dam is estimated about 3 m which would be higher than F.W.L. at downstream.

The dam crest elevation necessary to handle the 100 year probable flood, 718 m^3/s, with the diversion tunnel is EL.161 m. The dam embankment till the beginning of the second rainy season after the completion of river diversion will be concentrated in the upstream portion of dam and be able to be managed to embank up to EL. 161 m before the beginning of the second rainy season so that the dam under construction will be safe even in the event of a 100 year probable flood.

(6) Intake

The intake for water supply is designed at the left bank to be connected to the diversion tunnel in short length as shown in Fig.3.3.5. The diversion tunnel will be utilized to release water to downstream for water supply after the completion of dam. The intake has 5 gates to select water from the adequate range of depth in accordance with the water quality condition.

(7) River outlet

The river outlet facility would provide for the emergency release of water. The facility consists of concrete inlet tower, steel pipe and hollow jet valve as shown in Fig.3.3.4.

3.3.2 Water Transmission Facilities

(1) General

Raw water will be released from the dam into the GRNW. Then the raw water for treatment would be abstracted at the Municipal Dyke located on the way of the GRNW and transmitted by gravity to the Pailles Treatment Plant through raw water transmission pipelines.

Currently, raw water is transmitted to the Pailles Treatment Plant by way of "the Municipal Pipelines" consisted of three pipelines with diameters of 27", 19" and 18" installed before 1925 (19" CIP and 18" CIP) and comparatively recently in 1960 (27" RCP).

As water requirements will inevitably increase the transmission facility will have to be supplemented with an additional pipeline.

To this end, it is proposed that:

1) The existing pipelines continue to be used in the future as long as possible, along with repair work against pipe leaks.

2) An additional pipeline be installed in parallel with the existing pipelines to supplement their capacity.

3) Rehabilitation of the existing Municipal Dyke, if required, will be made to stop the leakage.

(2) Present and Future carrying Capacity of Existing Pipelines

The determination of diameter of the additional pipeline requires estimates of present and future carrying capacity of the existing pipelines. These are calculated as follows:

<u>Present Carrying Capacity</u>:

The present carrying capacity is calculated at 622 l/sec. as follows:

Water level in the Municipal Dyke = +76.177 m ..... (a)
(at the spillway-weir)

Water level in the Pailles T. Plant = +70.700 m ..... (b)
(at the receiving tank, HWL)

Total Head: H = (a) - (b) = 5.477 m

Minor losses of head: h_o = 0.200 m

Friction loss of head: h_f = H - ho = 5.277 m

Distance of the pipeline: L = 2,100 m

Hydraulic gradient: $I = h_f/L = 5.277/2{,}100 = 2.51 \times 10^{-3}$

Under the above conditions, the potential carrying capacity of the existing Municipal Pipelines is estimated as shown in the following table.

Carrying Capacity of the Three Municipal Pipelines
(Year: 1988)

Pipeline	(A) 19" CIP	(B) 27" RCP	(C) 18" CIP
Inner diameter (ID)	0.469 m	0.684 m	0.444 m
Sectional area (a)	0.172 m^2	0.367 m^2	0.154 m^2
Hydraulic gradient (I)	2.51×10^{-3}	2.51×10^{-3}	2.51×10^{-3}
C Value (C)	C = 88.0	C = 92.7	C = 88.4
Flow (Q)	132 l/sec (v=0.767 m/s)	375 l/sec (v=1.02 m/s)	115 l/sec (v=0.747 m/s)
Total flow (Q_0)	Q_0 = 622 l/sec = 53,741 m^3/day		

Note: Hydraulic Formula: Hazen-William's
$Q = 0.27853 \times C \times D^{2.63} \times I^{0.54}$

Flow was actually measured on 30 Oct. and 1 Nov. 1988 with a portable ultra-sonic flowmeter which was attached to the outer surface of the pipe walls of the existing Municipal Pipelines, at the flowmeter box in the Pailles Treatment Plant. The flow data were analyzed in detail to obtain the present hydraulical conditions.

Future Carrying Capacity:

The future carrying capacity was calculated to decrease down to 581 l/sec in 2010 and 544 l/sec in 2030 respectively as follows:

"C" value (Coefficient of velocity in the above Hazen-William's formula) is to decrease year by year due to increase of tuberculous corrosion on inner surface of cast iron pipe walls.

Pipelines (A) and (C) had C=88.2 on average in the year 1988. When they commenced new service in the year 1925, they were supposed to have had C value of C=130.

The annual rate of decrease of C value was therefore:

K=(130-88.2)/(1988-1925)=(41.8)/(63 years)=0.663/year

On the assumption that the above rate continues, the C value of pipelines (A) and (C) in the future will become 73.6 in 2010 and 60.4 in 2030. On the other hand, the C value of the pipeline (B) will not change significantly because it is made of concrete.

Thus, the future carrying capacity will be as follows:

Carrying Capacity in the Future
(Existing Municipal Pipelines)

Pipeline		(A) 19" CIP	(B) 27" RCP	(C) 18" CIP
Year 2010	C Value Flow (Q)	C = 73.6 110 l/sec	C = 92.7 375 l/sec	C = 73.6 96 l/sec
	Total Flow	Q_0 = 581 l/sec = 50,198 m^3/day		
Year 2030	C Value Flow (Q)	C = 60.4 91 l/sec	C = 92.7 375 l/sec	C = 60.4 78 l/sec
	Total Flow	Q_2 = 544 l/sec = 47,002 m^3/day		

(3) Future Raw Water Requirement and Required Carrying Capacity of Additional Pipeline

The future production requirement (r) is estimated as follows (at the output of the Pailles Treatment Plant):

Year 2010: r_1 = 78,569 m^3/day = 0.909 m^3/sec

Year 2030: r_2 = 82,490 m^3/day = 0.955 m^3/sec

Raw water requirement (R) is calculated as:

$R = r \times (1 + m) \times p$

where, r: Output of the Pailles Treatment Plant
m: Water use for production operation in the Plant=5%
p: Design factor = 120%

Accordingly, raw water requirement (R) in the future is:

