ENVIRONMENT IMPACT ASSESSMENT

Annex 2

Proposed Dredging for SIGATOKA RIVER

31/12/2012

STUDY REPORT —FINAL DRAFT

MINISTRY OF PRIMARY INDUSTRY

Land and Water Resources Management Division

COREREGA ENVIRONMENT CONSULTANTS

Executive Summary

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/ estuary to the sea in order to reduce the risk of flooding in surrounding areas and maintain balance on the existing ecosystem. The project is part of LWRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

The project is scheduled to commence once development approval is obtained from the Director of Environment and funding for the implementation of project activities secured. It is estimated that the scheme will cost approximately $21m. The funds may be sourced from government coffers or through bilateral arrangements with outside donors..

The overall design dredge channel would be approximately 16km long from the river foreshore to Nawamagi area. The channel would extend approximately 100—200m into the foreshore from the river mouth in order to desilt sediment that has built up and blocked the river mouth. Dredging is to be carried for flood mitigation purposes with a design of 1: 20 year flood return period. Dredging will be carried out by a cutter suction dredger. Dredging would cover the following major activities:-

- Construction Works in preparation for dredging works
- Excavation of spoil
- Transportation of spoils to Dumpsites
- Deposition & management of spoils at Dumpsites
- Operational activities regarding storage, supply and maintenance of dredging equipment, support equipment and consumables
- Monitoring Activities
- Rehabilitation of Dump Sites

As almost all of the equipment for dredging to include the vessel and pipeline on pontoons will be on water, it is crucial that dredging be undertaken during dry and flood free season. Any heavy down-pour and flash flood occurring at any time may result in extensive damages to the equipment, loss of work time and of course finances. To ensure that the use of good and dry weather is maximized all efforts must be aimed at finishing all dredging works during the dry season even if it means working 24hours/7 days shifts and using two or three dredgers simultaneously.

In general, there would be minimal impact on the physical parameters of the Sigatoka river if proper mitigation measures are put in place and implemented right from the outset. Short term disturbances would be in the form of increased turbidity and suspended sediments which would last the duration of the dredging period. Salinity factor would move upstream as dredging progresses and may cause upstream migration of the freshwater shellfish (kai).

The use of dump sites identified by LWRM & CEC for the stock piling of dredged materials are possible provided the consent of the land owners are obtained. The use of dredged material for fills in low lying areas near village and settlements along the river banks is favoured provided earth bundings or other forms of approved bunding materials are appropriately placed at these sites to prevent erosion and flow back onto the river before being treated.

Close monitoring of the prawn fisheries by LWRM and the Department of Fisheries is to be maintained during and after the dredging operation at the river mouth. Appropriate measures are to be implemented to counter any negative impact. Dredging preferably, is to be undertaken in the prawn off-season.

Impact on the other marine life would be minimal or temporary in nature.

The closest reef system is approximately 0.15km away and most have adapted to high sediment loadings of the river over the years. Dredging will have no significant negative environmental impacts on the mudflats and reefs. Management measures have been recommended for the minimization of impacts on the biological environment.

Losses of substance crops, and damage to residential and commercial properties due to flooding in the past have had a major impact on the business industry, and the community at large. It is for these reasons dredging has the overwhelming support of the Sigatoka community.

However, it is must be noted that dredging alone will not permanently solve the flood problems of Sigatoka. An integrated approach to dealing with the issue is recommended. This could be done by funding and co-ordinating proposed projects such as river channel re-alignment, drainage planning, providing dykes and flood gates at appropriate places and proper land-use practice.

Conclusion

The proposed dredging development project by LWRM is likely to have significant economical benefits to the local area, the region and the Country of Fiji and local residents are likely to benefit from the increase in productivity of the land through job opportunities.

The potential adverse effects of the development on the surrounding environment and community are recommended to be managed and mitigated by producing and adapting an Environment Management Plan to incorporate the following documents:

- Construction Environmental Management Plan (CEMP)
- Operational Environmental Management Plan (OEMP)

Monitoring should be carried out during both the construction and operation phases to record environmental impacts of the development on the environment and for LWRM to apply appropriate remedial actions when ever required.

In addition monitoring will enable LWRM to foresee and forecast any form of management issues occurring or about to occur at current and next stage of development to be able to steer the development back immediately to its proper course.

Laisiasa Corerega
Managing Director

CONTENT PAGE

CONTENT PAGE

CONTENT PAGE

CONTENT PAGE

CONTENT PAGE

CONTENT PAGE

CONTENT PAGE

1.0 INTRODUCTION

1.1 Purpose and Content of Report

The Land and Water Resources Management Division (LWRM) of the Ministry of Agriculture and Primary Industries is proposing to dredge the Sigatoka River. Dredging works will commence at Nawamagi and proceed 16 kilometers down stream to the estuary and thence 100—200 meters further out to the main marine environment. In conformity with the requirements of that part of Environment Act requiring an Environment Impact Assessment to be carried out on such a development, Corerega Environment Consultants (CEC) is being engaged to carry out the same for the above mentioned government organization.

This document is a Draft copy of the EIA Study report and is progressive leading to the development of a Final Draft document that will see to the Final EIA Study report document being produced to LWRM for submission to the Director of Environment for consideration. Inception, Progress and Interim reports were provided to the Director of LWRM. to keep informed of progress in every stage of work.

This report contains the findings of the EIA study with mitigation measures provided to prevent or minimize potential impacts identified, in the areas listed below.

- Physical aspects
- Biological and Terrestrial ecology
- Social and economic environment of immediate neighbours, visual amenity and archaeological resources.
- Public Health and other key environmental considerations such as water supplies, waste water treatment, noise, air and receiving water quality

This findings etc., will be reviewed and finalized in the Final Draft Report for the EIA Study, the next report we will submit to LWRM.

The Environmental Impact Assessment (EIA) Study was carried out in accordance with the Terms of Reference (TOR) provided by the Director of Environment (DO Environment). The TOR is at APPENDIX A of this document.

1.2 The Environmental Impact Assessment Process

The Fiji Government has provided a legal framework for the EIA process through the passing of the Environmental Management Act of 2005. The EIA process is currently administered through development approvals given under the Town and Country Planning Act.

The EIA process typically involves the following process:

1. Finalize the EIA scope including the TOR and consultation with Department of Environment, Department of Town and Country Planning and the relevant local authority
2. Undertake the EIA and associated investigations including:
   - i) Establishing ecological and social baseline environments
   - ii) Identifying and assessing impacts
   - iii) Recommend management measures
   - Iv) Recommend a monitoring program
3. In wide consultation with community and appropriate authorities prepare EIA Report
4. Submit draft to DOE for review
5. Consider, address and integrate comments where necessary
6. Submit the final EIA report to DOE for endorsement

1.3 Other Statutory Approvals Processes

LWRM is the sole authority for river dredging works in Fiji. However it has to comply with provisions stipulated in the Government Environmental Management Act (EMA) relating to EIA as well as ensuring full observance of the River and Stream Conservation & Pollution Acts of the Department of Lands. LWRM may have to work closely with Lands Department, MRD, Central Board of Health and other stake-holders in this development to ensure that it is conducted in the most sustainable manner.

1.4 EIA Study Team

The following professionals contributed to the study and the Environmental Impact Assessment study report.

Name	Qualification	Specialist area
Mr. Laisiasa Corerega 	*MSc. in Environmental Engineering,* University of New Castle Upon Tyne (UK), 1990. *Diploma in Public Health Inspection for General Over Seas Appointment,* Royal Society of Health, London, 1982. *(refer to CV for more information)*	**Team Leader** generally overlooking the management and operations of the project and specialising in consulting in the areas of *(but not limited to):* - **Public Health aspects** to include Water supply & quality, marine water quality, solid and liquid waste management, land and air Contaminants, health and hygiene, etc. - Facilitation of Community Consultation aspects; - Project management
Mr. Atunaisa Kaloumaira 	*MSc. in Water Resources Engineering,* University of Newcastle Upon Tyne, UK, 1984. *BE (Agriculture),* Canterbury University, NZ , 1975 *(refer to CV for more information)*	Consultant generally overlooking the **Physical Aspects** of the project specialising in the areas of *(but not limited to):* - Hydrology, Geology and Drainage. - Geo-Technical Assessment & Reports
Dr. Paulo Vanualailai	*PhD in Coastal Management & Environment* *(refer to CV for more information)*	Consultant generally overlooking the **Coastal Management Aspects** of the project specialising in the areas of *(but not limited to):* - River Flow & Channel creation - River mouth and estuaries
Mr. Eroni Tupua 	*BSc Earth Science (USP),*1998. *(refer to CV for more information)*	Consultant generally overlooking the **Geological and seismicity** aspects of the project specialising in the areas of *(but not limited to):*
Mr. Mosese Bati 	*BSc. Chemistry/Biology,* USP, 1994.	Consultant generally overlooking the **Biological Aspects** of the project specialising in the areas of *(but not limited to):* - Terrestrial, Flora and Fauna - Aquatic Ecology - Mangrove Ecosystems

Name	Qualification	Duties Performed
Mr. Maciu Lagibalavu 	*MSc Fisheries*, (UK), 2009.	Consultant generally overlooking the **Fisheries Aspects** of the project specialising in the areas of *(but not limited to):* - Marine Resource Management - Aquatic Ecology
Mr. Jese Vatuwaqa 	*Diploma in Environmental Health*, National University of Fiji *(now FNU-College of Medicine)*, 1997	Assistant Consultant to the Team Leader generally overlooking the Socio-Economic and Health Aspects of the project specialising in the areas of *(but not limited to)* - Public Health - Social Survey - Community Participation
Mr. Filipe Corerega 	*BA Hospitality & Tourism*, USP 2007.	Technical Assistant (part-time) overlooking the of the project specialising in the areas of *(but not limited to):* - Tourism & Hospitality aspects - Social Survey - Community Participation - Technical preparations for workshops
Footprint Designs	*Diploma in Graphics & Arts*, FIT, 2002.	Graphic Designing Company overlooking the areas of *(but not limited to):* - Graphics, Report Editing, & Finalization - Company publications and awareness - Social Survey - Community Participation

2.0 THE PROPOSED DREDGING DEVELOPMENT

2.1 Introduction and Background

The government has in the past quarter century identified and programmed measures to reduce the extreme risks to floods on communities along the Sigatoka river. Impacts are nationally felt as they affect the major economic sectors of the nation, unfortunately learned through experiencing many extreme historical flood events of this river. Over time the changes in land use pattern and extreme weather conditions have exacerbated flood levels and flood frequencies. Damages are becoming huge and unbearable as development is perceived to have increased our vulnerability to flood damages.

In the mid-nineties government started dredging the Ba river in an effort to alleviate flood events and damages. The dredger move to other Fiji rivers in early 2000, maintaining plans to return to Ba for maintenance dredging in the near future. However in January 2009 long duration extreme rainfalls in the highland caused massive flooding in both Ba and Sigatoka Rivers with resulting heavy sedimentation of the rivers. SOPAC initiated an economic cost study[1] on the losses that revealed total losses of over F$86 million of which about F$31 million (35%) were household losses and about F$56 million (65%) business losses. The same type of loses was experienced in March, 2012 when major flooding of the lower end of the Sigatoka River occurred. The Sigatoka River has not been dredged ever before though plans to carryout the same came to mind time after time. The flooding event in March, 2012 has prompted the government of the day to look at the matter seriously and take appropriate actions.

The LWRM Division manages the dredging programme and it is proposing that a sixteen kilometre stretch from Nawamagi to the River mouth be dredged and to continue to deep water to help pass the peak of the flood flows into the receiving sea water.

2.2 Purpose of the Development

Dredging is the underwater excavation of sediment for navigable purposes, port expansions, environmental remediation, flood protection, drainage improvements or winning minerals from underwater deposits.

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/ estuary to the sea in order to reduce the risk of flooding in surrounding areas and maintain balance on the existing ecosystem.

The project is part of LWRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

2.3 Description of the Proposed Project

LWRM would prepare the detailed design of the project and the execution of dredging works may be either outsourced or undertaken by LWRM. The overall design dredge channel would be approximately 16km long from the river foreshore to Nawamagi areas. The channel would extend approximately 100-200 meters into the foreshore from the river mouth. The subject area is depicted in **Figure 2—1: Development Area.**

2.3.1 Project Schedule

The project is scheduled to commence once development approval is obtained from the Director of Environment and funding for the implementation of project activities secured. It is estimated that the scheme will cost approximately $8—$10m. The funds may be sourced from government coffers or through bilateral arrangements with outside donors.

As almost all of the equipment for dredging to include the vessel and pipeline on pontoons will be on water, it is crucial that the dredging be undertaken during dry and flood free season. Any heavy down-pour and flash flood occurring at any time may result in extensive damages to the equipment, loss of work time and of course finances. To ensure that the use of good and dry weather is maximized all efforts must be aimed at finishing all dredging works during the dry season even if it means working 24hours/7 days shift and using two or three dredgers simultaneously.

2.3.2 Life Span of Project

The work done is planned to be lasting for up to ten years. Monitoring works will be carried out in accordance to an effective management plan that will be developed to ensure that the result of the dredging work now done is lasting and far reaching to reap maximum benefit for the planned life span of the project. The Sigatoka River has not been dredged ever before.

2.3.3 Justification of Project in Terms of cost/benefit analysis

In terms of the justification of this project in terms of cost/benefit analysis, the dredging scheme is solely for the purpose of deepening the Sigatoka River so that water can flow freely through the river during heavy down-pour without causing flooding to Sigatoka Town, nearby villages and adjacent land. LWRM should look at this dredging scheme from a wider perspective. There are other benefit that could be derived from the scheme and as follows:

- Dredged material to be stock-piled and later used for fill materials for extension of village sites
- Dredged materials to be stock-piled and used as filled materials for reclamation for future development purposes such as industrial, commercial & Hospitality and Tourism.
- Dredged materials to be stock piled and sold as construction fill materials.

Figure 2 —1: Development Area to be covered by EIA Study.

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2.3.4 Dredging Concept

LWRM has not come up with a definite dredging concept. It has not provided cross-sections and locations of areas to be dredged. In the absence of this It would be difficult to determine the amount of material dredged from a particular area and determine the area of land required on land to receive and store the same. in this regard it is assumed that dredging will be done mid-river most of the way and perhaps shift to the right or left as areas are found to be shallow and requiring attention.

2.3.4.1 Data given by LWRM to provide for a Dredging Concept

Base line data was provided on the Sigatoka River by LWRM which was adequate to provide a start for developing a drainage concept. However CEC took the initiative to pole the width of the sixteen kilometre stretch of the Sigatoka River proposed to be dredged at a kilometre interval to determine depths at 20—30m distances hence indicating river bed formation trend and structures. In so doing an approximate volume of river bed materials to be dredged was calculated. An approximate volume of dredged materials thus calculated is shown in Table 5.1/1 of Section 5.1.4 of this report and the river bed profile & structures across the width of the river of the sixteen (16) kilometre stretch at one kilometre interval is shown and discussed in Section 5.1 of this report.

Despite the short coming mentioned above other areas regarding the Sigatoka dredging concept are provided below:

2.3.4.1.1 Dredging Site

- Mouth of river 4km out to sea. (this will not be possible to do as the passage falls into the deep ocean waters at about 100– 200 meters immediately after the river mouth.
- Mouth of river to sixteen kilometer up river to Nawamagi areas.

The proposed dredging site has never been dredged at any time before. **In Fire 2 —2 is shown that part of Sigatoka River that is to be dredged.**

2.3.4.1.2 Proposed Dredging design

Mouth of river depth 5m - width 50m

Upriver will be determined by the existing natural grading of the river bed. Generally five meter in depth at 50m width

2.3.4.1.3 Dump Sites

Dump site will include those identified by LWRM and CEC.

Sediment dump will not be located more than 1km away inland from the river due to economical reasons.

Figure 2—2: Portion of Sigatoka River to be dredged

2.3.5 Proposed Dump Site

This refers to LWRM identifying and locating dump sites as stated in Section 2.3.4.1.3 and as follows.

- Dump site will be identified by LWRM.
- Sediment dump will not be as far away as a 1km from the river for economical reasons.

To date LWRM has not formally indicated to the consultant any specific areas it has identified for use as dump sites. CEC suggests that LWRM do this earliest. In its effort to identify and determine possible dump sites LWRM may also take in consideration requests heard at the Community Consultative Meeting that was held in Sigatoka on 29th November, 2012 in which strong representations were made from the Turaga ni Koro of villages that attended the meeting for the use of dredges materials as fill materials to facilitate the extension of village boundaries or to fill low lying areas normally water logged to prevent mosquito breeding. Details of the meeting is contained in Section 5.3.2.3 of this report.

After LWRM has read this section of the report it may be able to make a firm decision to identify dump sites promptly. In turn CEC and LWRM could make inspection jointly at a later date to confirm the suitability of sites identified by both organizations for use as dump sites.

2.3.6 Dredged Spoil Transportation & Deposition

A dredger deemed appropriate for the dredging of the Sigatoka River will be used. The dredger that uses a circular serrated edge cutter to excavate the spoil which is immediately sucked in by a pump and transported to the dump sites via pontoon fixed pipes is probably the best to use. These transfer pipes are constructed of steel pipes mounted on pontoons joined together with flexible rubber sleeves.

The total volume of spoils to be dumped at dump sites has not been given by LWRM. However CEC has calculated an estimate of 1.8 million cubic meters/inland and 0.5 million cubic meters/offshore.

CEC has identified twelve dumpsites, six on the left and six on the right banks along the sixteen kilometer stretch of Sigatoka River proposed dredging area. Details of dumpsites locations and possible quantities they can hold are discussed in length in Section 5.1.2.4:Preliminary Quantities & Possible Dump Sites of the Physical Report.

It is proposed to fill the dump site areas to more than 3 meters above ground level.

3.0 DEVELOPMENT PHASES

There are two faces of development in this project. The first is the Construction phase in which construction works and installation of equipment in preparation for dredging of the Sigatoka River are carried out and being monitored. After all construction works have been satisfactorily completed the Operation Phase proper will commence to include the use of suitable machines and equipment for the dredging of the river according to conceptual plans, stockpiling of dredged materials and continuous monitoring of activities for both the current and post dredging stages of the operation phase.

3.1 Construction work phase activities in preparation for Dredging of Sigatoka River

- Construction of work roads and their drains to designated dump sites
- Removing of Vegetation (Dogo/Tiri) for use as bunding materials for dump sites
- Construction of bunds for stock-piling dredged materials
- Construction of sedimentation ponds and outlets within stock pile area
- Monitoring of Construction activities and its effect

3.1.1 Construction of Roads and Access & Drains

The construction of roads and access to dump sites should it be required will take place prior to commencing of dredging activities. The construction of roads will involve removal of vegetation, earth works, grading, shaping up of the road to workable Macadam type. Rocks will provide foundation for graveled road. Road drains will also be provided on both side of the road. The road will be compacted well, and graveled.
Proposed roads and Details engineering plans are yet to be received from LWRM.

3.1.2 Removing Vegetation

Vegetation will be removed in the process of constructing access roads to designated dump sites.

Vegetation clearing may also be required in the setting up of pipelines on pontoons all the way from the dredging site to the dumpsite.

Tiri /Dogo will be used for the construction of bunds at the Dump sites.

3.1.3 Construction of Earth & Wooden Bunds for Dredged materials on Dump Sites

Earth and wooden bunds where ever appropriate would be constructed around Dump sites. Dredged materials then be pumped into the bunded area. The bund will hold and retain dredged materials at the bottom while it allows it to heap up to the required height. All water draining out of the heap will be collected in receiving drains and led into sedimentation ponds.

3.1.4 Construction of Sedimentation Ponds & provisions to drain Water from stock- pile area

Sedimentation ponds will be constructed in designated dump area. The ponds will trap and allow sediments travelling with escaped water from the stock pile to settle. While sediments will settle in the ponds escaped water from the heap is allowed to flow back into the Sigatoka River.

3.1.5 Monitoring of Construction Activities & Effects

3.1.5.1 Implementation of constructional works

There will be direct impacts imposed on the people and environment during the construction phase in preparation for the dredging operation phase. Construction works will be monitored to ensure that they are done correctly and in the most proficient and professional manner in accordance to approved engineering plans and specifications.

This is also to ensure that during the actual construction process impacts are prevented and minimized.

3.1.5.2 Effect of constructional works

There will be environmental effects on the terrestrial and ecology of the development area as result of constructional works. This will have to be monitored through an Environment Construction Management Plan for the development so the developers would be informed of the efficiency of its management plans and to review it if found un-wanting.

3.2 Dredging Operation Phase

Three activities are normally crucial for the success of any river dredging operation. For Sigatoka river dredging they are as follows:

3.2.1 Operation Management

This Phase coming after the satisfactory completion of all construction works will see to the management of the dredging operation on the Sigatoka River on a daily basis and the monitoring of the implementation of development conditions as set out by approving authorities on the development ensuring sustainability and safeguarding the well being of the people and all creatures that live in and around the development area.

The dredging of Sigatoka River is a 24 hour/6 days week affair. It will involve 3 work shifts, twelve persons for each shift.

LWRM may carry out dredging works itself or out-source it. Which ever of the two is adopted by LWRM, it is still responsible for the overall supervision and management of the project. As owner of the project it is its responsibility or its representative to obtain consent and approvals from appropriate authorities for any further development it wishes to carry out on site. It will ensure that all facilities at work stations, work equipment and machines under its control are functional, well maintained and in good state of repairs.

3.2.1.1 Work Station

The Nacocolevu Agriculture station will be the work station for the dredging of Sigatoka River at this point in time until LWRM decides otherwise.. All fuels and work supplies etc will be safely stored in containers at the work station & transported when ever needed to dredging sites by barge.

Accommodation for workers will be provided at the work station where potable water supply is readily available through WAF treated piped supply, electricity through FEA supply and the use of WC/Septic Tank/ Soil percolation system for the treatment of waste-water. In addition solid waste collection institutional system exists.

The Dredging vessel which has all facilities for basic amenities on board will be the work station at the work/ dredging site.

As for solid wastes at work/dredging sites Working Bins provided by LWRM will be arranged for use for storing solid waste on work sites and once they are full are transported by barge to the work station and then taken to the nearest sanitary landfill for final disposal.

3.2.1.2 Work Equipment

The type of equipment to be used on the dredging works will depend on the amount of dredged materials being worked out, the work time frame and the proximity of the dump sites. LWRM is looking at dumpsites that will be not more than one kilometer from the dredging sites. In this regard it may already have in mind the type of machine it may require to satisfactorily do the job.

The dredging works may be out sourced as is the case for the Rewa and Nadi rivers and it is most likely that equipment to be used in dredging the Sigatoka River will be of the same type used for Rewa and Nadi Rivers. In Figure 3.2—1: is shown the Dredging Equipment in use in Nadi River.

Figure 3.2—1: Dredging Equipment in use in Nadi River

3.2.2 Dredged materials Management

3.2.2.1 Dredge Material Quality

Dredged materials are expected to be slightly contaminated. The sediments samples acquired from bottom of the Sigatoka river at all sampling points were found to be odorous dark brownish and muddy in colour signifying heavy deposits of silt, sand and within all study Zones. Deposits appear to be concentrated and aerobic. In this regard much more efforts and time would be required to dredge the same.

Generally dredged materials are expected to be contaminated. Through out the dredging period samples of mud at the bottom of the river and water acquired from water columns will be analyzed and examined from time to time. Likewise samples from dredged materials in the stockpile will be acquired from all dumpsites and tested. This is to ensure that LWRM is informed of the water and sediment quality and take precautionary measures in regards to dredging operations when deemed necessary.

Dredged materials will not leave the site or used as fill materials or any other purposes until deemed fit to be used as such by LWRM.

3.2.2.2 Storm water Management in the stock pile area

The storm water falling directly on to the dumpsite will be clean and relatively of medium volumes. Volumes depending of the intensity of down pour. Those falling directly on to the stockpile will help in the cleansing of the sediments in the stock pile.

Sedimentation ponds will be constructed in designated areas in dump area. The ponds will trap and allow water escaping from stock pile and storm water going through the stock pile to settle.

While sediments will settle in the ponds excess water in the pond through suitable drainage system will be allowed to flow back into the Sigatoka River. Storm water falling directly into the pond may dilute contaminated water in the pond.

Water quality testing of waters in sedimentation ponds will be undertaken to ensure the quality of water going back into the river is free of contaminants at all times.

3.2.3 Monitoring of Dredging Activities

3.2.3.1 Dredging & Transportation of Dredging spoils Operation to Dumpsites

All Dredging operation will be closely monitored by LWRM to ensure that it complies with all aspects and requirements of the LWRM approved engineering dredging scheme plan. This will include monitoring work equipment & machineries, fuel & used oil storage, health safety and security aspects as well as transportation of dredged spoil to dump sites and water quality.

Dump site & stock piling process will be closely monitored to ensure that all activities within the dump site function as planned.

3.2.4 Rehabilitation of Dump Sites

At the end of all dredging operation works the dump site needs to be rehabilitated. Rehabilitation could be structural or vegetative in nature.

4.0 METHODOLOGY OF EXECUTING THE EIA STUDY

Approaches employed by CEC to ensure proper execution of the requirements of the Term of Reference (TOR) of the study within the 180 days work time– frame are as described hereunder.

4.1 Desk Studies

This was to be done in the initial stage of the study, the first three weeks where by consultants gathered information through studies and reports on dredging in Fiji, Dredging Technologies through internet, Current environment status of sites through annual reports of various government organizations like LWRM, the Forestry, Fisheries, Health, Social Welfare, Bureau of Statistics, Lands Departments and ITLTB. In carrying out the activities mentioned a consultant engaged in the study was equipped with knowledge to use in conducting field investigations and surveys.

4.2 Approaches for use in the Study

Each consultant was to developed and implement appropriate approaches and methodologies in the study to obtain data and information apart from those already obtained from desk studies to include looking up past study reports, literatures and internet etc.

4.3 Major study zones & Field Investigations

4.3.1 Zoning of Study Area to facilitate studies on existing environment

An initial site investigation was to be carried out to determine study zones for ease of study activities implementation to result in accurate and concise reporting. The initial investigation identified the following as major study zones to be thoroughly investigated during the EIA study. Figure 4—1 is a map of the proposed Zonings of study areas for Sigatoka River Dredging.

Zone A- Estuary/Mangrove
Zone B- Lower River
Zone C- Mid River
Zone D- Upper River

4.3.2 Field Survey and determination of Impacts

Field surveys to focus on two areas; existing environment and its current condition in terms of the physical, biological and economic and social aspects. Field tests were to be undertaken and baselines determined on the Sigatoka river status in terms of water quality and geological properties. Like wise inventories on fauna & flora was established. The approaches and methodology designed by the consultants for the study as mentioned in Section 4.2 above were to be used. The potential impacts of the development were then identified.

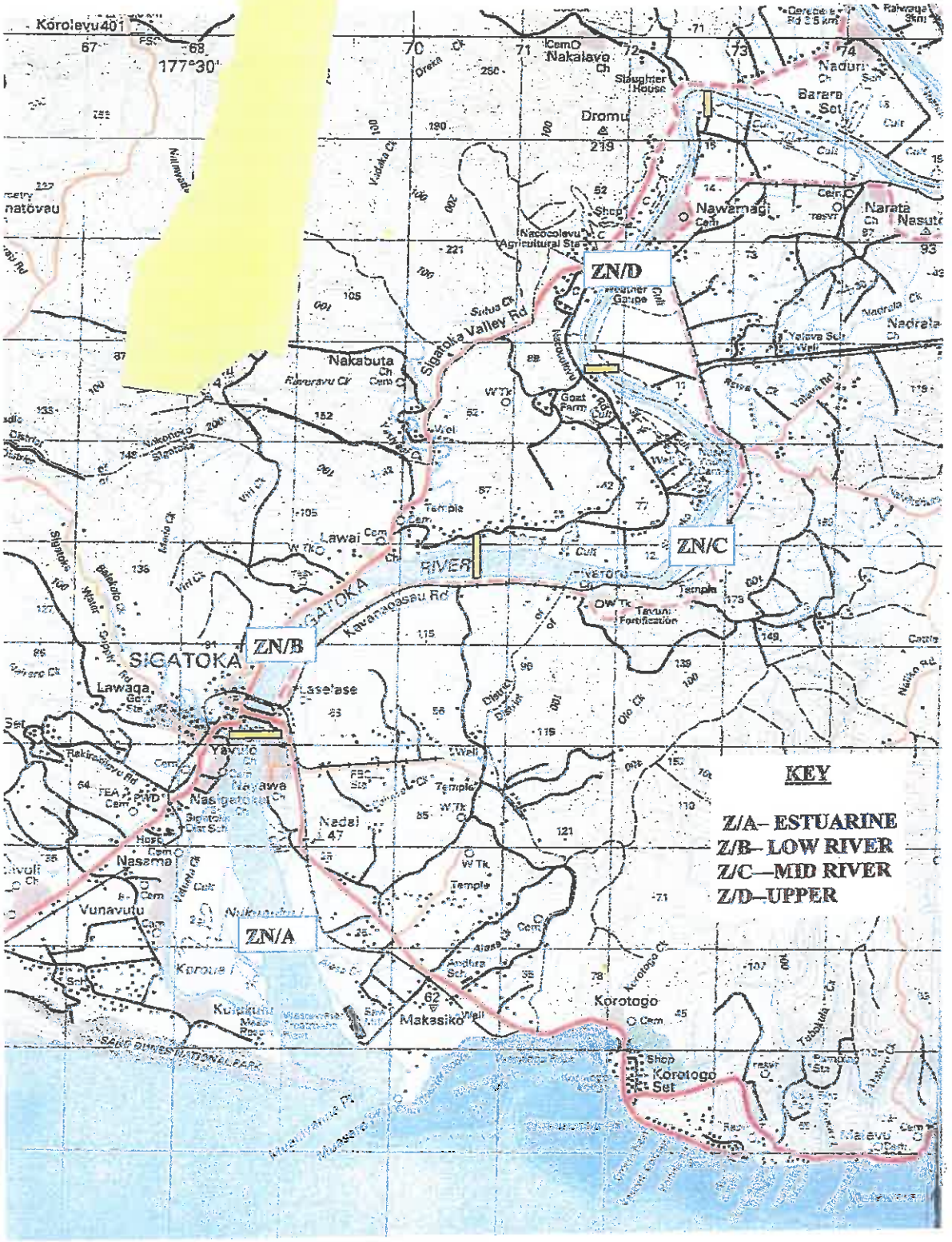


Figure 4—1: Study Zones for *Sigatoka* River (Source: Map Sheet L29 Sigatoka, FLIS)

4.4. Assessment to Determine degree of significance of Impacts

Potential impacts on being identified were assessed through ratings obtained by using the ad-hoc and the Check List Methods of determining the degree of impact on the environment or community resulting from the proposed development. In the case of potential natural hazard impacts the risks rating was determined by the CHAR method used by ANZECC countries and also adopted for use by the Fiji Government and small island countries of the South Pacific region.

For potential significant impacts identified in the study consultants will provide mitigation measures to assist, prevent, minimize and avoid their occurrences.

4.5 Community Consultative & Participatory Meeting

The Public was to be invited through advertisements in the local newspaper to attend a Community Consultative & Participatory meeting in regards to the proposed development. Likewise officials of government and non-government organizations deemed to be stake-holders in the development were also to be invited to attend the meeting. The reason for the meeting was to inform the community and stake-holders of the development and the results of the study. The participants will discuss issues and concerns raised in the meeting regarding the development. The concerns raised will be taken in by CEC and those that were not resolved in the meeting were to be incorporated in the final EIA report with mitigation measures put into place to prevent, avoid and minimize their occurrences.

4.6 Writing the EIA Study Report and submission of Drafts/Final Drafts and Final EIA Study Report & EMP to LWRM & DOE.

4.6.1 Draft/Final Draft & Final EIA Study Report

CEC will submit a Draft EIA Study Report over time to LWRM & DOE. Whilst the document will report on areas required by the TOR of the study to be addressed, it will be also be outlining mitigation measures that would reduce project related impacts on the environment for review.

CEC will prepare responses to comments received from LWRM on the Draft EIA Document and a Final Draft Report incorporating items and comments raised by LWRM in the Draft Report to also include other progressive study reports made available after the date of Draft submission, will then be prepared and handed over to LWRM for vetting.

4.6.2 Final EIA Study Report

CEC will provide a detailed and Final EIA Study Report including an Environment Management Plan (EMP) for carrying out the mitigation measures that is specified in the Final EIA Study Report Document. The EMP will contain a Construction Environment Management Plan and an Operation Environment Management Plan for the development.

Included in the activities of EMP will be strategies for monitoring and evaluating the success of potential mitigation measures.

5.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

This section also provides the baseline environmental (biophysical) and socio-economic context to which the potential impacts from the proposed dredging works will be assessed. Here under are the findings of the studies on existing environment.

5.1 Physical Environment:

5.1.1 Introduction

5.1.1.1 Development Objective

To reduce vulnerability and risks to flooding

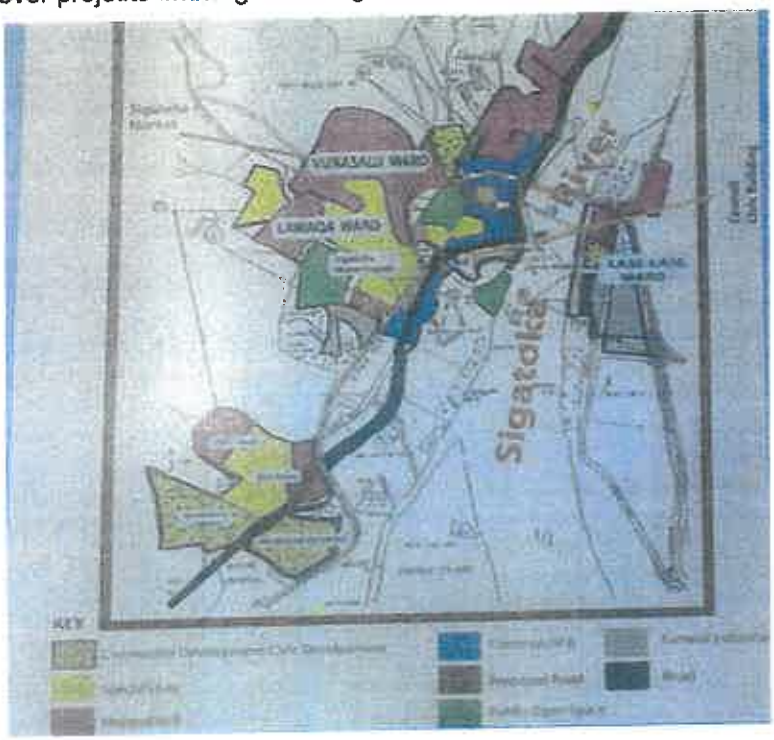
5.1.1.2 Synergies with relevant development plans over the Project area.

The dredging physical limits or dredging project area is from the river mouth to Nawamagi village about 13.5 km upstream along the river. The focus of development plans investigation in the context of dredging impacts is with respect of the dredging project area not withstanding that flood alleviation is a development issue concerning the whole Sigatoka River catchment of 1453 km^2.

Following are the key stakeholder targets; some with on-going development activities, some at project concept stage and some as good ideas upon prompting from the EIA Team.

Sigatoka Town Council

STC has pockets of development interests. There are no plans in the immediate future to expand Sigatoka Town zone. However projects enticing tourism growth is vital to Sigatoka.



From Town to Sovi Bay the focus is on rubbish collection towards good environmentally friendly waste management.

Of relevance to this Project are municipality areas vulnerable to flooding:-

(i) the lower areas of Vunasalu Ward comprising the commercial business centre, areas of special uses, small general industrial areas and public open spaces are subject to flooding special uses, small general industrial areas and public open spaces are subject to flooding from backwater flows. STC is filling the right bank of the river to gain small but highly valued extensions to public open spaces.

(iii) Lawaqa Ward is the centre of administration and subjected also to severe flooding affecting Government offices and quarters; the Nadroga Provincial Offices; the National Sports Council Lawaqa Stadium as well as nearby retailers.

(iii) Laselase Ward across the river has a larger general industrial area that is similarly flood prone.

Nadroga Provincial Council

The Council has no specific project to be listed but supports the creation of multi-purpose raised areas near flood-prone villages that could be used as evacuation areas / community open spaces /subsistence farming / village extension.

Provincial Administrator, Public Health Office and Technical Agencies

(i) The PA is the link between Divisional Commissioner Western and Development Committees for Nadroga province. The PA cited the on-going relocation plans for Semo village that was virtually destroyed in the 2011 flood. Whatever plans the dredging project can generate to support reduce the flood vulnerability of villages and settlements and / or mitigate flood damage impacts on flood prone areas will support government's risk reduction programmes for Sigatoka District.

(ii) The Health Officer is the Secretariat to the Nadroga Rural Local Authority and likewise could not mention any specific NRLA pipeline development projects in the dredging project area. The major development focus is the on-going road improvement and upgrading project up the upper valley of Sigatoka River going beyond Naduri opposite Nawamagi. He cautioned for a good assessment on the potential impacts dredging will have on the public water supply intake from Sigatoka River at Matovo, in the river reach close by Nawamagi.

(iii) In 2009, the then Dept of Water Supply and Sewerage Department, Fiji conducted a consultancy study entitled Sigatoka (Matovo) Water Safety Plan. This identified maintenance issues at the Treatment Plant and reticulation system with implicit statements that upgrading and increasing water supply capacity is needed urgently in the near future.

(iv) The Sigatoka River bridge sits in the dredging project area and is a constraint with respect of scouring to bridge abutments. This asset is under the National Road Authority.

(v) Sand & River Aggregate Mining

Small scale sand mining at the Sigatoka Sand Dunes(SSD) and gravel extraction at Naduri prompted government to undertake a study through SOPAC into assessing the sustainability of commercialising these sporadic ad hoc operations. The sand at the SSD is the same as that in Naduri. The mixed aggregates at Naduri "comprise more sand and fine gravel rather than coarse gravel".

Extraction of magnetic sand from the SSD is a major development proposal that is now the subject of negotiations between government and major investors. Mining comes under the Department of Mineral Resources and Mining.

Community Stake-holders

(i) The Kulukulu community is interested in commercial sales of sand.

(ii) Nadroga Rugby Union is interested to develop Ololo into a sports stadium of international standard.

(iii) The Sigatoka River is being increasingly used on sporting and festival activities in enhancing tourism growth in the region.

Constraints

(a) Zone D Water Supply: There is a shallow well at Matovo, drawing water from the river for public water supply. Salt water wedge is not to reach Matovo; advice of WAF is to be sought.

(b) Zone D There are aerial water mains and power lines crossing the river by Nawamagi.

(c) Zone B Present scour hole on the piers of the new bridge is observed to be about 0.5m depth, the difference between 3.75m upstream and 4.25m downstream depth. Dredging near the bridge requires utmost caution, and advice of road authorities should be sought.

(d) Zone A Mangrove is present near the mouth and it is very critical as the stand is not extensive. The bund is to go behind the mangrove.

(e) Zone A The river mouth is a high energy location. It will be very expensive to dredge the sand bar and then maintain an open channel. A wide open river mouth will subject Zone A and Zone B to high energy wave action, posing a high threat to villages and the town. Current practice is by locals during extreme floods to initiate a pilot channel that enlarges during very high flood flows. It closes naturally again in low discharges.

(f) Inland drainages where flood bunds are proposed will be affected and need to flow through floodgates.

5.1.2 Description of the Proposed Project

5.1.2.1 Dredging History

The Sigatoka River is included in government's plan of dredging major Viti Levu rivers but no dredging on Sigatoka has been done to date, one issue being the technical complexities of the river mouth coastal region. The practice now in LAWRM is to include outsourcing of dredging operations in addition to its own dredging fleet.

5.1.2.2 JICA Study

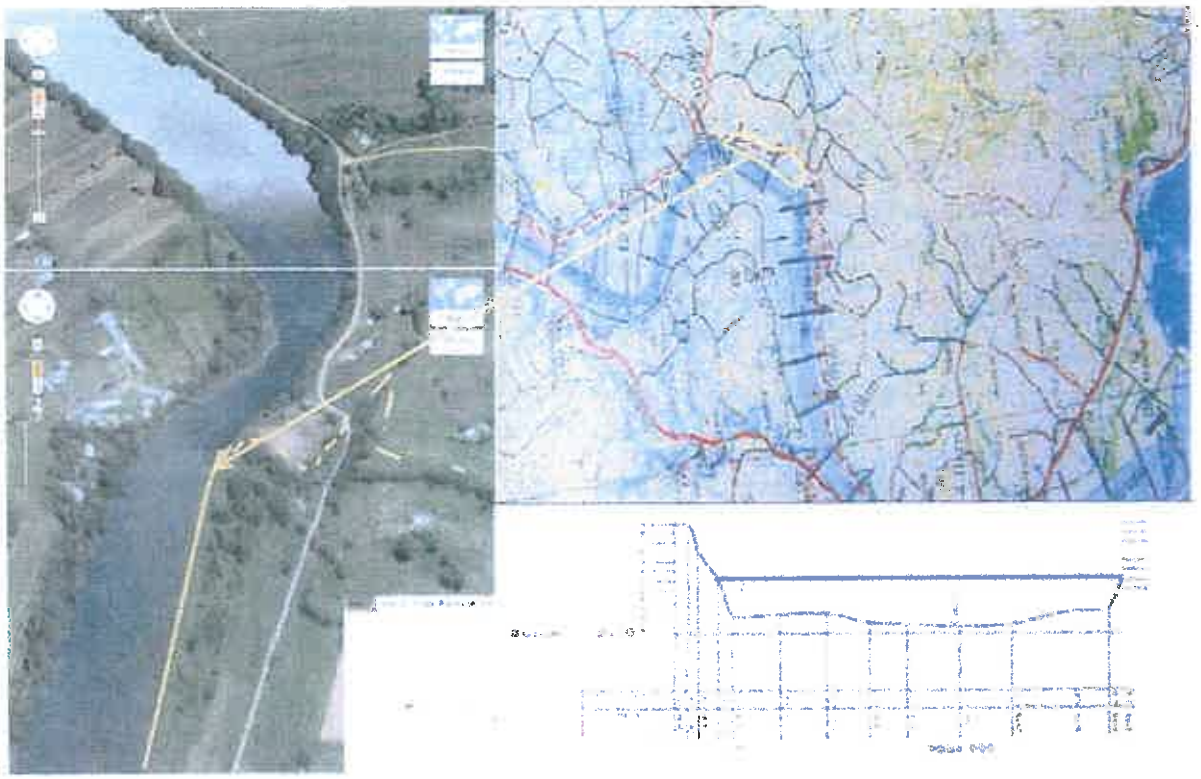
JICA through LAWRM has conducted a substantial study of Sigatoka River assessing the flood damage impact costs and recommending alleviation through dredging. This study and dredging proposal compliment LWRM's dredging programme for Sigatoka River and both are the core sources of information driving the dredging aspects of this EIA:-

(i) Phase 1 to lower flood level 2m by dredging 2m deep - this will contain the 1:20 year flood within the improved river capacity without opening of the mouth. JICA's preliminary dredging volume is 1.82 million cubic meters.

