

**INSTITUTE OF APPLIED SCIENCES
THE UNIVERSITY OF THE SOUTH PACIFIC**

**BASELINE ECOLOGICAL AND WATER
QUALITY STUDIES OF WAINIVESI AND
WAINAMAKO CREEKS, TACIRUA**

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by

**Alison Haynes
Batiri Thaman Hughes**

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WATER QUALITY STUDIES
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Alison Haynes &
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Institute of Applied Sciences
University of the South Pacific
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TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
1.0 INTRODUCTION	3
2.0 SAMPLING LOCATIONS	3
3.0 WATER QUALITY	8
3.1 Methodology	8
3.2 Results	8
3.3 Discussion	8
4.0 THE INVERTEBRATE FAUNA	9
4.1 Methodology	9
4.2 Results	9
4.3 Discussion	10
5.0 CONCLUSION	11
6.0 MONITORING PLAN	11
7.0 REFERENCES	13

EXECUTIVE SUMMARY

The Institute of Applied Sciences of the University of the South Pacific was commissioned by Erasito Consultants Ltd. to conduct a baseline assessment of water quality and ecological character of the creeks in the vicinity of the area likely to be impacted on by the development of housing at Tacirua, Suva.

The baseline study was conducted within the Wainivesi and Wainamako Creeks at Caubati and Tacirua respectively. Water quality and diversity and abundance of the aquatic fauna were assessed. A total of four sampling sites were chosen, two within Wainivesi creek and two within Wainamako creek. In each creek, one site was adjacent to the development site and one downstream.

The water quality in the Wainivesi and Wainamako Creek during the study was satisfactory/marginal when comparing to guidelines (Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water). The very high faecal coliform levels present in both creeks are a concern for human use of the creeks because they indicate contamination from faecal matter which could be a health risk. The housing development may cause some changes in water quality within the creeks, in particular the turbidity and sediment loading, however, the impacts are temporary and the current status of water quality can be expected to return after some time following completion of the project.

Both creeks were quite healthy in terms of aquatic fauna. Wainamako creek with 9 species per site was slightly less disturbed than Wainivesi creek with 7/8 species per site. The presence of a goby fish in the Wainamako creek suggests that the upper part of the creek is healthy and fairly undisturbed. None of the species found are likely to be used by nearby residents.

In conclusion, although the development of the housing at Tacirua may cause changes in water quality in the Wainivesi and Wainamako creeks and in turn affect the aquatic fauna, the current status of water quality and aquatic fauna abundance and diversity should return, given time, after the completion of construction works.

It is recommended that the water quality in Wainivesi and Wainamako Creeks be monitored during and following the development of the housing at Tacirua. The results should then be compared to the baseline levels from this study and if significant changes are found, mitigative measures carried out. Efforts should also be made to minimize the impacts during the construction phase.

1.0 INTRODUCTION

The Institute of Applied Sciences of the University of the South Pacific was commissioned by Erasito Consultants Ltd. to conduct an assessment of the existing water quality and aquatic fauna within the Wainivesi and Wainamako Creeks at Caubati near Suva. Erasito Consultants have been engaged by the Housing Authority to undertake the Construction Environment Management and Monitoring Plan (CEMMP) of the development of housing, the Tacirua Stage 2 Development. The development of housing adjacent to these two water bodies may affect the water quality and aquatic fauna within them. This assessment is necessary to establish baseline information prior to the disturbance. Aspects assessed included:

- The general status of existing water quality
- Aquatic invertebrate fauna and creek ecology

The study was conducted by a team from IAS, Batiri Hughes, Alison Haynes and Ponipate Nakabu on the 3rd of October, 2006. Heavy rain and flooding had occurred the previous week in the area. The water quality and aquatic fauna study were conducted simultaneously at the four sites. The weather was cloudy and overcast during the fieldwork.

