ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR PROPOSED RESIDENTIAL SUBDIVISION AT KULUKULU, NADROGA

Prepared for:
Mr Siva Krishnamurti .....

Public Trustee of Fiji .....

Date.....

By:
The Institute of Applied Sciences, USP

.....
Bale Tamata, PhD.
Principal

Nature Consultants of Fiji

.....
Viliame Baleivanualala
Lead Consultant
Date.....

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. EXECUTIVE SUMMARY

The subject of this report is the environmental assessment (EIA) of a proposed subdivision of part of the Work Estate, located on the outskirts of Sigatoka Town, in the area known as Kuluklulu in Sigatoka, Nadroga. The project proponent is a local businessman, Mr. Siva Krishnamurthi in conjunction with the Fiji Public Trustee. The EIA team consisted of two main agencies: the Institute of Applied Sciences of the University of the South Pacific in Suva, and a local environment consultancy company, Nature Fiji Consultants. The IAS team conducted the socio-economic study, the biological flora and fauna study, and the water quality study. Nature Fiji Consultants conducted the geotechnical and physical environment study. Each of these studies are reported as separate sections in the EIA technical report.

The Project

The project involves the subdivision of approximately 58 acres of freehold land, part of the Work's Estate in Kulukulu, Nadroga, into largely residential lots, with the aim of distributing the land equally among the existing legal beneficiaries of the 5 original owners (sections A – E, Appendix A). According to documents and records kept at the Public Trustee of Fiji, the five original owners of the estate were Walker Work, Christopher Blunding Work, Willis Waterman Work, Caroline E. W. Knowles, Joshua Hill Work and Helen Work as trustee for Joshua Hill Work, a minor.

The revised proposed subdivision differs from the previously submitted plan in that the current one clearly marks out the 'No building zone' at the foot of the sand dunes. This change follows discussion between the developer and the EIA team, on potential risk of burial from sand dune accretion. The project will consist of 145 residential lots, 1 lot each for an FEA sub-station, tourism operation, commercial operation, a boat ramp, and a utilities block. There is also provision for a mini bus station, a 6m wide access along the bank of the Vatueta Creek, and 11 lots are for a 9m wide access road. To meet conservation requirements, a buffer zone of 2 meters, and a sand dune reserve are part of the development. This development is being proposed by the beneficiary Representatives and the developer Siva Krishnamurthi for the Fiji Public Trustee Corporation Ltd., which is the current legal administrator for the Works' estate.

Project Benefits and Main Concerns

The proposed residential subdivision will meet the increasing need for proper housing, for low and middle income workers migrating into the area because of employment in the urban centre (Sigatoka Town), and the tourism-associated activities and operations along the Coral Coast. One other fundamental benefit of the project is the formalizing of occupancy of the area by the legal beneficiaries themselves, many of whom currently reside on the site.

The EIA study revealed two main concerns which the project proponent is being warned about: flooding risk, especially along the Vatueta Creek, and secondly, the effects of sand dune accretion on the lots closest to the sand dunes, south and west of the project site.

Services

According to the Water and Sewerage Department of the Public Works Department, the proposed subdivision will be supplied with water from the Lawai Reservoir via the main supply. There is already an FEA sub-station on the main Queens Road Highway, and there is provision for another FEA sub-station within the bounds of the proposed development. As far as services are concerned, the site is only a few kilometers from Sigatoka Town, so it is envisaged that services such as solid waste will be hooked up to the town's waste disposal systems in place at the moment. However, the project proponent has been advised by the Water and Sewerage Department to put in place alternative systems of sewage treatment and disposal because there is no centralized sewerage system in place in the area, at the moment.

Existing Environment

Physical environment

The land is generally flat and grassy, with the current use being mainly grazing. The land was formerly used for sugar cane farming. The main features of interest at the project site are the sand dunes to the south and west of the property, and the Vatueta Creek to the east. There are environmental issues pertaining to these features as explained further below. Based on preliminary geotechnical assessment, the clayey silt particles accumulated over years of inland erosion, and river transportation and deposition, have now compacted into good structural foundation for construction of low-rise buildings or homes. The fine sand material dominates the higher ground close to the foot of the sand dunes. These areas are not as stable as the lower level ground towards the creek, and may require further 'treatment' to support construction of buildings. Any 'Building and Construction Plans' for the project must be subject to satisfactory results of some foundation drilling to ascertain the geotechnical , engineering properties of the subsurface layers. Provided the sand dunes are not touched, and a reserve be established to ensure safety from accreting sand dunes, there is no real threat of sand dune erosion.

Socio-economic study

The socio-economic survey showed that almost all the current residents at the project site, are related in some way to the original Work families. Most of the residents have school-age children, and the second highest percentage of residents were unemployed. There was a generally laid-back style of living, with little economic activity to occupy the time and effort of the residents.

Biological environment

Biologically, the plants and animals found in the area are all common ones, with none requiring special, conservation attention. In fact, most of the plants found in the area are now regarded as weedy or invasive. Protection of the mangrove zone along the banks of the Vatueta Creek would ensure protection of the breeding grounds for fish and other invertebrates that enrich the mangrove communities.

Water quality

The water quality in Vatueta Creek showed contamination with faecal bacteria in the area immediately around the settlement. Further away and downstream of the settlement, the water quality improved, indicating that for now, the creek was able to dilute and disperse the pollution, most probably due to improper sewage disposal, and possibly seepage of effluent into the creek. The proposed development should see an improvement in the water quality, if sewage effluent is properly treated before being discharged into the environment.

Consultation

The consultation process involved meetings and discussion with a number of stakeholders: the Nadroga Provincial Office was informed about the proposed development, and invited to be part of the first site visit by the EIA team; the Public Trustee of Fiji office was visited on a number of occasions, and staff were interviewed about the project; the Director of the National Trust of Fiji Ms Elizabeth Erasito was also interviewed; the members of the Work families residing on the project site were also visited and interviewed. Other families living close to the project site (on the Methodist Church property) were also interviewed.

Assessment

The environmental impact assessment process identified a number of potential effects of the proposed development.

From the physical environment assessment, the low elevation of the land close to the Vatueta Creek and towards the sea meant that the water table will be shallow, and subject to fluctuation in response to diurnal tidal changes. These factors increase the potential for flooding in the low areas, especially in light of the progressive narrowing (and decreasing depth) of the Sigatoka River mouth. Flooding is an issue now because of the risk to residents that will occupy the proposed residential lots in the area. The stability of the subsurface is also questionable, thus the need for further 'treatment' and selective drilling, prior to approval for construction on these low areas.

The migration of the sand dunes westward created the risk of burial for any structures in the face of the westward movement. The effects of the south-east trade winds also moved the sand towards the north, posing a threat to structures along the foot of the sand dunes. These effects are being addressed in the recommendations. To some extent, the presence of the sand dunes to the south of the project provides protection against tsunami-generated waves.

As far as the social and economic assessment is concerned, the project is necessary. It is the desire of the Fiji Public Trustee, the legal administrator for the Work's Estate that the land be subdivided so that the beneficiaries of the original 5 owners can have titles to their own piece of land within the proposed project site (personal communication: Laisani of Public Trustee/Bale Tamata EIA consultant, March 2009). The proposed subdivision will also meet a need for proper housing for the local people and migrants to the area. The subdivision with a well-planned and

well-managed tourism operation should inject some much-needed economic activity in the area. At the moment, not much is happening, and this project may well be the doorway to economic progress for the Work families. The vision of the developer to adopt a 'green', or environmentally-friendly type of operation/construction is encouraging, and will blend well with the unique sand dunes forming a southern boundary to the whole subdivision.

A concern for the residents was the noise that would be generated during the earthworks and construction phase of the development. The Construction Environmental Management Plan (CEMP) should specify how many trucks will be involved, and what hours the work will take place. Some members of the Work families were unsure of the effects of the development on their own status, and it is up to the official representatives (recognized by Fiji Public Trustee) to clarify these matters to them.

The biological assessment showed that there were no species of significance in the area. The water quality assessment showed presence of sewage pollution in the Vatueta creek near the settlement, but improving further downstream. This result indicated that there was a need to improve sewage treatment and disposal of effluent. The project with its environmentally-friendly approach should bring about an improvement in the way sewage is handled and managed.

Overall, the EIA study findings indicate that the proposed subdivision development is necessary from a socio-economic perspective, and provided the recommendations listed below are adhered to, the project will not result in any significant adverse environmental impact.

Recommendations

Environmental Management/Monitoring Plan (EMP)

1. The points listed in the section 'Recommendations' make up the content of the brief EMP (section 5 of the TOR). A full EMP shall be submitted one month prior to commencement of construction work.

Critical Zones Impacting the Proposed Project

2. Because of natural disaster risk, there are two specific areas that will need strict development control. The EMP should allow for monitoring of construction in these areas.

3. The first of these is sand dune zone numbered 7, which is actively migrating where there was no dune before, covering up much needed land that could be usefully utilized for economic development. It is recommended that sand dune number 7 be mined, to allow for open space, and a safety buffer zone.

4. With proposed re-location of the road to the south of the property, part of the safety buffer zone designated 'no building zone' on the revised map (Appendix A) can be used for roading, and therefore sand mining along this stretch may be necessary to maintain the road portion. The area can also be used for recreational purposes for the residents.

5. The second critical zone is the area around the bank of Vatueta Creek, because of high risk of flooding. There is already an allowance of 6 metres for access but that does not include the risk due to flooding. The elevation around the bank is the lowest and should be filled in for up to at least 1 m, to safeguard the first row of lots against flooding.

Land Preparation

6. The low ground elevation, especially near the creek requires some reclamation work be carried out to raise the ground level by at least 1 meter to keep the ground dry at all times. This is not necessary for the land with higher elevation.

7. No construction work should be allowed until all remediation work is completed. This measure is critical and must be strictly followed for the safety of the residents and the structures. The EMP should allow for monitoring this process.

8. The Vatueta Creek bank must be properly armored to protect erosion of the fill material.

Sand Mining

Sand accretion is the cause of potential problems for the residents. In view of this, the following recommendations are proposed:

9. Any sand mining from the dune should be implemented with control through well devised plan and control, which should be part of the Construction Environmental Management Plan (CEMP).

10. Mining of sand from dune 7 will increase total use-able land, and will enable the developers to maximize usage for the proposed development.

Geotechnical Study

11. Before construction plans are approved, it is necessary to conduct some selective drilling to ensure stability of the subsurface, in view of this area being a flood plain, and being close to the Vatueta Creek.

Socio-economic study

12. It is recommended that a "Sand Dune Management Strategy" be established to monitor sand accretion and its effects on lots closest to the dunes. The management can include the National Trust of Fiji, the scientific/technological expertise, and the residents and working together to guide and monitor the use or management of the sand dunes.

13. The issue of noise as a nuisance for people in the area will have to addressed in the Construction Plans (CEMP), and the EMP.

14. The official representatives of the 5 original Work families will need to be regularly informing members of their groups about the development, i.e. potential benefits, what to expect etc.

Flora and fauna study

15. The mangrove forest is relatively in good health, and should be maintained, because of a very important function in the integrity of the ecology of the area.

16. If any river dredging work is to take place than placement of the sludge onto land should be carefully planned out so as to minimize negative impacts on the mangrove forest.

17. As part of sand dune management, it is recommended that active planting of creeper plants, pandanus and other local plants be done to reduce the impact of erosion into the proposed development site.

Water quality

18. The developer should ensure that a suitable sewage treatment facility is built as part of the development, to address the current lack of such a system in the area, and to ensure the sewage pollution observed near the settlement becomes a thing of the past.

19. It is recommended that children not be allowed to bathe in the creek, as the risk of infection of eyes, ears and the skin is very high, due to high sewage contamination.

20. Until the sewage pollution matter is resolved, it is recommended that consumption of fish and other river/estuarine food sources caught near the settlement be prohibited.

II INTRODUCTION

Statement of Need:

The project is an attempt to formalize the occupancy of the estate belonging to the Work family by subdividing part of the estate into residential lots, and providing legal titles for the lots to the members of the Work family. As far as possible, the project aims to create an amicable relationship among all the rightful beneficiaries to the land. To achieve this, the developer Mr Siva Krishnamurti has been working in close collaboration with the Office of the Public Trustee, which recognizes the five lines of legal beneficiaries by their appointed representatives. The subdivision is also a timely effort to provide developed land suitable for housing, for the increasing population in the area well known for its Tourism capability.

The proposed development site is part of a 100 acre private freehold lot originally belonging to a Ezra Walker Work, Christopher Blunding Work, Willis Waterman Work, Caroline E. W. Knowles, Joshua Hill Work and Helen work as trustee for Joshua Hill Work a minor.

The Public Trustee of Fiji is now the legal administrator for the Works Estate and is working with Pro-Survis and Development Consultants to subdivide approximately 58 acres of it into residential lots to be distributed equally to the existing legal beneficiaries of the 5 original owners. The legal beneficiaries will be determined by the Public Trustee of Fiji once the development plan is approved and genealogy research is completed and presented in court.

It is also perceived that the current residents of the proposed development area will remain in their current places and will obtain titles to their respective properties.

Justification for the necessity

Tourism boom in the area raises the need for housing for the workers. Squatter settlements are on the increase, and with squatter settlements, social and health problems are often side effects.

The Work families have been 'fighting' over the ownership of the land for a long time – this project is trying to formalize ownership, so that individual families can venture out into their own development.

Regulatory requirements

The Terms of Reference (TOR) for the EIA study was prepared by the Department of Environment (DoE), in accordance with the Environmental Management Act 2005.

The current timetable for the development

The Development Scheme Plans have been approved subject to an EIA study being completed and approved by the Department of Environment. The sooner this EIA report is approved, the sooner the development will proceed on to the next phase.

The Scheme plan was approved on December 24 2007 subject to conditions including an EIA Report. However, the plan has been revised by the developer to address the environmental, geotechnical concerns raised by the EIA consultants. The revised plan was submitted to the EIA consultants in December 2008, which explains the delay in finalizing the EIA Report.

Background information on consents

The approved Scheme Plan has information on all approvals todate. The Public Trustee Office is the Trustee for the estate. The Public Trustee Office on advise of the Beneficial Owners representatives have confirmed appointment of Siva Krishnamurthi as the Developer of the project.

The concerns raised by the Director of the National Trust have been incorporated into the revised plan, i.e. the 'no building zone' replaces the zone categorized as 'Secondary Dune Zone'. The sizes of the lots have been reduces to allow for the safety buffer zone. The total number of lots have reduced from 176 (previous plan) to 166 (revised plan, Appendix A).

Persons and parties consulted for the EIA preparation

The Nadroga Provincial Council, Work families; Fiji Public Trustee; the Director of the National Trust of Fiji; Planners.

Personnel involved in the preparation of the EIA Report

Viliame Baleivanualala – Geotechnical and Physical Environment Study
Lavenia Tawake – Socio-Cultural Environment Study
Marika Tuiwawa – Flora and Fauna Study
Bale Tamata – Team leader and Water Quality Study

III PROJECT DESCRIPTION

Project Description

The project is known as the "Proposed Subdivision of the Works Estate" in Kulukulu, Nadroga. The subdivision plan has been revised following the commencement of the EIA Study, and concerns raised by the EIA team, especially the geotechnical consultant. The changes have reflected the need for buffer zones where no building is permitted – at the foot of the sand dunes. This is in line with the concerns raised by the Director of the National Trust of Fiji. In place of residential lots in this southern border of the subdivision, the developer is proposing to have part of the safety buffer zone be set aside for the road and access to the Masa Club. This replaces the previous plan to have the road cutting through the subdivision.

In the revised subdivision plan, out of the 166 lots:

145 are for residential lots
1 Lot – FEA Sub-station
1 Lot – Special use (Tourism)
1 Lot – Commercial
1 Lot – Mini Bus Stand
1 Lot – Boat ramp
12 Lots in total - access roads
1 Lot – Utilities block
1 Lot -Buffer zone 2.0 metres
Sand dune reserve

These allocations are shown on the Revised Subdivision Plan in Appendix A

1.0 DESCRIPTION OF THE EXISTING PHYSICAL ENVIRONMENT

1.1 Physical Environment Study

1.1.1 Introduction

In October 2008, the Institute of Applied Science (IAS) which is a research arm of the University of the South Pacific (USP) sub-contracted the services of Nature Fiji Consultants to study the physical environment for a proposed residential subdivision at Kulukulu near Sigatoka.

The first field visit was carried out in collaboration with the IAS environmental officers who were there to gather baseline data on the existing terrestrial flora and fauna and also do a survey with regards to the social-cultural environment.

