CHAPTER 18 ENVIRONMENTAL IMPACT ASSESSMENT

18.1 Introduction

18.1.1 Objectives

The objectives of the environmental impact assessment (EIA) for the priority project are as below:

1) To describe the environmental setting in the project area

2) To analyze the impacts from the project implementation on the environment

3) To recommend measures for mitigation of any adverse impact from the project

4) To formulate an environmental management and monitoring plan

5) To consider measures for environmental mediation

18.1.2 Environmental Guidelines

The EIA shall follow the following guidelines:

1) Environmental Guidelines V. for River and Sabo Engineering (JICA, 1992)

2) Fiji's Sustainable Development Bill, Part III – Environmental Impact Assessment (Ministry of Urban Development, Housing and Environment, 1996)

18.1.3 Scope of Work

(1) Project Activities

The priority project includes Nadi diversion channel and shortcut channel. The EIA shall consider all the activities in the construction and operation of these two channels.

The diversion channel shall divert a flood flow up to 1,500 m^3/sec (1/20 probability flood) from the right bank of Nadi river at 14.6 km upstream from river mouth. It shall pass along the Enamanu road and discharge the flood to the Nadi Bay. The maximum dimension (corresponding to a 1/20 probability flood) of the channel is shown in Table-18.1

The shortcut channel shall discharge the river flow from the 9.0 km point straight forward to the 7.5 km point upstream from river mouth. Its dimension is shown in Table-18.1.

Along with the construction of the diversion channel, other facilities shall also be constructed. These include a bridge at the crossing of the channel with the Queens road, a bridge for sugarcane tram, roads along the two banks of the channel and replacement of some sections of sugarcane tramline, water supply and sewage pipe lines, electricity and telephone cables.

Table-18.1 Dimensions of Diversion Channel and Shortcut Channel

Diversion Channel*			
Total Length	Approx. 3,150 m	Bed Width	60 m
Top Width**	100 m	Land Acquisition Area***	108.8 ha
Shortcut Channel			
Total Length	Approx. 250 m	Bed Width	30 m
Top Width**	60 m	Land Acquisition Area	2.4 ha

* corresponding to 1/20 probability of design flood

** average width

*** including an area of 49 ha for disposal of the excavated materials

(2) Environmental Elements

The environmental elements to be studied shall basically be those specified in the JICA Environmental Guidelines (JICA, 1992) with consideration of the suggestion of the Dept. of Environment. Based on the results of the initial environmental examination (IEE) conducted for the Master Plan (refer to Chapter 7), some of the environmental elements have been considered not to be possibly under any impact from the project. They shall therefore not be included in the checklist for the EIA. Table-18.2 shows all the environmental elements to be reviewed in the following paragraphs.

Table-18.2 Environmental Elements for the EIA

Social Environment	Natural Environment	Environmental Hazard
Resettlement	Topography & geology	Water pollution
Community separation	Groundwater	Noise & vibration
Economic activity	Coastal area	Soil pollution
Traffic facilities	Flora & fauna	
Fishing right*	Landscape	
Public health		
Solid waste		

* The term, "Water Right/Right of Common", includes water right and fishing right, but there exists no problem of water right for the diversion channel and shortcut channel.

18.2 Environmental Settings

18.2.1 Social Environment

Nadi is renowned for its valuable contribution to the national economy due to its revenue generating potential from tourism and being the gateway of Fiji Islands. Nadi sub region has a multiracial and multicultural population totaling 30,791 according to the 1996 census for the urban and suburb areas -- consisting of 38.5 % Fijians, 55.7 % Indians and 5.8 % other races.

Due to the mountainous terrain of the region and the opportunities of employment, more than 80 % of the population live in the lower and fertile floodplains. While the mean population density is about 40 per km^2, on the average 10 to 20 people per km^2 or less live in the mountainous uplands.

The project area for the diversion channel is within the Namaka/Wailoaloa district and that for the shortcut channel within the Nadi Town district. In addition to tourism industry, small scale manufacturing and sugarcane farming are the main economic activities.

Four major resorts are located along the Nadi bay shores. The Denarau Island Resort, Vulani Island Resort and Club Fiji Resort have been fully developed while the Fantasy Resort at Wailoaloa shorefront is under development. The Wailoaloa beachfront is currently a recreational spot for local people and tourists – mostly for picnics, sailing and water boating. There is also a crematorium yard at the beachfront for post cremation rituals especially for the Hindu community in Nadi area.

The Nadi International Airport is a major landmark near the project area. Civil Aviation Authority of Fiji is implementing the project for runway extension to cater for the increasing demand.

The Queens Road is another major infrastructure in the project area for traffic accesses between Nadi and Lautoka areas. Also within the project area there is the McDonald's restaurant which is the first of this kind in Fiji and the only one in the Nadi district. For transporting sugarcanes to the sugar mill in Lautoka, several tramlines lie in the project area.

The Nadi area is served by a very good water supply system with almost 100 % population using tap water for domestic purpose. There is a sewage system collecting waste water from most of the town area. Nadi sewage treatment center has a capacity to serve about half of the total population. The Nadi Town has an organized solid waste collection and disposal system managed by the Nadi Town Council. An average of 20 trucks load of garbage and refuse are collected per day. Unfortunately up to now there is no specific site for dumping of solid waste. Instead the Nadi Town Council carries most solid waste and dumps it at Lautoka. There is only a small dumping site near Wailoaloa beach used by local residents.

18.2.2 Natural Environment

The Nadi river catchment is dominated by steep mountainous area deeply incised by small creeks and streams which contribute to the Nadi river flow. To the lower reach of the river where Nadi Town is located, flood plain stretches from the mountain foot to the coast of the Nadi Bay.

The Nadi Bay is known as a good breeding area for various marine life including the endangered turtles partly because of its isolation from possible hazardous contaminants. Several studies (Raj and Seeto, 1986; Harrison Grierson Consultants Ltd., 1989; Barrett Fuller and Partners, 1990) have confirmed the existence of many species of mullets, garfishes, ponyfishes, grunters, snappers, mud skippers and crabs in the river channel and mouth area.

To the northeast and southwest sides of the project area, i.e., Vulani and Denarau areas, mangrove strips provide a good buffer zone for the inter-tidal marine species and the adjoining residential and agricultural lands. The total area of mangrove within the Nadi sub district is 3,614 ha, of which 546 ha has been reclaimed, leaving 3,068 ha undisturbed (Dept of Town & Country Planning, 1996). Most of the mangroves on the seaward side

are Tiri Alliance and Stunted Tiri Alliance with Selala Alliance being dominant to the landward side. These mangrove forests were classified as resource reserve and traditional use zones except those developed for Denarau and Vulani resort area (Watling, 1987).

A great variety of soil types exist within the Nadi area – most are highly weathered humic latosols with varying contents of clay, silt and sand. Except during excessive rainfalls, the erosion resistance of these soils is fairly high due to their cementing agents. However, many agricultural soils are eroded and degraded because of careless tillage methods and other unwise land use practices.

In Nadi and Sabeto flood plain, there are groundwater aquifers with limited potential within the gravel and alluvial deposits. Present groundwater use is for gardening and sometimes for domestic use in emergency.

18.2.3 Environmental Hazard

Flooding is by all means the heaviest hazard in the Nadi area since it frequently occurs during the wet season and affect both the inner township area as well as the Namaka-Nadi and Sigatoka-Nadi approaches to the town which lies adjacent to or within the lower terrace of the Nadi river. The condition of flood damage has been fully described in the Chapter 6.

Soil and coastal erosion is another issue to be accounted for. The main types of erosion occurring are sheet, reel and coastal erosion. Sheet erosion mostly occurred on flat agricultural land where rich top soil are washed away during heavy rain fall; reel erosion occurred mostly along the Nadi river bank, coastal edges and at steep slope at the foot of the Sabeto Range; and coastal erosion is likely to arise in the reclaimed area around Denarau and Vulani Island under long term coastal drift of sand, or from waves and storm surge caused by short term events such as hurricanes. One of the main reasons for soil erosion is thought to be the increasing competition for flat land for residential, commercial, industrial and recreational purposes resulting in the shift of agricultural land to steeper marginal land where bad agricultural practices and frequent bush fire of the talasiga land has increased erosion five to nine times the rate of that of natural cover (Dept of Town & Country Planning, 1996).

Aircraft noise has impacts on the community around Nadi Airport. People complain about the noise especially as airplanes take off or land at light time. Loose restrictions on subsonic jet aircraft are thought to be the main reason.

Since the major industrial and residential centers in the Nadi area are built on low-lying ground, poorly or semi-consolidated predominantly shallow-marine to fluvial strata and close to major river systems or the coast, there lies the danger of landslide or ground subsidence especially during flooding.

As has been mentioned above, solid waste disposal is still a problem in Nadi area – transport of solid waste to Lautoka affects sanitary condition on roads and streets; garbage and refuse are sometimes dumped to rivers, coastal area or vacant land at some place; the temporary dumping site at Wailoaloa is not well managed.

Although water quality is thought to be good in Nadi area, there are some places where sewers discharge domestic wastes or effluent from septic tanks directly to river channels and result in water contamination.

18.3 Impact Analysis

18.3.1 Nadi Diversion Channel

Nadi diversion channel is planned as the main flood control structure for Nadi area. During a flooding up to a return period of 20 years, it will divert most of the flood flow to the Nadi Bay leaving a discharge of 300 m^3/sec in the existing river channel. The area downstream of the diverting point, where Nadi town and most of the tourist and commercial centers are located, will be effectively protected from inundation that has occurred almost every year. The positive impacts on the regional development are apparent.

Since the diversion channel is a large structure, its construction shall involve an excavation volume up to 2.3 million m^3, dike construction and supplementary works such as bridges, roads, and so on. With a length of 3.3 km and a width about 100 m (top width) with an additional area of 49 ha for disposal of excavated soil, land acquisition for its construction will associate with relocation of certain households. Completion of the diversion channel will also alter the landscape and more or less affect the natural environmental condition in the project area. Therefore, an assessment of all the possible impacts from the project becomes necessary. The following paragraphs will analyze item by item the extent of each of the envisaged impacts and at the same time give considerations on the countermeasures to mitigate the adverse impacts.

(1) Social Impacts

1) Land Acquisition and Resettlement

Figure-18.1 shows the area where the diversion channel will go through and land acquisition will take place. As can be seen from the colored area, most of the lands are currently for agricultural use, with three smaller pieces for residential use. Just in front of the Nadi bay, there is the Wailoaloa beach area for recreation use. Some lands behind the beach are vacant at present time.

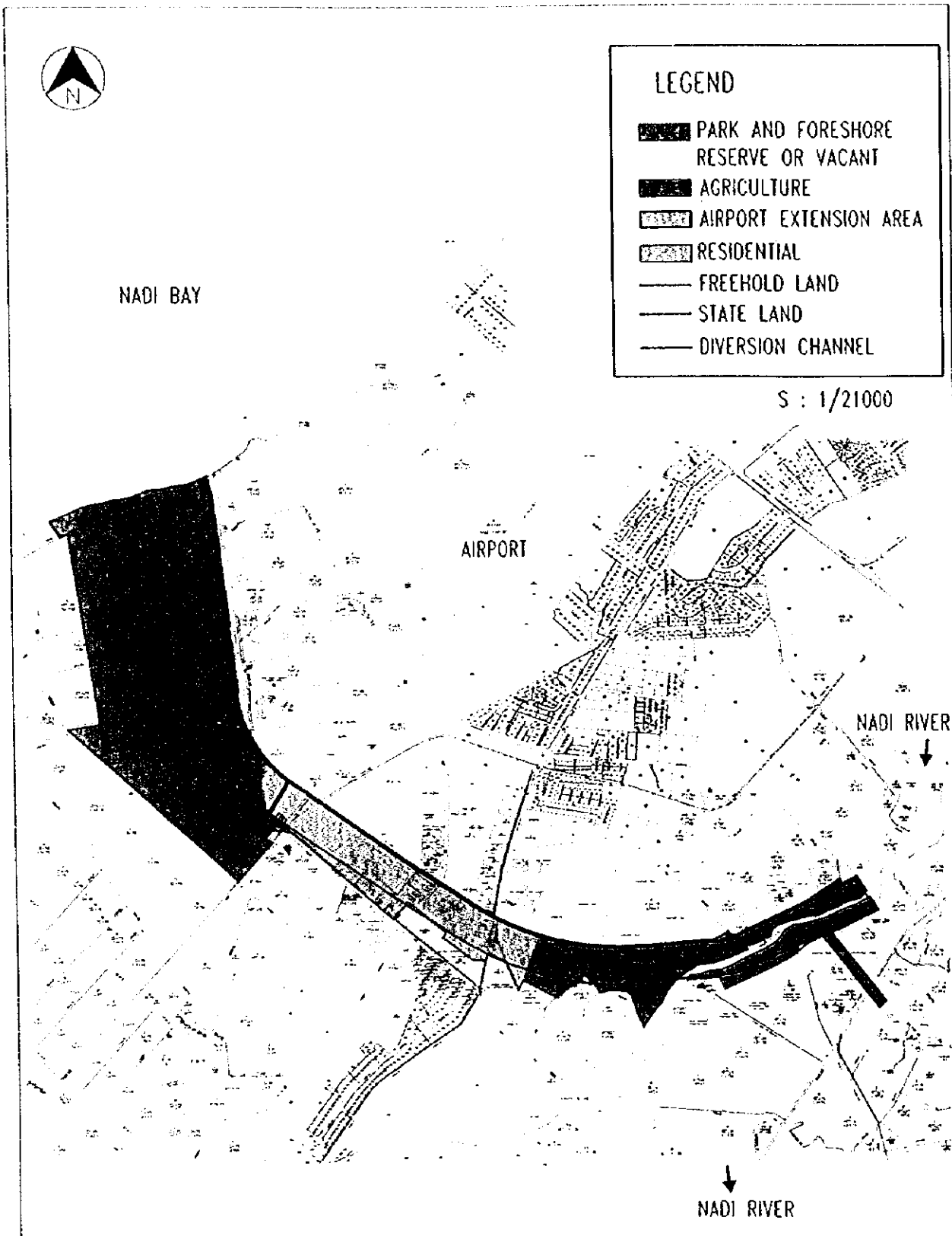

Figure-18.1 Land Acquisition Area for the Diversion Channel

Within this area, 36 households will possibly be involved in a resettlement program when the diversion channel is to be constructed. Table-18.3 shows the general condition of these households according to the results of an interview survey for this study. The number of households has been counted for all the houses that may more or less affected by the project and are thought to be the maximum. It is seen from the table that about 20 % of the households are farmers who depend mainly on sugarcane farming near their houses. The others include government/company/hotel employees, people running small scale business themselves and some without permanent occupation. Two third of these households are Indian. From their housing condition, it has been judged that most of these households belong to middle to lower class in Nadi area. More than half of the families reported their per capita annual income lower than F$ 2,000, some even as low as F$ 100.

Asked about their opinion on the diversion channel construction, most people showed their understanding of the importance of flood control since they had suffered from flood damage year by year. They would not object to resettlement when the government decides to build the diversion channel but want to be given good care as they move to a new place and also reasonable compensation on the lose of their properties.