Year 2010: $R_1 = 0.909 \times 1.05 \times 1.2 = 1.145\ m^3/sec = 1,145\ l/sec$

Year 2030: $R_2 = 0.955 \times 1.05 \times 1.2 = 1.203\ m^3/sec = 1,203\ l/sec$

In order to relieve the deficit (A) of the carrying capacity of the existing Municipal Pipelines, an additional pipeline will have to be installed. Its flow capacity has to be as follows (assuming that the existing pipelines would still work in the future though carrying capacity would gradually decrease):

Year 2010: $A_1 = R_1 - Q_1 = 1,145 - 581 = 564\ l/sec$

Year 2030: $A_2 = R_2 - Q_2 = 1,203 - 544 = 659\ l/sec$

(4) Determination of Diameter of Additional Pipeline

Required pipe diameter is calculated as follows:

Year	2010			2030		
Carrying flow (additional)	564 l/sec			659 l/sec		
Hydraulic gradient (I)	2.51×10^{-3}			2.51×10^{-3}		
C Value	C=130	C=120	C=110	C=130	C=120	C=110
Pipe diameter required (D)	702 mm	723 mm	748 mm	745 mm	767 mm	793 mm
	750 mm			800 mm		

Note: $D = 1.6258 \times C^{-0.38} \times Q^{0.38} \times I^{-0.205}$

Thus, it is determined that an additional raw water transmission pipeline with diameter of 800 mm be installed in parallel with the existing Municipal Pipelines.

(5) Preliminary Design for Water Transmission Facilities

The proposed transmission pipeline of 800 mm diameter with 2,100 m long is preliminarily planned and designed as shown in Figs.3.3.8 to 3.3.14. The pipeline is to be installed in alignment in parallel with the existing 27" RCP transmission pipeline.

The major work of the installation of the pipeline is composed of the following items:

- Supply of pipes, fittings and valves
  (Ø800 mm Ductile Iron Pipes, L=2,100 m)
- Installation of the aboves
- Modification work of the existing intake chamber

In respect of river crossing work; there are two sites for the pipeline to cross the river of GRNW on the transmission pipeline route; two alternative plans were studied: the one was construction of a concrete bridge for pipe installation, and the other was an idea of installation of pipes under the river bed. As a result of a technical comparative study, the latter idea (under the river crossing) was found to be the most economical solution and giving no particular technical difficulty. Therefore, the plan of under-river crossing is proposed for both sites.

3.3.3 Water Treatment Plant

(1) General

The required water treatment capacity will increase as follows:

Year	Required Treatment Capacity (m^3/day)
1988	74,450
1990	72,300
1995	78,900
2000	85,500
2005	89,900
2010	94,300
2030	99,000

In order to save costs, it is intended that the existing treatment facilities having capacity of 60,000 m^3/day be fully utilized. Further, stepwise installation in accordance with the growth of required capacity is also proposed to lessen the initial investment cost.

The following installation schedule is contemplated:

Time of Installation	New Installation (m^3/day)	Existing Capacity (m^3/day)	Total Capacity (m^3/day)
- Phase 1: At the completion of project (at the end of 1994)	30,000	60,000	90,000
- Phase 2: In 2005	10,000	90,000	100,000

A preliminary design is made for the above new water treatment plant for the formulation of water supply plan and cost estimate.

The design concepts for the new water treatment facilities are presented hereunder.

(2) Design Flow Rate and Peak Factor

The design flow rates of the new treatment plant are as follows:

Item	Phase 1	Phase 2
a. Raw Water intake - at Municipal Dyke	31,500 m^3/d	42,000 m^3/d
b. Treatment Plant - at receiving well	31,500 m^3/d	42,000 m^3/d
c. Distribution - at the outlet of Pilles reservoir	30,000 m^3/d	40,000 m^3/d

Note: These figures show the daily maximum flow rate with treatment plant losses of 5% at Pilles Treatment Plant.

The peak factor, i.e., ratio of maximum to average water demand is determined at 1.2 on daily water demand basis as explained below.

Fluctuations of monthly water production and consumption are shown on Table 3.3.2. The ratio of monthly maximum to average daily demand is computed at around 1.1. In view of the present water supply condition and ratios adopted for similar cities' water supply projects, it is considered appropriate to employ 1.2 as a peak factor (daily maximum/daily average demand).

(3) Water Treatment Process

The quality of raw water to be treated is outlined below:

- The turbidity is rather low in the normal condition, making it possible to treat the water by the slow sand filtration. However, it becomes highly turbid in time of flood, which makes it impossible to treat by the slow sand filtration.

- The colour is less than 5 degrees and can be eliminated by the flocculation and sedimentation functions provided in the rapid sand filtration system.

- The chlorine ion content is 12 to 19 ppm which is not particularly high.

- The hardness of 40 to 60 ppm is also not particularly high value.

- pH is rather on the alkaline side. Its alkalinity of 30 to 50 ppm is within the range that can be treated rather easily by the flocculation and sedimentation.

Taking into account the characteristics of raw water quality, it is economical and advisable to employ conventional rapid sand filtration (pre-chlorination + flocculation & sedimentation + rapid sand filtration) as the treatment process.

The proposed location of the new treatment plant is at the existing Treatment Works at Pilles. The designed water treatment will consist of the following processes, that is, water receiving, chemical mixing, flocculation, sedimentation, filtration and disinfection. Major conditions to be taken in design are tabulated below.

Facilities	Design Conditions
1) Sedimentation Basin	
-Process required:	To be tolerant of quantity and quality variation.
2) Rapid Sand Filter	
-Filtration rate:	120 m/day (5.0 m^3/m^2/hour) at normal operation.

3) Standby Ratio

Considering the hourly variation of water demand, availability of spare parts and time necessary for repair, the followings are applied.

-Filter surface wash pump:	100% of standby ratio because of its small capacity
-Chemical pumps and other equipment:	50%-100% depending on its capacity and fluctuation.

As for method of gauging and controlling flow rates, the weirs/meters installed at the receiving well and at the effluent pipe of clear water reservoir will give sufficient information on volume of raw water and production.