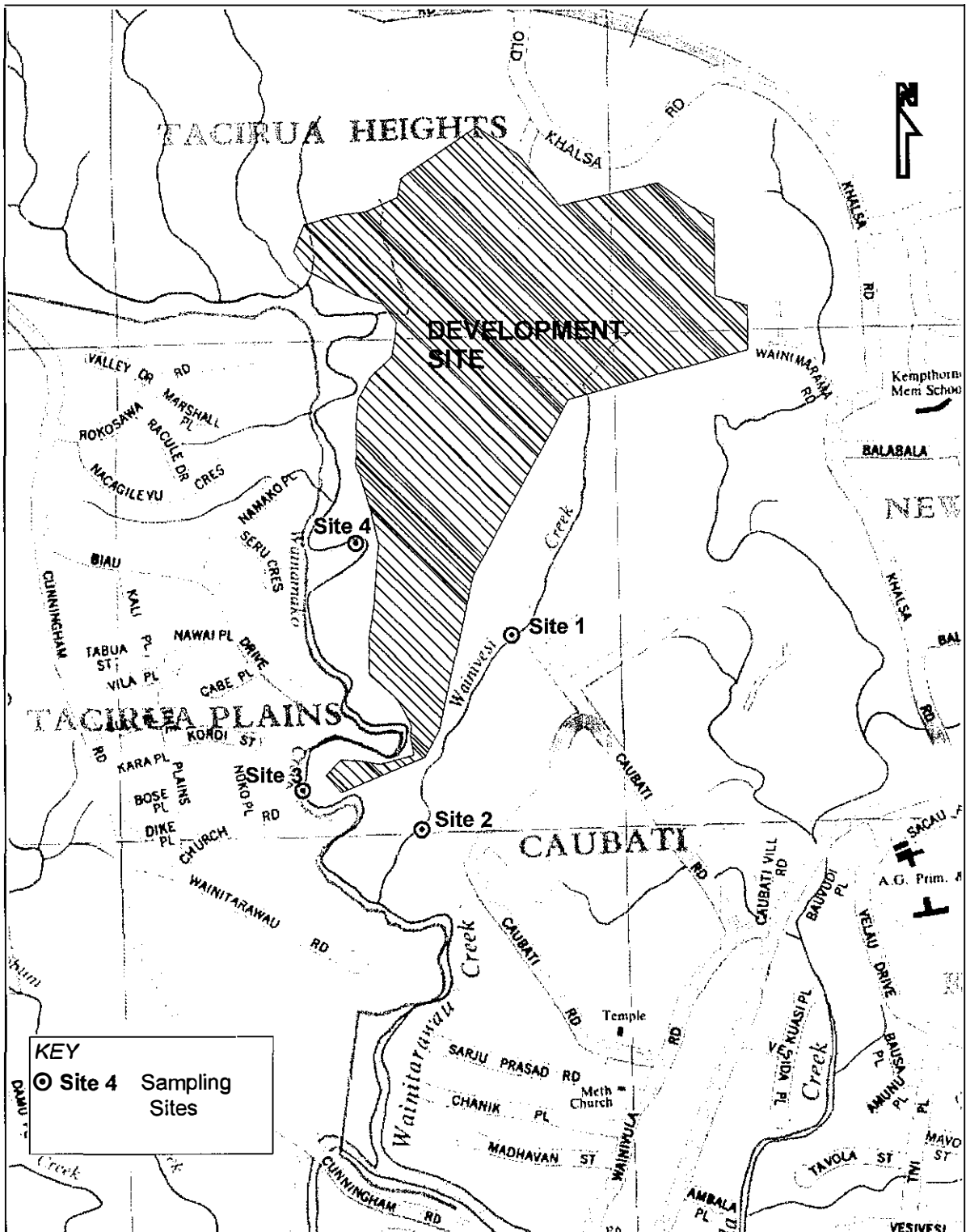
The results of this baseline study will serve as benchmark for assessing any impact on these two water bodies that may result from the development of housing being planned.