1.1.2 Location

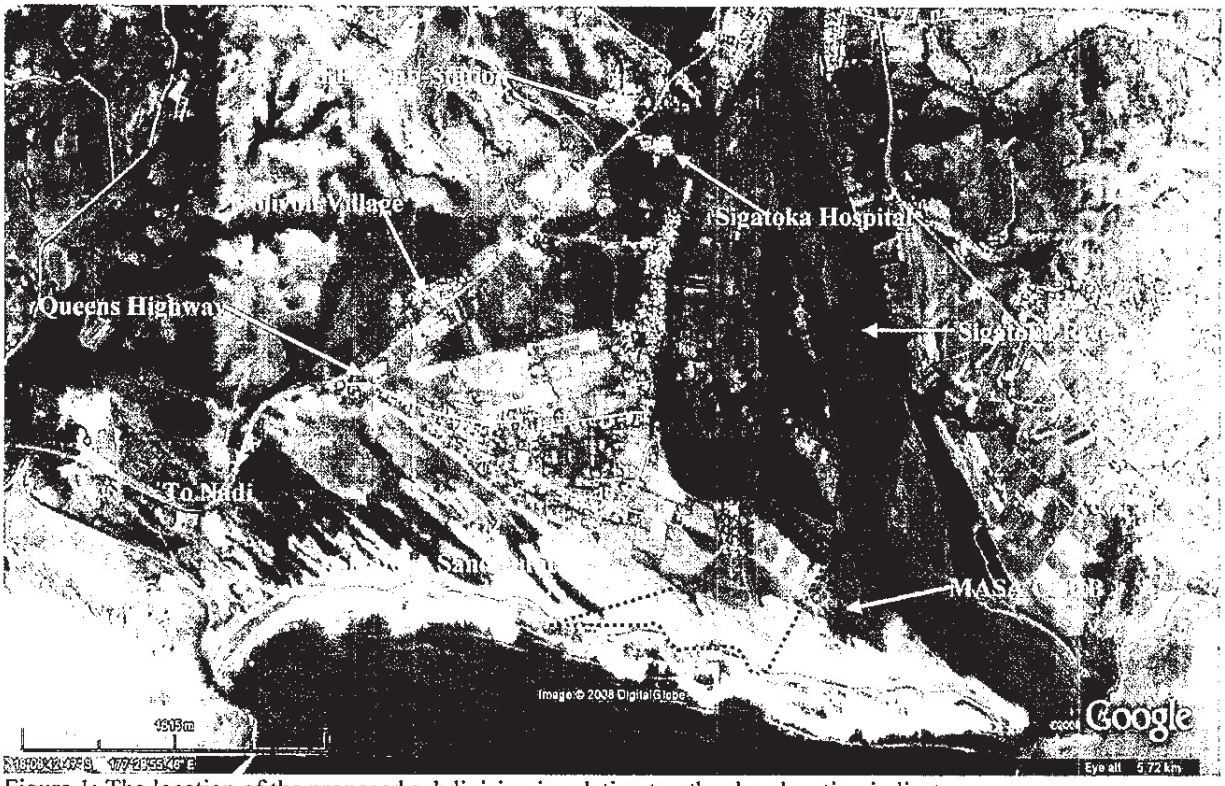


Figure 1: The location of the proposed subdivision in relation to other key location indicators

The site lies approximately on Longitude 177° 30' 30" E and Latitude 18° 10' 06'S. As is obvious in Figure 1, it is close to the MASA CLUB, and the well known Sigatoka sand dunes is immediately south of the proposed development site. There can be two entry and exit roads as are also visible in Figure 1. The road that leads to the Masa Club turns left about 60 metres from the turn off to the Sigatoka Hospital driving towards Nadi. On the right side of the Queen's Highway are the PWD and the FEA sub-station. This road is sealed and joins the gravel road at its turn towards the site.

Masa Club which was presumably established in the early 1990s is south east of the site.

1.1.3 Project Description

The project which is known as the "Proposed Subdivision of the Works Estate" in Kulukulu, Nadroga consists of the following:

145 residential
1 Lot – FEA Sub-station
1 Lot – Special use (Tourism)
1 Lot – Commercial
1 Lot – boat ramp
12 Lots in total - access roads
1 Lot – Utilities block
Sand dune reserve
Buffer zone 2.0 metres

The details of the residential and other uses lots are shown in the scheme plan in Appendix A.

1.1.4 Project Environment

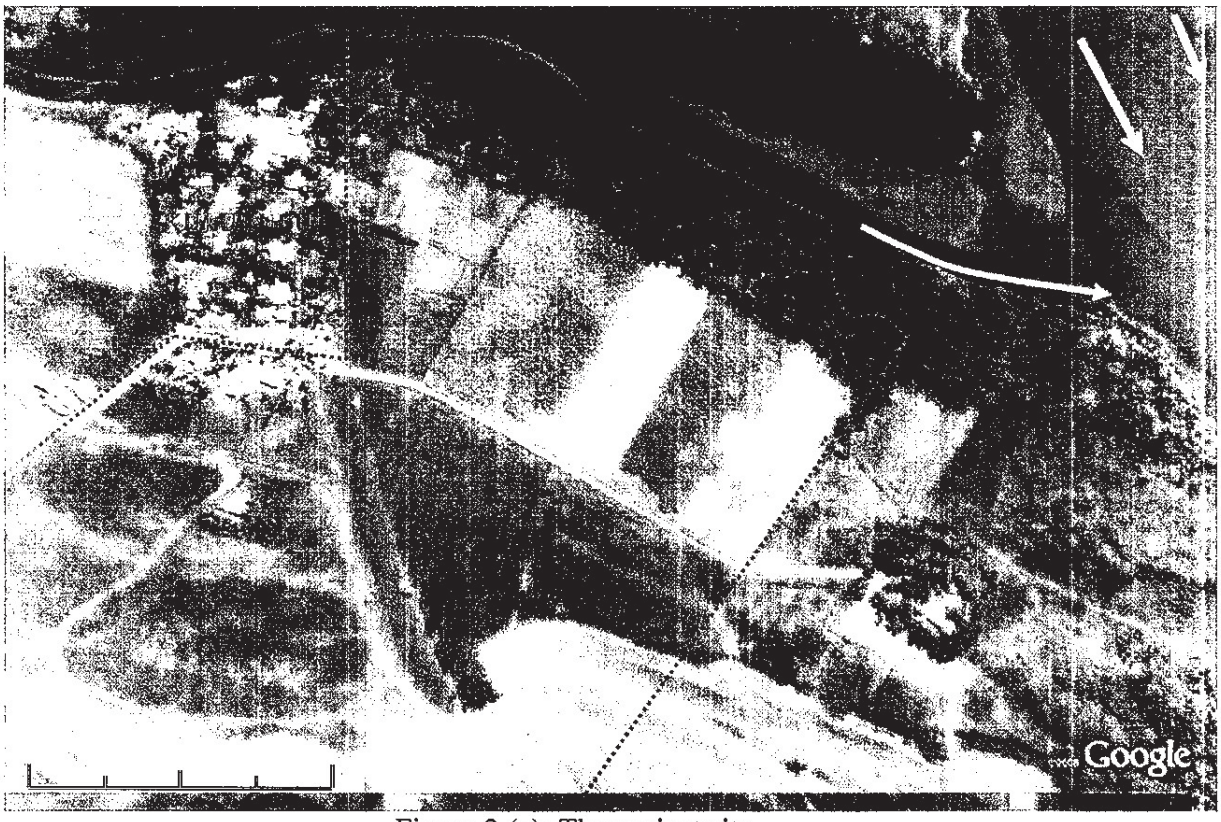


Figure 2 (a): The project site

Beginning from the top, the Vatueta Creek runs from west to east and re-joins the Sigatoka River as shown by the arrow. The Sigatoka River flows along the northeast corner. There is an area of tree vegetated area along the river bank. The project site looks to be very flat but the topographic map will show the elevations well which also pronounce the geology of the site. It is

clear that the site is currently used for grazing and was formerly used for sugar cane farming.

Figure2 (b): Close up views of the project site, its coastal, parallel waves, east sand dunes and the bottled-neck river mouth

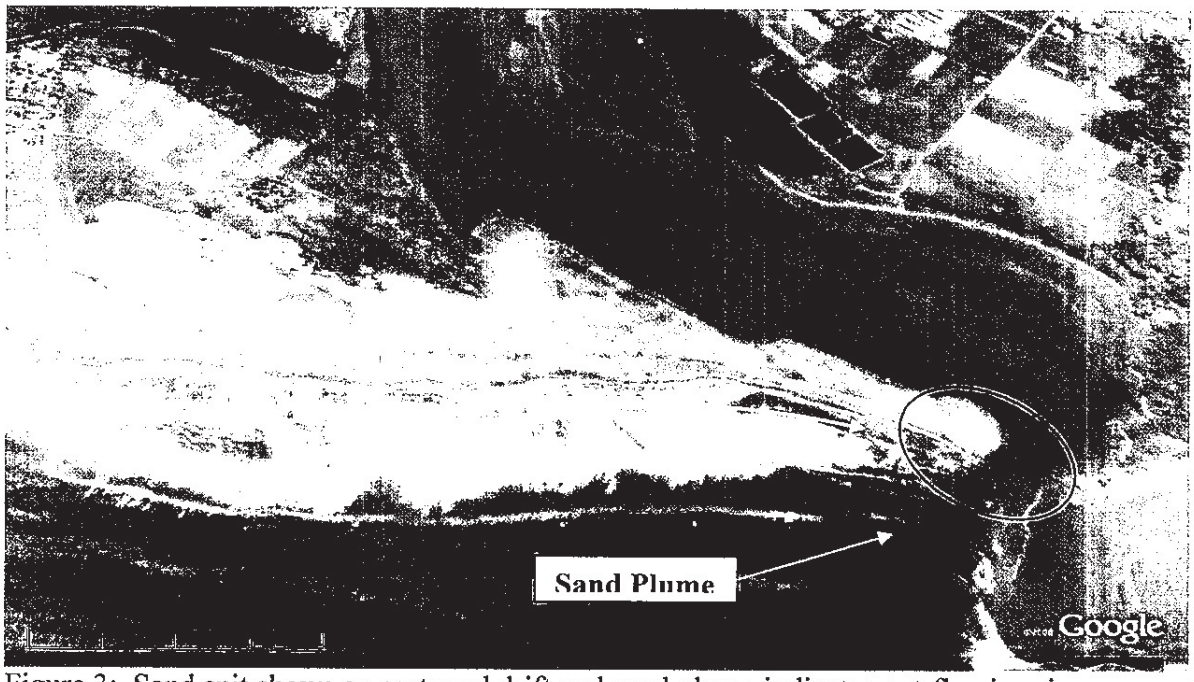


Figure 3: Sand spit shows an eastward drift and sand plume indicates out-flowing river current and sand dune migrating northwest. –

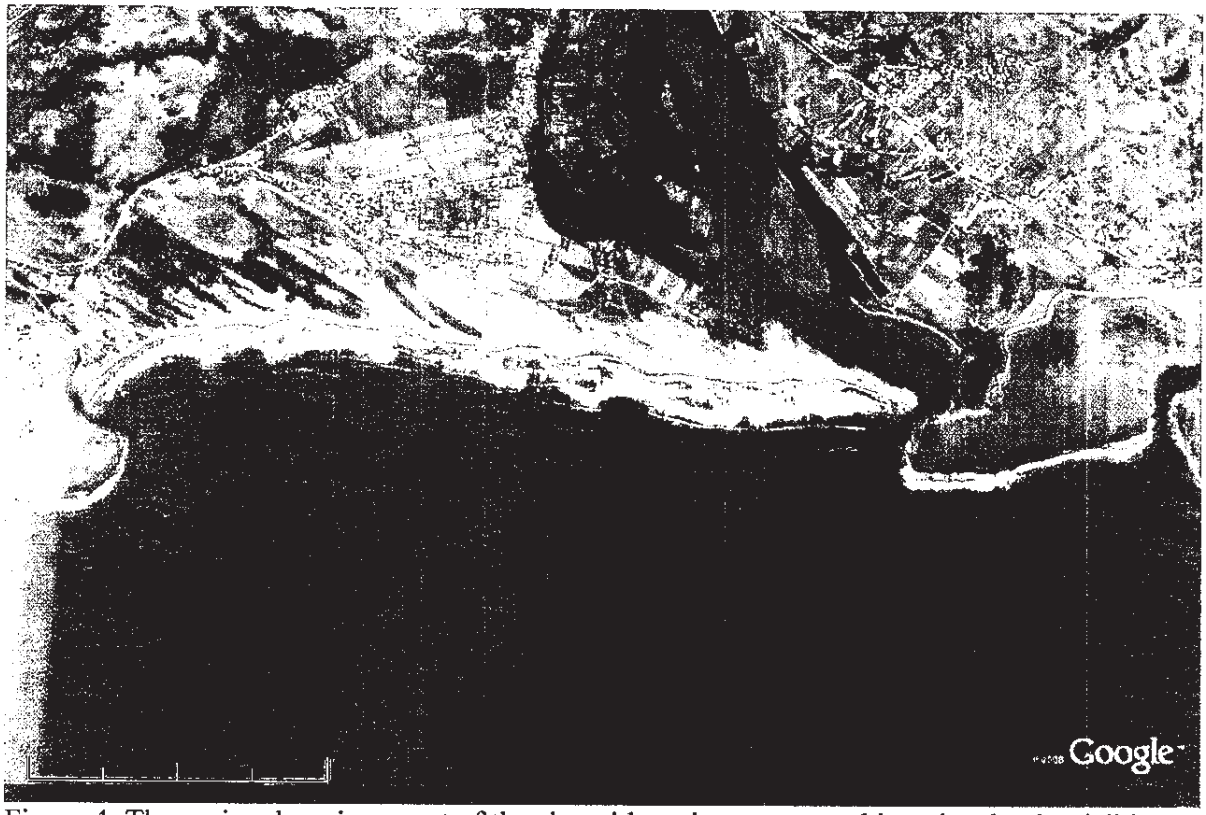


Figure 4: The regional environment of the site with various geomorphic units clearly visible – dunes, river, wide fringing reefs, meander bars and spits

1.1.5 Physical Environment - Geology

The study of the physical environment is based on the requirements of the Terms of Reference that was prepared by the Department of Environment and also agreed between the EIA study Team Leader and the Principal of Nature Fiji Consultants.

The geology of the area is distinctively described in two parts. Firstly, the lower Sigatoka River delta area which is an accumulation of silt and clay eroded from the upper catchment and transported down river by river current. This process has continued through time since the formation of this river system.

The clayey silt particles have compacted through time and if drilled through the subsurface layers would show consolidation as water and air are squeezed out of the pore spaces to become siltstone. Due to its fine grain size water will not be able to percolate through it so it will now be a good structural foundation.

Figure 5 below shows the distinct contact between the two rock types. The clayey silt particles are deposited by water whilst the fine and well graded sand particles were deposited by wind action. The sand particles were transported out to sea and re-worked back to the beach by waves and current before wind took over the process to transport them and deposit them where they are now.

The topographic map that provides more detail at 1.0 metre contour interval that was particularly surveyed for this project shows very clearly the difference in elevation of the two rock types. The change in elevation at the contact between the two rock types as shown in Figure 5 is very clear in the field.

