

ANNEX J: INITIAL ENVIRONMENTAL EXAMINATION – WASTEWATER SUBPROJECT – DRAFT

TABLE OF CONTENTS	PAGE
1.0 Executive Summary	1
2.0 Policy, Legal and Administrative Framework	3
2.1 National Level	3
2.2 International Level	9
3.0 Description of the Subproject	12
3.1 Kinoya WWTP Upgrade	12
3.2 Existing Pump Stations Upgrading	12
3.3 Upgrading All Existing Sewer Rising and Gravity Mains	12
3.4 Sewer Extension Program	12
4.0 Description of the Environment	13
4.1 Rewa Watershed	13
4.2 Biodiversity	13
4.3 Rewa River	15
4.4 Mining	26
4.5 Laucala Bay	29
4.6 Climate Change	30
4.7 Sustainability	36
5.0 Anticipated Environmental Impacts and Mitigation Measures	39
5.1 Kinoya WWTP Upgrade	39
5.2 Existing Pump Stations	40
5.3 Upgrading All Mains	40
5.4 Sewer Extensions	40

6.0	Analysis of Alternatives	42
6.1	Sewerage	42
6.2	Least Cost	42
7.0	Information Disclosure	43
8.0	Environmental Management Plan	44
8.1	Environmental Management Plan Framework	44
8.2	Mitigation Notes	47
8.3	Monitoring Notes	48
8.4	Implementation Notes	48
8.5	Performance Notes	49
9.0	Conclusions and Recommendations	50
9.1	Conclusions	50
9.2	Recommendations	50

List of Tables	Page
4.1. Average Salinity Values, ppt	17
4.2. Comparison of heavy metals from the reference site, study area and recommended levels: conc in ug/l	18
4.5 Overall means, reference site levels and recommended levels of heavy metals in kai, all conc. In ug/g	19
4.9 Heavy metals (ug/g) from reference sites and sediment quality criteria	20
4.10 Heavy Metals in Sediments of Study Sites	20
4.11 Trace Metal Concentrations in Namosi Ore and Waste Rock (mg//g)	21
4.12 Water Elevation Levels From Lokia to Viria	22
4.13 Water Quality at Planned Intake 600m Above Confluence with Waidina	23
4.1 4 Salinity Wedge Determination Sampling Dates 28 January 2015 to 28 February 2015	24
4.15 High Tide Salinity	24
4.16 Low Tide Salinity	25
4.17 Trace Metal Concentrations in Namosi Ore and Waste Rock (mg/kg)	28
4.18 Temperature Exceedance Forecasts to 2100	30
4.19 Rainfall Exceedance Forecasts to 2100	31
4.20 Sea Level Rise to Year 2100	31
4.21 Salinity Range From Rewa River Model	34
5.1 Kinoya Impacts and Mitigation	39
5.2 Impacts From New and Upgraded Infrastructure	41
8.1 Environmental Management Plan Framework	44

List of Figures	Page
------------------------	-------------

4.1	Rewa River Flow Data Time Series at Navolau Station	16
4.2	Rewa River Showing Results of NWQL Salt Water Sampling	25

1.0 Executive Summary

1.1 The Project

The subproject a Wastewater Subproject

- Upgrading wastewater treatment facilities at Kinoya with 2 SBRs, 2 primary settling tanks, an additional digester and upgrading the belt thickener facility
- Rebuild and/or replace 32 pumping stations
- Replace and/or reline mains
- Extend reticulation to an additional 4000 households

1.2 The Impacts

Sea level flooding and erosion, construction waste, sediment release, topsoil and vegetation removal, dust and noise, traffic delay, materials storage and vehicle servicing, standing rain water and vehicular emissions, release of treatment residuals, worker safety and health.

1.3 Mitigation

Barriers for sediment control, vehicle and machinery designated areas, collect and dispose solid waste, provide sanitary facilities, embankment reinforcement with rock and gabions, designate placement of soil and vegetation, place signage on road, place frequency limitations on vehicles, restore site with landscaping, filter rainwater, require all vehicles certified by LTA, routine water quality sampling, provision of safety clothing and equipment and health certification, design and plan for implementation of shoreline seawall protecting Kinoya assets.

1.4 Environmental Management

- shoreline reinforcement – Weekly inspection/photos and reports with WAF engineers and WAF Envir. Unit
- release of sediment – weekly inspection/photos with WAF engineers and WAF Envir. Unit
- waste – weekly inspection with Contractor and WAF Envir. Unit
- topsoil placement – weekly inspection with WAF engineers and WAF Envir. Unit
- traffic congestion – weekly report/photos with WAF engineer and WAF Envir. Unit
- dust and noise – weekly inspection/sound meter with WAF Envir. Unit
- access road – monitor with weekly reports/photos with Contractor and WAF Envir. Unit
- designated areas for vehicles and materials – monitor with weekly reports/photos with Contractor and WAF Envir. Unit
- rainwater – inspection with monthly reports/photos with WAF engineer, Contractor and WAF Envir. Unit

- vehicular emissions – report with documentation with Contractor and WAF Envir. Unit
- water quality during operation – monitoring with weekly reports with WAF Envir. Unit
- worker health and safety – monthly inspection/replacements with WAF engineers and WAF Envir. Unit

1.5 Conclusions and Recommendations

1.5.1 Conclusions

- a large portion of the Suva and Nausori metropolitan population will benefit from new or improved wastewater management services;
- no serious impacts are incurred as a result of this subproject and those impacts that are incurred are adequately mitigated
- natural waterways in the Suva and Nausori metropolitan area will show improved water quality from the upgrading of Kinoya and associated infrastructure

1.5.2 Recommendations

- capacity strengthening – in both the Trade Waste and Environment Unit and support of the National Water Quality Laboratory
- contractor certification – conduct training and certification in environmental requirements and practices; could be expanded to WAF wide operations
- watershed management – development of cooperative agreements with other stakeholders and push for legislation
- WAF library – provide adequate space and materials for archiving and reference; include full time librarian
- climate change – develop and implement action plan for all facilities

2.0 Policy, Legal and Administrative Framework

2.1 National Level

- 2.1.1 Environmental Management Act 2005.** The Environmental Management Act 2005 (EMA) was gazetted on 17 March 2005. The Act, or sections of it as determined, came into force at dates appointed by the Minister. The Act sets guidelines and policies for environmental impact assessments, waste management, pollution control and penalties. The Act has seven parts:

Part One, Preliminary, contains definitions, application and purposes (“to apply the principles of sustainable use and development of natural resources; and to identify matters of national importance for the Fiji Islands – a) the preservation of the coastal environment, margins of wetlands, lakes and rivers; b) the protection of outstanding natural landscapes and natural features; c) the protection of areas of significant indigenous vegetation and significant habitat of indigenous fauna; d) the relationship of indigenous Fijians with their ancestral lands, waters, sites, sacred areas and other treasures; and e) the protection of human life and health.

Part Two, Administration, includes the National Environment Council and its functions/terms/remuneration and meetings, functions/duties and powers of the Department of Environment, creation of the Environmental impact assessment unit, the resource management unit, the waste management and pollution control unit, the Environmental management units and committees, establishment of an Environmental Register, appointment and powers of inspectors, improvement notices and Environmental audits.

Part Three, Environment Reports and Plans, contains establishment of the National State of the Environment Report, the National Environment Strategy, the Natural Resource Inventory and the National Resource Management Plan, access to reports or plans.

Part Four, Environmental Impact Assessment, contains duties of approving authorities, the environmental impact assessment process, contents, review and approval of EIA reports, environmental management and monitoring, proposals subject to an EIA, and public hearings.

Part Five, Waste Management and Pollution Control, includes permits to discharge waste or pollutants, power to issue permits, facilities without permits, power to inspect and issue notices, order to stop work, environmental emergency declaration and appeal.

Part Six, Offences and Penalties, includes limitation period for offences, offence of undertaking unauthorized developments, other offences, pollution offences, general penalties and other orders, employee protection, defense regarding discharge of waste, civil claims and damages, liability of corporations and directors, matters of bankruptcy, evidence.

Part Seven, Miscellaneous, contains information on institution of proceedings, establishment of an Environmental Trust Fund, establishment of an Environmental Tribunal (for appeals), exemption from liability, power to give

directions, power to delegate, rewards, regulations (Minister), guidelines (Director), transitional and savings (contracts, reports, developments).

Schedule 1, Environment and Resource Management Acts (listing)

Schedule 2, Development Proposals – Part 1 approved by EIA Administrator, Part 2 approved by approving authority

Schedule 3, Development Proposals That May Not Require the EIA Process or an EIA Report

2.1.2 Environment Management (Waste Disposal and Recycling) Regulations 2007

The purpose of these Regulations is to prevent the pollution of the environment by controlling the discharge of solid waste from facilities, the discharge of liquid wastes, the emission of polluting gases, smoke, steam and dust, and the handling, storage and disposal of wastes and hazardous substances generally.

Part 5 of the Environment Management Act 2005 sets out the framework for waste management and pollution control in the Fiji Islands. It prohibits any commercial or industrial facility from discharging any waste or pollutant into the environment or handling or storing hazardous materials without a permit and gives the Waste and Pollution Control Administrator power to issue permits.

2.1.3 Environmental Management (EIA Process) Regulations 2007

There are 5 parts for the regulations.

Part One, Preliminary, sets out citation and commencement, definitions and authority for a development proposal.

Part Two, Screening, includes application for screening of a proposal, involvement of the Ministry as a proponent, procedure of the screening application, the screening decision itself and the classification of proposals and the role of the EIA Administrator.

Part Three, EIA Processing, contains the application for EIA processing of a proposal, the processing and scoping of the proposal, a site inspection that includes factors to be taken into account, records of the inspection and samples taken, scoping consultation including the public, preparation of the terms of reference for the EIA along with TOR meetings and contents of the TOR.

Part Four, EIA Study and Report, includes purpose and conduct of the EIA study, preparation of the EIA report, the required contents of the EIA report and the Environmental Management Plan, submission, publication and review of the EIA report, review meetings and decision.

Part Five, Miscellaneous, describes such matters as bonds, inspection, variations of approval, amendments, corporate body identification, discontinuance of application, consultant registration and loss of same, environmental register,

information confidentiality, EIA guidelines, notices, forms, fees, moneys recovery and appeals.

2.1.4 Environmental Impact Assessment (EIA) Guidelines 2008

The guidelines contain initial information on what is an EIA and then the EIA process for Fiji: step 1 – screening, step 2 – scoping, step 3 – the EIA study, step 4 – review of the EIA report, step 5 – EIA report approval and environment bonds, step 6 – appeal system, step 7 – compliance and step 8 – monitoring. Further information is provided through: flow diagram of the procedure, roles and responsibility of key participants, applicability of the EIA report, conclusion, FAQ, glossary of terms and a reference section. Appendices include: Site inspection form, scoping checklist, typical terms of reference, recommended format of public advertisement and environment bond.

2.1.5 National Liquid Waste Management Strategy 2007

The strategy contains the scope and objectives of the strategy and reasons for managing liquid waste, i.e. the extent of the problem and attendant consequences, information on Pacific wastewater policy and Fiji country background (current waste management in Fiji including legislation, sewage waste, industrial and commercial wastewater, wastewater from the tourism industry, animal wastewater, marine shipping, urban stormwater, leachate from landfill and dump sites and sludge (biosolids)). Appendices include: 1 – strategy for pollution prevention (i) Identifying existing liquid waste management activities and their effectiveness to determine best technologies and practice; ii) Developing a regulatory framework that effectively encourages adoption of best practice and monitors change; iii) Creating awareness and willingness of people ready to achieve goals; iv) Implementing pilot projects and up-scaling successful ones and v) Developing the human and capital resources required to carry out the needed activities.

2.1.6 Endangered and Protected Species Act 2002

The Act consists of 8 Parts:

Part One, Preliminary, consists of the short title and interpretation (definitions).

Part Two, Field of Application, contains the Appendices and Schedules of species: Schedule 1 species not listed in Appendix 1 includes Part 1- Fishes (7), Part 2 – Birds (11), Part 3 – Seabirds (12), Part 4 – Reptiles – Gekos (1), Part 5 – skinks (4), Part 6 – Mammals (3), Part 7 – Flora (42). Schedule 2 indigenous species not listed in Appendices I to III or Schedule I includes Part 1 – Fishes (10), Part 2 – Birds (Landbirds)(38), Part 3 – Reptiles (9), Part 4 – Skinks (8), Part 5 – Terrestrial Snakes (1), Part 6 – Amphibians (1), Part 7 – Mammals (1), Part 8 – Flora (85).

Part Three, Establishment of the Fiji Islands CITES Management Authority and the Fiji Islands CITES Council

Part 4, Permits includes export permits, import permits, re-export permits, permits for introduction from the sea, power to grant permits, validity of permits, keeping of records, application forms, species bred in captivity.

Part 5, Transit and Transshipment includes transit and transshipment of specimens, prohibited and restricted goods, exemptions.

Part 6, Registration and Possession contains registration of persons to trade in specimens, registration of captive breeders, etc.

Part 7, Enforcement includes offenses, offenses by directors, etc., detention of suspects, power of seizure and entry, general penalty, confiscation and forfeitures, reporting of breach.

Part 8, Miscellaneous, includes donations, appeals, delegation of powers, regulations, transitional and savings.

2.1.7 **Green Growth Framework (Draft 2014)**

Peter Wise, Permanent Secretary of the Ministry of Strategic Planning National Development and Statistics summarizes the National Green Growth Framework for Fiji: Restoring the Balance in Development that is Sustainable for Fiji as follows:

"The Framework is a tool to accelerate integrated and inclusive sustainable development that inspires action at all levels in the country to build environmental resilience, build social improvement and reduce poverty, build economic growth and build resilience to the anticipated adverse effects of climate change.

