposal).

5.5. Construction Impacts on Socio-economic Environment

5.5.1. Traffic

265. The area has many private property entrances and trucks may restrict access to the properties during construction phase. Haulage of construction materials and transportation of SHP plant to the site can create congestion and/or nuisance if not managed carefully. Trucks can transport dirt and debris on to main traffic routes and thoroughfares and belch smoke/emissions in residential areas if not properly maintained.

266. Mitigation measures include:

- Application of COEP 12 – traffic control during construction;

[5] Most fish species present are amphidromous meaning species that spawn in freshwater, the free embryos drift downstream to the sea where they undergo a plaktonic phase, before returning to the rivers to grow and reproduce. Upstream migration is thought to be triggered in part by high freshwater pulses into adjacent marine systems during heavy rainfall

- Traffic control measures identified in CEMP;
- Consultation with Ministry of Works as to most suitable haulage route;
- Traffic movements planned to reduce nuisance/congestion in residential areas.
- Vehicles will not idle in the vicinity of sensitive receivers (schools, church, health facilities).Construction vehicles will not use private driveways or access to turn vehicles or park; and
- Vehicles to be well maintained and cleaned prior to transportation to ensure dirt and debris are not dropped on roads and streets.

5.5.2. Establishment of Site Office and Works Yard

267. There will be no campsite. It is estimated that a maximum 50 workers will be required on site, with approximately 20 of these skilled workers and the rest unskilled. Unskilled workers will be sourced from settlements in the area and skilled workers will stay in hotels and rented houses. This will reduce issues associated with a camp site and residents.

268. A site office and work's yard (storage and plant station etc) is likely to be established for the duration of the construction period. The contractor will be required to adopt good management practices to ensure that both physical impacts and social impacts associated with a camp and/or office/yard are minimized. As noted previously fuels and chemicals, raw sewage, wastewater effluent, and construction debris associated with the construction site office and storage maintenance area will be disposed of appropriately. As part of implementation of the WMP waste will be disposed of under controlled conditions to reduce impacts (refer to section 5.3.6).

269. Social impacts include i) potential for conflict between workers from outside and local residents and communities; ii) risk of spread of communicable diseases including STIs and HIV; and iii) risk of contamination of local water sources. The proposed measures to mitigate the above risks and impacts include:

- Induction of workers shall be required under the Project's consultation and participation plan (CPP). Grievance redress mechanisms (GRM) and protocols established for any contact between local communities and contractor/workers shall also be included as well as CEMP provisions;
- Implementation of a communicable disease awareness and prevention program targeting risk of spread of STIs and HIV as outlined in the Project's poverty and social assessment (PSA) and gender action plan (GAP);
- Apply relevant provisions of COEP 5 – construction camps;
- As per CPP requirements the contractor will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- The facilities (site office and work's yard) will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;
- Potable water, clean water for facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. Adequate toilet facilities shall be installed and open defecation shall be prohibited. Separate toilets shall be provided for male and female workers;
- Standing and open water (including puddles, ponds, drains etc) within the camp or office/yard shall not be permitted to reduce possible disease vectors;
- To reduce risk of contamination of local water sources, wastewater effluent from contractors' yard (if any) will be passed through gravel/sand beds or an oil separator

and contaminants will be removed before discharging it into natural water courses. Oil and grease residues shall be stored, handled and disposed of as per the agreed WMP;

- Post-construction the contractor's facilities will be cleaned up to the satisfaction of PUMA and local community after use. The area shall be rehabilitated and waste materials removed and disposed to disposal sites approved by local authorities.

270. Effective implementation of the above measures will ensure that potential social impacts associated with the contractor's site office and work yard will be negligible.

5.5.3. Occupational Health and Safety

271. A Health and Safety Plan (HSP) as part of the CEMP will be submitted by the contractor to (i) establish routine safety measures and reduce risk of accidents during construction; (ii) include emergency response and preparedness; and (iii) accidental spill procedures highlighting the sizes and types of spills that may occur, and the resources (onsite and/or offsite) that will be required to handle and treat the spill. The HSP will cover both occupational health and safety (workers) and community health and safety. The HSP will be appropriate to the nature and scope of construction activities and as much as reasonably possible meet the requirements of good engineering practice and World Bank's Environmental Health and Safety Guidelines (ESHG) and national regulations[6].

272. The HSP will include agreement on consultation requirements (workers and communities) established in the Project's CPP, establishment and monitoring of acceptable practices to protect safety, links to the complaints management system for duration of the works (in accordance with agreed GRM), and system for reporting of accidents and incidents.

273. Mitigation measures to be implemented by the contractor include:

- Before construction commences the contractor will conduct training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and ESHG and national regulations;
- Ensure an adequate spill response kit is provided and that designated key staff are trained in its use;
- Regular meetings will be conducted to maintain awareness levels of health and safety issues and requirements;
- Legal working hours and official holidays to be respected. Any minimum wage requirements to be observed;
- Workers shall be provided (before they start work) with appropriate personnel protective equipment (PPE) suitable for civil work such as safety boots, helmets, gloves, protective clothes, goggles, and ear protection at no cost to the workers. Site agents/foremen will follow up to see that the safety equipment is used and not sold on;
- The site office and works yard will be equipped with first aid facilities including first aid kits in construction vehicles. A suitable vehicle will be available for transport to Apia town for medical or emergency treatment if required;
- Provision of potable water supply in all work locations; and
- Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works.

[6] Occupational Safety and Health Act 2002

274. All measures related to workers' health and safety shall be free of charge to workers. The worker occupational health and safety plan to be submitted by the contractor before construction commences and in tandem can be extended to cover public safety and approved by PUMA.

5.5.4. Community Health and Safety

275. Community safety can be threatened by works in public areas. General measures and requirements of the HSP which apply equally to community and workers have been discussed above. The HSP will cover measures to minimize risk to community safety including:

- Communication to the public through public/community consultation as per the provisions of the CPP including notice boards and meetings etc. regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- Barriers (e.g. fences) and signboards shall be installed around the camp and construction areas to deter access to or through the sites;
- The general public/local residents shall not be allowed onto site;
- Provision of warning signs at the periphery of the site warning the public not to enter; and
- Strict enforcement of speed limits through residential areas and where sensitive receptors such as schools, hospitals, and other populated areas are located.

276. Such measures will manage risk to community health and safety to acceptable levels.

5.5.5. Impacts on Physical Cultural Resources

277. Even though physical cultural resources have not previously been found in the general vicinity of the sites, the precautionary principle should apply, to minimize risk to any sites or archaeological remains during excavation or other works.

278. To reduce risk or damage and address chance finds the following will apply:

- A coordination mechanism between the contractor and the MNRE will be implemented in case of unexpected discoveries during works;
- The technical specifications will include the following: If the contractor locates any archaeological artefact or site or suspected archaeological artefact or site they shall immediately cease operations and notify the engineer and PUMA forthwith. Work will cease until authorized by the PUMA; and
- The CEMP will include procedures for chance finds.

5.6. Operational Impacts

279. The main impacts during operation include health and safety concerns in respect of the SHP sites and facilities and potential trespassing and ecological concerns associated with improved access to the watershed and catchment area and operation of the SHP potentially affecting river biodiversity.