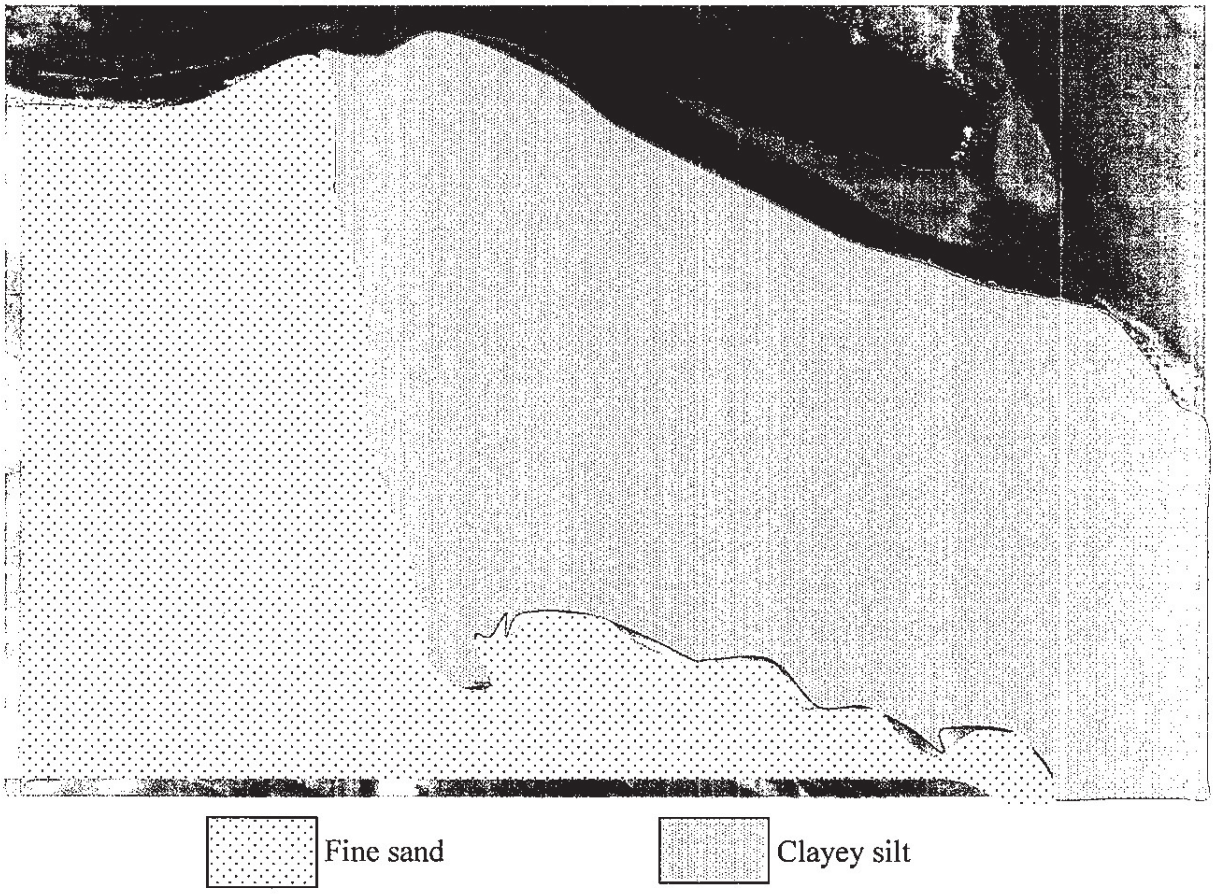


Figure 5: The geology of the site

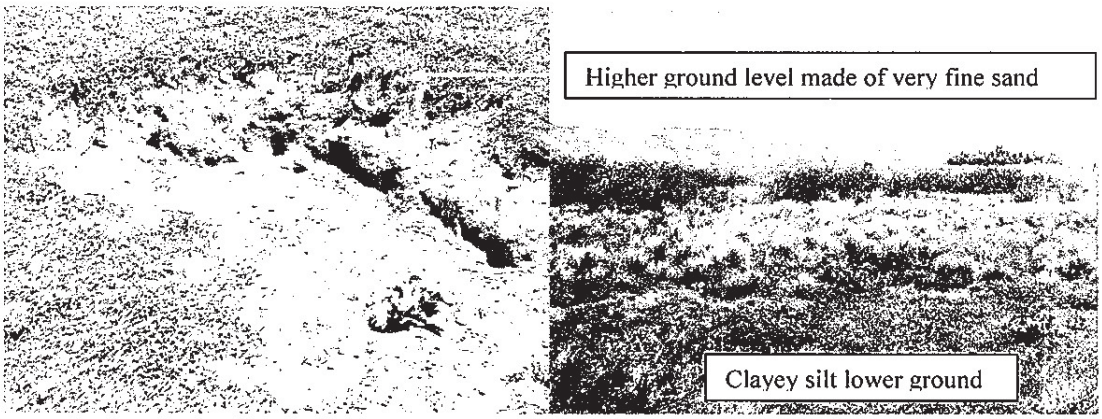


Figure 6: An excavation very close to the contact (red star in Figure 5) showing very fine sand; although well vegetated with grass once exposed to the weather it will start to erode

1.1.6 Topography

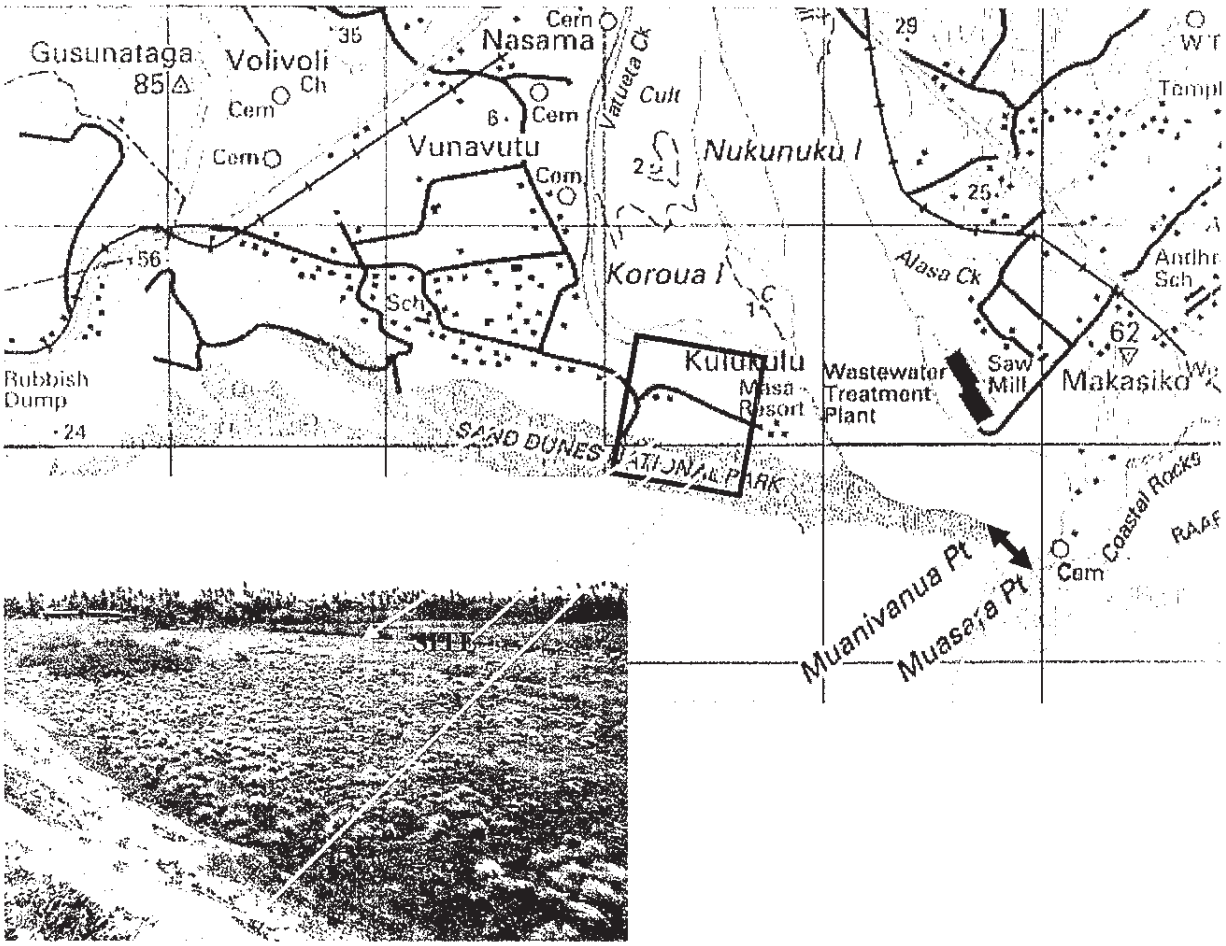
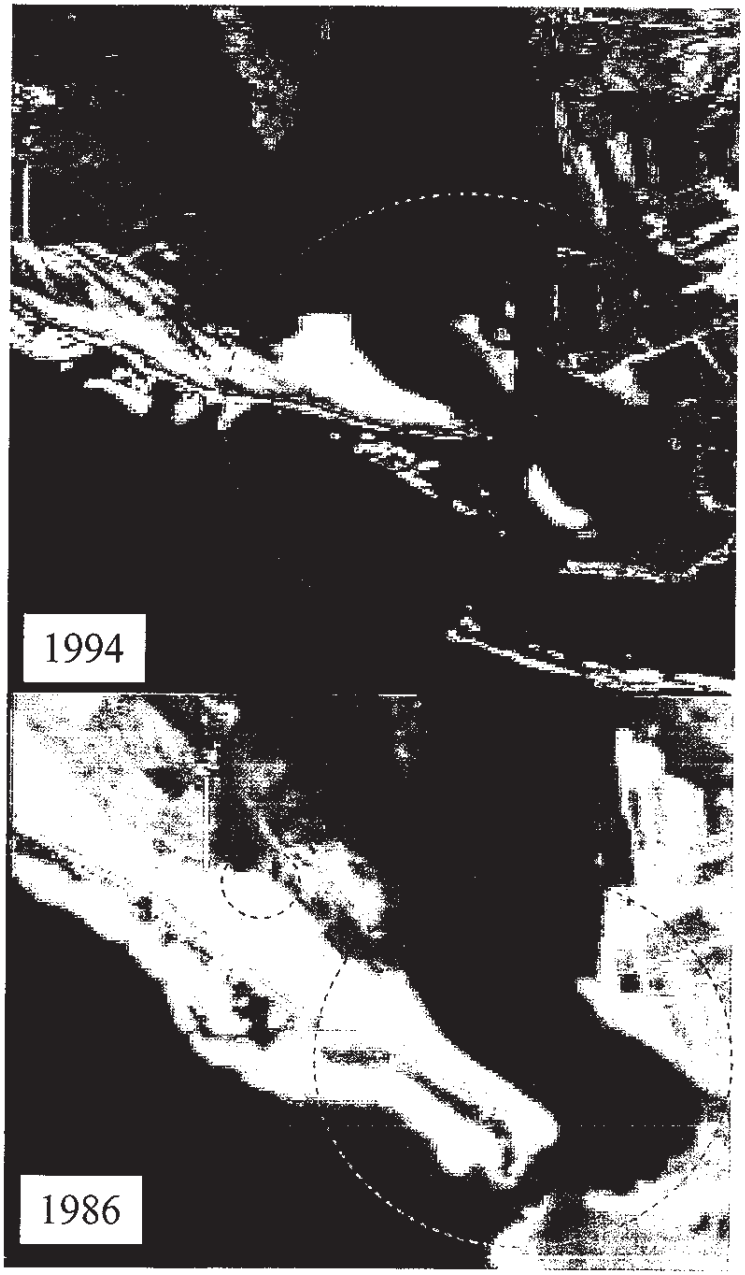


Figure 7: The regional topographic map which was drawn at a scale of 1:50000. The insert shows the project area, partly obscured elevation of the sand dune and the Kulukulu settlement partly seen at top left.

The vertical elevations interval on the map is 20 metres. That interval has obviously not able to show any elevation details at the site hence the insert to provide some ground truth understanding of the site. Appendix A shows very clear details of the topography as the elevation interval is one metre. Although the site looks very flat in Figure 8; there is a gentle tilt towards the mouth of the river and as well as the coast.

There are indications of occasional wet surface like dried up mud just around the base of the sand dune. The grazing animal footprints in this dried up muddy area indicate the amount of time the surface water is retained; soaked into the upper surface of the clayey silt and turned into mud by grazing animals.

Figure 8: The site viewed from the sand dune looking north. Its current use is obvious. The area shown here is composed of clayey silt



Arial views of the site looking back through time. It is unfortunate that overlays to fully appreciate the rate of changes can not be calculated because the images are of different map scales. However, there are obviously significant changes distinctly shown in the last 22 years.

- Sigatoka River is shallower in 2008 compared to 1994 and 1986
- Channel bar build-up along east bank of river
- Changes in the mouth bar is controlled by tidal system
- 1994 the elongated mouth bar was that is seen in 1986 was totally destroyed and moved about within the mouth.
- That could have been caused by Cyclone Kina in around March 1993 which caused flooding in the Central and Western Divisions
- In 2008, mouth bar has changed form again and sign of new deposition at mouth
- Sand dune has migrated much closer to the track (red) in 22 years
- The shoreline has also changed to a cuspate form in 2008

Figure 9 a, b, c: Historical changes around the site

1.1.7 Meteorology

OLOSARA RAINFALL DATA												
Date	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
1996	253.5		479.2			242.1					892	
1997	450							204.7			07	
1998												
1999	434	485.5		284							236.3	
2000				299	220.5						57.5	
2001	802		264.5								15	
2002									207.5			
2003		0	230.2									
2004										0	0	
2005												
2006											208	
2007		430									212	
2008		255.9	273.5		248.2							

<100 mm >100 mm >200 mm >300 mm >400mm >500 mm

Table 1: The rainfall data for the last 10 years taken from the Olosara Synoptic Weather Station.

Since Olosara is only a rainfall station, we do not have any wind data available from that area and other places close by. The only wind data available for Sigatoka would be from Nacocolevu. Please note that the rain gauge for Olosara Sector office is located at Kulukulu, which is much closer to the area you interested in. (Met. Officer- Pers.comm).

Date	Total Rainfall (mm)		Date	Total Rainfall (mm)
1	21		16	25
2	26		17	13
3	26		18	0
4	0		19	0
5	0		20	0
6	22		21	6
7	12		22	0
8	0		23	0
9	0		24	0
10	0		25	0
11	0		26	0
12	0		27	5
13	15		28	140
14	58		29	102
15	5		30	23
			31	2
			Total	501mm

Table 2: The detail of the daily rainfall data for January 2008

Overall Sigatoka is quite dry, however assessing the rainfall for each of the 10 years since 1996, it is obvious that rainfall is associated with the months of November to April. It is also important to note that although there is some rainfall as explained above, the average rainfall is only about 17 mm/day in January which is observed to be the wettest month every year for the last ten years
The colours given in Table 1 above distinctly implies that the drier months of every year for the last decade is around May to October and that would be related to the winter months in Fiji. However, although there is some rainfall as shown in the data, Nadroga or specifically Kulukulu and Olosara is still categorised as being in the dry side of Viti Levu.

Despite the data that shows a dry Sigatoka area, the rain sometimes falls continuously and very heavily in the upper catchment area. For example, in January, there was 500 mm of rainfall; 242 mm of rainfall in January fell on the 28th and 29th and was quite dry for most of the month. This would have some impact in the project site, so some ground improvement is required.

1.1.8 Surface and groundwater

The clayey silt is a fine grain rock that is not porous enough to be storing ground water, however since the site is very close to the coast and likewise to a major river in Fiji and that the elevation is just above sea level the water table will also be shallow and is likely to be fluctuating due to tidal influence. If such scenario is present then it will have impact on structures that will be constructed on the site. For such reason there is a need to do some foundation drilling to ascertain the geotechnical engineering properties of the subsurface layers.

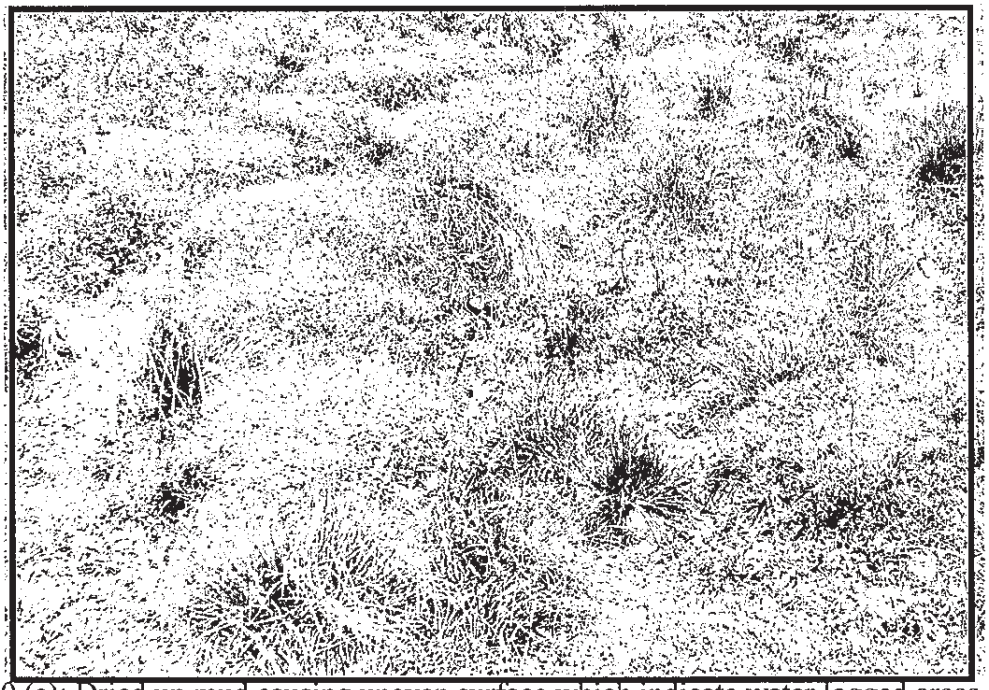


Figure 10 (a): Dried up mud causing uneven surface which indicate water logged areas and also occasional flooding.