(ii) Phase 2 to include river engineering works with a recommended 1: 50 year design flood.

JICA identified the critical section at 10km upstream which with surveyed data has been refined to 9.5km upstream.

Critical Section Opposite Nasau Training Centre



5.1.2.3 LAWRM Proposed Dredging Works

LAWRM is proposing to combine the above phases, with considerations to dredge the river mouth continuing 4km offshore. The Director is conscious of the high wave energy at the mouth and suggests a focus of investigation on widening of the existing breach at the mouth and dredging off-shore to reach a minimum 5m depth.

Existing off-shore water depth is very deep close to the shore with steep slopes reaching 200m a distance of only 300m from the mouth (Bathymetry Map Section 5.2.3). The river narrows at the mouth with a very narrow deep and very swift section at Muasara Pt on the east bank. Maintaining the ocean channel in lieu of the known substantial sand plume from inland river flow is a major consideration, hence a good alignment of the dredged channel with the sediment flow and littoral drift processes is used in considering positioning of the dredged offshore channel. There is a submerged reef close by offshore.

5.1.2.4 Maintenance Dredging

The proposed work will aim at improving the discharge capacity of the river as guided by the JICA study. Dredging costs in other Viti Levu rivers of approximately \$6 /m^3 is used as a guide. This study proposes allowance for a slight increase to \$8 per cubic meter dredging cost.

(i) Both JICA & LAWRM inland dredging would cost approximately \$14.6 million.

(ii) The off-shore 2km dredging would cost approximately \$4 million.

These are preliminary base cost figures more for indicative purposes and as yet exclude the associated engineering works as accesses, embankment protection and drainage structures.

In the previous Chapter, Figure 4—1 shows a map of the proposed Zonings of study areas for Sigatoka River Dredging.

For details as at present, the project area having been zoned into four distinct work areas A—D is shown with a pictorial description below of the proposed works in each ZEUEDF 8 – SOPAC Project Report 139, Reducing Vulnerability of Pacific ACP States, FIJI.

ZONE D

Avg Width: 80m Straight Length: 2.9km

Avg Depth: 2.25m
Excavation: 2.75 m deep x 90m
Approx Volume: 0.4 Million cubic meter

Note:

1.0 Bed material Compacted Gravel & pebbles 4" atop bedrock

2.0 LH bank close to Nawaiwagi fragmented basalt is exposed dipping to the river

3.0 RH Bank at bend part interbedded with conglomerate deeply weathered to hide dip and layering

Proposed River bund RHS 1.7km

Possible Dump Site

ZONE C u/s

RHS Bund 1.7km
LHS Bund 1.2km

Possible Dumpsite

bridge d/s

Avg. Width: 150 Approx Length: 1.7 km
Avg Depth: 2.25m
Excavation: 2.75 m deep x 90m x 1.7km
Approx. Volume: 0.2 Million cubic meter
Bed material Compacted sand
RH bank & LH bank fine soil predominant
fragmented basalt on LHS near Youth Training Centre

ZONE C d/s

RHS Bund 1.6km
LHS Bund 1.2 km

Avg : Width: 200m Length 2km Depth 2.25
Excavation 2.75 x 50 x 2km
Approx. Volume: 0.3 Million cubic meter
Bed material compacted sand
Bank material alluvial

ZONE B

RHS Bund 0.7 km
LHS Bund 1.3 km

Possible Dumpsite

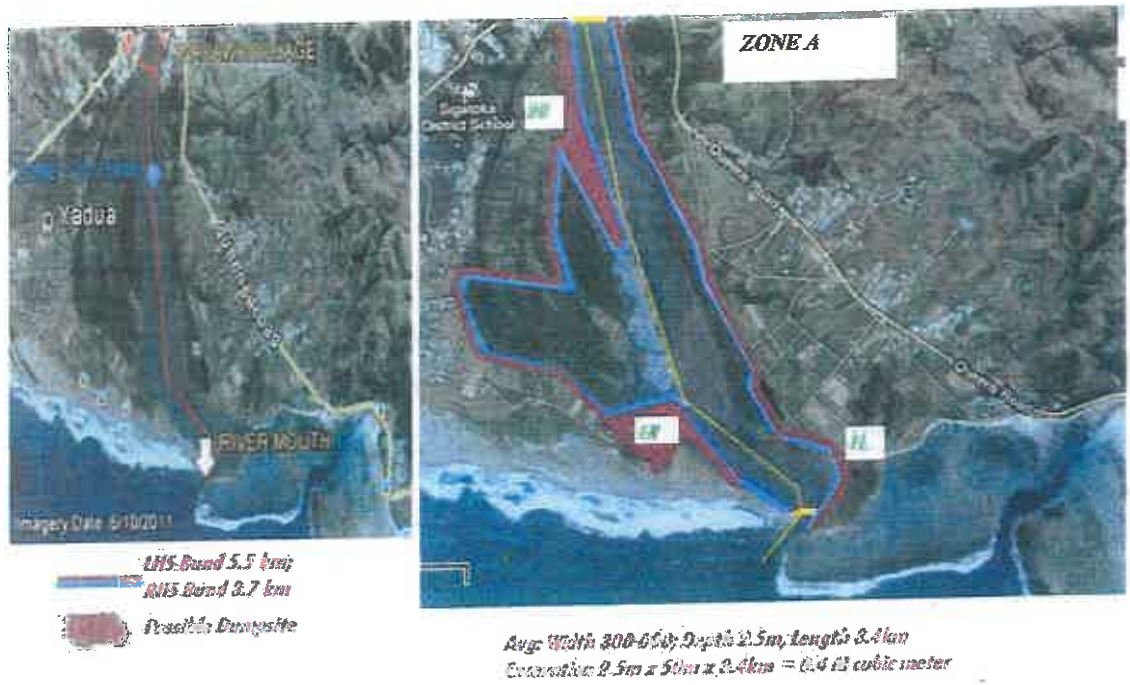
Olosalo Dumpsite 1.7 km away

Average: width 200-250m, length 3.3km, depth 2.25m
Excavation: 2.75m x 50m x 2.25m = 0.5 M cubic

Bridge Piers: u/s depth 3.75m; d/s depth 4.25m

Bed material:
u/s Compacted Sand LHS--> basalt RHS
d/s consolidated sand
Bank material: u/s fines on gravel; d/s Sand

COREREGA ENVIRONM CONSULTANTS



5.1.2.4.1 Preliminary Estimates Inland Dredging

Inland dredged-channel is to extend to Nawamagi with water depth at 5m. Preliminary total dredge volume would be 1.8 million cubic meter for a 50m wide deep dredged channel. (APPENDIX G:: PROPOSED DREDGED AREA CALCULATION)

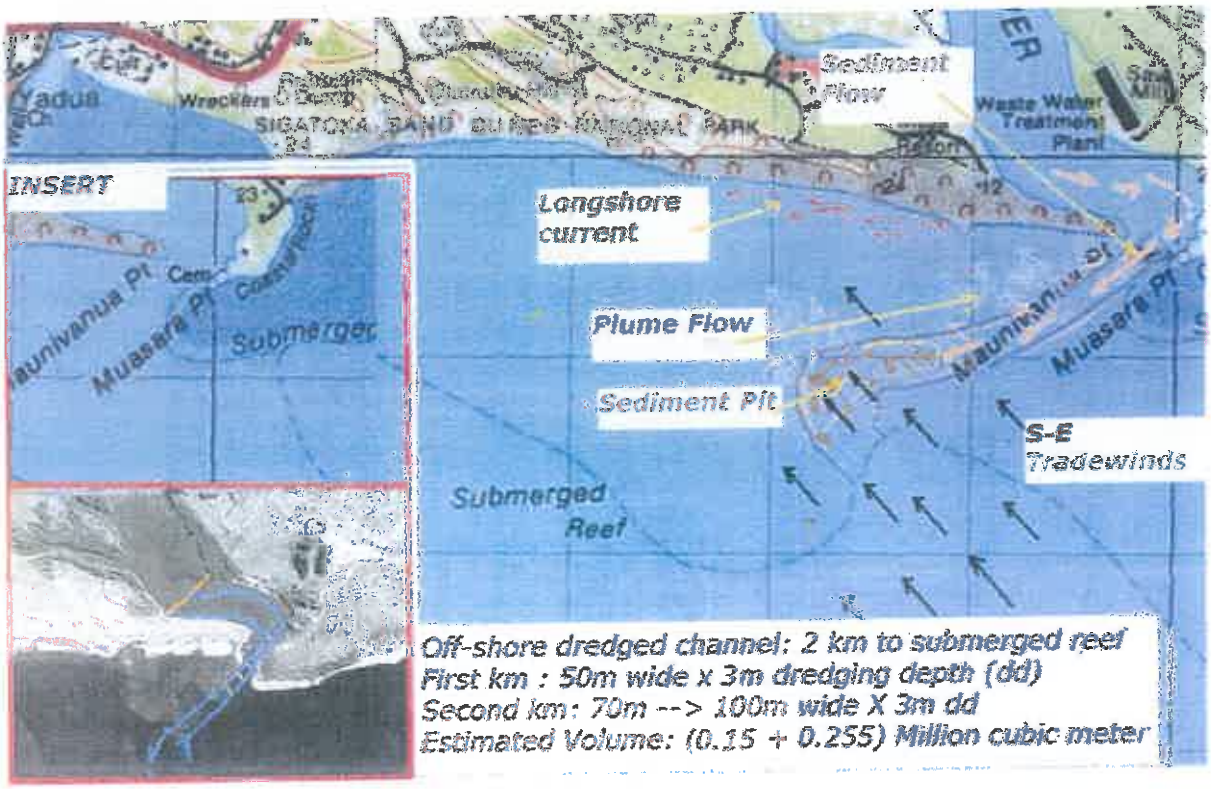
Dredging along Current Deep Channel & Volume

Zone	LHS Bund Length km	RHS Bund Length km	Dredging Volume Million cubic meter
4	-	1.7	0.4
3	2.4	3.2	0.5
2	1.3	0.7	0.5
1	5.5	3.7	0.4
	9.2	**9.3**	**1.8**

In APPENDIX G is shown details of the sufficiency of the 50m wide dredged channel to cater for the 1 in 20 year flood of 2800 cumecs.

5.1.2.4.2 Preliminary Estimates Off-Shore Dredging

For preliminary estimates, the EIA suggests maintaining the 50m width of deep channel from inland water through the Muasara Point with a channel about 1 km long which widens out gradually to 100m width at end of channel. This means approximately 3m dredging depth and hence 0.5 million cubic meters.



Estimation of Off-Shore Dredging Volume

5.1.3 Description Physical Existing Environment

5.1.3.1 Topography and Geology

The Sigatoka River is touted to be the longest in Fiji, with the origins of its 1453km^2 catchment high up in central Viti Levu. Very apt description of the watershed is provided by the JICA study which report is referenced extensively and its figures reproduced as appropriate.

The watershed is ridged by the Nadrau Plateau and Nadarivatu Ranges, abutting Nadi, Ba Rewa and Navua watersheds. JICA describes Nadrau Plateau as the catchment's major topographic feature aligning west to east with 29 peaks over 900m descending into the "highlands" comprising well rounded hills and from whose lower elevations the foothills are interspersed with narrow "alluvial plains" merging into the Sigatoka Valley and the river which eventually flows to the sea on the west coast of Viti Levu. These features characterise varying influences on rainfall pattern over the catchment:-

(a) Influence on Annual Rainfall: Sigatoka lies on the transition zone traversing from the wet Central Division to the dry Western Division. As the greater part of the catchment is to the west, the annual rainfall is less than the wet Navua and Suva.

(b) Influence on Tropical Cyclones: Though the upper catchment abuts with all major Viti Levu Rivers and is potentially subject to the same hinterland thunderstorms, in practice the surrounding Viti Levu inland ranges provide a buffer to Sigatoka catchment to the extent that Sigatoka catchment is leeward of storms approaching Viti Levu from the North clockwise to the south-west. Sigatoka catchment is most vulnerable to Westerly driven storms.

(c) Influence on Local Coastal Storms: The rounded hilly region terminates about 3km from the coast and at places abuts both sides of the river. Local thunderstorms will precipitate rainfall along the lower reach of Sigatoka River providing rain to the rich agricultural flats dubbed the salad bowl of Fiji.

JICA describes the Sigatoka River as having a very flat gradient of 1:2,000 in the lower reach up to 60 km upriver than steepens to 1:300 in the middle reach through the highlands a further 50km upriver, and finally 1: 60 in the last 40 km through the mountain ranges in the highland plateau.

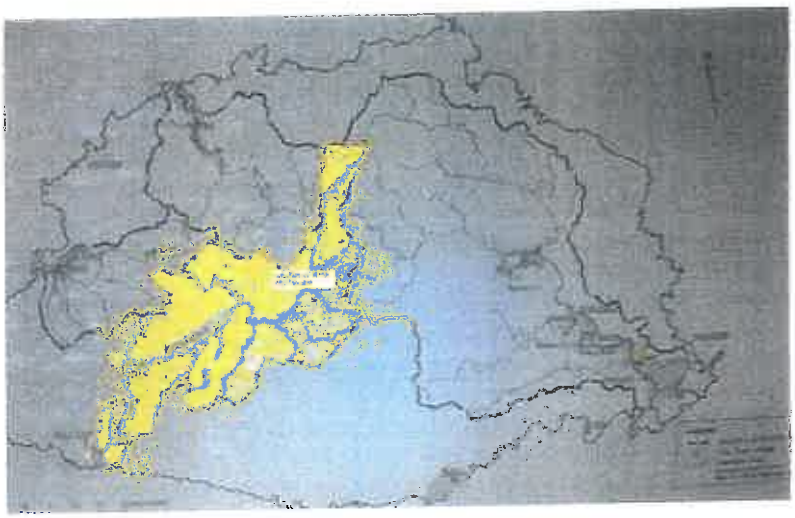


Fig Sigatoka River Catchment 1453 km^2

5.1.3.1.1 Specific Characteristics of the Lower Reaches

The focal area of interest is the coastal area adjacent to the river mouth traversing inland 15km to just upstream of Nawamagi. The embanked catchment is very different from Rewa and Ba Rivers dredging reaches. Sigatoka has undulating rounded hilly formation typical of the folding features of the coastal region extending from Sigatoka to Nadi. These hills contain fragmented rocks; parts of the steep slopes are under cultivation and otherwise others have very thin cover. These low hills also contribute gravel and pebbles to the sediment transport load; however the bulk of the bed load originates from mountain ranges in the hinterland.

The river is fairly uniform, of minimal meander with flat strips of fertile valley land separated from each other by spurs running to the river edges. Exposed basalt on the left bank is seen on steep hill-land slopes; and in places this outcrops as fragmented rocks on the bank and inclining riverwards. Weathering has masked the inter-bedding and layering between the marl and conglomerates on the right bank. This is the parent material contributing local gravel and coarse sediments to river sediment transport material.

The geological formations in the upper Sigatoka Valley is important as the parent material and source of river rocks /boulders that through weathering and natural erosion process down the hilly creeks end up downstream in the dredge project area as mixed aggregates and sand material.

A 2009 SOPAC Report by Akuila Tawake funded under EU EDF 8 *Reducing Vulnerability of Pacific ACP States* provides a very succinct description of the geology of lower Sigatoka River and river aggregates.

Other significant existing features verified during the field inspection include the following:-

- Tidal influence is strong and experienced upriver at Nawamagi.
- The average bed slope is very flat, with two tidal channels sporadically distinct at places.
- The river maintains an average uniform flow depth and average width of 150m which then widens below the bridge coinciding with the end of the low hills embanking the river.

Of significant interest in the dredging context is that the bedrock crops to the surface at various places in study Zones B, G & D. The shallow depths to the bedrock requires more detailed mapping for river dredging purposes. SOPAC in 1989 undertook a Seismic Reflection Survey of the Lower Reaches of the Sigatoka River and identified a 13m deep trench in the section by Lawai.

5.1.3.2 Meteorology

5.1.3.2.1 Rainfall (Nadi Met Office)

Table 1: Rainfall Return Period

Daily Rainfall (mm)	Return Period (Years)	Daily Rainfall (mm)	Return Period (Years)
100	1	200	8
125	2	225	15
150	3	250	28
175	5	275	51

Table 2: Climate Monthly Average for Nadi Airport

TYPE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	31.5	31.6	31.3	30.7	29.7	29.0	28.6	28.7	29.3	30.3	31.1	31.5	30.2
Min	22.8	22.9	22.8	21.8	20.2	19.2	18.4	18.6	19.3	20.5	21.8	22.4	20.8
Mean	27.2	27.3	27.1	26.3	25.0	24.1	23.5	23.7	24.3	25.4	26.4	27.0	25.5
Rainfall	343	292	341	160	89	65	45	65	70	102	132	178	1882
Sunshine	211	188	192	198	209	204	219	230	211	236	224	228	2550
RH	71.8	75.2	76.9	75.1	73.7	76.0	72.3	68.8	64.9	62.7	64.5	66.2	70.6

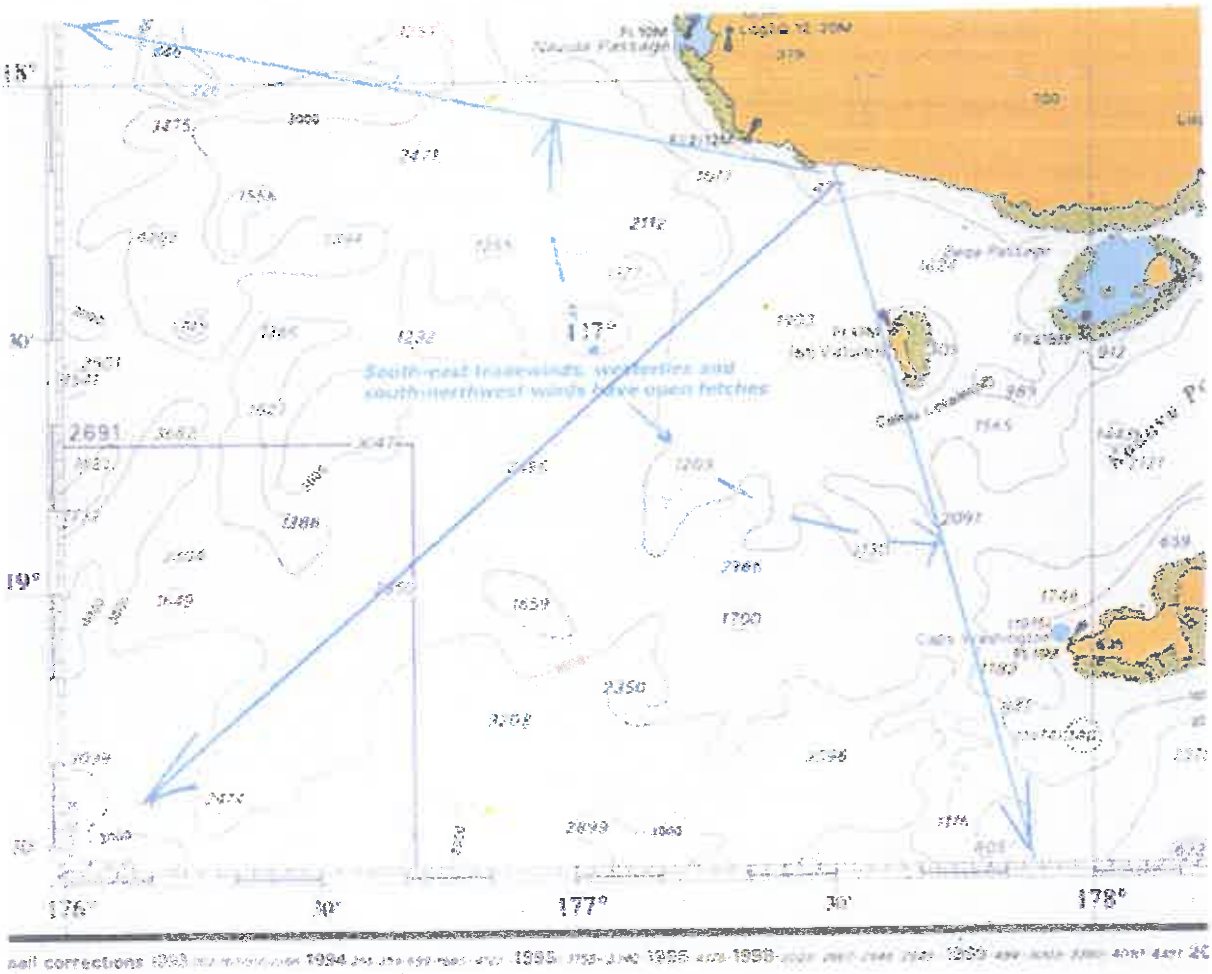
(Max - Mean Daily Maximum Air Temperature - °C), (Min - Mean Daily Minimum Air Temperature - °C), (Mean - Mean Daily Air Temperature - °C),
(Rainfall - Total Monthly Rainfall - mm), (Sunshine - Total Monthly Sunshine Hours - hrs). (RH – Relative Humidity at 0900hrs - %).

5.1.3.2.2 Wind, Waves & Tide

Table 3: Mean Surface Wind Velocity (1978-85) m/s ~ Nadi

J	F	M	A	M	J	J	Aug	Sept	Oct	Nov	Dec
2.8	2.5	2.4	2.2	2.5	2.2	2.8	3.1	3.2	3.3	3.2	2.9

The river mouth is exposed to open fetches which brings waves already 2-3m in slight breezy conditions. Tide is twice daily with Mean High Tide 1.0m above minimum sea level.



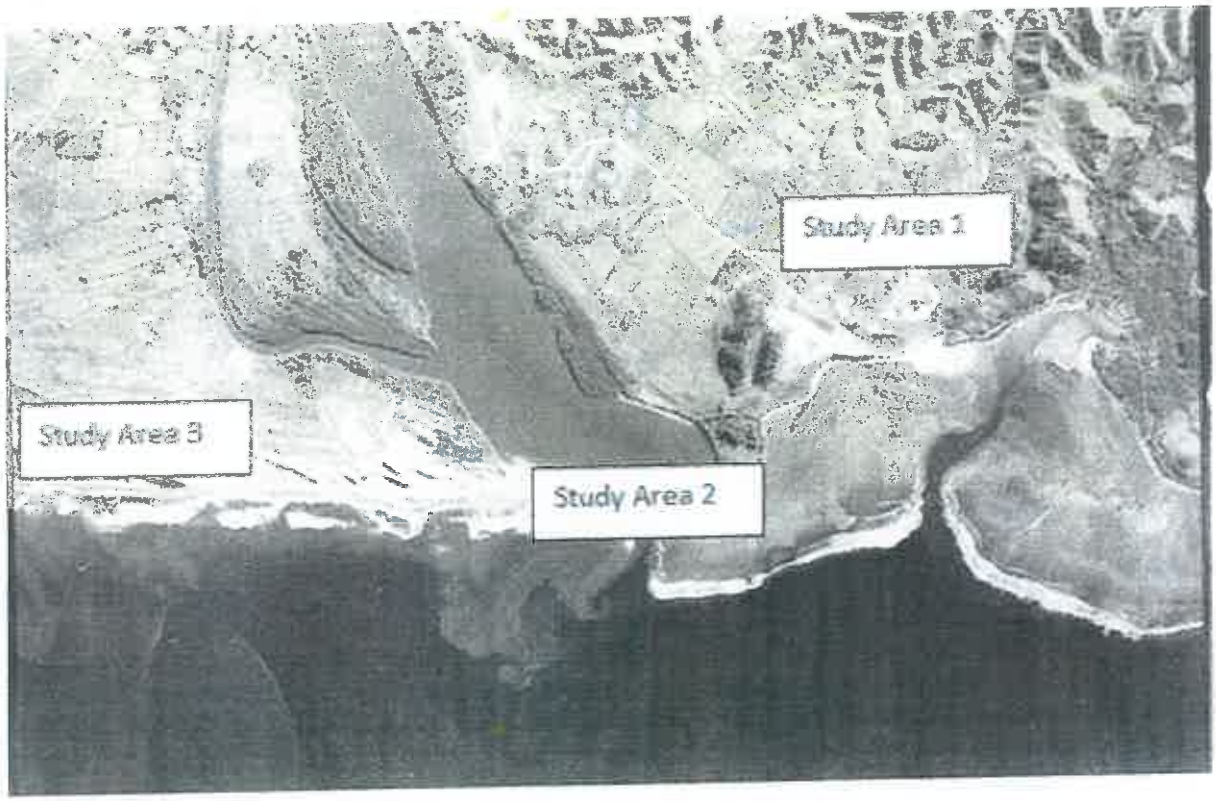
5.1.3.3 Sea Currents, Littoral Drift and Bathymetry

Field Baseline Survey

The offshore Coastal Study Area is from Korotogo Passage to Yadua Reef and this was sectioned in three distinct types for baseline studies.

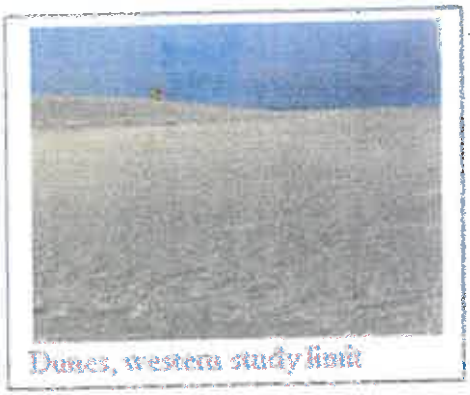
1. Study Area 1 Korotogo - littoral drift at Korotogo during incoming tide measured at 2m/sec near-shore and slowing towards the passage.
2. Study Area 2 Central region – the River mouth & central region has very high energy with very long open fetches. Waves breaking at 4m/sec on the sand bar which has high social usages
3. Study Area 3 Yadua - Very strong cross-currents noted along the western coastal strip strongly influenced by local geo-formations.

Nett drift westwards 10m/min
Very steep beach slopes >1: 3



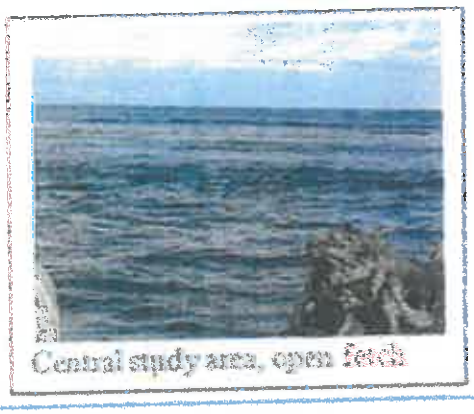
Limits of Study Area

Korotogo Bay, eastern study limit



Dunes, western study limit

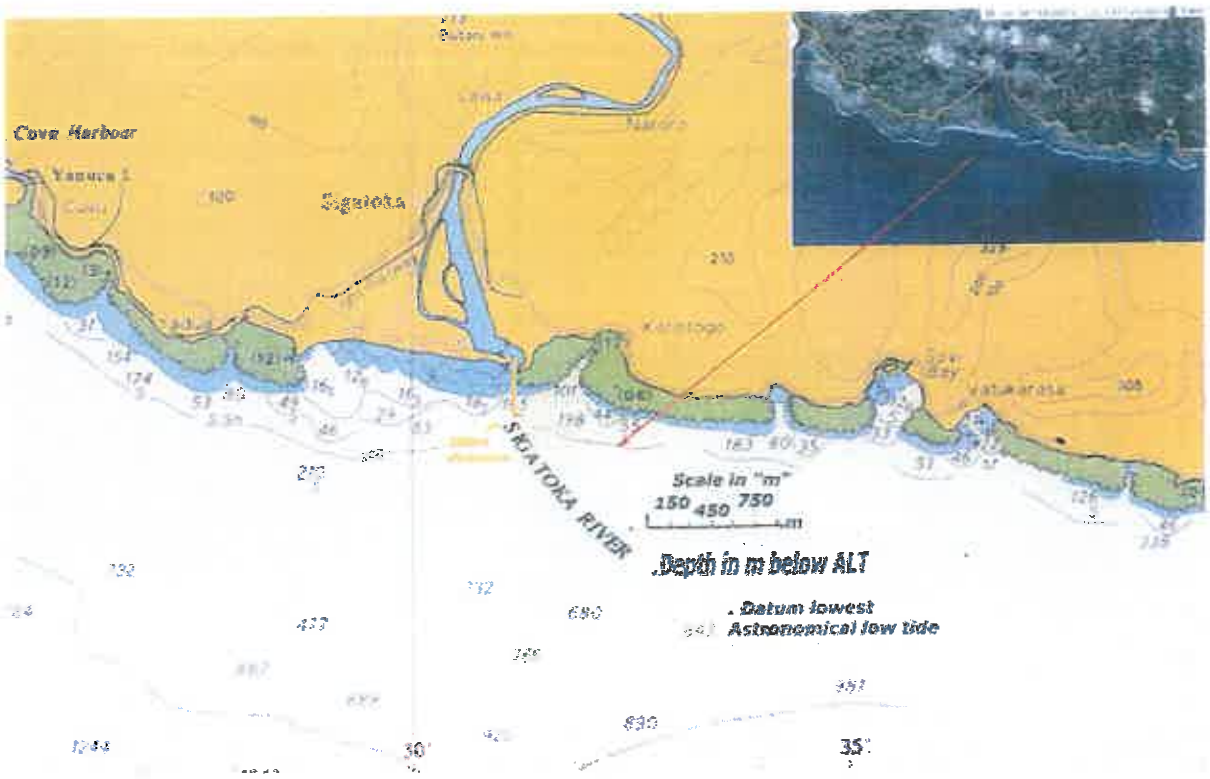
Inland limit upstream Navamaji



Central study area, open beach

Bathymetry

From navigational chart is seen that the river-mouth foreshore slopes evenly but steeply reaching 200m depth a short distance of 300m from the mouth.



5.1.3.4 Sedimentation

The SOPAC report by Akuila Tawake provides good description of aggregates in the river at Naduri just slightly upstream of Nawamagi and very detailed assessment of the sand dune sand resources.

In between floods, the mixed aggregates contain more fines and less coarse aggregates. Coarser aggregates seen downstream originate from the locality hill tops/gullies.

The SOPAC report also describes clearly the sand dune building processes from which the following figure is sourced.

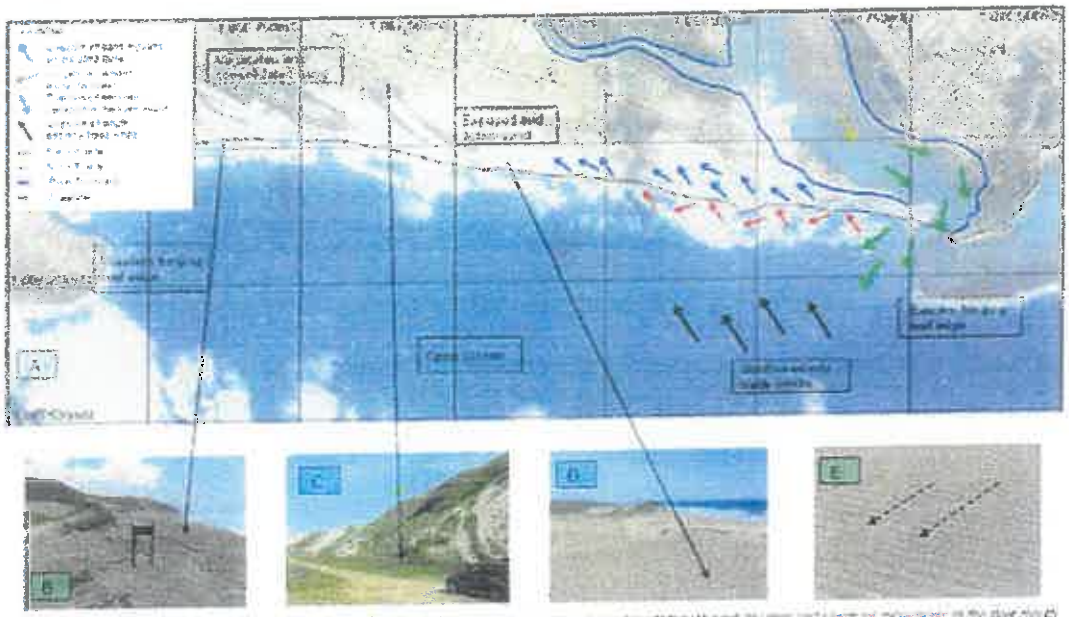


Figure 14.

Sediment Movement

5.1.3.5 Hazard Vulnerability and Risks from Natural Hazards

The risks from natural hazards impacting Sigatoka to Nadi will generally expose localities within the region to a similar level of risks.

The risk levels are established using the SOPAC Regional Guideline for Comprehensive Hazard and Risk Management (CHARM) which itself is adapted from the Joint Australia – NZ Risk Management Standard. It is the methodology that CEC uses in all recent EIA studies submitted to the Director of Environment. Risk levels are measured on the likelihood of the event and the degree of impact or consequence.

5.1.3.5.1 Descriptors of Likelihood, Consequence, Risk Rating and Levels of Risk.

To make a meaningful analysis amongst the various natural hazards, descriptors are used as measuring criteria to assist in categorising the risks. e g the following tabulated descriptors are used

Almost Certain	Yearly return period
Likely	About every 5 years over the last 20 years
Possible	At least once per generation
Unlikely	Every 100years
Rare	Over 100 years return period

Table 4 Likelihood Descriptors

Table 5 Consequence Descriptors

Insignificant	Very little felt damage
Minor	Some damage, little disruption to community. Some impact on environment with no lasting capacity. Some impact on revenue capacity.
Moderate	Significant damage. Some community disruption with temporary displacements. Wide impact on environment but with little long term effects.
Major	Significant numbers displaced for short periods. Significant damage requiring external assistance. Community functioning with difficulty. Severe impacts on the environment with long terms affects. Serious impacts on the revenue capacity.

Table 6 Risk Rating Descriptors

E – extreme	Extreme Risk- immediate action required.
H – high	High Risk- senior management attention required
M – moderate	Moderate Risk- Management responsibility must be specified
L – low	Low Risk- Manage by routine procedures

Table 7 Levels of Risk (Likelihood/Potential Consequences)

Consequencesà ¯Likelihood	Insignificant	Minor	Moderate	Major
Almost	M	H	E	E
Likely	M	M	H	E
Possible	L	M	M	H
Unlikely	L	L	M	H
Rare	L	L	M	M

5.1.3.5.2 Levels of Risk to Natural Hazards

Cyclone Risk– *cyclones are almost certain for this region*

The Sigatoka Valley is exposed to risks from tropical cyclones being directly on the paths of cyclones approaching from the West. Hence buildings and built features need to meet building code requirements and other appropriate risk reduction measures for cyclone proofing eg burying of electric and telecom cables, trimming of overhanging branches, top-dressing maintenance on coconut trees. Additionally management responsibility must be specified, particularly as the region is at extreme cyclone risk level and will threaten service flow into and out of the complex.

Storm Surge Risk – *storm surges and coastal flooding are likely*

Storm surges are associated with the development of atmospheric low pressures and depressions. However local features influence the impacts. Nearby Yadua village north end of the sand dune has been flooded from storm surges that occurred in the past. The sandbar restricts entry of the surge hence reduces its potential to build up due to the inlet physical features.
The threat of a surge and the consequences of storm flood damages over any major development on the lower levels of the coast will be significant placing the coastal strip in the category of having a high risk rating from storm surge.

Earthquake Risk – *earthquakes are likely.*

Fiji seismicity is described by Mineral Resources Dept under six zones of earthquake activity:-

Northeast and East of Vanualevu and Taveuni
North of Yasawa and Vanua Levu
West of Viti Levu
Kadavu
South-eastern Viti Levu
South-western Vanua Levu

Sigatoka is in the Western zone, and "although earthquakes in this Zone are felt occasionally in western Viti Levu the only one to cause concern was in 1921 when the M6.7 quake shook the above area with an intensity MM5-6. Notable damage has not resulted from earthquakes in this area." The earthquake hazard profile show the South West coast of Viti Levu through to the Yasawas is in a zone of high vulnerability to earthquake events.

Sigatoka area thus has an extreme risk rating for earthquakes.

Tsunami Risk - *tsunamis are possible.*

Local earthquakes can trigger submarine landslides or large displacements of the ocean floor that consequently generate local tsunamis. In addition, the whole Nadroga coastal region is exposed to international tsunami risks just as the rest of Fiji is. Barrier reefs do absorb some wave energy and offer some protection whereas this locality has a small fringing reef hugging the shore line and a submerged reef in front of the river mouth. It has similar reef-flat features as in Gizo in the Solomon Islands where in April 07 a locally generated damaging tsunami swept inland to heights of 3m.

There is scarce record on tsunami wave run ups in Viti Levu. The 1953 Suva event, a major one for Fiji had tsunami wave run up to a meter above high water level. Whilst erring on the safe side, and based on tsunami experiences in the Pacific region, anything below the 3m elevation would be vulnerable to tsunami damages.

As this coastal region is exposed to moderate damages from a tsunami event, management will need to establish tsunami response procedures that should clearly articulate its management responsibility.

Drought Risk – *droughts are likely.*

Droughts in the past have caused some community disruption and impacted the environment but fortunately these have been mostly short-term with little long-term effects. Drought with a likelihood of occurrence and anticipated minor consequence is classed, from the risk rating table as having a high risk rating for this coastal region. This has implications on food and water supplies as well as affecting the mobility of the workforce.

5.1.3.5.3 Natural Hazards Risk Rating Summary

Table 8 Summary Risk Rating of Natural Hazards

Cyclone	Storm Surge & Flood	Earthquake	Tsunami	Drought
Extreme	*High*	*Moderate*	*Moderate*	*High*

5.2 Biological Environment: Baseline

5.2.1 Purpose of Study

Firstly, to highlight the terrestrial (flora & fauna) and fisheries resources of the *Sigatoka* River that are in and around the proposed dredging sites of the river. The part of the EIA report is to include the Existing and Potential Impact on the 'biological and ecological environment' in and around the site/s of the proposed project. The areas to be specifically investigated are the aquatic (fresh water/marine/estuary) and terrestrial environments along the river system.

Secondly, the purpose of the study is to identify potential dump/spoil sites for the dredge materials along the riverbanks and surrounding areas where minimal impacts to the existing ecological systems would be minimal.

The major areas to be investigated as stipulated under the TOR prepared by the Department of Environment include:

- The baseline aquatic and terrestrial ecosystems.
- Existing floral and faunal communities.
- Sensitive habitats and natural sites.
- Ecosystems and Species of conservation significance.
- Identifications of suitable spoil/dredge materials sites.
- Potential Impact on the 'biological and ecological environment (both aquatic & terrestrial) of both dredging and spoil sites.
- Suggestion of mitigation and abatement measures.

5.2.2 Study Methodologies

The following methodologies as shown in Table 5.2/1 will be employed during the field investigations for the four zones identified in Section 5.2.3 herein.

Terrestrial Parameters	Methodology
Floral Distribution	Line transect (100 m)
Species Abundance	Braun-Blanquet cover abundance assessment (5x5m quadrat) at every 20 m along transect line
Growth Status	Qualitative assessment

Table 5.2/1: Terrestrial Parameters/Methodology

Note: The biomass and density of the freshwater clam, *Batissa violacea* (kai) and other borrows will be estimated by transects (50m) and quadrats (0.5 x 0.5 m). The estimate of the fishing resources will be determined through the use of creel survey techniques.

Survey was undertaken during low tide on the river mouth and mangroves channel areas.

5.2.3 Identification of major study zones (sample sites)

The initial site investigation identified the following major study zones to be thoroughly investigated during the EIA study. In Section 4: METHODOLOGIES IN EXECUTING THE STUDY of this report is contained **Figure 4—1: Map showing the four Study Zones for *Sigatoka* River** . Each zone covers about an average length of 3.5km.

Zone A-Estuary/River mouth
Zone B-Lower River
Zone C-Mid River
Zone D-Upper River

5.2.4 Description of the existing environment

5.2.4.1 General vegetation patterns

A total of four distinct land coverage zones (A-D) were identified along the *Sigatoka* River within the proposed dredging sites by field survey undertaken in September-November 2012 and the high resolution imagery acquired for the site.

In general, the vegetation pattern along the *Sigatoka* River has undergone changes from impacts of development (sugar cane farming, settlements, villages and related land activities, commercial farming) and also due to the flooding impacts (establishment of new species by dispersal and succession) along the river especially as one go from the lower river mouth upwards towards *Nawamagi* on the east bank.

Zone A

The vegetation towards the river mouth mainly composed of mixed vegetation with mangroves (*Bruguiera – dogo & Rhizophora–tiri*) and mangrove associates dominating the lower west boundaries around the deltaic island-*Nukunuku* Island (lower west bank) while some patches are also found on the east bank to the south of *Nayawa* village. The channel formed on the lower SE end of the *Nukunuku* island is dominated by mangroves (*tiri*). Commonly introduced species such as the commonly found rain trees (*vaivai*) (*Samanea saman*) and coconuts (*Cocos nucifera*) thrive along the lower river mouth especially on the west bank slightly found inland and towards the center of *Nukunuku* island.