Table-18.3 General Condition of the Households to be Possibly Involved in the Resettlement Program

Number of Households	36	Average Building Area	190.9 m^2
Average Family Member	5.7	Average Building Value	F$ 73,060
Family Annual Income (per person)		Building Type (% in Building Area)	
> F$ 10,000	3.0 %	Concrete	38.4 %
F$ 5,000 -- 10,000	9.1 %	Timber	33.3 %
F$ 2,000 -- 5,000	18.2 %	Corrugated Iron	28.3 %
< F$ 2,000	63.6 %	Land Status (for house and land)	
Unknown	6.1 %	State Land (Leased)	54.5 %
Race		Freehold	45.5 %
Fijian	24.2 %	Crop Type (for farmers)	
Indian	72.8 %	Sugarcane	73.3 %
Others	3.0 %	Vegetable	20.0 %
		Rice	6.7 %
Occupation			
Farmer	30.2 %	Self Employed	9.1 %
Employee	45.5 %	Others	15.2 %

Note: (1) Number of households for resettlement is counted for all the houses that are within the area for diversion channel construction and excavated soil disposal or adjacent to the channel.
(2) All the figures in the table are based on the questionnaire sheets answered by the interviewed families.

For almost all farmers, resettlement may affect their means of living. Their farming lands are located near the project site. Therefore, they will be reluctant to move to a place far away. As for the employees and business men, they are willing to live near their working place as well. Therefore, land acquisition and resettlement are very sensitive problems and need good arrangement and organization from the pre-construction stage. All these should be under government's well planned program for the project.

2) Community Separation

Although the project will not cause community separation, people living near Enamanu road may feel inconvenient during and after the diversion channel construction since it is difficult to provide more foot bridges across the channel for easy access between the two banks. For some farmers, their farming land will be separated from their houses and longer time will be spent to reach their working place. However this study has considered using the two banks of the channel as roads for local people. The condition of access to the direction of Queens Road will certainly be improved. The bridge planned for sugarcane tram line and another across the channel near the coast can also provide access in between the two sides.

3) Economic Activity

To those people involved in the resettlement program, certain adverse impacts are anticipated on their business or economic activities. Since the McDonald's food center is near the crossing point of the diversion channel with the Queens Road where a new bridge will be built, its business will be affected during the project construction. However, to the whole area, positive impacts will compensate or even overwhelm the minus factors. Firstly, the construction work will provide employment opportunity to many people and this will in turn require provision of living utilities, foods and other services, which will certainly stimulate development of the related businesses. Secondly, the project is to be implemented side by side with other developments such as resorts and hotels, recreation centers, green parks, etc., which will activate the economy in this area. Thirdly, as a result of flood control, the probability of flood damage will be remarkably reduced and steadier development in the whole Nadi sub region is expectant.

4) Traffic in the Related Roads

The diversion channel will cross the Queens Road and go parallel with the Enamanu Road. In order to understand the traffic condition on these two roads, the Study Team conducted a survey on traffic volume at the crossing of Queens Road and Enamanu Road near McDonald's on a weekday from 6:00 a.m. to 8:00 p.m. (see Figure-18.2 for the location of survey points). Figure-18.3 shows the hourly traffic volume distribution. As for the traffic volume by vehicle type, passenger car takes 53 % and then does small truck (21.5 %), microbus/minivan (16.9 %), large bus (5.3 %) and heavy truck (3.3 %) at section I shown in Figure-18.2. The results show that traffic volume is almost evenly distributed in the day time from 7:00 a.m. to 6:00 p.m. at Queens Road with an average traffic volume of about 820 vehicles per hour. The maximum volume is 1,214 vehicles per hour.

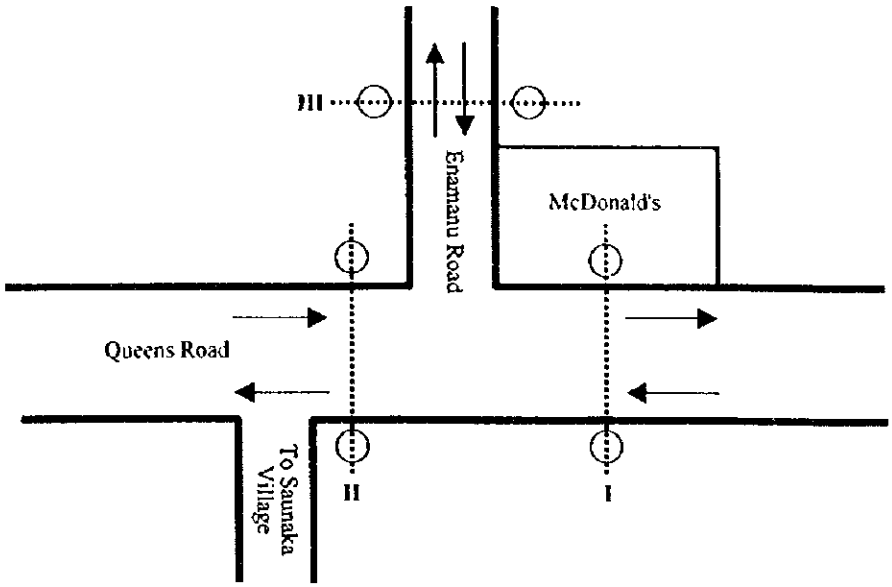

Figure-18.2 Location of Traffic Survey Points

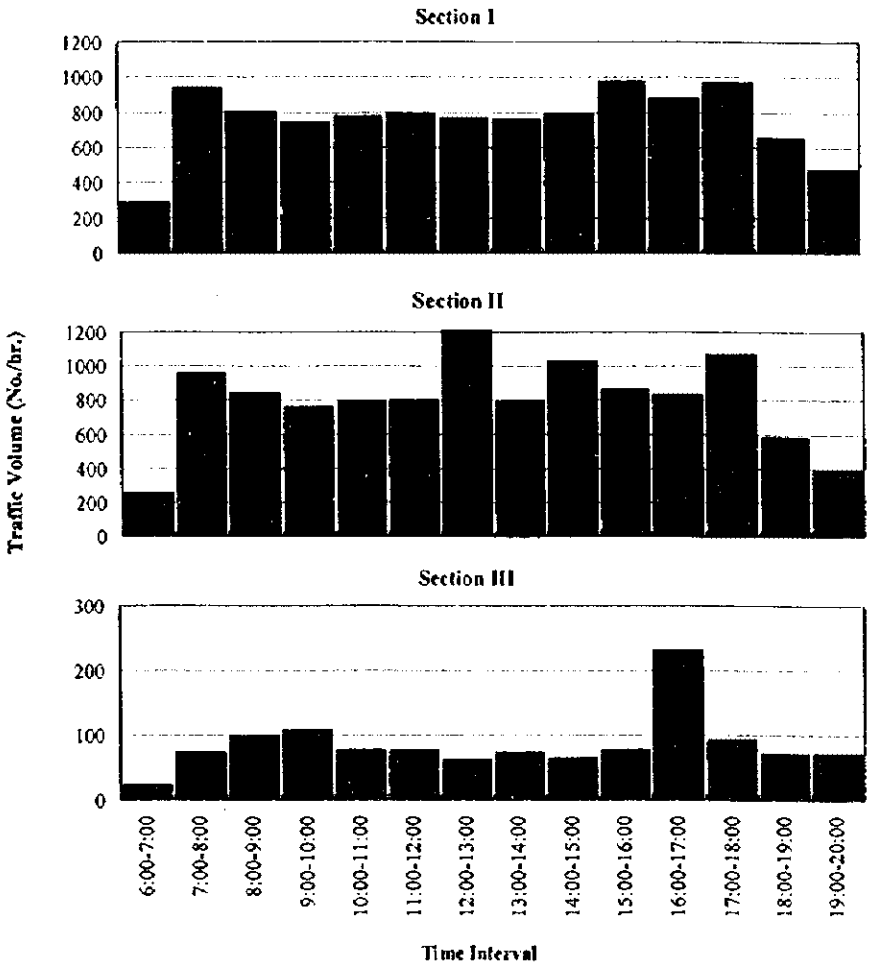

Figure-18.3 Hourly Traffic Volume Distribution

During project construction, a bridge shall be constructed on the Queens Road at its crossing with the diversion channel. This will inevitably result in a temporary stop of the existing road. At that time, a by-pass road shall have to be provided with the same width and quality as the existing road for keeping traffic conditions unaffected. Similar measures shall have to be taken for the Enamanu Road during the construction work, because the diversion channel will go side by side with this road. However, since this road will be the main access to the project site, it will be broadened before the construction work. Therefore, no blockage on traffic to the Nadi Bay direction is anticipated.

Vehicles shall be employed for transporting machinery, construction materials, excavated soils and labors to the project site. This will include vehicles travelling through the Queens Road and at the project site. The former are mainly for machinery and construction materials and the later mainly for transporting excavated soils since the disposal site is near the construction site. Therefore, the increase of traffic volume on Queens Road will not be so significant.

5) Fishing Right

Figure-18.4 is the map showing the customary fishing right of river mouth and ocean area near the project site. The area can be divided into the following four regions according to the demarcation of fishing right:

- Yavasa VA: in front of Wailoaloa beach toward Nadi Bay
- Vanua Sabeto: Saveto river mouth area
- Nakovacake: off Nadi Bay area including the mangrove forests to the south west of the project area
- Vanua Nadi: Nadi river mouth area including Denarau Island

Although not clearly shown in the map, the customary fishing right of Nadi River belongs to Vanua Nadi.

Since the outlet of the diversion channel is at Nadi Bay, the fishing right problem has to be taken into account before project construction. Consulting with Yavasa VA and Nakovacake will be necessary through the Dept. of Lands, Native Lands and Fisheries Commission.

6) Public Health Problem with the Diversion Channel

The diversion channel will work only when flood discharges exceed the design capacity (e.g. 300 m^3/sec) of the existing Nadi river. In normal times, it will just have a periodical flow under the tidal influence if there is no flood gate at the outlet, or have no flow at all if a flood gate is installed to stop the tides. In the later case, some stagnant water may be kept in the channel as has been experienced in many places in Fiji. The direct results may be mosquito breeding, emitting of unpleasant smell or odor, and unwanted growth of vegetation in the channel. This problem has been pointed out by many specialists and thought to be hazardous to public health in the surrounding area. Therefore, it is not recommendable from an environmental viewpoint that flood gates

should be provided to stop tidal flow into the channel although this is a common practice in Fiji as a measure for preventing sea water intrusion (see 3) of (2), 1) of (3) and 3) of (3) below for groundwater, water pollution and soil pollution).

7) Solid Wastes

The construction work will result in generation of large quantity of soils from excavation. Most of the excavated soils will be used for the channel embankment, and the residuals will be used for land reclamation in the disposal area. Therefore, no soils will have to be transported to other places for final disposal except for bulky construction wastes which should be disposed according to Fiji's solid waste management regulations.

(2) Impacts on Natural Environment

1) Topography and Geology

Generally speaking, the diversion channel construction will change the topographic condition in this area. The upper half of the channel will go through a gently hilly area where deep excavation up to 8 ~ 13 meters will be required at some locations for channel construction, while the lower half of the channel will go through a low-lying flat plain where the channel embankment will be elevated up to 5 meters above the ground.

Geologically, semi-consolidated clayey sand, gravely sand and sandy clay form the sound layer are distributed along the whole route of the diversion channel. The sound layer is overlaid by alluvial deposits composed of unconsolidated sandy gravel and clay, which is further overlaid by a very loose and soft sandy silt layer at the downstream area of the channel. Such a characteristic geological condition has to be taken into consideration in the design of the diversion channel, especially for its downstream half where the embankment is elevated.

2) Coastal Area

The effect of diversion on coastal area has been discussed in the section 17.3. No significant erosion or deposition in Nadi Bay is anticipated from the diversion channel construction.

In front of the Wailoaloa beach area, there are no coral reefs in existence. The existing coral reefs nearest to the diversion outlet are those at Malan Cay which is about 3.5 km away. Other well grown coral reefs are distributed around Alacrity Cays (5.0 km away) and Yakuilau Island (6.0 km away). The Institute of Applied Sciences, USP carried out a continuous monitoring of coral reefs at these locations regarding the impacts from Denarau marina development (Lovell, E. R. et al 1991; Lovell, E. R. et al 1993; Tamata, B. R. et al 1994). They pointed out the mortality of some coral species such as *Acropora* at Alacrity Cay, Malan Cay and Yakuilau Island from July 1992 to October 1993, and considered that Cyclone Kina would be the main reason of the damage on corals. At Malan Cay, coral development was poor as compared to the other offshore sites.

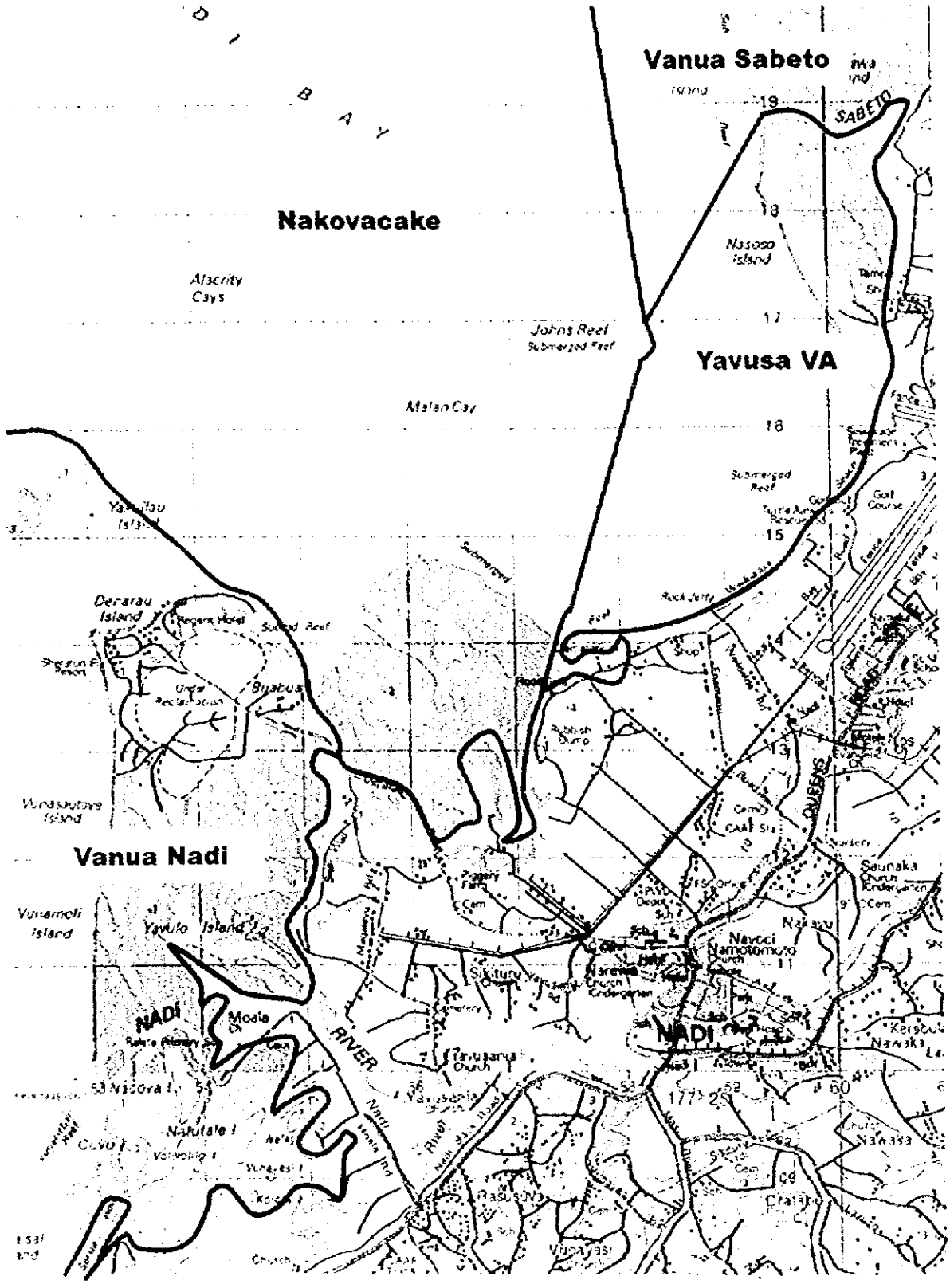

Figure-18.4 Customary Fishing Right in the Project Area

After the diversion channel construction, sediments carried to Nadi Bay may have impacts on coral reefs in this area, especially those at Malan Cay. However, since the bottom of the diversion channel at its inlet is higher than that of the existing river channel, this may result in sedimentation of most of the bed load and suspended solids in the existing river channel. Therefore only a limited amount of suspended sediments will be carried through the diversion channel to Nadi Bay. It should also be pointed out that at present time Nadi Bay is already a receiver of flooding discharge from the flood plain because the existing Nadi river has a too small capacity to discharge a flood flow.