To support its vision of "A Better Fiji For All" and taking into consideration the global and regional developments in green growth, the guiding principles of the Framework are as follows:

- Improving resource productivity (doing more with less);
- A new integrated approach, with all stakeholders collectively working together for the common good. The cross-cutting nature of issues relating to sustainable development requires harmony and synergy in the development strategies;
- Socio-cultural education of responsible environmental stewardship and civic responsibility;
- Increasing adoption of comprehensive risk management practices;
- Increasing adoption of environment auditing on past and planned developments in order to support initiatives that not only provide economic benefits but also improve the environmental situation;
- Structural reform to encourage fair competition and efficiency; and
- Incentivising investment in efficient use of natural resources.

Regulatory and institutional arrangements needed to further develop and strengthen the national enabling environment in order to support the application of this Framework and assure that risks are identified and addressed, and development is sustainable include the following:

- Partnerships;
- Informed Decision-Making;
- Human Resources and Capacity Building;

- Governance Mechanisms;
- Regulatory Framework;
- Technological Innovation and Development;
- Strengthening Private Sector Development; and
- Finance and Economic Incentives.

Ten Thematic Areas were identified to stimulate the development and/or strengthening of an integrated and cross cutting national enabling environment for future development. This contrasts with the traditional sector focused approach which has increasingly been referred to as "working in silos". This approach highlights the opportunity the Green Growth Framework provides for Fiji to do business differently. At the same time it encourages people to think outside the box. Furthermore, it is an approach that accepts that business as usual is no longer an option for Fiji. Every attempt has been made to keep the Thematic Areas to a manageable number whilst at the same time leaving nothing or no-one out. Each includes a section on key challenges and a way forward including actions and time-bound indicators. They are grouped in alignment with the three pillars of sustainable development.

Environment Pillar:

- Building Resilience to Climate Change and Disasters;
- Waste Management;
- Sustainable Island and Ocean Resources,

Social Pillar:

- Inclusive Social Development;
- Food Security;
- Freshwater Resources and Sanitation Management.

Economic Pillar:

- Energy Security;
- Sustainable Transportation;
- Technology Innovation and Development;
- Greening Tourism and Manufacturing Industries.

The National Summit endorsed the Framework and recommended it to Cabinet subject to some changes made during working group consideration of the Framework. It is anticipated implementation will commence with translation into the two vernacular languages and a vigorous advocacy and awareness campaign."

2.1.8 National Climate Change Policy 2012

The National Climate Change Policy is based on the *Climate Change Policy Framework*, endorsed by Cabinet on Tuesday 4 December, 2007. The Policy is aligned to the *Roadmap for democracy and sustainable socio- economic development 2009–2014*, which identifies the need to give priority to protection of the environment, sustainable management and utilisation of natural resources.

The policy presents objectives, principles and overarching strategies to effectively address constraints. It is intended to guide the development of detailed strategies and assist in the formulation and delivery of projects and initiatives.

Mission:

- To increase Fiji's capacity to cope with the impacts of climate change by strengthening institutional and legal frameworks, providing sound scientific information, and implementing effective awareness and education initiatives
- To maximise access to and secure globally available financing for climate change mitigation and adaptation efforts
- To strengthen Fiji's support towards neighbouring Pacific Island countries that are highly vulnerable to the impacts of climate change
- To strengthen engagement in international climate change policy processes and fulfil obligations on climate change mitigation and adaptation

Policy goals:

As a signatory to various international agreements and conventions such as UNFCCC, UNCCD, CBD, and the Kyoto Protocol, Fiji is obligated to develop appropriate national responses. It is also fitting that Fiji establishes national mechanisms that contribute to addressing issues identified in regional policies.

The goals of this climate change policy are:

1. to support the implementation of Fiji's *Roadmap for democracy and sustainable socio-economic development 2009–2014* under the *People's charter for change, peace and progress*;
2. to promote integration of climate change issues in national planning, budgeting and implementation processes;
3. to provide guidance on government's responses to climate change issues;
4. to guide sectors to develop appropriate climate change adaptation and mitigation strategies;
5. to support requests to regional and international agencies to provide resources and assistance in addressing national climate change issues;
6. to contribute to Pacific regional actions and to meeting international commitments.

Policy principals:

1. *Long-term sustainability*
2. *An integrated approach*
3. *Community ownership*
4. *Strategic partnerships*
5. *Scientifically sound and appropriate information*

6. Reporting and feedback mechanisms

7. Monitoring and evaluation

8. Equity and fairness

9. Practical, affordable and appropriate solutions

10. Gender considerations

11. Incorporating lessons learned

12. International collaboration

2.1.9 National Biodiversity Strategy and Action Plan

The Convention on Biological Diversity was signed by Fiji and more than 150 other nations on 5 June 1992, at the United Nations Conference on Environment and Development in Rio de Janeiro. The Convention came into force in December 1993 and as of February 1999, 174 countries and the European Union have ratified the convention. Fiji is, therefore, a Contracting Party to the Convention. One of the obligations of the CBD is preparation of a strategy and plan for biodiversity. It was endorsed by Cabinet in 2003.

GOAL To conserve and sustainably use Fiji's terrestrial, freshwater and marine biodiversity, and to maintain the ecological processes and systems which are the foundation of national and local development.

GUIDING PRINCIPLES

- The conservation and sustainable use of Fiji's biodiversity is the foundation for all
- Biodiversity conservation is central to sustainable use of biological resources.
- Biodiversity conservation is a collective responsibility of all levels of government, the private sector, resource users and landowners.
- Biodiversity conservation in Fiji is greatly dependent on the manner in which landowners and local user communities choose to manage their landholdings and fishing rights ownership;
- Control of local resources by traditional resource owners and users is critical to the success of biodiversity conservation.
- Biodiversity conservation initiatives ensure that local communities and both men and women have continued access to the resources required to meet subsistence needs.
- That although communal land ownership has played, and continues to play a positive role in biodiversity conservation, the increasing commercialisation of natural resource use is threatening this system and constitutes a major challenge to biodiversity conservation.
- Biodiversity is best conserved in those places where it naturally occurs (*in situ*), however *ex-situ* conservation may be needed to assist in the conservation management of threatened species or forms.

- The establishment of a comprehensive and representative system of reserves and conservation areas at the national and local levels is critical to successful biodiversity conservation;
- The conservation and sustainable management of Fiji's natural forests is the single most important means of conserving the vast majority of Fiji's endemic fauna and flora;
- To conserve and sustainably use Fiji's terrestrial, freshwater and marine biodiversity, and to maintain the ecological processes and systems which are the foundation of national and local development.
- The conservation and sustainable management of Fiji's reefs, lagoons and mangroves as well as its freshwater habitats are critical significance to sustaining the traditional livelihoods of the majority of Fiji's rural communities;
- The control of invasive organisms is critical to the success of biodiversity conservation.
- Improved scientific knowledge of biodiversity and enhanced ethnobiological understanding is required for improved conservation management and sustainable use.
- Inadequate knowledge should not be used to defer or prevent biodiversity conservation.
- Biodiversity conservation is a specialised discipline which requires advanced training, skills and international collaboration.
- Education, public awareness and local knowledge are essential for enabling the conservation of biodiversity.
- The principle of polluter and/or user pays be adhered to when assessing responsibilities relating to the use and conservation of biodiversity.
- Biodiversity conservation initiatives should be implemented in a way that local communities - men and women and youth are actively involved in their planning, implementation, monitoring and evaluation.
- The intellectual property rights to biodiversity, genetic resources, bio-derivatives and knowledge about biodiversity be recognised and that appropriate mechanisms adopted to ensure, henceforth, fair remuneration, credit or other benefits are received by local communities, the discoverer or developer, and the nation.

2.2 International Level

2.2.1 ADB Environmental Safeguards Policy and Procedure

For the ADB Safeguard Policy Framework,¹ safeguard policies are generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. ADB's safeguard policy framework consists of three operational policies on the environment, Indigenous Peoples, and involuntary resettlement. These are accompanied by *Operations Manual* sections on Environmental Considerations in ADB Operations; Involuntary Resettlement; and Indigenous Peoples. ADB's Handbook on Resettlement and Environmental Assessment Guidelines (2003) provide information on good practice approaches to implementing safeguards.

¹Safeguard Policy Statement. ADB Policy Paper, June 2009

An updated ADB document² provides guidelines for conducting an environmental assessment. Some of these features include guidance on the environmental assessment process:

- Project screening and categorization
- Scoping for environmental assessment
- Analysis of alternatives
- Project description
- Applicable policy, legal and administrative framework and standards
- Baseline environment
- Impact and risk analysis
 - i) type and scope of impact and risks
 - ii) impact assessment methods
 - iii) impact description
 - iv) mitigation measures and residual impacts
- Environmental management plan
 - i) actions to be taken to implement the mitigation measures
 - ii) monitoring and reporting
 - iii) institutional arrangements
 - iv) EMP implementation schedule and cost estimates
- Information disclosure, consultation and participation
 - i) information disclosure
 - ii) meaningful consultation and participation
- Grievance redress
 - i) grievance redress principals

Occupational and community health and safety – includes impacts on workers and communities involved in both construction and operation.

Biodiversity conservation and sustainable natural resource management – impacts on diversity of living systems, their conservation and whether or not the project is sustainable from a natural resource perspective.

Pollution prevention and abatement – efficient use of resources, wastes and hazardous materials analyzed, treated and mitigated, pesticides mitigated and greenhouse gas minimized.

Physical cultural resources – protection through environmental assessment and management via screening, consultation, management, chance find and removal.

2.2.2 Cartagena Protocol on Biosafety to the Convention on Biological Diversity 2001/3

See above discussion in 2.1.9 on biodiversity strategy and action plan

²Environment Safeguards, A Good Practice Sourcebook, Draft Working Document. ADB. December 2012

2.13 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) 1997. Ratified

See above discussion in 2.1.6 Endangered and Protected Species Act 2002

2.15 Convention on Wetlands (Ramsar)

Fiji signed on November 8, 2006 and it was entered in force on 11 August, 2006.

Recent meetings on the Pacific Mangrove Declaration have been held in Suva. Secretariat of the Pacific Regional Environmental Program (SPREP) is developing a draft Charter. The Rewa River area (Nasoata mangrove island) will be proposed to list under Ramsar Convention.

- 3.0 Description of the Project
 - 3.1 Kinoya WWTP Upgrade Sub-project
 - 3.1.1 [Two SBR plants](#)
 - 3.1.2 Additional Digester
 - 3.1.3 Two primary settling tanks
 - 3.1.4 Upgrading belt thickener
 - 3.2 Existing Pump Station (32) Upgrading Sub-project, All:
 - 3.2.1 Undersized pumps (15 small at 30L/s, 10 medium at 100L/s, and 10 large at 250L/s)
 - 3.2.2 Civil fittings such as bases , risers etc
 - 3.2.3 Deteriorated pump station structures (see 3.4.1)
 - 3.2.4 Automated control systems
 - 3.2.5 Installation of vents at pump stations and rising mains.
 - 3.3 Upgrading of All Existing Sewer Rising and Gravity Mains Sub-project (25 km of replacement and upgrade, 25 km of relining, 15 km DN 250 rising mains, 15 km of DN 300 gravity mains)
 - 3.3.1 Rising mains and gravity mains
 - 3.3.2 Manhole and civil fittings
 - 3.3.3 Replacement of AC mains
 - 3.3.4 Sewer relining
 - 3.4 Sewer Extension Program Sub-project, to Cover:
 - 3.4.1 [Backlog areas](#)
 - 3.4.2 Forecasted [residential](#) and [commercial](#) development
 - 3.4.3 Potential growth areas
 - 3.4.4 The sewer extension programme only includes the sewer reticulation systems.
 - 3.4.5 4000 properties to be connected

4.0 Description of the Environment

4.1 Rewa Watershed³

The Rewa River is the widest river in Fiji, and its watershed is the largest watershed in Fiji, covering an area of 3,092 km² which is about 1/3 of the total area of Viti Levu. The Rewa River originates in the largest peak in Fiji (Tomaniivi) in Ra Province, is fed by two large tributaries, the Wainibuka and the Wainimala, in the upper reaches, while the smaller tributaries such as the Waidina and the Waimanu contribute to the flow in the lower reaches of the Rewa River. The watershed spans five provinces, namely Ra, Namosi, Naitasiri, Tailevu and Rewa. These provinces are connected by tributaries of the Rewa River, but each is noted for very different land- use patterns, resource usage and contribution to the national economy.

In Namosi Province, where the Waidina River originates, the government-endorsed exploratory work for what is potentially the biggest copper mine project for Fiji is currently being assessed in an EIA study and process. In Tailevu Province, where one of the major tributaries (Wainimala River) originates, the country's main pastoral and dairy farms are located. Also, in the last several years, the construction of the Kings Highway along the northern parts of Viti Levu has been a major activity in the Tailevu Province. In Naitasiri Province, the country's largest hydropower plant is located in the upper reaches of the Wailoa River, which drains into the Waidina River. Logging of forests in the upper reaches of the Rewa River and intensive agriculture in the lower reaches of the rivers are having significant effects on the water quality in the Rewa River. The culmination of these activities in the Rewa watershed often impinges most grievously on the communities, the businesses and the villagers occupying the lower Rewa and the delta areas during periods of heavy rain and associated flooding. The high rainfall and the physical attributes of the terrain in the Rewa watershed exacerbate the devastating effects of flooding in the Rewa Delta.