The process of this treatment is shown on Fig.3.3.15. In future, if eutrophication may occur, water will be properly treated by two stage rapid mixing, namely, before sedimentation and before filtration. In Fig.3.3.15, functions of each process are also detailed at the bottom of the same figure.

As for chemicals to be used for water treatment, alum, lime and liquid chlorine which are currently used at the existing plants as coagulant, pH control agent and disinfectant respectively are considered appropriate. It is however anticipated that in the future the raw water quality may change and chemicals may be improved along with advances in technology, and so the above proposed chemicals should be changed as deemed necessary.

Dosage rates of the above chemicals at several occasions are shown in Table 3.3.3. Out of many kinds of chemical feeders, designed herein are simplified and unsophisticated one for easy operation.

(4) Preliminary Design of Water Treatment Facilities

The preliminary designs of the water treatment facilities are given in Figs. 3.3.16 to 3.3.18. The principal features of each facility are summarized in Table 3.3.4.

3.4 Construction Plan

3.4.1 Implementation Schedule

The dam is designed as rockfill type with center core, 75 m in height and 230 m in crest length. Embankment volume of the dam is 1.5 MCM. The Spillway is sidechannel type with crest length of 80 m. The diversion tunnel is aligned in the left abutment in 6.4 m diameter and 470 m length. The intake is constructed at left abutment and connected to the diversion tunnel for water supply.

Implementation schedule including tendering, contracting and construction was discussed with CWA. In order to solve the present and future water shortage problem, CWA intends to implement the Project as early as possible after the evaluation of the feasibility study report by JICA. The implementation schedule is prepared as shown in Table 3.4.1 and Fig. 3.4.1 in consideration of the discussion with CWA. The schedule is expected that the construction of the project is completed by December 1994.

It is recommended that the project will be executed under the following international competitive contracts and local contracts.

International competitive contracts

Lot 1. Construction of diversion tunnel

Lot 2. Construction of dam and appurtenant facilities (The diversion closure work shall be included in Lot 2.)

Lot 3. Supply and installation of water transmission pipeline and water treatment facilities

Local contracts

Lot 1. Preparatory works at site prepared by the Government

Lot 2. Construction of permanent access road and relocation works of the existing roads in the project area

3.4.2 Construction Plan

Construction time schedule is shown on Fig. 3.4.2. The layout of the construction facilities such as permanent roads, plants, quarters, offices, borrow area, quarry site, warehouse, repair shop and spoil banks is shown in Fig. 3.4.3.

(1) Preparatory Works

Following governmental works are recommended to be carried out for 17 months from October, 1990 to February, 1992.

- Construction of field office, quarters, field laboratory and clinic,
- Power and water supply facilities for construction,
- Telecommunication facility, and

- Permanent access roads in the project area

The preparatory works to be constructed by the contractors will be carried out for two months from March, 1991 to April,1991 for Lot 1 and for four months from Februartynt to May, 1992 for Lot 2. For Lot 3, the preparatory works can be done during three months from January to March 1994.

(2) Main Construction Works

The construction plan is prepared in consideration that the most of all works except the tunnel works are greatly affected by dry and rainy season.

Diversion tunnel

Diversion tunnel will be constructed for 13 months from May, 1991 to May, 1992. It will be closed by a gate in November, 1994 for execution of concrete plug work at the portion of dam axis and installation of pipes and valves, etc.

Coffer dam

Upper coffer dam will be built as a part of the main dam. Construction work including the initial coffering work is commenced from June, 1992 immediately after completion of the diversion tunnel and completed by October, 1992. Embankment material of about 116,000 m^3 is hauled from the borrow area at the upper right bank site and the quarry site near Mount Ory as shown in Fig. 3.4.3.

Main dam

Foundation excavation of about 258,000 m^3 would be commenced from June, 1992. Main dam embankment work is done during a period from September, 1992 to October 1994. Curtain and consolidation grouting works in the foundation area of the cut-off trench and along the dam axis are executed prior to the embankment thereon.

Out of the gross embankment volume of 1,369,000 m^3 except coffer dam, core material of about 238,000 m^3 will be supplied from the borrow area located near the right bank side, and the filter material of about 101,000 m^3 is quarried from the quarry site near Mount Ory. Of the random rock of 1,146,000 m^3 in total, weathered rock and fresh rock of about 332,100 m^3 from the excavation of main structures and tunnels are diverted, and the rest of 813,900 m^3 is sourced from the quarry site near Mount Ory. Distribution plan of excavated and embankment materials is as shown in Fig. 3.4.4.

Spillway

Excavation work is requested to be finished by January, 1994. Concrete work is done by June, 1994.

Pipeline and Water Treatment Facilities

The work for the water transmission and water treatment facilities will start so as to be completed at the same time with the completion of the project.

As for the water transmission pipeline, the necessary period for the manufacturing & shipping and its installation is estimated to be about 22 months. Thus, the manufacturing is scheduled to start in March, 1993. The installation work will start from March, 1994 and finish in December, 1994.

The manufacturing for the water treatment plant will start from July, 1993, and be completed in April, 1994 including its shipping, followed by the installation work of plant from May, 1994. The civil works for structures should start from August, 1993 so as to be finished together with the installation of plants. All the works including necessary test run will be completed in December, 1994.

3.4.3 Organization for Project Implementation

Fig. 3.4.5 presents overall construction organization chart. Ministry of Energy, Water Resources and Postal Services will have overall responsibility for the implementation of the Project. Design and construction of the Project will be executed by CWA.

For the execution of construction works, the field office of CWA tentatively named Port Louis Water Supply Project Office is required to be built. The construction works will be carried out by the contract basis with the international/local contractors under the supervision of the Project Office. A technical assistance by foreign and/or local consulting engineers will be provided for successful performance of the construction work.

3.4.4 O & M Plan

(1) Organization

Fig. 3.4.6 shows the existing organization of CWA. Under this organization, the operation and maintenance (O & M) for the existing water transmission pipelines, water treatment facilities and water distribution facilities, etc. is being executed satisfactorily in general, and therefore, the present organization is applicable for O & M on the existing facilities.