Typical littoral vegetations found also in these areas mixed with the other vegetation but closer to the bank HWM zone, include *tavola (Terminalia catappa), sinu* (*Excoecaria agallocha*), *mulomulo* and *vutu (Barringtonia asiatica*) and medium woody shrubs such as *vaivai* thickets, *Yaqoyaqona.* (*Piper methysticum*) and the beach hibiscus, (*vau*) (*Hibiscus tiliaceus*). No large vegetation is found on the lower west bank river mouth areas. *In* **Figure 5.2 —1** is shown **Zone A—Vegetation Distribution Map.**

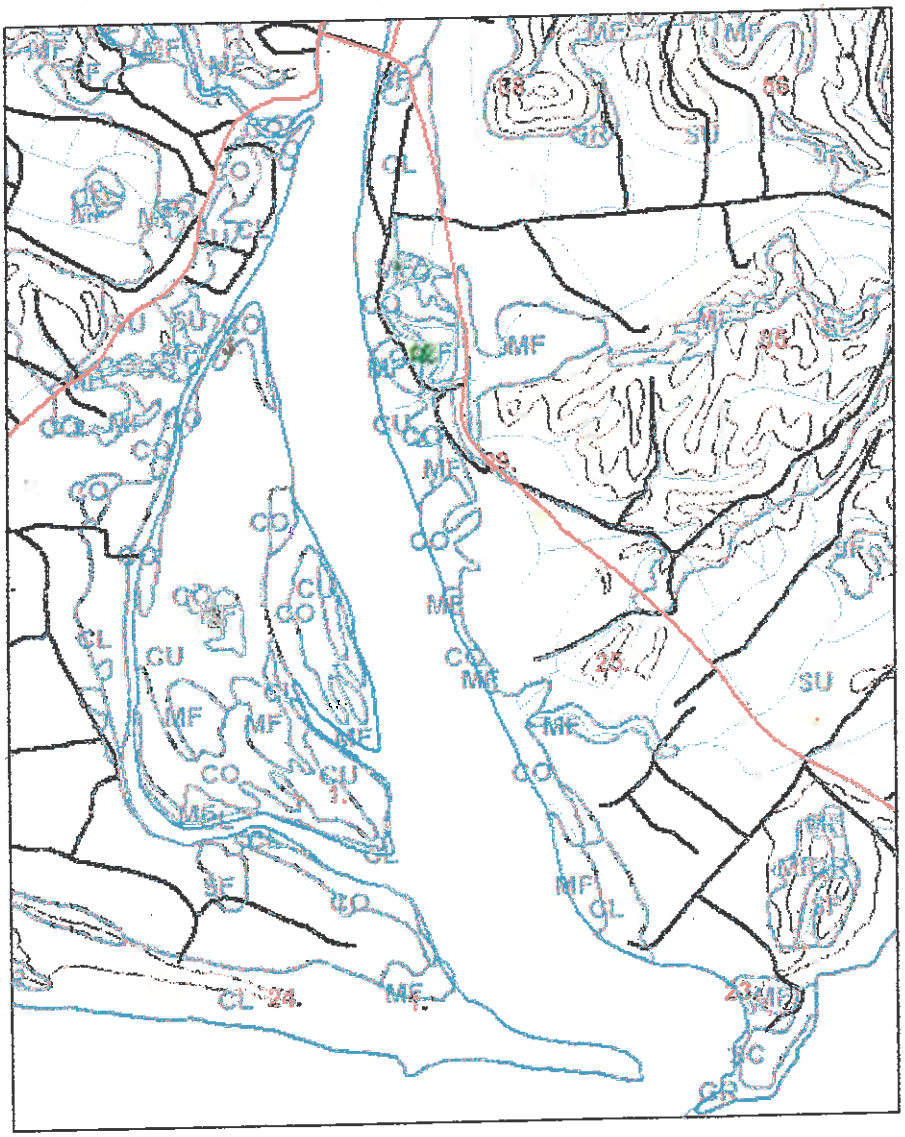


Figure 5.2 —1: Zone A—Vegetation Distribution Map (SOURCE: VANUA VIEW)

Zone B

These areas covers from the *Sigatoka* bridge upwards where the river bends due northeast up to *Naroro* Village. Two villages are located on the riverbanks within this zone with *Lawai* on the west while *Laselase* is located on the east bank.

The vegetation along the river banks are concentrated on the immediate river banks about 30-40m above HWM. The valley road up the river banks on west boundaries cuts between the narrowly vegetated bank (dominated by woody shrubs, deciduous plants and rain trees) and the steep elevated hills while the east bank land towards *Laselase* and *Naroro* are relatively flat from the river banks. The east bank vegetations are most impacted by cultivation activities.

locals (dalo, cassava, breadfruit, plantain, banana, pumpkin) while the steeper banks are dominated by the large rain trees (*vaivai*). Two *sinu* (*Excoecaria agallocha*) trees are located within this area on the east bank indicating the tidal movement of saline water from the river mouth. No mangroves are located in this region. On the east bank after Lawai village, the larger areas of flat land towards the bank are dominated by marginal forest (*vaivai* and woody shrubs) while sugarcane farming activities are also carried out on this side of the river. In **Figure 5.2 —2** is shown **Zone B—Vegetation Distribution Map**

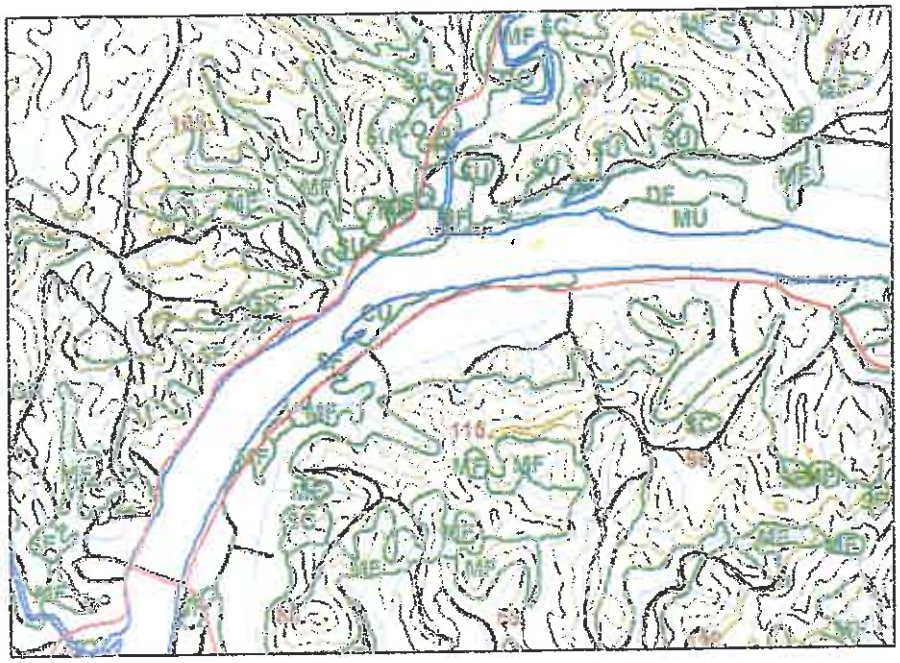


Figure 5.2 —2: Zone B—Vegetation Distribution Map (SOURCE: VANUA VIEW)

Zone C

The vegetation along this zone is mainly determine by the natural topography of the land .On the east bank, the narrow flat land is followed by the steep elevation with exposed rocks along the bending river. Large rain trees are located along the narrow side of the banks. Some areas of cultivation are located up stream after the bend with a few coconuts, breadfruit and mango trees located.

On the west bank large areas of low flat land are dominated by cultivated land and mix vegetation comprising rain trees, coconuts, mango and medium woody shrub trees and scattered vegetation. In **Figure 5.2 —3** is shown **Zone C —Vegetation Distribution Map**

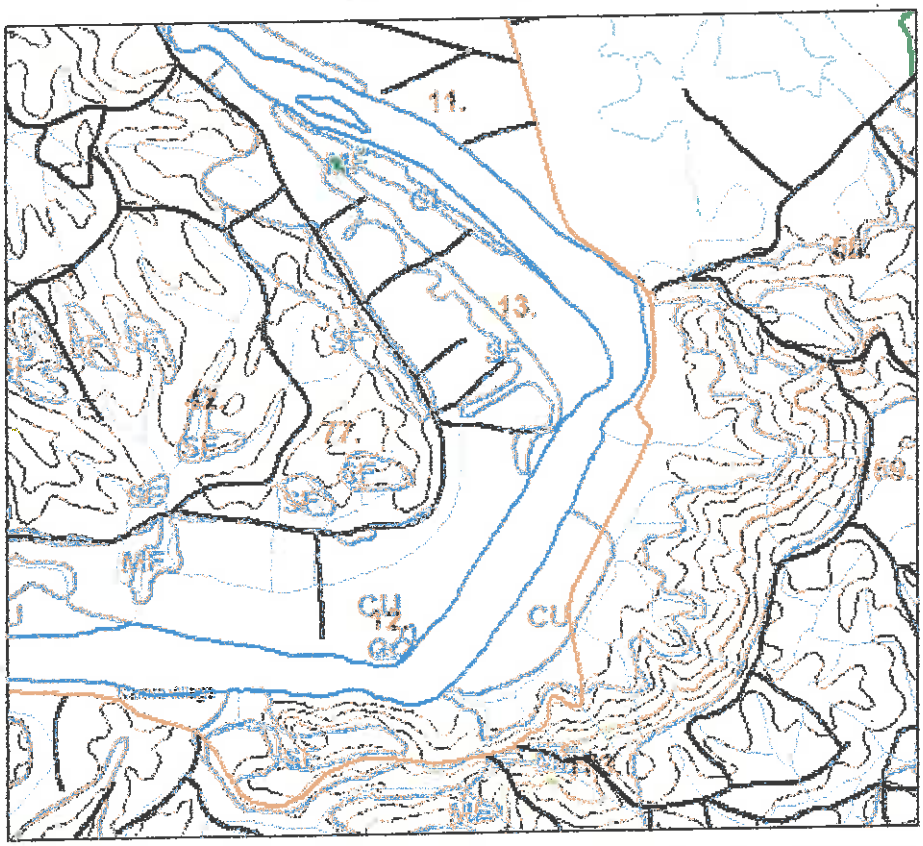


Figure 5.2 —3: Zone C —Vegetation Distribution Map (SOURCE: VANUA VIEW)

Zone D

The zone is mostly dominated by large cultivation plots (CU) on both river banks. *Nacocolevu* agricultural research station is located on the west riverbank while the village of *Nawamagi* is located on the opposite river bank.

Sigatoka Valley deltaic flatland areas are the most intensely farmed area in Fiji. The area is a major supplier of produce for much of *Viti Levu*, including nearby tourist resorts along the Coral Coast, and there are several farmer associations which export vegetables to Australia, New Zealand and Canada.

Large rain trees continue to dominate the east river banks while other scattered vegetation are also located. Sugar cane cultivation (SU) is also carried out on the upper areas after *Nawamagi* village on the east bank. In **Figure 5.2 —4** is shown **Zone D—Vegetation Distribution Map.**

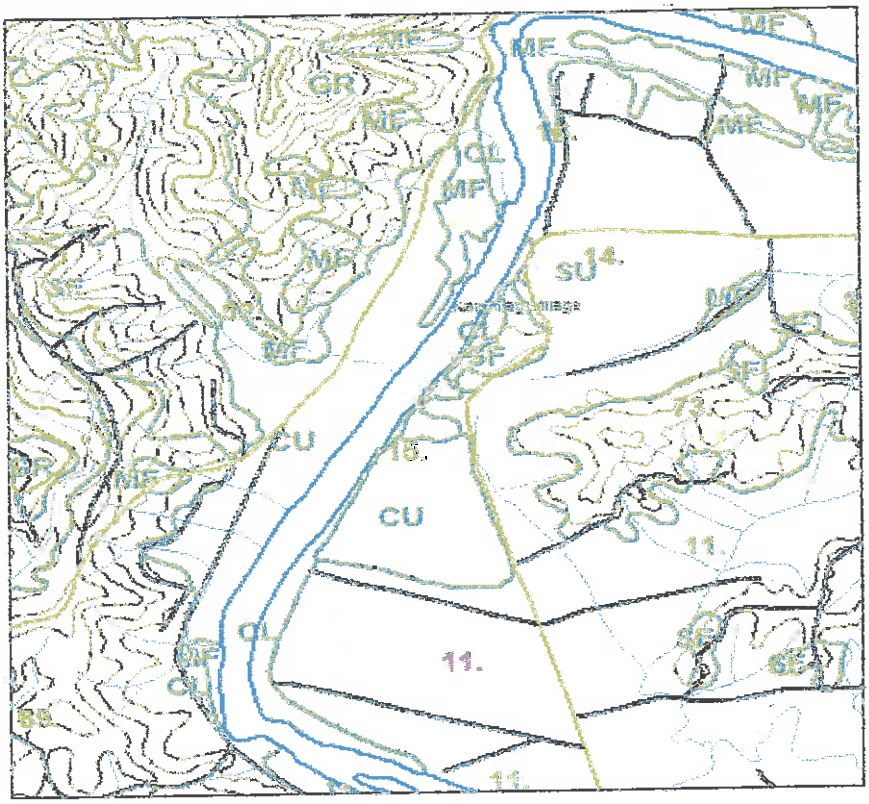


Figure 5.2 —4: Zone D—Vegetation Distribution Map (SOURCE: VANUA VIEW)

PHOTOGRAPHS

Zone	Name	Dominant Flora	Photograph
A	River mouth	Low vegetation cover (W) but marginal forest on the east bank	
	Mangrove Channels	Dense Mangrove-Rhizophora (*R.samoensis*, *R. stylosa*, x *selala*) and Bruguiera (*B. gymnorhiza*)	
B	Lower-River	Diffuse Bruguiera (*R.samoensis*, *R. stylosa*, x *selala*). Mixed vegetation (coconuts, rain trees)	

Zone	Name	Dominant Flora	Photograph
C	Mid-River	Cultivated plots (*Dalo, cassava, breadfruit*) *Leuceana leucocephala (vaivai thickets), Cocus nucifera (coconut), rain trees*	
		Grassland *Saccharum officiarum (sugar cane) Samanea saman (rain tree) Cocus nucifera (coconut)*	
D	Upper-River	Marginal forest, *Piper aduncum Samanea saman (rain tree), woody shrubs*	
		Grassland *Saccharum officiarum (sugar cane) Samanea saman (rain tree) Cocus nucifera (coconut)*	

5.2.4.2 General Vegetation Densities

Of the total vegetation area along the west and east river banks proposed area to be dredged, approximately 40% is covered by the most dominant species, *Samanea saman* thriving along both the banks. Mangroves are only present in zone A (*Bruguiera* and *Rhizophora)* make up only 12.8 % of the vegetation found immediately along the riverbanks. Large areas within zone C and D cultivated either at a subsistence and commercial level. Table below shows the vegetation densities found in the four study zones. In Table 5.2/2 is shown General Vegetation Densities. This is also reflected in Figure 5.2— 5:as Vegetation Densities by Graph.

Distribution	Zone present	Dominant Species	% Composition
Mangrove (MG)	A	*Bruguiera* and *Rhizo-phora*	12.8
Marginal Forest (MF)	A, B, C, D	*Samanea saman*	40.5
Coconuts (CO)	A, B, C, D	*Cocus nucifera*	18.2
Cultivation (CU)	A, B, C, D	*Mixed*	12.2
Grassland (GR)	C, D	*Reeds (M. floridulus) & paragrass*	9.1
Others (SU, SC, DF)	C,D	*Saccharum officiarum*	7.3
TOTAL			**100%**

Table 5.2/2: General Vegetation Densities.

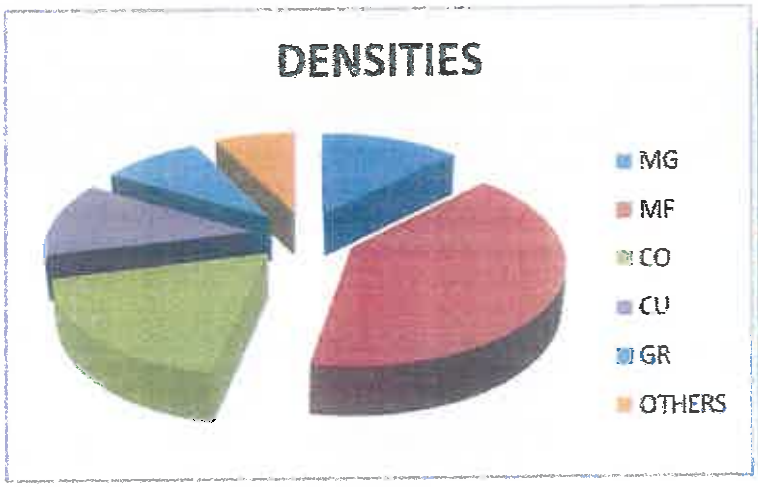


Figure 5.2—5: Vegetation Densities by Graph

5.2.4.3 River Ecology and Associated fauna

One of the key factors to be determined for this proposed dredging work is the hydrological role that this small creeks plays in acting as a diversion for fresh water from the main *Sigatoka* River into the mangrove areas contained in the proposed development site and, in turn, how this role may contribute to the natural mitigation of extreme discharge levels from the River.

Mangroves and their associated creeks are well documented as acting as important links between coastal fisheries and the juvenile life stages of commercially important organisms. Many of these organisms use the high productivity of mangrove systems as nursery grounds and the degradation of these systems has been shown to be detrimental to coastal fishery resources. In addition to acting in this role, the mangrove systems in the proposed development site support adult populations of ecologically important and commercially valuable species including, for example, the mud crab (*Scylla serrata*). Associated avifaunal life observed in these regions include the kingfisher, heron and the common space open birds species found in Fiji.

Zone C & D on the mid and upper river were observed to support significant numbers of wading birds. Of the species present, one in particular, the Pacific Golden Plover *(Pluvialis fulvia-**Ganiviti***) is worthy of note. Reef herons (***belo***) are also found up to Zone C during upcoming tide. Whilst global populations of this species are not thought to be threatened, it is a migratory species, spending summers in the arctic tundra before travelling huge distances to Australasia and the South Pacific. The species is included under the Convention on Migratory Species and whilst Fiji is not a signatory to this Convention, it does perhaps elucidate the importance of this migratory species.

5.2.4.4 Resource Use

The natural resources within the development site provide a rich resource. Over 80% of the area within the proposed dredging zone (Zones A-D) is classified as being part of the i *Qoliqoli* or customary fishing ground which extends offshore into the bay region and as such, it plays in an important role in the subsistence and artisanal fishery of the nearby local communities. This *i Qoliqoli* is owned by the various land-owning units. At the time of the site visits, on numerous occasions incidents of fishing and netting for mullet (Fijian: *Kanace*) (*Liza melinoptera*) were observed on the tidal river systems up to *Laselase* village.

Fresh water fish (*tilapia sp*) as well as other freshwater fishes are fished by locals along the mid and upper river banks while the fresh water mussels (*kai*) are collected in mostly Zone C & D by the villagers of *Naroro* and *Nawamagi*.

The river mouth and sand bank deposits are a daily favorite fishing ground for many Indo-Fijians living at *Kulukulu* settlement using fishing poles and nets.

Fisheries resources therefore would be a major consideration on the biological organisms in any aquatic environment and as in this project.

This report is to compliment the biological assessments determining the flora and birds occurring in and around the Sigatoka river where the proposed dredging project on the river would have impacts on.

The report highlights the survey methods, the fisheries resources, the assessments of the findings with possible impact of the dredging works on the resources and forwarding some mitigating actions on possible negative impacts of the dredge works and possible fisheries development that could evolve while capitalizing on the dredge works.

5.2.4.5 Fisheries & Survey

There were a number of survey and methods carried out to determine the fisheries resources of the Sigatoka river. Notable were:

(i) desk top study to identify reports on fisheries works carried out in the river, this included an extensive discussion with the staff of the Fisheries department in Sigatoka.

(ii) field observations by wading in the water for identification of species and locations of various sedentary animals in the various project zones.

(iii) netting by using gillnet to determine the pelagic fish resources in the various zones.

(iv) traps for assessments of crabs and other burrowing & bottom dwelling animals.

(v) interviews by written questionnaire method, krill by direct interviewing fisher folks while fishing, at landing site or at the municipal market to determine the present fisheries resources, harvesting methods and level of catches.

For the surveys, there were two trips done to the project site and surrounding area by the E.I.A team. The first trip was made on 16 October 2012 for three days. During this trip, the fisheries department office in Lawaqa [Sigatoka] was visited and an extensive discussion was held with the officer in charge on the current fisheries [type of fishing/ catch composition/ disposal of catches etc] in and around the Sigatoka River. A boat trip along the project site was carried out and number of fisher-folks were encountered line fishing from the bank of the river. The types of fish caught were examined.

The team took another trip to the project site on 31 October 2012 and the field surveys including the fisheries resources surveys were carried out for two days [31/10 & 1/11/12]. On this trip, thorough visual observations on the fisheries areas of the coasts to about 6 km east and 6km to the west of the mouth of the river were undertaken. Interviews of fisher folks on the mouth of the river and in the river encountered in all the zones were held. Nettings, trappings were done. The landing site near the bridge and the municipal market where fisher folks take and sell their catches from were visited.

A Dr. Payne in 1952 – 1953 has done some work on the fisheries resources of Sigatoka river. He was responsible for introducing Tilapia ["Maleya"] into the province and this fish is now the predominant fish species in all freshwater systems in Fiji and also the various parts of the river including the lower, middle and Upper reaches. Dr. payne had stated the interest in Khulia spp (Ika droka) for game fishing in the river a recreational activities of the Europeans during the colonial administration era.

5.2.4.5.1 Identification of major study zones (sample sites)

The initial site investigation identified the following major study zones to be thoroughly investigated during the EIA study . Each zone covers about an average length of 3.5km.

Zone A-Estuary/River mouth including coastal areas, supposedly to 4km seawards from the mouth.
Zone B-Lower River from the mouth to Laselase village on the old bridge
Zone C-Mid River from Laselase village to Naroro village
Zone D-Upper River from Naroro to Nawamagi village

5.2.4.5.2 Reported and Observed Fisheries of Sigatoka River (Project site)

The Fisheries Department in *Sigatoka* informed that the only prominent fisheries in the *Sigatoka* River is the "kai" [*Batissa violacea*]. Most fish supply to Sigatoka town comes mostly from the Western districts of the province. The report is confirmed by only about 3 commercial or licensed fishermen in Sigatoka. Again this fishermen obtained licenses for traditional customary fishing grounds to the West (Lomawai – Momi). Apart from kai, fishers are mostly for subsistence purposes. Zone A of the project area where the river joins the sea is very peculiar. From the mouth of the river, the channel opens up to deep sea without any barrier (fringing and barrier reefs). The estuary area where the river meets the sea is very turbulent with a swift current flowing through.

Fishers in the project area are mostly for subsistence. The fishers in Zone A and B normally stay on the bank or sand bar at the mouth and cast their lines from the shore. The commercial fishers that supply *Sigatoka* markets with fish are mostly from the Western part of the province towards the *Lomawai – Momi* area. Major supplies of fish to the municipal market are brought in by middlemen who procured the fish from other districts and province by and through their distribution network.

The Sigatoka river in terms of fisheries resources is similar to all rivers and freshwater systems in Fiji. It is well documented that the freshwater systems of Fiji lack FRESHWATER FISH SPECIES. The fishes that are found in rivers are marine coastal species that enter the river mouth and swim up the rivers. Some do these for various migratory purposes including biological however some are duly biological abilities and they are referred to as EURYHALINE species.

These included trevallies (saqa), caranax, mullets, therapons, mullidae (goat fishes), milkfish, sharks, snappers, jacks, biddies, eels etc. The stages of development of a fish in which it enters and stays in freshwater differs from species. Similarly the duration it lives in fresh water differs depending on their requirement. Some stay in freshwater where all their biological needs are developed [example: development of breeding apparatus] then return to sea. In view of the sentiments expressed above [lack of fish fauna in rivers and freshwater systems], Fiji law does not allow any commercial fishing in or any licensed fisherman in rivers moreover all non selective fishing gear and methods used in marine are not permitted in rivers.

5.2.4.5.3 *Observed Current Fisheries of the Sigatoka River*

5.2.4.5.3.1 **ZONE A**

ZONE A: mouth of the Sigatoka river
with the type of turbulence and openness to the deep ocean

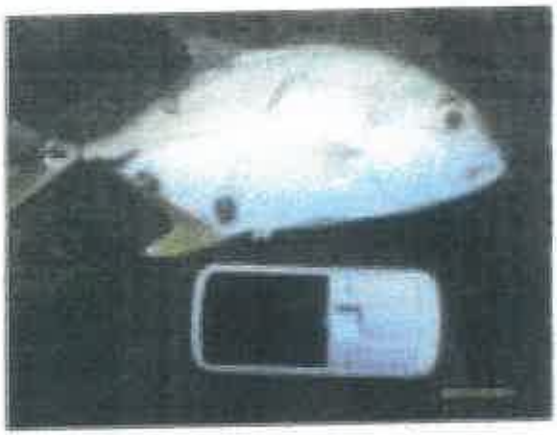
The project document stated that the dredge works on this zone should extend 4km seaward but due to the difficulty of the zone to traverse and high risk to lives of carrying out survey, the survey of fisheries resources was re-focussed to along the coastline to about 6km East and 6 km West. A unique feature of Sigatoka river mouth is that it opens straight out to the deep open sea and this is unlike other major river mouths where it has mangrove swamps and thick mangrove forests towards the mouth. The main fisheries along these coasts (from outer edge of reef to shore) as observed was octopus fishing.

The usual coastal fish species of Fiji as observed in the outer lying islands where the salinity is normally high and lack of influence of freshwater was observed. The coastline from the river mouth coast is more saline then been estuarine. The substrate is sandy to mixture of sand and pebbles then to coral stones. The mouths of the other major river systems in Fiji are usually swampy with heavy silt. [More explanation of this is in the physical section of this EIA report].

The type of fishes and fisheries in Zone A is quite different from similar areas of other major rivers of Fiji. In such areas the usual predominant species are mangrove crabs (qari), mud lobster (mana) and mud crab (kuka) which are NOT PRESENT in and around the Sigatoka river mouth. Zone A as observed contained species that are usually found outside the river mouths to the open sea that are mostly pelagic species. It is similar to coastal areas of the outer lying islands where there is no influence of freshwater.

The fishing methods employed on the river mouth are good testimonies of these and they are; "TROLLING" and nets {gillnet) and reels. The fishes caught included trevalies [saqa], caranax [kaikai], gar fish [busa & saku], therapon [qitawa], mugiliddae etc. and some samples are shown in the pictures below.

Fisherman cast netting at the mouth



Caranax spp (caught by hand reel)

mugilidae (caught by net)

The coastline running from the Sigatoka mouth eastwards and westwards are sandy and not heavy silt or muddy as of other major rivers of Fiji. Observed were lots of seashells [empty] including sand – bivalve ['sigawale'], 'kai dawa', 'qeqe' etc. There were no live specimen encountered there must have been a major changes in the area that has caused the loss of those fish resources. Similar zone of other rivers of Fiji would also have beds of mangrove oyster but not in Sigatoka. As stated above, there were only a small patch of mangrove near Nayawa village and at the congruent of the small stream coming from Lawaqa to the main river near the Sigatoka and FDB building.

5.2.4.5.3.2 ZONE B

Zone B is after the mouth to Laselase village as shown

The species observed in this zone are again dominated by pelagic species that come through the mouth from the sea. The species are as mentioned in Zone A and some are shown in the picture below.

Some fish species occurring in Zone B

There are only small patches of Mangrove in observed in Zone B beside Nayawa village on the east bank and at the junction of the river with the stream coming through Lawaqa. Mud crabs were sampled here with the trap. The crabs are smaller sizes.

It was reported that whittings [cigani] occurred in zone A & B. These are seasonal fishes and they are found to occur in the river three times in a year. The fish is a delicacy among the Indo Fijians in the Western districts. The intrusion of salt water is still prevalent in Zone B and as such no kai in the zone.

Fishing activities are mainly after dusk. The fisher folks will sit along the banks and cast their lines into the river for those pelagic species. There are some using nets specially for river. These are smaller than the gillnets used in the sea and a little bigger that hand nets [lawa vacua] normally use in the streams. The mesh is about 2.5cm.

5.2.4.5.3.3 ZONE C

Zone C: from Laselase village going upstream to Naroro village

The *Kai* or freshwater clam (*Batissa violacea*) has remained the main fisheries of the *Sigatoka* river carried out in Zone C (mid river) and Zone D (upper river) of the proposed dredge area. *Kai* is harvested for subsistence or own consumptions at home and for sale in the *Sigatoka* market (commercial). There is a campsite on the river near *Naroro* village where it was informed that women including those from the hills of *Ba* would use for few days (usually Tuesdays – Thursdays) to live in while collecting/ harvesting '*kai*.'

Interestingly the *kai* beds in the *Sigatoka* River are of gravely material as opposed to the *Rewa* River where it is mostly silt. In the *Rewa* the '*kai*' embedded themselves in the mud and feed by processing the mud. In the *Sigatoka* River, it would be by grazing on the gravel surfaces while smaller sizes pebble would be taken in.

Kai collected by 2 women who just began their dives

The second notable fisheries in the river column in Zone C and Zone D were targeting finfishes. The gear employed were lines (monofilament) by both men and women, skin diving with rods and elastic (*vakilivati*) by men and nets (hand and gillnets of 3cm mesh). The catches included tilapia, puntius, therapon species [*qitawa*], *kanace*, *saqa* including *kaikai* and freshwater perch.

A therapon spp found in the zone (the yellowish tips and on edges have faded out)

5.2.4.5.3.4 ZONE D

Naroro

The fisheries in this section of the river are quite similar to that of Zone C, however the density and intensity of kai and its harvesting is much higher. Freshwater fish species such as carps thrive well in the zone. Tilapia of recent breeds from the *Naduruloulou* Aquaculture station and released to major river systems in Fiji by the department of fisheries are found here. A fisherman diving in the area for about three minutes speared a genetically improved tilapia of about 800grammes and a puntius of about 400 grammes. Both these species are bred and raised at Naduruloulou and have been released into Sigatoka river..

Puntious on the left and a genetically improved tilapia on the right

5.2.4.6 River Water Quality

The quality of water in the Sigatoka river has to be determined before any development work commences in the development area. This is to provide the Baseline Data required for the monitoring of the effect of the development activities on the river water quality and river habitats as work commences and in progress.

5.2.4.6.1 Water Sampling Programme for Sigatoka River.

A water quality sampling programme to include identification of Water Sampling Points (WSP) and the determination of parameters to be looked at on each WSP at the four study zones A-D, was put into place. The programme particulars are as follows:

(a) STUDY ZONES (4)

Zone A – Zone D

(b). SAMPLING POINTS IN EACH ZONE

Zone A:	3	Zone C:	3
Zone B:	3	Zone D:	3

TOTAL 12

(c) PARAMETE LOOKED AT

(1) Water Tests for Physical parameters

PH	Turbidity
Temperatures	Conductivity
DO	Salinity

(2) Water Analysis for Chemical content (12 water samples from 12 sampling points)

(a) Nitrate	(12)
(b) Nitrite	(12)
(c) Nitrogen NH3	(12)
(d) Phosphate	(12)
(e) Sulphate	(12)

(3) BOD (12 water samples from 12 sampling points)

5.2.4.6.2 Water Quality Sampling Points

Water Sampling Points (WSP) were identified and water samples acquired during field visits at high tide. The Data acquired will act as Base Line in future water quality monitoring programme for the project.

Water Sampling Points (WSP) for water columns taken at each zone of study A—D are shown at Figures 5.2.4 —7 to Figure 5.2.4.—10

Figure 5.2. —6 is shown the Water Quality Sampling Points for ZONE A
Figure 5.2 — 7 is shown the Water Quality Sampling Points for ZONE B
Figure 5.2 — 8 is shown the Water Quality Sampling Points for ZONE C
Figure 5.2 — 9 is shown the Water Quality Sampling Points for ZONE D

Figure 5.2—6: Shows the water quality sampling points (WSP) in study area within Zone A from the mouth of the river to Sigatoka village.

Figure 5.2 —7: Shows the water quality sampling points (WSP) in study area within Zone B from the Sigatoka village to Nasau.

Figure 5.2 —8: Shows the water quality sampling points (WSP) in study area within Zone C in the Nasau settlement and farming area.

Figure 5.2 —9: Shows the water quality sampling points (WSP) in study area within Zone D from Nasau settlement to upper river of Nawamagi village.

5.2.4.6.3 Water Quality Tests Results

The study area is 15km from the mouth of Sigatoka river to upper bend of Nawamagi Village. The study area is divided in to 4 Study Zones and 3.75km per Zone. Three sampling point were identified in each Study Zone which is 1.25km intervals.

The samples were taken in the middle of the river and at a depth of 1.0m.The weather forecast was slightly drizzling in the morning when samples were taken at Study Zone C and D. The tides were also going out to sea and the physical appearances of the river which is slightly brown indicate that there was rain up at Navosa area the previous night.

The samples were taken at Study Zone A and B during the coming of the tides and the weather was fine.

ZONE	A	B	C	D	E (CONTROL)	ANZECC Guidelines
PHYSICAL						
PH	9.02	8.5	6.79	7.15	7.15	8—8.4
Temp	28.63	30..28	30.28	29.95	29.35	
DO (mg/L)	4.58	3.60	2.93	3.24	3.24	4—8
Turbidity (NTU)	46.40	63.5	26.5	25	24.5	1—20
Salinity (%)	2.8	3.18	1.1	0.11	0.02	3.5
Conductivity mS/cm	43.10	5.76	0.24	0.23	0.74	-
TDSolids g/L	28.29	3.74	0.156	0.16	0.178	
BIOLOGICAL						
Feacal Coliform/100mL	-	-	-	-	-	
CHEMICAL						
Nitrate (µg/L)	0.05	0.05	0.05	0.05	0.05	
Nitrite (ug/L)	0.05	0.05	0.05	0.05	0.05	
Nitrogen NH3 (ug/L)	0.73	0.71	0.49	1.5	1.62	
Phosphate (µg/L)	0.05	0.05	0.05	0.05	0.05	2—8

Table 4.2.3.6.1/1 : Water Quality & Sampling Resuts

5.2.4.6.3.1 *Interpreting Water Quality Test Results*

1. PHYSICAL

Ph

The p H for sites at A & B Zones were above the guideline range of 8 – 8.4 and are therefore alkaline in nature. This could be due to the presence of clay and lime in the soil finding its way into the river. Sites Water at SP at C—D were found to below the limit of 7.5 and acidic in nature.

Dissolved Oxygen

The dissolved oxygen concentrations at all three zones Zone B—D to include the control were found to be just below the guideline value of 4—8mg/L. These low values would make it difficult to sustain aquatic life except for he more tolerant and migratory species. However the water at Zone A was found to above minimum guideline of 4mg/L.

Turbidity

Turbidity values were well above the recommended range of 1-20 NTU for all site. This was due to rain falling in the water catchment area for over 2 weeks and water samples for physical and chemical tests happened to have acquired during that period. It may change over time as dredging works commences.

Salinity

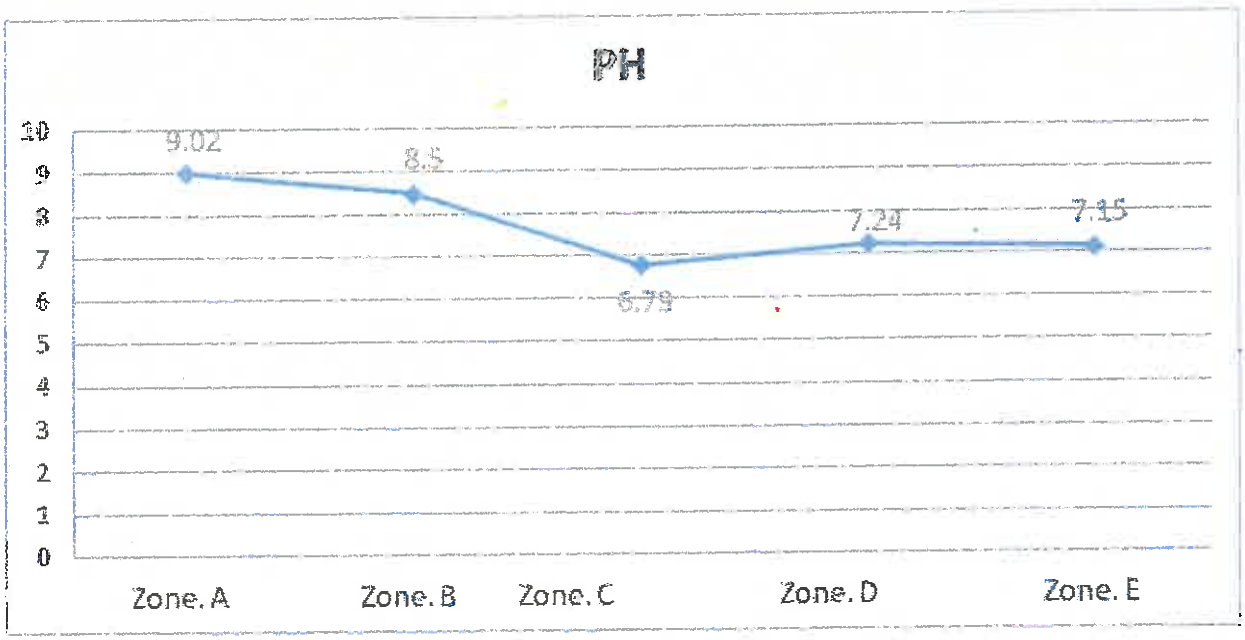
Test results indicate that the water at the Sigatoka river estuarine (Zone A—B) was fully saline. The salinity diminished over distance as one moves through other zones upstream to Zone D.

Conductivity

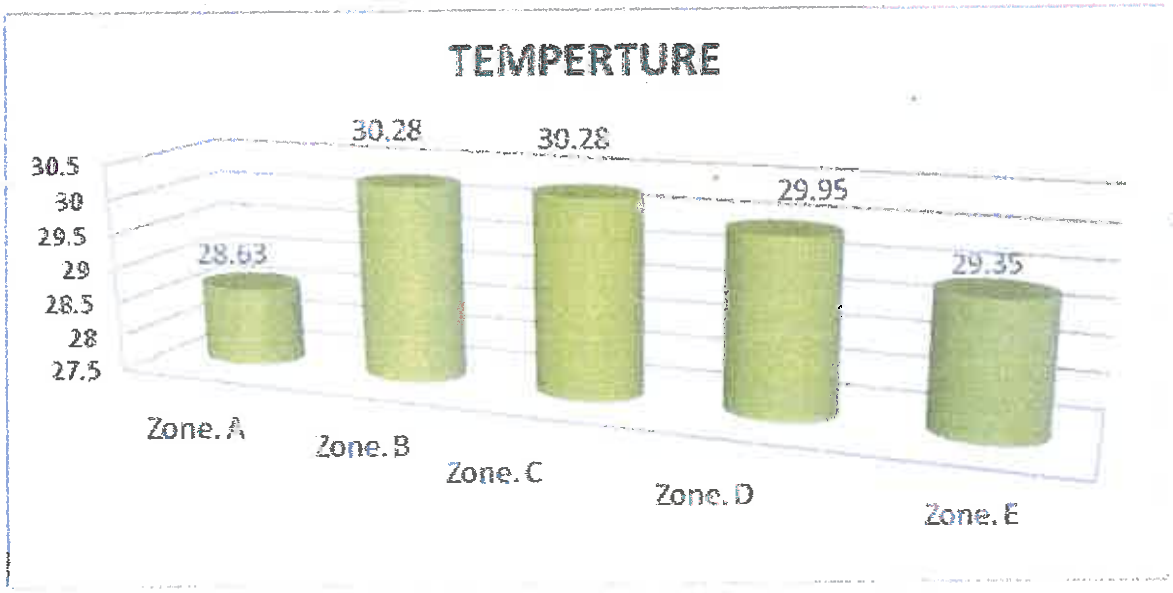
Conductivity test is carried out to generally determine the presence and intensity of metal in water. It does not identify the types. Conductivity readings was high at the estuarine water (Zone A). The conductivity reading diminished over distance as one moves through other zones upstream to Zone D.

Total Dissolved Solids

Except for water sample taken at sampling points of Zone A, waters at other SP locations upstream were found to contain Total Dissolved Solids contents well below the MAL. .

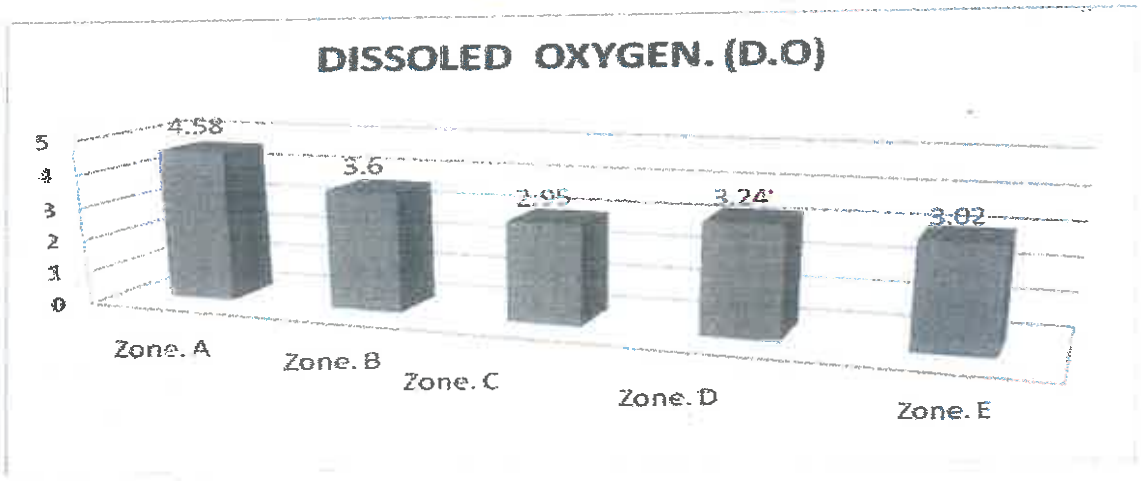


Line Graph: 1 Shows the average PH level from study Zone A as the highest to Zone E.