This watershed receives high rainfall of 2,500–4000 mm annually, one of the highest for Fiji. The Rewa watershed also has the highest runoff coefficient (0.6–0.9) when compared to Nadi and Ba catchments (0.4–0.6), computed from annual rainfall and annual discharge figures⁴. The very steep terrain is another contributing factor to erosion: as much as 70% of the Rewa drainage basin has slopes of >18°⁵

The Rewa watershed recorded the highest soil loss in comparison with the other watersheds in Fiji, namely Ba, Sigatoka and Nadi. Studies of soil within the Rewa watershed showed that the soil has a high erosive index of 1500–2000⁶. These

³The Need for an Integrated Approach to Understanding and Managing Coastal Change in River Delta Areas. The Case of the Rewa River. Ulukalesi Bale Tamata, James Comley, Lanieta Tokalauvere. J.Pacific Studies, Vol.2 pp 11-24. 2012

⁴The Study of Watershed Management and Flood Control for the Four Major Viti Levu Rivers of the Republic of Fiji Islands. Final Report. JICA. 1998

⁵An Assessment of Soil Erosion in Fiji. A Report Prepared for the Fiji National Environment Management Project. R.J. Morrison. Department of Environment. 1992

⁶Country Report of Fiji. S.T. Willat and L. Limalevu. IBSRAM Document. 1994

are factors contributing to the severe soil loss and floods for which the Rewa River and delta have, historically, been renowned.

4.2 Biodiversity⁷

The Rewa catchment is located on the windward side of Viti Levu and enjoys high rainfall for much of the year. The forest ecosystem supports high biodiversity of flora and fauna which in turn provides local communities with abundant natural resources.

4.2.1 Freshwater Fauna

Biodiversity of freshwater fauna is high in Fiji. There are 96 recorded species of Fijian freshwater and brackish fish. Four (4%) of these are endemic. Freshwater fish are an important food source for communities living on the banks of the Rewa River (and tributaries) as well as some commercial significance such as *Tilapia*. Available data suggest that between 20-35 percent of freshwater fishes in Fiji are vulnerable, endangered or extinct, mostly because of habitat destruction and degradation⁸.

4.2.2 Freshwater Clam (Kai)

The freshwater clam (*Batissa violacea*) called in Fijian kai ni wai dranu, is an important food item for many families in the Rewa, Tailevu and Suva areas. It is the largest single domestic fishery in Fiji, producing approximately 1,300 metric tonnes annually⁹. The current value of the fishery is estimated to be around FJD\$1million.

The clam provides a source of protein on a subsistence basis but it is also the basis of a substantial commercial fishery operated mainly by Fijian women.

According to market research by the Department of Fisheries (2011), a drop in the production of kai has been recorded over the past decade, including a significant reduction in kai sizes at the markets. Although overfishing is suspected as the major cause of this decline, extreme events such as flooding has been found to play a part in declining kai numbers in the Rewa River. Strong flows and heavy sedimentation during the flood bury or displace the kai from their original habitat. Over time as river hydrology and dynamics return to normal kai re-establish themselves in suitable habitat. The Department of Fisheries recorded a major drop in production between 1992 and 1993, which coincided with the extreme flood event during Cyclone Kina.

⁷ Strengthening the Capacity of Developing Member Countries to Respond to Climate Change. Fiji National Report. TA 7394-REG. July 2012

⁸ A Preliminary Investigation of Priority Ichthyofaunal Areas for Assessing Representation in Fiji's Forest Reserve Network. A.P. Jenkins Technical Report. Wetlands International-Oceania and Wildlife Conservation Society-South Pacific, Suva, Fiji. 2003

⁹ Richards, R. 1994. Fiji Resource Profiles. Research Co-ordination Unit, Forum Fisheries Agency & Fiji Fisheries Division, Ministry of Agriculture, Fisheries and Forest. FFA Report No. 94/4: pp 140 - 144.

4.2.3 Birdlife

The Rewa catchment, delta, coastal environs and off-shore islands provide sanctuary to terrestrial and marine bird species, some of which are endemic to Fiji.

The rainforests of upper Rewa catchment and parts of the mid-catchment (e.g. Colo-I-Suva) are known sanctuaries for Fiji's endemic terrestrial bird species including Fiji Goshawk (*Accipiter rufitorques*), Peale's Pigeon (*Ducula latrans*), Orange Dove (*Ptilinopus victor*), Golden Dove (*Ptilinopus luteovirens*), Whistling Dove (*Ptilinopus layardi*) and Fiji Flightless Pigeon (*Natunaornis gigoura*). With the establishment of introduced bird species in the lower reaches of the Rewa catchment, endemic bird species have been restricted to the pristine rainforests of the upper catchment.

The Rewa delta and Laucala Island (off-shore to the delta) provide unique coastal and marine habitat that is important breeding grounds for a number of migratory bird species, including frigate birds (*Sula sula*), two species of Shearwater (*Puffinus*), Tropic bird (*Phaethon*), Booby (*Sula*), Green Heron, Eastern Reef Egret, and the Fiji Petrel (*Pseudobulweria macgillivrayi*).

4.2.4 Coastal Environment

Oceanic activity in and around the Rewa coastal zone is characterized by predominantly south-easterly swells throughout the year, though during the period between July and December there are significant easterly swells. Tides are generally diurnal and sea surface temperatures have an annual average of between 24 and 31 degrees C. The annual mean tidal range is 1.1m with a range of neap tides of 0.9m and spring tides of 1.3m. Strong tidal currents occur three hours before and after low and high tides in coastal lagoons, such as Laucala Bay. The amount of water entering lagoons over reef areas and through passages is dependent on tidal heights.

4.2.5 Coastal Resources

4.2.5.1 Rewa Delta

The Rewa delta hosts the largest and most diverse area of mangrove forest in Fiji, including the largest peat swamp in Fiji, the Bonatoa Swamp. This is an important brackish freshwater system containing a high diversity of estuarine/freshwater fish.

4.2.5.2 Mangroves

The Rewa Delta is primarily a mangrove swamp with a variety of vegetation alliances varying in species composition. It is the largest mangrove forest in Fiji¹⁰.

¹⁰Watling, R. 1986a. A mangrove management plan for Fiji. Phase 1: Zonation requirements and a plan for the mangroves of the Ba, Labasa, and Rewa Deltas. Technical report, The Mangrove Management Committee, Fiji. A joint project of the Fiji Government and the South Pacific Commission. 67pp.

In 1991, there was approximately 70 km² of mangroves in the Rewa Delta. Recent studies by SOPAC and GIZ on forest cover change in the area shows that, in the period between 1991 and 2001, there was an overall deforestation of approximately 2 km² of mangrove forest. In the 10 years from 2001 to 2011, the Department of Forestry estimates that the mangrove deforestation rate has risen by 10% due to an increase in commercial mangrove wood harvesting¹¹ (Dogo).

The mangroves play an important role in supporting fish populations in both the delta proper and greater Suva area. More than 60% of the commercially important fish species in Fiji are associated with mangroves at some stage in their life cycles. In places where extensive reclamation of mangroves has taken place, there has been an associated decrease in fish production.

4.3 Rewa River

The Rewa River is the principal river in the Rewa Watershed, the largest watershed in Fiji, 2920 km²¹². The river is formed by the convergence of the Wainibuka and Wainimala Rivers and fed by two other tributaries – Waidina and Waimanu. These four rivers drain the Eastern, wetter side of Viti Levu. The lower reaches of the Rewa River are influenced by tide – about a meter rise and fall at Nausori¹³. As a future source of drinking water for the public, there were a number of concerns that had to be dealt with first concerning the river.

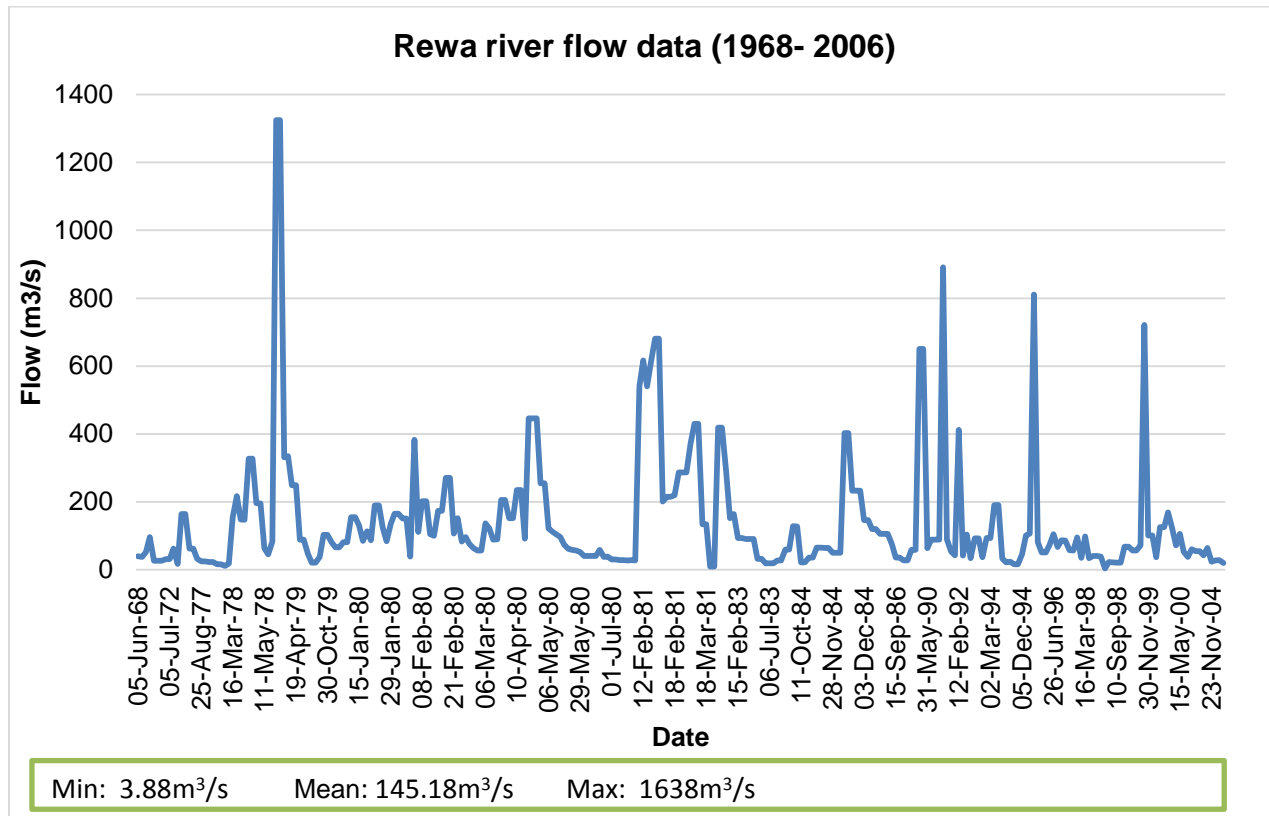
There are three studies that provide background relevant to the water supply subproject, particularly with regard to placement of the intake on the Rewa River. First is the study carried out in 2000 as a Masters Thesis by a student at the University of the South Pacific. Second is the Study of water quality in the Waisoi, Waidina and Rewa rivers in 1995 by Placer Exploration Limited. Third is the survey conducted in 2015 of the Rewa river by the National Water Quality Laboratory of the Water Authority of Fiji.

¹¹ Nakeke A. 2008, Mangroves go up in smoke, Fiji Times, Sunday, July 27, 2008

¹² Hydrology of Rewa and a Watershed. FAO Report to the Fiji Ministry of Primary Industries. Hasan, M.R. 1986

¹³ Nutrient Transport via Sedimentary Process in the Rewa Catchment, Fiji. Togamana C. MSc Thesis, University of the South Pacific. 1995

Figure 4.1. Rewa River Flow Data Time Series at Navolau Station



It should be pointed out that with minimum flow conditions, there would be a withdrawal by the planned intake below Viria at 30 ML/d of 8.9 percent of the minimum flow, of 0.02 percent of mean flow and 0.0002 percent of maximum flow.

4.3.1 The 2000 Study.

3

This study was designed to examine water quality at 8 sites over a 12 month period in 1999 on the Rewa River. The sites are:

- Site 1 – Laucala Bay
- Site 2 – Lokia
- Site 3 – Nakaile
- Site 4 - Naselai Village
- Site 5 – Nadali
- Site 6 – Nausori (estimated)
- Site 7 – Lakena (estimated)
- Site 8 – Kasavu

4.3.1.1 First was salinity. The extent of the influence of sea water on the intake would have to be clarified. In 2000 research on the Rewa¹⁴ showed that the salt wedge reached no further than Nadali (parallel to the Nausori airport).

Table 4.1. Average Salinity Values¹⁵, ppt

Laucala Bay	10.0
Lokia	4.5
Nakaile	2.0
Naselai Village	<1.0
Nadali	0.1 - 0.0

Table 4.1 would suggest that saline water during the course of the 12 month study seemed to not move further up river than Nadali, which would be about 10km from the mouth.

4.3.1.2 Heavy Metals

Next was concern for water quality, particularly heavy metals. The following tables show results from the 2000 study for heavy metals lead (Pb), copper (Cu), cadmium (Cd), iron (Fe) and zinc (Zn) in the water column, in kai (mussel) tissue and in river sediments.

The following table (Table 4.2 taken from the study) shows the mean concentrations of heavy metals in the water column at reference sites, study sites and recommended levels.

The reference site averages come from a site just inside the Waidina River, a site just above the confluence of the Waidina with the Rewa and two sites slightly further downstream on the Rewa at Namuamua

¹⁴The Study of Heavy Metal Pollution in Rewa river, Fiji. Randhir Prakash Deo, MSc Thesis, Chemistry Department, University of the South Pacific. July 2000.