However, since the proposed future Pailles treatment work will include the new rapid sand filter system with the associated facilities, it is recommended that the present work force of the water treatment plant should be reinforced both on quantity and quality to cope with the new water treatment system of the rapid sand filtration process which applies chemicals for water treatment and backwashing process for the filter beds.

After the completion of proposed Project, an organization to execute O & M for the dam and appurtenant facilities will additionally be required. This additional function is recommended to be organized in the present Operational Services system.

The additional organization for O & M of the dam and appurtenant facilities should have two functions of (i) inspection and maintenance, and (ii) operation. The proposed additional organization is also shown in Fig. 3.4.6, supplementing to the existing organization.

(2) Functions Necessary for O & M of Dam and Appurtenant Facilities

(a) Inspection and Maintenance function

Facilities such as the dam, spillway, approach roads, intake gates, pipes, valves and measuring instruments should be inspected and maintained periodically. An inspection and maintenance manual instructing how to inspect and maintain should be prepared. The Inspection and Maintenance Section under Principal Engineer of Operational Services in CWA is recommended to execute the inspection and necessary maintenance of facilities in accordance with the manual. CWA should prepare necessary personnel in accordance with the manual.

(b) Operational Function

Fig. 3.4.7 shows the operational function to be required for the operation of dam and appurtenant facilities.

The function will consist of (i) the data and informations processing, (ii) analysis and control and (iii) gates and valves operation.

Data and Informations Processing

Data and information processing division will receive various data and informations such as the rainfall, discharge, reservoir water level, required water supply volume, informations from measuring instruments to measure the leakage, deformation and settlement, etc., and indicate necessary operation of gates and valves through analyses on the data and informations as well as record the data and informations.

Analysis and Control

Analysis and control function will also analyze the data and information, and issue warnings and countermeasures when required.

Gates and Valves Operation

this section will actually operate the gates and valves in accordance with the instructions given by the preceding two functions.

As such, the operation section of dam and appurtenant facilities should have the equipment such as the computer together with computer programs, data transmitting and communication system as well as necessary staffs. An operation manual to be prepared should cover all the operation methods in detail.

(3) Training on O & M Staff

An appropriate training for the operators will be required for obtaining the proper technology for the new water treatment plant operation.

The staffs in the inspection and maintenance, and operational sections for the dam and appurtenant facilities should also be well trained. Then, the following training program is proposed.

The O & M engineer will stay for training on the staffs for one year after the completion of the Project. The O & M engineer will actually operate the project with the staffs in accordance with the O & M manual, so that the staffs be well trained during the period.

3.5 Cost Estimate

Unit price for the feasibility study is estimated taking into consideration labour wage, construction equipment, material prices, construction plan and so on. Data on labour wage, construction equipment cost and material prices were collected from CWA and some private companies such as contractors and construction equipment companies. Unit price is estimated by foreign and local currency portion at the price level of December 1988. The average exchange rate from 1984 through the former half of 1988 is used for conversion and they are as follows:

Japanese Yen ¥1 = Rs 0.105
US $1 = Rs 13.7

Construction cost is estimated on the basis of the feasibility design and the proposed construction plan and schedule. The following basic conditions are applied for the cost estimate.

a) The civil works are conducted under the contracts with selected contractors through the international competitive bidding.

b) Most of the construction materials are to be supplied by the contractors mainly from local markets.

c) Construction machinery, equipment and plant including spare parts are to be brought by the contractor, the costs are estimated as the foreign currency portion.

d) Costs for freight, insurance and inland transportation are included in the costs of all materials, plants and equipment, which are to be imported, but import tax and duty are not included.

e) Engineering service is estimated at 10 % of the direct cost.

f) Government administration cost is estimated at 2.5 % of the direct cost as the local currency portion including land acquisition cost.

g) Physical contingency is estimated at 10 % of the direct cost plus engineering service and government administration cost.

h) Price contingency is estimated by applying the annual inflation rate of 3.2 % for foreign currency portion and 7.2 % for local currency portion based on the data of consumer price index.

i) Annual O&M costs for dam and appurtenant structures are 0.5 % of the direct cost. Annual O&M costs for water transmission and treatment facilities are taken at 1 % and 2 % of direct cost, respectively.

Dam and Appurtenant Facilities

The bill of quantity of the construction cost for dam and appurtenant facilities is presented in Table 3.5.1. Total construction cost without price contingency is estimated at US$ 59.8 million (equivalent to Rs 819 million). It comprises US$ 41.8 million (Rs 571.6 million) of foreign currency portion and US$ 18.0 million (Rs 247.4 million) of local currency portion.

Water Transmission Facilities and Treatment Plant

The construction cost without price contingency for the water transmission facilities and water treatment plant is estimated at US$ 9.9 millions (equivalent to Rs 135.4 millions) consisting of US$ 6.5 millions (Rs 88.8 millions) of foreign currency portion and US$ 3.4 millions (Rs 46.6 millions) of local currency portion.

The breakdown of construction cost for the water transmission facilities is given in Tables 3.5.2 to 3.5.5. Table 3.5.6 presents the breakdown for the construction cost of water treatment facilities.