The mangrove forests at southwest side of the project area will not be affected by the diversion. Contrarily, with the diversion channel conveying flood flow at upstream side, the channels within the mangrove area will no longer function as flood ways as they do at present time. This will benefit mangrove conservation in this area.

Seagrass beds are poorly developed along the foreshore of the Wailoaloa beach according to the Study Team's investigation.

3) Groundwater

In normal times, seawater intrusion may be a problem due to inward tidal flow through the diversion channel. This may result in an increase of salinity of groundwater in the surrounding area. To understand the groundwater quality, electric conductivity (EC) measurement was conducted for the 12 boreholes drilled along the planned diversion route during the geological survey for this study. Table-18.4 shows the E-C measurement results.

Table-18.4 EC-Measurement of Borehole Water

Borehole No	Depth (m)	EC (μS/cm)	Description
B-1	5.0	1080	Nadi River side
B-2	6.0	411	-
B-3	7.0	115	-
B-4	4.5	120	-
B-5	5.0	161	-
B-6	5.0	205	-
B-7	3.0	580	-
B-8	2.0	1000	-
B-9	1.5	2700	-
B-10	1.5	5600	Near a drainage channel
B-11	2.0	10000	Near a drainage channel
B-12	1.0	4000	Sea side

Most of the borehole waters are fresh (No.2 – No.7) with No.1 at Nadi River side and No.8 – No.12 near the beach showing a tendency of salinity increase. The two with salinity higher than 5000 μS/cm (No.10 and No.11) are thought to be affected by drainage channels near the boreholes.

The Study Team also investigated the present condition of groundwater usage in the surrounding area. As a result, only 4 wells are found from the right bank of Nadi river to beach front. Among them, 3 are already dry and the only one with water is not used anymore. Therefore, there is almost no groundwater usage in this area.

Although no direct impacts on groundwater usage are anticipated, groundwater resource protection as well as soil pollution control (see 3) Soil Pollution of (3) Hazard Related Issues below) should be put into consideration. It is recommendable that the channel bottom and side walls should be firmly compacted to minimize infiltration of salty water and any plantation inside the channel should be strictly forbidden, except grass covering for bank protection.

4) Flora & Fauna

In the project area, mangrove is the most important flora which has been mentioned above in 2) Coastal Area of (2) Impacts on Natural Environment. On Wailoaloa beach, there are remnants of littoral forests and beach vegetation which has already been much altered by the influence of regional development. Coconut plantations, though not extensive, cover part of the area. The diversion channel construction may inevitably need clearance of some plantation area or cutting some trees. It is recommendable that new plantation area be created to maintain or even increase green coverage in this area. This has already been considered in the land use plan for this project (see Chapter 19).

Wading birds utilize the mangrove and intertidal areas for feeding and roosting. They are the main fauna in this area. The main species include mangrove herons (*Egretta sacra*), wild ducks (*Anas superciliosa*), jungle mynah (*Acridotheres sp*) and crested terns (*Sterna bergii*) (Harrison Grierson Consultants Ltd., 1989). Since the route of the diversion channel is through the flood plain area, no impacts are anticipated on these birds.

5) Landscape

After the project, a new water way will appear in this area resulting in a change of the landscape. Since its outlet is at Wailoaloa beach and not far from several existing and planned resorts, the appearance of the diversion channel will be very important to the tourist development in this area. If it appears as only a bare channel, it would obstacle the view of tourists, but if aesthetic factors are taken into consideration in the engineering design, the impacts may become positive. For this reason, hotel, park and housing development has been woven into the scheme of planning (see Chapter 19).

(3) Hazard Related Issues

1) Water Pollution

During project construction, pollutant load may increase due to employment of machinery, labors and result in water pollution of Nadi River and Nadi Bay, such as an increase of suspended solids, oil and grease, organic matters. Measures should therefore be taken to minimize water pollution. Excavation should be carried out in a way not to cause large quantity of soils entering river flow or being washed into the bay. Machinery should be well maintained and operation well organized that leakage of oil or lubricant can be prevented. Temporary toilets with waste disposal tanks should be provided sufficiently for workers at the job site. Disposal of any kind of rubbish or wastes should follow regional regulations.

In the operation phase, since no pollutant source would be added to the river or ocean, water pollution will not be a problem. For the Nadi River downstream of the diversion, a base flow of 300 m^3/sec will be kept when the diversion channel is working.

Therefore, the problem discussed in the IEE of this study (see the section 7.3) would not be encountered.

As mentioned in 6) Public Health Problem with the Diversion Channel of (1) Social Impacts, it is not recommendable to use flood gates to stop tidal flow into the diversion channel under a consideration of the problem of water stagnation which may bring about unwanted growth of weeds and aquatic plants, odor etc. With the influence of tidal flow, seawater intrusion may more or less occur and the direct result may be an increase of salinity of groundwater and soil pollution. Therefore, it is recommended that the channel bottom and side walls should be firmly compacted to minimize salty water infiltration. Groundwater salinity and water level monitoring is also recommended. However, the impact of seawater intrusion may not be significant since the area of agricultural land in the vicinity of the diversion channel will decrease according to the regional development plan.

2) Noise and Vibration

The machinery to be employed for the diversion channel construction will include crawler crane, truck crane, excavator, bulldozer and dump trucks. The noise level of a bulldozer at working is about 90 dB within a distance of 2 m, and that of the other machinery is about the same or lower. If 4-6 machines are working simultaneously at the same location, the resultant noise level is estimated to be 96-98 dB. The noise level may decay to less than 85 dB at a distance of 10 m. There is no regulation in Fiji on construction work regarding noise level yet. Referring to the regulation in Japan, a construction work with a noise level higher than 85 dB is only permitted in day time (Kajima Corporation, 1993).

Along the route of the diversion channel and in its surrounding area, there are few densely populated areas. Generally speaking, the impacts of noise and vibration from project construction may not be very significant, but the construction work should be carried out only in day time.

3) Soil Pollution

As has been mentioned in 3) of (2) above for groundwater, under the influence of inward tidal flow in the diversion channel in normal times, seawater intrusion may result in an increase of groundwater salinity. This may also cause a build-up of soil salinity. In the project area, most of the agricultural lands are for sugarcane farming. Although sugarcane is not a crop sensitive to soil salinity (Ayers R. S. and Westcot D. W., 1985), soil pollution protection should still be considered. The countermeasures are the same as those proposed for groundwater protection.

18.3.2 Nadi Shortcut Channel

(1) Social Impacts

The area where the Nadi shortcut channel is planned is a rural area with half of the land vacant and half for agriculture. There are no houses built in this area and therefore no problem of resettlement will be encountered for the channel construction. The only problem is that part of the land is Native Reserve. According to Fiji's law, the Native Reserve is originally assigned as the reserved area for the subsistence of the native Fijians,

i.e., it can only be leased to Fijians. For this reason, direct use of these lands for the channel construction is impossible. A recommendation is to find some vacant State Land near this area and exchange the status of that land with the Native Reserve. There has been such kind of practice in Fiji for some governmental projects.

The shortcut channel construction may more or less affect agricultural activity in the project area. But after the construction, flooding water from the upstream Nadi river will flow through the shortcut channel directly to the downstream side and the existing river channel will only discharge the flow from the Nawaka river. As a result, water can flow through these channels smoothly without overflow to the flood plain as that often happens at present time. This will surely benefit agricultural development in this area.

At the shortcut channel construction site, there are only some unpaved access roads for local residents. No significant impacts on traffic facilities are anticipated. Disposal of the excavated soil should be taken into consideration. There are vacant lands that can be used for soil disposal and then be reclaimed for agricultural or other developments.

(2) Impacts on Natural Environment

Comparing with the diversion channel, the shortcut channel will be more similar to a natural river course and will not much alter the natural condition in this area. No significant impacts on the natural environment are anticipated.

(3) Hazard Issues

The shortcut channel will not bring any contaminants to the river or surrounding area. The construction work will be completed within a very short period of time. Therefore, noise and vibration will not become a big problem during the construction.

18.4 Environmental Management and Monitoring Plans

18.4.1 Environmental Management Plan

Environmental management is important from the pre-construction stage to the post-construction stage. This includes not only the management of environmental issues related to the project, but also those related to environmental improvement in the whole project area. Recommendations can be given as followings.

(1) Organization for Environmental Management

Under the project office which is supposed to be organized by the government, there should be a branch with at least one acting officer in charge of environmental management. The environment branch shall make plans for environmental protection and improvement, and manage all activities related to the environment. A good coordination among the project office, local government and environment agencies are also very important.

(2) Management of Resettlement and Land Acquisition

Resettlement and land acquisition are very sensitive to social impacts and have to be well managed. Totally 36 households will possibly be involved in the resettlement program. Careful inventory of their houses, lands and properties, hearing on their opinion and desire

are indispensable. In addition to compensation, provision of locations for them to get new residential houses are also very important.

(3) Environmental Surveillance of Construction Work

Construction work should follow environmental regulations. This needs a well organization of the work and also surveillance during the work. Dispute may occur with local residents on environment related issues, or complaints may come to the project office or local government. These issues need to be resolved on the basis of environmental laws and regulations.

(4) Safety Management of the Diversion Channel

The diversion channel shall only be used as flood control structure but not for other purpose. Its safety management includes the channel's structural safety and the safety of people who operate the channel or live near the channel as well as tourists entering the channel area.

To keep the channel's structural safety, the Government should put forward regulations on all issues related to its management and usage. Arbitrary plantation in the channel area or on its two banks should be strictly prohibited. Discharge of sewage, wastewater or dumping garbage and refuse into the channel should be forbidden.

Even when there is no flow in the channel, free entrance to the channel or using it as access roads are very dangerous. The Government has to educate local residents and notice tourists the importance to keep the diversion channel as a protected area.

(5) River and Coastal Environment Management

As one of the non-structure measures, river environment management has been proposed in the flood control master plan and has to be considered after the project construction. This includes restriction on industrial wastewater and reduction of pollutants from domestic discharge.

The environmental condition of the Nadi Bay area is thought to be good at present time. However, to create a more beautiful coastal area should always be the objective of the watershed management. Measures should also be taken on further improvement of the coastal environment.

(6) Environmental Education

For an effective environment management, environmental and sanitary education is indispensable for raising public awareness of the importance of environment protection as well as the protection of the diversion channel and shortcut channel as has been mentioned above.

18.4.2 Environmental Monitoring

Environmental monitoring is important for understanding the environmental conditions before, during and after the project. At the pre-construction stage, environmental monitoring aims to an understanding of the environmental settings as what has been done

in the IEE and EIA for this project; during project construction, monitoring is for controlling the impacts on the environment; and after the project, for good maintenance of facilities and expanding the positive effect of the project. The followings are the main monitoring items.

(1) Traffic Volume Monitoring

At the pre-construction stage, the traffic volume of the main roads should be monitored for making a reasonable transportation plan for the project, and during the construction monitoring is still necessary to check the project impacts and raise working efficiency.

(2) Noise and Vibration

Noise and vibration levels should be monitored during the project construction especially at the locations where people complain about the impact. Following monitoring results, work plan should be modified and countermeasures be taken.

(3) Groundwater Monitoring

EC and water level of groundwater should be monitored for several numbers of boreholes distributed around the diversion channel to assess the effect of seawater intrusion and water level change. With the monitoring, countermeasures can be taken timely, if necessary.

(4) Coastal Environment Monitoring

At the feasibility study stage, due to limitation of available information and field investigation, many issues related to the coastal environment of the Nadi Bay area were not fully clarified. It is recommendable that a comprehensive study should be conducted at the pre-construction stage, including some important parameters related to rational engineering design, such as tidal movement, coastal erosion etc, and factors related to environmental planning and future impact prediction, such as oceanic flora and fauna. After the diversion channel construction, continuous coastal environmental monitoring is still necessary for understanding the impacts from the project and then taking effective countermeasures.

Another factor important to coastal environment is quantitative estimation of sediments to be discharged into the Nadi Bay through the diversion channel. Soil erosion has been thought to be serious in the upper stream mountain area, but due to lack of information, quantitative calculation is yet impossible. Comprehensive study on this factor is necessary in the pre-construction stage.

(5) Post Resettlement Survey

As has been mentioned above, resettlement is a sensitive issue related to social impacts. The impacts will not only be significant until people relocate to a new place but also continue for long period of time. Whether people are satisfied with their new living condition, what kind of problem they are facing and what do they want the government to do for them should be understood. It is recommendable that post resettlement survey shall be conducted to investigate these people's condition after the resettlement and hear on their opinion and requests. The information should be reported to the related governmental organization.

18.5 Consideration on Environmental Mediation

According to the guidelines specified in the 'Fiji's Draft Sustainable Development Bill' (Ministry of Urban Development, Housing and Environment, 1996), environmental mediation will be a required stage of the EIA, if the Environmental Assessment Administrator determines that it is necessary or appropriate. For the diversion channel and shortcut channel construction, the most probable issues which may need a mediation are land acquisition and resettlement or some dispute related to the customary fishing rights.

Mediation, at least for this project, means talking with people to understand their opinion and request, to explain the governmental decision and policy, to negotiate, if appropriate, on compensation issues, to achieve agreement or mutual understanding and finally solve the problem or dispute.

During the social environmental survey conducted in this study, many interviewees showed different ideas or opinions toward the diversion channel construction. Some of them estimated the cost of their houses and properties totally differently from the information from the governmental agencies. This is not uncommon but shows that a mediation process may be necessary at the pre-construction stage.

Fortunately, the above mentioned 'Fiji's Draft Sustainable Development Bill' has given clearly the procedures of environmental mediation. In addition to the Dept of Environment, there are other governmental agencies in charge of lands, fishing rights and native issues etc. Since this project will be implemented and managed by the government, it would not be difficult to solve all the possible disputes and problems after an appropriate mediation process.

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CHAPTER 19 LAND DEVELOPMENT PLAN WITH THE PRIORITY PROJECT

19.1 Present Land Use in Nadi

19.1.1 Vicinity of Nadi Town

Land use in the vicinity of Nadi town is characterized as follows:

- Urban development along Queens road with Nadi town in the south
- International airport located in the north - main gateway to Fiji
- Tourism development - concentration of hotels and tourist shops/restaurants
- Sugarcane - historical background and still major industry and landscape
- Fijian native villages distributed adjacent to the urban area
- Urban expansion to the south and to the north-east

The project area is located in the center of the urban area or between the airport and Nadi town. In addition, it faces the coast where urban and tourism area is still small and is going to be developed.