280. Ecological and watershed impacts can occur during the operation phase if access to sites is not carefully and thoughtfully managed. Rebuilding access roads or constructing new access roads for SHP infrastructure may allow easier access to previously remote areas of forest, encouraging forest clearance for agriculture or timber or illegal hunting of native birds and flying foxes, and water supplies pollution. While improved access may be beneficial from an ecotourism or recreational perspective, access needs to be managed

carefully so as not to inadvertently facilitate exploitation of timber, non-timber forest resources or activities that will reduce biodiversity values.

281. This is particularly important at the Tiapapata site where significant vegetation clearance will be undertaken to install access roads in an area which was previously difficult to access. If public access to this new area of the catchment is not controlled further vegetation loss could occur through local clearance for logging and to plant crops.

282. The most appropriate and sustainable way to manage potential future threats to SHP sites from increased access is for EPC to work closely with MNRE, SWA, local communities and other stakeholders on developing and implementing watershed management plans that recognize the multiple use/multiple benefits concept of holistic watershed management. The following activities may be relevant:

- Raising awareness amongst local communities on the values of protecting water catchments and constituent biodiversity and their multiple benefits if managed well;
- Encouraging villages to develop conservation areas in order to manage plantation development. This may be particularly important in the more heavily forested headwaters of catchments;
- Promoting tree planting programs and watershed restoration activities on areas impacted by development especially along river banks and on steep slopes;
- Allowing limited access to specific areas for recreational purposes only;
- Installing information signage at access points in Samoan and English covering the rules or restrictions on access, and on development activities such as agricultural activities and the harvest of natural resources (e.g. hunting, fishing, logging etc); and
- Promoting awareness about the dangers of invasive species.

283. Operational impacts on aquatic ecosystems include a reduction in flows in areas downstream of points of abstraction, potential for erosion and increased flows at the powerhouse. At Fuluasou, periodic dredging of the reservoir will be required to maintain storage. Mitigation will include:

- Implementation of environmental flows to ensure that in-stream values are maintained;
- Installation and maintenance of fish screens at water intakes and discharge locations.
- Use of silt curtains and methods outlined in section 5.4.4 above are to be used during reservoir dredging.

5.6.1. Impacts on Health and Safety

284. As far as practicable the SHP sites and penstock if not buried should include fencing and keep out signs. These will discourage trespassing, the risk of accidents and vandalism.

5.7. Vaisigano Catchment Cumulative Impacts

285. Cumulative impacts are changes to the environment that are caused by an action in combination with other past, present and future human actions (Hegmann, et al., 1999). In the case of the Tiapapata SHP, there are several competing uses for water which could potentially cause adverse impacts if not considered together.

286. The potential cumulative effects on the Vaisigano catchment are as follows:

(i) Operation and abstraction for four SHPs within the same catchment;

(ii) Abstraction by the SWA for water supply;

(iii) Potential commercial extraction for businesses (if any);

(iv) Private abstraction by residents (if any).

Existing SHPs

287. The proposed Tiapapata SHP will be the fourth hydroelectric power station in the Vaisigano catchment. The three existing stations are Alaoa located on the central branch (1MW), Fale o le Fe'e on the eastern branch (1.7MW), and Samasoni on the main river near the coast (1.7MW) (Figure 26).

288. A total of five existing SHP water intakes are located in the Vaisigano River catchment, with an additional source from the adjacent Vaivase Stream catchment (Figure 26). The Alaoa SHP takes water from the central Vaisigano branch (western intake) and a tributary of the eastern branch (eastern intake). Fale o le Fe'e takes water from the eastern branch (western intake) and Vaivase Stream (eastern intake). Samasoni has one intake on the main Vaisigano River located a short distance downstream from the confluence.

289. Data from EPC indicates that in 2008, the three existing SHPs in the Vaisigano catchment produced a total of 14,076 mWh and consumed a combined total of 47.64 gigalitres of water (Table 7). It is not known whether these figures represent a typical year.

290. EPC collects no hydrological information at the intakes of the SHPs, although hydrological monitoring does occur in other parts of the Vaisigano catchment. Water consumption at each SHP is calculated based on electricity generation (Table 7). This makes it difficult to determine existing flows, abstraction rates, and to determine the actual or potential impacts of the SHPs in the catchment.

291. The Alaoa west intake directs the full flow of the river into the intake, including high flows as the diversion channel is blocked. However an overflow structure on the intake canal does allow some water to return to the river.

292. It is not known whether there are any existing environmental flows released at the other intakes.

Table 7: Electricity production and water usage at SHPs in the Vaisigano catchment (Source: EPC unpublished data, 2008)

	Alaoa	Samasoni #1*	Samasoni #2*	Fale o le Fe'e	TOTAL
Total Hours (kWh)	**3,874,020**	**4,228,170**	**1,727,680**	**4,186,139**	**14,076,009**
Turbine full load (kW)	1,050	950	950	1,740	-
Sec in 1 hour	3600	3600	3600	3600	-
Flow rate at full load (L/s)	958	1,290	1,290	670	-
Volume flow rate (L/h)	3,448,800	4,644,000	4,644,000	2,412,000	-
Hours at full load in 2008	3,689.54	4,450.71	1,818.61	2,405.83	-
Litres consumed (Gigalitre)	**12.72**	**20.67**	**8.45**	**5.80**	**47.64**
Litres per kWh	3,284.57	4,888.42	4,888.42	1,386.21	-
Calculated rated head	111.73	75.07	75.07	264.73	-
Actual net head	135.6	86	86	300	-
% Difference of actual head & calculated	18%	13%	13%	12%	-

*Samasoni has two generators

Existing Water Abstraction

293. The SWA supplies approximately 20,000 customers or 85% of the Samoan population with water (SPC et al., 2012). The Authority operates five water treatment plants including the Alaoa Water Treatment Plant, located in the Vaisigano catchment below the Alaoa SHP. There are 44 SWA bores and 22 water intakes across Samoa.

294. The Vaisigano catchment provides much of the water supply for the city of Apia. The Samoa Water Authority (SWA) has a number water supply intakes in the Vaisigano catchment, with a dam and associated intake located upstream from the proposed Tiapapata SHP intake.

295. The flow rate at the Alaoa Mid and Alaoa East intake in October 2014 is provided below (Table 8). It is not known if there are additional SWA intakes in the Vaisigano catchment.

296. In October 2014, flow rates at the Alaoa Mid and Alaoa East SWA intakes were considered to be above to well above normal (MNRE, 2014). A baseflow of 64 litres per second (0.064 m^3/sec) is listed for Alaoa, which is understood to the environmental flow set for the catchment. This level is lower than the environmental flow of 0.09 m^3/sec proposed for the Tiapapata SHP.

297. Water shortages can occur in Apia during the dry season, especially during extended dry periods associated with ENSO (SPC et al., 2012). This can create competition between the EPC and SWA for available water resources. It is not known whether environmental flows are adhered to during these circumstances. It is acknowledged that are public health, social and economic reasons to ensure continued supplies of water and electricity.

298. No commercial or residential extraction is known to occur within the Vaisigano catchment, but this has not been confirmed by SWA. Commercial extraction requires a licence, however extraction for private use (single residential dwellings) does not require a licence.