2.0 SAMPLING LOCATIONS

A total of four sampling sites were chosen, two within Wainivesi Creek and two within Wainamako Creek (Figure 1). Photographs showing the general environment at various sites are also included. At each site the following characteristics were noted:

- Width
- Depth
- Substrate of bottom
- Creek flow
- Presence of aquatic flora
- Terrestrial flora and fauna
- Signs of human use or disturbance

Figure 1. Map showing Wainivesi and Wainamako Creeks, development site and sampling sites



Site 1

Site 1 was within Wainivesi Creek and was accessed from Caubati Road. It was just downstream from a small pool and a small waterfall of about a meter in height. The surrounding topography was hilly and fairly steep on the Caubati side which was planted with cassava. Other flora on creek banks were breadfruit and banana trees and paragrass and was fairly disturbed. Fauna present included insects such as dragonflies. Creek width was around 3 meters and depth around 10 cm. Creek flow was a slight steady flow. The creek bed was silty with a few stones. Aquatic fauna observed were gastropods, tadpoles, shrimps and small fish.

Photo 1. The small waterfall upstream



Photo 2. Site 2



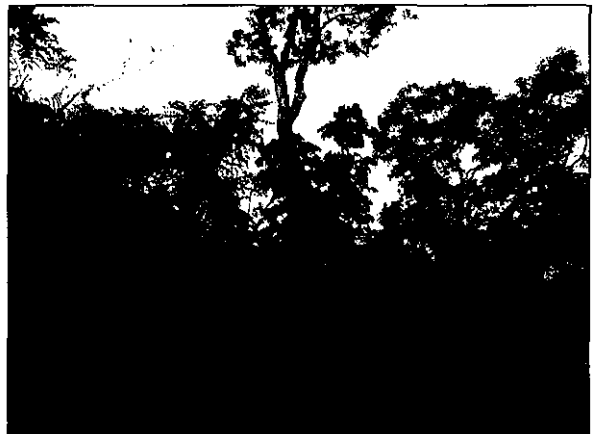
Site 2

Site 2 was also within Wainivesi Creek but downstream and just before the confluence with Wainamako Creek. The surrounding area was very steep and hilly with disturbed vegetation and planted with cassava. Paragrass was also present. Creek width was 1.5-2 m and depth 5-10 cm deepening to 20cm in pools. Creek flow was steady. The creek bed was Suva marl which ranges from siltstone to a fine grained sandstone with no stones or boulders. Moss was observed. The creek had obviously been recently flooded as debris was present on the sides and the vegetation was disturbed up to a meter on both banks. A lot of rubbish was also observed but may not have been from the surrounding areas but brought down with the floodwaters. Aquatic fauna observed included snails and small fish.

Photo 3. Site 2 showing disturbed vegetation on the banks



Photo 4. Vegetation at Site 2



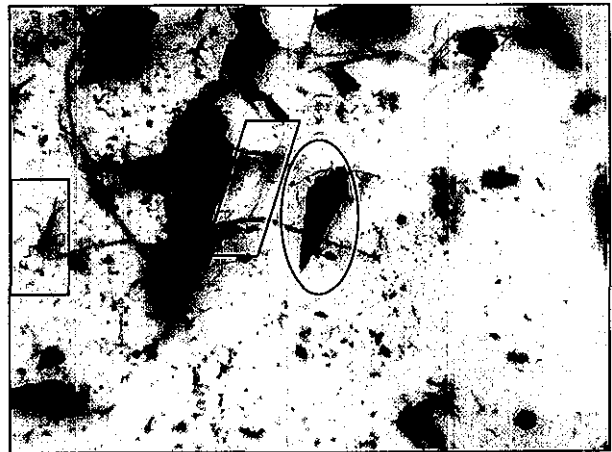
Site 3

Site 3 was within the lower part of Wainamako Creek. Access was at the end of Church Road and the site was close to a bridge crossing over the creek. Surrounding topography was slightly hilly but not as steep as Site 1 and 2. Surrounding vegetation was disturbed and included guava, African tulip, and breadfruit trees, ferns, and ginger plants. Creek width was around 6 meters and depth 40-50 cm. Flow was slight. The creek bed was silty with rocks present. There was sandstone on one bank. Moss was observed on the rocks. Aquatic fauna observed included small fish and water spiders. A lot of rubbish and debris was again observed on the banks from the recent floodwaters.