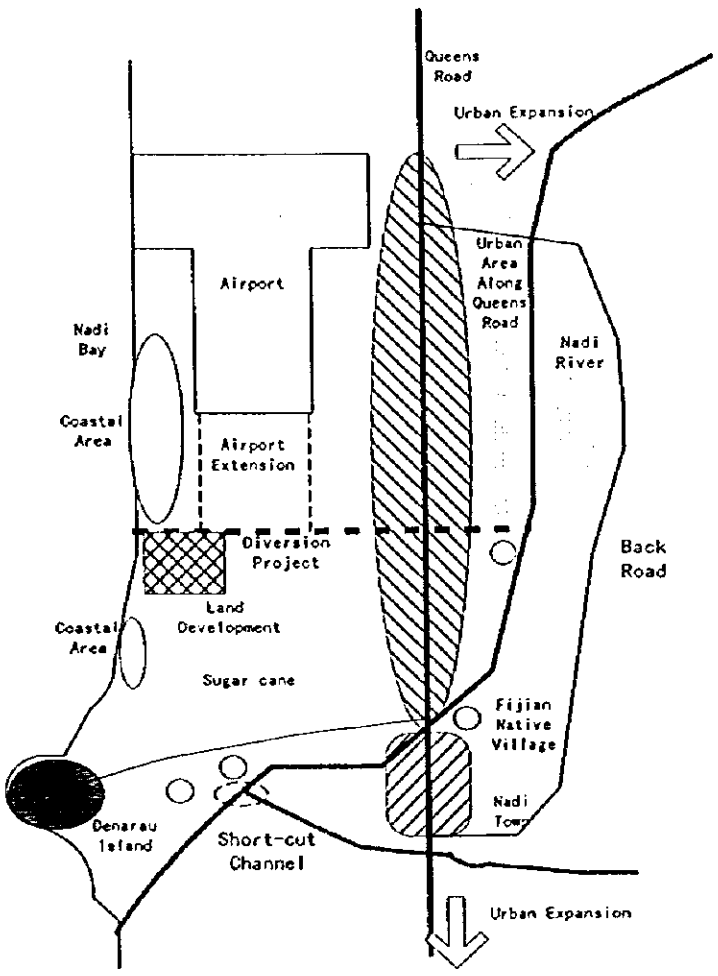


Figure-19.1 Schematic Plan of Nadi Area

19.1.2 Around Project Area

The present land use around the project area is shown in Figure-19.2.

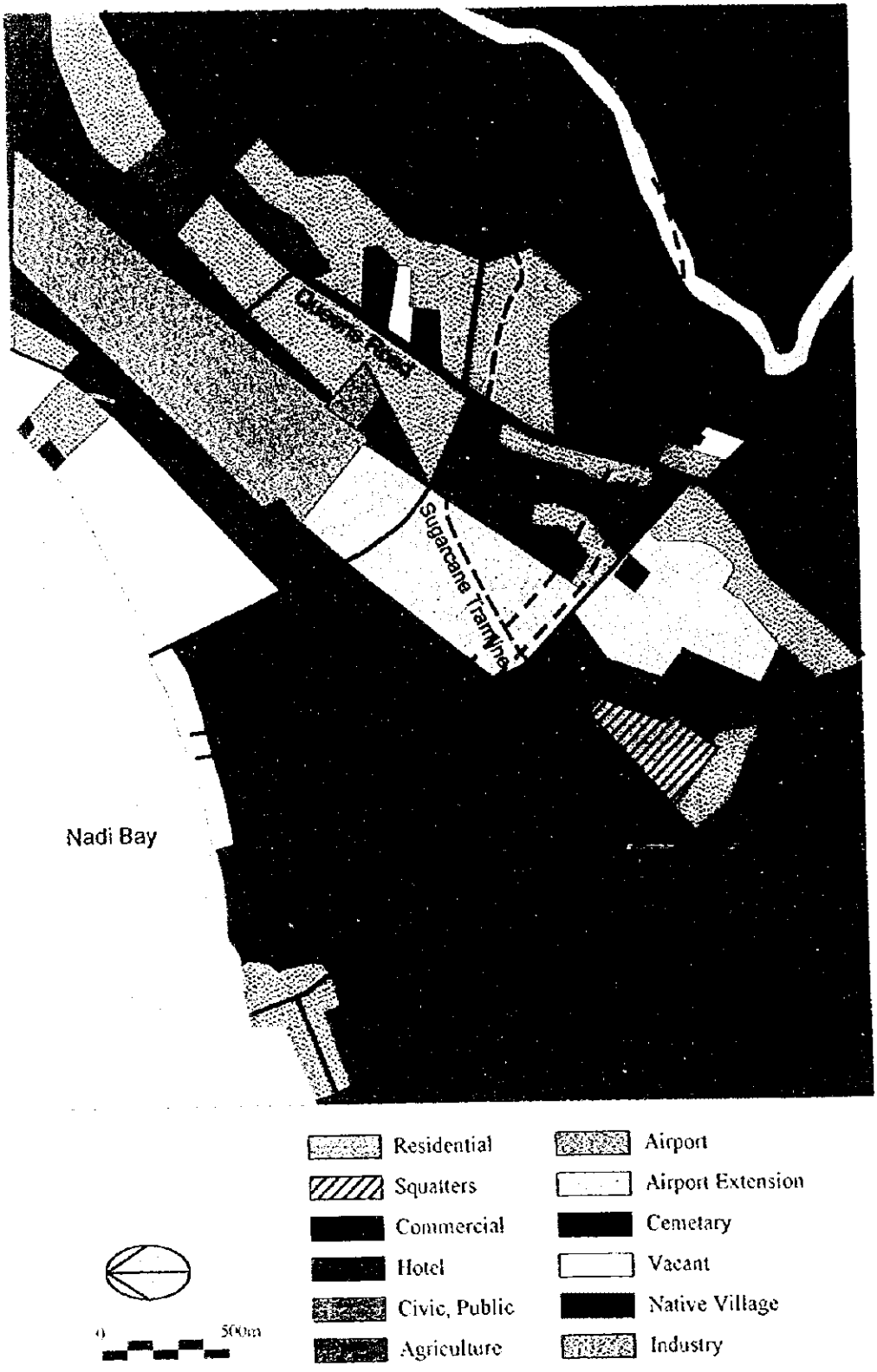


Figure-19.2 Present Land Use around Diversion Project Area

19.1.2 Around Project Area

The present land use around the project area is shown in Figure-19.2.

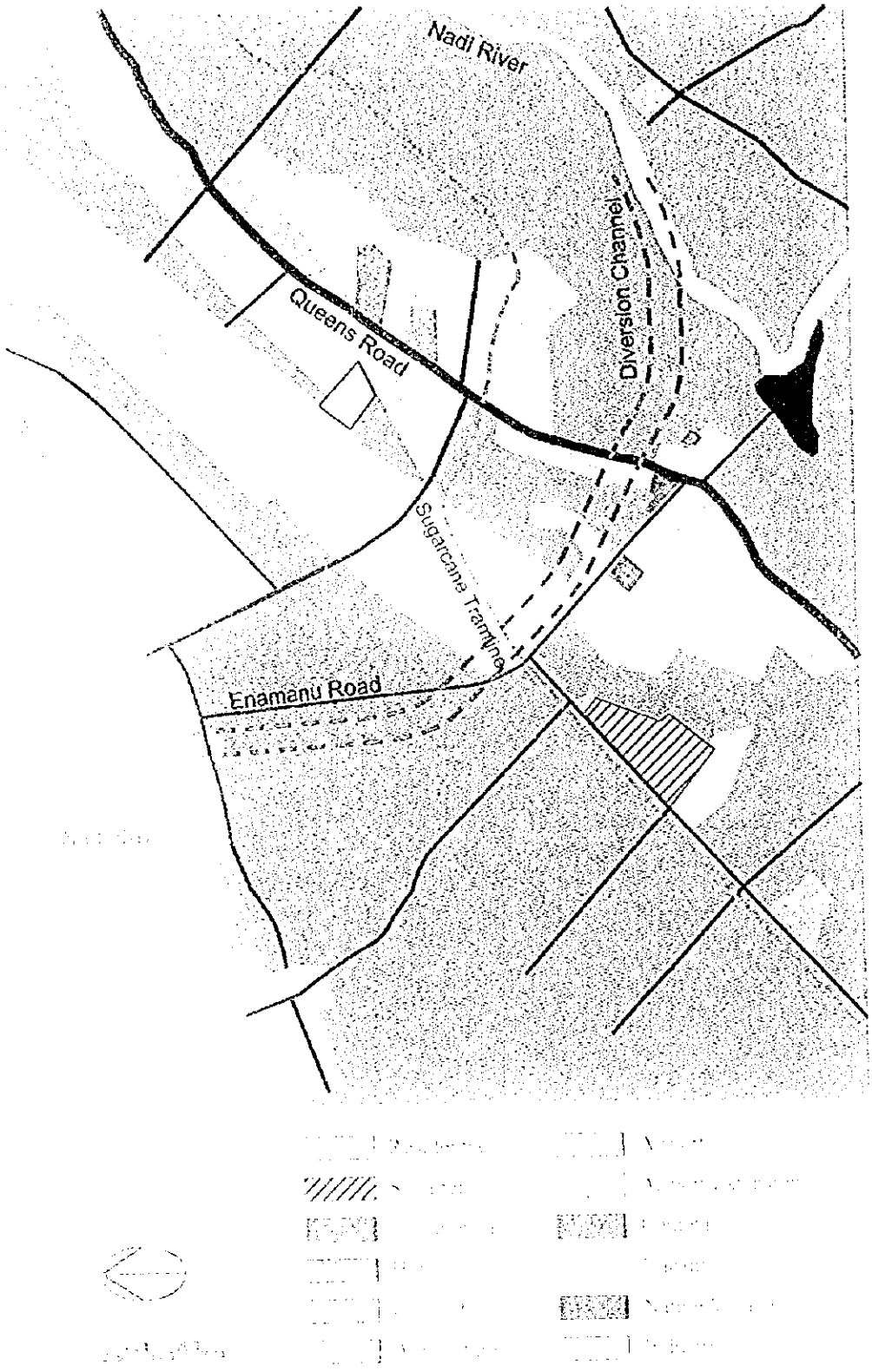


Figure 19.2 Present Land Use around Diversion Project Area

(1) Around Nadi River

The area around the site for diversion channel between Nadi river and Queens road is agricultural land, mainly of sugarcane and vegetables. There is also a small forest or belt of trees. On the left bank of Nadi river, a small hill extends to the east along Solovi road. There is an international school at the crossing of the back road and Solovi road. At the Saunaka native village, Nadi river winds almost perpendicularly.

(2) Around Crossing of Queens and Enamanu Roads

The west side of Queens road where the diversion channel will cross is residential area with housing lots; however, a few houses are built in the lots or not all lots have been utilized. At the corner of the crossing between Queens road and Enamanu road, there is the McDonald's with parking lots and the delivery house.

(3) Along Enamanu Road

From the crossing between Queens road and Enamanu road to the coast is mainly farm land with scattered houses along the Enamanu road and Wailoaloa road. There are facilities of CAAF (Civil Aviation Authority of Fiji) and PWD (Public Works Department), and the cemetery on the west side of Enamanu road. Both sides of Enamanu road is the extension area of Nadi airport. At the crossing of Enamanu road and the tramline, there is a small Hindu temple. At the end of Wailoaloa road, there is a damaged rock jetty. The coast is public sand beach.

(4) Along Coast

Along the coast, there are a small crematorium, two small resort hotels (24 + 15 rooms), "Fantasy Project" and vacant or undeveloped land to the west. The Fantasy Project is under construction to develop the residential area and hotel. In the eastern area of Nadi Bay road, there are the residential area with small hotels, Turtle Airways and a golf club house.

(5) Around the Short-cut Project Site (Figure-19.3)

The proposed site for the short-cut channel is basically agricultural land belonged to Native Fijian; however, it is not fully utilized but left uncultivated. Narewa native village is located on the right bank of Nadi river but the village is not in the project site for the short cut channel.

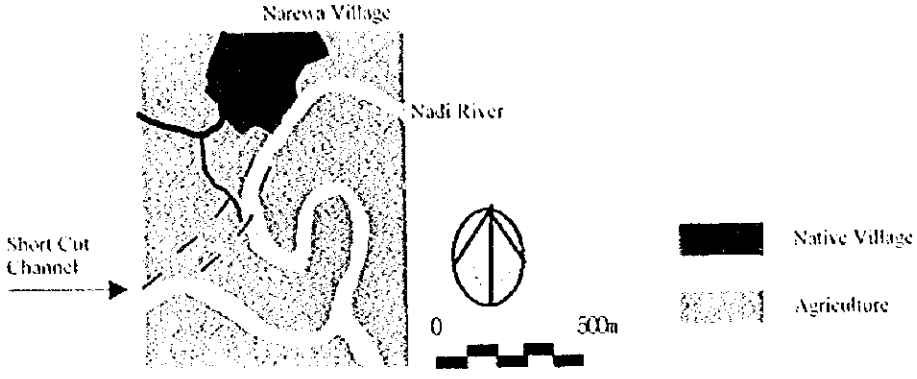


Figure-19.3 Present Land Use around Sort Cut Channel

19.1.3 Hotels

There are 1,653 hotel rooms in the Nadi area as shown in Table-19.1.

Table-19.1 Number of Hotel Rooms in Nadi Area

Location	Number of Rooms
Near the airport gate	448
Along Queens Road (including Nadi Town)	541
Coastal area	79
Denarau island	585
Total	1,653

The grade of the hotels along the Queens road varies from economy to first class. The hotels in Denarau island are all luxury. Many of the first class hotels along Queens road are getting old and need renovation.

19.2 Future Land Use in Nadi

The future land use in Nadi town and its vicinity shall be lead by Nadi Town Planning Scheme which is prepared by the Department of Town and Country Planning (Figure-19.4). The expected changes are extension of the airport in the east of Enamanu road and tourism development on the coastal area integrated with the Fiji Tourism Development Plan.

19.2.1 Nadi Town Planning Scheme

Nadi Town Planning Scheme, covering Nadi town, Nadi urban area and Nadi rural area, was provisionally approved in December 1996 and supposed to have the final approval by the end of 1997. The scheme aims to enhance the growth of Nadi in an efficient equitable and sustainable way paying particular concern to supporting the growth of the airport, facilitating tourism and protecting good cane land. To cope with flooding, development on flood prone area is restricted, and dredging of Nadi river and formulation of a flood mitigation plan are recommended.

In addition to the new expanded town centers of Vatualevu and Malolo, residential areas of Saunaka, Waqadra, Namaka etc. will be filled with houses. The main commercial center

will continue to be Nadi Town and secondary centers will be Narewa, Martintar, Namaka and Vatualevu. Hotel sites are earmarked in Denarau, Wailoaloa, Vulani and Vatualevu.