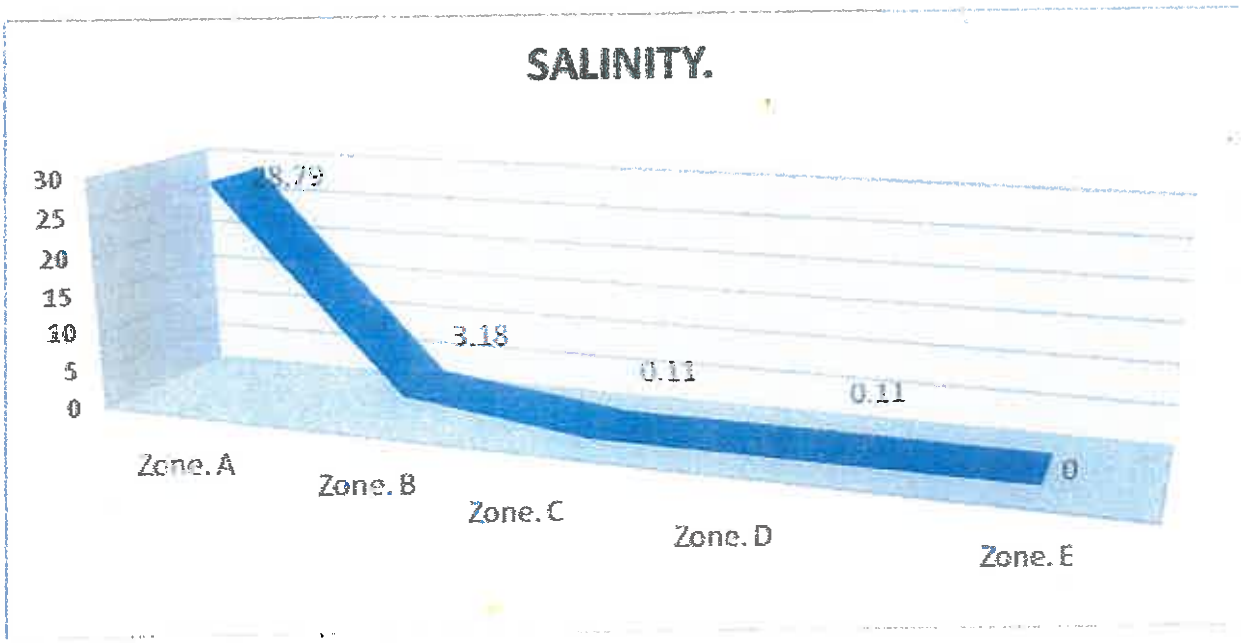
Bar Graph 1: Shows the average Temperature level at each study zone from A to E

DISSOLED OXYGEN. (D.O)



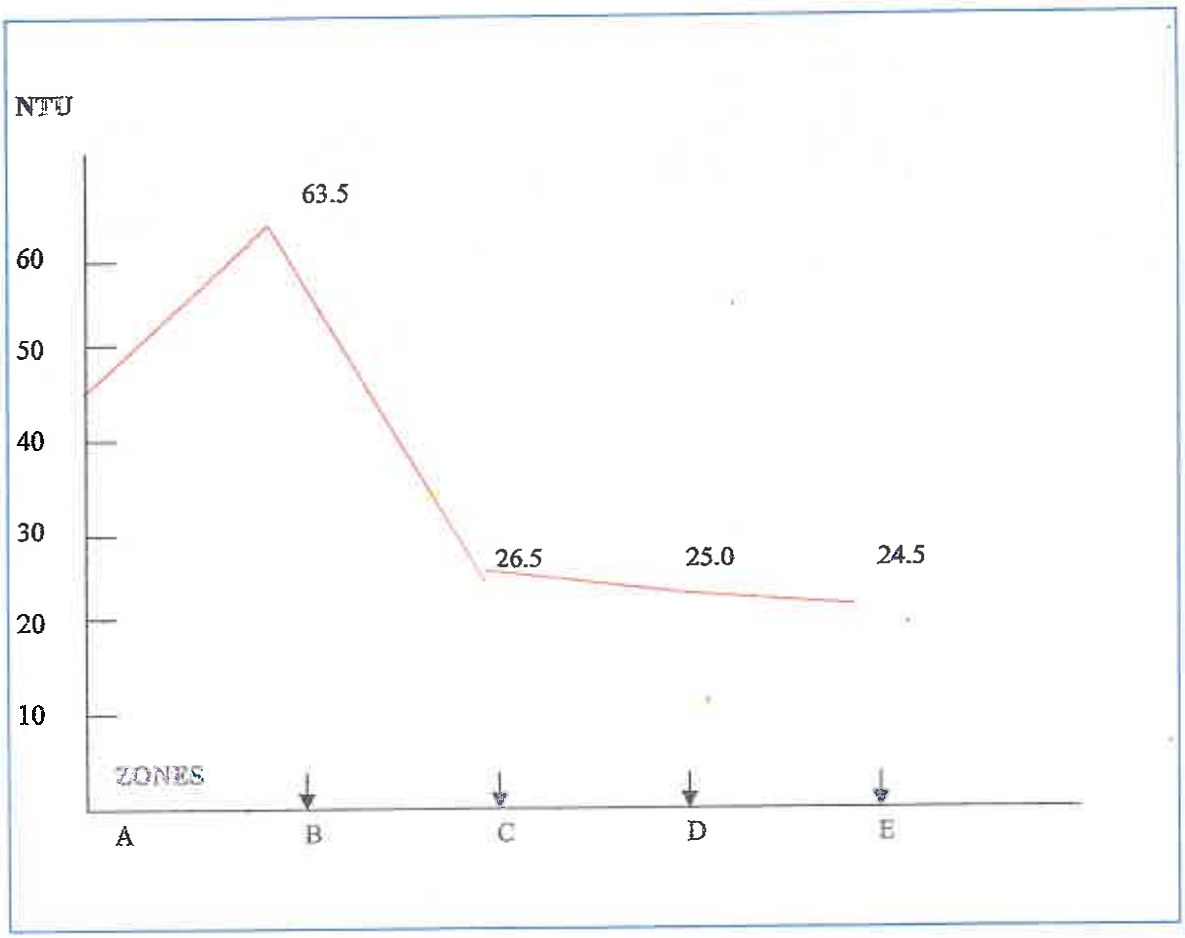
Bar Graph 2: Shows the average Dissolved Oxygen (D.O) level at each study zone from A to E

SALINITY



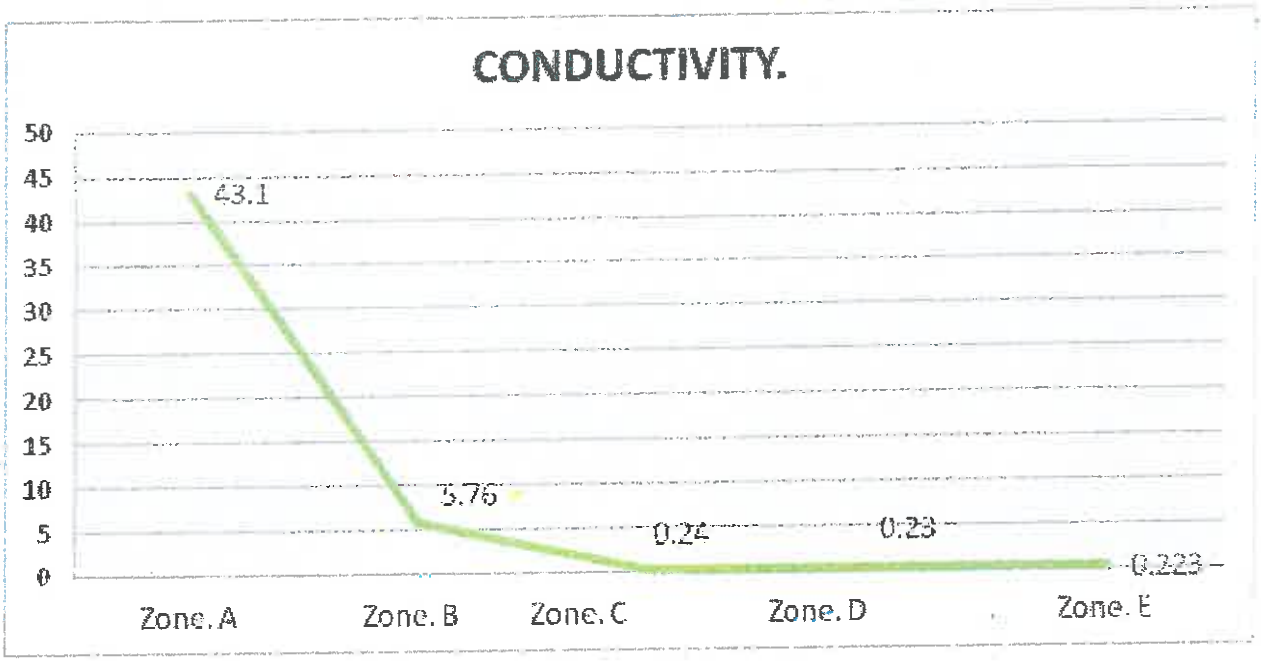
Line Graph: 2 Shows the average Salinity level from study Zone A as the highest to Zone E.

TURBIDITY



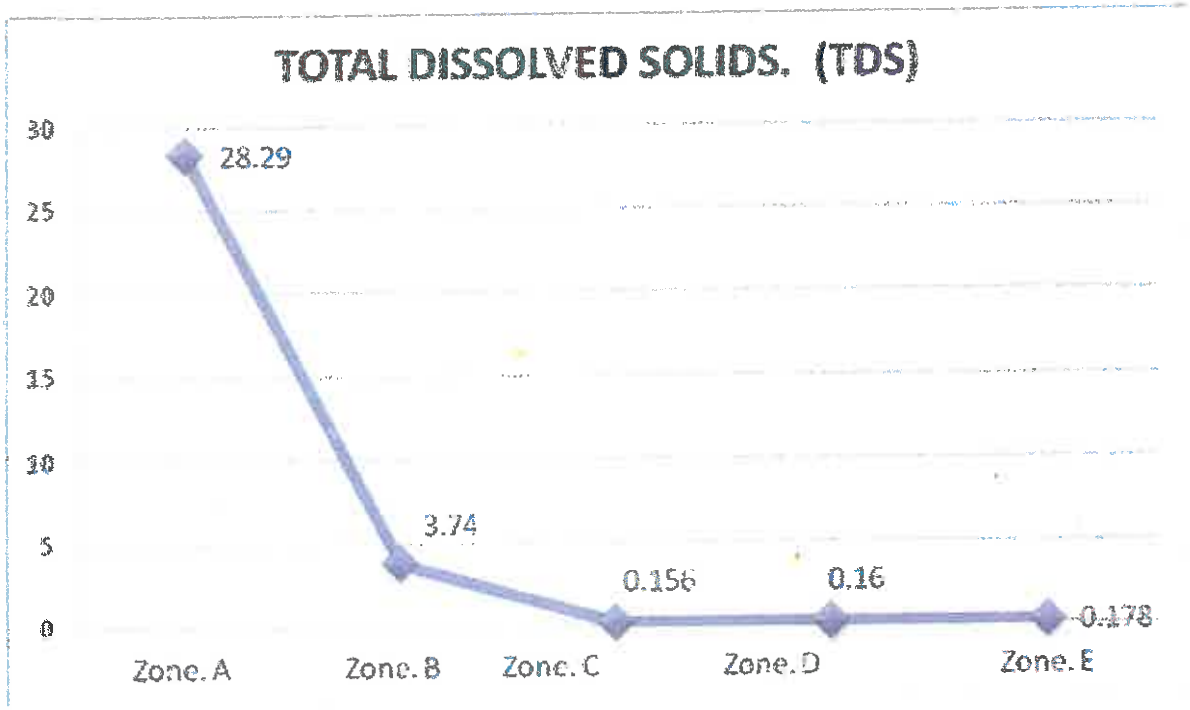
Line Graph 3: Shows the average Turbidity level from study Zone A to Zone D

CONDUCTIVITY.



Line Graph: 4 Shows the average Conductivity level from study Zone A as the highest to Zone E.

TOTAL DISSOLVED SOLIDS. (TDS)



Line Graph 5: Average Conductivity level from study Zone A as the highest to Zone E.

2. CHEMICAL

Nitrates—Well below MAL
Nitrites —Well below MAL
Nitrogen (NH3) - Well below MAL
Phosphates—Well below MAL

Water sampling test results FOR Chemical Analysis as supplied by the Water Authority of Fiji, National Water Laboratory is provided at APPENDIX E

5.3 Socio & Economic Environment

The purpose of the report is to firstly discuss existing social and economic environment in and around the development area. Next how CEC has interacted with communities within and around the development area acquiring data required for assessing potential socio & economic impacts deemed to result from the development and setting the platform for a community consultative and participatory meeting in which the community and the stake-holders are informed of the findings of the EIA study at that point in time. The community then raise its concerns and CEC take the concerns on board and provide mitigation measures for prevention, avoiding and minimizing impacts in the final EIA Study Report.

5.3.1 Methods used for Acquiring Data

5.3.1.1 Relating to Existing Environment

5.3.1.1.1 Available Literatures

The study acquire most of its demographic data on census and national annual report. Data on planned Infrastructures in the area was obtained from nation planning units of the various departments visited.

5.3.1.1.2 Visit to Development site Area and Inspection/study of Environment

Two weeks were spent on actual site visits/study. Settlements and villages within the four designated study zones were visited to find out real life situation in the area.

5.3.1.2 Relating to Socio—Economic status

5.3.1.2.1 Visit to Development site Area and Inspection/study of Environment

Two weeks were spent on actual site visits/study. Settlements and villages within the four designated study zones were visited to find out real life situation in the area.

5.3.1.2.2 One to one Interviews & the use of questionnaires

Socio-economic and health surveys were carried out throughout the study area to include visits to government agencies. It was done through house to house visits in villages and settlements within the study area with the use of one-to one interview approach and filling of Questionnaires.

5.3.1.3 Relating to Issues & Concerns raised & Discussed in Community Participatory Meeting

5.3.1.3.1 Pocket Meetings

Consultative meetings with the community through pocket meetings were carried out by individual consultants in regards to obtaining further information relating to their areas of work or to confirm study findings.

5.3.1.3.2 Community Consultative & Participatory Meeting

A community consultative and participation meeting was conducted on 29/11/2012 in Sigatoka Town where all stake-holders were invited to attend to be informed of the study findings and present their views and concerns on the development. All views and concerns were discussed thoroughly and CEC took on board those that would require to be actioned and provisions for appropriate mitigation measures provided for in the final EIA Study Report and EMP.

5.3.2 Study Findings

5.3.2.1 Existing Environment

5.3.2.1.1 Population of study area

The Census report of 2006 prepared by the Bureau of Statistics states that out of the total of 18,526 population of the Province of Nadroga & Navosa approximately 6,826 people live in the proposed development area and Sigatoka Town. Included are the population of the following villages and settlements.

- Laselase Village
- Lawai Village
- Nasama Village
- Nawamagi Village
- Nayawa Settlement
- Nayawa Village
- Sigatoka Village
- Yalava Settlement
- Yavulo Village
- Sigatoka Town

5.3.2.1.2 Infrastructure and Community Facilities

The study site has existing infrastructure in place. The water supply for the study area is from the Water Authority piped system. Electricity power is sourced from the Fiji Electricity Authority power grids. Telephone services is supplied by Telecommunication Fiji Limited, Vodaphone and Digicel.

The study site can be accessed from the main Queens road for both side of Sigatoka river banks up and down river. The area is serviced by public bus companies. Owners of three—five tonner trucks acquire license to carry excess passengers from LTA use their vehicles for public transportation purposes in the study areas.

The Sigatoka Valley Road on the Sigatoka Town side of the river is currently under going massive upgrading activities. So will the Kavanagasau road on the opposite bank in the very near future. All four study zones are accessible through existing earth and gravel roads.

5.3.2.1.3 Nearby Social and Commercial Development

Sigatoka Town facilitates all types of commercial and industrial activities and is the only town serving the Nadroga and Navosa province. It has several supermarkets and other commercial outlets in place to include banks. It has a post office, a police Station and three secondary and primary schools located within the study area. A considerable number of students walk to school.

In terms of health care provision, the Sigatoka Heath Centre at the heart of Sigatoka Town and the Koroumu hospital are within easy reach of the development area and medical officers serve the residents at the centre and hospital. Residents could also seek medical attention at the Nadi and Lautoka Hospital which are relatively close to the development area. There are a number of private medical practitioners in Sigatoka Town which the residents within the development area could also consult when ill.

There is no rubbish collection service in the study area outside Sigatoka Town so residents burn and bury their rubbish. In Sigatoka Town area though rubbish collection service exist some industrial, commercial and residential premises near the river discharge waste water and dump solid wastes into the creeks leading to the Sigatoka river or directly into the Sigatoka River. The solid wastes and waste water on being discharged into water courses, streams and the Sigatoka River will contaminate and pollute the waterways.

The Study area is normally flooded in events of heavy bouts of prolonged rain.

5.3.2.1.4 Cultural sites & resources

The National Archives of Fiji Museum was consulted on the issue. In addition on selective basis old resident were approached for in depth interviews and most revealed that nothing of historical value exist on land in the upper sections of the study area (ZONE B—D) to include proposed stock pile sites. However old historical refuge sites from Tongan invasions exist at Nawamagi.

However at areas around the river mouth, sand banks and dunes have formed and accumulated and these have become permanent land mark for the area.

Recent researches by National Archives/USP following the finding of human skeletons in these dunes revealed that the area may be of historical significance and needs to be included as cultural and preserved site. Further inquiries is to be made with the National Heritage & Archives in regards to the progress and outcome of the above mentioned research to ensure proper actions for mitigation is put into place accordingly.

5.3.2.1.5 Land Tenure

Majority of the land in the vicinity are under the Native Land and have proper records stored and could be acquired on asking at the office of the iTaukei Land Trust Board (TLTB) and the Lands Department of Fiji Government.

Much of the land on the lower river banks (Zones A-C) to the *Sigatoka* town up to *Naroro* is dedicated to a few villages and settlement while as you go up river, more cultivated plots and commercial farming are carried out along the valley road on the west bank.

5.3.2.2 Socio—Economic Status

5.3.2.2.1 Data Collection Methodology

5.3.2.2.1.1 Reports & Face to face Interview at offices

Data on population and economic activities was acquired from the Government Statistician and departmental annual reports of Ministry of Health, Ministry of Agriculture, etc. Likewise interviews were conducted with local ministerial officers and residents to acquire first hand information.

5.3.2.2.1.2 Site Inspections, Face to face Interview and Questionnaires in the Fields

A random house to house survey was conducted at the four villages and settlements located on the left hand bank of Sigatoka River and the proposed development area to include Nawamagi, Naroro, Laselase and Nayawa. On the right hand bank the villages of Naduri, Lawai, Sigatoka, to include Sigatoka Town and Kulukulu settlement were visited. Information were obtained through face to face interviews and questionnaires. A total of 150—200 people participated in the exercise.

5.3.2.2.2 Survey Results

The Socio Economic Survey was carried out within the proposed study site to ascertain the sub population group which live, work and depend on the Sigatoka River. The study design highlights the daily lifestyle of population, land use, river use pattern, and survival experience over the years. Questions provided derive specific answers related to the study site including positive and negative impacts assessments. No names are recorded for confidentiality purposes; however demographic data are included in minimal to portray respondent makeup.

A total of 7 Villages and 2 settlement were visited during the two week of survey. A random survey was conducted in Sigatoka town to complement the survey population. The survey sites are:

- Laselase Village
- Lawai Village
- Nasama Village
- Nawamagi Village
- Nayawa Settlement
- Nayawa Village
- Sigatoka Village
- Yalava Settlement
- Yavulo Village
- Sigatoka Town

A total of 92 people were surveyed from the 10 study sites. Out of the 92 respondents 65 are male ad 27 females. In reference to the word ***"respondents"*** or ***"participants"*** this refers to the people who took part in the survey.

The respondent's age group between the 20-50 years of age. All respondents (100%) live in close family with an average of 4-6 children.

5.3.2.2.2.1 Employment Status

The following is the breakdown for the employment status of the participants in the study. Most of the participants in the survey are farmers (40) whilst the second highest of employment status are domestic duties. Tourism is the backbone of Sigatoka economy. In Table 5.3.2.2/1 is shown form of employment found in the area.

Status	Number
Govt. Worker	4
NGO	4
Own Business	6
Domestic Duty	23
Farmer	40
Tourism	11
Rugby Player	3
Factory worker	1

Table 5.3.2.2/1: Form of employment in the area.

5.3.2.2.2.2 Proximity and knowledge of the study Site

Majority of the respondents in the survey live in close proximity to the study site ranging from 1-500m. The furthest is Nayawa village (1-3km) and Nasama village (1km). Over 80% of the respondents know the study area and associate it with flooding occurrences and have been involved with recommending to Tikina meetings for dredging to take place.

5.3.2.2.2.3 Duration of stay on study site and Land Tenure

Majority of respondents live in their respective villages and settlement for more than 10 years and are familiar with the surrounding and past history of the area. The response confirms that most respondents are originally from the area. For the Sigatoka Town residence duration of stay varies, some staying in Sigatoka Town for longer periods and some for less than 5 years.

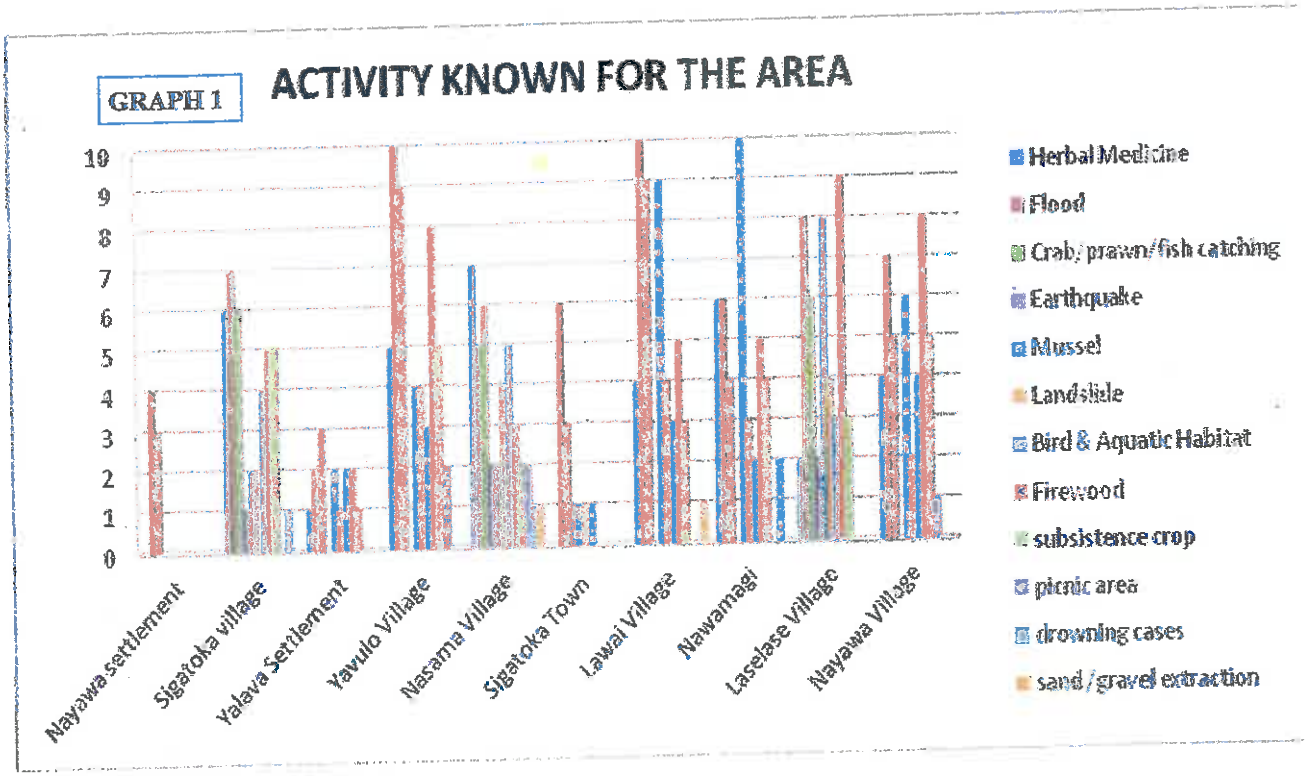
5.3.2.2.2.4 Activities & Uses of Land & Water resources in Development area

The questionnaire extracts information regarding common use of river water and land. This includes herbal medicine, flooding, fishing, mussel gathering, firewood collection, subsistence crop, picnic, etc. It also enquires into surrounding environment vulnerability to natural hazards.

In Table 5.3.2.2/2 and Graph1 is shown the number of respondents associating common activities re-owned for the site.

	Nayawa settlmnt	Sgtka village	Yalava Sttlmt	Yavulo Village	Nasama Village	Sgtka Town	Lawai Village	Nawamagi	Lase2 Village	Nayawa Village
Herbal Medicine		6	1	5	7		4	6	2	4
Flood	4	7	2	10	5	6	10	6	8	7
Crab/prawn/ fish catching	3	6	3	9	6	3	9	4	6	5
Earthquake		1			2	1			2	
Mussel		2	2	4	2	1	9	10	8	6
Landslide		2	1	4	4	1	4	3	4	2
Bird & Aquatic Habitat		4	2	3	5	1	3	2	3	4
Firewood		5	2	8	3		5	5	9	8
subsistence crop		5	1	5	2		3	4	3	5
picnic area				2	2					1
drowning cases		1			1			2		
sand /gravel extraction					1		1			

Table 5.3.2.2/2: Indicates the number of respondents for common activities renown for the site



Fishing, mussel gathering, crab catching are widely re-known activity in the study area. Moreover freshwater mussel gathering is the common of all, it provides food source and financial resource in the Sigatoka area. The "kai" as commonly known are responsive to salinity, but in the Sigatoka River the abundance of the kai yields in one gathering session on average 10-60 kg.

There is low reported incidence or mention of utilization of gravel and sand extraction from the Sigatoka River indicating high regulatory compliance within the region.

The common occurrence and vivid recollection by the villages and settlement is the recent flooding which occurred in February/March 2012. It has resulted in a very high rate of response calling for flooding prevention measures to be put into place and implemented immediately. Firewood gathering and herbal medicine are common within the entire ten (10) study sites indicating abundance of mangroves and associated tree species.

Fishing is the common practice for the area providing for domestic consumption. 40% of respondents go fishing on weekly basis and mostly during the night. The catching of fish and prawn are common for all respondents.

From the 10 study sites, participants for the survey mostly use fishing line to catch fish, followed by utilization of net and spear. Free diving is another method used by participants from Nayawa, Nawamagi, Yavulo and Sigatoka village. Whilst Graph 2 is shown the fishing method type employed for fishing in the river, the catch yield and type of fish caught is indicated in Table 5.3.2.2—3.

The participants for the survey clearly mentioned the types of fish and other river species caught in the zones. The comparison can be made with the fishery/ ecological report for the Sigatoka study site.

GRAPH 2

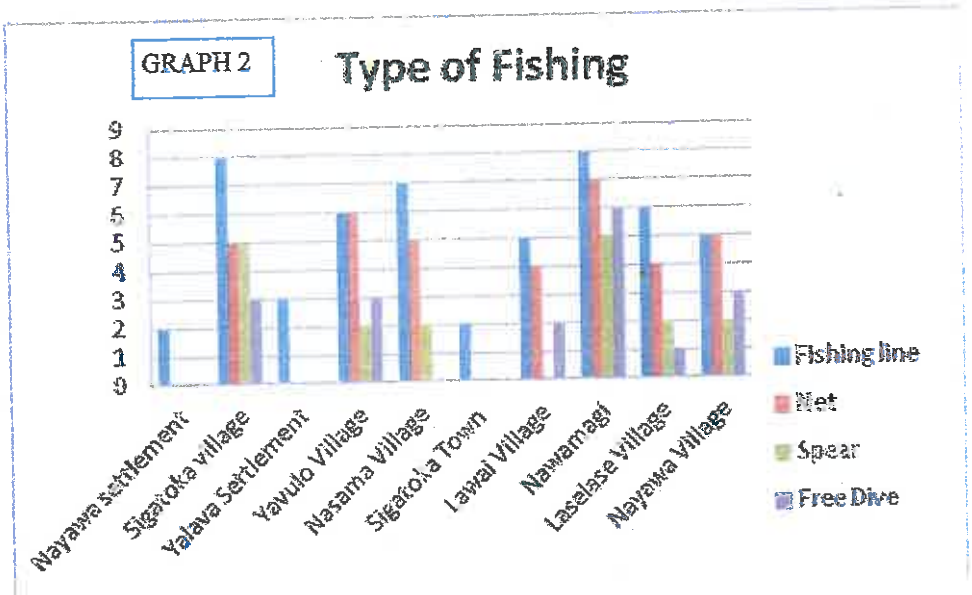


Table 5.3.2.2/3: Participant's response towards the catch yield and type of aquatic species found in each zone for the 10 different study villages and settlements.

Zones	Nayawa Settlement	Sigatoka village	Yalava Settlement	Yavuto Village	Nasama Village
Zone A	Qari (1-5)	Qari (5-10), Fish- Damu,Maleya, Vo. Kanace, Shark (10-30)		Qari, fish- damu,saqa, uru-uru, botabota, cigana, seu, vudi-vudi, sevou, qitawa, kaikai, vale, kabatia, vai, kavu	Qari (5-10), fish (10-50) * damu, maleya, vo, kanace, vale, duna, shark, bonu, qitawa, sevou, kake, cigana
Zone B	Fish: Uculuka, damu,saqa,botabota (5-15)	Kai (10-40kg), Prawn (0.5-1kg), Fish- Damu,Maleya, Vo, Kanace, Shark (10-30)	Kai (5kg)	Qari, Kai, fish	Kai (10-40kg), fish (10-50)*
Zone C		Kai		Kai	Kai (10-40kg)
Zone D			Fish- Damu,saqa, maleya, uru-uru & botabota (1-10)		
Zones	**Sigatoka Town**	**Lawai Village**	**Nawamagi**	**Laselase Village**	**Nayawa Village**
Zone A				Qari (1-10), kai(10-60kg), fish* damu, saqa, maleya, uru-uru, botabota, cigana, seu, vudi-vudi, vo, sevou, qitawa, kanace, yavula, kaikai, vale, kabatia, vai, kavu, ose, matad-radra, vuvudi, kulukulu (10-60)	Qari (1-10), kai 20kg, fish*- damu, saqa, maleya, uru-uru, bo-tabota, cigana, seu, vudivudi vo, sevou
Zone B	Fish- uculuka, damu, saqa,botabota, kanace, cigana (5 -15)	Qari- (1-20), Kai (10-60kg)	Prawn (0.5-1kg), fish* (20-30)	Kai (10-60kg), fish*	Qari (1-10), Kai, fish*
Zone C		Qari- (1-20), Kai (10-60kg), fish- 10-40, damu, saqa, maleya, uru-uru, cigana, seu, vudivudi vo, sevou, qitawa, yavula, kai-kai, vale, kabatia, vai, kavu, ose, matadradra, vuvudi, kulukulu, lowalu, duna, shark	Kai (10-50kg)		
Zone D			Kai (10-20kg) fish* damu, maleya, vo, kanace, vale, duna,		

River water mussel (kai) 10-60kg, Qari (1-10) and fish have been reported to be caught in abundance by participants of the study. Fish species reported vary within the zones. Participants of Lawai Village reported that seasonal fish "Cigana" usually comes 4-5 times a year, but now appears only 2-3 times. Another seasonal fish "Naotu" smaller than Cigana are not seen anymore. The same sentiments was shared by participants of Nasama and Sigatoka village mentioned that fishes (Cigana) which was present before is not there anymore because the river is shallow. The dredging will be beneficial to the river ecosystem.

Interestingly shark and huge deep sea fishes are now being caught in the river.

The fisheries information derived from the social—economic survey could complement data obtained through the fisheries study and survey mentioned in **Section 5.2.4.5: Fisheries** Survey of this report.

5.3.2.2.2.5 Health Status

The condition of people living in and around the proposed development area to include those living in the Town of Sigatoka is generally healthy.

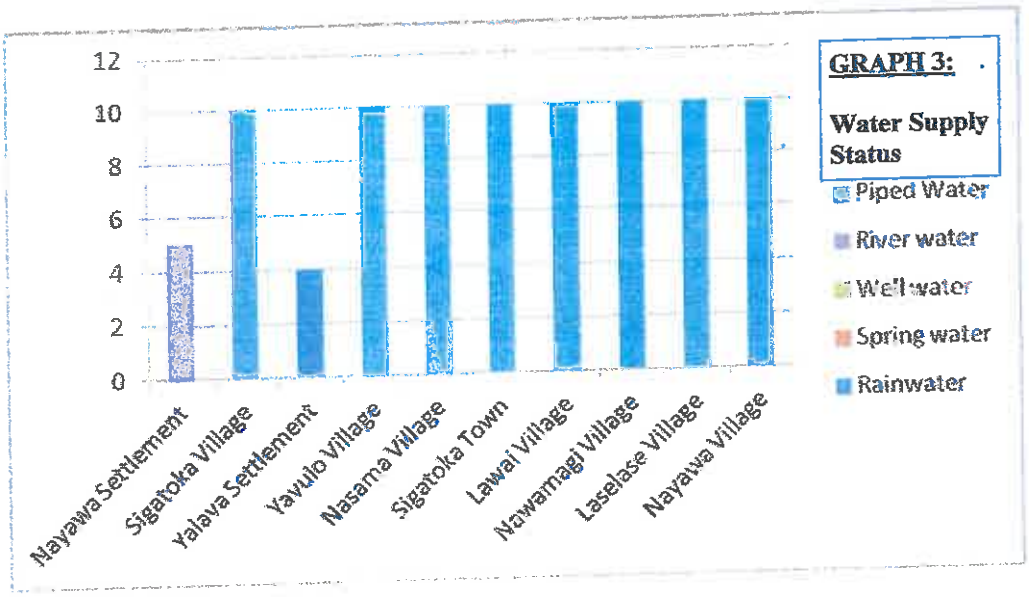
Domestic Water supply source for the development area and settlements is from WAF piped water main. This is supplemented by springs, bore-holes and stored rain water.

The majority of the people living within and around the development area have satisfactory methods of collecting and treating waste-water generated from domestic, commercial and industrial premises through water closet/ septic tank/percolation trench system and water-seal privies. A few still use ordinary pit toilets. Used water from kitchen sinks and all other slop water are treated in soakage pits.

5.3.2.2.2.5.1 Water Supply

Graph 3 shows Water supply status as well developed within the 10 study sites. However Nayawa and Yalava settlements are still relying on river water and rainwater as source of water supply.

Eighty seven percent (87%) of the respondents have piped water as main source of water supply.



5.3.2.2.2.5.2 Sanitary Facility

Above 73% of the respondents indicate that they have flush toilet and septic tank as sanitary facility. The Sigatoka Town area is connected to the sewer line. Water privy and ordinary pit toilet accounts for the other 27%. The sanitary facilities are well maintained and have percolation trenches. Design is within approved standards. Yalava settlement residents do not have constant water supply but relying on rainwater as source and have water seal privy in place. In Table 5.3.2.2/4 is shown the type of sanitary facilities used for waste water treatment in villages and settlements located within the study area.

	Septic tank& percolation trench	Water seal Privy	Ordinary pit privy	Soakage pit for grayish waters	Sewer Connection
Nayawa Settlement	5				
Sigatoka Village	10				
Yalava Settlement	2	2	2		
Yavulo Village	10				
Nasama Village	10				
Sigatoka Town					10
Lawai Village	10				
Nawamagi Village	4	5	2		

Table 5.3.2.2/4: Type of sanitary facilities used for waste water treatment in villages and settlements located within the study area

5.3.2.2.2.5.3 Suitability of River water for Bathing/swimming purposes

Water samples taken at sampling points above and slightly below the proposed development area of the Sigatoka River revealed the water at those points contained colonies of feacal coliforms. This means the water is already heavily polluted with feacal coliforms. Such a result may be due both to animal and human sources. The exact origin may have to be determined through further laboratory test. Water sampling results of such nature indicate that the waters of the Sigatoka River at the point where the samples were acquired are not fit for drinking, bathing or recreational purposes.

Some people who swim or wash clothes in the Sigatoka River experience body ailments on doing so.

5.3.2.2.2.6 Causes of Flooding in Sigatoka Town

The common contributing factor identified by respondents during the survey and needs to be addressed are:

- Inadequate drainage
- Badly designed drain
- Sand bars in the river mouth to be open
- Blocked drain
- Badly designed drain

All respondents agreed that the dredging will be of great benefit to the community. The positive contributing factors as mentioned by respondents include less flash flooding; improve on existing financial status and increase fish yield and catch.

Potential negative effects indicated by the respondents are the increase sediments in the water followed by river bank erosion and traffic congestion during construction and operation phase.

5.3.2.2.2.7 Changes in Sigatoka River Morphology over time

There have been noticeable changes as reported by the respondents. The river becoming narrow and shallow for 60% of the respondents and the other saying wide and shallow. These have significantly affected the fishing output in the area. Majority of the respondents think that dredging will be good for the area in terms of fish abundance of all types, navigation and flood mitigation.

5.3.2.3 Findings through Community Consultative Meeting Process

The Public was invited through advertisements in the local newspaper to attend a Community Consultative & Participatory meeting in regards to the proposed development. The meeting was held on 29/11/2012. Likewise officials of government and non-government organizations deemed to be stake-holders in the development were also invited to attend the meeting. The reason for the meeting was to inform the community and stake-holders of the development and the results of the study. The participants discussed issues and concerns raised in the meeting regarding the development. The concerns raised were taken in by CEC and those that were not resolved in the meeting will be incorporated in the final EIA report with mitigation measures put into place to prevent, avoid and minimize their occurrences.

A follow up meeting was held on 06 March, 2013 at Sigatoka Town Council Meeting Chamber to inform the Regional Provincial Administrator and the CEO of Sigatoka Town Council and others who were not present in the previous meeting of the development and get their views and concerns regarding the same.

In APPENDIX D4 is the minutes of the meeting held in November, 2012 and in the same APPENDIX D4 is the minutes of meeting held in MARCH, 2013;

The meetings were informed by participants that flooding of Sigatoka River were mainly caused by the following:

5.3.2.3.1 Failure to Clean up Individual Drains

The root problem highlighted were failures of drainage owners in the Sigatoka river basin to clean individual drains to allow for effectual flow of water to mainstreams, hence blocked drains causing fast rising waters, flooding and sedimentation in the Sigatoka River.

5.3.2.3.2 Unattended Outlet drains & Water– ways into Sigatoka River

Kulukulu has drainage issues that the community would like integrated into the dredging project as its main drain, which outlets into Sigatoka River, is congested and requires upgrading. Nukunuku & Korocia Islands have been eroded over the years that now only 4 acres remain from the original 8 acres. The community is interested in commercial sales of sand.

5.3.2.3.3 Poor land use Practice

Another major cause of sedimentation in the Sigatoka River is poor land use practices that result in erosion of side slopes and river banks which could prompt more dredging works to occur at later dates.

People should be advised on how to best look after their land. Controlling of sedimentation from the lands and hills will eventually control river flow. In fact, landowners and nearby villagers need to be educated about this. In addition, there is a need for an Inter-grated Management Plan to be developed and implemented to incorporate the above with a flood contingency plan.

5.3.2.3.4 Increase in Paved areas

Most development in Sigatoka Town require paved areas for access, car-parks, extra working and storage spaces. In this regard most of the spaces in Sigatoka Town are sealed. In so doing, natural filtration of storm water through the soil underneath paved areas cannot take place. The presence of considerable sealed and paved areas in Sigatoka Town has allowed large volumes of storm water to be collected in a short period of time over areas that are not suitably and adequately drained causing water to overflow and flooding the area.

5.3.2.3.5 Other Issues

5.3.2.3.5.1 Protection of Tiri Land from dredging

Social surveys carried out in each village especially those situated at Zone A & B of development site, revealed that the majority of the people interviewed mentioned how much the mangrove contributes to each household need each day, especially in terms of provision of firewood and mud crabs. Those attending the meeting and various stakeholders have also shown interest and strongly agree that it needs to be protected and maintained at all costs as the community and marine life dependent on it.

5.3.2.3.5.2 Ensuring Suitability and safety of Sites for Dumping dredged materials (Dump Sites)

It was highlighted in the Community meeting that this will be the first time Sigatoka River is being dredged. LWRM therefore needs to clearly identify dumpsite areas for use in the proposed development and to assess whether each area is suitable or not. Volumes of dredged material to be dumped at those sites need to be worked out and holding capacity of these dumping areas to be thoroughly assessed. Case studies need to be looked at in order to ensure that the best management practices are carried out within the dump.