Photo 5. Site 3 looking downstream to the bridge *Photo 6. Sampling with the net*



Photo 7. Debris from the recent flooding on the creek bank *Photo 8. Some of the invertebrates collected (shrimps, gastropod & damselfly nymph)*



Site 4

Site 4 was also within Wainamako Creek but upstream from Site 3. Access was from Seru Crescent and along a path of about 200 meters. It was in a small area of rapids just upstream from a large pool where a small waterfall dropped into the creek. The pool was used by the nearby residents for swimming. Surrounding topography was hilly on the cunningham side and very steep, cliff-like on the development side of the creek. Surrounding vegetation was disturbed and planted with cassava on the hilly side and forest on the development side. Creek width was around 3 m and depth 30-50cm. The creek bed was sandstone with large boulders. Flow was steady and fast. Moss was again observed on the boulders. Many gastropods were observed on the creek bed. Rubbish from the recent flooding which was about 1 m higher than the present water level, was again observed.

Photo 9. Site 4 showing small area of rapids



Photo 10. Waterfall and creek bank

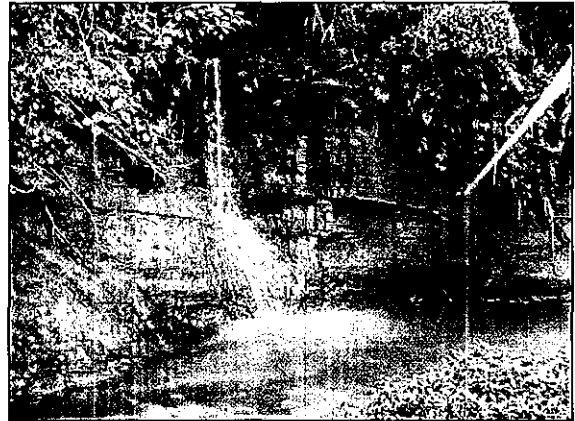
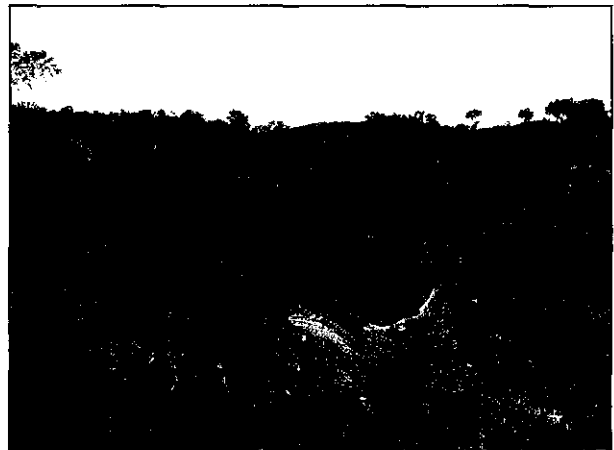


Photo 11. Forest-like vegetation on the bank on the development side of the creek



Photo 12. Looking towards development site from Cunningham side of Wainamako Creek



3.0 WATER QUALITY

3.1 Methodology

At each site, water temperature and pH were measured using a multimeter. Measurements were taken just below the surface. Water clarity was also noted. Water samples were collected at each site and analysed at the Institute of Applied Sciences laboratory for dissolved oxygen (as meter did not work in field), total coliforms, faecal coliforms, Total Suspended Solids (TSS), oil and grease and chemical oxygen demand (COD).