Table-19.2 Land Use by Nadi Town Planning Scheme

Land use	Area (ha)	%
Residential	246	40%
Commercial	54	9%
Industrial	37	6%
Open space	130	22%
Tourism	82	14%
Civic	53	9%
Total	603	100%

Source: Department of Town and Country Planning, 1996

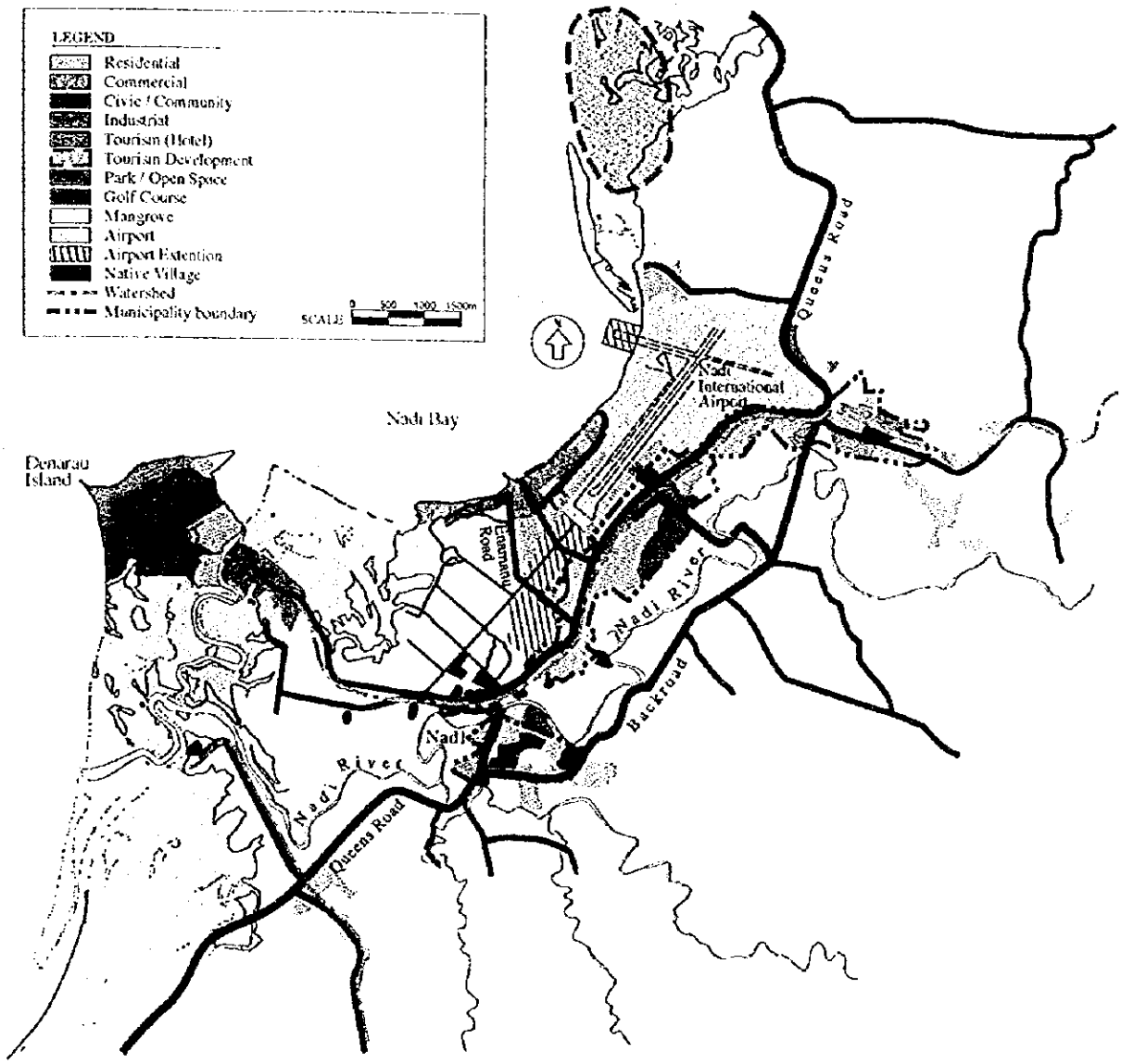


Figure-19.4 Nadi Town Planning Scheme

19.2.2 Fiji Tourism Development Plan, 1998 - 2005

Fiji Tourism Development Plan, 1998 - 2005, was issued in 1997, presenting the policy and direction of the tourism development. The emphasis is placed on the main existing tourism areas to be improved and consolidated, while more dispersed development of quality tourism throughout the islands is promoted. In Fiji overall, introduction of 2,500 rooms is aimed by 2005.

The plan has identified the Tourism Development Areas. Nadi bay is recommended for the pilot area including Wailoaloa bay in the center because Nadi bay has the potential for being a major resort center. The resort centers such as Denarau island within the Tourism Development Area should be integrated into a whole. Wailoaloa beach should be zoned for tourism and domestic recreation with a public beach facility. A beach center is proposed near Wailoaloa jetty.

19.2.3 Related Projects

(1) Fantasy Development Project

The total project area is about 32 ha comprising the state land and reclaimed land adjacent to the flood gate. The soil for reclamation is dredged from the sea forming channel and marina. The marina and housing lots which mostly front to the marina will be provided in the first phase. The number of lots is 95 with the area of 10.1 ha and 2.6 ha of roads. A hotel site with the area of 4.6 ha, villa site with recreation facilities of 3.8 ha fronting to beach, and foreshore reserve of 2 ha will be developed in the second phase.

(2) Wailoaloa Jetty Development Project

The application for development of Wailoaloa Jetty has been submitted for approval. It comprises expansion and improvement to the existing jetty preparing wharf, marina, restaurant, shops, tour offices and parking etc. The area is about 8,000 m^2.

(3) Vulani Island Development Project

Vulaini Island Project is located at 8 km north from the Nadi airport. In Stage I and II, it will include 4 hotel sites (10 ha x 4, about 1,000 rooms), 18 hole golf course, driving range, marina, 120 housing lots, commercial, condominiums, small aquarium, museum and cultural center in the area of about 160 ha. It is under construction.

(4) Development in Denarau Island

Denarau island is still under development having vacant sites for international hotels and condominiums. The condominiums with about 80 rooms and the hotel with about 300 rooms have been completed. There are still the sites for condominiums of 400 rooms and hotels of 300 rooms reserved. Denarau island is given completion priority in the "Fiji Tourism Development Plan, 1997".

19.2.4 Future Land Use

Based on the existing land use schemes discussed above and land development plan proposed in the next section 19.3, the future land use in the vicinity of the diversion channel

was projected. Land use conditions around the project site for the Nadi diversion channel are summarized below.

- Both sides of Nadi river adjacent to the diversion channel site are rural or agricultural areas.
- The area along Queens road is residential. The east side is about 20 m wide and the west side extends to the airport extension area.
- The airport runway will be extended up to Enamanu road and the airport facilities will be constructed on the west of Enamanu road. Accordingly the route of the tramline will be relocated outside the airport extension.
- The west of Enamanu road is rural area except the area along Queens road which is residential.
- The area in the north of the airport extension between Enamanu road and Wailoaloa road will be residential and hotel areas. The hotel area is located seaside and residential area is between the hotel area and the airport extension.
- The beach is public open space for recreation and access to the sea.
- The coastal area along Nadi bay road is designated as residential and hotel areas.

The projected future land use around the project area is shown in Figure-19.5.

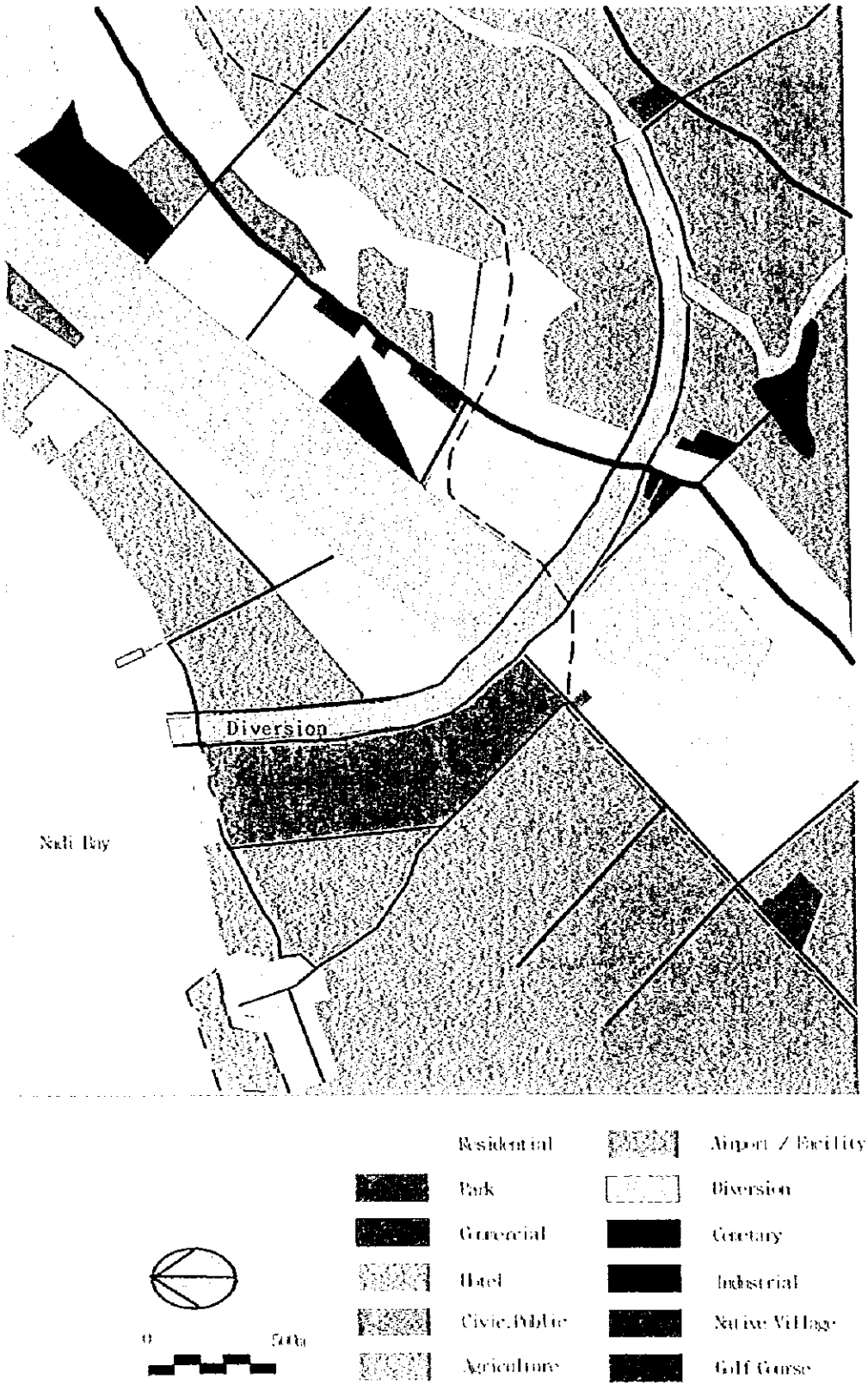


Figure-19.5 Land Development and Future Land Use

19.3 Proposed Land Development Plan with Diversion Project

19.3.1 Land Development of Soil Disposal Area

The proposed diversion channel will pass through a small hill after its inlet. Therefore, the upper reach of the channel (about half of the total channel length) will be the cutting section, while the lower reach will be the embankment section. Excavated soil will be used for the embankment section of the channel and surplus soil will be dumped in the disposal area located on the left bank in the lower reach of the channel. The maximum height of the soil disposal area is 6 m.

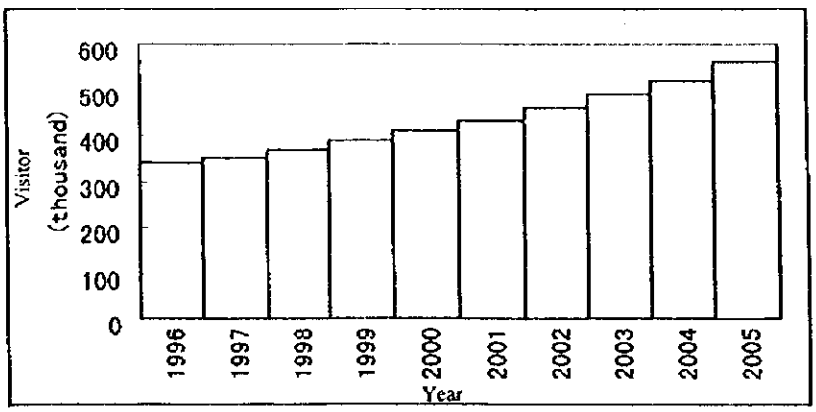
Since the soil disposal area is located seashore and its vicinity is designated as Tourism Development Area, this area has potential for urban development. Therefore, development of the soil disposal area was examined.

(1) Objectives of Development

Based on the present and future land use in the vicinity of the proposed site for the diversion channel, the following items were examined to assess their suitability for land development.

1) Hotel

Tourism is one of the most important sectors for the economy in Fiji and tourism development seems to be promising as the visitor arrivals are expected to increase considerably (Figure-19.6). More accommodation will be required for the increase of visitors. Therefore, a large scale luxury hotel should be promoted to cope with not only accommodation but also international conference, events and so on. The site as large as 20 ha facing the sea would provide ideal opportunity for such development of a luxury hotel with over 500 rooms with swimming pool, gardens, sports facilities, convention centers etc.

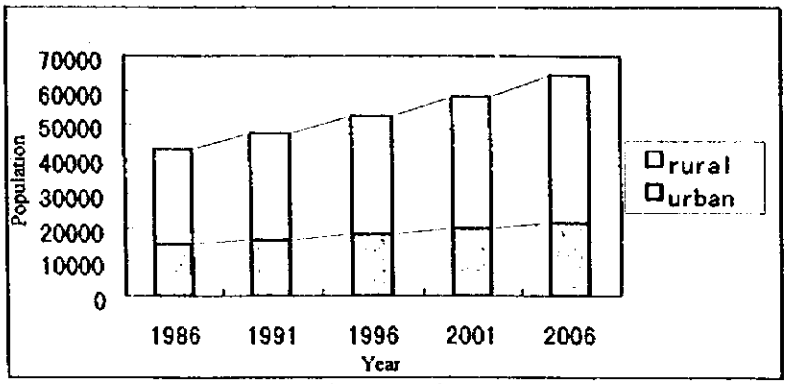


(Source : Ministry of Transport and Tourism, 1997)

Figure-19.6 Visitor Arrivals Projection

2) Housing

Housing is expected to be constantly required due to population increase in Nadi region (Figure-19.7). In particular, the demand for the first class residential area is anticipated to increase as appropriate land is limited and there are problems in tenure for development.



(Source : Department of Town and Country Planning, 1997)

Figure-19.7 Projected Population of Nadi Region

3) Shopping Center

Development of large scale shopping center might be difficult, considering the small future population in Nadi region (about 64,000 in 2006).

4) Park

As there is no large public park in Nadi area, it is worth to be considered for the public and tourists.

5) Nadi Theme Park (Fiji Experience)

Fiji Tourism Development Plan proposes a cultural center of "Fiji Experience", which includes a visitor center of Fijian history and culture, facilities for dance and cultural display and a wedding chapel. The cultural center would attract visitors.

As a result of examination of the above items, the soil disposal area is considered to be suitable for a high class hotel, residential area and park. Land development for the high class hotel and residential area would be profitable to the project (Nadi diversion and short cut channel), while the park is beneficial to the society.

(2) Land Development Scheme

Land development scheme in the soil disposal area (49 ha) is proposed as follows and the area of each land use proposed is shown in Table-19.3.