¹⁵ibid

Table 4.2 Comparison of heavy metals from the reference site, study area and recommended levels; concentration in $\mu\text{g l}^{-1}$

Metal	Mean Reference Levels	Overall Mean Levels	Recommended Levels¹
Fe (S)	399±66	481±48	1000 ^{**}
(B)	360±142	795±215	
Zn (S)	48±14	72±20	120 ^{*#}
(B)	63±29	70±16	
Pb (S)	124±17	205±136	82 ^{*#}
(B)	137±20	209±151	
Cd (S)	11±3	19±4	4 [*]
(B)	9.1±3.7	26±15	
Cu (S)	22±3	79±23	18 ^{*#}
(B)	22±7	90±37	

(S) - Surface waters

(B) - Bottom waters

1 - USEPA criteria developed for freshwater; Irvine, 1992

** - Chronic toxicity

* - Acute toxicity

- Assume water hardness 100 mg l^{-1} (CaCO_3)

The results shown in the above table from the overall water sampling data suggest contamination levels for some metals, however many samples were below detection limits. Lead, Cd and Cu levels exceed recommended levels and suggest the influence of the mineralized drainage area around the Copper mine.

4.3.1.3 Kai

As a biological indicator of heavy metal presence in waters, the mussel (kia), *Batissa violacea*, was selected for study. In addition kia is an important source of protein for Fijians, and in the Ba river, 36 percent of the whole population, based on commercial and subsistence data totaled 731,767 kg¹⁶.

Heavy metals in mussel tissue were collected at Naselai Village, Nadali, a site just above Nausori, perhaps Lakena, and Kasavu (at the 90 deg. bend in the river to the West).

Table 4.5 is reproduced from the study.

Table 4.5 Overall means, reference site levels and recommended levels of heavy metals in kai; all concentrations in $\mu\text{g g}^{-1}$

Metal	Reference Site	Recommended	Overall
	Levels	Levels	Mean
Fe	1026	Na	522
Zn	184	150	128
Cu	20	70	19
Cd	3.0	2.0	4.3
Pb	<2.3	2.5	29

Na - not available

In Table 4.5 there were seasonal variations in Fe and Zn. Overall means for the study area exceeded the recommended levels for Cd and Pb. Cu levels were under the recommended levels and Zn exceeded the recommended levels only at the reference site, presumable influenced by the Namosi mine.

¹⁶ Freshwater Clam Resource Assessment of the Ba River, Esaroma Ledua and Matoto, Sione; Vailala Sesewa, Apisai; Korovulavula, Jovesa. South Pacific Commission, New Caledonia and Fisheries Division, Suva. September, 1996.

4.3.1.4 Sediment

The heavy metals in sediment were studied in both reference sites and study sites and the results are shown in the following two tables.

Table 4.9 Heavy metals ($\mu\text{g g}^{-1}$) from reference sites and sediment quality criteria

Metal	U1	U2	C1	C2	SQC
Fe	4175	4719	2212	2747	–
Zn	13	20	14	8.1	110
Cu	4.7	8.2	<4.5	<4.5	25
Pb	<4.5	22	27	26	31
Cd	1.0	<0.4	0.6	1.0	1.0

SQC - Sediment quality criteria, Irvine, 1992

From the reference sites the mean values all appear to be within recommended levels, with those for Pb and Cd to be close to acceptable levels.

Table 4.10. Heavy Metals in Sediments of Study Sites¹⁷

Zn ug/g mean values								
site	1	2	3	4	5	6	7	8
conc	64	84	61	40	26	30	34	56
Pb ug/g mean values								
site	1	2	3	4	5	6	7	8
conc	27	29	34	30	22	34	16	22
Fe ug/g mean values								
site	1	2	3	4	5	6	7	8
conc	4057	3981	4710	4775	4739	4362	4338	4802
Cu ug/g mean values								
site	1	2	3	4	5	6	7	8
conc	18	18	27	29	17	17	15	29
Cd ug/g mean values								
site	1	2	3	4	5	6	7	8
conc	2.3	2.0	1.8	2.9	2.9	2.8	3.2	1.8

¹⁷The Study of Heavy Metal Pollution in Rewa River, Fiji. Randhir Prakash Deo. MSc Thesis, Chemistry Department, University of the South Pacific. July 2000

At the study sites some of the values are over suggested limits, but not significantly.

In summary for the 2000 study:

- For salinity, the influence of sea water only reaches Nadali;
- For heavy metals in the water column, Pb, Cd and Cu levels exceed recommended levels at both reference sites and study sites and suggest the influence of the Copper mine;
- For heavy metals in kai tissue, means for the study area exceeded the recommended levels for Cd and Pb, while Cu levels were under the recommended levels and Zn exceeded the recommended levels only at the reference site, presumably influenced by the Namosi mine;
- For heavy metals in sediment, values in the study exceed recommended levels for Pb, Cu and Cd at some sites and at the reference sites, all values are within recommended levels, with some close to the limit.

4.3.2 The 1995 Study¹⁸

A low-flow water sampling and analytical program was undertaken in the drainage system downstream of the Namosi Prospect in August 1994, where the primary objective was to characterise existing water quality at a number of stations during the 1994 dry season. Water samples were taken at:

- Waisoi Creek East
- Waidina River at Nabukaluka
- Rewa River at Nausori Bridge
- Rewa River at Drekeinakelo

4.3.2.1 Findings included:

- General water quality variables were generally typical of Ca-HCO₃ waters;
- Some marine influence was evident at the Nausori Bridge site (based on slightly higher conductivity readings);
- Total suspended solids concentrations at all sites were low;
- Concentrations of key trace metals (Cu, Cd, Pb, Zn, As, Sb, Se and Hg), other than Waisoi Creek, reflected the low suspended solids values;
- Arsenic and copper levels at Waisoi Creek East were elevated relative to concentrations at the other sites;
- Concentrations of the key trace metals, other than copper at Waisoi Creek East, were lower than relevant ecosystem protection and drinking water guidelines;
- Copper concentrations at Waisoi Creek East were potentially problematic with respect to aquatic biota.

4.3.2.2 N.B. Note the following table, taken from the study:

¹⁸ Low Flow Water Quality Investigation. Placer Exploration Limited. CR 622/8. September 1995

Table 4.11. Trace metal concentrations in Namosi ore and waste rock (mg/kg)*

		Cu	Zn	As	Sb	Se
0.9	Typical background levels	2-90	15-100	1-12	0.1-1	0.05-
	Namosi ore	4,000	250	50	2	4
	Namosi waste rock	0.18	180	30	1.2	3

* Source: Placer

4.3.3 The 2015 Study¹⁹

The National Water Quality Laboratory (NWQL) focused on four sets of analyses: salinity, riverbed slope, chemical constituents and heavy metals.

4.3.3.1 Riverbed slope

The riverbed slope is important in estimating the eventual reach of the salt water, not only for high and low tides and seasons of high and low flow, but also for estimating the consequences of climate change – the rise in sea level, and the lower lows and higher highs of river flow.

The following table presents the segments of river, the elevation at the water surface and the distance from one segment to the next for the length of the Rewa River from Viria down to Lokia Landing.

Table 4.12. Water Elevation Levels From Lokia to Viria

RIVER SEGMENT	DISTANCE, KM	ELEVATION FROM MSL
Viria		4.709
Viria to Janiweni	3.50	4.532
Janiweni to Deladamanu	5.10	3.482
Deladamanu to Naganivalu	2.80	3.504
Naganivalu to Nakini	3.10	2.714
Nakini to Nacokaika	2.50	3.130
Nacokaika to Mosque	1.10	3.416
Mosque to Koroqaga	4.70	2.984
Koroqaga to Naduruloulou	3.10	2.737
Naduruloulou to Kasavu	1.20	2.157
Kasavu to Verata	2.47	3.125
Verata to Lakena	1.40	3.078
Lakena to Manoca	1.06	2.886
Manoca to Crest	0.83	3.161

¹⁹Water Authority of Fiji, National Water Quality Laboratory. Unpublished data. 2015.

Crest to Rewa Bridge/Nausori	0.75	3.753
Rewa Bridge/Nausori to Vunimono	0.65	2.604
Vunimono to Nadali	1.60	3.709
Nadali to airport	1.15	1.893
Airport to Naselai	1.62	2.422
Naselai to Fisheries	1.77	2.439
Fisheries to Burebasaga	1.17	2.865
Burebasaga to Lokia Landing	1.58	2.623

The rough change in elevation from Lokia Landing, taken to be mouth of the river, but is actually 3 or 4 km upstream, to Viri suggests a straight line slope angle of 0.01 percent.

This is a gradual slope, however there are changes in the bottom profile across the width, complicated by dredging and partial rock shelving.

4.3.3.2 Chemical measurements

The following table presents an average of three separate sampling periods of water quality at the Viria planned intake site on the Rewa River.

Table 4.1. Water Quality at Planned Intake 600m Above Confluence With Waidina

MEASUREABLE	CONCENTRATION	WHO DRINKING WATER STANDARDS
Physical		
temperature	24.8 °C	
pH	7.41	6.5 – 8.5
conductivity	85.7 us/cm	<100 us/cm
salinity	0.0 mg/l	<1.0 mg/l
color	10 TCU	<5 TCU
turbidity	56.85 NTU	<5 NTU
Alkalinity & hardness		
alkalinity	37 mg/l	<200 mg/l
bicarbonate	37 mg/l	<100 mg/l
carbonate alkalinity	0 mg/l	<100 mg/l
total hardness	42.9 mg/l	<200 mg/l
calcium hardness	21.3 mg/l	<100 mg/l
magnesium hardness	21.3 mg/l	<100 mg/l
Solids		
total dissolved solids	55.7 mg/l	<500 mg/l
total suspended solids	N/A	N/A
Chemical analysis		
disolved oxygen	N/A	>5 mg/l

chlorides	6.0	mg/l	<250	mg/l
fluorides	0.017	mg/l	<1	mg/l
iron (total)	0.03	mg/l	<0.3	mg/l
iron (soluble)	0.017	mg/l	<0.3	mg/l
manganese (total)	0.017	mg/l	<0.1	mg/l
manganese (soluble)	0.01	mg/l	<0.1	mg/l
aluminum	0.02	mg/l	<0.2	mg/l
calcium	8.53	mg/l	<100	mg/l
magnesium	5.13	mg/l	<180	mg/l
copper	0.01	mg/l	<1	mg/l
nitrate-nitrogen	0.037	mg/l	<50	mg/l
orthophosphate	0.163	mg/l		N/A
fecal coliforms	53	cfu/100ml	<1	cfu/100ml

Values in this table appear typical of Ca-HCO₃ river waters and do not appear to present a problem for treatment during normal ranges of river flow. The details of this site and others further down the Rewa may be found in **Annex A-1**.

Background.

4.3.3.3 Salinity

Table 4.14. Salinity Wedge Determination Sampling Dates: 28th Jan to 28th Feb 2015

Dates	Sites Description	Salinity Comments
28-01-2015	From Naduruloulou till Rewa Bridge and 100m downstream of Rewa Bridge	No salinity detected. Samples taken at 3 points across the river banks at three different depth
03-02-2015	Same spot as above	No salinity detected. Samples taken at 3 points across the river banks at three different depth
05-02-2015	From Nadali till Nailili	Salt wedge detected at the Fisheries Office Low tide - highest point of salt intrusion during low tide
09-02-2015	From Lokia up til Nausori Town End	Salt wedge detected at Burebasaga Landing
11-02-2015	From Wainikalai -100mtrs upstream of Burebasaga Landing up til Naduruloulou	No salinity detected
12-02-2015	Naselai up til old Nausori Bridge	No salinity detected
18-02-2015	Burebasaga Village Nausori Airport Natogadravu	Salt wedge found at Naselai Village High Tide
20-02-2015	From Burebasaga Village till Verata Village	Salt wedge was located at Nausori Airport-Highest point of saltwater intrusion during high tide
23-02-2015	From Naduruloulou till Nadali	No salt wedge detected
24-02-2015	From Naduruloulou till Nadali	No salt wedge detected

25-02-2015	Naduruloulou till Nadali	No salt wedge detected (heavy rain with floodwaters on rewa river with strong current)
26-02-2015	Naduruloulou till Lokia	No Salt wedge detected (wedge moved further down due to strong currents and low tides from heavy rain flood)
27-02-2015	Baulevu Landing till Lokia	No Salt wedge detected
28-02-2015	Baulevu till Lokia	No Salt wedge detected
		Salt wedge during high tide reaches Nausori Aiport and low tide at the Fisheries Office. Please refer to map

Table 4.15. High Tide Salinity

Date	Site	Salinity	Comments
05-02-2015	Lokia Landing	Bottom Sample Reading Salinity 6.4ppt	Time Sampled :10.07am High Tide at 7.33am Low Tide:1.30pm
09-02-2015	Bureibasaga Village	Bottom Sample Reading Salinity Reading -1.5ppt	Time Sampled :10.00am High Tide at 10.05am Low Tide:4.14pm
20-02-2015	Nausori Airport	Bottom Sample Reading Salinity Reading 0.1ppt	Time Sampled :7.00am High tide: 7.00am

A total of 14 sampling exercises were carried out to determine the salt wedge .The above three results shows high tide results that stands out for maximum intrusion of salt water upstream.

The highest point is at Nausori Airport with a reading of 0.1ppt on the 20th of February and full high tide at 7.00am and sample was obtained at that point in time.