3.2 Results

Table 1. Water Quality Results for the four sites

Parameter	Site 1	Site 2	Site 3	Site 4	Guidelines *
Temperature (°C)	25.2	25.9	24.9	24.4	
pH	7.37	7.57	7.69	8.07	6.5 – 8.5 6.6-8.0**
Dissolved O ₂ (mg/L)	8.13	7.83	7.81	8.15	5 or greater
Clarity (m)	Bottom (10cm)	Bottom	Bottom	Very clear to bottom	>1.2 m
Total Suspended Solids (mg/L)	12	12	14	18	<6**
Faecal Coliforms (c/100mL)	2000	13000	10000	5800	<1000 for secondary contact <150 for primary contact**
Total Coliforms (c/100mL)	39000	110000	290000	150000	<1000 for recreational waters**
Oil and grease (mg/L)	<2	<2	<2	<2	
COD (mg/L)	<28	<28	<28	<28	
Other comments	Water very clear		Slightly turbid		

* Fiji Draft Sustainable Development Bill – specific criteria for Class 2 (Freshwater)

** ANZECC (Australia and New Zealand Environment and Conservation Council) (2000)

3.3 Discussion

Generally speaking the water quality in the two creeks is marginal. All of the physico-chemical parameters fall within recommended levels for freshwater except for total and faecal coliform levels. No oil and grease or COD were detected. Although water quality is satisfactory for supporting aquatic life, the very high faecal coliform levels are a concern and is an indication of contamination of the water faecal waste of humans and mammals. Sources of this would be leachate from septic tanks and wastewater from nearby piggeries which are transported to the creek during periods of heavy rain. Because the sampling was conducted following a period of very wet weather the levels were probably more extreme than normal. High faecal coliform levels could pose a health risk to residents of the area and the proposed development. Monitoring during dry weather however should also be carried out as a comparison.

It is to be expected that the housing development will cause some changes in water quality particularly in the turbidity and sediment loading during the construction stages. Heavy construction machinery could also lead to contamination from oil and grease. However these changes should be temporary as the water quality in the creeks, as seen during this monitoring following flododing, quickly returns to normal (apart from coliform levels) after an event. The establishment of additional housing may, however, contribute to the already high levels of faecal coliforms in the creeks unless proper sewage treatment facilities such as appropriate septic tanks are installed or houses connected to the sewer system.

It is recommended that the water quality in Wainavesi and Wainamako Creeks be monitored during and following the development of the housing at Tacirua. The same parameters should be monitored but perhaps COD is not needed. The results should then be compared to the baseline levels from this study and if significant changes are found, mitigative measures put into place.

4.0 THE INVERTEBRATE FAUNA

4.1 Methodology

Invertebrates and fish at each site were determined by taking 10 sweeps with a 1 mm mesh net and by washing any animals clinging to stones on the bottom into the net. Stones were selected at random along a 10m stretch of stream. All fauna caught within the net were collected in a white tray and identified and counted. Any other fauna observed were noted.

4.2 Results

Table 2 lists the aquatic fauna and their relative abundance at each site. Insect larvae were found at all sites, however more common at Sites 1, 2 and 3. The most common species was the damselfly nymphs. The atyid shrimp *Caridina* sp. was the most frequently found crustacean. Gastropods, however were the most common invertebrate collected, particularly those of genus *Melanoides*.

No water plants were found living in either creek.

Table 2. Invertebrates present at the 4 sites in Wainivesi and Wainamako Creeks (* indicates present & C indicates common)