5.3.2.3.5.3 Dredged Spoils for Land Reclamation

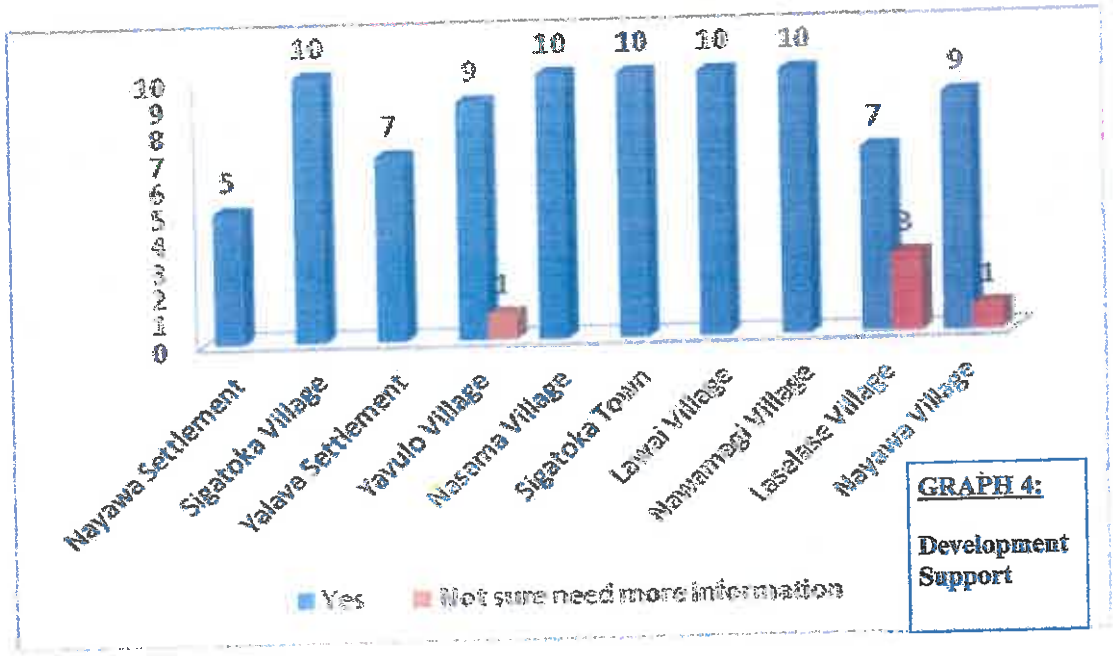
Dredged materials would make good fill materials to reclaim or to create spaces for the extension of village spaces, open spaces, playing fields and for cultivation.

The plea of the people of villages attending the meeting was for the use of dredged spoils as fill materials to facilitate the needs shown above. It came over and over again very strongly in the course of the study and during the survey, pocket and community meetings.

In the Community Consultative Meeting that was held in Sigatoka on 29th November, 2012 strong representations was again made from the Turaga ni Koro of villages for the use of dredged materials as fill materials to facilitate the extension of village boundaries.

5.3.2.4 Support for development

Support for the dredging of the Sigatoka River was overwhelming.. Out of the ten (10) survey sites, ninety five (95%) percent of the respondent support the development. The main reason given is that dredging will prevent flooding which has been frequently occurring of late. The other 5% are from Yavulo village (1 respondent), Laselase (3 respondents) and Nayawa village (1 respondent) need further information on the river dredging and development process to make an informed decision on supporting the development. In Graph 4 is shown support for the dredging development.



GRAPH 4:

Development Support

Consultation will be conducted on all concerned parties to strengthen awareness on dredging activities to come and their effects on the environment and human lives. This will be in partnership with Provincial Council and other concerned offices and organizations.

5.3.2.5 Summary

The overall summary of the Socio Economic survey provides ample support for the development. The need to consider livelihood and reduce flooding impact is the greatest concern of the participants of the survey especially in villages and settlements who rely on freshwater produce as source of food and livelihood.

Consultations which include awareness on the proposed development should be highly considered since 5% of respondents are not sure of the development and require further information. The engagement of Provincial office and both Local Authorities to provide awareness and clarifications on the development is recommended to offset any doubt or fear of flooding within the community.

The awareness should be carried out prior to the dredging process and with great consideration especially on the short term impact to surrounding environment.

Lastly , the provision of proper drainage, and removal of sand bar at the Sigatoka River entrance are further suggestion highlighted by the participants of the survey to be taken into consideration.

6.0 POTENTIAL ENVIRONMENT IMPACT

Having discussed the environmental baselines at and around the proposed site and the development plans, this sections evaluates the potential environmental impacts that the development may have on the environment. As well as the positive economical effects that the development will have on the community. there may also be adverse effects that the development could have on the people, community and environment. The purpose of this section is to discuss both of these effects objectively.

It is common that much of the environmental damages caused by developments occur during the construction phase (P Morris et al, 2000). On the contrary environmental issues during operation phase of development is normally deemed as less worrying in nature provided all appropriate control measures for mitigation in respect to negative impacts are put into place and implemented. Under normal circumstances these would have been addressed separately. However for this particular development constructional activities will continue right through the entire duration of the operation phase in form of river dredging. For these reasons the potential construction environmental effects and the potential operational environmental effects are being discussed together in this section.

6.1 Potential Impacts & Risks during both phases of development

This report uses a qualitative risk analysis to rank and manage the potential environmental and social effects for both the phases of this project.

The EIA requires that the physical, biological, economic and socio environment aspects to include public health aspects be identified, the risks to vulnerable elements thereon assessed and mitigation measures planned to reduce the adverse impacts of these risks. In addition identify the existing management, technical systems and procedures to control risk. Controls should be developed in accordance with the hierarchy of controls, (i.e. elimination, then substitution, then engineering controls, then administrative or procedural controls, and finally personal protective equipment).

The approach adopted is based on the Ad-hoc and Check-List methods universally adopted for environment assessment and the Comprehensive Hazard and Risk Management approach (*CHARM) to Natural Hazard* that Fiji government in its National Strategic Plan requires of all project proposals.

CHARM has been adapted from the joint Australia/NZ Risk Management Standard. It is a systematic risk management process comprising these steps:
(a) Risk Management Context
(b) Identifying the Risk
(c) Analysing the Risks
(d) Evaluating the Risks
(e) Developing Risk Reduction Measure.

Discussion on this methodology is at Section 5.1.3.5.1 Descriptors of Likelihood, Consequence, Risk Rating and Levels of Risk, of this document.

Whilst impacts on the physical, biological, public health and social settings are mostly short term and reversible those occurring in the operational phase are deemed to be of long term nature and requires proper mitigation measures to be put into place to ensure the effects of the development on the environment and the residents of the area are avoided, prevented or minimized.

These are the impacts and risks to be considered during the construction and operation phase of the development.

6.2 Physical Impacts

The vision of the project is to reduce extreme floods. The agricultural main drainage systems in Fiji are designed to a 1 in 1 year daily rainfall. For the developed areas of the Sigatoka town and wards with paved surfaces, a higher drainage design standard of between 2 to 10 years return period rainfall would be a minimum design rainfall to protect the higher investments in the paved surfaces, residential building and other important structures. The design return period used by LWRM is a 1:10 flood event. This may be under-designed as a flood protection objective and is reviewed upwards.

All upstream agricultural, rural and urban drainage systems currently deliver their storm waters through the tributary channels into the Sigatoka River that their cumulative loading effect would be significant for there is no integrated water storage - flood plain drainage plans for the Sigatoka watershed.

CEC in consideration of the cumulative loading effect and acknowledging government's concerns to reduce flood damages downstream has noted that standard overseas practice on design flood discharges opt for 1:25 to 1:50 year return flood event. These are used as better reflecting the economic lifespan of investments. In highly developed areas of USA, still higher design standards of 1 in 100 year storms are demanded as in the Dane County, Wisconsin, USA.

6.2.1 Inland and Off-Shore Dredging

Perhaps obvious is that dredging involves excavating and dumping of dredged material which for inland dredging in Sigatoka River is mostly mixed aggregates comprising more fine material with coatings of clay. The sand dunes are the existing end result of deposition of sand and fines transported through the mouth to be continuously moved and blown by high energy waves and wind onto the dunes.

6.2.1.1 Impact of unsound Engineering Concept Planning

6.2.1.1.1 Unsuitable River Dredging Engineering Concept & Works Design

At Zone A, the river mouth is a high energy location. It will be very expensive to dredge and as well maintaining an open channel through the sand bar. To do so will subject Zone A and Zone B to high energy wave action, a threat to villages and the town.

6.2.1.1.2 Unsuitable River Bank Bund Design

At Zone A. a thin strip of mangrove is present near the mouth. It will be very critical if an appropriate design for bunding is not applied to save river bank areas from over-topping of flood waters and the mangrove species which is not extensive within the area could completely die out

6.2.1.2 Excavation Impacts

Inshore

Excavating the river section will directly impact on the habitat of living organisms in the river and along the banks.

Improved flood flow through dredging is likely to result in higher velocities/ swifter currents with potential to scour the river banks and bed. Swifter currents also means a longitudinal displacement downstream of coarse material deposition and fines carried further downstream than at present. Movement upstream of the salt water wedge will be enhanced by deepening. There are a number of lifeline infrastructures crossing the river that are potentially impacted by dredging works.

Offshore

The off-shore excavation will increase the depth hence increase in wave energy that moves the dispersed, transported and suspended fine material towards the dunes. The higher composition of suspended matter will impact the marine habitat along the near-shore in the coastal front waters around the dunes.

6.2.1.2. Excavation Risks

6.2.1.2.1 Risk of Intrusion of salt water on Community Water supply source

In Zone D at Matovo is a shallow well drawing water from the river for public water supply. Salt water intrusion if dredging is allowed to travel further upstream as result of dredging will subject the allow salt water intrusion in the well and may affect water treatment costs.

6.2.1.2.2 Risk of Dredging near bridge

In Zone B Scour on the piers of the new bridge is present of about 0.5m depth, the difference between 3.75m upstream and 4.25m downstream depth. Dredging may impact severely on the bridge capability of holding its frame-work together which could result in the bridge collapsing over time.

6.2.1.2.3 Risks of damages to Water pipes & Electricity lines across river

In Zone D there are aerial water mains and power lines crossing the river at Nawamagi. Conducting dredging activity in that area may significantly affect existing arrangements. Any damages occurring to these mains and power lines will disrupt services to the community and bring about financial constraint to owners.

6.2.1.3 Impact of scouring and River Bank Erosion

Heavy scouring exists now along the banks of Sigatoka River. Deepening of the river is aimed to increase discharges which will mean higher velocities and increased risk of scouring and river bed and bank erosion.

6.2.1.4 Dumping Impacts

The dump volumes are sizeable hence sites would be big and will have significant impacts on drainage systems of dump localities. Dumping implies potential destruction of existing vegetation and creation of new physical features in the locality to require aesthetic considerations. Dump sites also offers opportunity for establishing value-added community projects as extension of housing or gardens or evacuation sites.

Dump sites involves usage of tracked and wheeled plants and vehicles hence new access roads built with all the associated physical and socio-economic impacts eg increased mobility to market and public services of affected localities.

The dump material contains high percentage of fines with clay coatings hence high likelihood of wind-blown dust and sediment transportation.

6.2.1.4.1 Un-availability of proper Dump Sites for Dredged materials

The fact that LWRM will need a number of dumpsites for spoils from the dredging of the 16 km channel of the Sigatoka River under study cannot be over emphasized.

Unavailability of dumpsites will result in indiscriminate and crude dumping of dredged materials in the locality. Indiscreet dumping not being supervised brings about insanitary conditions thriving within a dumpsite resulting in the creation of potential breeding places for mosquitoes, files and rodents the vectors of many communicable diseases in Fiji. More over being a threat as well to the Sigatoka River, its estuarine and marine environment and its habitat by way of siltation and re-discharge of pollutants in dredged materials back into the river.

It is crucial that dump sites for spoils of the river channel stretching through the 16 km be identified at once and the sites prepared in every respect to receive dredge materials.

6.2.1.4.2 Impact of Erosion at Dump site

Erosion of dredged spoils may occur at dump sites during heavy down pour if there is no methodical way of retaining the spoils within dump sites;

This is a major area of concern if the dump site is not properly managed due to the potential impact of increased sediment load in the river. Any increase of suspended solids in the river will have a negative impact on the filter feeders (bivalves) down stream, decrease water clarity and smother coral, eggs and molluscan larvae of the fringing reefs.

A study carried out by Nawadra and Hines on Ba River dredging in 1990 revelled even when spoil dump management is very poor, suspended levels in the river are unaffected outside 100m radius. This would not pose any significant threat to coral reefs in comparison to that which already exist due to continual movement of large quantities of sediment down the river.

However it is not desirable for sediment to be going back into the river from the dump site after deposition as this not only reduces water clarity in the immediate area but will mean that the cross-sections under dredging needs to be dredged again sooner than is anticipated.

To reduce the necessity for re-dredging the same area and decrease sediment loads in the immediate area, proper mitigation measures are to be put into place to ensure that dredged materials placed at the dump sites are retained within at all times and under all weather conditions. In addition proper management of the dump sites is to be a priority.

6.2.1.4.3 Impact of Sediment Washout from Dump site.

Suction dredging picks up a large amount of water with the sediment and this water has to drain out when the spoil is dumped. This water is a major source of suspended sediments from the suction dredging operation.

The dredged materials washout having a lot of contaminants in them may go back into the river during heavy down pour and pollute the water and if taken up by living organisms in the river will make them severely poisonous. If such organisms are taken in by fish, crabs or kai etc., people consuming them would become seriously ill. To ensure impact of sediment wash out are minimized proper mitigation measures are to be put into place.

6.2.1.4.4 Impact of Transportation of Dredged Spoil

Leakages from the transfer pipes from the dredger to the dump sites are due to small splits in the rubber sleeves. Any leaks occurring and pipelines unattended to immediately will result in a major break down not only to the pipeline on pontoon but could also cause mechanical problems with the dredger itself. Leaks on pipes that transport the spoil to the dump site is to be avoided at all costs at all times.

6.2.1.5 Natural Hazards are Potential Risks on the proposed development

Natural Hazards of any kind and magnitude would always pose all sorts of risks during the course of any dredging works. Not only will the dredging equipment and personnel be put at risk when ever natural disaster strikes during the dredging operation, the area already dredged will also be put at risk of back-filling.

The risks from natural hazards impacting Sigatoka to Nadi will generally expose localities within the region to a similar level of risks. This is well discussed in **Section 5.1.3.5:Hazard Vulnerability and Risks from Natural Hazards** of this document.

The risk levels are established using the SOPAC Regional Guideline for Comprehensive Hazard and Risk Management (CHARM) which itself is adapted from the Joint Australia – NZ Risk Management Standard. It is the methodology that CEC uses in all recent EIA studies submitted to the Director of Environment. Risk levels are measured on the likelihood of the event and the assessed degree of impact or consequence.

6.3 Biological potentially significant impacts

The full assessment of the potential impacts of the proposed dredging works would de described in the following areas:

- Aquatic ecology (habitats-river and benthic)
- River and channel flow
- Mangrove Ecosystems
- River mouth and estuary
- Terrestrial (flora and fauna spoil dumpsites)

6.3.1 Aquatic Ecology (habitats-river and benthic)

During the operation of the dredge machines, the major environmental impacts would be the sedimentation and the production of wastes including liquid, solid and gas emission. Environmental risks from spill or seepages of toxic materials to the soil and adjacent waterways are areas of major concerns. Waste management procedures must be part of the environmental management plan to minimize the impacts of waste, handling, disposal, treatment and spill.

The table below show some significant species found in the river system and the potential impacts from the proposed dredging and spoil dump works.

Class	Common/Scientific name	Impacts
Crustacean	(Land crab) *Cardisoma spp.*	Habitat inundation may reduce abundance for the short term. Will probably decolonize areas dumped with spoils
	(Mud lobster) *Thalassina anomala*	Habitat inundation may reduce abundance for the short term. Will probably decolonize areas dumped with spoils
	(*Kuka*) *Eriphia sebana*	Habitat inundation may reduce abundance for the short term. Will probably decolonize areas dumped with spoils
	(Mangrove crab) *Scylla serrata*	Most impacts will result from habitat destruction and degradation and general spoil disposal. Minimal impact as spoil dump areas are not located in the mangrove areas
Molluesa	*(kai) Batissa violacea*	Movement of salinity vector upstream because of river deepening will displace the kai fishery to areas upstream.
	kaikoso	Channel dredging will remove some habitats but little of which is fished. Limited area in the proximity of the channel will be affected temporarily and impacts are considered low.
	Other edible mollusks	Channel dredging will remove some habitats but little of which is fished. Impacts are considered temporary and low.

	Fisheries (Mullet, *salala*)	Fish are not so obviously affected, although death resulting from clogging of the gills may occur in sensitive species. Suspended and deposited sediment may alter fish community composition, both by interference with run-riffle-pool sequences and by favouring olfactory feeders over visual feeders. In many situations, aesthetic reactions to suspended sediment may be of more concern than biological ones. In already turbid water, a 20-50% reduction in clarity may not be detectable whereas in normally clear water a clarity reduction of 10-15% is distinguishable. Dredging during the optimum fishing and breeding seasons may have greater impacts. Impacts is likely to be minimal and temporary due to mobility.

Suspended sediment that can arise from the dredging and stockpiling activities on the river banks may alter the water chemistry, and cause temperature decreases and turbidity increases. Deposition of sediment may change the character of the substrate, block interstices, and reduce interstitial volume. Turbidity levels as low as five (5) NTU can decrease primary productivity by 3-13%. An increase of suspended sediment levels increases the drift fauna and may reduce benthic densities as well as alter community structure. Recovery from the effects of suspended sediment deposition is usually rapid, once the source of contamination is removed and as long as the stream is prone to regular spates; the aesthetic recovery may only take days whereas biological recovery may take months (Paddy A, 2006).

6.3.2 River Flow & Channel creation

Another potential impact from the development on the hydrology is the impact of change in flow regime, decreasing water depth and changing water temperature that can alter the breeding of some of these fresh water species (during flood period). Higher temperatures may also produce faster growth rates but smaller adult size in some freshwater invertebrates. An increase in the frequency of extreme climatic events will have the capacity to alter aquatic community structure and higher temperatures may enhance the reproduction of parasites with consequent negative effects on their hosts (Ryan, 2006).

The change of hydrography of the river entrance will create a new benthic profile that is intended to ameliorate the flooding problem. In addition, it will create an all tide navigable channel into the estuary. Finfish, crabs and prawns may use the deep water for migration and habitat (SKM, 2002).

The short-term effect will have high adverse impacts during the operation but low to negligible in the long term. The increase sedimentation should cease as the area stabilized.

River channels are characterized by rapid flowing currents, fluctuating salinities and turbidity. As a result, they are relatively lower in diversity. The re-working of sediments here creates a difficult existence, even for in fauna. They are transit for fish travelling into the lower river mouth and estuary.

6.3.3 Mangrove Ecosystems (lower river)

Past researches have shown that excessive sedimentation will cause the death of mangroves. This is due to the burial of aerial roots lenticels (pneumatophores). The dumpsites should be considered subject to this effect unless the sediments are loose or gravels. Burial to a depth of 10cm may stress *Rhizophora sp.* (*Tiri*). The prop roots are subject to mortality at levels approximating this soil depth as the lenticels foe respiration area located near the soil surface.

While mangroves are extremely tolerant species growing in intertidal areas, it is shown that excess input of sedimentation can cause the death of trees owing to root smothering.

6.3.4 River mouth and estuaries

These areas of study adjacent to the river mouth have been subjected to sediment loadings from the river systems. The buildup of the existing sand bank across the river mouth as a result of the opposite forces downwards and from the wave actions from the open sea on the outer river mouth reduces the width of the river outlet flow. The sediments and inputs of low salinity waters limit the algal and coral growths on the estuary and outer areas towards the open sea.

Existing sand bank

6.3.5 Terrestrial (flora & fauna- potential spoil dumpsites)

The effect of dredging on the in fauna or burrowing organisms is high during the operation where the habitat and organisms are being removed. In the case of any channel creation and by pass, this may be positive with the increase in habitat variability and the all tidewater depth leading to the estuary. Likewise, the suspended sediments may affect the existing fauna but only during the period of dredging operation.

The fauna in the proposed dumpsites will be inundated but in all cases these are low diversity areas and not sites identified which will affect ecosystem biodiversity or existing fisheries.

The dredging should not pose any major threat to the survival of any species occurring in the river as already noted in rivers of *Rewa*, *Nadi*, *Labasa* etc where such exercises had been carried out. The only likely impact would be brought about by the environmental changes that would be influenced to the level of salt intrusion into the river system. A positive impact from the dredging operation would be the flushing out of the outlets from sewer, sand bank and the filthy silt along the lower river mangrove channels.

Some areas identified along the river banks have been used for Agriculture and subsistence farming by the locals and the impacts of dumpsite would affect their livelihoods.

West river bank-mouth

East river bank-mouth

East river-west of *Laselase*

East river bank- NE *Laselase* village

West bank-E of *Lawai* village

West bank-E of *Lawai* village

Within the eight (8) proposed dumpsites, no plants considered rare and or threatened or deserved special conservation attention are found in the areas proposed or deserve special attention (IUCN Red List 1994). Most of the upper river sites identified are low in biodiversity in terms of plants and associated in-fauna species.

However, special attention should be directed towards the degradation of the river and the mangrove systems found therein on the lower river. Short-term impacts of dredging will include possible inundation of habitats as a result of increase flow. As discussed earlier, dumping near mangrove systems could lead to destruction of the already stressed *tiri* alliance stand and laying of pipelines for the spoil outlets can also lead to damages to the mangrove stands.

6.3.6 Summary of impacts

6.3.6.1 *Dredging works*

- Alteration/degradation of habitats (both aquatic/benthic & burrows)-from loss of habitats, flow regime, breeding/spawning periods
- Increase in sedimentation, removal of some prawning areas
- Change in hydrology of the river
- Disturbances from work/noise-migration/loss of species (aquatic & avifauna)
- Decrease water quality-from sediment disturbances and fuel leakages
- Increase salinity-distribution of aquatic species e.g., *kai*
- Migration/loss of fisheries-from decrease river water quality

6.3.6.2 Spoil dumping works

- Alteration/degradation of habitats & feeding areas (terrestrial fauna/wading birds)-from loss habitats, breeding/spawning periods Suffocation of mangroves-sedimentation & aerial roots.
- Increase sedimentation-loose aggregates & spoil sites near water ways
- Increase river capacity/depth-prone to more inundation impacts- spoil sites near HWM

International conservation groups such as the WWF are focusing efforts on a select group of priority species that are especially important, either for their ecosystem;

- Species forming a key element of the food chain
- Species which help the stability or regeneration of habitats
- Species demonstrating broader conservation needs

or for people

- Species important for the health and livelihoods of local communities
- Species exploited commercially
- Species that are important cultural icons

These species fall into two groups:

- *Flagship species* – iconic animals that provide a focus for raising awareness and stimulating action and funding for broader conservation efforts
- *Footprint-impacted species* – species whose populations are primarily threatened because of unsustainable hunting, logging or fishing.

Strategically focusing efforts on these species will also help conserve the many other species, which share their habitats and/or are vulnerable to the same threats.

6.4 Impacts of the Dredge Works to the Fisheries resources

The three main influencing factors for the well being of the fisheries resources in a body of water are;

(i) quality of the water
(ii) habitats for breeding/ feeding etc
(iii) Food/Feeding and development

6.4.1 Quality of Water (Positive Impact)

The most determining factor for survival of living organisms including fishes in water is oxygen. The oxygen available to the fish is the amount of oxygen that is dissolved in water and referred to as Dissolved Oxygen (D.O.). The sources of D.O. is mostly from atmosphere and by the process known as photosynthesis whereby chlorophyll in green plants engaged the energy of the sun and a product of the process is oxygen. Oxygen, normally is abundant in flowing river. The dredging of the Sigatoka river will cause the water to flow more freely and properly. D.O. therefore should be improved from the dredge works.

Depletion of oxygen could be by to high decomposition matters in the water or certain chemicals intruding into the water that can fix the oxygen. Some of these chemicals could be from agriculture development on land. Again the dredging will clean up the bottom with debris and other decomposing organic matters in the river. More so the improved flow will quickly flush out any influencing chemicals in the water.

6.4.2 Fish Habitat (Positive Impact)

The main important habitat that will be affected by the dredge works would be for the kai that dwell on the floor of the river. Currently, the kai beds are of fine gravel and there are areas where the grave is coarse. The gravel is from the upper reaches of Sigatoka river that often roll down to the subject area by fast flowing waters of the region. The dredge is expected to reach a bed of rock as explained in the physical component of the report. The kai could live on the rock surfaces but how well would be interesting to learn. The most important factor on kai is that the habitat in which it breeds in is not affected by the dredge works. The breeding place for kai in the Sigatoka river is in the higher reaches than from where the dredge is to begin. *The dredging of Sigatoka river will not influence the breeding and recruitment of kai to the project area.*

Deepening the river by dredging will be beneficial for the finfishes. Larger size could be expected and more numbers as the volume of water could increase significantly.

6.4.3 Feeding and Development (Positive Impact)

The productivity of a water column depends very much on the level of primary production and these are the production of foods that are produced by the fixation of Carbon and hydrogen ions with sun's energy. This process results in production of phytoplanktons [unicellular plants] in the water. These are foods for primary feeders and the chain goes up to carnivicre. Sources of carbon and hydrogen ions are usually from decomposing organic matters and chemicals or nutrients from the land. The more the food would result in the fishes able to maintain themselves and grow in size and development of their biological systems including breeding. Dredge works will have very little influence on primary production of the water as the river is a flowing system.

6.5 Potential Public Health Impacts

6.5.1 Noise & Lights

Heavy machines working and being operated on the site in the construction of roads and drains to Dump Sites will emit noises that are likely to carry over to the neighbouring residences and village.

In the operation phase lighting and noise from the proposed development could also pose an intrusion to neighboring residences especially during evenings and weekends as the dredging activities are 24hr/7day operations.

6.5.2 Dust Emission

The fines in the dredged material will during dry periods enhance dust nuisances during construction of roads and drains. The dry climate of Sigatoka will enhance dust nuisances during both the construction and operation phases.

6.5.3 Gas Emission

Gas and fumes will be produced by machineries used on work sites during both phases.. The fumes and gases emitted could be hazardous and have the potential to cause significant adverse impact to human beings and the environment near the places of work.

Proper mitigation measures are to be put into place to minimize impacts from the same.

6.5.4 Fuel & Oil Wastes Handling & Storage

The plants and equipment expected for use on the site will be of the same types as those to be sited on civil engineering works of the same scale. Tracked excavators, bulldozers, graders, rollers and wheeled dump trucks are the heavy plants envisaged.

Generators will also be used on site during the construction phase of development. Most of these plants will require provision of facilities for fuel storage and means of handling fuel and used oil on site.

This has the potential to pose significant risks on the environment and people around the development area.

Proper mitigation measures are to be put into place to minimize impacts.

6.5.5 Environmental Spills

The potential risk of environmental impacts from oil spills or fuel leaks during refueling activities is considered to be low to moderate.

Medium to large fuel spills could lead to ground and river water contamination which could seriously affect aquatic life and a threat to the lives of the people using them and therefore risk mitigation measures are recommended.

6.5.6 Shortage of Water Supply

Water would be required at both construction and operation work sites for work and domestic uses. Shortage of water on site during both phase of development will have potential significant effect on productivity and the health of people working on site.

Mitigation measure is to be put into place to ensure that no shortage of water occurs at the work sites during both phases of development.

6.5.7 Wastewater Treatment

Wastewater at the site will have the potential for significant environment and public health risks during both the construction and operation phases if it is not treated and the effluent disposed of directly on land or in the river.

Satisfactory treatment and disposal methods at work sites are to be put into place during both phases of development as part of mitigation measures for likely impacts.

6.5.8 Solid Waste

Construction wastes will be present at the site The potential for littering and pollution from the improper disposal of solid waste during construction phase is considered low. Like wise in the Operation phase if proper mitigation measures for storage, transportation and disposal are put into place.

Proper mitigation measures for control is to be put into place.

6.5.9 Storm Water in Dump sites

The potential environmental impacts of Storm water falling on dredged material stock piles are related discharges to the environment during wet weather conditions.

The Storm water falling on dredged materials at dump sites is likely to contain contaminants lodged in the sediments dredged as it seeps through the spoil. The risk of that water in coming out and gaining entry into Sigatoka river is identified as being moderate to high.

It is important therefore that mitigation control measures are put into place to ensure impacts from storm water falling on stock piled materials are minimized.

6.5.10 Vector Breeding

Storm water from the development area specifically those falling on the dump sites if not drained properly and allowed to stagnate will provide the right environment for mosquito and fly breeding and a potential risk to public health.

Mosquitoes are vectors for dengue fever, a fatal disease if not treated early. Filarisis or elephantiasis is another communicable disease that is transmitted by mosquitoes to man. Diseases that are transmitted by flies from a sick to a healthy person include typhoid fever, cholera, dysentery and diahorrea. In view of this it crucial that vector breeding is not to be encouraged as a preventative measure for the spread of these diseases.

The risks of water on being stagnant in dump sites and causing vectors of communicable to breed is rated high.

Proper mitigation measures for control are to be put into place.

6.5.11 Security and Safety

Heavy machineries will be moving about in the development area and would likely pose potential risk to road users on affected road during the construction phase.

Pipe lines placed on pontoons on water may also be potential risks to water user during both day and night in the operation/dredging phase. The risk is rated low to moderate as the river is considered too wide for a mishap to happen during the daytime. Proper mitigation measures for control is to be put into place for the night time.

6.6 Potential Social Impacts

This section deals with direct and indirect, specific and broad, actual and potential, possible and probable, positive and negative impacts that are likely to emanate from the proposed dredging of the Sigatoka River.

The analysis proceeds on the assumption that in addition to dredging, the Government will have the necessary capital to carry out related measures as bank protection, realignment of the river course and environment awareness.

6.6.1 Positive Impacts

6.6.1.1 Reduction in Crop Damages

Reduction in damages to crops would be one of the obvious benefits of dredging. This applies to subsistence and as well as cash crops. Subsistence farming is an important activity for the both the Fijians and Indians.

The loss to crops is due to flooding in general and water logging in low lying areas. The only estimate available from the Sigatoka Agriculture office is the loss suffered during the recent flood in February, 2012. No estimate is available for the loss of livestock. Discussion with people living along the bank of the Sigatoka river indicated that small livestock's such as poultry, ducks, pigs and goats are lost in the floodwaters. There are times when even cattle are washed away.

6.6.1.2 Savings from Damages to Residential/Commercial Property & Loss of lives

An attempt was made to assess damages to residential and commercial property in dollar terms. Several sources of information were explored but no hard data was available. The sources tapped included Sigatoka Town Council, Insurance companies, and Sigatoka Chamber of Commerce.

According to the CEO of Sigatoka Town Council and the Secretary of Nadroga Rural Local Authority, no formal survey or investigation was carried out to assess the extent of the damage. However, the Town Council's estimate of flood loss is around $4—10 million for the 2012 flood.

Dredging of the Sigatoka river would prevent flooding and save costs for putting residential and commercial properties back in good order again. Like wise prevent loss of lives during flooding accompanied by storms.

6.6.1.3 Reduction of pollution in River

At present, the level of pollution in Sigatoka river is similar to areas that have a large river and rely on it as an alternative dump. Preventive steps are to be taken, or the situation will worsen leading to adverse social, economic and environmental effects. The main source of pollution identified during the field study are:

- Littering by some villagers living near the river bank (household/solid waste).
- Parts of slaughtered animals thrown into the river during communal feast.
- Items used during Hindu religious ceremony.
- According to some villagers, automotive waste (spent oil, grease, etc) from garages and service stations and sometimes dumped at creeks and water course flowing to the Sigatoka river.
- Waste water discharges from Sigatoka Town

This dredging operation presents an opportunity to clean the Sigatoka River bed and prevent future abuse of the natural environment.

6.6.1.4 Land Reclamation through dredging

One or two villages near the Sigatoka river hardly have any space left for residential expansion. The population in the village is growing and more land is required for residential purposes. The dredge spoil can be used to reclaim land. This is one of the benefits that will accrue to the villagers as a consequence of dredging. However the suitability of the materials to be used either for construction or agricultural purposes has to be properly checked out before use.

6.6.1.5 Creation of Opportunities for Social Amenities through land filling using Dredged Spoils

As stated earlier, it is assumed that dredging operation will go hand in hand with other measures. Such measures could include bank protection, tree planting, realignment of the river, recreational space, and cleaning the river system. The use of dredged material will be a great asset in facilitating some aspects of activities mentioned. As a result, the aesthetic value of Sigatoka Town and neighbouring rural areas will improve and both the urban and the rural communities will stand to benefit. This augers well with all out efforts put in by residents of the local area to maintain Sigatoka the best Tourism location in the country.

6.6.1.6 Creation of Opportunities for Sustainable Resource Management

Prawn fishing is an important source of cash income for the villagers in the development area. From discussion, it appears that there is no concept of sustainable management of this renewable resources present and there is no management plan in place. People are free to catch prawns of all sizes and shapes and as much as they can.

The dredging operation will bring about some disturbance in the prawn environment. The villagers are more likely to pay attention to the idea of sustainable management of the prawn resource.

The fisheries department can take advantage of this opportunity and put in place a system for the sustainable management of this resource if it has not been done.

6.6.2 Negative Impacts

6.6.2.1 Impact of Dredging on Navigation

Obstruction to navigation is very much minor as the river is very wide. Lights on the dredger will have to be turned on at night for visibility.

6.6.2.2 Amenity and Landscape Value

The Sigatoka River landscape, will not be significantly altered as it is currently partially covered with mangroves and terrestrial ornamental trees and shrubs and very little will be removed as result of the development. As for the east side channel, the diversion new structures may be found intruding upon the green landscape.

Visual Amenity impacts are subjective and relate to the values that people hold about their environment and community. Currently the view of the area from the nearby hills and mountain range is one of a rural landscape bordering the flat land. It is considered that this view may have a permanent but minor to moderate loss of natural amenity value to some residents but will likely not matter to others.

Lighting and noise from the proposed development could also pose an intrusion to neighboring residences especially during evenings and weekends if the activities within are allowable at nights.

6.6.2.3 Loss of Land Use Options

The loss of optional uses for the land in the future is considered a negative impact when the development of the site has taken place. The development to include road construction and drains will take up a fair amount of land area and will result in loss of the options for alternative land use (farming, gathering of firewood and fruit picking) and thus represents an irreversible commitment of land resources for the period of a lease (99years) if one is acquired.

6.6.2.4 Possible Loss of Resources & Rights

The river belongs to the Crown. Most of the pieces of land on the river banks are Itaukei owned land. The reclamation in some parts and filling up of acres of land beside river banks may deprive them of a wood land for firewood and fishing area where they can always catch fish and get them for free. The developers may have to acquire the approval of the owning unit for the use of their land for this development at some costs though.

7.0 MITIGATION MEASURES

7.1 Physical

7.1.1 Mitigating Excavation Impacts

7.1.1.1 Impact of Unsuitable River Dredging Engineering Works Design

To prevent severe impact and effect of opening up the river mouth on villages and settlements situated near river banks within study zones A & B, the study feels that JICA and SOPAC recommendations are to be seriously considered for adoption.

(i) Phase 1 to lower flood level 2m by dredging 2m deep - this will contain the 1:20 year flood within the improved river capacity without opening of the mouth.

(ii) Phase 2 to include river engineering works with a recommended 1: 50 year design flood.

For the off-shore dredging the alignment should use to advantage the natural processes causing littoral drift to take sediments onto the dunes. This should not pose any significant impacts

Maintaining the ocean channel in lieu of the known substantial sand plume from inland river flow is a major consideration, hence a good alignment of the dredged channel with the sediment flow and littoral drift processes is to be used in considering positioning of the dredged offshore channel.

The current practice by locals to initiate a pilot channel that enlarges during very high flood flows and closes naturally again in low discharges is worth considering.

7.1.1.2 Impact of Unsuitable River Bank Bund Design

An appropriate and suitable river bank bund design for flooding could start off by having the river width at appropriate places down sized and banks bunded and filled. The bund is to be designed in such a way that river water during flood do not burst the banks and not allow fills back into the river easily as to prompt further pollution of the river.

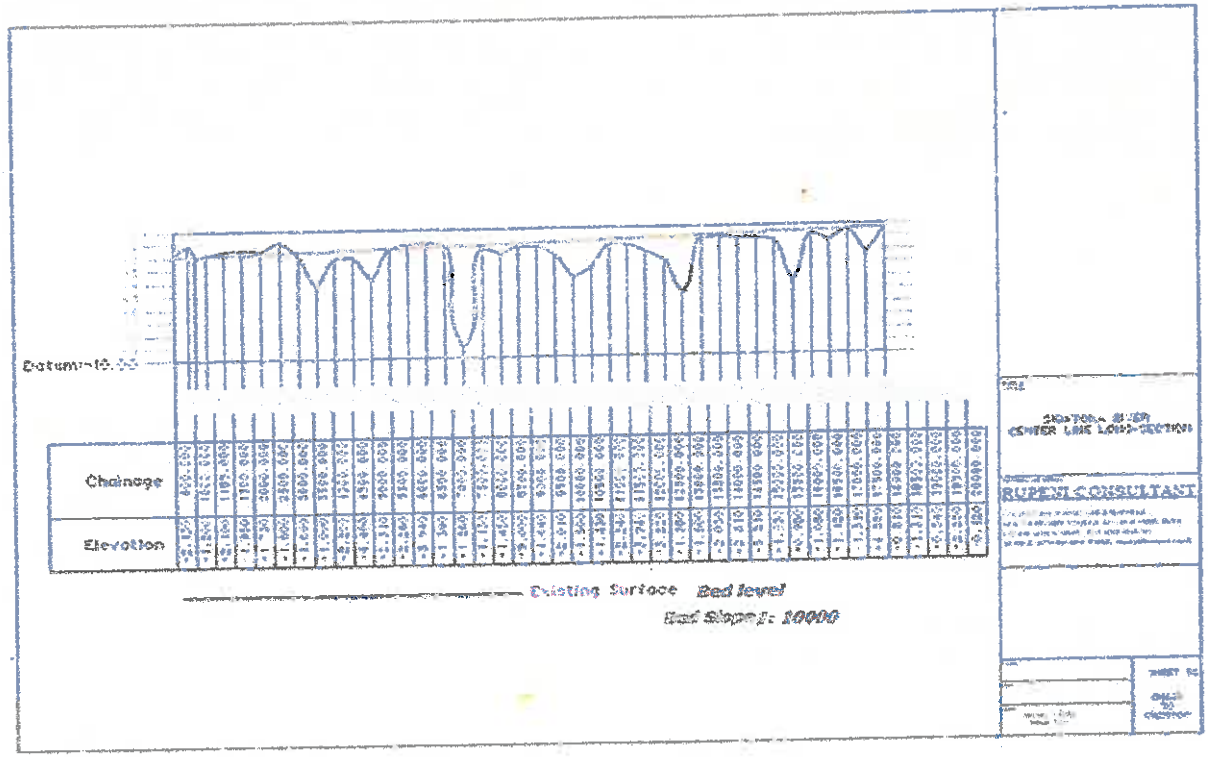
Bunding materials may vary and the best and economical type be considered for use for the purpose to achieve desired results. The bund is to go behind the mangrove strip located in ZONE A.

7.1.1.3 Impact of River Bed and Bank Scour

The Team proposes no changes be made to the existing bed slope with first calculations (Annex 1 *Proposed Dredged Area Calculation)* showing a dredged section of 50m width by 2m average dredged depth as recommended in this report caters adequately for a 1 in 20 year flood flow with acceptable safety factor around 1.5.

(a) Current conditions allow vegetation to grow roots and protect the banks. Maintaining existing slope will allow good establishment of vegetative embankment protection on new dumpsites as well as on erosion vulnerable river sections as around the banks.

(b) Daily tidal movement of the tide will naturally influence/define the zone of longitudinal deposition of the sediment/transported material. Hence it is not anticipated that there will be significant impact from shifts in deposition of material sizes.



Typical Sigatoka River Vegetative Bank Stabilisation

7.1.1.4 Mitigating Excavation Risks

7.1.1.4.1 Risk of Dredging near bridge

The risk of exacerbating scours around bridge piers will need to be addressed by declaring a "no dredging zone" around the bridge, which zone needs to be defined in consultation with the National Roads Authority.

Dredging with caution near the bridge, and advice of road authorities sought to prevent the bridge from collapsing.

7.1.1.4.2 Risk to Community Water supply source

Salt water wedge is not to reach Matovo. This can be only possible if proper engineering plans for dredging is implemented so that the degree of salinity present around that area and below is kept at a minimal stance. On the other hand WAF is to seek expert opinion in regards to the possibility of improving and upgrading or re-siting the existing well source to another area to minimize the presence of salinity in water drawn for treatment and used as public water supply.

Water samples taken in the four study zones of the Sigatoka River in October, 2012 on testing revealed that the value of salinity at zone A was 28.89 Sal and falls abruptly to 3.19 Sal at Zone B. This continues to diminish over distance upstream to 0.11 at Zone C and D. Waters above Zone D are saline free.

Matovo is located in Zone D and current salinity level of waters in that area is 0.11. Refer to **Section** ***5.2.4.6.3. Water Quality Samples Test Results—Salinity.***

This may change to higher levels if un-sustainable dredging takes place in the Sigatoka River.

7.1.1.4.3 Risk to transportation Water supply & Electricity across river

In Zone D There are aerial water mains and power lines crossing one bank of the river to the other at Nawamagi. The FEA Power station is located at Koromumu in Sigatoka Town and the water supply treatment plant at Matovo, both on the western bank of the Sigatoka river. To avoid and prevent damages to the water main and power lines, it is proposed that dredging and dumping be done with caution as the area is approached. LWRM is to liaise and seek advice from FEA and WAF in this regard.

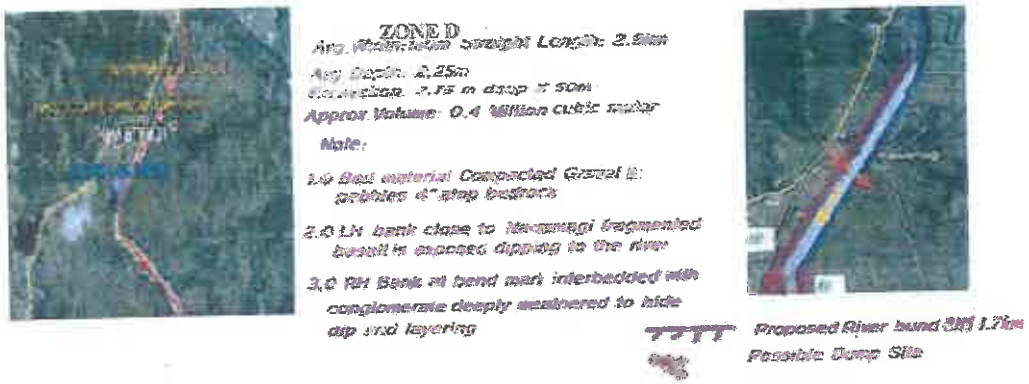
7.1.2 Mitigating Dumping Impacts

LWRM is to ensure that pieces of land are made available as dump sites for spoils. Some possible sites have been identified by CEC. LWRM could start negotiation with owners for their use. On the other hand LWRM could also look at the possibility of creating bunds with Dump Spoils as means of safely disposing spoils for worthwhile reasons and as recommended here under.