- Seaside park with tropical plants, a pond and facilities, such as picnic table, bench, children play lot, car parking and so on
- Resort hotel with 500 ~ 600 rooms, inclusive of swimming pool, sports facility, convention hall, shopping arcade and so on
- High-grade residential area (1,200 m^2 x 100 lots)

- Buffer green belt on boundary slope to protect bank and improve landscape from the surrounding area because the soil disposal area is elevated 6 m at maximum from the present grand
- Road construction on the western boundary
- Road within the residential area

Table-19.3 Land Development Plan Proposed for Soil Disposal Area

Land Use	Area
Park	12 ha
Hotel	20 ha
Residential Area	15 ha
Buffer Slope Green Belt	2 ha
Total	49 ha

There are two alternatives depending on the location of hotel as shown in Figure-19.8. One (Alternative A) is to locate the hotel on the beach with about 250 m width and 800 m length. The park is located along the diversion channel with about 50 ~ 100 m width and 1,300 m length. The residential area is in the south of the soil disposal site.

Another (Alternative B) is to locate the park on the beach with about 350 m width and 340 m length. The hotel is located between the park and residential area.

Image of land development scheme (Alternative A) with the diversion channel is shown in Figure-19.9.

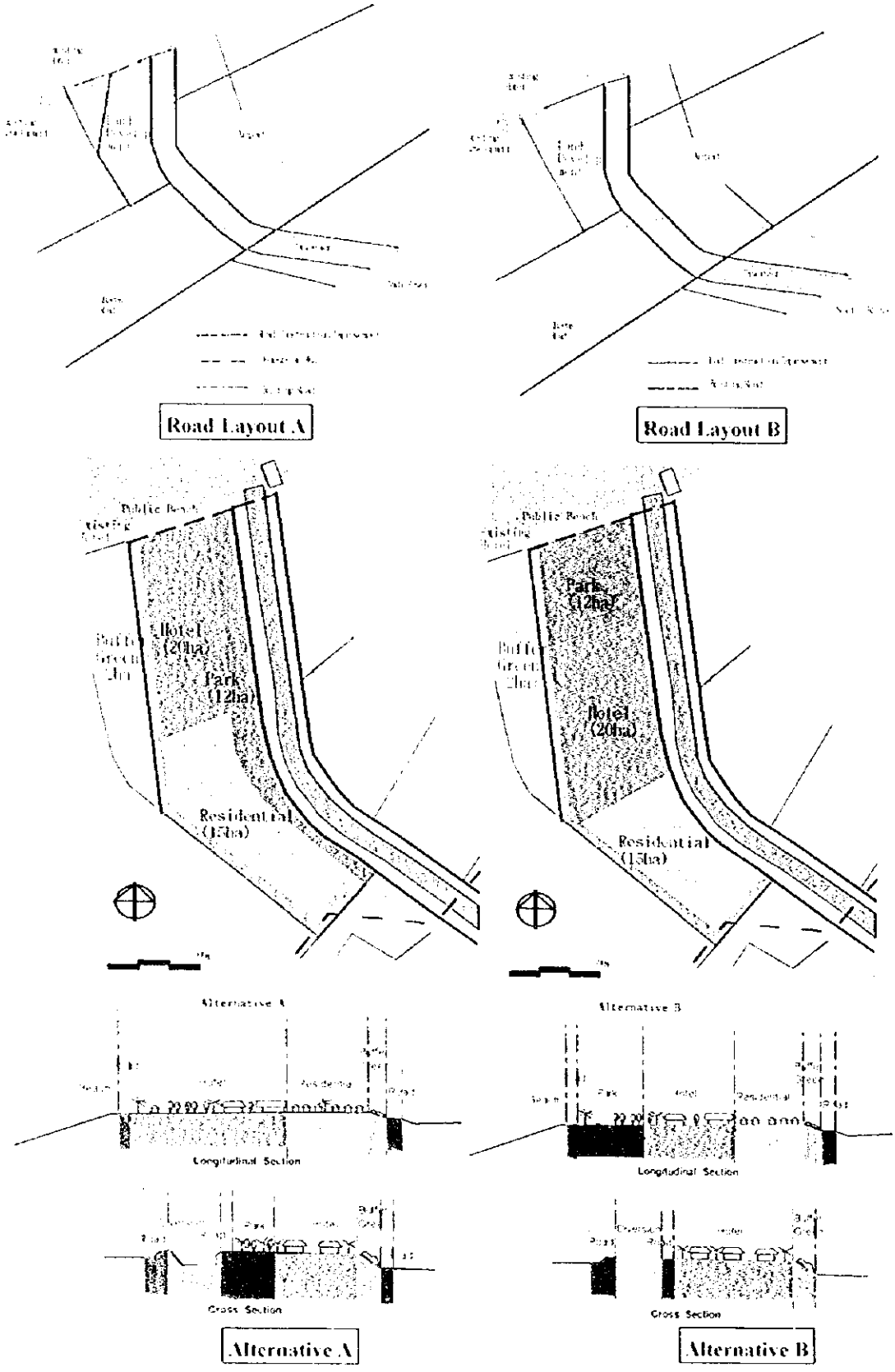


Figure-19.8 Schematic Plan of Land Development Alternatives

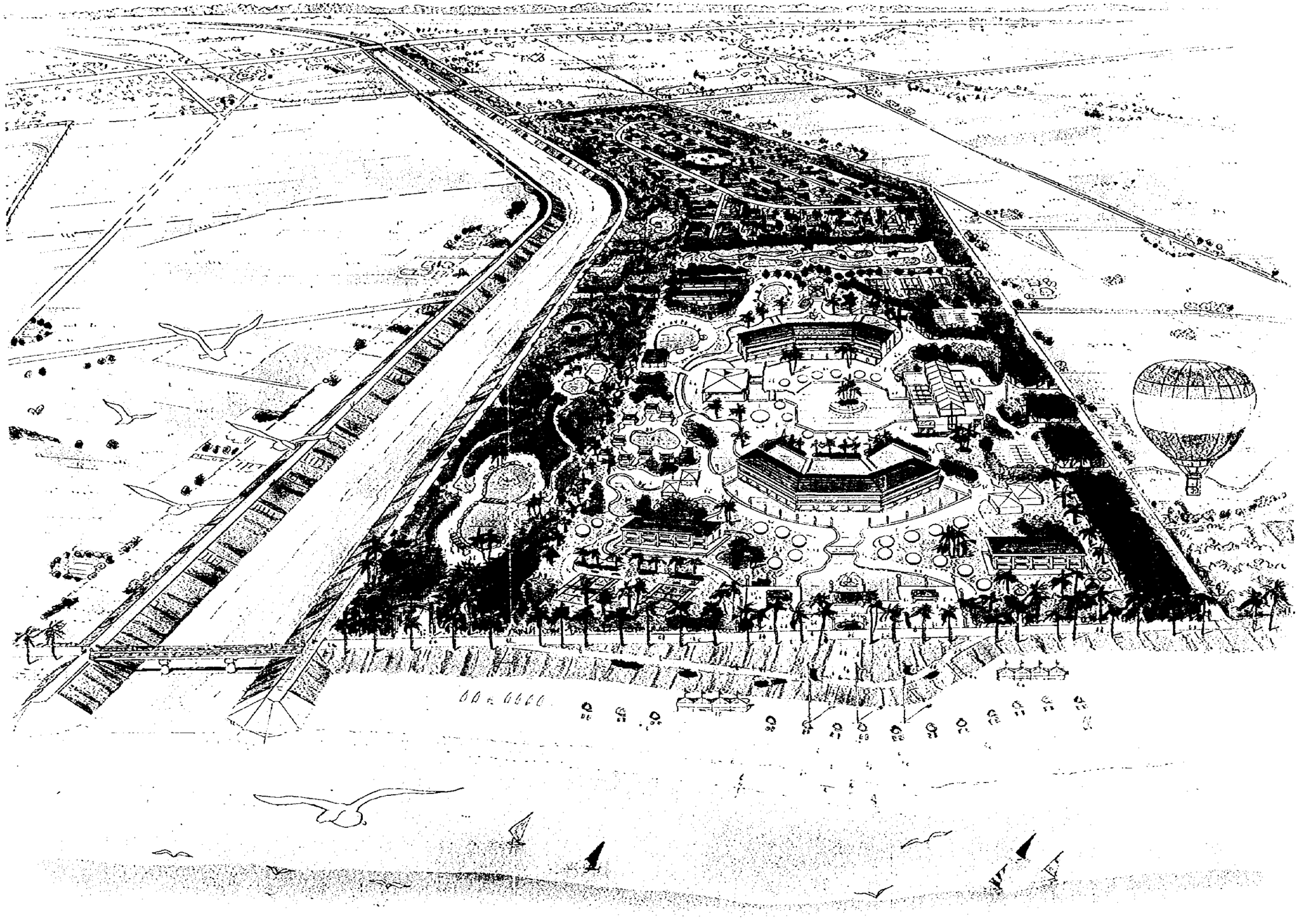


Figure-19.9 (1/3) Image of Land Development in Soil Disposal Area with Diversion Channel

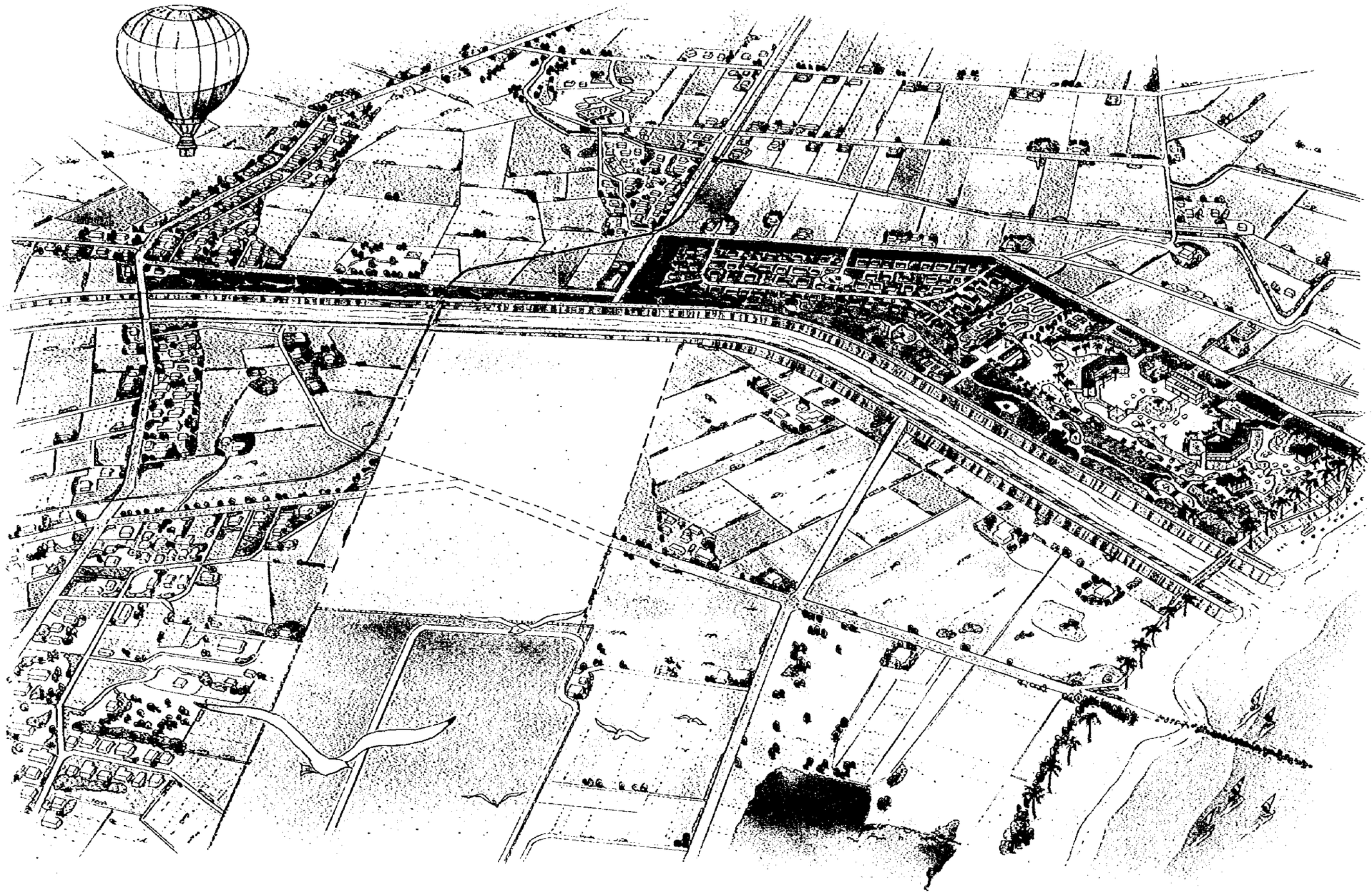


Figure-19.9 (2/3) Image of Land Development in Soil Disposal Area with Diversion Channel

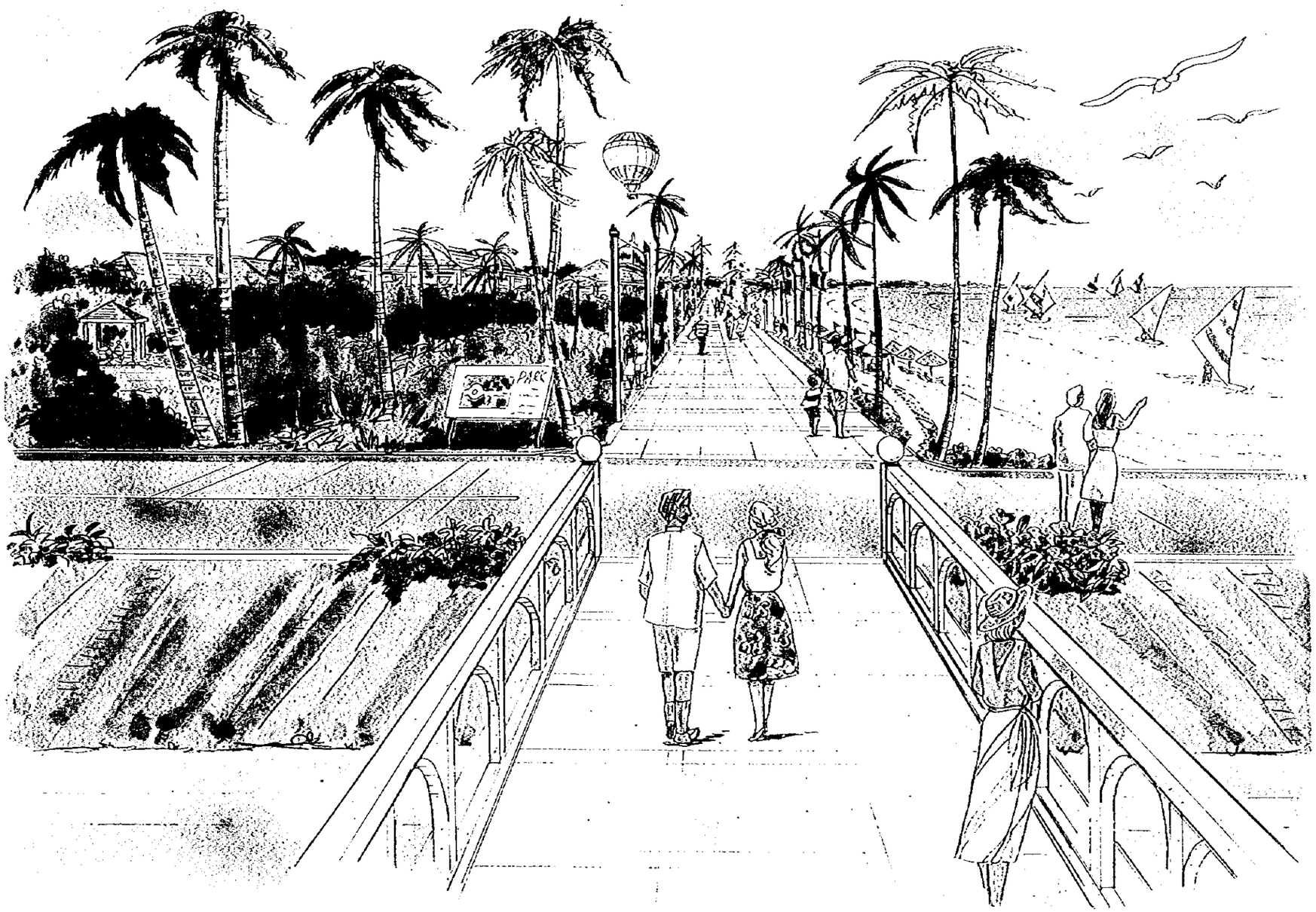


Figure-19.9 (3/3) Image of Land Development in Soil Disposal Area with Diversion Channel

19.3.2 Cost Estimate

Cost for land development consists of items shown in Table-19.4. Embankment of the soil disposal area, land acquisition are already included in the cost for the diversion channel, while construction of the hotel area is conducted by a private sector. Therefore, the cost of land development is mainly preparation of site with the public infrastructures, such as a park, roads, water supply, sewerage, electricity and telephone.