Summary of Cost Estimate

The summary of the cost for dam construction, water transmission facilities and treatment plant works is as follows:

Unit: Rs 1,000

WORK ITEM		F.C.	L.C.	Total
A.	DAM CONSTRUCTION WORK			
1.	Preparatory Works	21,900	54,700	76,600
2.	Diversion	53,400	19,500	72,900
3.	Dam	283,400	71,300	354,700
4.	Spillway	108,200	50,700	158,900
5.	Intake	5,500	3,500	9,000
	Direct Cost	472,400	199,700	672,100
6.	Compensation	-	200	200
7.	Engineering Service & Government Administration	47,200	25,000	72,200
8.	Physical Contingency	52,000	22,500	74,500
	Sub-total	571,600	247,400	819,000
	(US$ 10^6)	($41,800)	($18,000)	($59,800)
B.	WATER TRANSMISSION FACILITIES AND TREATMENT PLANT WORKS			
1.	Pipe Materials	14,500	1,100	15,600
2.	Construction/installation of pipe and Rehabilitation of Existing Municipal Dike	10,700	12,900	23,600
3.	Treatment Plant	48,300	23,700	72,000
	Direct Cost	73,500	37,700	111,200
4.	Engineering Service & Government Administration	7,300	4,700	12,000
5.	Physical Contingency	8,000	4,200	12,200
	Sub-total	88,800	46,600	135,400
	(US$ 10^6)	($6,500)	($3,400)	($9,900)
	Total (A+B)	660,400	294,000	954,400
	Price Contingency	98,300	99,300	197,600
	Grand Total	758,700	393,300	1,152,000
	(US$ 10^6)	($55,400)	($28,700)	($84,100)
		66 %	34 %	100 %

The disbursement schedule of the construction cost in accordance with the implementation schedule is as shown in Table 3.5.7. The annual O&M cost for the dam and appurtenant facilities is estimated at Rs 3.4 million (0.5 % of direct cost). The annual O&M cost for the water transmission facilities and treatment plant is estimated at Rs 1.8 million (1 % of direct cost for transmission facilities and 2 % of direct cost for treatment facilities). Table 3.5.8 presents the cost of each project.

TABLES

Table 3.2.1 SUMMARY OF ALTERNATIVE DAM SCHEDULE

	Item	Unit	NW0 Dam	NW0 Dam	NW3 Dam	TR0 Dam	TR0 Dam	Bocage Weir	Guibies Dam	Baptiste Dam	TR9 Dam	CA2 Dam
	Catchment area	km2	114	114	88	55	55	23	4.7	19	13.5	17
RESERVOIR	Gross capacity	10^6 m3	7.2	7.2	6.8	6.7	6.7		6.5	6.9	2.8	1.6
	Effective capacity	10^6 m3	6.0	6.0	6.0	6.0	6.0		6.0	6.0	2.3	1.2
	Flood water level	El. m	114.2	114.2	170.0	196.2	196.2	322.2	107.0	381.5	388.0	378.0
	High water level	El. m	111.2	111.2	167.0	193.2	193.2	317.0	106.0	380.0	386.5	376.5
	Low water level	El. m	74.4	74.4	132.6	153.6	153.6		87.0	369.0	370.4	363.0
	Surface area	km2	0.2	0.2	0.3	0.3	0.3		0.5	1.4		
	Mean runoff	m3/s	3.4	3.4	2.3	1.8	1.8	1.0	-	0.8	0.4	0.6
	Design flood	m3/s	1,796	1,496	1,536	1,136	947	454	181	539	420	498
	Return period		(1.2x200yr)	(200yr)	(1.2x200yr)	(1.2x200yr)	(200yr)	(100yr)	(1.2x200yr)	(1.2x200yr)	(1.2x200yr)	(1.2x200yr)
DAM	Type		Rockfill	Gravity	Rockfill	Rockfill	Gravity	Gravity	Rockfill	Rockfill	Earthfill	Earthfill
	Crest elevation	El. m	117.2	116.2	173.0	199.2	198.2	323.0	109.0	383.5	390.0	380.0
	Height (from river bed)	m	68.4	67.4	62.0	79.2	78.2	7.0	38.9	23.0	25.0	26.0
	Crest length	m	180	142	272	253	238	44	640	1,762	1,530	1,023
	Embankment volume	10^3 m3	1,421	355	1,561	1,542	334	2	1,044	1,819	1,424	648
SPILLWAY	Type		Side channel and Gate	Gate	Side channel	Side channel	Overflow	Weir	Side channel	Side channel	Side channel	Side channel
	Crest elevation of weir	El. m	111.2	104.5	167.0	193.2	193.2	317.0	106.0	380.0	386.5	376.5
	Width of weir	m	70.0	64.0	170.0	100.0	100.0	18.0	100.0	160.0	120.0	140.0
	Discharge	m3/s	1,796	1,496	1,536	1,136	947	454	181	539	420	498
	No. of gates	nos	2	4								
	Width of gate	m	10	16								
	Height of gate	m	7	7								
Project Cost		US$1,000	67,327	75,695	72,571	58,433	71,012	8,870	79,500	60,313	51,213	28,533

Table 3.2.2 (1) COST ESTIMATE FOR ALTERNATIVE DAMSITE (1/2)
(GUIBIES : ROCKFILL, 6.0 MCM)

	Construction Cost for Guibies Dam Scheme					6 MCM
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		10,710
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(963)
	Open Cut	Common	m3	12	4	48
		Weathered Rock	m3	11	5	55
		Fresh Rock	m3	2.39	10	24
	Embankment	Earth	m3	0	6	0
		Mass Concrete	m3	0	95	0
		Reinfrocement Bar	t	0.03	800	24
	Tunnel	Excavation	m3	2.61	200	522
		Lining	m3	1	130	130
	Grout	Consolidation	m		140	0
	Backfill		m3		5	0
	Gate		t	0.04	4,000	160
3	DAM					(50,877)
	Excavation	Common	m3	1860	4	7,440
		Weathered Rock	m3	1.00	5	5
		Fresh Rock	m3	0.10	10	1
	Embankment	Core	m3	241	10	2,410
		Filter	m3	90	18	1,620
		Rockfill	m3	891	15	13,365
	Cut-off Concrete		m2	48.4	450	21,780
	Grout	Curtain	m	20	180	3,571
		Brangket	m	5	140	685
4	SPILLWAY					(1,690)
	Excavation	Earth	m3	29.7	4	119
		Weathered Rock	m3	65.3	5	327
		Hard Rock	m3	61.5	10	615
	Backfill		m3		5	0
	Concrere	Mass	m3	1.60	95	152
		Structural	m3	3.10	130	403
	Reinfrocement Bar		t	0.09	800	74
	Grout	Curtain	m		180	0
	Gate		t	0	4,000	0
	Direct Cost					**64,240**
5	Compensation	(Land)	km2	0	2,000,000	0
6	Engineering &	10% *	(1~4)			8,030
	Administration	2.5% *	(1~5)			
7	Physical Contingency					7,230
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**79,500**