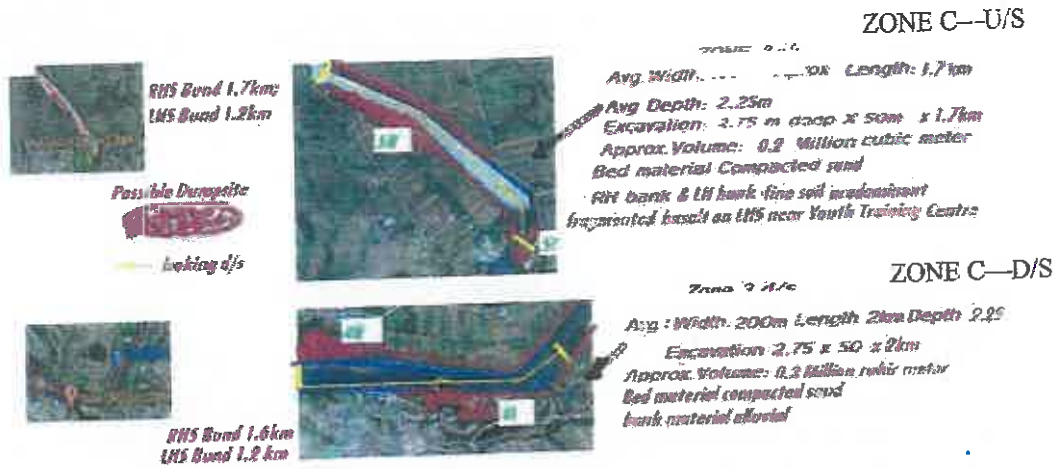
7.1.2.1 Making Useful Creation with Dump Spoils—RIVER BUNDS

CEC Study Team recommends that spoils be used to build river bunds. These bunds would not encroach onto the flood path for the design flood but will serve to prevent overland flow of flood events bigger than the design flood.

(a) The first target of protected areas are the fertile agricultural flats in Zones B, C & D over which major investments on capital infrastructures is still ongoing since the Ministry of Agriculture's initiative *Sigatoka Valley Rural Integrated Development Project* of the early 90's. River bunds constructed to rural access road standards should be aimed at to support commercial marketing of agricultural products as well as broaden primary base to include commercial aquaculture. Areas in the left bank as around Kavanagasau are constrained since the damage to the sugar-cane rail bridge. Bunding and land fill opportunities as proposed will facilitate healthy diversification to other primary productions.



Zone D Possible Bund & Dumpsites



ZONE C Possible Bunds & Dumpsites

Zone B Possible Bunds & Dumpsites

Zone B includes a proposal to dump spoils at Oloolo in support of a development proposal by the Nadroga Rugby Union (through Mr Epeli Nasome) to develope an international standard stadium in there.

(b) Bunding in Zone A is proposed with constructed revetments eg sheet-piling for Zone A are targeted at supporting tourism related growth. In addition special considerations are given firstly to improving the drainage system in Kulukulu locality; and the second and very important is to preserve the small stands of mangrove in the lower reaches around the river mouth by skirting all mangrove stands.

Zone A Bund with revetments to enhance tourism growth. Bund to skirt mangrove stands and integrate with improved drainage system for Kulukulu locality

7.1.2.2 Mitigating impact of Erosion at Dump sites

As a precautionary measure against soil erosion into water ways and the possibility of smothering adjacent mangrove species, sediment traps in the form of earth bunding need to be constructed around the sea or river end parameter of all dump sites.

Sedimentation traps may be constructed also from stock pile dogo logs or any other suitable logs. Posts of 3m lengths are to be driven 2m into the ground at 3-4m intervals. Other posts are to be stacked cross-wise against driven posts and a second set of posts driven to hold-cross logs with braces. Coconut leaves and organic materials to be placed inside of the traps to form a base before spoil is pumped into. **At APPENDIX F1 is illustrated proposed Erosion Control facility at Dumpsites**

7.1.2.3 Mitigating impact of Sediment Washout at Dump site.

The dredged materials washout having a lot of contaminants in them may go back into the river during heavy down pour and pollute the water.

To ensure impact of sediment wash out are minimized sedimentation ponds are to be constructed within the dump sites to receive wash water through an inlet drain from Dredged Material Heap in the Dump Site. Any sediment accompanying the wash water will settle at the bottom of sedimentation pond (SP)1 while clear water will be allowed to flow to SP2 where further sedimentation takes place and the resultant water allowed back into the river through an outlet drain, At a timely fashion the sediments in SP1 & SP2 will be pumped back into the dredged material heap. **At APPENDIX F2 is illustrated proposed Sediment washout Control facility at Dumpsites**

7.1.2.4 Mitigating Impact of Transportation of Dredged Spoil

Leakages from the transfer pipes needed to transport the spoil to the dump site could easily be controlled by shutting of the dredger and having the sleeves repaired.

The management is to ensure spares parts are always readily available on site to facilitate repair work needs. Through this, not only will repairs be attended to earliest, there will be savings in wasted work time and finances.

7.1.3 Other Mitigation and Abatement Measures

Other mitigation and abatement measures need to be considered are:

1. LWRM needs to seriously initiate a two - fold approach on preparedness:

   (a) Review for implementation the Sigatoka River Flood Response Plan. Additionally JICA has just started a 3-year JICA CBDRM Project aimed to enhance preparedness and response capacity of the Sigatoka basin community especially during the warning and evacuation phases. LWRM is to lend support to this project; and

   (b) Concurrently, LWRM to coordinate the development of a flood mitigation plan for the Sigatoka Watershed to address concerns on reducing flood damage costs.

2. LWRM to explore establishing a flood zone. Development to be controlled in this zone which is a natural flood path during extreme flood events.

3. Stronger regulation and monitoring of dump sites to ensure availability for future use.

4. LWRM to extend scope of dredging objective to integrate development initiatives.
   a. Sand to be used to fill low lying areas near villages or raise low lands alongside river banks for housing development.
   b. Sand to be used as fill for sporting project proposals not to mention others included in the Sigatoka district development projects for the year 2013.

7.2 Biological Aspects

Suggested mitigation and abatement measures to reduce potential impacts from the dredging development proposal are as follows:

7.2.1 Mitigation & Abatement Measures for construction phase

There are overlapping considerations in reduction of constructional and of operational risks. The major distinction is the former has a short time span for during construction only whereas the latter looks at addressing long term risks. However for potential construction impacts the following mitigation measures are recommended.

Removal of vegetations by clearing and earthworks of the Dump site can be best mitigated by the immediate rehabilitation of the area by re-vegetation work by replanting of short-lived, fast growing species to recapture the site.

Replant canopy trees such as *tavola*, coconut to hold loose soil on cut slopes and to restore biodiversity. Timing restrictions on works should be developed so that peak work activities occur outside the wet seasons, November to April.

Removal of trees on river edges and coastline areas should be avoided as much as possible. A 30 m set back of mangroves from the river edges and HWM areas are to be conserved to stabilize these vulnerable areas.

Phasing of work, key erosion control and earthwork principles to reduce the amount of area that is disturbed at any one time should be undertaken to optimize resources, financial expenditure and to assist in the mitigation of the potential impacts of land disturbances.

Sediment control devises are put in place in cut/exposed surface to minimize the risks of sediments washed to nearby water ways. Coastal and river edges armoring is suggested to reduce the impact of erosion and siltation of waterways.

The proposed integrated scheme construction and operation, shall consider the following provisions for control of catchment hydrology, and any requirements for compliance of proposed minimum flows and discharges to natural river water.

7.2.2 Mitigation & Abatement Measures for Operation phase

Increase waste production during the operational stages will require efficient waste management strategies. Proper sorting and storage of solid wastes on site from workers is important with regular removal and disposal to nearby approval landfill sites. Liquid effluents emanating from machines on the riverbanks must be led to treatment ponds on the lower areas for treatment before reaching into waterways. Emission of gas during operation must be within the national safety guidelines.

Site operational plans must outline the operation controls on various aspects of the project including traffic management, noise and vibration management and operation of the machines and workers camp. Emergency response plans for any environmental spills and evacuations plans must be put in place to minimize any potential risks.

Environmental monitoring plans are required to set out habitat and aquatic monitoring sites along the waterways during and after the operation to assess the impacts from the operation on the surrounding habitats and water qualities.

Sediment can affect habitat and aquatic organisms while in suspension in the water and as deposited material on the stream bed and banks. Sediment discharges are only expected from the work area and any stockpiles from spoil dump sites during storm events, because of run-off (SKM, 2006). The impacts, however is considered to be temporary. To mitigate against this the following can be implemented:

7.2.2.1 Dredging works

- Dredging operation to be outside breeding/spawning seasons-(May-October) outside for prawns & *Kaikoso;*
- Conduct dredging during the off season of the fisheries;
- Soil dump sites recommended-outside Zones A and B;
- Containment of spoil on dump sites to reduce sedimentation impacts-compaction, silt fences, screens, set back; and
- Liming applications of spoil-for agriculture use to neutralize acidifications.

7.2.2.2 Spoil dumping works

- Location of dump sites away for live mangrove areas
- Dumpsites to be at least 30m from the river HWM areas
- Spoil dumps require traps to confine the spoil.
- Minimal removal of vegetation during dumping of spoil
- Minimal disturbances to avifaunal wild life during dumping of spoil
- Restriction of works on densely vegetated areas and areas of mangroves

7.2.2.3 Mitigation for depletion of fisheries resources

The Sigatoka river mouth as most of the major river systems in Fiji are important spawning, hatcheries for larval growth etc of fishes, crustaceans etc. Numerous of these are important food fishes and are of high commercial values. The crabs, prawns and numerous fishes are nursed in the river mouths when young before they migrate to their usual environment in the sea or upper reaches of the river. The Sigatoka river mouth has been a "TABOO" area (no fishing for over 5 years hence the noticeable high densities of fisheries resources as the breeding, larval growth and recruitments are in "healthy status.

7.2.2.4 Recommendation

The dredge materials could be used to increase the fisheries in *Sigatoka*. It is to be used as dikes or walls to create ponds and reservoirs and be stocked with various species of fishes, crabs, prawns etc.

7.3 Mitigation for Public Health Effects

Appropriate Mitigation measures are suggested for activities listed hereunder wherever applicable in both Construction and Operational phases as follows:.

7.3.1 Noise

The developer should ensure high level of mechanical maintenance; particularly with focus on the plants exhaust systems to keep noises to acceptable level. Notice of late works at night will also be a kind consideration for the benefit of the villagers and nearby residents.

7.3.2 Dust

The fines in the fill material will during dry periods enhance dust nuisances during construction.

Moistening and dampening of problem surfaces with water are standard practices to reduce dust and at the same time improve soil compaction

7.3.3 Gas Emission

Emission of gas during the construction and operation phases must be within the national safety guidelines. LWRM is to ensure compliance with OHS Requirements and provision for Work place and Employees relating to gas emission.

7.3.4 Oil, Lubricant & Used Oil Handling & Storage

Adverse effects from the storage and handling of fuel, etc, can be avoided by ensuring an appropriate storage and handling procedures.

Lubricants and oil, etc will be stored in the container or equivalent covered structure at the Work Station (LWRM Depot).

The location of bulk fuel tanks will be approved by appropriate authorities. The bulk storage tanks will be bunded if over head tank is used. The capacity of the storage formed by the bund will be equal or greater than the storage capacity of the tank. All fuel and oil transported from the Work Station to the Work/Dredging Sites are to be in properly sealed containers. Greatest care is to be exercised.

All used oil will be stored in secure containers and returned to the Work Station or other appropriate places for transportation to approved disposal areas/facilities.

7.3.5 Wastewater Treatment and Disposal

Possible pollution resulting from the treatment and disposal of wastewater will be minimized by:

During Construction

Water seal privies will be constructed and installed on site prior to construction commencing. This water seal privy will be dismantled once proper and permanent waste water facilities for the operation phase of the project are put into place.

During Operations

The dredge boat facilities will used be by employees and waste water is to be disposed of in the most sanitary manner. Regular monitoring of river water quality to ensure the facility is operating satisfactorily and no seepage of any sort has occurred.

7.3.6 Solid Waste Management

All solid waste will stored in bins and properly disposed of in dug holed on iand.

A skip bin of suitable size will be put at work areas where ever required to store wastes and refuse during t h e operation/dredging phase. When full it will be taken away from the work site to the work station by barge thence to suitable disposal areas and replaced.

7.3.7 Environmental Spills

The soil substrate is relatively permeable together with sand of a height of 12 inches above at an allocated fuelling area any minor spills during the construction phase could easily be removed by shovel as required and filter media removed safely and replaced.

In the case of medium spill, Spill Contingency Plan is to be put into place for use in the study area.

7.3.8 Vector Breeding

Possible breeding areas for mosquitoes the vector of a number of vector borne diseases like Dengue fever, elephantiasis etc would be minimized if the dumpsite area and its surroundings have effectual drainage and the water not allowed to be stagnant over time. Main drains should be regularly cleansed and made to be free of overgrowth at all times.

7.3.9 Security and Safety

The developer needs to control entry into the construction site. Security personnel should be on hand and signage erected as appropriate, including at the Queen's Road at places near Sigatoka Valley and Kavanagasau road junctions to fore warn motorists using the road..

During the operation phase, the dredging phase, pipelines are to be painted with such a colour that the river users could not miss it and end up in mishaps as they travel through the river during the day. Light refractors are to be put on pipe lines to show water users where the pipes are located at night.

7.4 Mitigation for Socio & Economic Effects

7.4.1 Amenity and Landscape Value

The impacts could be mitigated through the following :

- Planting of vegetation along the site boundaries to act as a buffer between the development site and adjacent properties;
- Use of a landscaping architect in order to ensure that the development blends in with the surrounding environment;
- Lights will be focused to point towards the development.

7.4.2 Loss of Land Use Options

This is addressed in some form through the land rent the developer pays may pay to ITLB for the use of land that may be required for use by the development project. Further incentive could be discussed through a Forum of some sort if the developer and landowners agree to form one and use it as a means of addressing issues of importance to them. May be allowing the dredged spoil to be used as fill for reclamation and extension of village boundaries could prompt good will perhaps may give land free by land owners for use as dump sites and roads to dump sites.

7.4.3 Possible Losses of Resources & Rights

The developer is to acquire the approval of the owning unit for the waiving of the customary fishing rights where ever applicable and a suitable and appropriate amount of money is to paid out to them if deemed necessary for the partial or total loss of their fishing area to the project.

8.0 ENVIRONMENTAL MANAGEMENT PLAN

The developer will submit an Environmental Management Plan (EMP) once this EIA Study Report has been judged satisfactory by the Department of Environment and not later than a month from that date. The EMP will contain a Construction Environment Management Plan (CEMP) and an Operational Environment Management Plan.

The CEMP will deal with impacts relating to proposed Construction Works and as follows:

- Management Structures
- Security, Fencing & Gates
- Signage
- Worker's Housing
- Construction Equipment
- Fuel & oil storage and Handling
- Vegetation Protection
- Sedimentation and Erosion Control
- Noise Control
- Dust Control
- Mud Control
- Fire Control
- Water Supply management
- Waste water management
- Solid waste/litter management
- Storm water & External Run-off management
- Safety
- Complaint Register
- Reporting Procedures

The OEMP will deal with impacts relating to:

- Management Structures
- Security, Fencing & Gates
- Signage
- Work Station/Dredging Site
- Equipment Management
- Fuel Transportation & Storage Management
- Noise Control
- Water Supply Management
- Wastewater treatment and disposal
- Solid waste management
- Erosion and Sedimentation Management in Dump Sites
- Storm water Management in Dump sites
- Vector Control
- Fire Control
- Safety
- Emergency management
- Future Development
- Rehabilitation of Dump Sites

Appropriate Environmental monitoring conditions will be developed as part of the OEMP.

9.0 SUMMARY AND CONCLUSION

9.1 Summary

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/ estuary to the sea in order to reduce the risk of flooding in surrounding areas and maintain balance on the existing ecosystem. The project is part of LWRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

9.1.1 Existing Environment

PHYSICAL

The focal area of interest is the coastal area adjacent to the river mouth traversing inland 15km to just upstream of Nawamagi. The embanked catchment is very different from Rewa and Ba Rivers dredging reaches. Sigatoka has undulating low hilly formation typical of the folding features of the coastal region extending from Sigatoka to Nadi. These hills contain fragmented rocks; many steep slopes are under cultivation and otherwise others have very thin cover. The low hills contribute gravel and pebbles to the sediment transport load; however the bulk originates from mountain ranges in the hinterland.

The river is fairly uniform, of minimal meander with flat strips of fertile valley land separated from each other by spurs running to the river edges. Exposed basalt on the left bank is seen on steep inland slopes; and in places this outcrops as fragmented rocks on the bank and inclining riverwards.

Weathering has masked the inter-bedding and layering between the marl and conglomerates on the right bank. This is the parent material to gravel and coarse sediments. In Figure 5.1 —2 is shown the Geological Map.

As the bedrock in Zone B, C & D is at shallow depth, the river maintains an average 2.5m normal flow depth of deep channel and width 150m which only widens below the bridge past the low hills. The shallowness of the upstream bedrock requires detailed mapping for dredging context. Survey by SOPAC identified a 13m deep trench in the section by Lawai. A deep channel width of 50m x 5m deep is proposed.

Baseline Field survey revealed the following for :the Coastal Area from Korotogo Passage to Yadua Reef.

- Korotogo - littoral drift at Korotogo during incoming tide measured at 2m/sec near-shore and slowing towards the passage.
- Yadua - Very strong cross-currents noted along the western coastal strip strongly influenced by local geo-formations.
- Nett drift westwards 10m/min.
- Very steep beach slopes 1: 3 approximately.
- Central region – the River mouth & central region has very high energy with very long open fetches. Waves breaking at 4m/sec on the sand bar which has high social usages.

BIOLOGICAL

From findings on field inspection, the Sigatoka River mouth fits the classification of a Current Dominated Delta.

A total of four distinct land coverage zones were identified along the *Sigatoka* River within the proposed dredging sites by field survey undertaken in October & November, 2012 and the high resolution imagery acquired for the site.

In general, the vegetation pattern along the *Sigatoka* River has undergone changes from impacts of development
(sugar cane farming, settlement and town) along the river especially as one go from the upper river to the lower river mouth. The vegetation towards the river mouth mainly composed of dense mangroves (*Bruguiera & Rhizophora*) and mangrove associates are intact while the advent of sugar cane farming and settlement has seen some removal of mangroves and the introduction of trees such as the common rain tree, invasive *vavai* and rain trees.

SOCIO—ECONOMIC

The Study revealed that people living in the proposed development area is generally healthy and the majority of the people living on the development area have satisfactory methods of collecting and treating waste-water generated from domestic, commercial and industrial premises through water closet/ septic tank/percolation trench system and water-seal privies.

Domestic Water supply is sourced from the Water Authority of Fiji main for the Sigatoka Municipality and surrounding areas to include all villages and settlements situated along the Sigatoka River to the coast. No one uses the river as source for domestic water supplies except to swim in and for animals to drink and bath in. However the Sigatoka river has a lot of resource in it that are used by the local population for home use as well as for economic purposes. Such like commodities are kai, crabs, prawns and firewood.

There are approximately 800—1,200 house holds living around the development area with a population of approximately 1,700 people living in Sigatoka Town and about approximately 7,988 living in the immediate vicinity of the development site. Overall residents are enthusiastic about the development with most seeing this as a way of mitigating and preventing flooding in the future. Hence saving of damages to properties and lives. The development will boost income generation within the Sigatoka area especially in the agricultural and tourism sectors.

9.1.2 Potential Environmental Impacts

A qualitative risk analysis was used to rank and manage the potential environmental and social effects for the construction and operational phases of this project. The ranking is based on The Check - List method of assessing environmental impacts.

The CHARM, method of identifying, assessing, quantifying natural hazard risks and providing appropriate mitigation measures for the same was also used.

The project development has been phased for discussion purposes. Phase 1 being the Construction Phase and Phase 2, the Dredging Operation Phase.

Phase 1 will be in two stages. Stage 1 of phase 1 includes earthworks. Stage 2 of Phase 1 the preparation of allocated sites and construction of infrastructure and installation of equipment for use during the Dredging Operation Phase.

The greatest potential impact during Stage 1 of Phase 1 is considered to be associated with the use of heavy machinery and the potential speed of deliver truck movements along the main Queen's on to Sigatoka Valley And Kavanagasau roads. Secondary impacts of this would include safety of pedestrians, noise and dust. If managed properly these impacts would be medium term and reversible.

The biological environment and its habitat is likely to be impacted as a results of land being cleared of vegetation, earth excavation works and fills and road construction which will likely result in erosion and sedimentation. Although risks are considered to be low to moderate impacts are deemed reversible and short term. The report has provided appropriate mitigation measures for habitats that will be affected and for species that will be removed, damaged or violated through the proposed development.

Stage 2 of Phase 1 is likely to have minimal environmental impacts provided responsible construction methods and procedures are applied by owners/contractors. The biological environment and its habitat is likely to be impacted still as result of excavations required to be carried out as part of some activities in Stage 2. The Traffic impact discussed in stage1 will still apply and consideration will need to be paid to neighbours with regards to noise and visual impacts as these have the potential to be significant.

The operational impacts that the dredging development is likely to have on the surrounding physical and social environment are considered to be long term and generally relate to issues associated with initial changes of the development area. These impacts relate to physical effects like river bank erosions, water quality depletion, ecological effects relating to fisheries, traffic increases, visual amenity changes, transportation and storage of fuel on site, dump sites management, solid and hazardous waste management and emergency and natural disaster management.

The potential positive socio - economic impacts arising from this project relate to:

- Reduction in subsistence crop damage
- Reduction in Damages to sugar cane crops
- Saving for Damages to Residential/Commercial Property and Loss of Lives
- Reduction of Pollution in River
- Land Reclamation through dredging
- Creation of Opportunities for provisions of social amenities through dredging
- Creation of Opportunities for sustainable resource management

Potential adverse socio economic impacts may include:

- Impact of dredging on navigation
- Amenity and Landscape Value
- Loss of Land use Options
- Possible loss of Resources and Rights.

9.1.3 Recommended Mitigation Measures

Management, technical systems and procedures were identified to control risk. Controls should be developed in accordance with the hierarchy of controls, (i.e. elimination, then substitution, then engineering controls, then administrative or procedural controls, and finally personal protective equipment).

Impacts during construction are proposed to be mitigated by:

- The use of sediment traps during construction activities close to the drains and the water course.
- No major earthworks will be undertaken during periods of heavy rainfall.
- Limiting construction activities to daylight hours.
- Generators being suitably encased or bunded to reduce noise emissions.
- Fuel being stored in appropriately sealed tanks and bunding placed around the tanks.
- Implementation of Proper fuel management methods and procedures.
- A traffic management plan being developed and implemented in order to minimize the potential for accidents.
- Ensuring safety and precautionary measures when earthwork is occurring.
- Notices and signage are to be put in strategic places to inform general public of significant traffic movements and peak work hours at development site.
- A 40 km/hr to imposed on the development area during Construction phase.
- Only experienced and qualified operators are to be employed to use the machines.
- Operators are to ensure that the best of cutting technologies and techniques are used through out.

Operational Impacts are proposed to be mitigated by:

- The developer is to ensure provision of adequate potable water and reliable water supply in the development area in the operation phases.
- The developer is to research supplementary water sources like the use of storage tanks for rain water harvesting On work sites.
- Provisions for storage on work sites of garbage and refuse and proper disposal of solid waste.
- Regular maintenance and cleansing of all drains leading to water courses and coastal waters from the dredged spoil dump sites to ensure un-interrupted flow that would lead to chaotic health and sanitation problems.
- Regular cleansing and maintenance of equipment and facilities on site.
- Regular monitoring of creek and coastal water quality to ensure proper and safe dredging operation.
- Warning swimmers and bathers through signage of potential public Health risks on river and creek swimming should the need arise.
- Management putting into place a hazard emergency and management plan to ensure safety of community and minimum disruption to services.
- Rehabilitation and Re-vegetating the spoil dump site with appropriate species after use.

In addition to the above the following are also recommended:

- Depth of dredge channel should not exceed design bed level of 3.5m.
- Spoil dumps require traps to confine the spoil for areas where dumps are located may be subject to erosion.
- There may a need to extend the pipeline beyond the normal 1 km range in such instance additional booster pumps are to be used.
- Joints of infrastructural pipe works for dredge spoil pipes to be closely looked at for proper allowance in movement from earthquake.
- Sediment traps are to be constructed on the edge of the salt marsh end of dump sites on Marshland. Dumping to begin from the edge of the marsh moving inland. It is recommended that the adjacent salt marsh is preserved for wild ducks who visit the area locally.
- Gabion baskets and silt-traps/screens/ponds should be used to manage silt transportation and deposition during dredging operations.
- For agricultural purposes, reclamation of areas using spoil needs proper management. Soil acidification will occur if the soil is comprised of anaerobic mangrove soils. Liming will help neutralise the soil.
- Building cement structure on top of soil is to be avoided due to the likelihood of subsidence and cracking of the structure.
- The recommended timing of the dredging operation should be during May to October so as not to interfere with the prawn fishery.
- LWRM to monitor surface water quality of the Sigatoka River utilising the 5 established sampling stations.
  Details for requirements for the monitoring is in the attached Management plan.
- Rapid siltation, poor drainage of the Sigatoka basin and uncontrolled soil erosion from bad land use practice would continue even at the end of the dredging project. Flood problems would definitely return after
  temporary relief. However an awareness and education programme for land users to be seriously considered by LWRM for implementation.
- It is important that due to the current and forecasted future investment in Sigatoka an integrated approach to flood control should be considered by the government to minimise flooding in the long-term.

The following issue should be dealt with simultaneously or staggered in stages:

- Improve drainage of Sigatoka Town and surroundings;
- Implement a Water shed management Strategy, including Water Resource Management, River Management, Environmental Management and Land Use Management and conservation.
- Bank protection and river channel.
- Stakeholder and community participation.
- Improve waste Management and Pollution Control.

Conclusion

The proposed dredging development project by LWRM is likely to have significant economical benefits to the local area, the region and the Country of Fiji and local residents are likely to benefit from the increase in productivity of the land through job opportunities.

The potential adverse effects of the development on the surrounding environment and community are recommended to be managed and mitigated by producing an Environment Management Plan containing the following documents:

- Construction Environmental Management Plan (CEMP)
- Operational Environmental Management Plan (OEMP)

Monitoring should be carried out during both the construction and operation phases to record environmental impacts of the development on the environment and for LWRM to apply appropriate remedial actions when ever required.

In addition monitoring will enable LWRM to foresee and forecast any form of management issues occurring or about to occur at current and next stage of development to be able to steer the development back immediately to its proper course.

10.0 LIMITATIONS

This EIA report was prepared to address specific site issues on the proposed development for LWRM based on CEC's understanding of the scope of works.

CEC has prepared this report exclusively for LWRM for specific application to the subject project, and locations/areas identified in this report according to generally accepted practices.

CEC accepts no responsibility or liability for the use of this information for any other purposes.

11.0 STATEMENT OF RESPONSIBILITY

12.0 REFERENCES

- Sinclair Knight Mertz; *EIA Study Report on dredging of Nadi River.*
- Sinclair Knight Mertz; *EIA Study Report on dredging of Navua River Mouth,*
- Coreregа Environment Consultancy; *EIA Study Report on dredging of Ba River.*
- Coreregа Environment Consultancy; *EIA Study Report on Gravel Extraction at Keiyasi in Sigatoka River .*
- Water Quality Study Report on Sigatoka River, SOPAC
- Kai Study Report on the Sigatoka River
- Remi Odense & Bob Lloyd; *Flood Hazard Assessment And Tidal Current Measurement of the Nadi Bay Amusement Park Area*
- Wayne C. Teng ;1971. *Foundation Design*
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- Pitman, C. Chung, Q. and Smith, R; 2001. *Coastal Processes and Erosion at Tagaqe Village, Coral Coast Fiji Islands.* SOPAC.
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- Sustainable coastal Resources management For Fiji, *A Background Paper prepared for the Fiji National Workshop on Integrated Coastal Management:* April 9-11, 2002 Suva, Fiji
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- Salvato.A.J; *Environmental engineering and sanitation.*
- Davies.R.E. & Davies; *Handbook of Environmental health.*
- Sawyer & McCarty; *Chemistry for environmental engineering.*
- John Wiley & Sons; *Water & Waste water Technology.* Mark J Hammer
- Metcalf & Eddy, INC. *Waste water Engineering Treatment Disposal & Reuse - George Tchobanoglous*

Other Studies:

- A Feasibility Study on Sigatoka River Dredging
- Water quality data.
- Hydrology report.
- EIS report done by the department some years ago.

TECHNICAL REPORT
River Aggregate Assessment in Nakavu Navua and Naduri Sigatoka and the Sigatoka Sand Dunes, Southern Viti Levu, Fiji.
Akuila K. Tawake, SOPAC Secretariat, April 2009 one showing key details as appropriate.

EU EDF 8 – SOPAC Project Report 139, Reducing Vulnerability of Pacific ACP States
FIJI TECHNICAL REPORT River Aggregate Assessment in Nakavu Navua and Naduri Sigatoka and the Sigatoka Sand Dunes, Southern Viti Levu, Fiji; April 2009

APPENDIX

CONTENTS

APPENDIX: A

TERM OF REFERENCE (TOR)

SIGATOKA RIVER DREDGING CHANNEL

Terms of Reference

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

Ministry of Primary Industries
Land and Water Resource Management Division
Robinson Complex
Grantham Road
Raiwaqa.
P. O. Box 1292
Suva.
Telephone: (679) 3383155
Fax: (679) 3383546

CONTENTS

ACRONYMS AND ABBREVIATIONS

DOE	-	Department of Environment
EIA	-	Environmental Impact Assessment
EMA	-	Environmental Management Act (2005)
LWRM	-	Land and Water Resource Management Division
MRD	-	Mineral Resources Department
NGO	-	Non-Governmental Organisation
NLTB	-	Native Land Trust Board
STC	-	Sigatoka Town Council
TOR	-	Terms of Reference

1. INTRODUCTION

This document presents the Terms of Reference (TOR) for the Environmental Impact Assessment (EIA) of the proposed dredging works in Sigatoka River. The TOR is adopted from both local and international environmental assessment guidelines for the planning and execution of coastal and estuarine dredging works and disposal of the dredged materials. The Land and Water Resource Management (LWRM) Division of the Ministry of Primary Industries has prepared the TOR for the consultants to conduct the EIA and report accordingly.

The EIA is a technical study, which will examine the potential environmental impacts (both positive and negative) of proposed dredging works in Sigatoka River and will identify appropriate mitigative/optimisation measures. Mitigative and/or optimisation measures are those procedures or protocols that should be employed to ensure that negative effects are minimised and positive effects are maximised during the dredging works.

Additional options identified during the environmental assessment process such as location of potential spoil dumpsites shall also be considered wherever applicable. Following the assessment study, an EIA Report will be produced and submitted to both LWRM and DOE.

2. REVIEW

The LWRM Division has initiated a project of outsource dredging of the Sigatoka River including the river mouth/foreshore area and to review disaster mitigation program in order to reduce vulnerability and impact of flooding. LWRM would prepare the detailed design of the project and the execution of dredging works may be either outsourced or undertaken by the LWRM. The overall design dredge channel would be approximately 20 km long from the river foreshore to upstream of Nawamagi area. The channel would extend approximately 4.0 km into the offshore from the river mouth at the depth of at least 5.0m. The depth of the whole river stretch will decrease as we move upstream in order to maintain its river gradient. The subject area is depicted in **Appendix A.**

3. PURPOSE OF PROJECT

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/estuary to the sea in order to mitigate the risk of flooding in surrounding areas. The project is part of LWRM's ongoing flood mitigation programs under which various other major rivers namely Navua, Qawa, Labasa, Wailevu, Ba, Nadi and Rewa have been dredged both in the past years and recently.

4. EIA STUDY

The EIA study should incorporate the effects of the proposed works on the environment. In this regard, the environment includes all relevant aspects of the natural, biological, biodiversity, flora and fauna, fisheries and marina resources.

The EIA must evaluate the expected effects on human health, activities of communities within the impact area, the natural environment and on real estate and infrastructures. The study therefore requires a multi-disciplinary approach in order to assess the project for its environmental feasibility. Furthermore, the EIA study must recognise the legislative requirements of the *"Environment Management Act (2005)"* and the EIA reporting should adhere to the standards defined in the Act and its regulations.

The key focus of the EIA study should be as follows:

- Gather and collate existing information
- Undertake comprehensive sampling and surveying of existing conditions
- Identify and assess impacts of the proposed dredging works
- Assess the proposed dredge spoil sites
- Assess and evaluate all impacts (positive and negative) of the project
- Define potential impact mitigation measures and recommend feasible measures at impact levels where these should be implemented
- Design an adequate environmental management plan for monitoring the actual impacts of the dredging project and assessing the need to adopt necessary mitigation measures.

5. SCOPE OF WORK

The scope of factors to be taken into consideration in the EIA Report is described in this section. Should additional relevant issues, concerns, or potentially significant environmental effects (positive and negative) be identified through discussion with the regulatory agencies, other stakeholder consultation or in any other recognised way, these factors must be incorporated into the assessment of the potential environmental impacts of the project. The assessment will include consideration of, but should not be limited to guidelines in this section.

Potential project-related environmental effects (positive and negative), resulting from dredging and the operation of dredging works, and dumping of dredge spoil on disposal sites (including potential environmental effects resulting from accidents or malfunctions) should be included in the assessment. These environmental effects should be characterized (i.e., magnitude, frequency, duration, geographic extent, reversibility, ecological and socio-cultural and economic aspect) and their significance should be determined based on residual environmental effects. The environmental effects of the project should be compared to the Status Quo or "no action" alternative.

The following core tasks must be performed for the preparation of the EIA report:

5.1 Executive Summary

A concise executive summary of the EIA should be provided in a non-technical language with the findings and recommendations. The evaluation of the environmental assessment should examine both the short-term and long-term effects as well as the sustainability of the altered environment.

5.2 Introduction

Identify the development project to be assessed and explain the executing arrangements for the EIA. Include the following aspects:

- Describe the rationale for the development and its objectives.
- Describe the context for the proposed dredging works in relation to plans for development of the Sigatoka Watershed, Sigatoka Township and in particular, Sigatoka lower reaches. Information on this aspect can be obtained from organisations such as LWRM and STC.
- Briefly describe the major components of the proposed project, the implementing agents, a brief history of the project and its current status.
- Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project (e.g. dredged material disposal sites).
- State the historical background in terms of flooding within the project area highlighting the losses and damages that have incurred and the type of rehabilitation works required.
- Tabulation of personnel involved in the preparation of the EIA, their expertise and their roles in the EIA process (this portion can be detailed in the appendices).

5.3 Description of the Proposed Project

Provide a full description of all relevant parts of the project, using maps at appropriate scales where necessary. This is to include description on:

- Quality and volume of sediments to be dredged in each area;
- Type of dredging equipment to be used and the manner of deployment including handling, transportation, and disposal of dredged material, sediment containment, settling and turbidity control measures;
- Alternative dredging methods;
- Project schedule;
- Life span of project;
- Justification of project in terms of cost/benefit analysis.

This section should give a detailed statement of all the critical activities, which will be involved in the proposed project including start-up and commissioning through to operational phase of the facilities.

5.4 Description of the Existing Environment

Description of the environmental setting is a record of conditions prior to implementation of the proposed project. It is primarily a benchmark against which to measure environmental changes and to assess impacts. Baseline data should be assembled, evaluated and presented based on the relevant environmental characteristics of the study area (and disposal sites), including the following:

5.4.1 *Physical Environment*

The description should include but not be limited to the following aspects:

- Geomorphology;
- Meteorology (rainfall, wind, waves and tides);
- Sea currents and bathymetry, as required;
- Surface hydrology and estuarine/marine receiving water quality;
- Drainage pattern and ground water table, as required for the subject area;
- Ambient noise.
- Sedimentation rate along dredge channel and long shore sedimentation formation

5.4.2 Biological and Ecological Environment

The description should include but not be limited to the following aspects:

- Terrestrial and marine flora and fauna;
- Rare or endangered species;
- Wetlands, coral reefs and other sensitive habitats;
- Flora/fauna species of commercial importance and species with the potential to become nuisances.
- Colonisation, spawning area and density numbers

5.4.3 Socio-Cultural Environment

The description should include but not be limited to the following aspects:

- Navigational/boating activities and use of the river;
- Population and land use;
- Planned development activities;
- Employment, recreation and public health;

- Archaeological and historical sites (especially in relation to sand dunes formation and its actual position on the ground and dredge dump sites);
- Community perception of the development and vulnerability of occupants.

5.4.4 *Hazard Vulnerability*

The description should include but not be limited to the following aspects:

- Vulnerability of area to natural disasters such as flooding, hurricanes, storm surge, tsunami and earthquakes. Characterise the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. A frequency analysis of the aforementioned natural disasters should also be included especially rainfall and the corresponding flooding.

5.5 Legislative and Regulatory Considerations

This section of the report should describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project. Relevant authority jurisdictions that will specifically apply to the project should also be identified.

5.6 Potential Impacts of the Proposed Project

Impact identification should be seen as a critical step in the EIA. The process usually consists of two stages. First, an exhaustive list of all impacts is drawn up. Then the impacts are selected, based on magnitude, significance, extent and spatial sensitivity, for further study.

Magnitude refers to the amount of change to be created by the impact. For some impacts, magnitude is calculated by computer modelling. Significance refers to the actual effects. it looks beyond magnitude. Extent refers to the area to be affected. Quantification of impacts is a technical aspect of an EIA. For some impacts, the theoretical basis for computing the magnitude does not exist. Such impacts may have to be addressed in a qualitative way.

Impacts related to dredging, spoil disposal and possible land filling should be identified. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making.

5.6.1 *Physical Environment*

The effects of the project (dredging and spoil disposal) on water quality, sedimentation, stability of adjacent river banks and shorelines should be assessed. The impact assessment should include but not be limited to the following aspects:

- River bank erosion;
- Water quality (Salinity, Dissolved Oxygen, pH, Temperature and Turbidity);
- Sediment movement/sedimentation;
- Wave energy;
- Tidal flushing/storm surge;
- Wind speed;
- Drainage pattern;
- Ground water table.

5.6.2 *Biological and Ecological Environment*

The effects of the project (dredging and spoil disposal) on existing river/coastal and adjacent ecosystems and resources should be assessed. Changes in water quality, flow, sediment drifts, flooding and sedimentation may affect the coral reef system, coastal sea floor, river/estuaries, mangroves and other ecosystems which need to be identified and assessed. The impact assessment should include but not be limited to the following aspects:

- Sediment toxicity (if any) on the marine flora and fauna;
- Change in marine ecosystems;
- Effects on marine resources such as reproduction and migration.
- Colonisation, spawning area and density numbers

5.6.3 *Socio-Cultural Environment*

The interaction between the human environment and the ecological environment must be evaluated from which the impact of the project should be assessed. The impact assessment should include but not be limited to the following aspects:

- Maritime, boating/navigation, road traffic, fishermen, and rights/operations of any other stakeholders;
- Future development and the tourism sector;
- National heritage, archaeological/historical and burial sites;
- Ambient noise levels.

5.6.4 *Hazard Vulnerability and Risk Assessment*

The effects of the project (dredging and spoil disposal) on vulnerability of the area to flooding, hurricanes, storm surge, tsunami and earthquakes should be assessed. Furthermore, the risk associated with the operation of the project should be assessed, preferably with use of appropriate matrices.

5.7 Socio-Economic Analysis of Project

The socio-economic characteristics of the area in the project proximity should be identified. The impacts of the proposed project on the socio-economic environment should then be analysed.

The analysis should include the use of land, the main economic activities e.g. tourism, agriculture and fisheries, the social status of communities, employment levels and the existence of archaeological or historical sites. Impacts should be categorised as positive and negative. Examples of negative impacts include pollutants discharged that have potentially adverse effects on water bodies of economic importance. Positive impacts include creation of jobs, decrease in flooding risks, public health and safety, upgrading of physical infrastructure, and training of workers.

5.8 Mitigation and Abatement Measures

It is recognised that to eliminate an adverse environmental impact altogether is seldom possible, but it is often feasible to reduce its intensity. This reduction is referred to as mitigation. For each potential adverse impact identified, the plan for its mitigation at each stage of the project should be documented and its cost assessed. It is essential that these costs of mitigation be adequately assessed and be fully documented. This is very important in the selection of the preferred alternatives. In the case of beneficial impacts it should be demonstrated how these can be maximised.

Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to dredge spoil disposal and dispersal/sedimentation control, as well as measures to minimise disruption to existing navigational operations of the river. Provide cost estimates of the mitigation measures and the equipments and resources required to implement those measures.

Mitigation measures recommended should be practical and readily implemental. These should be discussed with the proponent prior to finalisation of the EIA report.
The following factors should be taken into consideration:

- Wide consultation and public involvement

- Set tolerance limits for impacts
- Effective management of project

5.9 Analysis of Alternatives to the Proposed Project

All the alternatives taken into account in developing the project should be documented. For example, if the project were to be sited elsewhere, the impacts associated should be reviewed and the associated mitigation action and costs defined. Each alternative should be evaluated in respect of its potential environmental impact and capital and operating costs. The environmental losses and gains must be combined with the economic costs and benefits to give the full picture for each alternative. An analysis of the "no action" alternative should be included. Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative. This includes dredging vessel types and disposal sites. Distinguish the most environmentally friendly alternative.