Construction cost and project cost is shown in Table-19.4 and Table-19.5, respectively. Since the construction is expected to be completed in one year, price contingency is not necessary.

Table-19.4 Construction Cost for Land Development

Description	Quantity	Unit	Amount (1,000 F$)	Remarks
Road construction within residential area	1,100	m	330	paved road within residential area
Road construction and improvement	1,500	m	530	along the west boundary
Extension of sewer and pump station	1	L.S.	450	1,200(hotel) + 120(residential) m^3/day
Extension of water supply	1	L.S.	350	1,200(hotel) + 120(residential) m^3/day
Extension of electricity	1	L.S.	1,300	3,000 kW (hotel) + 300 kW(residential)
Underground telephone line	1	L.S.	300	30 pairs (hotel) + 120 pairs (residential)
Park	12	ha	1,300	landscaping, facilities
Green belt landscaping	2	ha	20	vegetation
Infrastructure in residential area	1	L.S.	1,150	water supply, sewerage, electricity
Total			5,730	

Table-19.5 Project Cost of Land Development

(1,000 F$)

	Project cost	Local	Foreign
1. Construction cost	6,000	2,280	3,720
1.1 Material & Equipment	4,200	840	3,360
1.2 Labor	1,800	1,440	360
2. Administration	300	300	0
3. Engineering	900	180	720
4. Physical contingency	360	140	220
Sub-total	7,560	2,900	4,660
5. Price contingency	—	—	—
6. Tax	760	760	0
Total	8,320	3,660	4,660

19.3.3 Economic Evaluation of Land Development with Diversion Channel Project

Economic cost of the land development was estimated based on the financial project cost (Table-19.5). As a result, economic project cost is F$ 7.30 million as shown in Table-19.6.

Benefit of the land development is acquired by selling or leasing the hotel and residential areas to a private sector developer and individuals. The price for land was assumed to be F$ 70/m^2 for both hotel and residential areas, resulting in the total income of F$ 22.4 million (F$ 70 x 320,000 m^2). Based on the financial benefit, economic benefit was estimated and result is shown in Table-19.6.

Table-19.6 Economic Cost and Benefit of Land Development

Unit: F$ 1,000

Economic Cost	Economic benefit
7,300	18,950

Economic evaluation of the combined project of flood control (Nadi diversion channel and short cut channel) and land development was conducted to assess the economic feasibility of the whole project. For the diversion channel, the economic cost and benefit for 1/20 probability flood was adopted. The result is shown in Table-19.7.

Table-19.7 Economic Analysis for Combination of Flood Control & Land Development

Item of Analysis	Result of Analysis
Annual economic benefit of 3rd year (F$1,000/year)	27,228
Annual economic benefit after 4th year (F$1,000/year)	8,278
Economic project cost (F$1,000)	56,297
Annual economic OM cost (F$1,000/year)	36
EIRR (%)	17.24
B/C (ratio)	1.58
NPV (F$1,000)	30,176

Discount rate: 10 %

EIRR and B/C of the economic evaluation for the whole project are 17.24 % and 1.58 respectively, while those for the diversion and short cut channels (1/20 probability flood) are 14.45 % and 1.46. Some of the total financial project cost (approximately F$ 71.2 million) for the combined project could be financed by selling or long-term leasing the developed land (F$ 22.4 million). The remaining cost to be financed by the Government would be F$ 48.9 million. The result is favorable to the combined project.

Literature Cited

Department of Town and Country Planning (1996). "Nadi Town Planning Scheme, Report of Survey", p57 & drawings, Ministry of Local Government and Environment.

Ministry of Transport and Tourism (1997). "Fiji Tourism Development Plan, 1998-2005", p25-29 & p78.; p21-50, Appendices Volume II

CHAPTER 20 INSTITUTION AND TRAINING

20.1 Organization in Charge of Implementation of the Project

It is recommended that the Government of Fiji will hire a consulting engineering firm to assist the proposed organization to implement the detail design and construction supervision, and a contractor for the construction. The following entities should check, supervise and authorize the works by the contractor with the consultant. In order to promote technical transfer from the consultant and to save the engineering cost, the initiative should be held by the entities discussed below.

The discussion below does not contain the institution for the development of hotel and residential lots at the disposal site of the soil excavated for the construction of the diversion channel. The institution for the development at implementing stage should be examined separately from the institution for the diversion construction or operation/maintenance.

Since the Project will be related to many fields of the government administration, some advisory committee should be organized, whose members should represent various departments/divisions of the Government not only within the Ministry of Agriculture, Fisheries and Forests (MAFF) but also from those in other ministries.

Because of the large scale and importance of the Project, some project office should be established separately from the current section under the Director of the Land and Water Resource Management Division (LWRMD). The composition of the Project Office should change according to the phases of the Project implementation; detail design phase, construction phase and operation/maintenance phase.

The River Engineering Section and the Drainage and Irrigation Section in the LWRMD in the MAFF, as head quarter organizations, should back-up the establishment and operation of the Project Office. Some of the staff of the Sections could move to the Office in order to realize a smooth start of the Office, to minimize the increase in the number of staff of the Division or the Ministry in total, and to enhance the efficiency of performance. The Sections should give technical support to the Office.

The relation of the Project implementation entities to the current organizations are illustrated below:

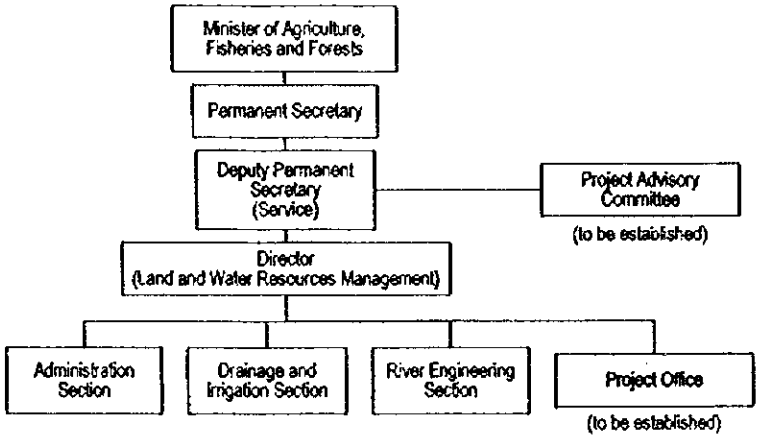


Figure-20.1 Proposed Set-up for Project Implementation

(1) Project Advisory Committee

The members of the Project Advisory Committee could be comprised of officers, preferably director level from departments/divisions of other ministries or statutory bodies related to the detail design and construction of the Project, such as Public Works Department, Department of Lands and Surveys, Native Land Trust Board or Civil Aviation Authority, for example. The members of the Committee should not only represent the interests of the respective organizations but also coordinate support from the organizations for the Project implementation.

(2) Organization of the Project Office at Detail Design Phase

A model of the project site office at detail design stage is shown below. The personnel could be moved from other sections of the LWRMD or divisions of the MAFF or from departments or divisions of other ministries. Strong support and close cooperation of the Department of Lands and Surveys and Public Works Department would be inevitable.

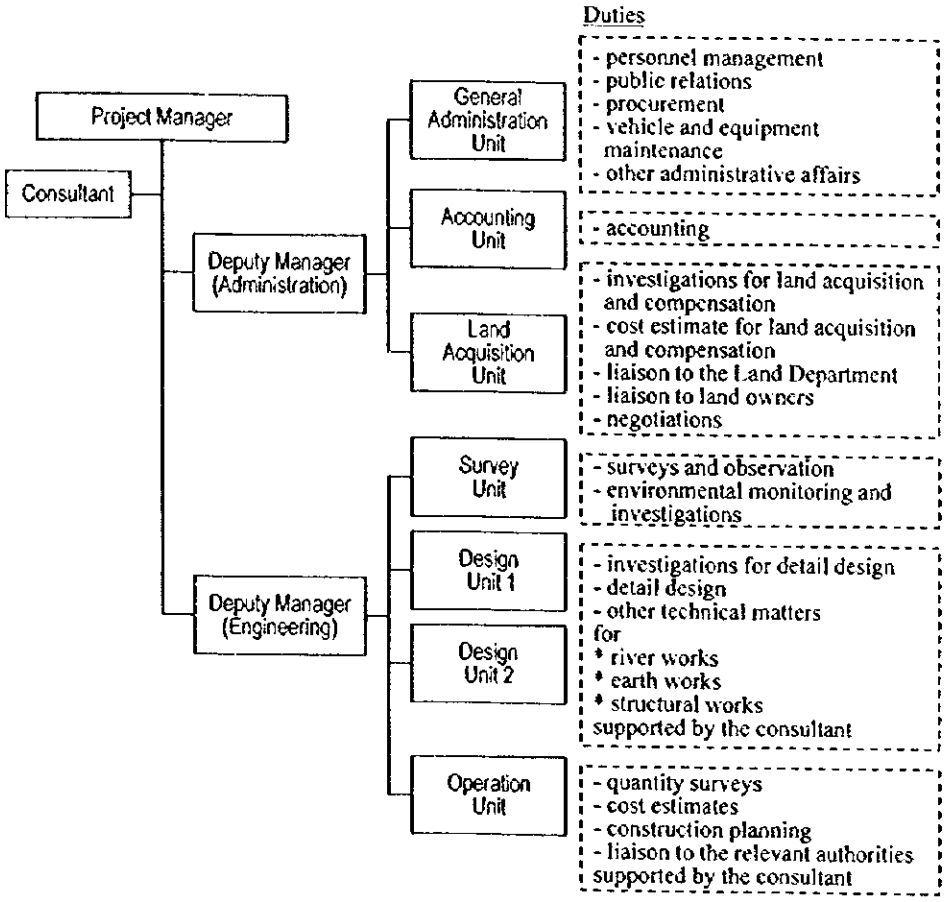


Figure-20.2 Proposed Project Office at Detail Design Stage

(3) Organization in Charge of the Construction Supervision

Proposed organization of the Project Office at construction stage is illustrated below. The Land Acquisition Unit, the Survey Unit and the Design Unit should remain in the construction phase although the size could be reduced.

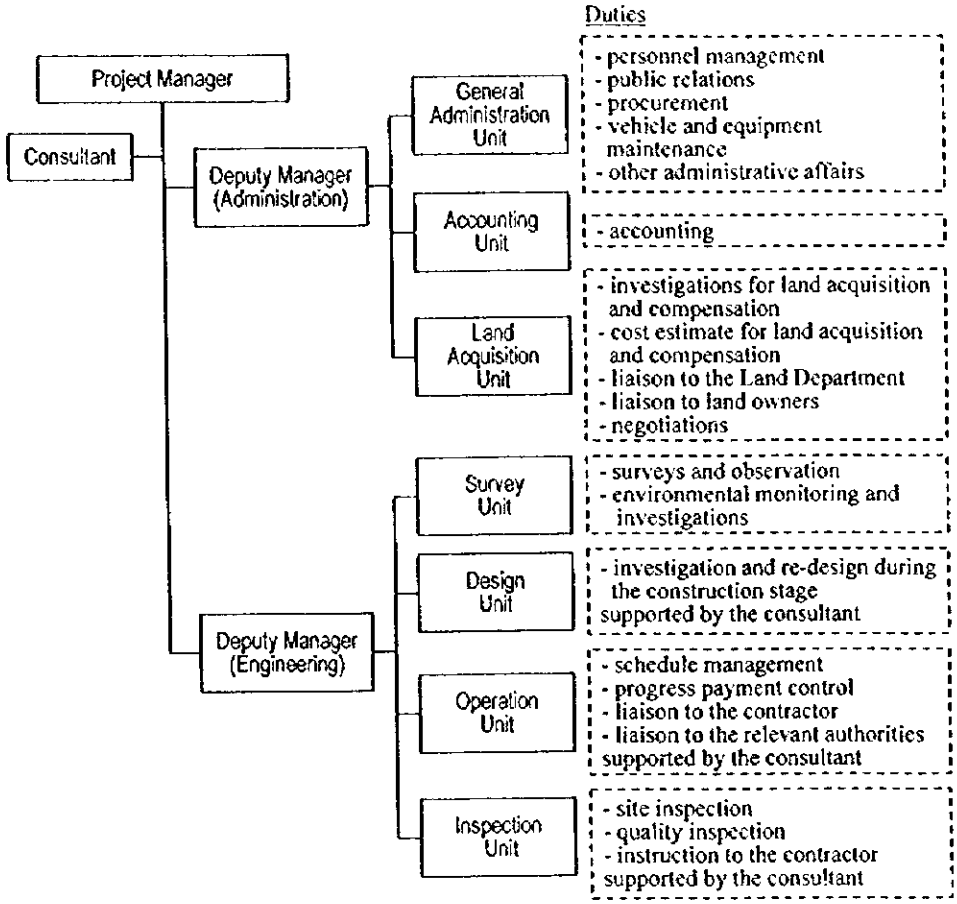


Figure-20.3 Proposed Project Office at Construction Stage

(4) Organization in Charge of Operation and Maintenance

The diversion channel and the shortcut channel can be handed over to the Drainage Board for maintenance after the completion of construction. The Board currently maintains drainage schemes with a total length of 271 km with the organization. In case any special operation and maintenance other than those for drainage channels is not necessary, the Board can maintain the channel and the shortcut with the current techniques. Additional assignment of one of the established staff in the Board specialized for the operation/ maintenance of the diversion channel and the shortcut could be enough.

In case some rate collection for cost recovery is not approved, the costs for operation/maintenance of the diversion channel and the shortcut should be paid from the Government budget to the Board. In case of rate collection, such as that from additional property tax in town area or additional lease fee in State Land and Native Land, an additional clerical officer might be necessary.