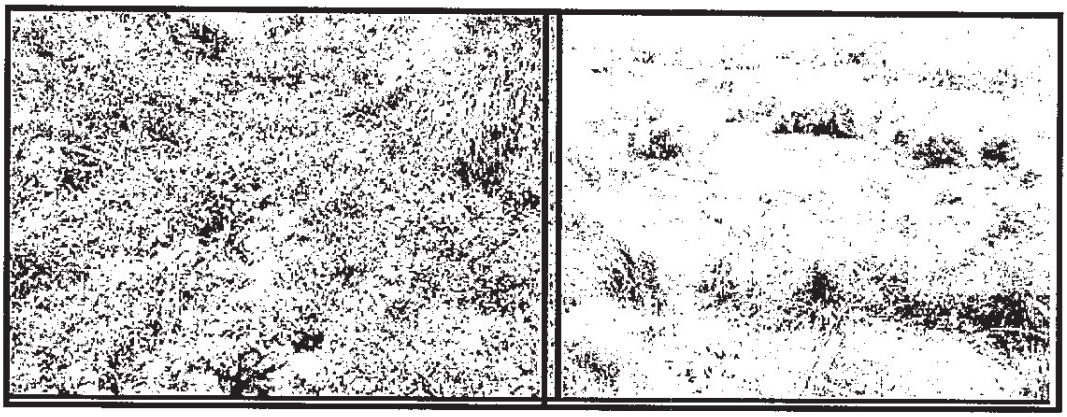


Figure 10 (b & c): Other areas that indicate surface water and soft underfoot which can be detrimental to structures.

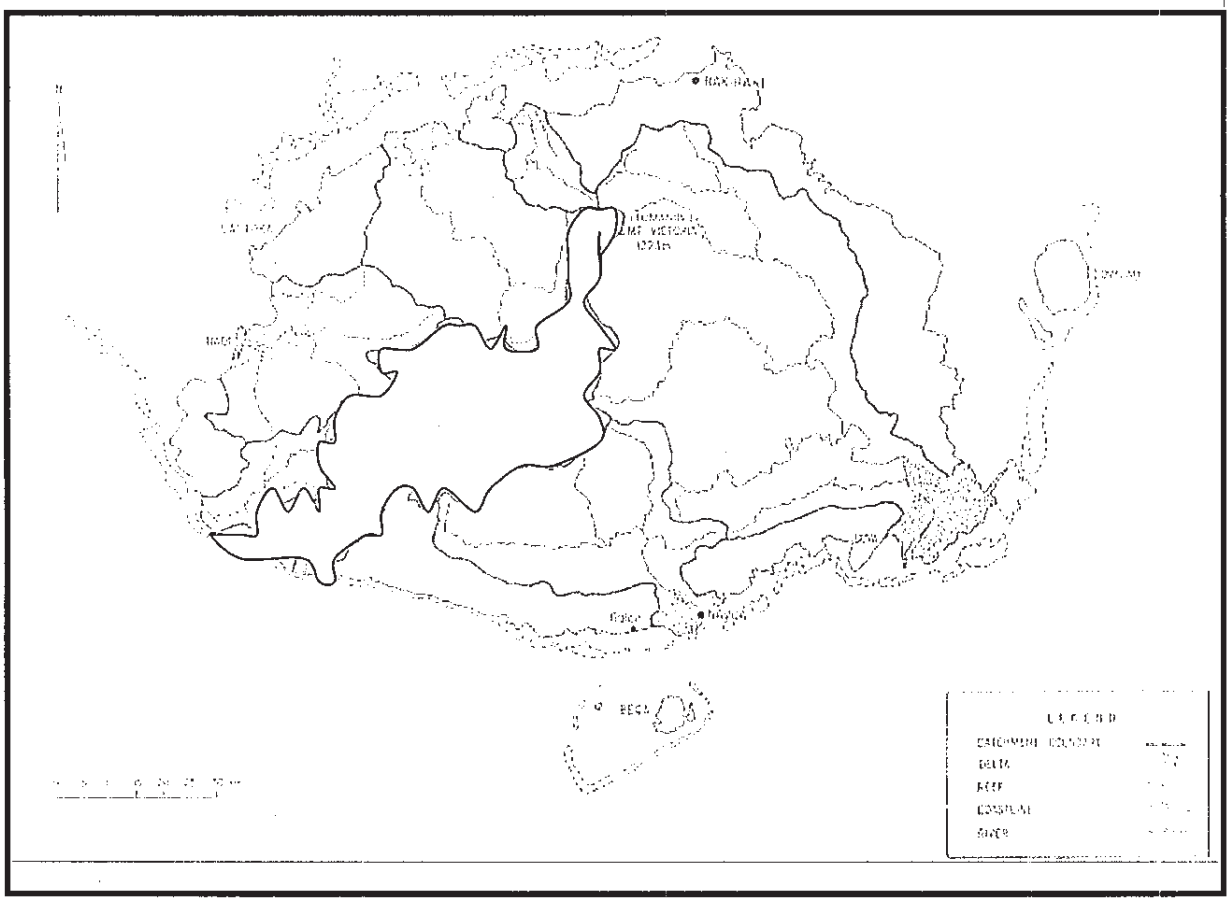


Figure 11: The watershed area for the Sigatoka River and lower delta flood plane is marked in yellow. The area that will be impacted by flooding is in the red box

The total watershed area for the Sigatoka River is about 1452 $km^{2;}$ all rainwater which becomes surface run-off will somehow end up in the Sigatoka River and ultimately to the lower river delta flood plane. With the rapid shallowing of the river caused by erosion in extensively cultivated upper river delta; it has put pressure around the site in recent past and must be seriously considered as one of the major impact to the proposed residential development.

1.2 Vulnerability of the project to natural disasters

1.2.1 Cyclones

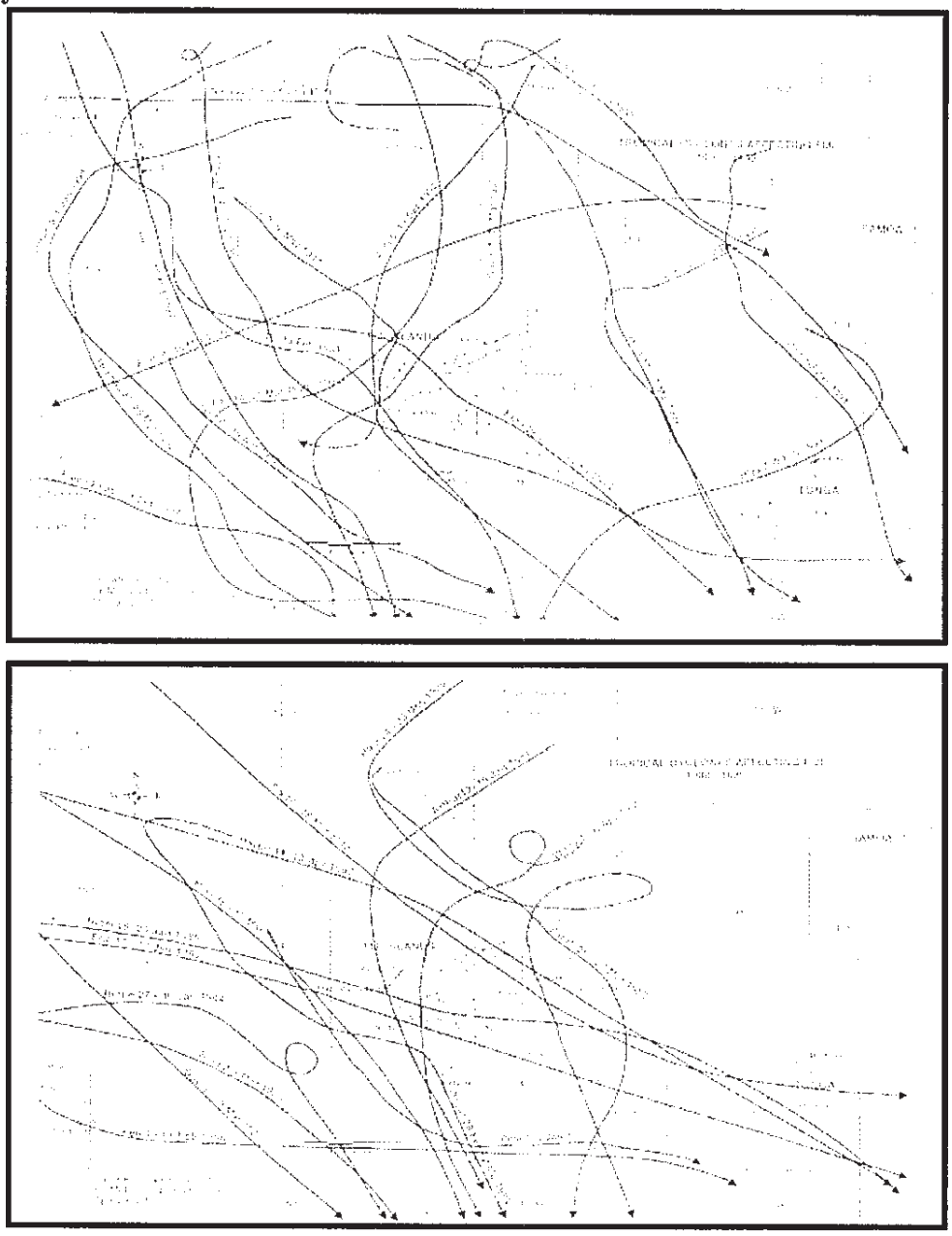


Figure 12 (a & b): The cyclone track map for cyclones that went past Fiji in the decades 1980-1999.

The cyclone tracks shown above shows that the coral coast and south west Viti Levu are regularly ravaged by strong winds. In many cases, in the recent past there has been more damage by flood waters rather then hurricane force winds. The site being on the lower delta flood plane is subject to occasional flooding during cyclones. The Sigatoka River is

the longest in Fiji and all rainfall in the upper catchment will definitely flow down river to the coast and that is where the project site can be impacted just like any other lower delta area.

1.2.2 Seismic Risk

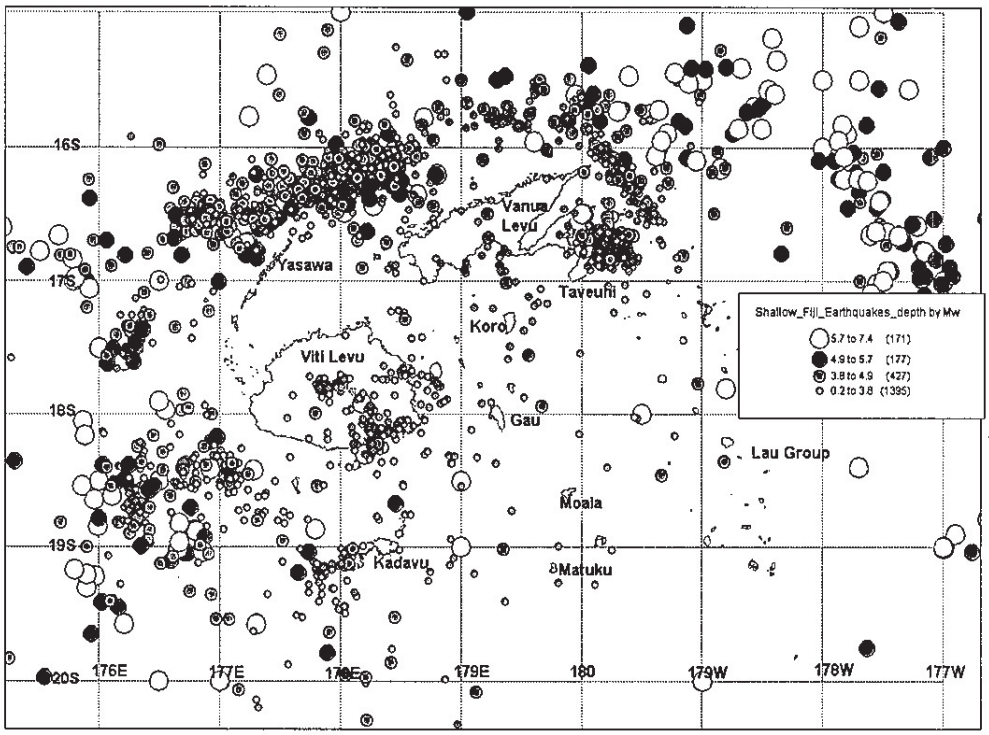


Figure 13 (a): The earthquake epicentres around Fiji

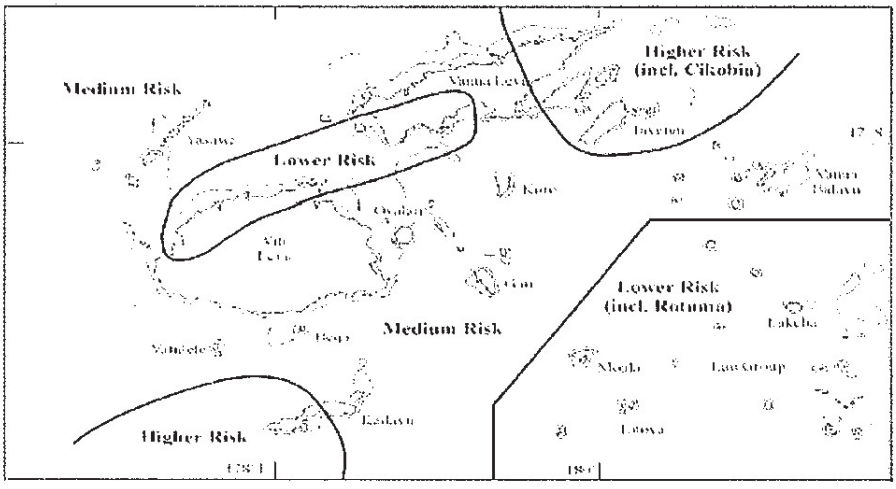


Figure 13 (b): The seismic risk zoning map based on the data in Figure 13 (a)

The site is in the earthquake medium risk zone as shown in Figure 13 above. Figure 13 (a) shows the Sigatoka area to be quiet and can be downgraded in risk level from medium to low risk.

Apart from the above a colour variation is used to classify the magnitude of the shake. Close look at the scale given will prove that those little green circles around or near the Sigatoka region are the weakest tremors. These are shallow earthquakes that are more damaging, so at the scale of 0.2 to 3.8, the site is seismically safe however, since there are some stronger shakes around the spreading centre the Sigatoka area is classified in the medium risk area to maximise safety. To maximise safety building codes and all other available building regulations must be adhered to.

1.2.3 Tsunami

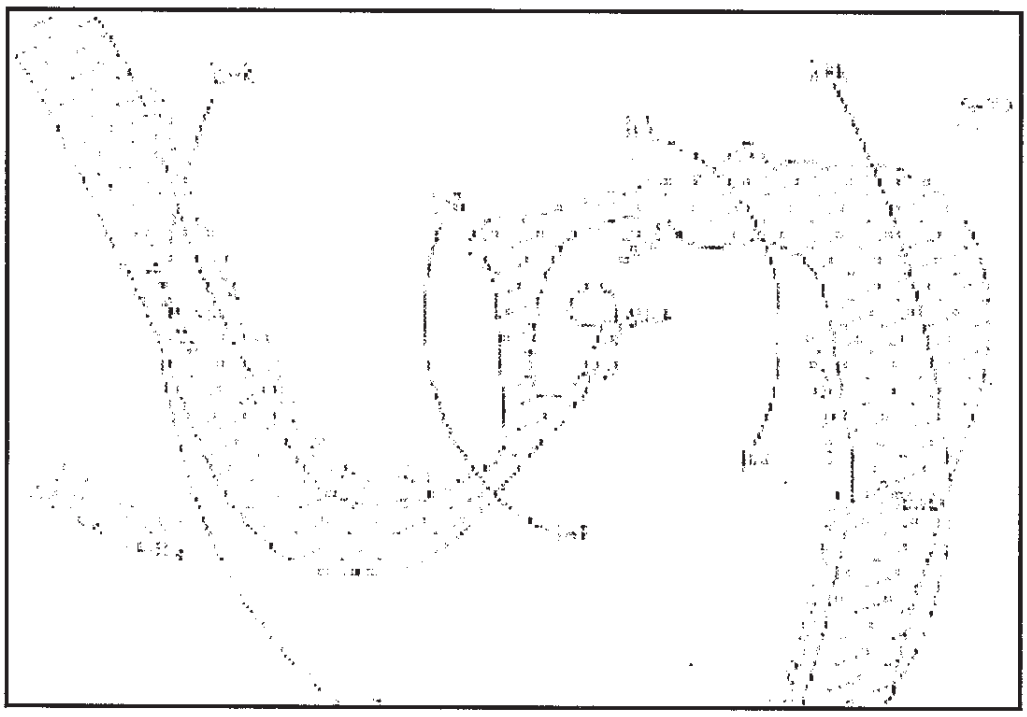


Figure 14: A local tsunami travel time around Fiji

Fiji is bounded from the west and east by active convergent (subduction) zones. Between the Fiji Group of islands and the east and west convergent zones are divergent or spreading centres. To the north and south beyond the Yasawa Group and Kadavu respectively are fracture zones where faulting is actively occurring.