5.10 Inter-Agency Coordination and Public/NGO Participation

Identify appropriate mechanisms for providing information on dredging activities and progress of project to stakeholders. The assessment can be co-ordinated with the assistance from relevant government agencies and in obtaining the views of local stakeholders and affected groups. It is anticipated that there will be considerable public interest concerning sediment disposal and turbidity and the economic benefits to be derived from the project.

The NGO's and the communities affected by the project implementation should be given the opportunity to be involved in the EIA study. This can take two forms, direct involvement of the affected public and the inclusion of local knowledge and expertise in the environmental study methodology. Local perceptions can be used to differentiate between those impacts that are of major importance in the locality and those, which are not.

The NGO's should include but be not limited to:

- Environmental NGO's
- Sigatoka Town Council
- Service Clubs
- Tikina Councils/Community Groups
- Native Land Trust Board

The above listed NGO's should be formally contacted in writing and be informed of the project. Comments should be sought from all parties who will be affected by the proposed action.

information obtained from NGO's and community groups can be of invaluable assistance in providing approaches to problem solving and resolving conflicts. This information obtained as part of the public consultations should be documented in the EIA report. The public consultation methods that may be employed depending on the size of the audience, expertise required, and the problem solving value should also be documented.

5.11 Development of Environment Monitoring and Management Plan (EMMP)

This section should focus on environmental monitoring, management and training. Environment management during the implementation of the project at both initialisation and operational phases should be documented. The training programme for employees of the facility should be generally outlined. This section should identify any institutional needs for implementing the recommendations of the EIA.

Identify the critical issues requiring monitoring/management to ensure compliance to mitigation measures and present impact management and monitoring plan for dredging/disposal operations and post monitoring plan for dredged and disposal site areas.

A detailed environmental monitoring/management plan should be described. The reasons for and the costs associated with the monitoring activities should be covered. It should be noted that some details presented might change depending on the final designs after the EIA preparation and review. These changes and provisions concerning such changes must be accordingly incorporated in the report.

The monitoring plan/programme should clearly state the:

- Institutional arrangements for carrying out the work
- Parameters to be monitored
- Methods to be employed
- Standards or guidelines to be used
- Evaluation of the results
- Schedule and duration of monitoring
- Initiation of action necessary to limit adverse impacts disclosed by monitoring
- Format and frequency of reporting

5.12 Summary and Conclusions

Appropriate conclusions should be drawn from the study. It would also be useful to summarise the environmental impact assessment, which must include but not be limited to the potential environmental impacts, mitigation measures supported by the benefit versus cost analysis.

5.13 References

Any publication or papers, both published and unpublished that were used as reference should be adequately listed.

5.14 Appendices

All required technical sampling protocols or sample data sheets should be included in the appendices. Any technical studies associated with the project should also be included.

6.0 RESPONSIBILITIES AND REPORTING

6.1 Consultants Responsibilities

The specific responsibilities of the consultant in the preparation of the EIA report are covered in this section and detail time line is highlighted in the contract document. Whatever the case may be, the consultant needs to have a clear understanding with LWRM as to what is expected in the following areas:

i.] **Scope of Work:** A preliminary scope of work (outlined in this document) has been developed by LWRM, and is provided to the consultants for their use in preparing technical proposals and/or presentations. Following selection of the most qualified consultant, LWRM and the consultant may negotiate and amend the work scope and schedule if need be. After contract execution, the consultant is responsible for carrying out the work specified in the negotiated work scope, within the specified budget and timeframe. Any subsequent revisions to the work scope or budget require LWRM's prior approval. In some cases, the contract will provide for further refinement of the study plan following preliminary investigations. Otherwise, the consultant must notify LWRM if a change in the work scope or level of effort appears warranted.

ii.] **Contacts within LWRM:** Although the Director (LWRM) is the primary link between the consultant and LWRM, it may be appropriate for the consultant to directly communicate with other LWRM staff. The Director (LWRM) may delegate certain responsibilities directly to the technical staff members. These direct contacts would be usually restricted to information gathering purposes.

iii.] **Contacts with Other Agencies:** The consultant may be involved in two kinds of contact with other agencies- informal and formal. Informal contacts to obtain background information on the project study area may be made without prior approval of Director (LWRM). However, the consultant is required to keep records of all informal agency contacts and to submit copies of those records with the regular progress reports. Formal contacts with other agencies for the purposes of discussing project impacts or mitigation measures may only be made with the specific approval of the Director (LWRM). The consultant will document the discussions, decisions and commitments made with these agencies and forward this information to the Director (LWRM).

iv.] **Report Requirements:** The type of report, due dates, number of copies, and review periods will be specified in the contract.

v.] **Presence at Project Meetings:** The consultant is expected to attend certain project meetings where environmental issues will be discussed to gain firsthand knowledge of project details and to include environmental data in project decision-making. These meetings may include project scoping meetings, project development team meetings, interagency coordination and consultation meetings, and field reviews.

vi.] **Other Deliverables:** Several work products may be required from the consultant in addition to the EIA report described in detail in this document. These other products are briefly described below:

Inception / Progress Report: The consultant should submit this report with the invoice for payment. Its purpose is to document that the contract requirements have been met to date and to summarize the contacts made with outside agencies. The contract may specify other items to be included in this report, such as problems the consultant has encountered in carrying out the work.

Interim Report: The purpose of this report is to check the progress of the consultant's work to date in order to determine if any redirection of the consultant is required to meet the contract objectives. Typically, the consultant at the completion of major work phases prepares an interim report, which includes aspects such as background research or field studies and it presents the information that has been gathered.

Plan of Study: In some situations, a detailed scope of work cannot be developed during initial contract negotiations, and some decisions may be deferred until after the consultant has begun the investigation. For example, it may not be possible to define a field survey strategy until the background research has been completed. Alternatively, the results of initial field surveys may be required to establish the need for, or scope of,

fieldwork that is more intensive. In these cases, the contract may outline a phased approach, and require the consultant to prepare a more detailed study plan for LWRM's review and approval.

Draft EIA Report: The consultant would be required to prepare a draft EIA report outlining potential mitigation measures that would reduce project-related impacts on the environment. Other items included in this report may be strategies for monitoring and evaluating the success of potential mitigation measures. This report may be prepared prior to discussions with regulatory agencies. The mitigation measures are only recommendations until they are part of an environmental document as accepted by LWRM.

Final EIA Report: The consultant is required to prepare a detailed and final EIA report including an Environment Management Plan for carrying out the mitigation measures that is specified in the EIA Document.

Responses to Comments: The consultant will be required to prepare responses to comments received on the Draft EIA Document.

vii.] **Involvement after the EIA Document Phase:** The consultant's services may be required beyond the submittal of the EIA report. These services may include items such as updates on the environment management plans.

6.2 Reporting

6.2.1 Contents

The EIA report, to be presented in digital format and hard copies, should be concise and focus on significant environmental issues. It must contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental impact assessment report should be organized according to, but not necessarily limited by, the outline suggested below.

- Executive Summary
- Description of Proposed Project
- Policy, Legal and Administrative Framework
- Description of the Existing Environment and Hazard Vulnerability
- Significant Environmental Impacts
- Impact Mitigation Measures
- Inter-Agency and Public/NGO Consultation Process
- Environmental Monitoring/Management Plan
- Conclusions and Recommendations
- List of References / Appendices

6.2.2 *Report Review and Approval*

All reports prepared by consultants for LWRM will be submitted to LWRM in draft and undergo a review before being accepted by Director (LWRM). The review will usually be performed by LWRM staff (mainly technical staff) and may also be performed by external agencies with special expertise or regulatory responsibility at the discretion of the LWRM Division. Public involvement in the review process is also at the discretion of LWRM. The draft EIA report may be distributed to organizations, like the Department of Environment, Ministry of Health (rural local authority), NLTB, STC etc. and a public presentation may have to be arranged by the proponents and consultants.

The review will focus on the following areas:

- Meeting contract commitments
- Coverage of study area
- Legal compliance with applicable environmental laws
- Technical accuracy.

Comments will be returned to the consultant who will revise the draft document in response. The consultant or LWRM may request a meeting to discuss the comments. If comments are extensive, the Director (LWRM) may request a second draft be prepared which would undergo a second round of review. After revisions are made, the consultant will be required to submit the report in final form to LWRM and DOE. The contract would specify the review and revision periods allowed, and how many copies of the reports are to be submitted.

The report must be dated and signed by the consultant or consultant's representative. The signatory will assume full responsibility for the contents of the EIA report.

Furthermore, the consultant will be responsible for attaining approval for the EIA report from the DOE and in doing so, comply with the necessary procedures in accordance with the EMA and its regulations on behalf of LWRM.

APPENDIX A

SIGATOKA RIVER DREDGE CHANNEL LAYOUT for EIA STUDY

APPENDIX: B

RISK ASSESSMENT METHODOLOGY-CHARM

- The assignment requires that the physical environment be identified, the risks to vulnerable elements thereon assessed and mitigation measures planned to reduce the adverse impacts of these risks.

The approach adopted is based on the Comprehensive Hazard and Risk Management approach (*CHARM)* that Fiji government in its National Strategic Plan requires of all project proposals. CHARM has been adapted from the joint Australia/NZ Risk Management Standard.

It is a systematic risk management process comprising these steps: (a) Risk Management Context (b) Identifying the Risk (c) Analysing the Risks (d) Evaluating the Risks (e) Developing Risk Reduction Measure

3.1 Establishing the Risk Management Context

Very simply this describes the systems that are in place by which decisions are made "how are decisions made" and the many different factors that influence decision making "what influences the decision making".

3.1.1 The Context of How Decisions Are Made

- For decision-making on this Project, referral has to be made to a number of specific legislations particularly those pertaining to the concerns on environmental sustainability, the meeting of service requirements as embedded within the authorities of the local councils, the national development strategies and required approval processes, the culture of resource management as practiced traditionally as well as other decision - management framework serving community needs.

3.1.2. The Context of What Influences Decisions

- The decisions to be made will be influenced by the benefits and losses assessed from the impact that the Project will have on the community and the nation. A holistic comprehensive assessment of impacts is needed for which the Consultant has opted for the "HELPERS" risk assessment in developing risk evaluation criteria:

  Health
  Economy
  Livelihood
  People (and Society)
  Environment
  Reputation
  Sustainability

This organised approach adds value to the standard measures of risks using frequency of occurrence of event matched against the level of assessed consequences.

Table 1 Likelihood Descriptors

Almost Certain	Yearly return period
Likely	About every 5 years over the last 20 years
Possible	At least once per generation
Unlikely	Every 100years
Rare	Over 100 years return period

Table 2 Consequence Descriptors

Insignificant	
Minor	Some damage, little disruption to community. Some impact on environment with no lasting capacity. Some impact on revenue capacity.
Moderate	Significant damage. Some community disruption with temporary displacements. Wide impact on environment but with little long term effects.
Major	Significant numbers displaced for short periods. Significant damage requiring external assistance. Community functioning with difficulty. Severe impacts on the environment with long terms affects. Serious impacts on the revenue capacity.
Catastrophic	

Table 3 Risk Rating Descriptors

E – extreme	Extreme Risk immediate action required
H – high	High Risk senior management attention required
M – moderate	Management responsibility must be specified
L – low risk	Manage by routine procedures

Table 4 Levels of Risks (Likelihood/Potential Consequences)

Consequencesà **¯Likelihood**	Insignificant	Minor	Moderate	Major	
Almost	H	H	E	E	E
Likely	M	H	H	E	E
Possible	L	M	H	E	E
Unlikely	L	L	M	H	E
Rare	L	L	M	H	H

The methodology above is an overarching approach that Corerega Consultants is incorporating overall in its communication and consultation processes particularly with specifics on the disciplines reflected in the TOR.

APPENDIX: C

COMMUNITY PARTICIPATION

APPENDIX: C1– SOCIO-ECONOMIC IN COMBINATION SURVEY QUESTIONNAIRE

SOCIO-ECONOMIC SURVEY.

QUESTIONNARE.

1. **RESIDENTS DATA:**
   - 1.1. NAME OF VILLAGE
   - 1.2. NO. OF HOUSEHOLD:
   - 1.3. NO. OF POPULATION SURVEYED:

2. How long have you lived here? Please give a tick in the appropriate column.

☐	Less than 12 months
☐	Between 1 year – 5 years
☐	Between 5 years – 10
☐	More than 10 years

3. **LAND OWNERSHIP:**
   3.1. What is your entitlement on the land you live on? Please give a tick where ever applicable.

☐	Owner
☐	Lessee
☐	Squatter
☐	Other: Got married in this village.

4. **KNOWLEDGE OF THE LAND TO BE DEVELOPED:**
   4.1. Do you recognize the proposed dredging area marked on the sketch plan?

☐	YES *(Also one has been carried out some years ago.)*
☐	NO

   4.2. How far away is it from where you live?

☐	1m – 500m	☐	500m-1km
☐	1km – 3km	☐	More than 3km

5. PYSICAL & BIOLOGICAL:

5.1. Do you know of anything that the area is renowned for? Please tick beside where ever applicable?

	Herbal Medicine.		Bird and Aquatic Habitat Area		Flood
	Prawn & Fish Catching Area.		Fire Wood Collection Area.		Earthquake
	Mussel & Sea weed collection Area.		Subsistence Crop Cultivation		Landslide
	Crab Catching/Trapping Area.				Kai Diving Area

6. FISHERIES:

6.1. Do you or any family members catch fish, crab or kai along the Ba river?

	YES
	NO

6.2. How often do you go fishing along the Ba river?

	Every day.
	Once a week.
	Once a month.

6.3. At what time of the day do you go fishing?

	Day *(Depend on the tide)*
	Night *(Depend on the tide)*

(Use of fishing net)

6.4. What type of fishing do you carry out per trip? (Please identify study zone shown on attached map.)

	No. of Crab Trap.
	No. of Kai collected bags(10kg bag)
	No. of Prawn caught.
	No. of fish caught.

Study Zones Identified:

A		B		C		D		E	
A		B		C		D		E	
A		B		C		D		E	
A		B		C		D		E	

Key [*] Identified study zone where fish species is caught.
[-] None catch zone.

Note: The study zone identified is where the community catch fish and prawn trap crab and dive for (kai) fresh water mussel along the Ba river.

6.5. If by boat, is it powered by engine?

[ ] YES
[ ] NO

If yes please specify the type of engine power.....

.....

6.6. What type of fish species do you catch per trip?

Species: No. caught Study Zones Identified:

No.			ZONE A		ZONE B		ZONE C		ZONE D		ZONE E	
1			A		B		C		D		E	
2			A		B		C		D		E	
3			A		B		C		D		E	
4			A		B		C		D		E	
5			A		B		C		D		E	
6			A		B		C		D		E	
7			A		B		C		D		E	
8			A		B		C		D		E	
9			A		B		C		D		E	
10			A		B		C		D		E	
11			A		B		C		D		E	
12			A		B		C		D		E	
13												

Key [*] Identified study zone where fish species is caught.
[-] None catch zone.

Note: The study zone identified is where the community catch fish and prawn trap crab and dive for (kai) fresh water mussel along the Ba river.

6.7. Where do you collect fire wood for cooking?

[ ] Mangrove area.
[ ] Other place please specify.....Farming area.....

6.8. What type of fire wood species do you collect?

No. Household SPECIES

[ ] Dogo
[ ] Vaivai
[ ] Others...Oki./ Vaivai Dina / Mocemoce.....

Study Zones Identified:

A		B		C		D		E	
A		B		C		D		E	
A		B		C		D		E	

Key [*] Identified study zone where fish species is caught.
[-] None catch zone.

6.9. How many bundles do you collect per week?

- ☐ 2 Bundles
- ☐ 4 Bundles
- ☐ 6 Bundles
- ☐ More than 6 Bundles.

7. PUBLIC HEALTH ASPECT:

7.1. Has any member of the family experienced skin ailments when swimming in the waters of the proposed development area?

- ☐ Yes
- ☐ No

If the answer is YES please state the cause_____

7.2. What is your domestic water supply source?

- ☐ Rain Water.
- ☐ Spring Water.
- ☐ Well Water.
- ☐ Pipe water source from up land stream.
- ☐ PWD treated water supply pipe.
- ☐ River Water

7.3. What method of night soil disposal facility has you in place?

- ☐ Septic Tank & Percolation trench.
- ☐ Water seal privy.
- ☐ Ordinary pit privy.
- ☐ Soakage pit grayish waters.

7.4. What types of disease are common in your community?

- ☐ Diarrhoea
- ☐ Dengue
- ☐ Others_____

8. ECONOMIC & SOCIAL ASPECTS:

8.1. Do you think the dredging of Ba river will be of benefit to the community?

- [ ] Yes
- [ ] No

8.2. How would it benefit you?

- [ ] There will be less flesh floods.
- [ ] Will be able to improve on existing financial status.
- [ ] More fish and bigger in size to catch.

9. POSTIVE & NEGATIVE IMPACTS:

9.1. Please indicate issues that will positively affect you and your environment resulting from the development?

- [ ] Increase in amount of fish we catch.
- [ ] Provision for good basic amenities.
- [ ] Land reclamation inland and along the river.
- [ ] Others: Farm will be safe.

9.2. Please indicate with a tick in appropriate boxes issues that will negatively affect you and your environment resulting from the development?

- [ ] Loss of Kai area.
- [ ] Water to deep to dive for Kai.
- [ ] Traffic congestion during construction & operation phase.
- [ ] Sediments in water.
- [ ] Soil Erosion.
- [ ] Loss of firewood supply area.
- [ ] Loss of crab catching area.
- [ ] Loss of prawn catching area.
- [ ] Others: Spoils kills cassava when planted on the filled land.

9.3. Please indicate other issues that you think will be of great concern to the environment surrounding the dredging of Ba river, the people that live around it and the people that work in it? (continue at the back of page if deemed necessary)

A. In the Construction Phase:

B. In the Operation Phase: During the dredging operation

10. SUPPORT FOR DEVELOPMENT:

10.1. Please indicate where or not you support the dredging of Ba river?

- ☐ Support.
- ☐ Do not support.
- ☐ Not sure.

10.2. Do you wish to comment further on this development?

- ☐ Yes
- ☐ No

If YES, comment on space provided: _____

_____

_____

_____

_____

Thank You.

APPENDIX: C2- SOCIO-ECONOMIC IN COMBINATION SURVEY QUESTIONNAIRE RESULTS

SOCIO-ECONOMIC SURVEY.

QUESTIONNARE.

1. RESIDENTS DATA:
   1.1. NAME OF VILLAGE. (PERCENTAGE COVERAGE) Nalaga 17.5%, Natutu 45.5%, Koroqaqa 68.9%, Votua 17.2%, Nawaqarua 43.7%
   1.2. NO. OF HOUSEHOLD: 80
   1.3. NO. OF POPULATION:

2. How long have you lived here? Please give a tick in the appropriate column.

0%	Less than 12 months
1.25%	Between 1 year – 5 years
1.25%	Between 5 years – 10
97.5%	More than 10 years

3. LAND OWNERSHIP:
   3.1. What is your entitlement on the land you live on? Please give a tick where ever applicable.

98.75%	Owner
0%	Lessee
0%	Squatter
1.25%	Other: Got married in this village.

4. KNOWLEDGE OF THE LAND TO BE DEVELOPED:
   4.1. Do you recognize the proposed dredging area marked on the sketch plan?

86.25%	YES *(Also one has been carried out some years ago.)*
13.75%	NO

   4.2. How far away is it from where you live?

46.25%	1m – 500m
18.75%	1km – 3km
20%	500m-1km
15%	More than 3km

5. PYSICAL & BIOLOGICAL:

5.1. Do you know of anything that the area is renowned for? Please tick beside where ever applicable?

70%	Herbal Medicine.	26.25%	Bird and Aquatic Habitat Area	43.75%	Flood
88.75%	Prawn & Fish Catching Area.	88.25%	Fire Wood Collection Area.	1.25%	Earthquake
45%	Mussel & Sea weed collection Area.	51.15%	Subsistence Crop Cultivation	1.25%	Landslide
78.75%	Crab Catching/Trapping Area.			48.75%	Kai Diving Area

6. FISHERIES:

6.1. Do you or any family members catch fish, crab or kai along the Ba river?

91.25%	YES
8.75%	NO

6.2. How often do you go fishing along the Ba river?

53%	Every day.
27%	Once a week.
20%	Once a month.

6.3. At what time of the day do you go fishing?

75%	Day *(Depend on the tide)*
25%	Night *(Depend on the tide)*

(Use of fishing net)

6.4. What type of fishing do you carry out per trip? (Please identify study zone shown on attached map.)

5-35	No. of Crab Trap.
¼ - 3	No. of Kai collected bags(10kg bag)
1kg – 5kg	No. of Prawn caught.
5-100	No. of fish caught.

Study Zones identified:

A	-	B	*	C	*	D	*	E	-
A	*	B	-	C	-	D	-	E	*
A	-	B	*	C	*	D	-	E	*
A	*	B	*	C	*	D	*	E	-

Key [*] Identified study zone where fish species is caught.
[-] None catch zone.

Note: The study zone identified is where the community catch fish and prawn trap crab and dive for (kai) fresh water mussel along the Ba river.

6.5. If by boat, is it powered by engine?

28.75%	YES
68.75%	NO

If yes please specify the type of engine power.....15hp - 40hp,Village boat, Small tin boat.....

6.6. What type of fish species do you catch per trip?

	Species:	*No. caught*	*Study Zones identified:*									
			ZONE A		ZONE B		ZONE C		ZONE D		ZONE E	
No.												
1	Saqa / Dole	1-75	A	-	B	*	C	*	D	*	E	-
2	Shark (Baby)	2	A	-	B	-	C	*	D	*	E	-
3	Damu	3-100	A	*	B	*	C	*	D	*	E	-
4	Vai	2	A	-	B	-	C	-	D	*	E	-
5	Lulu (Small Kanace)	5-600	A	*	B	*	C	*	D	*	E	-
6	Sonisoni	5-400	A	*	B	*	C	*	D	*	E	-
7	Kakafia	3	A	-	B	-	C	-	D	*	E	-
8	Qitawa	5-40	A	-	B	*	C	*	D	*	E	-
9	Malea	5-9	A	-	B	-	C	-	D	*	E	-
10	Kawakawa	2	A	-	B	-	C	-	D	*	E	-
11	Kurukoto	10	A	-	B	*	C	-	D	*	E	-
12	Beleti	3	A	-	B	-	C	*	D	-	E	-
13	Ikasa	40	A	-	B	*	C	*	D	-	E	-
14	Kiki	20-140	A	-	B	*	C	*	D	-	E	-
15	Salala	90-240	A	-	B	*	C	*	D	-	E	-
16	Baba	3-60	A	-	B	*	C	*	D	*	E	-
17	Saku	2	A	-	B	*	C	*	D	-	E	-
18	Nuqa	30-60	A	*	B	*	C	*	D	-	E	-
19	Busa	5-120	A	-	B	*	C	*	D	-	E	-
20	Lua	90-120	A	*	B	-	C	-	D	-	E	-
21	Busa	3-120	A	-	B	*	C	*	D	-	E	-
22	Silasila	6-70	A	*	B	*	C	-	D	-	E	-
23	Baba	3-90	A	-	B	*	C	*	D	*	E	-
24	Buna (qaq)	3	A	-	B	-	C	-	D	*	E	-
25												

Key (*) Identified study zone where fish species is caught.
(-) None catch zone.

Note: The study zone identified is where the community catch fish and prawn trap crab and dive for (kai) fresh water mussel along the Ba river.

6.7. Where do you collect fire wood for cooking?

93.75%	Mangrove area.
21.25%	Other place please specify.....Farming area.....

6.8. What type of fire wood species do you collect?

No. Household	SPECIES
87.5%	Dogo
40%	Valvai
18.75%	Others...Oki./ Valvai Dina / Mocemoce.....

Study Zones identified:

A	-	B	*	C	*	D	*	E	*
A	-	B	-	C	*	D	*	E	*
A	-	B	-	C	*	D	*	E	*

Key [*] identified study zone where fire wood species are collected.
[-] None catch zone.

6.9. How many bundles do you collect per week?

50%	2 Bundles
40%	4 Bundles
10%	6 Bundles
0%	More than 6 Bundles.

7. PUBLIC HEALTH ASPECT:

7.1. Has any member of the family experienced skin ailments when swimming in the waters of the proposed development area?

17.5%	Yes
82.5%	No

If the answer is YES please state the cause... ***Kids suffer from scabies, skin infection and boil. Skin disease like ringworm due to the FSC discharge or town waste water. Skin rash, itch skin and water smell bad may be caused by FSC mill.***

7.2. What is your domestic water supply source?

0%	Rain Water.
0%	Spring Water.
0%	Well Water.
0%	Pipe water source from up land stream.
100%	PWD treated water supply pipe.
0%	River Water

7.3. What method of night soil disposal facility has you in place?

31.25%	Septic Tank & Percolation trench.
48.75%	Water seal privy.
30%	Ordinary pit privy.
0%	Soakage pit grayish waters.

7.4. What types of disease are common in your community?

26.25%	Diarrhoea
5%	Dengue
0%	Others.....

8. **ECONOMIC & SOCIAL ASPECTS:**

8.1. Do you think the dredging of Ba river will be of benefit to the community?

95%	Yes
5%	No

8.2. How would it benefit you?

96.25%	There will be less flash floods.
90%	Will be able to improve on existing financial status.
80%	More fish and bigger in size to catch.

- ✓ *Votua Village: Income of catch per trip is $30.00 to $100.00.*
- ✓ *Nawaqanea Village: Income of catch per trip is $30.00 to $200.*
- ✓ *Natatu Village: Income of catch per trip is $30.00 to $200.00.*
- ✓ *Nailaga Village: For family need.*

9. **POSTIVE & NEGATIVE IMPACTS:**

9.1. Please indicate issues that will positively affect you and your environment resulting from the development?

81.25%	Increase in amount of fish we catch.
43%	Provision for good basic amenities.
46.25%	Land reclamation inland and along the river.
1.25%	Others:...Farm will be safe.....

9.2. Please indicate with a tick in appropriate boxes issues that will negatively affect you and your environment resulting from the development?

30%	Loss of Kai area.
21.25%	Water to deep to dive for Kai.
0%	Traffic congestion during construction & operation phase.
6.25%	Sediments in water.
22.5%	Soil Erosion.
56.25%	Loss of firewood supply area.
54.75%	Loss of crab catching area.
57.5%	Loss of prawn catching area.
1.25%	Others...Spoils kills cassava when planted on the filled land.....

9.2. Please indicate other issues that you think will be of great concern to the environment surrounding the dredging of Ba river, the people that live around it and the people that work in it? (continue at the back of page if deemed necessary)

A. In the Construction Phase:.....

B. In the Operation Phase: During the dredging operation:

1. Pollution fine sediment suspended and can be seen floating on the water.
2. Oil leak from the dredging machine.
3. No comments.
4. It does not affect since I do open sea fishing with some Indian fisherman.
5. Catching of fish will stop for the time of operation.
6. No effect on my daily routine.
7. Activities in the village will be suspended during the dredging period.
8. During the dredging period we will experience oil suspended on the surface of the water.
9. The spoil or sediments was dump in the mangrove hills breeding place for fish.
10. We notice oil on the river near the dredging machine.
11. Water pollution, water turns brown and dirty.
12. All fishing will stop until dredging is done.
13. Catching of fish and all the activities will stop during the dredging.
14. All the caching of crab will be suspended for the time of dredging operation.
15. It will not affect us since we go fishing once a month.
16. Disrupt the fishing daily.
17. It will not affect our daily lives.
18. Unsafe for fishing.
19. None that I know of.
20. For kai divers it will be difficult for them to dive and also catch fish.
21. Could endanger our marine life.

10. SUPPORT FOR DEVELOPMENT:

10.1. Please indicate whether or not you support the dredging of Ba river?

95%	Support.
3.75%	Do not support.
1.25%	Not sure.

10.2. Do you wish to comment further on this development?

33.75%	Yes
66.25%	No

If YES, comment on space provided:

1. During post dredge it prevents flooding of the village.
2. Spoils filled on the land or river bank needs to be protected by stone wall due to flooding this erodes back in to the river.
3. We need spoils for land reclamation in certain place of the village.
4. Our cemetery needs land fill for extension.
5. I want the dredging to return because certain parts of the river are getting shallow which can cause flooding.
6. We need land to be refilled for planting of cassava.
7. Buggy place needs to be refilled foe extension of village boundary for housing of our young generation.
8. We usually plant cassava on the dredge spoils.
9. The dredge spoil filled area was the only place that the flood did not reach.
10. We have experience two dredging of the river which we know its benefit, that's why I am supporting it.
11. Dredging it deeps the river which is good for fishing using the nets, one trip minimum cash $100.00.
12. Decrease the flooding problems that we face.
13. Minimize flooding.
14. Minimize flooding during flooding season.
15. Dredging avoids flooding in the village.
16. Avoids flooding because it affects the lives of people.
17. The last dredging save my house from the last flood.
18. PSC mill waste which drains in the river kills fish, crabs, other living things in the river and the foul smell we breathe during the night.
19. Nawaqarua village has sifted 4 times before the current location. These used to be our fore fathers farming area.
20. The village land area is too small now which is approximately 1 ¼ acre.
21. The last dredging was in 1994 since than no flood in the village until early last year.
22. The existing dump site is used as farming area now.
23. We need the mangrove land to be filled with spoil for extension of our village.
24. The sizes of prawn will increase to bigger size due to the increase in depth of the river.
25. Even the last dredging we still experience floods and soil erosion due to the fast travelling of fishing boats on the river.
26. This will make the river deep which is good prevent flooding.
27.

Thank You.

APPENDIX: D

COMMUNITY CONSULTATION

APPENDIX: D1:

INVITATION TO THE PUBLIC TO ATTEND MEETING

Environment Impact Assessment (EIA)
Community Consultative & Participatory Meeting

The Land and Water Resources Management (LAWRM) Division of the Ministry of Primary Industries has initiated a project to dredge the Sigatoka River including the River mouth/foreshore area. The overall design dredge channel would be approximately 16 km long from the river fore-shore to Nawamagi area. The channel would extend approximately 5.0 km into the offshore from the river mouth.

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/estuary to the sea inorder to mitigate the risk of flooding in surrounding areas. The project is part of LAWRM's ongoing flood mitigation programme under which various other major rivers namely Navua, Ba, Waqa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

The Environment Management Act (EMA) requires an Environment Impact Assessment (EIA) Study be under taken for the development and Corerega Environment Consultant (CEC) has been commissioned to carry out the same.

To this end, the Public is invited to attend a presentation and discussion relating to the proposed LAWRM development.

The scheme plan for the dredging development for the Ba River is yet to be finalized.

Date: **Thursday, 29th November, 2012**
Time: **10 am – 12pm**
Venue: **Sigatoka Town Council Hall, Civic Centre, Sigatoka**

Enquiries contact: 9026520/3602138 (Laisiasa)

Corerega Environment Consultants

APPENDIX: D2

INVITATION TO GOs & NGOs TO ATTEND MEETING

COREREGA ENVIRONMENT HEALTH SAFETY CONSULTANT

Lot 10, Tacirua Heights, Suva, Fiji Islands
P.O.Box 7618, Valelevu, Nasinu, Fiji Islands

Mobile: 9026520
Home: 3602138
E-mail: l.corerega@gmail.com

TIN 03-0320-0-8

15th November, 2012.

The Provincial Administrator,
Provincial Administrator's Office,
Lawaqa,
Sigatoka,
NADROGA

Dear Sir, **CONSULTATIVE & PARTICIPATORY MEETING ON THE PROPOSED DREDGING OF THE SIGATOKA RIVER**

The Land and Water Resources Management (LAWRM) Division of the Ministry of Agriculture and Primary Industries has initiated a project to dredge the Sigatoka River including the River mouth/foreshore area. The overall design dredge channel would be approximately 20 km long from the river fore-shore to Nawamagi area. The channel would extend approximately 4.0 km into the fore-shore from the river mouth.

The purpose of the Sigatoka River dredging project is to maintain a clear passage through the river channel/estuary to the sea inorder to mitigate the risk of flooding in surrounding areas. The project is part of LAWRM's on-going flood mitigation programme under which various other major rivers namely Navua, Ba, Qawa, Labasa and Wailevu (including Rewa) have been dredged in the past years.

As normally the case in developments of this nature, the environment and the public at large will be impacted and many will be affected either positively or negatively as a result of the development. In this regard the Environment Management Act (EMA) requires an Environment Impact Assessment (EIA) Study be under taken for the development and Corerega Environment Consultant (CEC) has been commissioned by LWRM to carry out the same.

As part of the EIA study exercise a Consultative Meeting is to be conducted with members of the community who may be affected and also government and non-government organizations that may

Your organization has been identified as one of the key stakeholders in this development. In this regard you are cordially invited to attend a consultative meeting to be held at the Sigatoka Town Council Hall, Sigatoka Civic Centre on 28th November, 2012 at 11 am - 1 pm to be informed of the study and its results as well as give us your views on the proposed development.

Likewise copies of this letter are being sent to similar organizations deemed to be important stake holders inviting them to attend the same. An advertisement in the "SUN" newspaper of even date

Last and not least we thank you in advance for participating in this exercise and we hope to see you at the meeting venue on the scheduled date and time.

Yours faithfully,

Laisiasa Corerega
Managing Director

c.c

Na Gone Turaga na Ka Levu, Cuvu, Nadroga
The Roko Tui Nadroga/Navosa, Nadroga Provincial Office, Lawaqa, Nadroga
The Chairman District Development Committee, c/- Provincial Administration Office, Nadroga
The Chief Executive Officer, Sigatoka Town Council, Sigatoka, Nadroga.
The President of Retailers & Wholesale Association, Sigatoka, Nadroga.
The Sub-divisional Medical Officer, Ministry of Health, Sigatoka, Nadroga
The Secretary, Nadroga Rural Local Authority, Health Office, Sigatoka, Nadroga
The Officer in Charge, WAF, Sigatoka, Nadroga
The Officer in Charge FEA, Sigatoka, Nadroga
The Road Supervisor, PWD, Sigatoka, Nadroga
The Officer in Charge, Agriculture Department, Sigatoka, Nadroga
The Officer in Charge, Fisheries Department, Sigatoka, Nadroga
The Manager, Fiji Sugar Corporation, Cuvu, Nadroga
The Director of Town & Country Planning, Ministry of Local Government, Urban Development & Environment, Suva.
The Director of Environment, Ministry of Local Government, Urban Development & Environment, Suva
The Director LAWRM, Ministry of Agriculture & Primary Industries, Suva
The Commissioner Western, Commissioner's Office, Lautoka
The Divisional Engineer Western, PWD, Lautoka
The Divisional Surveyor Western, Lands Department, Lautoka
The Divisional Estate Manager, ITLTB, Lautoka
The Officer In Charge, Department of Environment, Lautoka

APPENDIX: D3

INVITATION TO TURAGA NI KOROs TO ATTEND MEETING

COREREGA ENVIRONMENT HEALTH SAFETY CONSULTANTS

COREREGA ENVIRONMENT CONSULTANTS

Lot 10, Tacirua Heights, Suva, Fiji Islands
P.O.Box 7618, Valelevu, Nasinu, Fiji Islands

Mobile: 9026520
Home: 3602138
E-mail: l.corerega@g.mail.com

15 ni Noveba, 2012

Na Turaga ni Koro.
Koro ko Nawamagi,
Conua,
Nadroga

I'saka,

VEISURETI KI NA BOSE ME BALETA NA KENA QIVATI NA UCI WAI NA SIGATOKA RIVER

Ko ni sa na rogoca tiko beka vakacaca na lalawa ni matanitu me qivati na uci wai levu na Sigatoka River e na dua na gauna lekaleka mai oqo. Oqo e na kena gadrevi tiko ga me vaka titobu taki na Uciwai me rawa ni na drodro vinaka na wai e na gauna ni uca bi me kakua kina ni luvu na veivanua bucabuca e tiko tikiva na Uciwai.

Ni dau vaka yacori na cakacaka ni qivati ni Uciwai e kunei ni vuqa na ka e dau vakamariqeti vei keda e dau tarai yani na ke dra i tuvaki me vaka na kai; na kena rawa ni vakalailaitaki ni kedra i wiliwili se na kena vakacacani ni vanua e ra dau sokomuni kina ya e na kena vakatitobutaki na veivanua vodea kara dau kune kina vakalevu e liu ka sa na dredre sara na kedra nunuvi e na vanua vata ga koya ni sa vaka titobutaki. E sega wale ga ni ca kece na veika e na kauta mai na qivaqiva, e vuqa na veika vivinaka tale ga e rawa ni na yaco me vaka oqo:

- Rawa ni tarovi kina na waluvu ni vanua.
- E rawa ni na rawati e na loma ni Uciwai na Ba River na ika e dau kune mai wasa bula baleta ni sa na titobu na wai ka rawa kina vei ira na ika mai takali me ra curuma cake main na uciwai .
- Rawa ni vaka yagataki na nuku me buli vanua vou (reclaimation) me vakayagataki e na kena vakalevutaki ni loma ni bai vaka i tikotiko (koro) se vanua ni teitei.

Ia me vaka ni koni kila vaka vinaka cake na Uciwai oqo, e na vukuna na Director ni LAWRAM keitou cakacaka tiko e na vukuna, keitou sa sureti kemuni kei ira talega na lewe ni Committee ni Koro ko ni namuna ni dodonu me ra tiko me vaka na i Liuliu ni soqosoqo ni marama, kina dua na bose e na veitalanoa taki kina na cakacaka oqo ka mo ni mai vakaraitaka tale ga kina na nomuni nanuma me baleta na ke na qivati na Uciwai levu na Sigatoka River.

Na bose oqo e na vakayacori e na 11 ki na 1 na kaloko (11 am – 1.00 pm) e na Siga Lotulevu 29/11/2012 e na Vale ni Soqo (Meeting Hall), Sigatoka Town Council, Civic Centre, Sigatoka.

Ko

Laisiasa Corerega
Managing Director

APPENDIX: D4

MINUTES OF COMMUNITY & STAKE-HOLDERS CONSULTATION MEETING—29/11/2012

Minutes of Sigatoka River Dredging Consultative Meeting held at the Sigatoka Town Council Chambers on Thursday 29th November 2012.

Welcome- Mr Laisiasa Corerega welcomes the members of the public and organizations present during the meeting and offered a short devotion.

Members Present- Refer to Annex (Participants List)

Introduction of participants-

Mr Corerega introduced the member of the Team specializing in each area.

Team Leader (Insert team members)

Presentation (all presentation were in power point except for Socio Economic Study)

Mr Corerega proceeded to the Objective of Study and TOR. The Outcome of the study was reviewed and presented. He further highlighted on the following;

Introduction of Environment Management Act and its application, process and procedure;
Land Water and Resource Management Unit was the initiator of the project;
Further elaborated on the proposal to dredge the Sigatoka river 20km from river foreshore to Nawamagi area.
Extend 4km out to the sea from the river mouth.
The three main activities includes;
Dredging the Sigatoka River
Managing the Spoil
Monitoring activities

At 12.00p.m the second session was presented by Mr Tupua and Mr Atunaisa Kaloumaira on the PHYSICAL ASPECTS of the study. Reference was made to earlier studies conducted by SOPAC and JICA.
Presented on existing baseline data from previous studies and making comparison to the current scenario. Indicated a shift in geological setup on the river structure. Increase gravel/ alluvial and sediment
Near river mouth made up of limestone structure
River have expanded to westward alluvial side and there is an increase of volcanic rocks in the bottom surface.
The study strongly favours that sand bar should be removed since it acts as a natural barrier to the open exposed waves from the sea
The study model proposes a 1/20 years framework instead of 1/50 earlier mentioned in JICA report
$ to $ value on spoils to be utilized

The third session commenced at 12.32p.m with presentation from Mr Mosese Bati on the BIOLOGICAL ASPECTS of the study. Highlighted low bio diversity in all 4 areas and recommended flooding bunds/ spoils to be placed on which area in the zones.

Mr Maciu Lagibalavu addressed the participants on the fisheries and marine ecology. There is not much river type of fish. There is a lot of fishing going on for domestic consumption. Mentioned the impact on "kai " species. Recommendation on mitigation measures were presented to participants including timing of dredging to take into consideration the spawning seasons.

The fourth session commenced at 12:53p.m with presentation again from Mr Corerega on the socio economic study. The oral presentation was only briefs of the actual survey carried out. Mr Corerega highlighted that 95% of the respondent support the dredging of the river with the remaining 5% are not sure on the benefits and about dredging activity. The Socio Economic study recommends greater awareness be made on all stakeholders and the communities around the 4 zones regarding the dredging.

Open Discussion Forum

Mr Kaloumaira highlighted the need to consider the bridge setup and above rwater FEA line during dredging activity.

Issues	Raised by	Response
Utilization of Spoils	Department of Environment	LAWRM- Mr Peni responded that under the River Act all spoils belong to the State. $ to $ value comes in play. Consent needed from Director of Lands
Proximity of placement of spoils near to river edge can be washed away on next flood	Department of Environment	CEC- The suggestion was noted and Responded by Mr Corerega that it should be placed further away from river edge
Two issues raised-Opening of sand bar and kai migration due to salinity.	Naroro villager	Mr Maciu CEC responded that the study does not support the opening of the sand bar and that to enable the prosperity of kai species it recommends 5m should be dredged depth.
Small tributary contributes to the flooding	Naroro villager	Mr Atunaisa of CEC responded that flood gates and some other engineering measures can be put in place to address this
Documentation on use of spoils	CEC	Mr Vatuwaqa CEC highlighted that spoils can be used by vilagers. In support Mr Peni of LAWRM added that the use of spoils will follow the proper administration procedure to avoid disagreement amongst landowning unit.
Compensation for dumping of spoils in landowners land	Naroro Villager	Mr Peni added that the involvement of Provincial Council is crucial in the planning phase. Consultation will be done on that note. The initial step have been carried out by the consultants to identify which area to dump the spoils. The most important thing is for the works to move and real issue such as minimizing flooding to be done. Mr Atunaisa of CEC in support highlighted that consent by landowners will be taken into consideration.