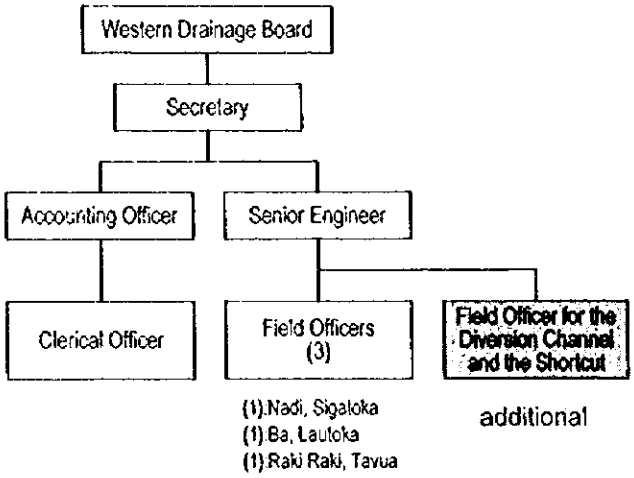


Figure-20.4 Organization of the Western Drainage Board

20.2 Required Training for Project Implementation

Since the Government of Fiji has no experience for construction of diversion channel in the scale of the Project, some training for the implementation of the Project is necessary.

Some training to prospective staff of the Project Office at all phases, and the staff of the River Engineering Section and the Drainage and Irrigation Section is required before the implementation of the Project. The training can start with site observation of similar projects by a candidate for the manager of the Office and managers of these Sections, followed by joint case studies by the engineers and technical staff of the Sections on the model projects selected by the managers. Assistance of foreign experts with experience of similar projects would be quite helpful.

CHAPTER 21 EVALUATION AND RECOMMENDATIONS

21.1 Evaluation of Priority Project

(1) Economic Evaluation

Construction of the priority project (Nadi diversion channel and short cut channel) with design flood of 20 year return period would require the project cost of F$ 62.9 million and cause the annual economic benefit of F$ 8.3 million. The economic internal rate of return (EIRR) of the project was estimated at 14.5 %, the benefit-cost ratio (B/C) is 1.46, and the net present value (NPV) is F$ 21.4 million. The economic feasibility is high, comparing with the opportunity cost of capital of 10 % in Fiji. The EIRR in an unfavorable condition, 10 % decrease in the economic benefit and 10 % increase in the costs is 11.9 %. The economic viability holds even in the condition.

Land development of 49 ha for a hotel and high-grade residential lots reclaimed with surplus soil of the diversion channel construction would accrue a total cost of F$ 71.3 million and cause sales of F$ 22.4 million, resulting in reduction of financial requirement to F$ 48.9 million. The EIRR, B/C, and NPV of the combined project was estimated at 17.2 %, 1.58 and F$ 30.2 million, respectively. The combination would enhance the economic viability of the project.

(2) Financial Examination

Because of the large scale of the project cost, a large portion of the costs should be funded with overseas loans. Financial feasibility were examined with two typical scenarios as follows, assuming 85 % of the cost is to be financed by overseas loans.

Scenario 1: 1.7 % of interest rate, 25 years of repayment including 7 years of the grace period

Scenario 2: 7.0 % of interest rate, 17 years of repayment including 5 years of the grace period

In Scenario 1, the total repayment, maximum and average annual repayment would be F$ 67.1 million, F$ 3.8 million and F$ 2.7 million, respectively. These figures in Scenario 2 would be F$ 90.9 million, F$ 7.8 million and F$ 5.3 million, respectively. The maximum annual repayment and average annual repayment in Scenario 1 correspond to 12 % and 8 % of the average overseas loan repayment (F$ 32.8 million) in the mid-term projection of the government overseas loan repayments (1996-2000) by the Ministry of Finance.

In parallel with the repayment of the overseas loan, 15 % of the project cost, F$ 9.4 million, should be allocated with the government budget. The average cost of F$ 4.7 million over construction period of 2 years accounts for 5 % of average capital expenditure (1991-1995) by the whole Government (F$ 98.0 million), and 11 % of average expenditure for infrastructure development by the Government (F$ 40.9 million). The allocation of this portion can be considered quite possible. If the land development at soil disposal site is combined, the profit of the land development would be F$ 14.1 million (F$ 22.4 million of sales of developed land minus F$ 8.3 million of cost of the land development.). The profit might be enough to cover the cost of F$ 9.4 million, which would not be financed by overseas loan.

(3) Environmental Impact Assessment

Construction of the diversion channel and the short cut channel will largely reduce areas and duration of inundation caused by floods and mitigate direct and indirect flood damage drastically, contributing to socio-economic development and improvement of social welfare in the area. The positive effects would be huge.

Adverse effects on social and natural environment by the project, coupled with the countermeasures against the effects, are discussed in Chapter 17. Recommended countermeasures would adequately cope with the effects. Among them, significant adverse effects would be as follows.

- Resettlement: Before the construction, 36 household would possibly be involved in resettlement. Sufficient negotiation with residents on conditions for the land acquisition and compensation is necessary.
- Topographical and scenic change: The appearance of the diversion channel with a width of 100 m would cause substantial changes in topographical conditions and the landscape. Land development in the disposal site of excavated soil for parks, a hotel and high-grade residences with sufficient landscape design would better be combined.
- Coastal areas: The results of sediment load analysis in the Study show that no particular impacts would be caused by sedimentation. There are no mangrove forests near the outlet and the nearest coral reef is as far as 3.5 km.
- Deterioration in water quality: Since the diversion channel is designed to let Nadi river drain daily discharge of 75 % of year, no sensible change in water quality would be resulted in the main stream. No flood gate at the outlet of the diversion channel is planned to avoid stagnant water and to keep the water quality in the channel by periodical flow of tide. Although salt water wedge cannot reach to the diverting point, infiltration of saline water to groundwater or soil would possibly occur. Careful design and construction have to be employed to mitigate the adverse effect. Regular monitoring of ground water quality should be conducted.

21.2 Recommendations

(1) Implementation of the Priority Project

Proposed project of Nadi diversion channel and short cut channel will bear a great deal of economic benefits and is financially feasible. The implementation would contribute socio-economic development and improvement in the welfare of the residents. The project should be implemented immediately.

(2) Forming Consensus in the Government and with the Residents

Formation of consensus in the Government of Fiji should be encouraged as early as possible through examining the results of the Study and establishing an organization for promotion of the implementation. In parallel, understanding and agreement of the residents and the nation should be obtained through sufficient explanation.

(3) Application for Overseas Loan

A large portion of the project cost has to be covered by overseas loans. It would take a long time to reach loan agreements. Preparation of application should be started promptly. Budget allocation for the rest of the cost should be prepared immediately.

(4) Starting Negotiation for Land Acquisition and Compensation

Land acquisition and compensation agreement takes a long time generally. Sufficient explanation and meetings would be required for equitable agreement with the residents. Meetings with the residents should be started as soon as possible.

(5) Hydraulic Model Experiment and Environmental Monitoring

Before the construction, hydraulic model experiment would be strongly recommended to reexamine the design of the diversion and short cut channels. Environmental monitoring should be started soon to evaluate impacts of project implementation.

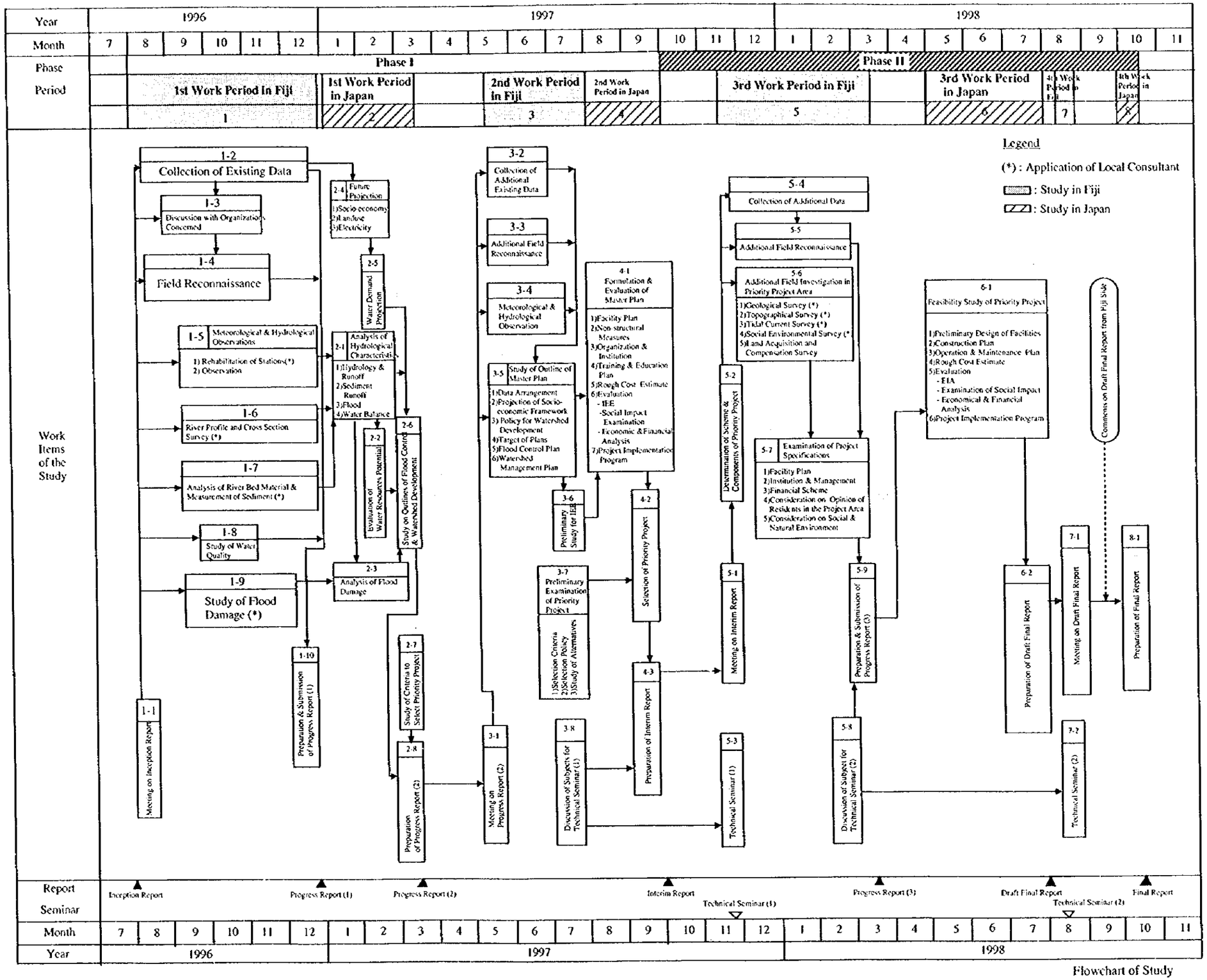
(6) Land Development of Soil Disposal Area

Proposed land development combined with the project would be of significant importance in terms of financing the project cost. Procedures, such as determination of implementing entity, organization set-up, marketing, planning and design, manner of sales or leasing, etc., for the implementation of the land development should be examined and determined early.

APPENDICES

APPENDIX 1

Flowchart of Study



Flowchart of Study

APPENDIX 2

Members and Assignment Schedule of the Study Team

Assignment Schedule

Assignment	Name	1996									1997												1998						
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Team Leader /Watershed Management	Yoshio Nakagawa																												
Flood Control	Norio Hanaoka																												
Water Resources Development	Ryuzou Higashijima																												
Meteorology, Hydrology & Flood Analysis	Kazuhiko Otani																												
Topography & Geology	Yosuke Sasaki																												
Forest & Soil	Masaharu Mizoguchi																												
Surveying	Toshiki Kuroiwa																												
Facility Design/ Construction & Cost Estimate	Kazuya Hirano																												
Landuse/ Regional Development	Naoyuki Minami																												
Institution	Naoki Hara																												
Socio-economy	Kiyoshi Tanioka																												
Environment	Wang Xiaochang																												
Coast	Satoru Nishino																												
Coordinator	Taikan Kuwabara/ David Merrett																												
Report				IC/R				PR(1)		PR(2)							IT/R					PR(3)					DF/R		F/R

Legend ■ Work in Fiji

□ Work in Japan

APPENDIX 3

List of Committee Members

LIST OF JICA ADVISORY COMMITTEE

NAME	POSITION	ASSIGNMENT PERIOD
1. Shin TSUBOKA	Chairman	July 1996 ~ May 1997
2. Toshiyuki AOYAMA	Chairman	May 1997 ~ October 1998
3. Kenzou HIROKI	Member	July 1996 ~ October 1998

LIST OF STEERING COMMITTEE

as of 18 August, 1998

	DESIGNATION	DEPARTMENT	NAME
1.	Deputy Permanent Secretary	MAFF	S. Ulitu
2.	Permanent Secretary	Ministry of Planning	R. Yarrow
3.	Deputy Permanent Secretary	Ministry of Regional Development and Multi-ethnic Affairs	P. Ravea
4.	Director	Department of Energy	D. Kumaran
5.	Director	Land and Water Resource Management Division, MAFFA	S. N. Swami
6.	Acting Director	National Trust of Fiji	E. Erasito
7.	Principal Town Planner	Department of Town and Country Planning	S. Dakaika
8.	Principal Environment Officer	Department of Environment	M. Sovaki
9.	Principal Engineer (RE)	Land and Water Resource Management Division, MAFF	K. Win
10.	Disaster Co-ordinator	Department of Regional Development	A. Tuifagalele
11.	Senior Hydrologist	PWD	R. Raj
12.	Senior Economic Planning Officer	Ministry of Planning	C. Yuen
13.	Disaster Mitigation Advisor	UNDHA	A. Kaloumaria
14.	Engineer (Road Design)	PWD	A. Ketenilagi
15.	Senior Agricultural Officer	MAFF	J. Feresi
16.	Engineer (Admin.)	MAFF	A. Lal

LIST OF TECHNICAL COMMITTEE

DESIGNATION	DEPARTMENT	NAME
1. Director (D&I)	Drainage and Irrigation MAFF & ALTA	Satya N. Swami
2. Director (Extension)	Extension Division MAFF & ALTA	Samisoni Ulitu
3. Director (W&S)	Water and Sewerage Section Public Works Department	Shandil
4. Director (NTF)	National Trust of Fiji	Birandra Singh
5. A/Principal Economic Planning Officer	Central Planning Office	Reena Ram
6. A/Principal Economic Planning Officer	Central Planning Office	Aisake Taito
7. Senior Research Officer	Land Use Section MAFF & ALTA	Inoke Ratukalou
8. Senior Hydrologist	Hydrology Section Public Works Department	Rishi Raj
9. A/Deputy Conservator of Forests	Department of Forestry MAFF & ALTA	Sairusi Bulai
10. Principal Scientific Officer (Applied Geology)	Mineral Resources Department	Prem Kumar
11. Principal Environmental Officer	Department of Environment	Sefanaia Nawadra
12. Disaster Coodinator	Ministry of Regional Development	S. Varea
13. A/Principal Engineer (RE) Administration	Drainage and Irrigation MAFF & ALTA	Anup Lal
14. A/Principal Engineer (RE) Technical	Drainage and Irrigation MAFF & ALTA	Khin Maung Cho
15. Senior Engineer (Design)	Drainage and Irrigation MAFF & ALTA	M. M. Myint
16. Senior Forestry Officer	Department of Forestry MAFF & ALTA	Etuate Basaga
17. Senior Town Planner	Department of Town and Country Planning	Maria Ubitau
18. Senior Technical Officer	Fiji Meteorological Service Suva Office	Marika Rokoduru
19. A/Senior Engineer (RE)	Drainage and Irrigation MAFF & ALTA	Shabnam Yee Yet
20. Dredge Superintendent	Drainage and Irrigation MAFF & ALTA	Colin Simmons