Table 4.16. Low Tide Salinity

Date	Site	Salinity	Comments
18-02-2015	Fisheries	Bottom Sample Reading 0.1ppt	Time Sampled :2.00pm Low tide: 11.42am

For low tide the salt wedge was detected at the Fisheries Station which is 1.62km down from the Nausori Airport.

This was the only low tide result as the other 14 sampling results have no salinity value detected since location was changed mainly from upstream at Nadali till Naduruloulou.

Figure 4.2. Rewa River showing results of NWQL salt water sampling



4.4 Mining. The Namosi Joint Venture

For any planned water supply source for public consumption, it is important to identify all activities that may have an impact on that water supply source. The planned copper and gold mining activity on two tributaries of the Waidina River, itself a tributary of the Rewa River, is one such activity.

4.4.1 History²⁰

Interest in copper deposits have been around the Namosi area since the early 60's first by the Fijian Geological Survey and later exploration in the 70's. Several companies have been involved since that time, drilling more than 300 exploratory holes. In the early 2,000's Nittetsu of Japan won a government tender and by 2008 formed a joint venture with Mitsubishi (Japan) and Newcrest Mining Limited (Australia).

A five year lease for prospecting was obtained (SPL 1420) in 2010 covering 734 km². Exploratory drilling has taken place primarily in the Wainavadu and Waisoi Valleys. These valleys are parallel streams draining into the Waidina River, a tributary to the Rewa River. The lease is currently in renewal and an EIA, begun

²⁰ Namosi Supporting Environmental Studies, Report prepared for Namosi Joint Venture. August 2014.
Palaris Australia Pty Ltd.

in 2012 is half-finished. Current deposits show Cu content at around 0.3 to 0.4, however there are other deposits in the SPL with Cu content of 1.0 to 1.5 percent.²¹

4.4.2 Planned Operation²²

There will be two open pits in the Waisoi Valley – at the end of the operation, the West pit would be as big as 180 rugby fields and the East pit would be almost half the size of the West pit at 100 rugby fields. Approximately 16 million tons of ore would be taken from the pits each year.

During mining, rocks that contain only very small amounts of metal would be placed in waste rock storage in two areas. One, approximately 75 times the size of a rugby field and located in the Waisoi Valley. The other, would be 375 times the size of a rugby field and would be located in the Wainavadu Valley.

Tailings, a mixture of finely ground rock, water and processing chemicals, are what is left over after ore treatment. Tailings would be placed in storage behind the Wainavadu waste rock storage. The tailings facility might cover an area as large as 1,000 rugby fields. A 180 meter rock wall would be built across the Wainavadu valley to keep the tailings in place.

Project rainwater management would include a rainwater retention dam behind (upstream) the tailings/waste rock storage and this retention dam would divert rainwater around the project area and back into the Waisoi and Wainavadu Creeks. Some dirty water would be treated to standards set out in the environmental approval.

For extraction and processing, land is cleared, holes are drilled and explosives break up the ore blocks. These blocks are trucked to the crusher reducing the blocks to smaller pieces that are sent to a sag mill (tumbler) and thence to a ball mill for further reduction using steel balls. The product at this point is about the size of sand and has sulphides, CuS, Cu₂S or other form. The product then goes to a flotation tank where it is mixed with water and reagents (organic compounds – xanthates, dithiophosphates) causing the copper to become hydrophobic and float to the surface with blowing air, forming froth, where it is skimmed off and dried. The rock not floating is sent to tailings or for other extraction. The product at this point is dried and shipped to port facilities on Coral Coast and thence to Japan for smelting. Copper is 25 to 35 percent pure at this point²³.

4.4.3 Issues With Normal Operation

Blockage. Both the Waisoi and Wainavadu creeks are blocked with diversion dams designed to return flow to the creeks. A principal problem as the tailings and acid waste rock fill up the storage facilities, is the seepage both into ground

²¹ Greg Morris, personal communication

²² Waisoi Project Information. November 2011

²³ Greg Morris, personal communication

water and thence to the Waidina and the seepage of waste water through the rock tailings dam.

Sulphate Soil. Much of the soil in the area has a sulphate content that when exposed, as in construction, to rain, makes a weak acid, that, over time begins to erode all it touches.

Waste Rock. Waste rock in both storage facilities has a weak acid content, which, in the aggregate within a very large facility both seeps around storage natural earth walls and seems underground to groundwater and thence to the Waidina River.

Heavy metals. Always associated with Cu, different ones can occur in different degrees at different mines, but they will be present in both tailings and waste rock. They could also appear in the dust at the crushing and milling stages. Typically present are Zn, Fe, Cu, and As, Cd, and Hg can also occur. The following table is taken from a 1995 study of the Namosi prospect²⁴

Table 4.17. Trace metal concentrations in Namosi ore and waste rock (mg/kg)*

	Cu	Zn	As	Sb	Se
Typical background levels	2 – 90	15 – 100	1 – 12	0.1 – 1.0	0.05 – 0.9
Namosi ore	4,000	250	50	2	4
Namosi waste rock	0.18	180	30	1.2	3

- Source: Placer

Rain. Assisting with the movement of acids, wastes and heavy metals downhill to streams is rainfall.

Acid Mist. The wide occurrence of sulphides liberated in the crushing and grinding process, the waste rock and in tailings can combine with water – rain, drizzle to form a weak, but potentially persistent acid.

Water impacts. Adverse water quality impacts are caused primarily by land disposal practices that fail to contain wastes, by run-on and run-off controls that are inadequate to prevent surface water from flowing through impoundments, or by groundwater infiltrating surface impoundments. In addition, the large-scale land disturbances associated with open-pit mining may disrupt the natural flow of surface and ground water, and may lower the water table in the mine area. Lowering the water table may cause water shortages, land subsidence, and fracturing; the latter facilitates the transport of contaminants into and through an aquifer.

4.4.4. Issues With Events That Are Not Predictable, But Are Both Probable and Possible

1. A seismic event. Fiji has a history of seismic events, both earthquakes as well as volcanoes, although the latter dates from geologic time, but the former is more frequent.

²⁴ Low-flow Water Quality Investigation. Namosi Prospect Environmental Program. Placer Exploration Limited. NR Environmental Consultants. September 1995.

Geologic fault lines have been identified in SPL 1420 running north-west and north-east²⁵. Since 1918 there has been an earthquake of magnitude 6 or more on an average of every three years.²⁶ Depending on the exact location of the quake and its severity, damage to the mining operation could vary but the most susceptible structures to damage are the dams releasing wastes and rock to the Waidina and then to the Rewa. Also with potential damage are the rock storage facilities. Depending upon how long the waste has been accumulated, there could be releases of as much as 192 million tons of waste ore if the project is half-finished. **Estimated Risk Value on a scale of 1 to 10: 4**

2. A cyclone event. Fiji also has a history of cyclones. Although Fiji gets roughly 3 cyclones every 4 years, recent cyclones have had significant wind and water effects – in 2007 Cyclone Daman hit northern Fiji with wind gusts up to 205 kmh, Cyclone Gene hit Suva with wind gusts up to 185 kmh in 2008 causing widespread flooding and in 2012 Cyclone Evan hit Viti Levu with winds up to 230 kmh, uprooting trees, destroying buildings, power and water sources. For a mining operation, wind damage would be significant, but pales in comparison to the effects of flooding. With hard and steady rainfall on the operations the tailing and rock storage facilities and rainwater storage dam facilities could experience failure and the results would be similar to those from an earthquake, dumping waste into the Waidina and Rewa Rivers. Flooding of all pits, holes, low places will wash out wastes to run downstream as well. **Estimated Risk Value on a Scale of 1 to 10: 7**

3. An Accident Event. Given the high use of explosives, heavy equipment, construction of structures vulnerable to failure due to construction faults or other factor or other accident and mines are an enterprise highly susceptible to accident. The accident could be minor in scale and seriousness and corrective measures could prevent downstream problems. The accident could be major and controls were not effective and the mining operation could be helpless to prevent downstream consequences. Torrential rainfall could cause landslides and structural damage could ensue causing failures from damaged systems. An example is the breach of the tailings dam at Mount Polley Mine, an open pit copper mine in 2014. Five million cubic meters of waste was released into nearby creek and lakes threatening drinking supplies.²⁷ **Estimated Risk Value on a Scale of 1 to 10: 5**

4.5 Laucala Bay²⁸

The Laucala Bay lies in the wet zone of Viti Levu, i.e., there is no marked dry season. The area has a humid tropical climate. Suva city lies at a latitude of approximately 18° South and for most of the year the Southeast trade winds prevail. However, from November to March the Fiji group is under the influence of the north east monsoon, characterized by a general drop in wind strength and

²⁵ Namosi Supporting Environmental Studies, Report Prepared for Namosi Joint Venture. August 2014.

Palaris

²⁶ Ministry of Lands and Mineral Resources, Mineral Resources Department, Suva, Fiji

²⁷ Global News. Canada. August 4, 2014

²⁸ Water Quality Studies on Selected South Pacific Lagoons. S. Naidu, et al. UNEP Regional Seas Reports and Studies No. 136. SPREP Reports and Studies No. 49. UNEP 1991

an increase in occurrence of calms, coupled with the sporadic incidence of the passage of intense low pressure areas.

Much of the Suva area is located on uplifted calcareous marl, probably of lagoonal origin. There are also basaltic breccia deposits and tuffs in the area and much of the coastline consists of deposits derived from the weathered products of the marl, tuffs and breccia. Much of the coastline has been covered with mangroves, but the recent development activities have seen destruction of substantial areas of mangroves, in some cases by construction activities and in others as a consequence of overexploitation.

Laucala Bay lies between Suva peninsula on the West and the Rewa River delta on the East. A series of broad coral reefs isolate and protect the bay from the Pacific Ocean. The bay is connected on its West side to Suva Harbor. At high tide the reefs are submerged and a shallow layer of seawater enters the bay twice daily around high water.

The major source of fresh water into the bay is the Vunidawa River, a distributary of the Rewa River, which discharges into the Northeast portion of the bay. Minor sources come from the Vatuwaqa and Samabula Rivers along the Western shore. Estuarine water enters from the South of Laucala Island.

At high water, Laucala Bay has a surface of 4500 ha. And at low water an area of about 3900 ha.

The tides in Laucala Bay are predominantly semi-diurnal with a mean range of 1.1 m. Tide height is continuously recorded on a gauge on Suva wharf and tidal predictions are published for Suva based on a harmonic analysis of the record from the gauge. The range between high and low waters is 0.9 m for neap tides and 1.3 m at spring tides.

4.3.5.1 A recent study²⁹ of nutrients in Laucala Bay summarized results as follows:

- Laucala Bay is more polluted than Suva Harbour;
- In Laucala Bay, nearshore areas around Vatuwaqa and Samabula Rivers are more contaminated than the outer reaches near the reef;
- The Kinoya wastewater treatment plant has a large local input into Laucala Bay;
- Nutrients (N&P) are outside guidelines (Environmental Management Act '05 and Water Quality Guidelines for Fresh and Marine Waters) by a factor of at least 2 to 9 for Laucala Bay (inshore);
- In the Bay's open waters data is below standards for primary contact (swimming) N.B. recent sewer line rupture notwithstanding;
- A break in the 1.6 km sewer outfall, roughly 3m below the surface (designed for 1.6 length with 100m diffuser) creates a boil at the surface of the discharge – at least 0.5m³/s and contaminating the nearshore;

²⁹Dissolved Nitrogen and Phosphorous in Suva Harbour and Laucala Bay. Anderson, Edward. Aquatic Science Pacific.WAF Contract No. 11/026. 31 August 2014

- Benthic organisms within 200m of the outfall display a stressed distribution, with no

4.6 Climate Change

Climate change and its effects on both the planned water supply system on the Rewa River as well as the upgraded wastewater treatment at Kinoya are important factors in planning for these projects. Having some idea of the likely scenarios will help in developing adaptive mechanisms.

There are three studies that were used in assessing climate change for the water supply and wastewater upgrade project.

4.6.1 **The First Study** is the one by KBR³⁰. The following information is taken directly from this report.

The following tables of climate change trends and risks were generated as a result of a series of workshops.

Temperature

Warmer and drier climate for Nausori (meaning the Rewa watershed) toward 2100 with minimum and maximum temperatures increasing over the next 100 years

Table 4.18. Temperature Exceedance Forecasts to 2100

Year	Temperature, °C	Exceedance
2025	35	Equal or exceed 45 times
2050	35.5	Equal or exceed 80 times
2075	36	Equal or exceed 100 times
2100	36	Equal or exceed 40 times

Minimum temperature also going up to 25°C and equaled or exceeded 180 times in 2100.

Rainfall

Table 4.19. Rainfall Exceedance Forecasts to 2100

Year	Rainfall, mm	Exceedance
2025	450	Equal or exceed 331 times
2050	450	Equal or exceed 458 times
2075	450	Equal or exceed 685 times
2100	450	Equal or exceed 900 times

³⁰ Strengthening the Capacity of Developing Member Countries to Respond to Climate Change, Fiji. National Report. DBR Pty, Ltd. TA 7394 –REG, July 2012

Regional scenarios point to an El Nino mean-state (El Nino like conditions dominates), with a decreasing trend in annual rainfall with the drier season (in Fiji May to October) getting wetter and the wetter season (in Fiji November to April) becoming drier. Short durations of high intensity rainfall are expected in the future and the likelihood of drought like situations for Nausori to be higher.