Table 8: Current state of low flow at selected SWA intakes October 2014 compared to the 2011 drought and 2012 near drought (MNRE, 2014)

SWA Intakes	Dates of Low Flow Record	Low Flow Rate (l/s)	Current flow (l/s)*	Rainfall	Baseflow (l/s)
Vailele	29/09/11 28/08/12	11 12	12 at intake	Solosolo below average	-
Fuluasou East	05/08/11	124	159 at intake	Lanoto'o below average	7
Chinese 1	27/07/12	27	32 at intake	Lanoto'o below average	7
Chinese 2	27/07/12	31	35 at intake	Lanoto'o below average	7
Alaoa Mid	Sept 2009 Octo 2009 July 2011	72 66 34	129 upstream 121 at intake	TBC	64
Alaoa East	21/06/11 18/07/11 12/09/11 21/09/11 22/09/11 12/10/11 10/07/12 27/07/12 27/07/12 10/09/12 10/09/12 19/09/12 16/10/12	71 69 62 89 45 46 237 76 120 77 85 80 71	264	TBC	64
Tafitoala	July 2011 July 2012 Sept 2013	39 45 50	45 at new intake	TBC	-
Togitogiga	April 2011 July 2013 Aug 2006 May 2006	9 14 12 12	14 at intake	TBC	-

*First week of October 2014.

Assessment of Cumulative Impacts

299. The proposed Tiapapata SHP will involve a single intake on the Vaisiano west branch which will discharge to the Vaisigano central branch upstream of Alaoa SHP. This will result in a decrease in flows in the Vaisigano west branch from the intake to the confluence with the central branch.

300. The western branch of the river is the only tributary of the river which does not have an existing SHP present. This tributary is currently used for water abstraction by SWA, and an existing dam and intake is located upstream of the proposed Tiapapata intake. This means that the tributary is already modified through installation of access roads, pipes and associated infrastructure.

301. To minimise cumulative impacts from the existing and proposed SHPs, environmental flows will need to be provided across the catchment. If not, large volumes of water will be extracted and, if there are no environmental flows, would only be released at the Samasoni powerhouse which is located at the very bottom of the catchment.

302. The environmental flow that has been calculated for the Tiapapata scheme uses a conservative figure of the 95th percentile of the flow duration curve (0.09 m^3/sec). This figure accounts for water that is abstracted by SWA upstream of the site. This provides more water to the ecosystem than previous reports and is also higher than the baseflow figure referenced by MNRE/SWA (MNRE, 2014). This figure also provides some buffer should small-scale abstraction occur downstream.

303. The IEE for the repair and operation of the existing three SHPs in the Vaisigano catchment proposes environmental flows of at least 80% of seven-day MALF (ADB, 2013). This will mitigate any cumulative impacts that could be caused by having multiple SHPs in the one catchment.

304. The following recommendations will minimise cumulative impacts in the Vaisigano catchment:

- Implementation of environmental flows at all SHPs in the Vaisigano catchment to ensure that in-stream values are maintained. This may require additional hydraulic monitoring and/or modelling in order to determine existing flow levels.
- Environmental flows will need to be engineered into the design of SHP intakes to ensure that flows are maintained and cannot be manually switched off during periods of low flow.
- The SWA should be contacted to confirm the location and volume of public and private water abstraction in the Vaisigano catchment.
- If large-scale commercial or residential abstraction is or is likely to occur in the Vaisigano western tributary, the environmental flow from the Tiapapata SHP intake may need to be increased.

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1. Introduction

305. The EMP covers all phases of subproject implementation from preparation through commissioning and operation. It aims to ensure the monitoring of environmental impacts and implementation of mitigation measures. The EMP will be incorporated into the construction, operation and management of each sub component.

306. An EMP for the rehabilitation component is presented below and complies with ADB's requirements as specified in the Safeguard Policy Statement 2009. The EMP includes the following information:

(i) Implementation arrangements including:

- institutional roles and responsibilities for EMP implementation throughout all stages of the project (procurement, design, construction, operation)
- capacity building requirements for executing agency to ensure ADB's environmental management requirements are properly understood and fully implemented
- Grievance redress mechanism

(ii) Environmental mitigation and monitoring matrices including:

- potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction, operation)
- proposed mitigation measures to address each impact identified
- agency responsible for implementing each mitigation measure
- monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project
- schedule and responsibility for monitoring

(iii) Costs associated with implementation of all aspects of the EMP.

6.1.1. Mitigation Measures

307. Environmental protection and mitigation measures will: i) avoid impacts where possible; ii) mitigate environmental impacts; iii) achieve compliance with national environmental regulations and ADB safeguard standards; iii) provide compensation or offsets for lost environmental resources; and iv) when possible, enhance environmental resources.

308. To ensure that mitigation measures contained in the EMP are successfully implemented appropriate steps will be taken to ensure that:

- The EMP is to be included in the tender documents;
- The tender document specify that the contractor will engage experienced staff to implement the required EMP and other measures and undertake monitoring specified in the EMP
- In response to the approved EMP and based on the specific construction methodologies to be employed, the contractor prepare a construction EMP (CEMP);
- The contractor submit to EPC and PUMA its contractor management plan for approval (site clearance, site drainage, waste and material management, pollution control, traffic, noise and dust management)
- Project documents are disclosed and made available to public;

- The GRM made known to the public prior the start of the project; and
- EPC ensures there are sufficient resources to oversee EMP implementation in all project sites.

309. The EMP matrix incorporating the activities, impacts, mitigation measures required to address the impacts, and monitoring requirements is set out in Table 6.1.

6.2. Implementation Roles and Responsibilities

310. **Implementation of the EMP**. The MOF is the executing agency for the Project and EPC is the implementing agency. As such EPC, though the existing PMU, will be responsible for overall implementation of the Project. The PMU will be supported by the project management consultant (PMC). EPC through the PMU will be responsible for ensuring, on a day-to-day basis, that the EMP is implemented during each stage of the project (design, procurement, construction and operation). This includes ensuring that all GoS and ADB requirements and procedures relating to environmental safeguards are complied with.

311. Implementation of mitigation measures and monitoring during the construction and operational phases will be the responsibility of EPC and PMU. The construction and rehabilitation mitigation measures contained in this EMP will be included as necessary activities in the contract documents.

312. **PMU Environmental Responsibilities.** EPC will be responsible for ensuring that sufficient resources are in place to undertake its environmental safeguard responsibilities. The PMU will be supported by a PMC during all aspects of project implementation. The International Environmental Specialist (IES) and Environment Officer (EO) will support the PMU in the following tasks:

- Preparation of the tender documents including integration of the EMP from the approved IEE and draft method statements for various aspects of the EMP such as HSP, MSMP and WMP;
- Consult with PUMA to check whether the IEE is suitable as PEAR under the Act or re-format as necessary, make the application for development consent on behalf of EPC and obtaining consent and additional permits as required;
- Ensuring that EPC, PMU and contractor are aware of any consent conditions and implications those might have for Project implementation;
- Work with the PMU's social specialists in respect of implementation of the CPP and GRM;
- Supporting EPC in tender evaluation with respect to contractors' environmental management capability and proposed EMP provisions;
- Providing training/induction on EMP updating (based on detailed design) and requirements to successful contractor;
- Review and approval of contractor's site and methodology specific CEMP;
- Monitoring compliance of the contractor with the approved CEMP and other provisions of the contract;
- Advice and support on threatened species monitoring, replanting and pest control.
- Support for EPC and MNRE to create the Vaisigano National Park;
- Review of contractor's monthly reports on safeguards application;
- Providing inputs to quarterly progress reports and safeguards monitoring reports to be submitted to EPC and ADB; and

- Capacity building of EPC in environmental management and supervision aspects of project implementation.