A local earthquake close to Suva triggered submarine slumping along the reef slope that caused a tsunami that hit Suva and nearby areas around Nukui in Rewa and Nakasaleka in Kadavu. There are no records for any tsunami hitting the southwest of Fiji. Since it is bordered from the sea by the sand dune the site although on low delta elevation it is very

well protected from tsunami. There may be some water entering through the narrow river mouth but it will not be much of a risk as most of its energy would be lost out at the coast. The shallow sea area (nearshore) will immensely reduce the wave energy although the wave height will increase to break violently onto the shore. The sand dune will act as the natural barrier to any impact at the project site.

1.3 Mitigating against the potential adverse impacts

There are certain potential impacts that must be addressed at the initial phase of the development before any construction is to take place.

1.3.1 Flooding

The site can occasionally flood during very high rainfalls. Information gathered from the estate owners, residents in the vicinity, the Provincial Office and the Department of Water and Sewer at Sigatoka all agreed to the finding of fine silt to clay size particles around the site which are indicators of suspended sediments settling in the area when the flood waters receded. It is unfortunate that no flood data was available at any of the said key offices. Several reasons for flooding were identified as follows:

- The Sigatoka River is the longest in Fiji hence the water catchment area will also be equally similar and that all water collected within that area will flow down to the river.
- The very narrow mouth of the Sigatoka River which would drastically slow down water flow.
- The lower Sigatoka River level is influenced by the rise and fall of the diurnal tidal system so high tide will further exacerbate the flood impact.
- The sand dune acts as a dam from the south boundary of the project site.

Figure 15: A pool of water by the sand dune probably filled in during the last rainfall. The head of the dune that is migrating westward is behind the pool of water.

1.3.2 Sand Dune Migration

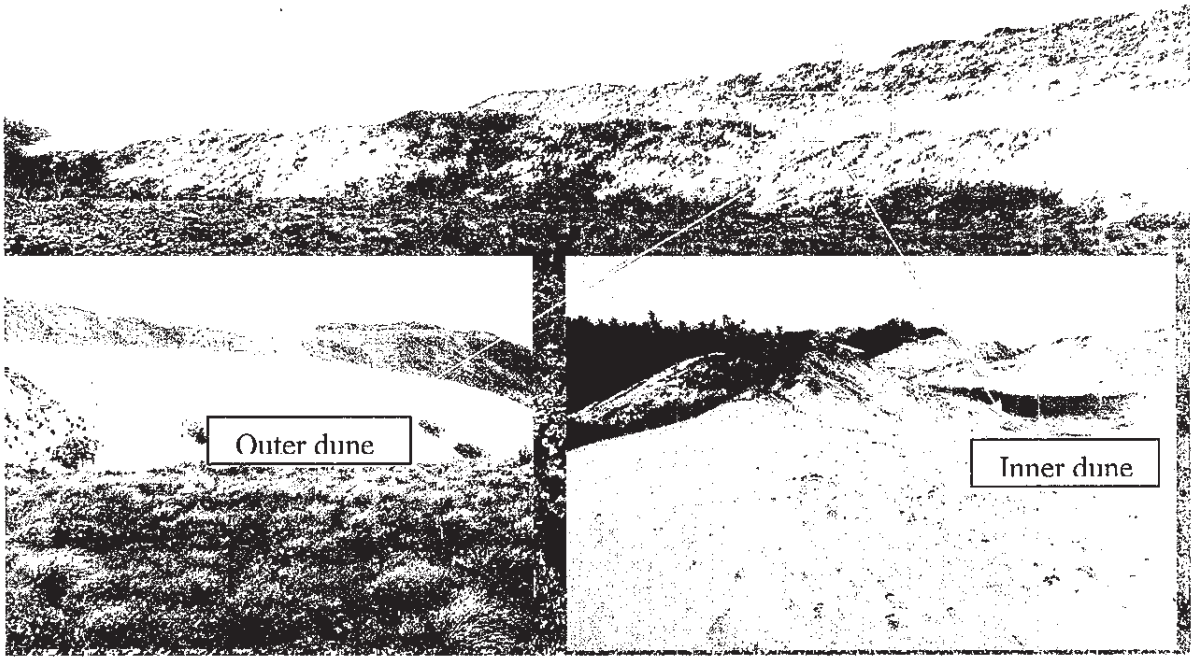


Figure 16: The side elevation of sand dune # 7 which is migrating westward within the site. The insert on the left shows the outer and head of the dune, whilst insert on the right shows the inner dune looking back from the head. The dune field seen here contains 3 dunes elongated sub-parallel to each other.

It is very important to observe the attitude of the dunal system. The elevation is seen in Figure 16 above and the head is seen in Figure 15. There are a series of four dune systems visible in Figure 16 and they are all within the site. All the elevations are showing some positive signs of stabilising as indicated by the ground vegetations that grows along the sides of the dunes. All dune systems are elongated in the direction of movement which is linear towards the west. While the outer dune is stabilising as can be seen above the inner dune part is active in the migration process causing a hollow within, as the sand moves forwards as seen in insert 2 above.

Once a dune system is formed it will maintain its width as it moves forward. That is a characteristic that is controlled by the wind and is evidently supported by the vegetation growing along the side. In the case of this development site, the area of most concern is in front of the dune rather then the side. However, a no building zone is always the first logical solution that should be applied to provide enough open spaces between the first row of residential lots and the dune. The open spaces which will act as a safety buffer from adverse weather changes can also be used for recreation purposes by the developers.

This study however, has noted with clear evidence that if dune # 7 is mined it will still achieve the safety open space that is required and explained above. Dune 7 is the last one and is encroaching into the proposed subdivision. Dunes are moving sand bodies and the removal of this particular dune will have no effect at all on the dune field as it is the outermost one. It will add value in terms of much needed space for housing in the area.

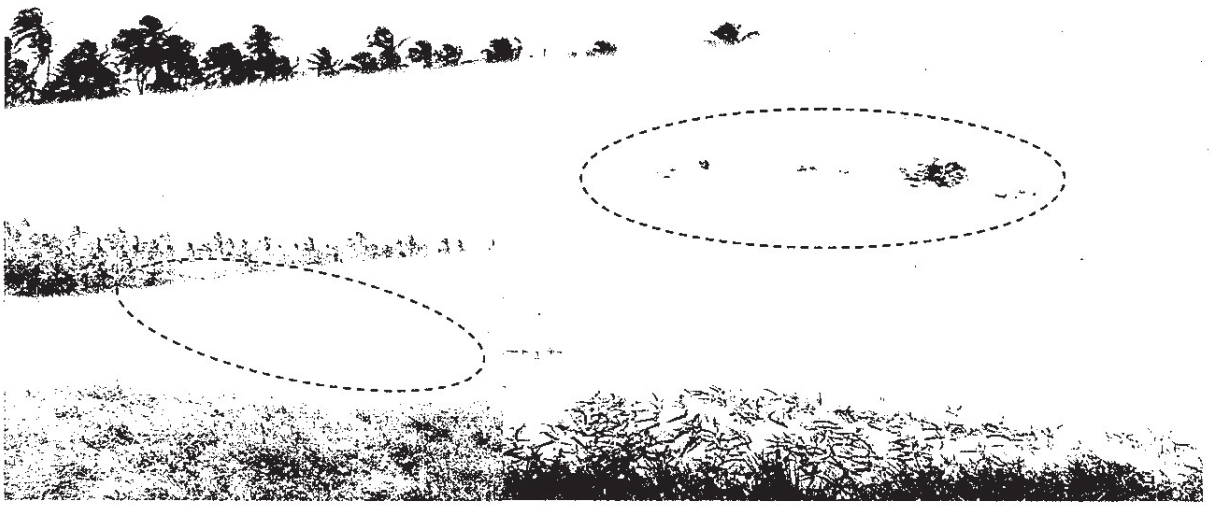


Figure 17 living plants and shrubs are buried by migrating sand within the estate. This is a natural process that is moving huge volumes of sand; anything in its way will be buried likewise.

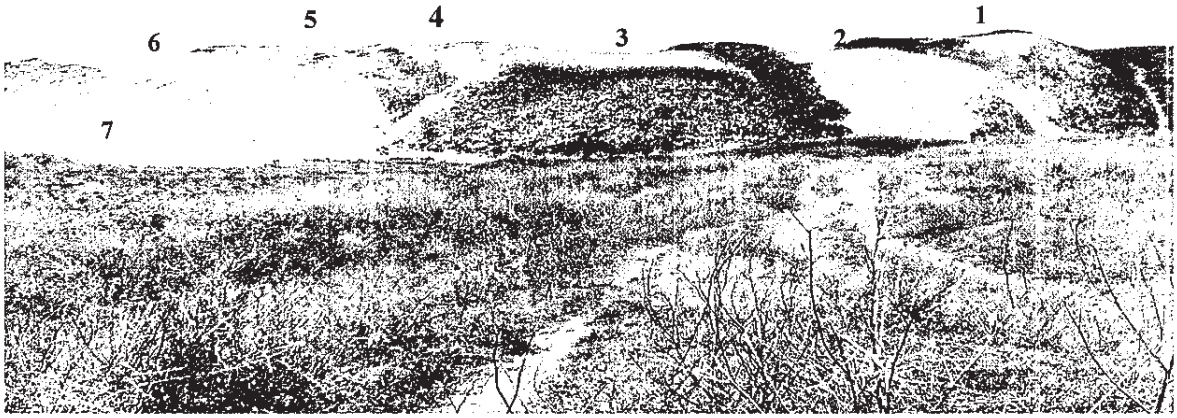


Figure18: The active part of the sand dune that is within the project site (Appendix A)

Figures 16, 17 and 18 show the area that can be mined. By mining this area it will leave dune number 6 (Firgure18) as the outermost dune in the area. Through removing dune 7, the risk for the last row of lots due to the encroaching dune is totally removed. That will leave the area where dune 7 is as the open space between the lots and the dune. It very clear from Figure 16 that dune 7 has already undergone a lot of changes – the hollow inner part is migrating westward leaving the side to be just occupying much needed land.

1.4 Recommendations and Conclusion

1.4.1 Critical Zones Impacting the Proposed Project

Due to natural disaster risks there are two specific areas that will need strict development control.

- The area where sand dune number 7 is located as shown in Figures 15,16,17 and 18 and also refer to Appendix A. This particular dune is migrating where there was no dune before and is using up much needed land for economic development purposes. With the increasing population around the area the land has become the most important asset for any family in the area.

- The other critical area is around the bank of Vatueta Creek. There is already an allowance of 6 metres for access but that does not include the risk due to flooding. The elevation around the bank is the lowest and the first row of lots is critical as they will be subjected to flooding before any other lot within the proposed subdivision.

1.4.1.1 Conditions to Build

- Sand dune 7 is to be mined to allow for open space and safety buffer zone. Based on its existing state the value of this particular dune is obviously nil. It is encroach on land that can be usefully utilised for other purposes as in this case residential subdivision. Any monetary gain from mining dune 7 can be channelled into developing the other dunes in the project area.

- The area along the river bank must have a properly engineered levee to decrease any possibility of excess water overtopping into the subdivision. A "Flood Early Warning System must be put in place and implemented during heavy rainfall which are normally associated with cyclones for the area.

- Apart from what is explained above, the whole site must be reclaimed to an elevation of 1 metre to raise the area and decrease any chances of inundation during flood. This is explained in further detail below,

1.4.2 Land Preparation

- Due to the low ground elevation which causes occasional flooding and soft underfoot during
  rainfall it is important that some reclamation work must be carried out to raise the ground level by at least 1 metre to keep the ground dry at all times.

- No construction work should be allowed until all reclamation work is completed. This measure is critical and must be strictly followed for the safety of the residents and the structures.

- Sand must not be used for reclamation as it is not good for fill material and will create other problems

- The Vatueta Creek bank must be properly armoured to protect erosion of the fill material

1.4.3 Sand Mining

- Any sand mining from the dune should be implemented with control through well devised plan and control. This plan should be included in the CEMP.

- Mining of sand from the site of dune 7 will increase the total use-able land area. It will also enable the developers to maximise land use for the proposed development.

- Mining will create space for the road required for excess to MASA and the Sigatoka River mouth and dune field without any disturbance of heavy traffic in the middle of the subdivision

- Mining does not pose any threat to erosion of the rest of the dune field

1.4.4 Geotechnical Study

- Due to the nature of the site there is a need to do selective drilling to gather more knowledge and understanding of the subsurface conditions.

1.4.5 Roading

- The road that runs through the proposed subdivision to the MASA Club must be moved to the southern border of the project area and be re-routed through the location of dune 7 when it is removed. A diversion to MASA Club can be easily run from the end of the road. This planned move will benefit the proposed subdivision residents by keeping away the busy traffic road, will allow the MASA Club residents and guests to move freely at all times, and also free access to the sand dunes for its management purpose.

1.4.6 Dredging of River Estuary

- This is a long standing Government project. The Sigatoka River mouth is the narrowest of all major rivers in Fiji. It is moving out water from the longest river in Fiji with a total catchment area of 1452 km^2. With the kind of agricultural land use along the upper river delta; silting of the lower delta and river mouth is not surprising. This has caused frequent flooding in the recent past. The only lasting solution is to dredge the silted river bed around the lower delta from the Melrose Bridge to the river estuary. It is recommended that the developers pursue this dredging project further with the Land and Water Resources Management Division.

1.5 CONCLUSIONS

The developers must include the recommendations made above in its engineering design. The only two known risks that will impact the development are flooding and migration of the sand dune, but with proper mining plan and engineered levee above the reclaimed bank both problems will be abated.

Flooding has never been considered a threat till now because the current land use is only for grazing. There has neither been any casualty, nor any damage to properties in the past. Once the construction phase of the proposed subdivision begins the site will naturally be considered a risk to anyone who will reside there, unless the recommendations made above are implemented.

Once the above abatement measures are put in place the subdivision will be one of the safest and best residential sites around the Sigatoka area.

This residential subdivision is targeting the low and middle income earners. There is an in-flux of people from other parts of Fiji around the Coral Coast due to employment opportunities in the hotel industry. Several squatter settlements are seen along the coral coast and are associated with housing needs in the last decade. That will place this proposed subdivision at a higher demand by migrant workers. For that reason, it is important to start the development in the manner that places safety of the people in the forefront of its planning.

2.0 SOCIAL-CULTURAL ENVIRONMENT

2.1 Introduction

The proposed development site is part of a 100 acre private freehold lot originally belonging to a Ezra Walker Work, Christopher Blunding Work, Willis Waterman Work, Caroline E. W. Knowles, Joshua Hill Work and Helen work as trustee for Joshua Hill Work a minor.

The Public Trustee of Fiji is now the legal administrator for the Works Estate and is working with Pro Services and Development Consultants to subdivide approximately 58 acres of it into residential lots to be distributed equally to the existing legal beneficiaries of the 5 original owners. The legal beneficiaries will be determined by the Public Trustee of Fiji once the development plan is approved and genealogy research is completed and presented in court.

It is also perceived that the current residents of the proposed development area will remain in their current places and will obtain titles to their respective properties.