The El Nino like mean state predicts cyclones or storms of higher intensity for the area. The estimated return period for an extreme event in a reduced rainfall scenario was found likely to be less than 20 years. As a result more frequent and more damaging floods are a risk for the Nausori urban and peri-urban watershed in the future. In particular flooding in the Waidina, Wainimala and Waimanu Rivers is likely to increase in frequency and magnitude. The estimated return period for an event similar to (or worse than) the 1993 extreme flood event is likely to be less than 20 years. [Note: cyclone Evan in 2012]

Sea Level Rise

Sea level is predicted to rise up to 1 meter higher in 2100 as compared to 1990 sea levels.

Table 4.20. Sea Level Rise to Year 2100

Year	Sea Level Rise, m
2030	0.4 Level reaches Kinoya
2060	0.8 Level may inundate Kinoya
2100	1.2 Likely cover Lokia, Burebasaga, up to Navatuyaba

Simulations of the Rewa river delta show large rates of shoreline recession. Using the best-guess and high sealevel rise estimates, the delta is shown to recede by 32- and 650m respectively by 2100. This is due primarily to coastal erosion plus high energy weather events.

Summary of climate change threats to the Rewa River watershed, based on baseline information plus projections:

1. More frequent high intensity lower catchment flood events;
2. More frequent upper and mid-catchment flash flood events;
3. Storm surge increasing in frequency and magnitude;
4. Large scale extreme flooding (flash flooding, intensive rainfall, storm surge, king tide combined);
5. More frequent drought – saline intrusion, hydropower outages.

The following saline projections are based on i) existing saline intrusion, ii) existing drought impact, and iii) sea level projection of a 40cm rise by 2030:

- Saline water is projected to intrude into mid-catchment river system
- By 2030 with 0.4m sea level rise salinity intrusion will extend to Lokia
- By 2060 with 0.8m sea level rise salinity intrusion will extend to Burebasanga
- By 2100 with 1.2m sea level rise saline intrusion will extend into Waimanu

Coastal flooding of flat lands during storms

- By 2030 will reach Lakena
- By 2060 will reach Vareta
- By 2100 will reach Kasavu

Adaptation Options

1. Engineering – dykes, walls, drainage
2. Social – resettling
3. Land use planning – zoning, development controls
4. Economic instruments - subsidies, tax incentives
5. Natural systems management – rehabilitation, conservation, watershed management

4.6.2 **The Second Study** information is taken from Climate Change Hazard Report TA 8526 Fiji Final 160115, a consultant's report by Rosa Perez, November 2014.

Meteorological Hazards

Tropical Cyclones

In the large geographical area from Northern Australia eastward to French Polynesia numerous cyclones develop, most, but not all develop west of the international date line, that would include Fiji. During El Niño³¹ periods, however, they may develop east of the dateline. On average this area sees about nine tropical storms annually, with half becoming severe cyclones. Other sources indicate similar numbers – three cyclones reach Fiji directly or indirectly out of every four years.

Flooding

In a compilation of total flood events and notable flood events³², data from 1849 to 2009 show seasonal events that match the rainfall pattern – during the wet season, November to May, Fiji experienced approximately 245 floods and during the dry season, June to October, 32. It should be noted that only during July and November of that time period did Fiji escape a notable flood.

Drought

Prolonged dry periods occur in Fiji and are particularly sensitive to populations in

³¹The El Niño- Southern Oscillation7(ENSO) has a large influence on Fiji's climate. In Suva, El Niño events tend to bring dry seasons that are drier and cooler than normal, while La Niña events usually bring wetter than normal conditions.

³²McGree, S., Yeo, S. and Devi, S., 2010: Flooding in the Fiji Islands between 1840 and 2009

rural and outer island communities. They can last for longer than a year and appear to occur during strong El Niño periods. A significant majority of El Niño events lead to drought.

Climate Risk

A study³³ was released in 2013 indicating that the Climate Risk Index (CRI) for 2012 cited Fiji as fifth in the top ten countries with high CRI. The score was weighted and averaged and the indicators used were death toll, deaths per 100,000 inhabitants, absolute losses in millions and losses in GDP.

Trends and Projected Change

Temperature

Over a 52 year period³⁴ the data in a recent publication show an increase in both minimum temperatures (0.62°C) and maximum temperatures (1.15°C).

Daily maximum temperature of 35°C in the Suva area is expected to become more frequent toward the end of 2100 and occurring twice as often as in 2050.

Rainfall

Rainfall over the last half-century shows no significant change, however there are events on an annual basis that are influenced by El Niño. In various Fiji locations the maximum daily rainfall of 200mm may decrease by 2100, however in Suva extreme rainfall may decrease slightly compared with other locations.

Sea Level

Based on satellite altimeters³⁵ the rate of sea level rise in the seas surrounding Fiji is about 5 to 6mm per year, therefore the maximum readings at tidal gauges in the Suva will become more frequent, with a possibility that 100 year events such as a 2.4m rise in sea level for the Suva area could be more frequent by 2050 and become the norm by 2100.

The report has this to say about climate change projections in summary:

“...future temperature projections indicate that warming will continue with more hot days and warm nights. Temperature increase will be in the range from 1.4 to 2.6 C by 2100. Rainfall patterns are projected to decrease in dry season and to increase in wet season. The projected occurrence of extreme daily rainfall though, has a very high uncertainty due to conflicting results of different models

³³Source: Kreft, S. and Eckstein D., 2013: Briefing Paper, Global Climate Risk Index 2014: “Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2012 and 1993 to 2012”. GermanWatch, released in November 2013

³⁴Republic of Fiji, 2014: Fiji’s Second National Communication on Climate Change - Suva, Fiji : Ministry of Foreign Affairs, 130 p.; ISBN 978-982-9163-01-1

³⁵Australian Bureau of Meteorology and CSIRO, 2011: Climate Change in the Pacific: Scientific Assessment and New Research. Volume 1: Regional Overview. Volume 2: Country Reports.

used.³⁶ By the end of this century projections suggest decreasing numbers of tropical cyclones but a possible shift towards more intense categories. Sea level around Fiji has risen and will continue to rise throughout this century. In the absence of downscaled projections in the GSA, these projections at the national level may be used as indicative of what are expected at the GSA.”

- 4.6.3 **The Third Study**³⁷ focused on location of water supply intake options on the Rewa River. Presented here are results of modeling the intrusion of salt water into the Rewa River, which was a consideration in the feasibility study.

Previous studies of water supply schemes on the Rewa River have identified the extent of saline intrusion as a key issue that could influence intake site selection. Those studies reported that saline water (at very low concentrations) has been detected at Navuso, approximately 20km upstream of the river mouth.

The conclusion from this assessment and detailed modeling is that under extreme low conditions, there is still sufficient flow in the Rewa River to minimize the risk of saline water being drawn into the planned intakes between sites at 33, 29 and 26 km above the river mouth.

A 1970 study provided, without information on river flow or tidal stage, the following:

Table 4.21. Salinity Range from Rewa River Model

Estimated River Chainage (km)	Salinity Range (ppt)
16.0	<0.100
14.0	0.100 to 0.600
13.0	0.160 to 0.450
12.0	0.450 to 1.600
11.0	1.600 to 3.300
10.0	3.300 to 10.00
9.0	10.00 to 16.00
6.0	>16.00

Modeling results show the following:

Water levels

During drought conditions, water levels throughout the entire modeled area

³⁶ More details are found in Volume 2 of the Australian Bureau of Meteorology and CSIRO, 2011: Climate Change in the Pacific: Scientific Assessment and New Research 20 The number of days with extreme 24-hrs rainfall (defined as 200mm/day) is projected to decrease according to the Fiji Second National communications to UNFCCC; while the Pacific Climate Change Program (PCCP) indicates increases in frequency. PCCP is a cooperative study effort of Australian Bureau of meteorology, Commonwealth Scientific and Industrial Research Organization (CSIRO) and Fiji Meteorological Service

³⁷ Suva-Nausori Water Supply and Sewerage Project, Vol. 1 – Feasibility Study Report. TA 3055 FIJ.

(32km in length) are controlled by tidal variation.

Subsequently, the water surface gradient of the Rewa river is very mild, as is common for reasonable size coastal rivers. The gradient at any one time is dependent on the magnitude of flow and the state of the tide. For a flow of $10\text{m}^3/\text{s}$ (representing drought conditions), and a tide level of -0.6m, the water level at the top end of the model (chainage 32km) is approximately 0.4m. This equates to a gradient of 1 in 32,000 (0.003 percent).

For a similar case using a flow of $100\text{m}^3/\text{s}$, which is representative of data in 1999, a larger gradient is shown (1.4m in 32km) of 0.00437 percent.

For drought conditions ($10\text{m}^3/\text{s}$), but with a 0.5m rise in mean sea level, climate change means the gradient remains the same, with all water levels effectively raised by 0.4 to 0.5m, in keeping with the change in mean sea level.

Salinity

In reviewing salinity concentrations, the key target is the salinity threshold. For this study, a threshold of 0.500 ppt was selected (Australian Water Quality Guidelines for Fresh and Marine Waters, November 1992).

Salinity exceeds the nominated potable threshold of 0.500ppt downstream of 16km. At the end of the ebb tide, this threshold has moved downstream by 5km to chainage 11km.

Model figures further demonstrate how salinity concentrations vary with time at selected locations. The most obvious conclusions from these figures are that whilst concentrations remain relatively high at the mouth of the river, and at a distance of 5km upstream of the mouth, they then drop off rapidly further upstream. In addition, the tidal effects are still evident throughout, with concentrations varying with tide level.

While low, concentrations still exceed the potable limit at 10km, but have dropped sufficiently by 15km to be considered acceptable. This is consistent with anecdotal evidence of salinity being recorded as far up as the junction of the Rewa and Waimanu Rivers.

Of most importance to this study, however, is the effect that a restricted river channel has on salinity. For the existing restriction at , the upstream of salinity is prevented from reaching chainage 7.5km. Instead, it can reach no further upstream than approximately 6.7km. These results were modeled using a flow of $100\text{m}^3/\text{s}$.

If significant dredging occurs, there is obviously the potential for the upstream migration of saline water. During a drought condition, the upstream extent of salinity may move upstream by another kilometer or so.

Greenhouse Effect (Climate Change)

In the case of a drought flow and a 0.5m sea level rise, the salinity threshold of

0.500ppt will extend up to 18km (previously 16km). Also the downstream extent of salinity also indicates the salinity threshold extending another 2km to 13km. The previous extent was at 11km.

A time history comparison of salinity concentrations shows higher salinity levels at all locations, with the effect most pronounced (and most meaningful) at the 10km and 15km locations, where concentrations have more than doubled. At the 15km mark in particular, the increase in salinity raises concentrations above the nominated threshold of 0.500ppt. At the 20km mark, concentrations remain low, despite the proportional increase.

Overall, it can be seen that the impact on salinity of climate change with a sea level rise would be significant.

The study conclusions are given below, verbatim:

1. *The location of the proposed intake at chainage 28km is supported by the results of salinity modeling.*
2. *Despite the fact that bed levels in the Rewa River are below sea level, there appears little likelihood of salinity extending up to the proposed intake site for current tidal ranges.*
3. *The model supports an assumption made that the system is well mixed. That is, there is little indication of any strong variation in salinity with depth. This implies that there is no salt wedge effect, and hence it appears unlikely that higher concentrations of salt will occur for intake locations located close to the river bed.*
4. *The following factors will cause salinity concentrations to increase within the Rewa River:*
 - i. *a lowering of the river bed through dredging;*
 - ii. *consistent periods of very low flow;*
 - iii. *a rise in sea level.*
5. *On the basis of some of the unsupported anecdotal evidence obtained, it is possible that the model may slightly underestimate salinity concentrations at upstream locations. However, the modeled upstream extent does support evidence nominating the detection of saline water at the junction of the Waimanu River.*
6. *If all factors nominated in Items 4 and 5 were to coincide, it would seem likely that salinity in the Rewa River will exceed a threshold of 0.500ppt up to a chainage of at least 20km, and probably of the order of 23km.*
7. *Salinity concentrations vary significantly with the state of the tide. The location of the threshold concentration would appear to move up and down the river by as much as 5km in response to tidal variations. Hence, even if salinity levels exceeded the potable water threshold at the location of the intake during high tide, it is likely that water could be still extracted at other times.*

4.7 Sustainability

4.7.1 How do we define “sustainability”?

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment.

Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.

Sustainability is important to making sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment.

In more general terms, sustainability is the endurance of systems and processes. The organizing principle for sustainability is sustainable development, which includes the four interconnected domains: ecology, economics, politics and culture.

Despite the increased popularity of the use of the term "sustainability", the possibility that human societies will achieve environmental sustainability has been, and continues to be, questioned—in light of environmental degradation, climate change, overconsumption, population growth and societies' pursuit of indefinite economic growth in a closed system.

4.7.2 How then can we look at environmental sustainability in Fiji?³⁸

Ensuring environmental sustainability is the seventh MDG, which provides a framework for integrating the principles of Sustainable Development into national policies, with the focus on ensuring availability of safe drinking water, improving sanitation, and reducing other social ills such as poverty and unemployment.

The Environmental Management Act (EMA) 2005 provides the legislative framework for the sustainable development of land and water resource management. However, there have been a number of constraints in implementing the EMA such as inadequate resourcing of the Department of Environment, outdated subsequent legislations and regulations, the absence of accredited laboratories, and poor coordination among agencies.

Achieving sustainable development, while overcoming environmental challenges such as deforestation, land degradation, logging of watersheds, over-exploitation of terrestrial and aquatic biological resources, improper waste management and pollution control, impact of climate change, and the attitude of people in terms of the unsustainable use of their resources, is a central challenge of this plan.

- The improper disposal and treatment of solid waste is one of the gravest environmental problems faced in Fiji. The problem is most acute in fast growing urban centers and other highly populated areas and is beginning to be a major concern for the tourism industry. This concern led to the organization of annual Clean Up Fiji Campaigns, which has run for 13years and is well supported by the business community.