313. The PMC will include an IES to oversee that the EMP design and construction requirements are fully integrated into the tender documents and assist EPC meet all its obligations for EMP and safeguards implementation as outlined above. A key aspect of the IES's role will be training and capacity building of the EO and other EPC staff (including management) in implementation of its obligations under GoS law and regulations as well as general training in safeguards to raise the awareness and build capacity of environmental management in EPC operations.

314. **Capacity building**. The EPC has a unit dedicated to social and environmental matters. The EO will lead supervising the implementation of the EMP and its monitoring. The environmental officer will be solely responsible for all EPC activities and monitoring. It is advisable to temporarily reinforce the EPC environmental capacity by seeking the assistance of an international expert to ensure the proper integration of the EMP measures into the contractor work plan and the preparation of the CEMP. An international expert(s) will be contracted and paid from the grant budget and will provide intermittent assistance to the EPC environment division helping it to fulfil its supervision and monitoring responsibilities. The expert will also provide monitoring reports for the ADB (see Terms of Reference in Annex 2). The EO with the guidance of the IES will undertake the incorporation of EMP provisions into the contract documents

315. **Contractor**. The contractors will be engaged by EPC for construction and rehabilitation activities. Each contractor will be responsible for the implementation of construction and rehabilitation activities for one site. The contractors will have the responsibility for implementing the impact mitigation measures in the construction phase and the EO will supervise their performance. The contractor will appoint staff who are specifically responsible for preparation and implementation of the CEMP. Based on the detailed design of the Project, the contractor will be required to prepare the CEMP, which describes the contactor's construction methodology and measures and plans for implementing the EMP as specified in the tender contract. This includes maintaining a site diary and a grievance registry. The CEMP shall be approved by the EPC prior to the contractor's mobilization to the site. The contractor will be required to report on the implementation status of the EMP to EPC.

6.2.1. Grievance Redress Mechanism

316. EPC does not have a formal GRM. It has enquiry boxes where the public can deposit complaints or suggestions. The EPC Public Relations Officer will extract documents from the inquiry box and distribute them to the relevant EPC persons to be addressed. There are no records of complaints and individual responses are not sent to the complainant.

317. EPC will need to develop a mechanism for complaints to be taken into account and solved, and information provided back to the complainant. The GRM needs to be a step-by-step procedure to receive, register and track all grievances concerning the environment. The current referral procedure as used by PUMA could be adapted by EPC to address project and wider complaints in a more organized way.

318. For the project the following will be implemented as the GRM.

- Members of the public will have rights to make grievances known to the EPC and for them to be addressed, to the extent practicable and reasonable. During project construction, a Supervising Field Engineer, EPC PMU Head, EPC's Public Relations Officer and as required members of Environmental and Social Unit shall be available to address concerns.

- The contractor is required to record any complaints received directly along with notes detailing how and when the issue was resolved. The contractor's record or register will be subject to monitoring;
- The affected people will file their complaint through matai, women's council or village chief to the EPC–PMU community liaison team. The name and contact details of these individuals will be presented on a notice board within the village and/or town of the project area. Complaints can be also filed in person, via email or via a letter to EPC. The EPC liaison team will hear grievances and initiate appropriate remedial action;
- For complaints over major issues, such as compensation, damage to property, or occupation of land during construction without due agreement, EPC-PMU will respond within 24 hours and arrange a meeting with appropriate personnel including a representative of EPC-PMU to hear the complaint.
- If a solution, agreeable to all parties, is not reached within a period of seven days, depending on the nature of the grievance (land issue or environmental issue) the complainant may file the grievance with the Secretary of MNRE or Secretary of the Samoa Land Board, who will hear his/her grievance when the Board meets monthly. The complainant also has the right to take his/her grievance to the Magistrate Court for resolution;
- If the complainant remains dissatisfied with the corrective action proposed, he /she may take his/her complaint to the Magistrate's Court. It is not anticipated that the level of complaints from the project will be significantly high such that current resources of the Court will be stretched. However, should this situation arise, the Court will appoint a Magistrate to deal specifically with Project related cases, to avoid lengthy delays.

319. A register of project complaints will be maintained by the EPC–PMU, recording dates, name of complainants (men or women), action taken and personnel involved. The contractor will also be required to keep a register of complaints or issues and how and when they are resolved. These will be incorporated into the contractor's Monthly Reports and be subject to monitoring.

320. A summary on grievances and their status will be reported through regular progress reports and safeguard monitoring reports.

321. The process of documenting the GRM will include the following elements:

- Tracking forms and procedures for gathering information from the contractor/highway section and complainant(s);
- Updating the complaints database routinely;
- Identifying grievance patterns and causes, promoting transparency and information disclosure, and periodically evaluating effectiveness of the environmental GRM, environmental controls, and their implementation; and,
- To ensure that the GRM is effective and accessible, the public will be made aware of the GRM and how to use it. This will need to be done by EPC.

6.3. Monitoring

322. Environmental monitoring will be carried out and the results will be used to evaluate the extent and severity of actual environmental impacts against the predicted impacts and the performance of the environmental protection measures or compliance with regulations.

323. **Monitoring program**. The Project monitoring program will focus on the environment within the project's area of influence and for threatened avifauna in the wider catchment.

324. **Monitoring parameters**. Monitoring parameters are detailed in the EMP matrix (Table 9). The monitoring program will focus on parameters which can be monitored by appropriate local specialists and equipment.

325. **Management**. During construction, the EPC will make appropriate arrangements for monitoring according to the progress of implementation. Monitoring reports will be made available to the EPC and PUMA (MNRE) as required, on a monthly basis during construction. When complaints are received from the public (either directly or via the formal grievance redress mechanism), monitoring staff will conduct additional inspections immediately.

326. **Monitoring costs**. The continuing activities of the EPC monitoring during construction will be funded from the construction budget. EPC ongoing monitoring costs (after the completion of construction) will be covered by their operational budget.

327. **Reporting**. The contractor will prepare monthly reports which will include a description of CEMP implementation, any non-compliances or corrective actions required. These reports will be submitted to PMU. The PMU will prepare quarterly progress reports which will cover safeguards aspects, including summary of contractor's monthly reports and CEMP compliance monitoring undertaken by PUMA. EPC will also prepare safeguards monitoring reports to be submitted to ADB every six months.