Table 3.2.2 (2) COST ESTIMATE FOR ALTERNATIVE DAMSITE (2/2)
(BOCAGE : CONCRETE WEIR, 6.0 MCM)

		Construction Cost for Bocage Weir Scheme				
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2.+3.+4.)		770
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(80)
	Open Cut	Common	m3	0	4	0
		Weathered Rock	m3	0	5	0
		Fresh Rock	m3	0	10	0
	Embankment	Common	m3	0	6	0
		Mass Concrete	m3	0	95	0
		Reinfrocement Bar	t	0	800	0
	Tunnel	Excavation	m3	0	200	0
	Culvert		m3	0	130	0
	Sand Flush Gate		t	0.02	4,000	80
3	Weir					(356)
	Excavation	Common	m3	9	4	36
		Weathered Rock	m3	3	5	15
		Fresh Rock	m3	0	10	0
	Concrete	Mass	m3	1	95	95
		Wall	m3	1	130	130
		0	m3	0	0	0
	Grout	Curtain	m	0.31	180	55
		Consolidation	m	0.18	140	25
4	DIVERSION TUNNEL					(3,404)
	Tunnel	Excavation	m3	12	200	2,400
		Lining	m3	6	130	780
	Backfill		m3	0	5	0
	Concrere	Mass	m3	0	95	0
		Wall	m3		130	0
	Reinfrocement Bar		t	0.18	800	144
	Grout	Curtain	m		180	0
	Gate		t	0.02	4,000	80
	Direct Cost					**4,610**
5	Compensation	(Land)	km2	0.0014	2,000,000	2,800
6	Engineering &	10% *	(1~4)			650
	Administration	2.5% *	(1~5)			
7	Physical Contingency					810
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**8,870**

Table 3.2.3 COST ESTIMATE FOR ALTERNATIVE DAMSITE (BAPTISTE : EARTHFILL, 6.0 MCM)

		Construction Cost for Baptiste Dam Scheme				
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20% of (2.+3.+4.)			7,700
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(1,762)
	Open Cut	Common	m3	33	4	132
		Weathered Rock	m3	17	5	85
		Fresh Rock	m3	0	10	0
	Embankment	Common	m3	9	6	54
		Mass Concrete	m3	9	95	855
		Reinfrocement Bar	t	0.27	800	216
	Tunnel	Excavation	m3	0	200	0
	Culvert		m3	2	130	260
	0	0	m		0	0
	0		m3		0	0
	Gate		t	0.04	4,000	160
3	DAM					(26,750)
	Excavation	Common	m3	893	4	3,572
		Weathered Rock	m3	151	5	755
		Fresh Rock	m3		10	0
	Embankment	Common	m3	1819	10	18,190
		0	m3	0	0	0
		0	m3	0	0	0
	Grout	Curtain	m	17	180	3,011
		Consolidation	m	9	140	1,222
4	SPILLWAY					(9,981)
	Excavation	Common	m3	261	4	1,044
		Weathered Rock	m3	345	5	1,725
		Fresh Rock	m3	120	10	1,200
	Backfill		m3	15	5	75
	Concrere	Mass	m3	9	95	855
		Wall	m3	33	130	4,290
	Reinfrocement Bar		t	0.99	800	792
	Grout	Curtain	m		180	0
	Gate		t	0	4,000	0
	Direct Cost					**46,193**
5	Compensation	(Land)	km2	0.0014	2,000,000	2,800
6	Engineering &	10% *	(1~4)			5,840
	Administration	2.5% *	(1~5)			
7	Physical Contingency					5,480
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**60,313**

Table 3.2.4 COST ESTIMATE FOR ALTERNATIVE DAMSITE (TR0 : ROCKFILL, 6.0 MCM)

		Construction Cost for TR0 Dam Scheme				6 MCM
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		7,870
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(8,103)
	Open Cut	Common	m3	6	4	24
		Weathered Rock	m3	8	5	40
		Fresh Rock	m3	2.29	10	23
	Embankment	Earth	m3	0	6	0
		Mass Concrete	m3	0	95	0
		Reinfrocement Bar	t	0.33	800	264
	Tunnel	Excavation	m3	30.71	200	6,142
		Lining	m3	11	130	1,430
	Grout	Consolidation	m		140	0
	Backfill		m3		5	0
	Gate		t	0.045	4,000	180
3	DAM					(22,728)
	Excavation	Common	m3	84	4	336
		Weathered Rock	m3	30	5	150
		Fresh Rock	m3	13	10	130
	Embankment	Core	m3	233	10	2,330
		Filter	m3	89	18	1,602
		Rockfill	m3	1063	15	15,945
	Grout	Curtain	m	11	180	1,999
		Brangket	m	2	140	236
4	SPILLWAY					(8,523)
	Excavation	Common	m3	65	4	260
		Weathered Rock	m3	101	5	505
		Fresh Rock	m3	371	10	3,710
	Backfill		m3	0	5	0
	Concrere	Mass	m3	9.7	95	922
		Structural	m3	20	130	2,639
	Reinfrocement Bar		t	0.61	800	487
	Grout	Curtain	m		180	0
	Gate		t	0	4,000	0
	Direct Cost					**47,223**
5	Compensation		km2			
6	Engineering &	10% *	(1~4)			5,900
	Administration	2.5% *	(1~5)			
7	Physical Contingency					5,310
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**58,433**

Table 3.2.5 COST ESTIMATE FOR ALTERNATIVE DAMSITE
(TRO : CONCRETE GRAVITY, 6.0 MCM)