There being no other issues to be discussed the meeting was closed at 13.24 p.m.

MEETING PHOTOGRAPHS

above: CEC Team Leader, Mr. Laisiasa Corerega presenting on the EIA Report

above: Members of the Community, interested individuals and various stakeholders gathered at the meeting in the Sigatoka Town Council Meeting Chambers, Sigatoka

CONSULTATIVE MEETING ATTENDANCE LIST

SIGATOKA TOWN COUNCIL CHAMBERS, SIGATOKA

Thursday, 29 November, 2012

	Name	Organisation	Signature
1.	[illegible]	[illegible]	
2.	Vesimia Roko.	Nabara Village.	
3.	Dhanesh Rajesh — Nabara		
4	Andre Rokonadi	T/Koro Nabara.	
5	Mosese [illegible]	[illegible]	
6.	Tima Lewanavanua	Dept. Social Welfare	
7.	Sanjesh Kumar	Lautoka City	
8.	David T. Chang	LAMTA	
9.	Joeli Kerevaki	T/Koro Vuda	
10.	Vatiri [illegible]	Nalawa Vuda	
11.	Salanisa Tubana.		
12.	Eliki Talanaki	Health Inspector	
13.	[illegible]	[illegible]	
14.	Ioneteni Salabalabe		
15.	Leweni Vakalele	Nakorovatu Village	
16.	Apisalome Tonimeve	F.W.D.	
17.	[illegible]	M.O.I	
18.	Osea Naburewa	M.O.I	
19.	[illegible]	[illegible]	
20.			

NO	NAME	ORGANISATION/DEPT	SIGNATURE
13	Lasiasa Cocaga	CEC	
14	Mateo Vuniwaqa	CEC	
15	Eroni Tupua	CEC	
16	Mr Logi Lo	Coastal Dev	

06/03/2013

COMMENTS FROM STAKE-HOLDERS IN MEETING WITH STAKE-HOLDERS ARRANGED BY LAWRM—06/03/2013

EPI-(LAWRM)- Stresses that dredging will focus downstream from Sigatoka Bridge
-Tangible issues to look at include location of potential dumpsites for spoils
-Need to work closely with STC as they own land parcels along the mid and lower banks
-LOU also urged to come with the potential dump site locations

CEO (STC)- Whose responsibility lies with the carting of spoil to potential development sites after stockpiles? Potential dumpsite is the existing STC landfill site beside western wreckers and the Sigatoka sand dunes and national trust office

EPI (LAWRM)- Carting of spoils to development sites will be responsibility of the proponent or developer and not LAWRM.

LOU (Nayawa)- We need to dump spoils near villages along the banks to raise village and for revertment walls e.g. at Laselase village. Other potential site include the back of Yavulo village.

ATU (CEC)- No dumping close to villages as there is risks of injuries from the dumping of spoils from the pumps. Spoil will be dump and stockpile away from populated site and then will be carted to places for development or bank improvements. Other potential developments is village boundary extension, sand mining and construction works raw materials.

LOU (MATA NI TIKINA)-Impacts of dredging on the *kai* (mussle), the livelihood of people on the up stream towards Nawamagi village.

ATU (CEC)- Dredging will concentrate on the river banks' sides while the middle will be left out so impacts will be minimal.

MOSESE (CEC)- Impacts of dredging such as salinity movement upstreams and distrurbances to benthic habitats will be temporary. Source of *kai* is still upstream of the *Nawamagi* which there will be no dredging. Need bunds around the lower man grove island , Nukunuku to prevent sedimentation impacts on the mangroves form flushing impacts of upstream dredging as mangroves are ecologically im portant as well as natural bank protection mechanisms.

EPI (LAWRM)-	The department will be carrying out monitoring and maintenance dredging
LOU (mata ni tikina)-	Will one time dredging activities solve the problem of flooding permanently?
TUIDRAKI (SA)-	Experiences from Nadi River dredging does not guarantee a permanent solu tion. Nadi River is in the 4th stage of dredging and maintenance drainage works. Government commitment is to have a dredge in each of the large rivers for maintenance dredging.
LOU (mata ni tikina)-	Can the work of maintenance dredging be sub contracted to the LOU and have their own dredge machine?
EPI (LAWRM)-	Yes, there is a possibility, but work will be tendered out by normal process and criterions and all work must comply with the engineering designs and other specifications
LOU-	Government to consider engaging the LOU to opening the sand bar on the lower river mouth during major flooding as is practice before.
EPI (LAWRM)-	Responsility now lies with the PM's office and not with the LAWRM department.
STC-	what is the possibility of dredge being materials washed back on to the river?.
ROKO (NNPC)-LOU,	Land developments up streams need to consider impacts of any unmitigated work will compound the problem of flooding such as logging, river bank developments. The Land Use department is formulating a proper land use plan for all activities in the district and province.
ATU (CEC)-	Dredging work is only part of the solution to flooding.
ROKO (NNPC)-	How long will the pipeline be that is going to be used?
EPI (LAWRM)-	Length will vary from 750-1000m
EPI (LAWRM)—	CLOSSING REMARKS Impacts of dredging will be felt but temporary Fisheries impacts may be positive due to creation of new habitats and flushing of silts More positive impacts than negative LOU, NTC and other stakeholders to continually come up with more potential sites Need more inputs from all stakeholders Stage 1 dredging work will start in 2014—Bridge and downstream

CONSULTATIVE MEETING ATTENDANCE LIST

Tuesday, 06 th March, 2013

gatoka Town Council Meeting Chamber, Sigatoka

Si-

1

COUNCIL.

: 10 30am

me ·	Organisation	Post	Telephone Contact/ema	sig
ivini Sausauwai	LWRM, Dept. Agriculture	Environment offic	834305	
osua Rangasa	Yavusa.	Mata ni Tikina	9463273	
pineri Cangavanua	LWRM, DoA	TO	9772643	
NIASI VAKILI	JUBANIWAI ENVIROMENT Council	SOCIAL WORKER	9430945	
ekini Kamoto	Nayavu	Turaga ni Vanua	9649653	
TMOCI ROKEVA	JUBANIWAI ENVIRO MENT WORKING CO.	SOCIAL WORKER	8657220	
IVIRIMAIA RARIRACHI	SIGATOKA TOWN COUNCIL	EXECUTIVE SECRETARY	9327471	
Esami Saurel	OTSCA, Fiji	Project Consultant	8407844	
Laisiasa Cavuti	CEC	Director	9026520	
Ratu Semi Filipe	Sigatoka T. Council.	C.E.O	9042495	

Meeting Ends @ 12.25pm -

02/13 - 10:30am

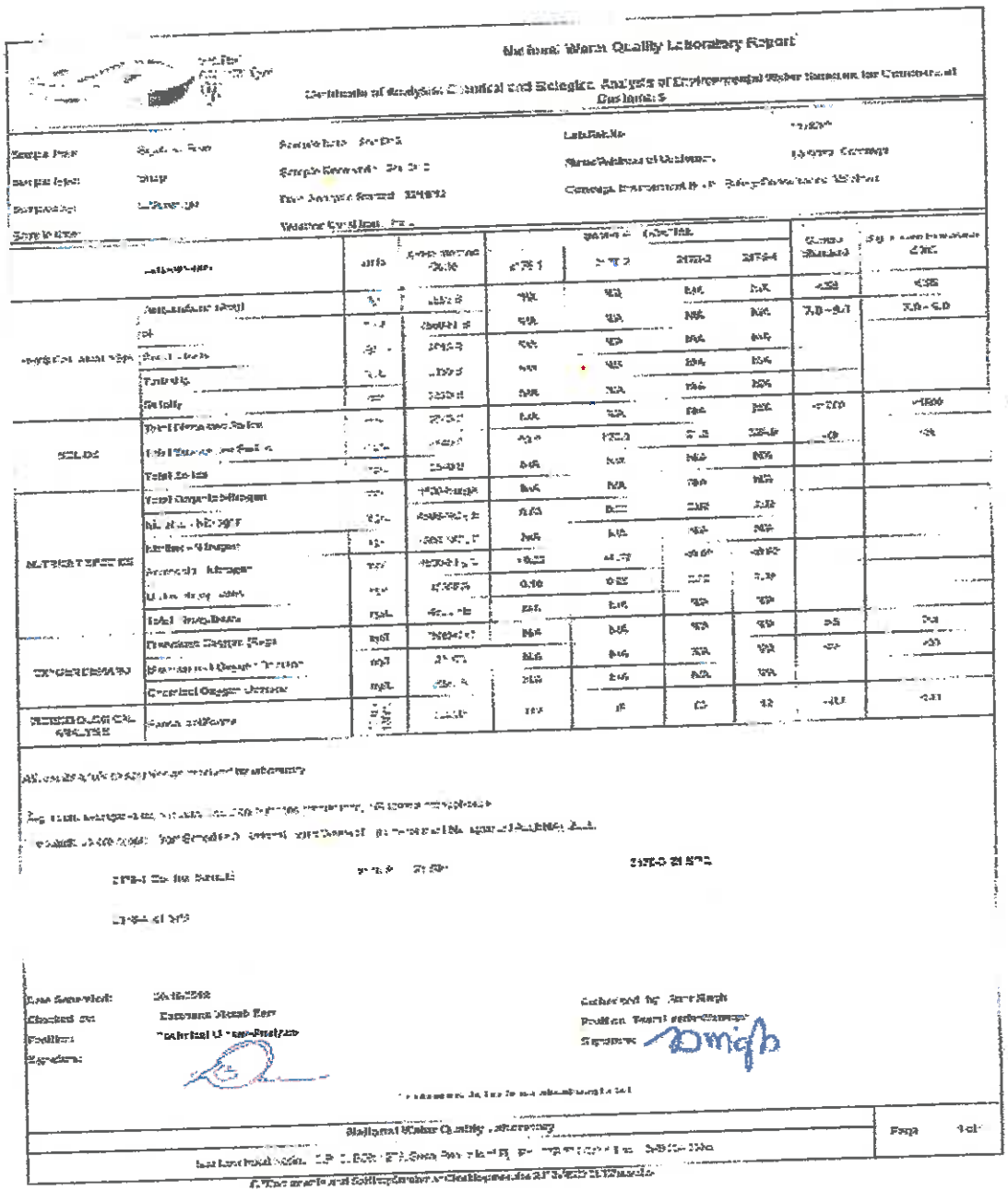
ne	Organisation	Post	Telephone #	Signature
Angela Tumbuka	Sec'tl / Wada Town Coun'l	Special Adviser	0995 33444	
Rusiate Raidavelo	NN Prov. Office	Asst. Rep	7669727	
MOSESE BATI	EIA CONSULTANTS	CONSULTANT	942726	
LAI COLEREGA	CEC	PRINCIPAL	9026520	
ATUNAISA KALOUMAIVA	CEC	CONSULTANT	9218605	
VIRIMACA RARIACHI°	SIGATOKA TOWN COUNCIL	EXECUTIVE SECRETARY	9327471	
TIMOCI ROKEVA	JUBANIWAI ENVIRONMENT COUNCIL	SOCIAL WORKER	8637220	
Anare Boseiwaqa	Landcare	Tavua	9150438	

28/03/2013

MINUTES OF FINAL DRAFT PRESENTATION MEETING
EIA Study on the Proposal Dredging Development of the Sigatoka River
Thursday, 28th March, 2013
LWRM, SUVA

APPENDIX: E

WATER QUALITY TEST RESULTS



National Water Quality Laboratory Report

Certificate of Analysis: Chemical and Biological Analysis of Environmental Water Samples for Commercial Customers

Sample Point	Sigatoka River	Analysis Date	29/04/10	Lab Ref. No.					
Sample Type	Grab	Sample Received	29/04/10	Name/Address of Customer				Laboratory Comments	
Sampled by	Customer	Time Sample Taken	12H30	Comments Interpretation & Recommendations (if any)					
Sample Date		Weather Conditions	Fine						

		Units	Limit of Detection	27/04/10	28/04/10	28/04/10	28/04/10	Guideline Standard	Sigatoka River EMC
PHYSICAL ANALYSIS	Temperature (field)	°C	0.1°C	NA	NA	NA	NA	<35	<35
	pH	pH	0.1pH	NA	NA	NA	NA	7.0 - 8.5	7.0 - 8.0
	Conductivity	µS/cm	1µS/cm	NA	NA	NA	NA		
	Turbidity	NTU	0.1NTU	NA	NA	NA	NA		
	Salinity	ppt	0.01ppt	NA	NA	NA	NA		
SOLIDS	Total Dissolved Solids	mg/L	20mg/L	NA	NA	NA	NA	<1000	<1000
	Total Suspended Solids	mg/L	4mg/L	5.3	172.3	5.3	126.6	<5	<5
	Total Solids	mg/L	25mg/L	NA	NA	NA	NA		
NUTRIENTS	Total Organic Nitrogen	mg/L	0.05mg/L	NA	NA	NA	NA		
	Nitrate + Nitrite Nitrogen	mg/L	0.005mg/L	0.03	0.1	0.08	0.08		
	Nitrate + Nitrite Nitrogen	mg/L	0.005mg/L	NA	NA	0.08	0.08		
	Ammonia Nitrogen	mg/L	0.005mg/L	0.02	0.07	0.03	0.03		
	Ammonia Nitrogen	mg/L	0.005mg/L	0.02	0.07	0.03	0.03		
	Total Phosphorus	mg/L	0.01mg/L	0.01	0.05	NA	NA		
OXYGEN DEMAND	Dissolved Oxygen (field)	mg/L	0.1mg/L	NA	NA	NA	NA	>5	>5
	Biochemical Oxygen Demand	mg/L	2mg/L	NA	NA	NA	NA	<5	<5
	Chemical Oxygen Demand	mg/L	20mg/L	20	24	NA	NA		
MICROBIOLOGICAL ANALYSIS	Fecal Coliforms	MPN/100ml	1.8MPN/100ml	170	17	13	33	<50	<50

All samples were analysed in accordance with [illegible]

[illegible]

[illegible]

Date Received:	29/04/2010	Authorised by:	[illegible]
Checked by:	Esmeralda Nasedi Ravi	Position:	Technical Team Leader/Chemist
Position:	Technical Team Leader	Signature:	[signature]
Signature:	[signature]		

[illegible]

National Water Quality Laboratory	Page 1 of 1
[illegible]	

[illegible]

National Water Quality Laboratory Report

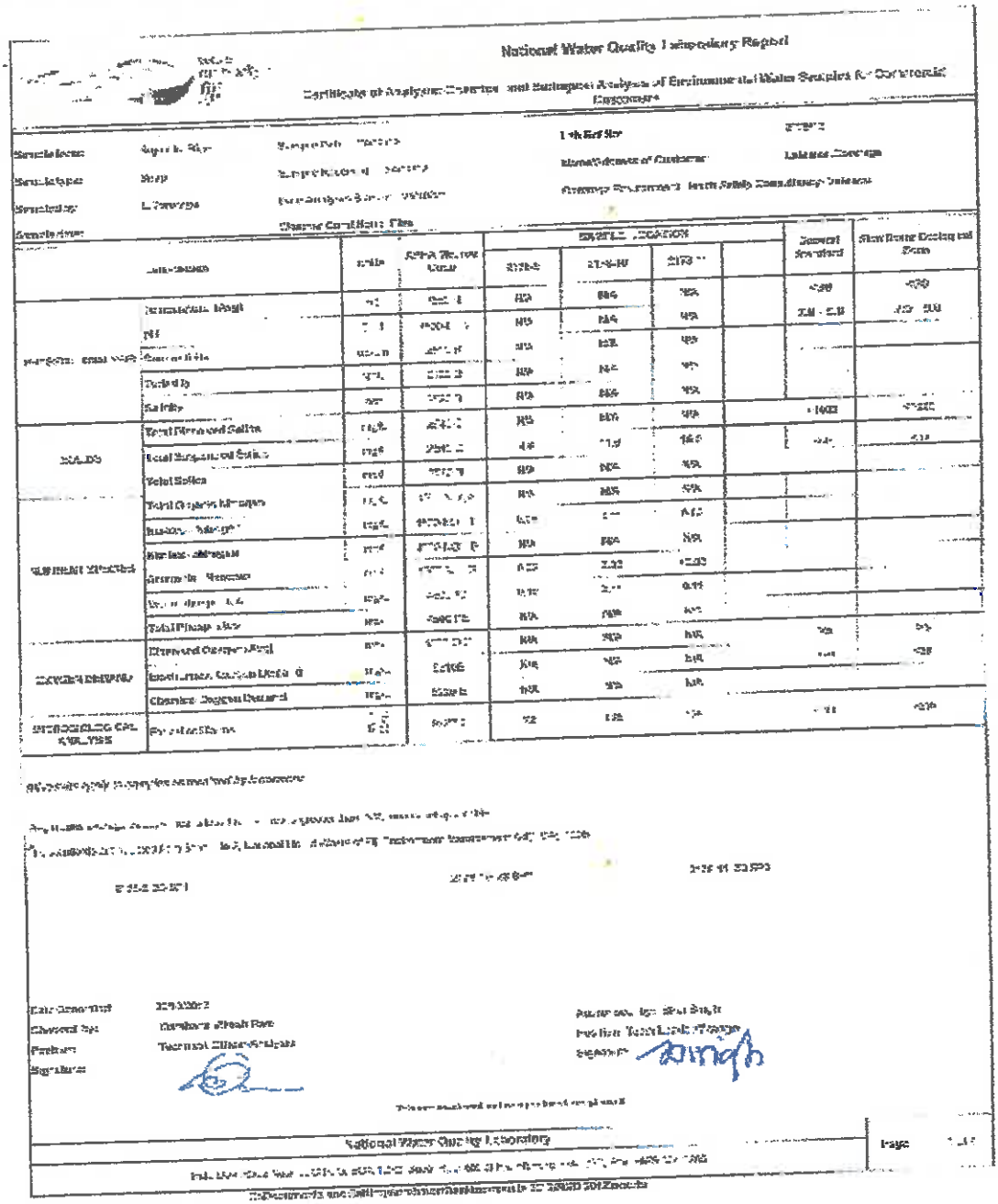
Certificate of Analysis: Chemical and Biological Analysis of Environmental Water Samples for Commercial Customers

[illegible]

				SAMPLE LOCATION				General Standard	Significant Ecological Zone
	Parameter	Units	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
PHYSICAL ANALYSIS	Temperature	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	pH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.0 – 8.5	7.5 – 9.0
	Conductivity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	Turbidity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	Salinity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
SOLIDS	Total Dissolved Solids	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total Suspended Solids	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total Solids	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Chemical Oxygen Demand	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

National Water Quality Laboratory



National Water Quality Laboratory Report

Certificate of Analysis: Chemical and Biological Analysis of Environmental Water Samples for Commercial Customers

Sample Name:	Sigatoka River	Sample Point:	Sigatoka	Lab Ref No:	[illegible]
Sample Type:	Water	Sample Collected By:	[illegible]	Name of Person of Customer:	Laboratory Coordinator
Sampled By:	L Tawake	Sample Analysed By:	[illegible]	Customer Requirement:	[illegible]
Sample Area:		Chemical Certificate:	Yes		

Sub-Group	Analyte	Analytical Method Used	Sample Location				Standard	Sigatoka Dredging EIA Study
			[illegible]	[illegible]	[illegible]			
[illegible]	Temperature (degC)	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	pH	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Conductivity	[illegible]	[illegible]	[illegible]	[illegible]			
	Turbidity	[illegible]	[illegible]	[illegible]	[illegible]			
	Salinity	[illegible]	[illegible]	[illegible]	[illegible]			
SOLIDS	Total Dissolved Solids	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Total Suspended Solids	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Total Solids	[illegible]	[illegible]	[illegible]	[illegible]			
NUTRIENT [illegible]	Total Organic Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]			
	Ammonia Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]			
	Nitrate-Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]			
	Nitrite-Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]			
	Ammonia Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]			
	Total Phosphorus	[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	Dissolved Organic Carbon	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Biochemical Oxygen Demand	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Chemical Oxygen Demand	[illegible]	[illegible]	[illegible]	[illegible]			
BIOLOGICAL ANALYSIS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

[illegible]

[illegible]

Date Received: [illegible]
Checked by: Dr Viliame Waqa Rere
Position: Technical Officer-Chemistry
Signature:

Name of: [illegible]
Position: [illegible]
Signature:

National Water Quality Laboratory

Page [illegible]

[illegible]

National Water Quality Laboratory Report

Certificate of Analysis (Conventional, Biological Analysis of Environmental Water Samples for Commercial Customers)

Sample from	Sigatoka River	Sample Date	[illegible]	As Per Lab	[illegible]
Sample type	Raw	Test to be Completed	[illegible]	Water Analysis of Sigatoka	Lautoka Approved
Submitted by	[illegible] Consultants	Date Sample Received	[illegible]	[illegible]	
Batch No:		Station Coordinates	[illegible]		

PARAMETERS		UNITS	APHA Method Used	SAMPLE LOCATION				Local Standard	Regional Standard
				[illegible]	[illegible]	[illegible]			
PHYSICAL PARAMETERS	Temperature (Deg)	C	[illegible]	30	30	30		<30	<30
	pH	pH	[illegible]	6.9	6.9	6.9		7.0 - 8.5	7.0 - 8.5
	Conductivity	[illegible]	[illegible]	50	100	90			
	Turbidity	[illegible]	[illegible]	50	100	90			
	Salinity	[illegible]	[illegible]	50	100	90			
SOLIDS	Total Dissolved Solids	mg/L	[illegible]	50	100	90		<500	<500
	Total Suspended Solids	mg/L	[illegible]	50	100	90		<50	<50
	Total Solids	mg/L	[illegible]	50	100	90			
NUTRIENT SPECIES	Nitrate as Nitrogen	mg/L	[illegible]	<50	100	90			
	Nitrite as Nitrogen	mg/L	[illegible]	100	0.03	0.04			
	Sulfate (Nitrate)	mg/L	[illegible]	250	100	90			
	Ammonia - Nitrogen	mg/L	[illegible]	<0.02	0.02	0.03			
	Orthophosphate	mg/L	[illegible]	0.01	0.03	0.04			
	Total Phosphate	mg/L	[illegible]	0.06	0.03	0.04			
OXYGEN DEMAND	Dissolved Oxygen	mg/L	[illegible]	6.6	7.6	6.5		>5	>5
	Biochemical Oxygen Demand	mg/L	[illegible]	6.6	6.9	6.5		>6	>6
	Chemical Oxygen Demand	mg/L	[illegible]	6.6	6.9	6.5			
BIOLOGICAL ANALYSIS	Total Coliforms	MPN/100ml	[illegible]	77	79	78		<50	<50

All results apply to samples as received by laboratory

Analytical methods are in accordance with standard methods for examination of water and wastewater, 20th edition, 1998.

As requested by client, results have been reported on an as received basis. Uncertainty of measurement data is available on request.

[illegible]

Checked by: [illegible]
Position: Technical Officer Analytical
Signature:

Authorised by: The Chief
Position: Water Quality Laboratory Manager
Signature:

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National Water Quality Laboratory

[illegible] GPO Box [illegible] Suva [illegible] Fax: [illegible]

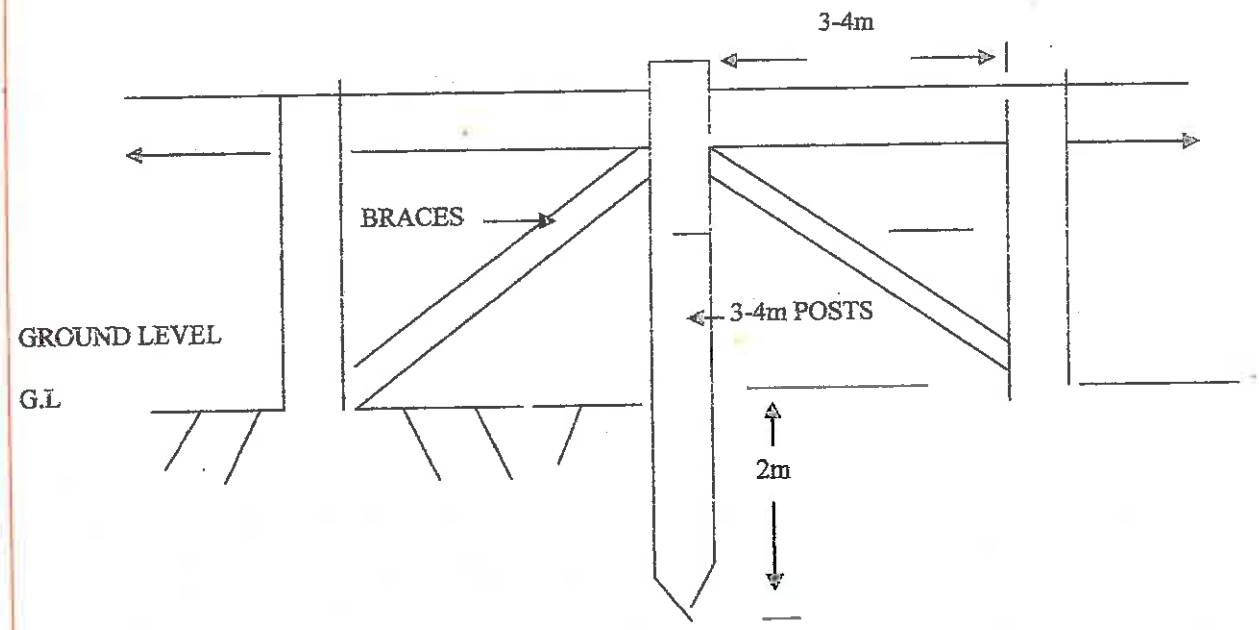
Page 1 of 1

APPENDIX F:

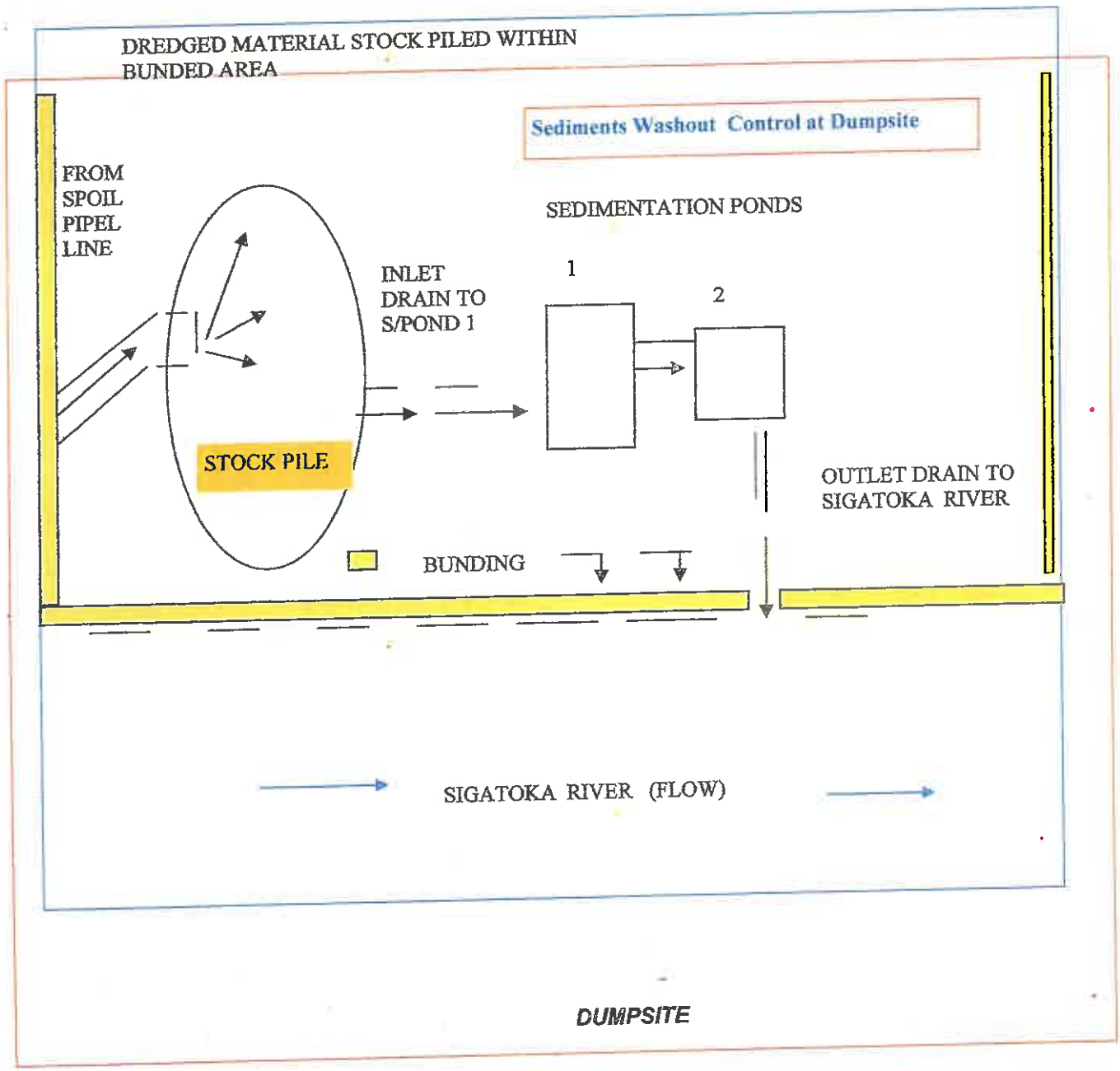
MITIGATING EROSION AND SEDIMENT WASHOUT AT DUMPSITES- (ILLUSTRATIONS)

APPENDIX F1: Mitigating impact of Erosion at Dump sites

Figure 6.1.3.2: Sedimentation Traps constructed of Wood/Dogo



APPENDIX F2: Mitigating impact of Sediment Washout at Dump site.



APPENDIX G:

PROPOSED DREDGED AREA CALCULATION

ANNEX 1: Proposed Dredged Area Calculations

From information gleaned from the cross-section survey data provided by LAWRM, the river is wide with average uniform depth across sections.

During the Team's field survey, an average 2.5m deep channel and width 150m was observed from Nawamagi to downstream of Lawai from which Sigatoka River widens below the bridge, once past the low hills that typified the upstream topography.

JICA mentions

(a) the critical section of river discharge capacity is at 10km where floodwaters overtop the bank at a flow of 2500 m^3/sec (cumecs), the river flood flow capacity;
(b) a preliminary slope of 1:2000 was provided for the lower reach up to 60km upstream.
(c) JICA used a Mannings roughness coefficient $n = 0.03$.
(d) a 2m lowering of the bed level at the critical section will increase discharge capacity to 2800 m^3/s, of return period 1 in 20 years

Actual river survey data has enabled the Team to refine the JICA preliminary data with the following:-

(a) the critical section is at chainage 9.5km from the mouth, where the right bank is lowest at 3.14 m above mean sea level – see Annex on crosssections .
(b) centre-line bed slope from the mouth upstream is on average 1:10000 for the first 20km .

Using the 1:10000 centre-line bed slope, two calculations have been made:-

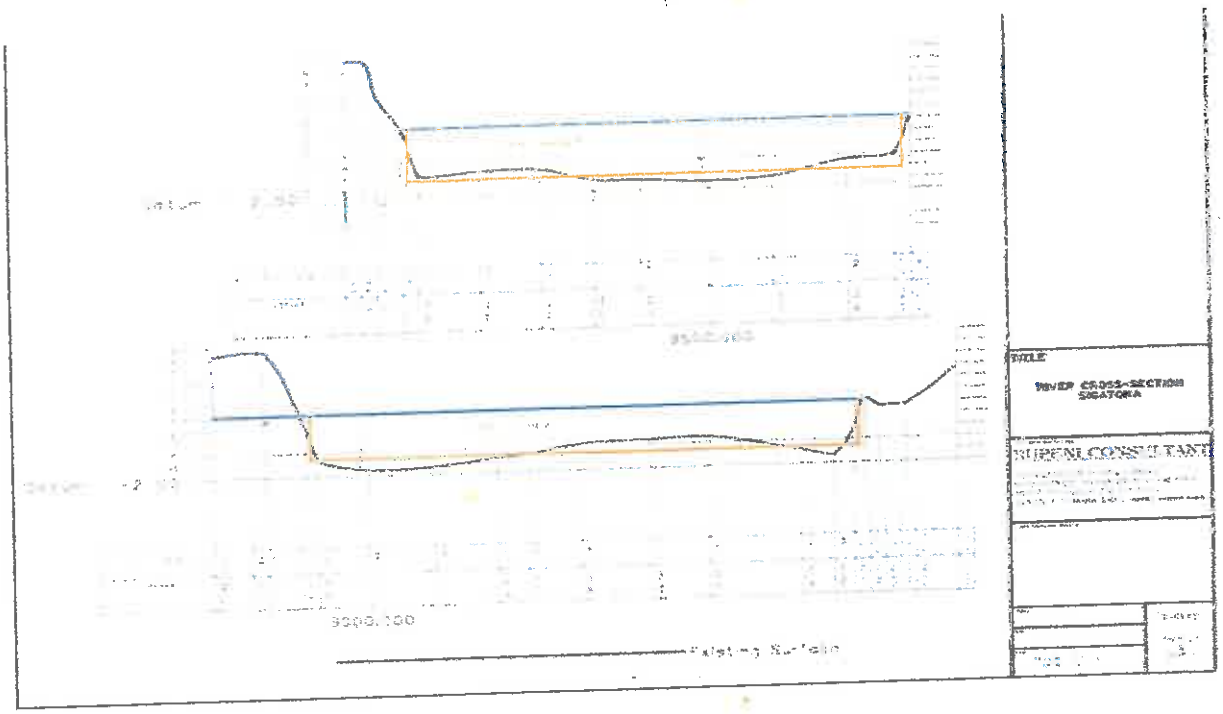
(a) the estimated flood water level upstream of the critical section has been calculated for a uniform discharge of 2500 cumecs. The uniform discharge is useful as it provides the minimum flow area.
(b) For the 1 in 20 year flood of 2800 cumecs, a constant 2m lowering of the bed by dredging is assumed for the whole reach upstream to Nawamagi which is at 13.5km from the river mouth
(c) Everything else remaining the same, the increase in area required by dredging is calculated simply by multiplying the original area with a factor of 1.12 (2800/2500) then finding the difference.

The results are tabulated below for Chainage 9500 to 13500.

Chainage	Flood flow width (m)	Q = 2500 cumecs			Q = 2800 cumecs
		Flood level m (amsl)	Avg Flood Flow Depth (m)	Flow Area m^2	Required Increase in Area m^2
9500	163	3.14	4.2	660	79
10000	148	3.19	3.7	548	66
10500	150	3.24	3.7	555	67
11000	38 +102	3.29	3.3/4.5	584	70
11500	140	3.34	4.6	644	77
12000	19 + 87	3.39	1.9/5.0	472	57
12500	132	3.44	4.1	547	66
13000	110	3.49	4.8	528	64
13500	106	3.54	4.4	526	63

A quick analysis shows that a dredged section of 50m width by 2m depth recommended in this report caters adequately with acceptable safety factor around 1.5.

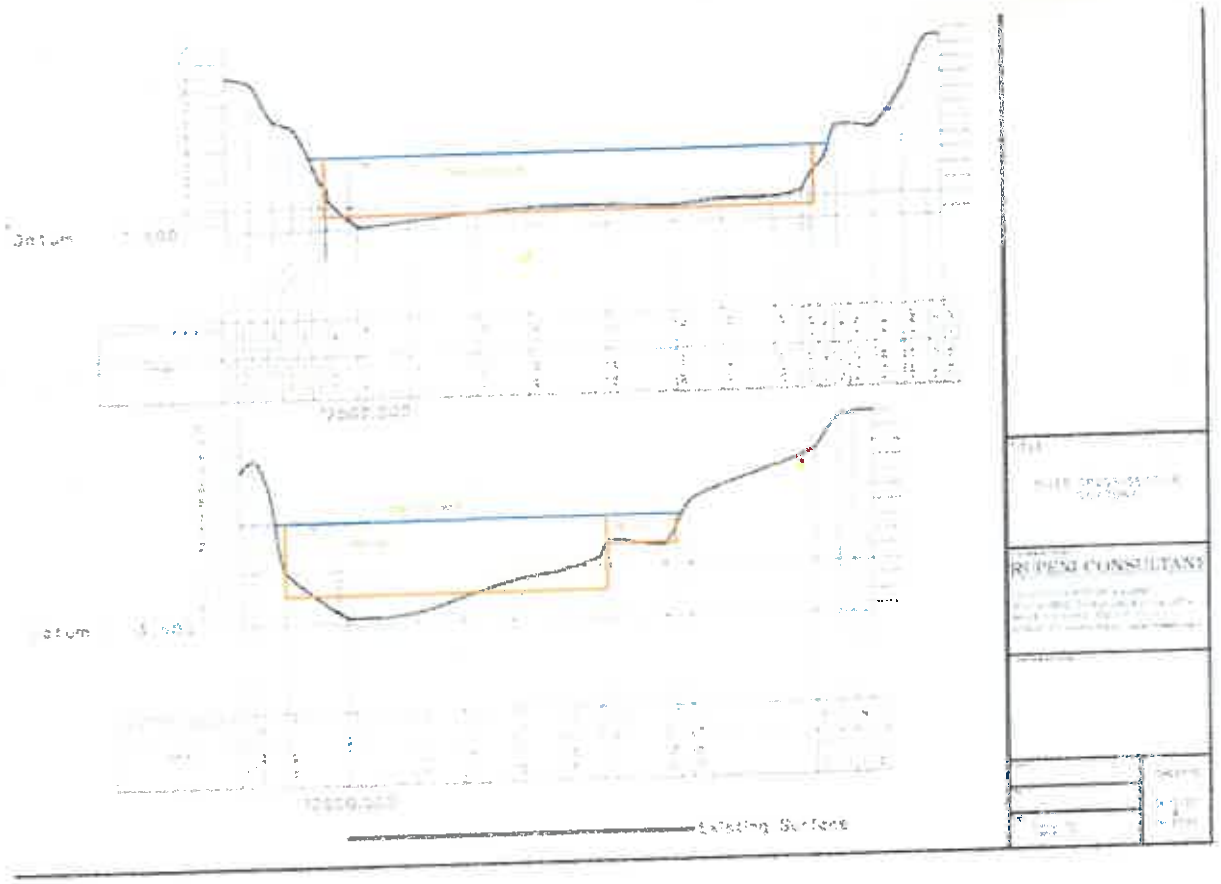
ANNEX 2: Long Section & Cross Section 9.5km—the critical section



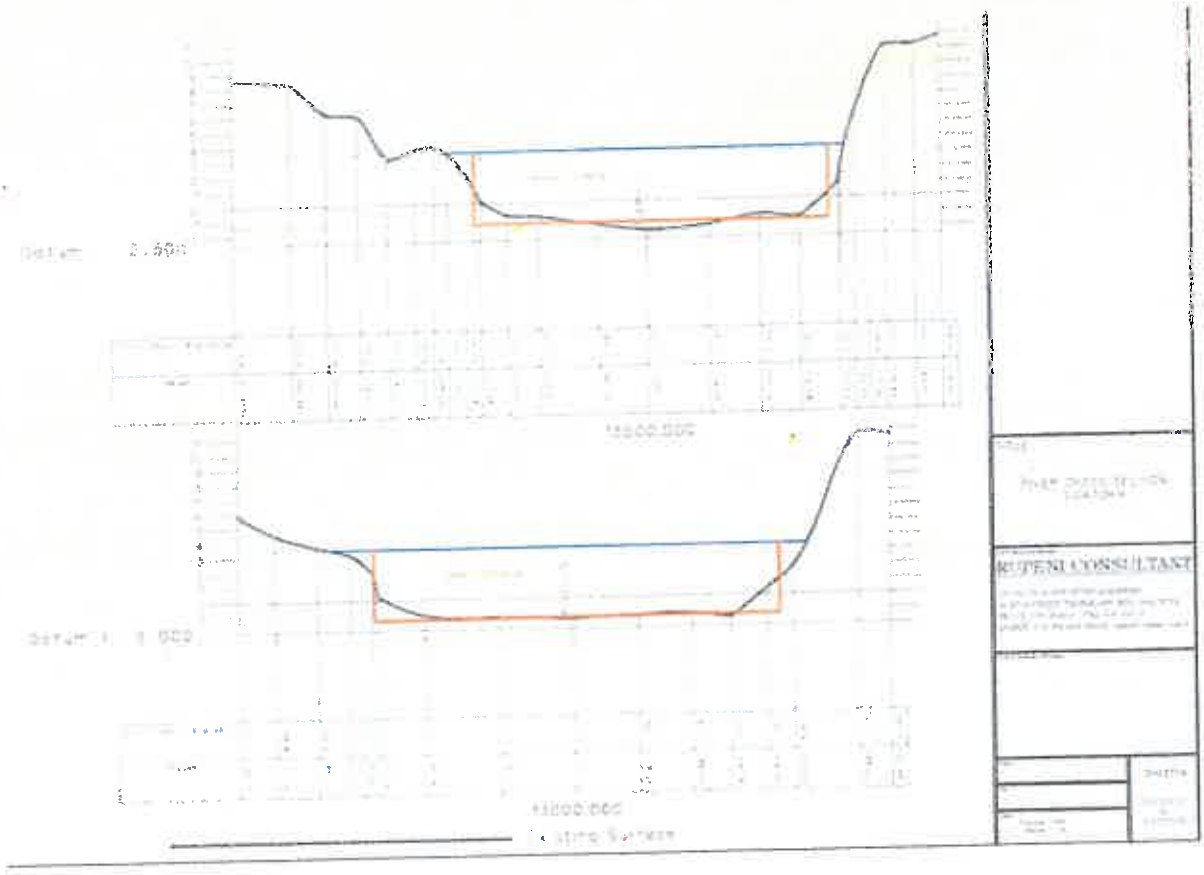
Section 9000-9500

Annex 3 Cross Section 10km – 13.5km

Section 10000 – 10500



Section 12000 – 12500



Section 13000 - 13500