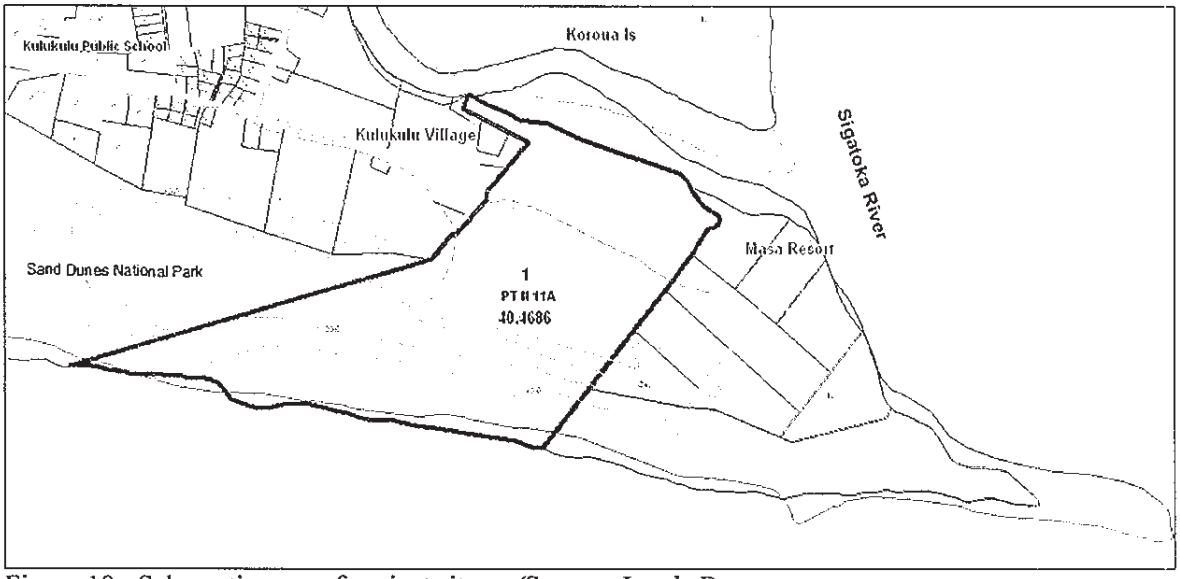


Figure 19 : Schematic map of project site *(Source: Lands Department*

2.2 Land Use

The north of proposed development site is bounded by approximately 700m of a branch of the Sigatoka river called the Vatueta creek. A strip of approximately 80 to 90m wide of mangrove runs parallel to the river inside the development site. On the other side of the creek is part of the Koroua Island in the Sigatoka river which is fully vegetated and covered with mangroves at the southern end facing the development site.

Out of the 100 acre property, only approximately 7.9 acres is occupied by the Kulukulu settlement, 42 acres is all sand dune adjacent to the Sigatoka Sand Dune Park and the rest is bare grass land or cattle grazing land.

From the west to northwest within 1km of the development site are approximately 60 scattered residential lots occupied mainly by Indo Fijians and part of the larger Kulukulu settlement area.

Figure 20: Boundaries for socio-economic survey

2.3 Represented Demographics

Within 1km zone of the development site is approximately 90 households, 19 of which make up the Kulukulu village and the rest are to the northwest in the Kulukulu settlement area. According to the Bureau of Stats, in the last census, there was a total population of 490 in the area demarcated 080517138 of which the Kulukulu settlement is part of and a total of 68 people making up the other races category (see Appendix A).

2.4 Water Source

The Water and Sewerage Department have confirmed that the subdivision can be fed from a 6"dia main that is fed from the Lawai Reservoir and can be made available. However it is not clear whether there will be a sufficient supply of water to the proposed 176 plots to be developed.

2.5 Noise Impacts

Noise impacts cannot be defined clearly without a detailed construction plan of the subdivision where size and frequency of trucks and machinery to and from the site, routes taken and duration of work over time is known. However the development site is approximately 500m away from the nearest settlement and therefore noise will not be a significant factor.

2.6 Existing Infrastructure

There is a primary school, Kulukulu Public School approximately 1.2km to the west of the development site. The Fiji Electricity Authority supplies the main source of electricity in the area. The nearest business centre where the main hospital and post office are situated is the main Sigatoka town which is less than 3km away from the proposed development site and can be accessed through the local bus transportation services. Otherwise taxis and hire mini bus services are also available from the main business centre in the area.

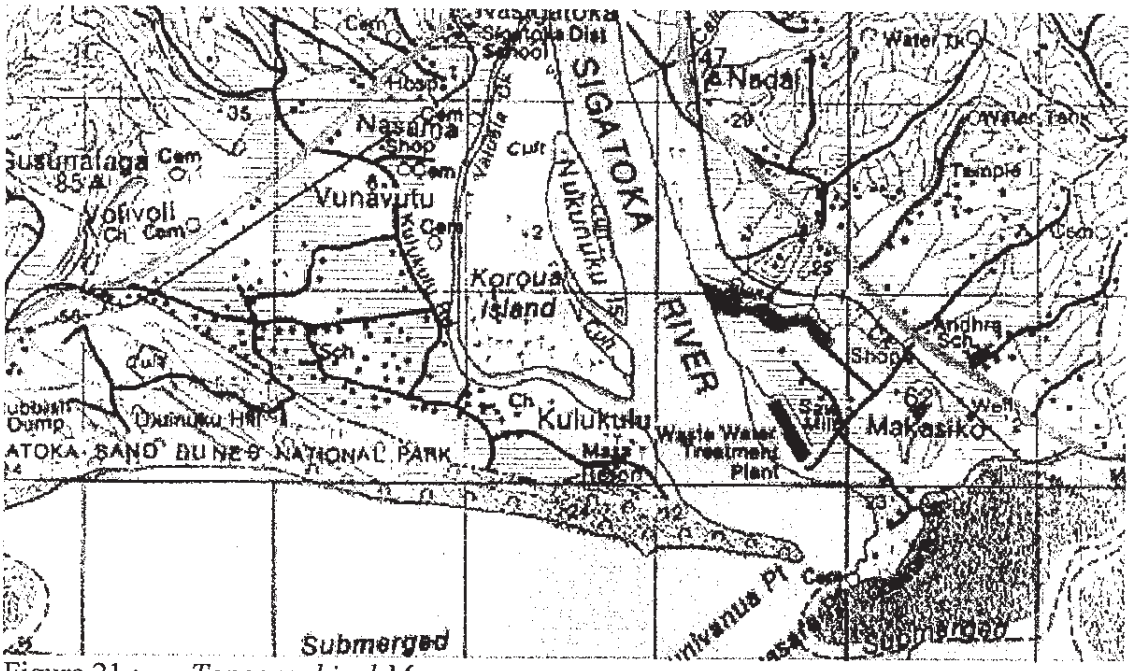


Figure 21 : *Topographical Map*

2.7 Archeological/historical site – Sigatoka Sand Dunes

42 acres of the Work's Estate is made up of sand dunes adjacent to the Sigatoka Sand Dune Park managed by the National Trust of Fiji Islands. The National Trust of Fiji has made the necessary recommendations to the Director of Town and Country Planning regarding the subdivision to be carried out. Since the dunes are continually accreting inland, suitable areas for subdivision and development continues to decrease. This therefore warrants the need to manage the accretion of the dunes so there is enough land to develop.

2.8 Methods and Results of Household Questionnaire Survey for Kulukulu village.

Kulukulu village is currently made up of 19 households and is unlike a normal Fijian village with a village headman but similar to a settlement therefore a household questionnaire (see attachment B) survey was conducted instead of a whole community

consultation. From the 12 households interviewed, it can be said that all of the people living in the Kulukulu village area are relations to the original Work family where more than 60% are of Part European decent and the rest Fijians. More than 60% of them are Methodists, 17% Catholic and the rest either Assemblies of God or Pentecostal.

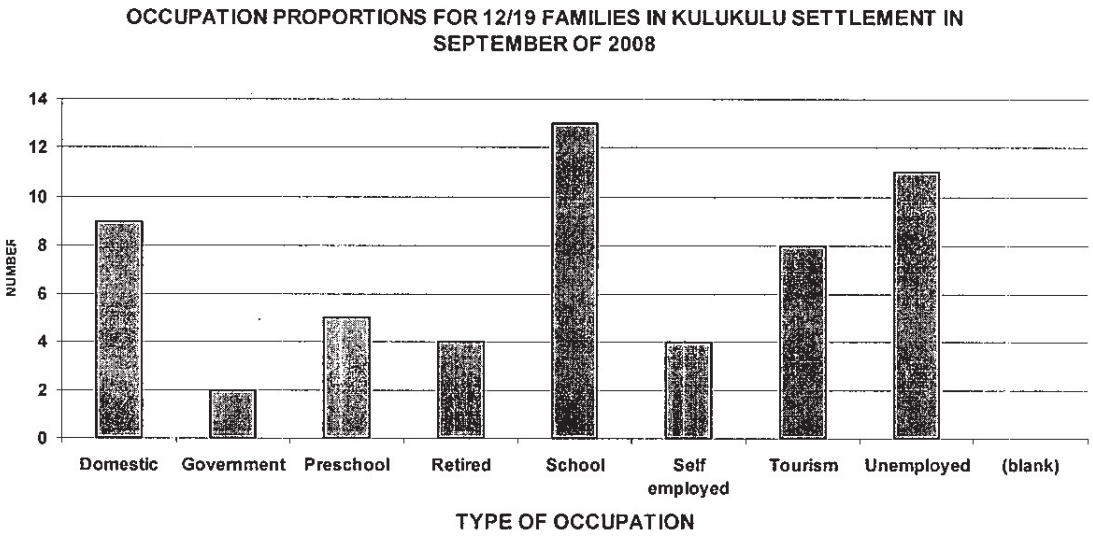


Figure 22: Occupation proportions for surveyed families - Kulukulu

About 50% of the population is made up of preschool, school children and unemployed people representing the significant reliance on plantation produce and marine resources for food.

Out of the 12 households interviewed, 5 households thought they would benefit from the proposed development because they would now have their own titles to a piece of the land. 5 other households were not sure how they would be affected and 2 felt that they would not benefit at all from the proposed development because they were totally dependent on the plantations and the marine resources for their livelihood and the development would limit this.

2.9 RECOMMENDATIONS

Based on the discussion above, there are 3 main recommendations:

1. Dune management needs to be well planned to maintain the size of the subdivided plots closest to the dunes. This will need suitable scientific dune management strategies apart from a sound management body.
2. Noise impacts to the surrounding settlements will have to be reviewed on construction plans of subdivision.
3. Households who are unsure of the impacts of this subdivision to them will need to be made aware by their family representatives of the development plans and the implications to them so there is no feeling of insecurity about their future.

3.0 Baseline Survey of the Flora and Fauna – Proposed Subdivision at Kulukulu, Nadroga.

3.1 Background

More than half (56% or 800+ species) of Fiji's native vascular plants are endemic and for the vertebrates, there are 25 endemic birds out of a total of 37 (ICBP 1992). Major threats to the biodiversity include Fiji's steady increase in population, incursion of evasive species to the native forests, roads, mining and commercial and subsistence agriculture developments (Watling and Chape 1993). Landowners and rural communities are facing enormous problems with deforestation in the form of logging and the continuing expansion of agricultural land. The loss of biodiversity in forest areas will become a very serious problem given that rural dwellers rely heavily on their forest and other natural resources to supplement their food, medicinal needs, income and materials needed for the construction.

The survey was carried out on the 8th October 2008. During the survey and after the herbarium work a checklist of the flora and fauna for the area to be impacted by the development was compiled and analyzed.
Special attention was given to any plants and animals deemed to have special conservation status, in-terms of their rarity and or their being considered endangered in Fiji, where recommendations for their protection and conservation would be provided.

3.2 Method

The survey involved the documentation of terrestrial plants and animals found in and around the immediate surroundings of the proposed development area. An annotated checklist of the plants and animals was compiled that included abundance, form and distribution information based on field observations whilst trekking through the proposed development sites.

Plant names are those used by Smith 1979-1991 for Spermatophytes and for the ferns those used by Brownlie 1974.

3.3 Result / Discussion.

3.3.1 Site description

The development site is located on a flood plain, adjacent to the southwest boarder of the Sigatoka Sand Dunes and bordered to the west by the Sigatoka River. The site is about 2 km away from the coast and is accessed from the Queens Highway by a 5km dirt road .

The bulk of the area to be developed is pasture land and this extends westward from the base of the sand dunes to the Sigatoka River. Pockets of freshwater / brackish water swamps were observed in pastyres immediately adjacent to the sand dunes.

Adjacent to the banks of the Sigatoka river, a strip of land that ranges from 50m to about 500m wide from the high tide mark of Sigatoka creek embankment is used by the locals as garden sites. This later site is the only forested area therein and its also earmarked to be developed. Cattle sand other domesticated animals freely graze in the area. The bulk of the area is occasionally inundated with water when there is high rainfall in the area and also during neap tides.

3.3.2 The vegetation

The original vegetation for the area would have been a mixed lowland-coastal vegetation where remnants can still be observed in nearby areas. For the area proposed to be development three distinctive vegetation types were noticeable- the pasture land, coastal and mangrove vegetation.

For the pasture area no plants of national importance (rare, threatened or endemic) was observed. Plants found in the area are common weedy plants most of which are exotic and can be found elsewhere in Fiji. An interesting observation was the presence of some ponds with plants associated with brackish water swamps (see checklist) growing around it but again none of it is of any national significance.

The coastal vegetation is a mix of lowland and coastal forest and this forest type is observed in areas adjacent to the mangrove forest. The most common and dominant tree species found in the site are *Cocos nucifera* and *Albizia saman*. They dominated the upper canopy and in most places formed a closed canopy. Also some of the more common trees present include *Dysoxylum richii, Dracontomelon vitiensis, Pometia pinnata* and *Artocarpus altilis*. The subcanopy or under-story was dominated by *Annona muricata* and the common *Ficus vitiensis, Morinda citrifolia, Citrus sp.* and *Mangifera indica.* Other plants observed included the relatively common trees like *Bambusa vulgaris, Barringtonia asiatica, Albizia samanea, Elastachys falcata, Morinda citrifolia, Pandanus tectorius, Inocarpus fagifer* and *Erythrina variegata.* Small trees and shrubs included *Solanun torvum, Psidium guajava, Barringtonia raemosa* and *Hibiscus tiliaceus*. Creepers included *Derris malacense, Derris trifoliata* and *Entada phaseoloides*. In areas where little light penetrates the canopy, *Oplismenus compositus, Mikania micrantha* and *Blechnum pyramidatum* dominated the ground cover. In the more exposed areas *Merremia peltata* and *Operculina turpethum* dominated. Overall the vegetation was mostly composed of economically important trees. These plants are common elsewhere not only in the adjacent forests but elsewhere in similar forest systems in Fiji.
A lot of subsistence farming takes place in the area and cattle and horses are allowed to freely graze in the area. Crops such as bananas, breadfruit, oranges, coconuts, taro and cassava were noticed in abundance. Other plants like the edible Vutu kana (Barringtonia edulis), kavika (malay apple), soursop, sweet patatoes, peanuts, chillies, pandanus, wild yams, pawpaws and many vegetables are planted and/or are allowed to grow wild. A lot of the traditional orchard fruit trees like custard apple, ivi, tarawau (*Dracontamelon vitiense*), wi (*Spondus dulcis*)and dawa (*Pometia pinnata*) were observed.

The mangrove forest is rather well developed where *Rhizophora mangle* was the most common towards the river side and mixture of Rhizophoras including *R. Selala* and *Bruguiera gymnohizza* were noticed towards the landward side of the river bank.
Other mangrove plant species observed included *Exocaeria agollocha*, *Xylocarpus mullusense, Hirietaria littoralis*, and the fern *Acrostichum aureum*. Behind this mangrove systems creeping plants like *Cleredendron inerme, Premna serratifolia*, and *Annona glabra* were common .

3.3.3 Fauna

Animals observed on the site between 10.00am to 4.00pm and those reported by the local informant on the day of the survey, and from latter observations during brief visits to the area by the author are listed in Table 3 below.

Table 3. A preliminary list of animals observed during the survey of the proposed development site.

	Scientific Name	**Local name**	**Abundance & distribution**
Molluscs	*Littorina scabra*	Large periwinkle	Common
	Boleophthalmus boddaerti	Mud skipper	Common
Crustaceans	*Scylla serrata*	Qari	uncommon
	Caridina sp.	Small shrimps	Common
	Thalassina anomala	Mana	uncommon
	Sesarma erythrodactyla	Kuka	Common
	Paleomon coneinnus	Moci	Common
	Cardisoma carnifex	Lairo	Common
	Clibanarius sp.	Hermit crab	Common

Mangrove invertebrates and vertebrates.
The most common invertebrate noticed along the coastal forest adjacent to the mangrove swamps were the *Cardisoma carnifex* or Lairo as indicated by the many burrows observed. A few *Thassalina* (mud lobster) mounds were also noticed. and in amongst the mangrove roots the dark and robust *Sesarma erythrodactyla* (Kuka) were noticed, and according to the local informant the mud-crab *Scylla serrata* was occasionally caught.
Brackish water fish are either caught using gill nets or using hand lines and these include Mullets, Trevallys, Tilapia, Mangrove jack, Cresent perch (qitawa), Pony Fish and the Mangrove shrimps (*Paleomon coneinnus*).
A thorough survey in the adjacent creek could result in finding aquatic organisms of interest but the scope for this work does not allow for it.