		Construction Cost for TR0 Dam Scheme				El.198.2
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		9,560
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(8,103)
	Open Cut	Common	m3	6	4	24
		Weathered Rock	m3	8	5	40
		Fresh Rock	m3	2.29	10	23
	Embankment	Earth	m3	0	6	0
		Mass Concrete	m3	0	95	0
		Reinfrocement Bar	t	0.33	800	264
	Tunnel	Excavation	m3	30.71	200	6,142
		Lining	m3	11	130	1,430
	Grout	Consolidation	m		140	0
	Backfill		m3		5	0
	Gate		t	0.045	4,000	180
3	DAM					(35,192)
	Excavation	Common	m3	25.7	4	103
		Weathered Rock	m3	41	5	205
		Fresh Rock	m3	99	10	990
	Embankment					
		Mass Concrete	m3	266	95	25,270
		Mat Concrete	m3	67.5	95	6,409
	Grout	Curtain	m	11	180	1,978
		Consolidation	m	2	140	236
4	SPILLWAY					(4,528)
	Concrere					
		Structural	m3	29	130	3,822
	Reinfrocement Bar		t	0.88	800	706
	Grout	Curtain	m		180	0
	Gate		t	0	4,000	0
	Direct Cost					**57,382**
5	Compensation		km2			
6	Engineering &	10% *	(1~4)			7,170
	Administration	2.5% *	(1~5)			
7	Physical Contingency					6,460
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**71,012**

Table 3.2.6 COST ESTIMATE FOR ALTERNATIVE DAMSITE (NW0 : ROCKFILL, 6.0 MCM)

		Construction Cost for NW0 Dam Scheme				6 MCM
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		9,070
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(9,812)
	Open Cut	Common	m3	1	4	4
		Weathered Rock	m3	1	5	5
		Fresh Rock	m3	1.65	10	17
	Embankment	Earth	m3	0	6	0
		Mass Concrete	m3	0	95	0
		Reinfrocement Bar	t	0.42	800	336
	Tunnel	Excavation	m3	37.35	200	7,470
		Lining	m3	14	130	1,820
	Grout	Consolidation	m		140	0
	Backfill		m3		5	0
	Gate		t	0.04	4,000	160
3	DAM					(23,412)
	Excavation	Common	m3	147	4	588
		Weathered Rock	m3	91	5	455
		Fresh Rock	m3	231	10	2,310
	Embankment	Core	m3	250	10	2,500
		Filter	m3	95	18	1,710
		Rockfill	m3	982	15	14,730
	Grout	Curtain	m	5.5	180	985
		Brangket	m	1	140	134
4	SPILLWAY					(12,113)
	Excavation	Common	m3	29	4	116
		Weathered Rock	m3	111	5	555
		Fresh Rock	m3	358	10	3,580
	Backfill		m3		5	0
	Concrere	Mass	m3	16	95	1,520
		Structural	m3	39	130	5,070
	Reinfrocement Bar		t	1.17	800	936
	Grout	Curtain	m		180	0
	Gate		t	0.084	4,000	336
	Direct Cost					**54,407**
5	Compensation					
6	Engineering &	10% * (1~4)				6,800
	Administration	2.5% * (1~5)				
7	Physical Contingency					6,120
		10% * (1~7)				
8	Price Contingency					
9	**Grand Total**					**67,327**

Table 3.2.7 COST ESTIMATE FOR ALTERNATIVE DAMSITE (NWO : CONCRETE GRAVITY, 6.0 MCM)

	Construction Cost for NW0 Gravity Dam Scheme					6 MCM
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		10,190
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(9,812)
	Open Cut	Common	m3	1	4	4
		Weathered Rock	m3	1	5	5
		Fresh Rock	m3	1.65	10	17
		Reinfrocement Bar	t	0.42	800	336
	Tunnel	Excavation	m3	37.35	200	7,470
		Lining	m3	14	130	1,820
	Gate		t	0.04	4,000	160
3	DAM					(37,638)
	Excavation	Common	m3	62	4	248
		Weathered Rock	m3	66	5	330
		Fresh Rock	m3	223	10	2,230
	Embankment					
		Mass Concrete	m3	307	95	29,165
		Mat Concrete	m3	48	95	4,560
	Grout	Curtain	m	5	180	971
		Consolidation	m	1	140	134
4	SPILLWAY					(3,525)
	Concrere					
		Structural	m3	19.4	130	2,522
	Reinfrocement Bar		t	0.58	800	466
	Gate		t	0.13	4,000	538
	Direct Cost					**61,165**
5	Compensation		km2			
6	Engineering &	10% *	(1~4)			7,650
	Administration	2.5% *	(1~5)			
7	Physical Contingency					6,880
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**75,695**

Table 3.2.8 COST ESTIMATE FOR ALTERNATIVE DAMSITE (TR9 : EARTHFILL, 2.3 MCM)

		Construction Cost for TR9 Dam Scheme				
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20%	of (2+3+4)		6,900
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(2,372)
	Open Cut	Common	m3	77	4	308
		Weathered Rock	m3	41	5	205
		Fresh Rock	m3	0	10	0
	Embankment	Common	m3	0	6	0
		Mass Concrete	m3	11	95	1,045
		Reinfrocement Bar	t	0.33	800	264
	Tunnel	Excavation	m3	0	200	0
	Culvert		m3	3	130	390
	0	0	m		0	0
	0		m3		0	0
	Gate		t	0.04	4,000	160
3	DAM					(20,906)
	Excavation	Common	m3	578	4	2,312
		Weathered Rock	m3	121	5	605
		Fresh Rock	m3		10	0
	Embankment	Common	m3	1424	10	14,240
		0	m3	0	0	0
		0	m3	0	0	0
	Grout	Curtain	m	15	180	2,730
		Consolidation	m	7	140	1,019
4	SPILLWAY					(11,205)
	Excavation	Common	m3	542	4	2,169
		Weathered Rock	m3	625	5	3,125
		Fresh Rock	m3	0	10	0
	Backfill		m3		5	0
	Concrere	Mass	m3	9	95	829
		Wall	m3	33	130	4,290
	Reinfrocement Bar		t	0.99	800	792
	Grout	Curtain	m		180	0
	Gate		t	0	4,000	0
	Direct Cost					**41,383**
5	Compensation					
6	Engineering &	10% *	(1~4)			5,170
	Administration	2.5% *	(1~5)			
7	Physical Contingency					4,660
		10% *	(1~7)			
8	Price Contingency					
	Grand Total					**51,213**