Table 9: EMP matrix

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
DESIGN & PRE-CONSTRUCTION								
Obtain development consent (other permits as required) and project disclosure	1. Consult MNRE, submit IEE or re-format as PEAR and make development consent application under statutory process 2. Ensure MNRE approved EMP and any conditions of development consent are included in Contract documents 3. Disclose project documents and establish GRM	PMU/PMC	1 & 2: Start of preconstruction 3: Before start of civil works	1 to 3: Cost included in PMU/PMC admin. And project costs	Environmental approval for the project (and SHP rehabilitation works per site) obtained from MNRE	Prior to signing of Contract and start of site works. Once	PMU	Cost met by PMU/PMC staffing and project
Climate change adaptation measures to be properly considered and incorporated into design as necessary	Design criteria in respect of extreme weather events and peak flood. Critical structures include: 1 Intake weir 2. Intake structures isolation facilities 3. Powerhouse	PMU/PMC	Contract documents preparation	Included in overall project cost	Civil design specifications in tender document Contractor's detailed civil design	Prior to signing off. Contract and start of site works. Once	PMU/PMC (IES & EO) PMU/PMC (IES & EO)	Included in overall project cost
Environmental design for maintenance of aquatic ecosystem – establish minimum flows	1. Project design is to include provision for environmental flows. 2. Environmental flows will be set at least at the 95th percentile of the flow duration curve. 3. Should large-scale abstraction occur downstream of the Tiapapata intake, environmental flows at this site may need to be increased.	PMU/PMC	SHP design Contract documents preparation	Included in overall project cost	Eco flows established. Hydraulic design specifications in tender document Contractor's detailed hydraulic design	Prior to signing off Contract and start of site works. Once.	PMU/PMC (IES & EO)	Included in overall project cost
General ecological principles applied to design	1. Prevention of adverse flow turbulence 2. Infrastructure to allow for fish massage; 3. Maintenance of natural waterway processes 4. Protection of terrestrial and aquatic habitat 5. Prevent degradation of water quality 6. Installation of fish screens on intake and outlet structures 7. Use of bridges in preference to culverts for river crossings	PMC	SHP design	Included in overall project cost	Design documents; Stream, river and ecosystem health	Part of site and ecological monitoring	PMU	Included in overall project cost
Environmentally responsible procurement	1. EMP included in bid documents 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues 3. Contractor to submit site specific environmental management plan (CEMP) based on contractual EMP for approval by PUMA/PMC 4. Contractor recruit qualified and experienced staff to oversee implementation of environmental and safety measures specified in the EMP.	1 & 2: PMC for PMU 3: Preparation of CEMP –Contractor, Approval of CEMP - PMC 4: Contractor	1 & 2: Bid preparation 3 & 4: Before start of civil works	Included in bid cost	1 & 2: Inclusion in bid docs 3 & 4: Check compliance	Bid preparation stage. Before start of site works	PMU / EO & IES	Cost met by PUMA project staffing
Environmental capacity development	1. EPC to commit to provide sufficient resources for project duration to oversee EMP implementation. 2. PMC to train PUMA/EO in implementation of EMP as well as general training in safeguards requirements. A mix of workshops and on-the-job training to be used. 3. Conduct contractor / workers' orientation on EMP provisions.	1: EPC PMU 2: PMC 3: PMC, Contractor	Initiate during procurement period and continue throughout project construction	1: & 2: IES and EO cost included as part of PUMA (project) costs 3:Included in Contract cost	1. ADB loan covenants 2. IES TOR, PMC progress reports to EPC/ADB 3. Tender documents and check during construction.	Prior to start of site works and throughout construction phase.	PMU	Cost met by PUMA project staffing
Raise awareness of contractor on environmental management	Induction safeguards training for Contractor	PMC	Before submission of CEMP	Cost included in project and contract	Approved CEMP	Before submission of CEMP	SEIA/ PMU	Cost met by PMU/PMC
CONSTRUCTION STAGE								
Physical Impacts								
Noise	1. Application of national noise standard 2. Advance notice to nearby residents at start of construction activities 3. Construction equipment and vehicles will be maintained to a good standard and shall be provided with muffler	Contractor	Throughout construction phase	Cost included in contract	Check implementation	Twice a month as part of routine construction monitoring	PMU	Cost met by PMU/PMC & project staff

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	silencers. 4. Adherence to legal working hours to avoid disturbance, schedule noisy activities between 0900 and 1700 5. Monitor and investigate complaints; propose alternative mitigation measures.							
Air quality and dust	1. Reduce vehicle speed through settlement areas 2. Cover stockpiles and flatbeds of trucks when carrying loose materials 3. Utilize vehicles with low emissions 4. Construction equipment and vehicles will be maintained to a good standard and shall be provided with muffler silencers. 5. Ensure watering of access road adjacent to residential areas during dry periods 3. Monitor and investigate complaints, propose alternative mitigation measures	Contractor	Throughout construction phase	Cost included in contract	Check implementation	Twice a month as part of routine construction monitoring	PUMA	Cost met by PMU/PMC & project staff
Erosion and loss of topsoil	1. Apply COEP 6, COEP 7, COEP 8 and COEP 9 as relevant; 2. Contractor to prepare Erosion and Sedimentation Control Plan as part of CEMP; 3. Construction materials obtained from existing quarries and comply with MWTI requirements; 4. Schedule excavation activities in the dry season 5. As much as practicable, align the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors. 6. Minimize vegetation clearance corridor or footprint of components 7. Ensure slope cuts are properly engineered and re-vegetated immediately after cutting 8. Install cut-off drains above excavated areas on steep slopes 9. Install river bank protection measures (masonry, gabion baskets etc) in river channel adjacent to headworks structures and powerhouse tailrace 10. Stockpile topsoil for later use in landscaping or by community 11. As far as possible ensure cut to fill balance	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items; Turbidity of streams and river	Twice a month as part of routine construction monitoring	PUMA / PMC	Cost met by PMU/PMC project staff
Sedimentation and water quality (impacts due to site runoff)	1. Application of COEP 6 and COEP 13; 2. Contractor to prepare Erosion and Sedimentation Control Plan as part of CEMP; 3. Schedule excavation activities in the drier months 4. Align the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors. 5. Minimize width of vegetation clearance corridor 6. Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles 7. Use silt curtains when working in or near watercourses 8. Runoff to be directed to sediment traps before discharge to water course 9. Install cut-off drains above excavated areas on steep slopes to reduce erosion 10. Earthworks to be conducted during the dry season.	Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	PUMA	Cost met by PMU/PMC & project staff
Materials and Spoil Management	1. Application of CEOP 8 and COEP 9 2. Contractor to prepare Materials and Spoil Management Plan as part of CEMP	Contractor to prepare MSMP, PMU /PMC to assist	1, 2: One month before start of site works 3 to 10: throughout	Cost included in contracts	Check implementation of items 1-10 and MSMP provisions	1, 2 before construction 3 – 10	PUMA	Cost met by PMU/PMC & project staff