3.3.4 The Avifauna.

The only bird of national interest found in the area was the endemic Fiji Woodswallow that is normally observed perched on electrical cables and or on high branches of dead trees.
All other birds found in the area are common native birds found in similar areas all over Fiji (see Appendix XXX for bird list for the area). The White faced Heron was noticed feeding in ponds found in the pasture. A total of 9 birds were noticed in the field on the day of the survey (see Table 4).

Table 4. List of Birds found in the area during the survey,.

Scientific Name	**Common Name**	**Abundance & Distribution**
Ardea novaehollandiae	Belomatavula, White-faced Heron.	Common, native
Todirhamphus chloris	White collared kingfisher	Uncommon, native
Foulehaio c. carunculata	Wattled honeyeater	Uncommon, native
Pycnonotus cafer bengalensis	Red vented bulbul	Common, exotic
Acridotheres tristis	Common mynah	Common, exotic
Pluvialis dominica fulva	Dolidoli, Pacific Golden Plover	Uncommon, Native
Streptopella chinensis	Spotted Dove	Uncommon, native
Erythrura pealli	Fiji Parrot-finch	Common, Native
Artamas mentalis	Fiji Woodswallow	Uncommon, endemic

3.4 Conclusion and Recommendations

All plants listed in the checklist are found elsewhere in Fiji. Most of the plants listed in the checklist are exotics and are now regarded as weedy and invasive. Also some especially the trees are of economic importance as they provide food for the locals. None of the plants in the checklist are listed as threatened or endangered in the botanical report of Technical Group #3 for the Fiji Department of Environment titled "Botanical Biodiversity in Fiji – Report submitted in contribution to the development of a Biodiversity Strategy and Action Plan, June 1998.

There are no pristine forests adjacent or close to the area earmarked for the development. Native forest found here are mostly coastal forests that are being used by the locals for gardening and where they allow their cattle and other domesticated animals to graze. The mangrove forest is relatively in good health. It should be maintained as it plays a very important function in the integrity of the ecology of the area. So if any river dredging work is to take place than placement of the sludge onto land should be carefully planned out so as to minimize negative impacts onto the mangrove forest.

For the pastured area, of concern is the erosion of sand into the area proposed for development. All parties in the development, together with Fiji National trust should look into ways of reducing the impact of erosion into the proposed development site. Suggest that plants be planted in sections of the dunes that are relatively stable to act as wind breakers.

3.5 REFERENCES

Brownlie, G. 1977. The Pteridophyte Flora of Fiji. Cramer, Vaduz. Liechtenstein.

Fiji Department of Environment. 1998 Report. "Botanical Biodiversity in Fiji" for a Biodiversity Strategy and Action Plan. pp27.

ICBP. 1992. *Putting Biodiversity on the map: priority areas for global conservation.* ICBP, Cambridge. IUCN. 1980. World Conservation Strategy. IUCN-UNEO-WWF.

Smith A. C. 1971-1991. Flora Vitiensis Nova. Pacific Tropical Gardens. Lawai, Kauai. Hawaii Vol. 1-6.

Watling, D. and S. Chape (eds.). 1993. *The national environment strategy - Fiji.* Government of Fiji and IUCN, Gland, Switzerland.

4.0 Water Quality Assessment

4.1 Introduction

The project site is bordered by the Vatueta Creek, a tributary of the Sigatoka River on the north-eastern border. As part of the baseline studies, water quality in the creek was assessed on 19 November 2008. Baseline water quality assessment is important for the purpose of monitoring the effects (if any) of the proposed sub-division on the important parameters such as dissolved oxygen, clarity, temperature and conductivity. The marine environment plays a very significant role in the livelihood of the people living in coastal villages. It provides sources of food including fish, shellfish, seaweeds and other invertebrates. For resorts along the coast, the marine environment, in particular the clear and clean waters along the Fiji coastline especially the Coral Coast area and the coral reefs are part of the main attraction for tourists. However, with progressive land clearing occurring inland, for agriculture, forestry and other infrastructural needs, the quality of the water in rivers and creeks has continually deteriorated in recent times. The concentrations of suspended matter in the water has increased (thereby reducing water clarity and the general aesthetic value), nutrient loading has increased leading to fertilization of coral reefs and death for the corals. It is important therefore to gauge the pre-development status of the creek water, for future monitoring and mitigative measures.

4.2 Methodology

On 19 November 2008, 3 sites along the Vatueta Creek were chosen and assessed (see Figure 22). The weather was fine, and the tide was out-flowing during sampling. Sampling started at the Vatueta Creek mouth, and moved upstream to wards the Kulukulu settlement. At each site, 2 water samples were collected following standard procedures for sample collection (ANZECC, 2000). A sample of the creek water was also collected in acid-cleaned plastic bottles, for the non-microbiological tests, and the samples for microbiological analysis were collected in sterile bottles, prepared in the laboratory at IAS. Immediately after sampling, sample bottles were transported in eskies of ice to the laboratory at IAS, USP for analysis. The parameters assessed were Electrical conductivity, pH, Total suspended solids (TSS mg/L), and for the microbiological tests, Total coliform, Faecal coliform and E. coli.

4.3 Results and Discussion

The results of the water quality testing are shown in Table 5. For each parameter, the result is compared with an internationally recognized guideline, in this case the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000" (ANZECC, 2000).

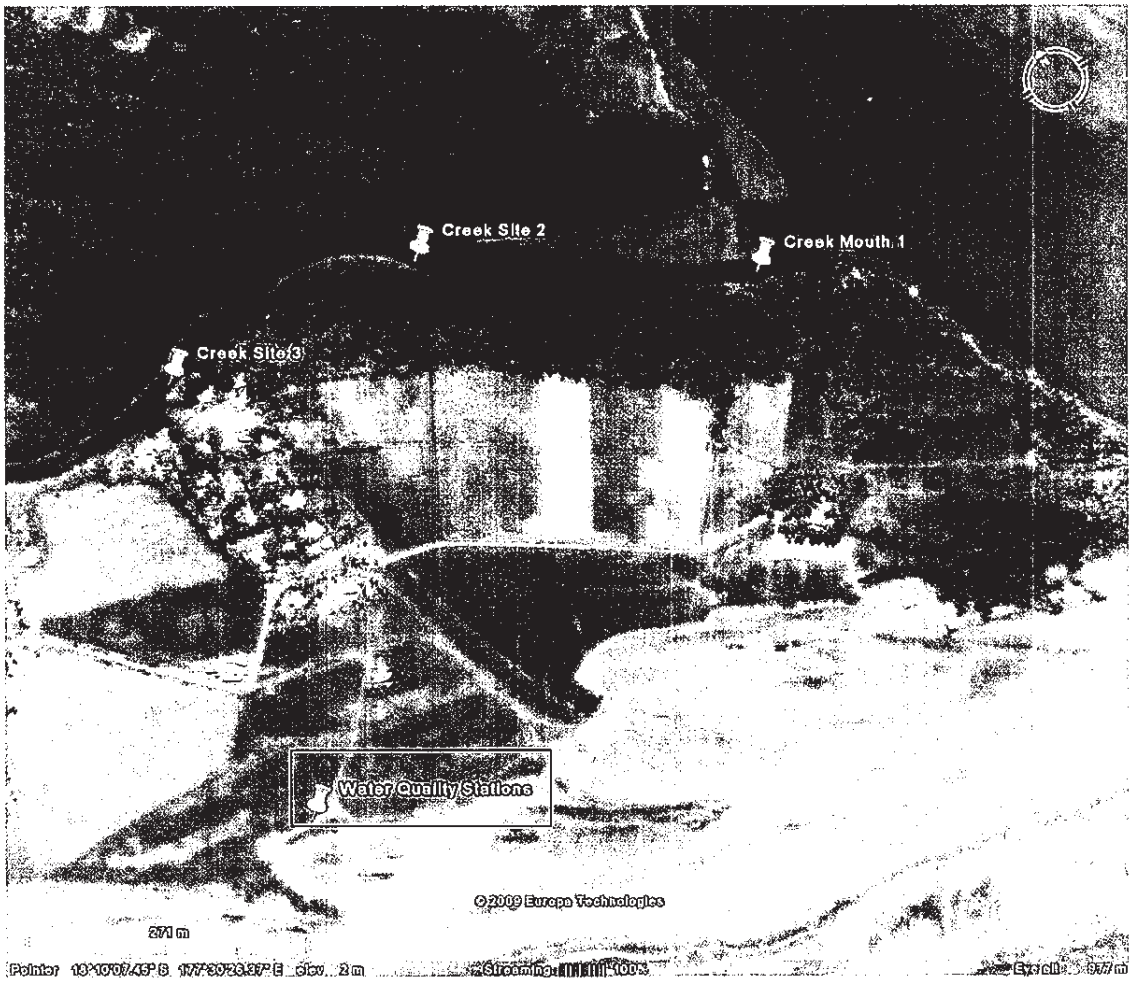


Figure 23: Vatueta Creek in Kulukulu showing water quality and sampling stations, 19 November 2008.

4.3.1 Microbiological Testing Results

The results clearly show how the human settlement at Kulukulu was already affecting the water quality, i.e. at site 3, the levels of faecal coliform and E.coli were way above the generally acceptable levels for recreational waters. In other words, site 3 was clearly the most polluted, most likely from sewage discharge. Fortunately, effects were quickly diluted and reduced as one moves away from site 3 (sites 2 and 1 recording <1 for E.coli and faecaal coliform), indicating that the receiving water was adequately diluting and dissipating the volume of sewage effluent being received. However, with the proposed subdivision, the situation may differ, and only a long-term monitoring of the water quality in the creek can reveal the effects of the proposed development on the Vatueta Creek. Apart from faecal coliform and E.coli levels, the other parameters were generally similar for all 3 sites.

Table 5: Results of Water Quality Tests for Vatueta Creek Samples, November 2008.

Parameter (units)	Vatueta Creek Mouth (Site 1)	Vatueta Mid-Creek (Site 2)	Vatueta Creek - Settlement (Site 3)	Acceptable Levels/Standards & Comments
Electrical conductivity (mS/cm)	27.9	15.3	14.6	High for Fiji rivers (seawater intrusion & upstream agricultural usage)
pH	8.4	8.0	8.1	6-9 (Recreational purpose, ANZECC 2000)
Total Suspended Solids (TSS mg/L)	6	3	8	100 (Ports Authority, Fiji). Within usual range for unimpacted rivers in Fiji e.g. Votua Dam site 2008.
Total Coliform (c/100mL)	1.4×10^4	3.1×10^4	2.3×10^4	No guideline due to multiple sources
Faecal coliform (c/100/mL)	<1	<1	1.1×10^4	<150 (ANZECC 2000)
E.coli (c/100mL)	<1	<1	5.7×10^3	35 (up to max. of 60 – 100, ANZECC 2000)

4.3.2 Electrical conductivity and Total Suspended Solids (TSS)

The levels of electrical conductivity were generally high in comparison with other creeks in Fiji, e.g. Votua creek along the Coral Coast. Possible explanations for elevated electrical conductivity in Vatueta Creek are the long-term and historical usage of land in the Sigatoka catchment for agriculture including sugar cane planting, and sea water intrusion into the area. Anecdotal information from local residents reveal how sharks had travelled up the creek and attacked people, but that was when the creek was much deeper (pers. Communication Bale/Chris Work, November 2008).

The concentrations of TSS were within the usual levels for un-impacted creeks during fine, dry weather. Similar values were recorded got Votua Creek and dam in the Coral Coast (Votua Water Quality Monitoring, 2008).

4.4 Conclusions and Recommendations

The baseline water quality results showed contamination of the water from sewage effluent around the settlement. At the moment, the Vatueta Creek is able to accommodate this pollution source, however, with increased habitation and population as a result of the proposed development, the situation may worsen unless, sewage treatment and disposal are managed properly, and contained within the subdivision. With such levels of faecal

coliform and E. coli around the settlement, it is recommended that children not be allowed to bathe in the creek, as the risk of infection of eyes, ears and the skin is very high. Consumption of fish and other river/estuarine food sources caught near the settlement is not recommended. In the best interest of the health of local residents and future residents, it is recommended that sewage effluent be treated and prevented from entering the creek untreated.

4.5 References for Water Quality Study

ANZECC, 2000. National Water Quality Management Strategy –Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council.

APHA-AWWA-WEF, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition.

5.0 Brief Environmental Management and Monitoring Plan (EMMP)

5.1 Plans

Since this EIA study has identified two main critical zones within the proposed development site:

- Sand dune number 7, actively migrating towards the north-west and into the proposed subdivision;
- The low area along the bank of the Vatueta Creek;

the development proponent Mr Siva Krishnamurti is required to prepare a Construction Environmental Management Plan (CEMP), to be submitted to DoE for approval prior to commencing the development. The contents of the CEMP will include the recommendations for mitigative action to address issues relating to the 2 critical zones. These recommendations are contained in the Executive Summary under 'Recommendations'.

In addition, selective drilling would need to carried out to ascertain the subsurface conditions, as a condition to approval for any building plans.

5.2 Monitoring

It is recommended that the developer together with the Work family or their representatives undertake regular monitoring of the dune system, in light of its active migration and accretion which may pose a threat to residents closest to the dunes.

It is also recommended that a 'Sand Dune Management Committee' be established by the developer, in collaboration with other stakeholders, to monitor the dunes and ensure their protection.

APPENDICES

APPENDIX A : REVISED SUBDIVISION PLAN

APPENDIX B - EIA TOR

Prepared by the Department of Environment

TERMS OF REFERENCE FOR PROPOSED RESIDENTIAL SUBDIVISION AT KULUKULU, NADROGA FOR SAM WORK

BACKGROUND

These terms of reference is prepared for the proposed residential subdivision at KULUKULU , Sigatoka on the outskirts of Sigatoka Town for the Sam Work. The development comprises of residential subdivision.

PURPOSE OF THE TERMS OF REFERENCE

The purpose of the Terms of Reference is (a.) to determine the environmental baseline condition at the site, (b.) assess the environmental impact of the construction and operation of the project and (c.) identify practicable mitigating measures.

The components of the EIA are to be:

- a full technical report
- a non technical summary of the same report

- The report is a scientific document and should be presented as such, strictly adhering to the format and layout of the terms of reference.

RESPONSIBILITY

The report should be signed and dated by the developer or his representative at the beginning of the report. The signatory will assume full responsibility for the contents of the EIA document and implementation of recommendations contained within it.

I EXECUTIVE SUMMARY

Provide a concise summary of the EIA in a non- technical language with the findings including major potential impacts and recommendations.

II. INTRODUCTION

Explain why, for whom and by whom the EIA has been prepared. Include sub-sections on the following:

- Statement of need (objective of the project)
- Justification for the necessity of the project
- The current timetable for the development
- Background information on a list of all consents required or consents sought with their areas of interest in relation to the project.
- Identification of people/parties consulted in the preparation of the EIA.
- Tabulation of personnel involved in the preparation of the EIA, their expertise and their roles.

III. PROJECT DESCRIPTION

Provide a brief description of the typical features of the site in terms of location (including map), social, economic activities, population of the surrounding areas, geography and environment and any limitations to any resources (as relevant).

All aspects of the development should be clearly highlighted and detailed descriptions of their citing should be discussed.

Also include information on:

- Location criteria, including constraints
- Area of the land for development and the current type of uses.
- Any area of reclamation.
- The proposed materials to be used (including brief details as quantities, sources and nature of materials for fill) and the transport methods and routes;
- Excavation to be undertaken
- The source, location, quantity and nature of any excavated material and the proposed method and location of disposal or use;
- Methods of storm water drainage, including details of the expected volumes and velocity of discharge and the proposed point/s of discharge into receiving waters.
- Sewerage treatment and water supply for the residential subdivision.
- Infrastructure and utilities to be applied on site.
- A description of the type of buyers expected at the subdivision

1.0 DESCRIPTION OF EXISTING ENVIRONMENT

1.1 Physical Environment

Geology, landscape, and topography, with emphasis on :

- Water quality of adjacent watercourse likely to be affected (this may include any freshwater creek).This baseline survey will be fully utilized for the purpose of monitoring during construction and operation.
- Conduct baseline water quality sampling including parameters such as temperature, clarity / turbidity / suspended sediments, conductivity, pH, dissolved oxygen/Biological Oxygen Demand. total - faecal coliform count, Nitrates.
- Describe geotechnical conditions to gauge site stability for building, topography, soils, meteorology, surface and groundwater as needed.
- Bottom sediment also needs to be described with relation to the stability of structures proposed within the residential area
- Examine cyclone frequencies in relation to the proposed site.
- Assess the integration of the residential subdivision to associated facilities in the existing environment.