Invertebrates	Sampling Sites			
	1	2	3	4
INSECTA				
Damselfly nymphs	*	*	*	
Mayfly nymphs			*	*
CRUSTACEA				
Palaemonidae (prawns)				
<i>Macrobrachium</i> sp.	*			
Atyidae (shrimps)				
<i>Caridina</i> sp. small	C	C	C	C
<i>Atyopsis</i> sp. (larger)		*	C	
MOLLUSCA				
Gastropoda (snails)				
<i>Melanoides tuberculata</i>	C	C	C	C
<i>Melanoides aspirans</i>		C		C
<i>Melanoides plicaria</i>		C		
<i>Physastra nasuta</i>	*		*	*
<i>Fluviopupa pupoidea</i>	*			*
<i>Neritina</i> egg cases		C		
<i>Neritina canalis</i> (shell)			*	
FISHES				
Guppies (small)	*	*	C	*
Goby				*
ANNELIDA				
Leeches (predatory)			*	*
NUMBER OF SPECIES	7	8	9	9

4.3 Discussion

Both creeks were quite healthy in terms of aquatic fauna. Wainamako Creek with 9 species per site was slightly less disturbed than Wainivesi Creek with 7/8 species per site. Altogether Wainamako Creek had 11 species and Wainivesi had 9 species. The presence of a goby fish in the Wainimako Creek suggests that the creek at this point is healthy and undisturbed. Another interesting feature was finding the small (2-4mm in length) endemic snail *Fluviopupa pupoidea* in both creeks. In the past this snail has been found further inland on Viti Levu and Vanua Levu. It is unlikely that any of the fauna are used by the residents in the area.

Both streams are likely to be adversely effected by the development as mud and grit will be carried into them during rain. The mud and grit washed down will cover the bottom stones and their covering film of algae in the less swift parts of the creek. This algae is the food of snails and goby fish. These

effects, however are likely to be temporary particularly on the steeper areas of the creek and once the silt is washed away.

5.0 CONCLUSION

The baseline study of the water quality and aquatic fauna within Wainavesi and Wainamako Creeks in October 2006 revealed the following:

- Physico-chemical status of the water quality is satisfactory/marginal.
- Although most parameters satisfy the recommended guidelines (Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water) very high faecal coliform levels are a concern for human use of the creeks.
- Both creeks were quite healthy in terms of aquatic fauna. Wainamako creek with 9 species per site was slightly less disturbed than Wainivesi creek with 7/8 species per site. The presence of a goby fish in the Wainimako creek suggests that the upper part of the creek is healthy and fairly undisturbed.
- The study was undertaken following a long period of wet weather and flooding but water quality and aquatic fauna had returned to satisfactory condition fairly quickly.

In conclusion, although the development of the housing at Tacirua may cause changes in water quality in the Wainivesi and Wainamako creeks and in turn affect the aquatic fauna, the current status of water quality and aquatic fauna abundance and diversity should return, given time, after the completion of construction works.

However, it is recommended that measures, such as maintaining a buffer area of vegetation between the creek and the housing, should be taken to reduce as much as possible the siltation and disturbance of these two water bodies that may result from the development.

6.0 MONITORING PROGRAMME & MITIGATION MEASURES

A monitoring plan for water quality would include the following:

Frequency	At the beginning, middle and following construction
Weather	Sample following wet and dry weather
Sites	Same 4 sites
Parameters	On-site: pH, temperature, dissolved oxygen, turbidity, clarity, conductivity Collect for Total Suspended Solids, oil and grease, total and faecal coliforms
Other	Observe for presence of aquatic fauna and algae
Cost per monitoring	\$1240 (plus \$500 for sampling and reporting)
Possible Laboratories	Institute of Applied Sciences, University of the South Pacific

Measures that could be taken to avoid negative effects on water quality would be to:

- Leave a buffer zone/river reserve between clearing and waterbodies
- Construct silt traps/pits before buffer zone
- Ensure proper drainage and construction of stormwater drains
- Ensure all liquid waste (sewage) is connected to a developed sewerage system
- Avoid construction during periods of wet weather
- Check all construction machinery regularly for oil and diesel leakages

7.0 REFERENCES

Australian and New Zealand Environment and Conservation Council. 2000. *Australian Water Quality Guidelines for Fresh and Marine Waters*. ANZECC.

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Fiji's Draft Sustainable Development Bill. 1996. Government of Fiji