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	3. Construction materials, as much as possible, to be sourced from existing quarries. 4. Balance cut and fill requirements to minimize need for aggregates from other sources 5.Areas for disposal to be agreed with land owner and recorded by the PUMA/PMC and monitored 6. Spoil will not be disposed of in rivers and streams or other natural drainage path. 7. Spoil will not be disposed of on fragile slopes, flood ways, wetland, farmland, forest, religious or other culturally sensitive areas or areas where a livelihood is derived. 8. Surplus spoil will be used where practicable for local repair works in consultation with local community. 9. Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 10. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.	and approve 1 to 10: Contractor	construction phase			Implementation of MSMP provisions: Monthly		
Waste Management	1. Prepare and implement Waste Management Plan as part of CEMP 2. Areas for disposal to be agreed with land owner and PUMA and checked, recorded and monitored 3. Segregation of wastes shall be observed. 4. Recyclables shall be recovered and sold to recyclers. 5. Residual wastes shall be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams. 6. Site offices and works yard shall be provided with garbage bins 7. Burning of construction and domestic wastes shall be prohibited. 8. Disposal of solid wastes into drainage ditches and public areas shall be prohibited. 9. All general solid waste will be collected and removed from the work areas and disposed in local waste disposal sites as identified by the PUMA.	1: Contractor to prepare WMP, PMU /PMC to assist and approve 2 to 9: Contractor	1: One month before start of site works 2 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items 1-9 and WMP provisions	1: Before construction 2 – 9 Implementation of WMP provisions: Monthly	PMU / PMC	Cost met by PMU/PMC & project staff
Use of hazardous substances and hazardous waste disposal	1. Hazardous substances shall be stored in adequately protected sites consistent with international best practices 2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations. 3. Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution 4. Ensure all storage containers are in good condition with proper labeling. 5. Regularly check containers for leakage and undertake necessary repair or replacement. 6 Store hazardous materials above possible flood level 7. Used oil and other hazardous materials, including oil contaminated water shall be disposed of off-site at a facility authorized by the PUMA/PMC 8. Ensure availability of spill cleanup materials specifically designed for hazardous substances stored on site. Designated staff shall be trained in clean up procedures. 10. Spillage, if any, will be immediately cleared with utmost	Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	PMU	Cost met by PMU/PMC & project staff

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	caution to leave no trace							
Biological Impacts								
Removal of vegetation	1. An Environmental Specialist is to identify and mark large native trees that are not to be removed. 2. If any mature native trees cannot be avoided, at least 10 trees of the same species shall be replanted as a replacement. 3. Vegetation clearance is to be conducted at the beginning of the dry season and outside of the main nesting period for mao from June to October. 4. Minimize damage to riverbank vegetation, particularly vegetation that shades low-flow channel 5. Hand clear riverbanks and slopes wherever possible 6. Replant riverbanks and cleared areas with native vegetation appropriate for the catchment 7. 100,000 native trees are to be planted within the upper Vaisigano catchment to replace the vegetation that is to be felled. 8. No invasive species shall be used for replanting	1. EPC / PMU 2,3,4,5,6,7,8. Contractor	Site surveying and vegetation clearance Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	PMU	1. Approx US$5,000 2. Approx. US$25/tree + labour 3-6. Included in overall project costs 7. Approx US$400/ha/yr 8. Included in overall project costs
Impacts on threatened avifauna	1. The location and distribution of mao and manumea within the Vaisigano catchment will be monitored prior to, during, and post-construction. If adverse effects are found, adaptive management will be required. 2. Install gates and security to restrict access for people and vehicles prior to during and post-construction (in perpetuity). 3. Pest control for rats and cats is to be conducted along the route. Predator control is to commence at the start of construction and continue for five years after completion of construction 4. The EPC and MNRE are to work together to protect the Vaisigano catchment. 5. The EPC and MNRE are to work together to establish the Vaisigano National Park on the land owned by the Government of Samoa (refer Appendix B).	Prior to and during construction: 1,5,6. EPC / PMU 2,3,4. Contractor Post-construction: 2,4,5. EPC/PMU	Prior to, during and post-construction	Included in overall project cost	Check implementation of all items	Monthly	PMU	1. Approx US$10,000 per survey x 3 2. Included in overall project costs 3. Approx US$400/ha/yr 4,5. Cost met by PMU/PMC & project staff
Impacts on other terrestrial fauna	1. Workers prohibited from poaching or hunting birds and fauna from within the project area and wider catchment (sanctions to be imposed) 2. Prohibition on use of invasive species in replanting	Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items Sanctions imposed on workers not adhering to 1	Monthly	PMU	Cost met by PMU/PMC & project staff
Impacts on river ecosystem	1. All petrol and hazardous materials are to be stored in a bunded area at least 20m from any watercourses. 2. All stormwater runoff is to be diverted away from watercourses through bunds and trenches 3. Diversions and damming of river flows to be minimized; 4. In-stream work should be scheduled for the driest time of the year; 5. In-stream construction be completed as quickly as possible to lessen the impact on fish and habitats; 6. Fish screens are to be installed on SHP inlets and outlets; 7. Installation of infrastructure is to minimise restrictions on fish passage; 8. Monitoring of pH, TSS, TPH and heavy metals 9. Monitoring of fish and macroinvertebrate communities 10.At completion of in-stream works disturbed areas shall be replanted with native vegetation.	Contractor	Prior to, during and post-in-stream construction activities	Cost included in contract	Visual observation Check implementation of all items	Weekly during works	PMU /PMC (IES & EO)	Cost met by PMU/PMC & project staff
Impacts of reservoir dredging	1. Work is to be conducted during the dry season; 2. Dredging is to be staged, working from upstream to downstream	Contractor	During dredging activities	Cost included in contract	Visual observation Check implementation of all items	Weekly during works	PMU /PMC (IES & EO)	Cost met by PMU/PMC &

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	3. Use of silt curtains around the area of staged works to prevent sediment discharges 4. Dredged material to be stockpiled on land to be dewatered naturally before being removed. 5. The dewatering area is to be bunded with silt curtains. 6. Dredged material is to be disposed of off-site to landfill or to an existing cleared area.							project staff
Socio-economic Impacts								
Traffic	1. Application of COEP 12 – traffic control during construction; 2. Traffic control measures identified in CEMP; 3. Consultation with MWTI as to most suitable haulage route; 4. Traffic movements planned to reduce nuisance/congestion in residential areas. 5. Vehicles to be well maintained, and cleaned prior to transportation to ensure dirt, debris and weeds are not dropped on roads and streets	Contractor MWTI	Prior to construction (CEMP) Throughout construction period	Cost included in contracts	Check implementation of items	1: Before construction Monthly	PMU /PMC	Cost met by PMU/PMC & project staff
Establishment of site office and works yard	1. Induction of workers on requirements of the Project's CPP, GRM and contact with local communities. 2. Implementation of a communicable disease awareness and prevention program targeting risk of spread of STIs and HIV as outlined in the Project's poverty and social assessment (PSA) and gender action plan (GAP); 3. Apply relevant provisions of COEP 5 – construction camps; 4. As per CPP requirements the contractor will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions; 5. The facilities (site office and work's yard) will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited; 6. Potable water, clean water for facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. Adequate toilet facilities shall be installed and open defecation shall be prohibited. Separate toilets shall be provided for male and female workers; 7. Standing and open water within the camp or office/yard shall not be permitted to reduce disease vectors; 8. Wastewater effluent from contractors' yard (if any) will be passed through gravel/sand beds or an oil separator and contaminants will be removed before discharging it into natural water courses. 9. Post-construction the contractor's facilities will be cleaned up to the satisfaction of PMU and local community after use.	Contractor	1, 2 One month before start of works 3 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items	1, 2 Before construction 3 - 9: Monthly	PMU /PMC	Cost met by PMU/PMC & project staff
Occupational Health and Safety	1. Contractor will conduct training for all workers on health, safety and the environment 2. Regular meetings will be conducted to maintain awareness levels of health and safety issues and requirements; 3. Legal working hours and official holidays to be respected. Any minimum wage requirements to be observed; 4. Workers shall be provided (before they start work) with appropriate personnel protective equipment (PPE) suitable for civil work at no cost to the workers. Site agents/foremen will follow up to see that the safety equipment is used and	Contractor	1: One month before start of works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items	1: Before construction 2 - 8: Monthly	PMU /PMC	Cost met by PMU/PMC & project staff