³⁸ Fiji National Assessment Report. Ministry of National Planning. Government of Fiji. January 2010.

- The generation of waste for disposal has been steadily increasing and is likely to continue to increase with the growth of urban centers and an increasing middle class population which is driving the rise in demand for imported goods. The composition of waste has also changed and now non-biodegradables account for a greater proportion of waste.
- Waste on land is catered for by rubbish dumps, with the first landfill established in Naboro in 2003/2004 to cater for waste from Navua, Lami and the greater Suva areas. The Naboro Landfill was designed to offer 40-50 years of clean, safe and sanitary waste disposal and all waste coming into this site was to be assessed for its suitability for disposal, and special treatment administered to it wherever necessary. The operation of the facility was also designed to allow for revenue generation to assist in the running of the landfill. Approximately 60,000 tons of waste is dumped at the landfill annually. Implementation of the National Solid Waste Management Strategy 2008– 2010, launched in June 2008, needs to be prioritized. A key component of the Strategy is a public awareness campaign and creating partnerships amongst all stakeholders including municipal councils, the business sector and the community at large.
- Fiji's economy and its people, like other small island states, are also susceptible to the impacts of climate change. Since ratifying the UN Framework Convention on Climate Change (UNFCCC), policies adopted by Government in successive Development Plans have recognized the critical importance of managing the environment and natural resources, to ensure social and economic prosperity in the present and for the future. The implementation of these policies, however, has not been adequately supported with the required budget. As a developing nation with scarce resources and competing priorities and obligations, the Government has preferred to rely predominantly on foreign aid and assistance to finance 'environment' projects.
- Climate change is beginning to have substantial and widespread impacts on Fiji, affecting sectors as varied as health, coastal infrastructure, water resources, agriculture, forestry and fisheries. As a predominantly agricultural based economy, the impact is being felt more by the rural populace who depend on the agriculture sector for their livelihood. The increasing incidence and intensity of droughts, cyclones and flooding is taking its toll on the economy and the lives of ordinary citizens.
- The sea-level rise is leading to coastal erosion. With the majority of villages and settlements in Viti Levu located along the coast, there is a noticeable infiltration of the sea into the village compound during high tide. The increase in the frequency and intensity of tropical cyclones over the past decade is fueling coastal inundation and erosion. Intensive urban development along the coast, as well as deforestation of catchments has also contributed to exposing large coastal areas to flooding and erosion.
- Continuous coastal erosion is also taking its toll on inshore fisheries on which the villages rely for food. The drop in the size of the catch is attributed to the build up in sedimentation. Coastal populations and their assets are exposed to higher vulnerability to extreme events such as storm surges, tsunamis, and high tides. The erosion of coastal areas is also now slowly leading to the movement of villages away from low lying areas.

- The most recent flooding occurred in late December 2008 and early January 2009. Experts conceded that these floods were the worst in Fiji's recorded history with 11 and agriculture. Damage to crops and loss of livestock from the recent flooding in late December 2008/early January 2009 was estimated at F\$40million. Around half of these losses are attributed to the sugar industry, the backbone of the agriculture sector and the economy. The aftermath of floods increases the risks of exposure to water borne diseases, leptospirosis, and contamination of water sources. The floods directly affected about 150,000 people, almost a fifth of Fiji's population. While tropical cyclones are expected at this period, what has been noted is the increasing intensity of these natural hazards, particularly over the past decade.

5.0 Anticipated Environmental Impacts and Mitigation Measures

5.1 Wastewater Subproject: Kinoya WWTP Upgrade

- 2 sequential batch reactors
- A digester
- 2 primary settling tank
- upgraded belt thickener

5.1.1 Construction activities include: land clearing, excavation, a short access road

5.1.2 Construction consequences

Table 5.1. Kinoya Impacts and Mitigation

Impacts	Mitigation
Sediment release from trenching, digging, leveling	Placement of removed earth in position away from drainage into trenches and excavated areas during rain
Clearing of vegetation	Storage of overburden in selected areas and restore when finished
Standing water from rain	Pump rain water out of settled area and into storage tanks for disposal or release water to ditch after filtration
Waste	From workers provide sanitation facilities for workers, as well as washing facilities and service at least weekly. For solid waste collect daily and place in container and dispose container weekly in landfill.
Storage of construction materials and supplies	Designate areas for equipment and materials storage and vehicle servicing, which should have impermeable surface and a protective berm around the edges.
Open trenches and holes	Erection of barriers and signage on open trenches and light fixtures for night time
Vehicular emissions	Ensure that construction contractors' vehicles have all safety and emissions certified by Ministry of Health and Land Transportation Authority
Worker risk and accidents	Maintain full first aid equipment and materials as well as require all safety clothing, equipment and materials

5.1.3 Operational consequences

Climate change:	rise in sea level up to 1m by 2100; increased flooding from storms and cyclones
Mitigation:	to protect Kinoya assets develop a plan for erecting a sea wall around property of at least 2 to 3m with room for expansion
Positive:	improved quality in discharge overall, but questionable regarding meeting national discharge standards, particularly for fecal coliforms
Mitigation:	develop agreement with Department of Environment to adjust discharge standards or plan for phased in tertiary treatment or both.
Positive:	Elimination of pollution from inadequately treated sewage and industrial waste; treatment of waste from increasing populations and commercial enterprises for the future; environmental and public health benefits

5.2 Existing Pump Station (32) Upgrading Sub-project, All:

5.2.1 Undersized pumps (15 small at 30L/s, 10 medium at 100L/s, and 10 large at 250L/s)

5.2.2 Civil fittings such as bases , risers etc

5.2.3 Deteriorated pump station structures (see 3.4.1)

5.2.4 Automated control systems

5.2.5 Installation of vents at pump stations and rising mains.

5.3 Upgrading of All Existing Sewer Rising and Gravity Mains Sub-project (25 km of replacement and upgrade, 25 km of relining, 15 km DN 250 rising mains, 15 km of DN 300 gravity mains)

5.3.1 Rising mains and gravity mains

5.3.2 Manhole and civil fittings

5.3.3 Replacement of AC mains

5.3.4 Sewer relining

5.4 Sewer Extension Program Sub-project, to Cover:

5.4.1 Backlog areas

5.4.2 Forecasted residential and commercial development

5.4.3 Potential growth areas

5.4.4 The sewer extension programme only includes the sewer reticulation systems.

5.4.5 4000 properties to be connected

5.5 Construction Impacts and Mitigation

5.5.1 Construction activities: earth removal in repairing, replacing or upgrading pump

stations and installation of vents at stations and mains; trenching and laying new pipe and relining existing pipes and making connections. Subprojects are mainly in residential areas.

5.5.2 Construction Consequences

Table 5.2. Impacts from New and Upgraded Infrastructure

Impacts	Mitigation
Sediment generation from trenching and clearing; removal of vegetation from residential property	Stockpile overburden away from trenches to avoid backwash in rain; place excess overburden in agreed-upon location and restore when finished
Hydrocarbons from contractors' machinery and vehicles	Designate areas for equipment and materials storage, especially liquids and vehicle servicing with impermeable surface and a protective berm constructed
Dust and noise	Wet trafficked areas when necessary and place noise frequency (80 to 85db) limitations on all generators and vehicles and establish work hours in agreement with residents
Traffic congestion	Assign contractor personnel to direct traffic
Open trenches and holes	Erect barriers, signage and lighting for night time
Waste	From workers provide portable sanitary facilities and service at least weekly along with washing facilities; For solid waste, collect daily into containers and deposit weekly in landfill (Namboro or other)
Standing water from rain	Pump rain water out of trenches and holes and into storage tanks for disposal or release water to ditch after filtration, changing filters each 3 hours or as needed
Vehicular emissions	Ensure that construction contractors' vehicles have all safety and emissions certified by Ministry of Health and Land Transportation Authority
Worker safety risk and accidents	Maintain full first aid equipment and materials as well as require all safety clothing, equipment and materials

5.5.3 Operation consequences

Elimination of pollution in waterways from poorly operating or improperly designed septic tanks; elimination of pollution of waterways from direct

discharges of wastes; public health benefits are greatly increased;
environmental quality is enhanced

6.0 Analysis of Alternatives (Note: Sections 6.1, 6.2 and 6.3 below are taken from the Economic Analysis in the Main Report)

6.1 Sewerage

6.1.1 In the case of the “**with project**” scenario,

- capacity of the Kinoya wastewater treatment plant is expanded from 175,000 equivalent persons (EP) to 275,000 EP in 2019
- assuming the system having been expanded by the Water Authority of Fiji from 105,000 EP to 175,000 EP in 2016 through a planned contract to re-commission sequencing batch reactor (SBR) units which are not currently operative.
- The project develops capacity to connect an additional 20,000 households to the sewerage system, and funds reticulation of the sewer network to 4,000 of these households.
- It is assumed that additional investment to reticulate the sewer network to the balance of these households proceeds outside the project over the period to 2033.

6.1.2 In the case of the “**without project**” scenario,

- planned investment by the Water Authority of Fiji (WAF) to re-commission SBR units proceeds in 2016 (increasing nominal capacity at Kinoya to 175,000 EP),
- but the infrastructure supporting the before project capacity (105,000 EP) deteriorates to an extent due to lack of supporting investment, reducing before project capacity by 10 percent over the period to 2033.

6.2 Least cost analysis of project options

The least cost analysis is undertaken on the basis of a comparison of the present value of economic costs (both capital costs, and costs of operation and maintenance), of technically viable project options.

6.3 Sewerage

The project options considered in the least cost analysis are:

Option 1

A “centralised” strategy, which assumes that all sewerage, except sewerage from Nausori, will be diverted to and treated at the existing plant in Kinoya. The Kinoya sewerage treatment plant would be upgraded accordingly.

Option 2

A “decentralised” strategy, which envisages utilising the existing plant at Kinoya, together with new plants to be located in growth areas at the extremities of Suva’s sewerage system, at Waila and Lami.

Option 1 is found to be the least cost option, confirming earlier work done on the cost of these options.

7.0

Information Disclosure, Consultation and Participation

In as much as WAF is the principal stakeholder and property owner for the work done at Kinoya, there was felt to be no need for a stakeholders consultation for that part of the subproject.

For the other subproject elements of upgrading and improving the services of the WAF infrastructure and providing new services to backlogged communities, it was felt that the positive benefits were so strong that there would be no significant objection or resistance. In residential areas, the environmental issue is not that there shouldn't be any infrastructure in their neighborhood, but rather in how the project is executed. Sound environmental management on the part of the Water Authority of Fiji and their contractors will be necessary here.

Issues with property rights, land use and other social impacts are dealt with elsewhere by appropriate specialists.

However, upon review of the main report it is felt that a consultation with certain parties should be held, this can be done.

8.0**ENVIRONMENTAL MANAGEMENT PLAN**

Note: This section contains management framework for both Water Supply and Wastewater Subprojects

8.1**Management Framework****Table 8.1. Environmental Management Plan Framework**

Impact	Mitigation	Monitoring	Implementation	Cost
1. bank erosion and flooding – Rewa River and all other rivers and streams, permanent and intermittent	Protect pump electricals; enforce embankments with large rock and gabions	During construction: inspect adequacy. Weekly report with pictures. Post construction: periodic inspection.	Contractor to provide protection per specs in contract. WAF Project Engineer to inspect, Plant Mgr. after construction along with WAF Envir. Unit	Estimated cost: \$15k to \$20k
2. Release of sediment a. during clearing b. during trenching c. during embankment construction	Erection of temporary barrier structures, particularly on sloping land - 15° or more. Arrange in series if required by WAF Envir. Unit	During construction: inspect adequacy. Weekly report with pictures. Make corrections when advised. Maintain properly.	Contractor to provide per specs in contract. Project Engineer to inspect along with representative from WAF Environmental Unit	Estimated cost: \$10k to \$15k
3. Waste from workers and hygiene practice	Collect solid waste daily and place in container and dispose of container in landfill (Namboro or other official landfill) at least weekly; provide portable sanitary facilities and service at least weekly. Provide washing facilities.	Inspection by Project Engineer, follow-up by WAF Enviro. Unit. Weekly report	Contractor to provide and maintain facilities per contract. WAF Enviro. Unit to inspect. Contractor to make any advised adjustments	Estimated cost \$20k to \$30k
4. Removal of topsoil and vegetation – trees, shrubs, grasses and other plants	Place in designated low areas, with WAF Envir. Unit agreement and restore site when finished	Weekly inspection by Project Engineer or WAF Envir. Unit. Monthly report with pictures	Contractor, per contract, identifies placement area with WAF Enviro. Unit approval. Contractor restores.	Estimate cost \$4k to \$5k