- Assess drainage plan against the storm water to minimize silt-soil being discharged into the surrounding watercourses.

1.2 Biological Environment

- Present baseline inventories of both terrestrial and freshwater fauna and flora with emphasis on *endemic, rare or endangered species of conservation significance.*
- Present baseline inventory creek ecology in terms of species composition and their ecological significance.
- Present information on any mangroves that may occur on or around the site and how they will be affected by any aspect of the development (if at all)
- Locate ecologically sensitive habitats and significant natural sites (as relevant)

1.3 Socio- cultural Environment

Describe the relevant aspect of the existing human environment surrounding the area, including community patterns within the environment to be affected by the proposal.

- Provide a description of the settlement and land-use within 1km of the project site and provide representative demographic profiles and population numbers;
- Adjacent land-use.
- Describe the current sources of water supply and provide evidence of sufficiency for the entire development
- Noise impacts including traffic.
- Describe the existing infrastructure – access and transportation;
- Describe additional services to the site.
- Determine the presence of archaeological or historical sites through consultation with landowners (or ancestral landowners); the Fiji Museum; the Native Lands Commission and a site survey.

1.4 Vulnerability of the project to natural disasters

The vulnerability of the project to natural disasters such as cyclones and/or earthquakes also needs to be clearly discussed. Appropriate building heights/ and or designs also need to be proposed with justifications.

2.0 POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACTS

All the Environment impacts, which are likely to be significant, should be assessed. The impacts are to be assessed as follows: The potential significant impacts needs to be precisely addressed from several aspects such as conservation of endemic, rare, endangered significant species, minimization of forced cutting, application of managed forest cutting,

application of managed forest concept after development and the formulation of inventory map induced from the above-mentioned baseline survey of terrestrial habitat

2.1 **Design and engineering**

Includes issues such as compatibility with existing structural plans; site survey siltation (both during construction and operation); disposal of rubbish; wastewater treatment; excavation method and balanced excavation to fill; suitability of fill for foundation/construction purposes and determine the location.

Geotechnical investigations must show the subsoil condition by drilling and other means so that compatibility with structural plans for proposed residential and commercial development.

2.2 **Construction**

Including land take and site boundaries, site preparation works, effect of the development on the local topography e.g. via earthmoving, soil stability and erosion, effect of constructing access roads and disposal of any surplus material, length and time expected in construction; identification of routes that construction vehicles will use to and from the site; wastewater treatment and disposal, solid waste disposal, sewage treatment and disposal.

2.3 **Operations and Maintenance**

Use and disposal /reuse of surplus solid waste material wastewater treatment and disposal; use and storage and disposal of fuel, chemicals and oil as relevant. Deterioration of surface water quality due to pollution from silt runoff, visual impacts, effects of the project on ambient noise levels, cyclone risk, storm water discharge, effects of the project on any historical resources (as relevant).

2.4 **Ecological impacts**

Terrestrial and aquatic habitats – including loss of, damage to and alteration of habitats, effects of the project on the water quality, and creek ecosystem.

2.5 **Social Study**

The study area will encompass an area around 1km from the border of the development sites. Within the study, area the consultant will prepare demographic profiles of current land use. The impact of the proposed project on human beings and their activities shall be assessed. Particular attention shall be paid to impacts to the squatter settlement and archaeological sites and features (if present). The impact of the project on the community values, community life and social organizations shall also be addressed.

Also, include secondary effects mainly arising from the extraction and consumption of resources necessary to implement the project such as water, energy, and construction materials, as well as from

developments supporting the project e.g. new roads, sewers, power lines and telecommunications.

Central to the purpose of the social study is to identify issues or problems, which the land /qoliqoli owners and /or in or around the study area, may have concerning the proposal

The following needs to be conducted;

- Hold at least one meeting in the presence of the Provincial Council/ District Advisory Council and other relevant governmental agencies. Minutes of these meetings must be kept and appended to the report.
- House to house interviews should be conducted with the local communities and villagers who use the adjacent *qoliqoli's* with the purpose of inviting comments and/or concerns. Any questionnaires used and response should be appended to the report.

The summary needs to include the expression of commitments of the developer to the respective issues raised in the social study, for instance, how to solve the issues raised, which will be eventually incorporated in the mitigation measures addressed in the subsequent chapter.

3.0 MITIGATION AND ABATEMENT MEASURES

The study shall examine and recommend suitable mitigating and abatement measures for the adverse impacts identified. The effectiveness of the measures proposed, should be stated and impacts of significance clearly identified. Measures recommended should be practical and readily implemental. This should include a description of the measures envisaged to prevent, minimize and where possible offset any significant adverse effects on the environment of the project. The major issues and/or concerns raised should be addressed well in the mitigation measures.

4.0 SUMMARY & CONCLUSION

Appropriate conclusions should be drawn. It is useful to summarize the environmental impacts of the proposal and the steps that would be taken to mitigate adverse impacts.

5.0 ENVIRONMENT MANAGEMENT/MONITORING PLAN (EMP)

A brief management/monitoring plan shall be addressed referring to the mitigating measures and recommendations of the EIA report. The full plan shall be submitted one month prior to commencement of construction work.

6.0 REFERENCES

Any publication or papers,both published and unpublished, that were used, as reference should be listed and appended to the report where appropriate.

7.0 APPENDICES

Append any raw data or any other information relevant to this development.

APPENDIX C : SOCIO-ECONOMIC SURVEY QUESTIONNAIRE

COMMUNITY & HOUSEHOLD SOCIO-ECONOMIC SURVEY (KULUKULU, SEPTEMBER 2008)

Purpose: To gather baseline information on households' in_____

Name of Village:_____Tikina:_____Yasana:_____

_____

Mataqali:_____Tokatoka:_____

Household Number / Name: _____

Date: _____Time: _____

Name of Respondent:_____Status in Family_____

A: BASIC HOUSEHOLD INFORMATION

1: Please tell us who lives in the household now (include respondent)

First name:	Sex	Age	Marital status	Occupation/household role	Special skills	Ethnicity	Formal Education Level	Faith

B: LIVELIHOOD

1: List according from highest to lowest your sources of income (Fishing, Farming, Business, Livestock Farming, Other).

Number	Sources of Income	Resource Type(Specify)
1		
2		

3		
5		

2: List in order from highest to lowest what you spend your income per month on (Education, Religious/Family/Community Obligations, Household Expenditure etc)

Number	Items of Expenditure
1	
2	
3	
4	
5	

3: Please tell us the frequency by which the three main marine or land resources are collected / harvested <u>for sale</u>.

Resource	Frequency (daily, weekly, monthly, occasionally)	Quantity of units collected / harvested Eg: bundle, sack etc.	Price per unit	Place sold
Marine (specify)				
Land (specify)				

4: Please tell us the frequency by which marine or land resources are collected / harvested for <u>household</u> use.

Resource	Frequency (weekly)	Quantity of units collected / harvested for <u>personal use</u>. Eg: bundle, sack etc.	Quantity of units harvested for <u>special occasion.</u>
Marine (specify)			

Resource	Frequency (weekly)	Quantity of units collected / harvested for personal use. Eg: bundle, sack etc.	Quantity of units harvested for special occasion.
Land (specify)			

C: Benefits from Marine Environment

1a): Are you currently getting any cash benefits from marine environment that has been proposed to be developed?

☐ **Yes**
☐ **No**

b): What is your average income per month?-
☐ Less than $30 ☐ $30 to $49 ☐ $50 to $99 ☐ $100 to $199 ☐ $200 to $499 ☐ $500 to $1000 $1000 and more

2: Is the marine environment an important part of your culture?

☐ Yes, in what way is it important part of your culture?

_____

_____

_____

_____

_____

☐ No

3: How dependent is your family on marine resources and habitats particularly for daily financial and social obligation and needs

☐ Not dependent at all
☐ To some degree
☐ Very Dependent

D: HOUSING AND SERVICE (Observational Questions)

1: Type of dwelling: _bure__corrugated iron _____wooden/bamboo _____
____concrete (cement) _____ others (specify)_____ _____

2: Furniture and appliance ownership: _____radio__tape/cd player _gas stove_____ bed ____sewing machine _____T.V/Video ___T.V __refrigerator __others (specify)_____

3: Lighting facility: __kerosene lamp _____benzene lamp _own generator _village generator _____ ____main power supply (FEA) _____others (specify) _____

4: Cooking facility: __open fire _____kerosene stove_____other
If other_____ _____

5: Toilet Facility: ___pit toilet _____water sealed __ flush type ___no toilet
Waste disposal method:_____ _____

6: Water supply: ____piped _____tank _____well _____other
If other_____ _____

7: Other services
☐ Access roads ☐ Jetty ☐ health ☐ Telephone Fax ☐ Computer
☐ Internet

F: PERCEPTION OF DEVELOPMENT IMPACTS

1. Do you think this development will benefit you?

☐ Yes

Why?

_____

☐ No

Why?

_____

2. How will this development impact the marine environment?

☐ Positively

How?

_____

☐ Negatively

How?

_____

3. List your concerns on this project development if any?

_____

_____

_____

Community Consultation with Qoliqoli owners and villagers of Voua, Cuvu.
Facilitated by the Institute of Applied Sciences. The University of the South Pacific.

Name (Yacamu)	Mataqali	Signature (Saini)

APPENDIX D

Annotated Checklist of plants and animals documented from the study site.

Table 1. Ferns & Orchids

Family	Botanical Name	**Distribution & Abundance**
Aspleniaceae	**Asplenium nidus**	Indigenous; Common
	Acrostichum aureum	Indigenous, uncommon
	Nephrolepis sp.	Common
Polypodiaceae	**Pyrossia adnescens**	Indigenous; Common

Table 2. Trees

Family	**Botanical Name**	**Distribution & Abundance**	**Other comments**
Anacardiaceae	*Dracontomelon vitiense*	Indigenous, Uncommon	Food, medicinal
Anarcadiaceae	*Mangifera indica*	Exotic, Locally common	Food
Annonaceae	*Annona muricata*	Exotic, Very common	Nat./ Edible fruit
Arecaceae	*Cocos nucifera*	Indigenous, Very common	useful
Barringtoniaceae	*Barringtonia edulis*	Indigenous, Common	
Barringtoniaceae	*Barringtonia asiatica*	Indigenous, uncommon	
Caesalpiniaceae	*Inocarpus fagifer*	Indigenous, Common	Edible fruit
Euphorbiaceae	*Macaranga sp.*	Uncommon	
Euphorbiaceae	*Premna serratifolia*	Indigenous, Common	Medivcinal
Malvaceae	*Hibiscus tiliaceus*	Indigenous, uncommon	
Meliaceae	*Dysoxylum richii*	Endemic, Common	Medicinal

	Elastotychys falcata	Endemic, uncommon	
Mimosaceae	*Albizia lebbeck*	Exotic, Very common	Invasive plant
Mimosaceae	*Albizia saman*	Exotic, Very common	Invasive plant
Moraceae	*Artocarpus altilis*	Exotic, Locally common	Abo. introduction
Moraceae	*Ficus barclayana*	Endemic, Uncommon	
Moraceae	*Ficus prolixa*	Indigenous, Uncommon	
Moraceae	*Ficus vitiense*	Endemic, uncommon	Fruits edible
Myrtaceae	*Psidium guajava*	Exotic, Uncommon	Naturalized, noxious
Pandanaceae	*Pandanus tectorius*	Indigenous, Uncommon	Medicinal
Rhamnaceae	**Alphitonia zizyphoides*	Indigenous, Uncommon	Medicinal
Rubiaceae	*Morinda citrifolia*	Indigenous, uncommon	medicinal
Rutaceae	*Citrus limon*	Indigenous, Uncommon	Food, edible
Sapindaceae	*Pometia pinnata*	Indigenous, common	Fruit edible
Urticaceae	*Dendrocnide harveyi*	Indigenous, common	

Table 3. Grasses, Herbs & Shrubs

Family	**Botanical Name**	**Distribution & Abundance**	**Other comments**
Acanthaceae	Mimosa pudica	Uncommon	
Asteraceae	*Synedrella nodiflora*	Exotic, Uncommon	
Asteraceae	*Vernonia cinerea*	Exotic, Uncommon	
Caesalpiniaceae	*Chamaecrista nictans*	Exotic, Uncommon	
Euphorbiaceae	*Jatropha curcas*	Exotic, Locally common	
Fabaceae	*Crotalaria pallida*	Exotic, Common	
	Indogufera		

Lamiaceae	Hyptis pectinata	Exotic, Common	Noxious weed
Malvaceae	Sida acuta	Indigenous, common	Noxious weed
	ZAW pungens		
Malvaceae	*Urena lobata*	Exotic, Common	Weed
Melastomataceae	Clidemia hirta	Exotic, Common	Weed
Mimosaceae	*Leucaena leucocephala*	Exotic, Locally common	Noxious weed
Mimosaceae	*Mimosa pudica*	Exotic, Common	
Myrtaceae	*Psidium guajava*	Exotic, Uncommon	Weed
Myrtaceae	Syzygium gracilipes	Endemic, Uncommon	
Poaceae	Brachiaria mutica	Exotic, Uncommon	
Poaceae	Dicanthium aristatum	Exotic, Very common	Naturalized
Poaceae	Dicanthium indicus	Exotic, Very common	Naturalized
Poaceae	Digitaria ciliaris	Exotic, Common	
Poaceae	Echinochloa colona	Indigenous, Common	
Poaceae	*Eleusine indica*	Exotic, Locally common	
Poaceae	Ischaemum indicum	Indigenous, Locally common	
Poaceae	Lappacea Centotheca	Indigenous, Very common	
Poaceae	Pennisetum polystachyon	Indigenous, Common	Naturalized
Poaceae	Setaria glauca	Exotic, Common	
Poaceae	*Sporobolus indicus*	Exotic, Common	Naturalized
Solanaceae	*Capsicum frutescens*	Exotic, Uncommon	
Solanaceae	Solanum torvum	Exotic, Common	Noxious weed
Verbenaceae	Lantana camara	Exotic, Locally common	Noxious weed & Invasive

Verbenaceae	Stachytarpheta urticaefolia	Exotic, Common	Naturalized
Verbenaceae	*Vitex trifolia*	Indigenous, Locally common	

Table 4. Creepers, Vines and Lianas.

Family	Botanical Name	Distribution	Other comments
Araceae	*Epipremnum pinnatum*	Indigenous; Common	
Arecaceae	*Dioscorea bulbifera*	Exotic; Locally Common	Aboriginal Introduction
Convolvulaceae	*Merremia peltata*	Indigenous; Common	Naturalized & invasive
Convolvulaceae	*Operculina turpethum*	Indigenous; common	Naturalized
Cucurbitaceae	Coccinia grandis	Exotic, Common	Weed & invasive
Euphorbiaceae	*Mikania micrantha*	Indigenous, Common	Naturalized & invasive
Fabaceae	*Entada phaseoloides*	Indigenous; Uncommon	Naturalized
Passifloraceae	Passiflora foetida	Exotic, common	Naturalized & invasive
Passifloraceae	*Passiflora suberosa*	Exotic, Common	

Table 5. Avifauna list

Common Name	***Scientific Name***	**Distribution**	**Local Name**
Fiji Goshawk	*Accipiter rufitorques*	Endemic	Latui, tuitui, reba
Jungle mynah	*Acridotheres fuscus*	Introduced	Maina, mainaloa
White-Rumped Swiftlet	*Aerodramus spodiopygia*	Native	Kakalaba
Red Avadavat	*Amandava amandava*	Introduced	Siti, midi, sidi
Fiji woodswallow	*Artamus mentalis*	Endemic	Levecagi, sikorere, vukase
Pacific Harrier	*Circus approximans*	Native	Manu levu
Fiji Parrot Finch	*Erythrura pealii*	Endemic	Kulakula, rokosolo
Wattled honeyeater	*Foulehaio carunculata*	Native	Kikau, kaisau, kaisevau
White-collared	*Halcyon chloris*	Native	Secala, lele, sese

kingfisher			
Red-vented bulbul	*Pycnonotus cafer*	Introduced	Ulurua, uluribi

Table 6. Mammal List

Mongoose		Introduced	
Samoan fruit bat	Pteropus samoensis	Native	Beka lulu

Table 7. Other animals

Cow	Horse
Goats	Pigs