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	not sold on; 5. The site office and works yard will be equipped with first aid facilities including first aid kits in construction vehicles. A suitable vehicle will be available for transport to Apia town for medial or emergency treatment if required; 6. Provision of potable water supply in all work locations; and 7. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works.							
Community Health and Safety	1. Communication to the public through public/community consultation as per the provisions of the CPP 2. Barriers (e.g. fences, gates) and signboards shall be installed around the camp and construction areas to deter access to or through the sites; 3. The general public/local residents shall not be allowed in the sites; 4. Strict imposition of speed limits through residential areas and where sensitive receptors such as schools, hospitals, and other populated areas are located.	Contractor	At all times throughout construction phase	Cost included in contracts	Check implementation of items	Monthly	PMU /PMC Approved service provider	Cost met by PMU/PMC & project staff
Impacts on physical cultural resources, chance finds	1. A coordination mechanism between the contractor and the MNRE will be implemented in case of chance find discovery during works; 2. The technical specifications will include the following: If the contractor locates any archaeological artefact or site or suspected archaeological artefact or site they shall immediately cease operations and notify the engineer and PUMA forthwith. Work will cease until authorized by the PUMA; and 3. The CEMP will include procedures for chance finds.	Contractor, MNRE	As required	Included in contract	Chance find procedure incl. in CEMP Check implementation of items	As required Monthly	PMU /PMC	Cost met by PMU/PMC & project staff
OPERATION STAGE								
Maintenance of aquatic ecosystem and resources;	1. Ensure minimum ecological flows maintained 2. Raising awareness amongst local communities on the values of protecting water catchments and constituent biodiversity and their multiple benefits if managed well; 3. Encouraging villages to develop conservation areas in order to manage plantation development. 4. Promoting tree planting programs and watershed restoration activities 5. Allowing limited access to specific areas for recreational purposes and provide appropriate infrastructure for controlled recreation 6. Installing information signage at access points in Samoan and English covering the rules or restrictions on access, and on development activities such as agricultural activities and the harvest of natural resources; and 7. Promoting awareness about the dangers of invasive species.	EPC, MNRE (Forest Division), SWA	Operation phase	Included in overall project cost	Watershed, River flow immediately downstream of intake	Against baselines As required Periodically during dry periods	EPC reporting	Included in EPC Operation and maintenance costs
Public safety around project facilities	1. secure fencing to be provided to ensure no public access 2. Keep out signs erected	EPC	Operation phase	Included in overall project cost	Security fencing intact and effective	Periodically during routine maintenance activities	EPC	Included in EPC O&M costs
CUMULATIVE IMPACTS								
Cumulative impacts on the Vaisigano catchment caused by water abstraction and development from multiple sources	1. Ensure implementation and adherence to environmental flows at all SHPs in the Vaisigano catchment. 2. Engineering design of the intake is to ensure that environmental flows are maintained and cannot be manually switched off during periods of low flow. 3. The SWA will be contacted to confirm the location and volume of public and private water abstraction in the	1,3. EPC/PMU 2,4. EPC, PMC	1, 2. Design 3. Operation	Included in overall project cost	SWA consulted. Eco flows established. Hydraulic design specifications in tender document Contractor's detailed hydraulic design	Prior to signing off Contract and start of site works.	PMU/PMC	Included in overall project cost

Environmental Issue/project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameters to Monitor	Frequency & Verification	Responsible to Monitor	Cost
	Vaisigano catchment. 4. Should large-scale abstraction occur downstream of the Tiapapata intake, environmental flows at this site may need to be increased.							

7. CONSULTATION, PUBLIC INFORMATION AND DISCLOSURE

7.1. Consultation and Public Information

328. Since 2011, the EPC have held several public consultations to prepare the project. During the preparation of the draft Resettlement Plan (RP), complementary meetings were held with affected persons. Minutes of these meetings are to be found in the annexes of the draft Resettlement Plan.

329. Consultation was undertaken for Fuluasou and Tiapapata SHPs following field visits conducted to the hydropower plant areas, meetings with the affected households and a review of the layout of the hydropower plant scheme. Based on the available information, the potential impact and land area for the components of the hydropower schemes has been estimated and outlined in the draft RP.

7.1.1. Fuluasou SHP

330. A total of four families and two government agencies will be affected by the Fuluasou SHP. The existing components of the SHP fall within government land, including easements. The rehabilitation and reconstruction of the SHP will mainly follow the existing route.

331. The survey map of Ministry of Natural Resource and Environment (MNRE) for the existing components of the Fuluasou SHP shows that 44 acres of land was acquired in the present reservoir area by the colonial administrator, Government of New Zealand, between 1947 and 1949.

332. During the field visit conducted in July 2013 it was found that three households are encroaching on the acquired Government land area on part of the existing penstock and one household is cultivating land by encroaching on land by the reservoir. Two of the families have built houses by the existing penstock. The one family has built the main house and kitchen within half a meter of the penstock. The other family has built a kitchen and cultivated a garden close to the penstock. With the construction of the new penstock, the houses may be affected but where possible will be accommodated.

333. The old penstock route traverses the Faleata Golf Course. The golf course is managed by the Samoa Land Corporation Ltd, a government entity. The Craig Family Construction Company, located next to the Faleata Golf Course, built an apartment building in 2011 which encroaches over the easement of the old penstock. All the affected parties were consulted in 2013 and follow up meetings were held in September 2014 with Mr Craig and the Samoa Land Corporation.

334. At the meeting held with Mr Craig on 17 September 2014, it was agreed that the penstock would follow the existing legal easement from the dam to the powerhouse except for a slight realignment inside his property where a house and a new apartment were encroaching over the existing easement. The EPC agreed to resurvey the realignment to accommodate these buildings, and also to ensure that the proposed penstock would be 2 meters away from the corner of a warehouse located on his property. EPC will register the new realignment of the legal easement on Mr Craig's property in exchange for the original legal easement at no cost.

335. The old penstock is currently above ground and it was explained that the new penstock would be placed underground. Mr Craig had concerns that his property could be damaged by the construction works and requested that there be minimal damage and disruption during the works.

336. The new penstock will pass through the Faleata Golf Course. The golf course and the land are managed by the Samoa Land Corporation Department (a Government Agency). The EPC has consulted the Corporation on a number of occasions and has received verbal consent that it agrees in principle to the construction of an underground penstock traversing the golf course. The consultation during the PPTA study in 2013, Ms. Tupia and the Manager (at the time) of the golf course stated that they would like to have details of the proposal from EPC. A follow up meeting was held on 18 September 2014 with the current General Manger, Ms. Peseta Tiotio and the plan of the proposed route was discussed with her.

337. Ms Tiotio requested that the old penstock route be used through the golf course to ensure that there would be the least amount of damage and disruption to the course. She was concerned that there would be significant disruption to the golfing activities. It was agreed that the route would follow the old route to minimize the disruption. The route would pick up from where it would be realigned through the Craig property.