5. Waste from machinery and vehicles – solid and liquid, particularly hydrocarbons	Designate areas for servicing and parking with impermeable ground cover and low berm. Remove spills where possible. Collect solid waste and dispose with worker solid waste	Construction monitoring by Project Engineer and followup monitoring by WAF Envir. Unit with weekly report with pictures	Contractor, per contract, to prepare area. WAF to monitor and report.	Estimate cost \$2k to \$4k per area
6. Traffic congestion	Place signage on road alerting drivers to construction ahead and advise caution; use construction personnel and traffic cones to direct traffic where necessary	Monitoring by Project Engineer and WAF Envir. Unit with weekly report with pictures	Contractor, per contract, to provide equipment and personnel. WAF Envir. Unit to monitor and report	Estimate cost \$5k to \$7k
7. Dust and noise	Trafficked area to be wetted periodically and decibel limit (80 to 85 db) to be set for vehicles and equipment	Weekly inspection with report and sound meter	WAF Envir. Unit to monitor and report	Estimate cost \$4k to \$6k
8. Habitat disturbance (principally rural – estim. 3 to 4 acres total) a. human activity b. loss of land cover c. already disturbed as in crop and orchard land	Soil, rock and veg. disposal area restored and land around intake, treatment plant and reservoirs landscaped with indigenous species where possible when construction finished	WAF Envir. Unit to monitor with monthly report with pictures	Contractor, per terms of contract, to restore and landscape	Estimate cost: \$5k to \$6k
9. Access roads a. Rewa intake/treatment plant/reservoir (estimate 150m) b. possible reservoir at Waitolu (estimate 200m) c. Kinoya upgrades	Erect temporary barriers to block downhill sediment loss to river, streams and ditches	WAF Envir. Unit to monitor construction and operation of barriers with weekly reports and pictures	Contractor to install and maintain per contract with WAF Envir. Unit approval	Estimate cost: \$4k to \$6k

(estimate 100m)				
10. Storage of construction materials and supplies, particularly lime, cement, hydrocarbons, acids	Designate areas with impermeable ground cover and low berm (similar to vehicular service area)	Proj. Engr. to inspect adequacy of construction and WAF to monitor operation with weekly reports with pictures	Contractor to construct and WAF Envir. Unit to monitor. Contractor to make adjustments per WAF Envir. Unit advisory	Estimate cost: \$6k to \$8k
11. Standing water from rain in low areas, trenches, holes and other excavated areas	Pump rainwater into storage tanks for settling, separation and disposal or pump to river, stream or ditch, but using filters that are changed at least each 3 hours	Proj. Engr. to inspect adequacy of operation and WAF Envir. Unit to provide monthly reports with pictures	Contractor to provide equipment and materials per contract with WAF inspection	Estimate cost \$8 to \$10k
12. Vehicular emissions from trucks, construction equipment (heavy and generators)	Ensure that construction contractors' vehicles have all safety and emissions certified by Ministry of Health, Land Transportation Authority and other relevant authorities	WAF Envir. Unit to inspect and report with documentation	Contractor per contract to provide adequately certified vehicles	Estimate cost: \$4k to \$6k
13. River water quality from upstream (Viria 2km)	Implement regular river water quality sampling routine – elements of attention would be heavy metals and fecal coliforms; install screens on pump intakes at Rewa	WAF Envir. Unit to monitor with treatment plant staff on weekly basis. Add monthly sample of full chemical range to monitor trends; Project Engineer to inspect screens	WAF Envir. Unit to process samples in National Water Quality Laboratory; contractor to install screens; Lab personnel to clean screens as needed, but inspect daily	Estimated recurring weekly cost: \$500
14. Release of residuals, particularly alum solids from water treatment plant operation	Construction of holding basin for filter backwash sediments for separation and release (similar to design and operation at Waila WTP)	Project Engineer to inspect. WAF Envir. Unit to monitor with monthly reports during operation	Contractor to construct per contract and Proj. Engr. to inspect quality and adequacy and WAF Envir. Unit to advise	Estimated cost: \$50,000 to \$75,000
15. Worker safety risk and accidents; health protection	Maintain full first aid equipment and materials as	Project Engineer to inspect initially and monthly;	Contractors, per contract, to provide all items of first	Estimated cost: \$15k to \$20k

	well as require all safety clothing, equipment and materials; require physician's health certification, with annual renewal	provide replacements where necessary	aid, safety and health certification. WAF Envir. Unit and Project Engineer to verify	
16. Rising sea levels	Implement a plan at Kinoya for designing and constructing barriers to future rising of sea levels at Laucala Bay	Project to be designed by WAF engineers, with Project Engineer to monitor	Contractor to construct per specs in contract and Project Engineer to approve with review by WAF Envir. Unit	Estimated cost: \$400k to \$600k

8.2 Mitigation Notes

- Since alluvial soils in the Rewa watershed have a high erosion index, protection of embankments from construction disturbances with large rock and rock filled gabions are needed;
- Commonly used temporary materials can be effective against sediment washing downhill if constructed and maintained properly. In some cases of very steep slopes, arrangement of barriers should be placed in a series when a single barrier may not be sufficient;
- Solid waste will accumulate at construction sites – from materials and from workers. Sanitary waste is handled through portable toilet facilities and washing facilities. Solid waste is collected in containers and deposited at the nearest official landfill, such as Naboro;
- Placement of top soil and vegetation in nearby low areas, but not intermittent streambeds, if not to be reused, is restored, ie compacted and if possible covered with soil and seeded;
- Areas for parking of vehicles and equipment should be in a place with an impermeable ground cover – paved or compacted clay to prevent seepage of hydrocarbons to groundwater and nearby environment and a protective berm should be placed around the edges of the area (one that cannot be flattened by vehicles/equipment);
- In coordination with the Land Transportation Authority, when traffic becomes congested, assistance to drivers is provided by an individual directing traffic and with traffic cones for direction. This is used along with signage warning of construction ahead.
- Dust and noise, particularly in residential areas, are controlled through wetting with used oil or water, whichever is appropriate for the area, and noise is controlled both by setting limits (80 to 85 db) for noise and to also obtain agreement with residents for working hours;
- Disturbed areas can be restored with landscaping using indigenous plants, rather than ornamentals or imported species, where possible. Under no circumstance should a disposal area or disturbed area be merely left to “regenerate” on its own. In some cases this may involve simple landscaping, while in others extensive damming, bracing and terracing may be required;
- In constructing access roads, often at steep angles, controlling sediment loss (after clearing and deposition) is important both to prevent future soil erosion

from exposure and to prevent sediment deposit into watercourses, so the use on access roads is common and often in a series;

- Similar to areas for parking of vehicles and equipment, the storage of construction materials and supplies, if not in sheds or covered buildings, should be done in areas with impermeable ground and a low berm around the edges;
- In Fiji rains are frequent and water runoff and control is important, so that clearing excavated areas of rain water is frequent and the return of sediment from pumped water is to be avoided – through capture and holding for separation and disposal or through the use of
- Air pollution is to be avoided also, so that, besides the prohibition of open burning, all contractor vehicle emissions should be certified by LTA before construction begins;
- Advanced knowledge as well as trend information and status quo all are important to supplies of raw water for public consumption, therefore identifying and collecting this information is a front line defense against contamination of supplies;
- Normally the operation of a water treatment plant is benign regarding emissions, however, the release of residuals (from the filter backwash process), particularly alum solids should be avoided through capture and settling for separation before releasing the supernatant and disposing of the alum solids residual;
- Workers health and safety should always be secured, therefore having all necessary certification and supplies available and required use is critical
- In the coming forecasts of impacts of climate change, securing the property of assets such as the Kinoya wastewater treatment plant are important, thus the design and construction of barriers to rising waters of the Laucala Bay will become advisable.

8.3

Monitoring Notes

- Inspections are conducted during construction by Project Engineers, WAF engineers, Contractors and WAF Environment Unit personnel. They will be filing reports concerning quality of work, adherence to schedule, potential issues to be addressed. They more often will be recording the inspection with photos. Some inspections will be weekly because of the pace of work and the nature of the item for inspection, sedimentation, for example and other inspections may be monthly, habitat disturbance, for example. Some inspections may increase to daily should there be a need for the change due to environmental conditions – sedimentation control, river water quality sampling, for example.
- In the case of weekly river sampling, the following constituents as a minimum will be routinely monitored:
i) temperature, ii) pH, iii) conductivity, iv) turbidity, v) TDS, vi) DO, vii) chlorides, viii) iron, ix) iron (total), x) manganese (total), xi) aluminum, xii) calcium, xiii) magnesium, xiv) copper, xv) nitrate-nitrogen, xvi) fecal coliforms and this weekly sampling is to be accompanied by recording the flow data at Navolau gauging station, so that weekly flow data will complement weekly water quality data.

8.4

Implementation Notes

- All construction contractors will have specified in their contract, with the guidance and approval of the WAF Environment Unit, **requirements** for
a) bank stabilization for all streams

- b) sediment control for clearing, trenching, excavation, access road construction and all other removal of land cover
 - c) worker, vehicular and machinery waste management
 - d) placement of topsoil and vegetation
 - e) traffic congestion equipment and personnel
 - f) dust and noise control procedures
 - g) habitat restoration and landscaping
 - h) creation and management of areas for storage of equipment and supplies and for parking and servicing of vehicles and machinery
 - i) management of standing rainwater at construction sites
 - j) provide certification of emissions for all vehicles
 - k) design and construction of settlement basin for alum solids at Rewa WTP
 - l) provision of safety equipment and clothing and certification of health for all workers
- The following parties will share **implementation** responsibilities (indicated in the EMP table) for:
 - a) bank stabilization – WAF Project Engineer, WAF Envir. Unit
 - b) sediment control – Project Engineer, WAF Envir. Unit
 - c) waste management – WAF Envir. Unit
 - d) topsoil and vegetation placement – WAF Envir. Unit
 - e) traffic management – WAF Envir. Unit (coordination with LTA)
 - f) dust and noise management – WAF Envir. Unit
 - g) habitat management – WAF Envir. Unit
 - h) access roads – WAF Envir. Unit
 - i) materials and supplies storage – Project Engineer, WAF Envir. Unit
 - j) standing water management – WAF Envir. Unit
 - k) vehicular emissions – WAF Envir. Unit (coordination with Department of Environment)
 - l) river sampling – WAF Envir. Unit with treatment plant personnel
 - m) residuals management – Project Engineer, WAF Envir. Unit
 - n) worker health and safety – Project Engineer, WAF Envir. Unit
- Each contractor will retain a full-time environmental staff person to assist WAF Envir. Unit in monitoring and reporting and also act as liaison in communications, briefings and progress reports. This person must be available at all times and not share duties with other contractor personnel. This position is the Contractor's Representative to the WAF Environment Unit.
- Each contractor will be subject to all Fiji environmental laws and subject to penalties if violated.
- Each contractor will provide all work, reports, materials and equipment per contract on schedule. Any delay, misrepresentation or failure in delivering services, project and materials will result in delay of payments until restitution is made.

8.5

Performance notes

Potential performance indicators that may be measurable, include:

- Number of environmental protective works completed on time and with high quality control;
- Successful operation of the alum solids control process;

- No accidents to workers that are protected (goal)
- No complaints from residents regarding noise and dust (goal)
- No accidents with persons falling into excavated areas (goal)
- No spillage of liquids, chemicals, materials into water bodies (goal)

9.0 Conclusions and Recommendations

9.1 Conclusions

- a large portion of the Suva and Nausori metropolitan population will benefit from new or improved wastewater management services;
- no serious impacts are incurred as a result of this subproject and those impacts that are incurred are adequately mitigated
- natural waterways in the Suva and Nausori metropolitan area will show improved water quality from the upgrading of Kinoya and associated infrastructure

9.2 Recommendations

- **Capacity Strengthening**

In the planning, design, construction phases of the project there is a need for staff, equipment and materials in both the Environment Unit and the Trade Waste Unit. Examples of this need are:

engineering and technical expertise, safety clothing and equipment, appropriate vehicles for sample, staff and equipment transport and formation of joint agreements with international NGOs, with international trade waste companies. An associate need is full funding and support for international certification of the National Water Quality Laboratory – equipment, procedures and staff.

- **Contractor Certification**

As part of their qualifications to contract for the Subprojects, Contractors should be required to provide certification they all project managers and project technical personnel have both attended a short course – at least one week on Environmental Management. Course to be provided by WAF Environmental Unit, WAF staff in cooperation with Department of Environment and other relevant institutions – USP/FNU, natural resource agencies, and others. Example topics might include: laws and legislation, procedures for sampling, installation of control measures, water supply and wastewater technology, monitoring and mitigation, natural resources in Laucala Bay and Rewa River watershed and other topics.

NOTE: this certification could be expanded to include all WAF contractual procedures, scheduling, requirements, penalties, qualifications and other topics.

- **Kinoya Outfall**

In a recent water quality survey of Laucala Bay, it was verified that the 1.6 km outfall from Kinoya WWTP had been ruptured close to

shore and wastewater was 5for nearshore water quality and community living next to the treatment plant. The 100m diffuser is ineffective and there is a need to repair and/or replace the outfall so that it operates as it was designed.

- **Watershed Management**

Given the role as a principal stakeholder in the quality and natural functions of the watersheds of Fiji, it is important for the Water Authority of Fiji (WAF) to take on a leadership role in promoting coordinated management of these watersheds. The social and economic costs of business as usual cannot be sustained by the WAF and society as a whole. In proposing an aggressive program of integrated water resource management through legislation ultimately, but through committees, working groups and other cooperative arrangements, a solution can be achieved. There are many approaches already in place – local, regional and with national agencies claiming responsibility for water resources, but there is no permanent legislation clearly spelling out roles, responsibilities at all levels to preserve what is still a natural gift to the Fijian people.

- **Develop a WAF Library**

There is a need to develop a serious library for permanent and reference records, for critical documents, for books as both reference and background – subjects in engineering methodology, survey techniques, environmental quality and meregulations and guidelines, accounting and auditing processes. Provision of adequate space for now and future expansion is as important as the content of the library. There should be a **full-time** librarian in charge.

- **Climate Change**

Given the government policy, international verification and immediate impacts of climate change in the South Pacific, it is time for WAF to develop a full and complete (with annual revisions and updates) Climate Change Action Plan and to implement same. This is a task for perhaps the Strategic Planner to initiate with inputs from all WAF units and relevant personnel. Eventually best practice procedures should be developed for all departments going forward and implementation of the Plan should be part of all reports and projects.