338. The EPC agreed to further discussions with the Corporation when details of the design were finalized and when the construction methodology was known. The nature of the disruption, the likely duration of the construction of the penstock and how the Corporation will be compensated for the loss of revenue would be confirmed at that stage.

339. The Tafeamaalii Philip Kerslake, Manager, Technical Division of the Samoa Water Authority (SWA) was consulted previously and was concerned about whether rehabilitation of the dam and other facilities would create an inconvenience to the water supply system during the Commonwealth Youth Olympics in 2015 at the Tuanaimato Sports Complex. The SWA would want a constant and reliable water supply to the facilities during the games. The SWA requested that EPC coordinate with SWA on the construction schedule of the dam and the penstock so that there is no disruption to the water supply. The EPC is of the opinion that the rehabilitation of the existing dam is likely to disrupt water supply of SWA but this will be managed in close consultation with SWA.

340. The SWA mentioned that the existing water facility installation may not be affected, unless the water mains from the intake need future repairs. The SWA will require access to their intake, which currently runs through the connection of the two streams. The SWA water mains are currently located underground of the existing access road and precautions will be required with the laying of the underground penstock. The EPC will need to work closely with SWA in preparing a schedule for the refurbishment of the Fuluasou dam, in the design of the access to the water intake, and with the construction of new underground penstock.

7.1.2. Tiapapata SHP

341. A meeting was held with the Ministry of Natural Resource and Environment and Assistant Chief Executive Officer on 16 September 2014 to discuss land and clarify land ownership issues and, if required, compensation for the land acquired for the Tiapapata SHP. Due to the lack of survey information and the inadequacy of the land plans, the status of the land could not be confirmed.

342. The Tiapapata SHP will be established on Government land most of which is identified under The Land for Water Supply Purposes Ordinance No 18, 1921. The route is proposed to cross two land units, occupied by the Malietoa family and the Seumanutafa family. Meetings were held with these two families in October 2014 and it was stated that the land was government owned. Minutes of the meetings are included in the draft Resettlement Plan.

343. More consultations will however, be undertaken when further information is available on the topographical survey and cadastral boundaries for the Tiapapata SHP.

7.2. Disclosure

344. Following the requirements of SPS and ADB's Public Communications Policy 2011 project documents, including this IEE, will be disclosed on the ADB website and made available locally by EPC.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Project Benefits

345. The proposed project will result in substantial diesel saving and greenhouse gas emission reduction and improve the energy infrastructure of Samoa. The other benefits generated from this project are:

(i) Saving diesel consumption and importation;

(ii) Reducing the price of electricity;

(iii) Increase independency of Samoa for energy production and diversification of its sources;

(iv) Increasing the proportion of renewable energy in national energy production; and

(v) Protecting the Vaisigano catchment as a National Park.

346. The project's benefits in energy savings have been estimated and are shown previously in Table 6. In addition to the significant total savings in gallons of fuel per year is the prevention of associated pollutants from combustion of fossil fuels entering the local air-shed.

8.2. Conclusions

347. The proposed Fuluasou SHP is a highly modified environment. No significant adverse environmental impacts that are irreversible, diverse, or unprecedented have been identified.

348. The IEE concludes that the potential negative impacts arising from the construction of the Fuluasou SHP on the site of an existing (damaged) SHP will be relatively minor, localized and acceptable, providing that the set of mitigations measures set out in the EMP are incorporated in the design and implemented properly.

349. The proposed Tiapapata SHP is located in habitat that has been modified by human and natural disturbance. The site includes habitat for the endangered mao and critically endangered manumea. With careful mitigation and environmental management the habitat for these species can be maintained and possibly enhanced. No significant adverse environmental impacts that are irreversible, diverse, or unprecedented have been identified.

350. The IEE has identified the potential negative impacts arising from the construction of the Tiapapata SHP, including approximately 70,000m^2 of vegetation clearance, increased accessibility to an area of the Vaisigano catchment, and associated threats to endangered avifauna. These adverse effects will be mitigated by planting 100,000 native plants in the catchment, undertaking pest control, and the proposal to create a new Vaisigano National Park linking to the adjacent O Le Pupu-Pue National Park.

351. The EMP identifies potential environmental impacts arising from the project along with a corresponding schedule of mitigation measures to ensure potential impacts are maintained at insignificant levels. It also includes the institutional arrangements for implementing the EMP to ensure its effectiveness.

352. This IEE, including the EMP is considered sufficient to meet ADB's and GoS environmental safeguard requirements. No further or additional impact assessment is considered necessary at this stage.

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APPENDIX A: Flow Data for Fuluasou and Tiapatata SHPs

Exceedance values for the Flow Duration Curve of Fuluasou River
Source: Egis International 2011a

Area (km^2)	17.2
Module (m^3/s)	1.713
Specific module ($m^3/s/km^2$)	0.100
Q (m^3/s)	Exceedance (%)
30.16	0.0%
13.93	0.5%
8.91	1.0%
5.70	2.5%
4.48	5.0%
3.74	7.5%
3.37	10.0%
3.09	12.5%
2.89	15.0%
2.67	17.5%
2.52	20.0%
2.36	22.5%
2.18	25.0%
2.02	27.5%
1.90	30.0%
1.79	32.5%
1.67	35.0%
1.55	37.5%
1.45	40.0%
1.38	42.5%
1.32	45.0%
1.25	47.5%
1.18	50.0%
1.11	52.5%
1.03	55.0%
0.98	57.5%
0.91	60.0%
0.85	62.5%
0.79	65.0%
0.75	67.5%
0.71	70.0%
0.67	72.5%
0.65	75.0%
0.61	77.5%
0.57	80.0%
0.54	82.5%
0.52	85.0%
0.49	87.5%
0.46	90.0%
0.42	92.5%
0.36	95.0%
0.28	97.5%
0.15	99.0%
0.09	99.5%
0.04	100.0%

Exceedance values for the Flow Duration Curve of the Vaisigano River at the Tiapapata intake
Source: Egis International 2011b

Area (km2)=	5.42
Module (m3/s)=	0.446
Specific module (m3/s/km2)=	0.082
Q (m3/s)	**Exceedance (%)**
21.90	0.0%
4.44	0.5%
2.71	1.0%
2.04	2.5%
1.41	5.0%
1.11	7.5%
0.92	10.0%
0.79	12.5%
0.71	15.0%
0.62	17.5%
0.57	20.0%
0.52	22.5%
0.47	25.0%
0.43	27.5%
0.40	30.0%
0.38	32.5%
0.36	35.0%
0.33	37.5%
0.31	40.0%
0.29	42.5%
0.28	45.0%
0.26	47.5%
0.24	50.0%
0.23	52.5%
0.22	55.0%
0.20	57.5%
0.19	60.0%
0.18	62.5%
0.17	65.0%
0.16	67.5%
0.16	70.0%
0.15	72.5%
0.15	75.0%
0.14	77.5%
0.13	80.0%
0.13	82.5%
0.12	85.0%
0.11	87.5%
0.10	90.0%
0.10	92.5%
0.09	95.0%
0.08	97.5%
0.05	99.0%
0.02	99.5%
0.00	100.0%

APPENDIX B: Survey Plan Showing the Proposed Vaisigano National Park

The proposed Vaisigano National Park is located on land owned by the Government of Samoa for water supply purposes (marked in orange below).
It sits within the Apia Catchment KBA priority area for conservation.