Table 3.2.9 COST ESTIMATE FOR ALTERNATIVE DAMSITE (TR9 : EARTHFILL, 4.0 MCM)

		Unit	Quantity (x1,000)	Unit Price	Amount ($1,000)
1 PREPARATORY WORKS		20% of (2+3+4)			7,180
.Access & Service Road					
Yards					
Buildings					
2 DIVERSION					(2,372)
Open Cut	Common	m3	77	4	308
	Weathered Rock	m3	41	5	205
	Fresh Rock	m3	0	10	0
Embankment	Common	m3	0	6	0
	Mass Concrete	m3	11	95	1,045
	Reinfrocement Bar	t	0.33	800	264
Tunnel	Excavation	m3	0	200	0
Culvert		m3	3	130	390
Gate		t	0.04	4,000	160
3 DAM					(21,042)
Excavation	Common	m3	360	4	1,440
	Weathered Rock	m3		5	0
	Fresh Rock	m3		10	0
Embankment	Common	m3	1559	10	15,590
Grout	Curtain	m	17	180	3,060
	Consolidation	m	7	140	952
4 SPILLWAY					(12,480)
Excavation	Common	m3	332	4	1,328
	Weathered Rock	m3	0	5	0
	Fresh Rock	m3	0	10	0
Backfill		m3		5	0
Concrere	Mass	m3	72	95	6,840
	Stractural	m3	28	130	3,640
Reinfrocement Bar		t	0.84	800	672
Grout	Curtain	m		180	0
Gate		t	0	4,000	0
Direct Cost					43,074
5 Compensation		ha		20,000	0
6 Engineering & Administration	10% * (1~4) 2.5% * (1~5)				5,380
7 Physical Contingency		10% * (1~6)			4,850
8 Price Contingency					
Grand Total					53,304

Table 3.2.10 COST ESTIMATE FOR ALTERNATIVE DAMSITE (CA2 : EARTHFILL, 1.2 MCM)

		Construction Cost for CA2 Dam Scheme				
				Quantity		Amount
			Unit	(x1,000)	Unit Price	($1,000)
1	PREPARATORY WORKS		20% of (2+3+4)			3,840
	Access & Service Road					
	Yards					
	Buildings					
2	DIVERSION					(3,199)
	Open Cut	Common	m3	55	4	220
		Weathered Rock	m3	51	5	255
		Fresh Rock	m3	12	10	120
	Embankment	Common	m3	0	6	0
		Mass Concrete	m3	16	95	1,520
		Reinfrocement Bar	t	0.48	800	384
	Tunnel	Excavation	m3	0	200	0
	Culvert		m3	4	130	520
	Gate		t	0.045	4,000	180
3	DAM					(10,914)
	Excavation	Common	m3	326	4	1,304
		Weathered Rock	m3	101	5	505
		Fresh Rock	m3		10	0
	Embankment	Common	m3	648	10	6,480
	Grout	Curtain	m	11	180	1,931
		Consolidation	m	5	140	693
4	SPILLWAY					(5,110)
	Excavation	Common	m3	146	4	584
		Weathered Rock	m3	131	5	655
		Fresh Rock	m3	48	10	480
	Backfill		m3	0	5	0
	Concrere	Mass	m3	13	95	1,235
		Wall	m3	14	130	1,820
	Reinfrocement Bar		t	0.42	800	336
	Grout	Curtain	m		180	0
	Gate		t		4,000	0
	Direct Cost					**23,063**
5	Compensation		km2			
6	Engineering &	10% *	(1~4)			2,880
	Administration	2.5% *	(1~5)			
7	Physical Contingency					2,590
		10% *	(1~7)			
8	Price Contingency					
9	**Grand Total**					**28,533**

Table 3.2.11 CASH FLOW AND PRESENT WORTH OF PROJECT COST FOR ALTERNATIVE SCHEMES

Dam Cost		64,681	58,433	8,870 79,500	60,313	51,213 28,533 45,000	53,304 40,000
Pipeline Cost		2,676	3,932	3,551	3,932	3,932	3,932
Alternatives	Year	NWO	TRO	Bocage-Guibies	Baptiste	TR9+CA2 +TRO	TR9(B)+ Baptiste
1	1990	12,936	11,687	17,674	12,063	17,376	20,661
2	1991	19,404	17,530	26,511	18,094	29,630	35,991
3	1992	19,404	17,530	26,511	18,094	22,497	25,991
4	1993	15,612	15,618	21,225	15,994	14,317	14,792
5	1994	337	312	460	321	11,668	486
6	1995	337	312	460	321	22,918	486
7	1996	337	312	460	321	11,668	486
8	1997	337	312	460	321	643	486
9	1998	337	312	460	321	643	486
10	1999	337	312	460	321	643	486
11	2000	337	312	460	321	643	486
12	2001	337	312	460	321	643	486
13	2002	337	312	460	321	643	486
14	2003	337	312	460	321	643	486
15	2004	337	312	460	321	643	486
16	2005	337	312	460	321	643	486
17	2006	337	312	460	321	643	486
18	2007	337	312	460	321	643	486
19	2008	337	312	460	321	643	486
20	2009	337	312	460	321	643	486
21	2010	337	312	460	321	643	486
22	2011	337	312	460	321	643	486
23	2012	337	312	460	321	643	486
24	2013	337	312	460	321	643	486
25	2014	337	312	460	321	643	486
26	2015	337	312	460	321	643	486
27	2016	337	312	460	321	643	486
28	2017	337	312	460	321	643	486
29	2018	337	312	460	321	643	486
30	2019	337	312	460	321	643	486
31	2020	337	312	460	321	643	486
32	2021	337	312	460	321	643	486
33	2022	337	312	460	321	643	486
34	2023	337	312	460	321	643	486
35	2024	337	312	460	321	643	486
36	2025	337	312	460	321	643	486
37	2026	337	312	460	321	643	486
38	2027	337	312	460	321	643	486
39	2028	337	312	460	321	643	486
40	2029	337	312	460	321	643	486
41	2030	337	312	460	321	643	486
42	2031	337	312	460	321	643	486
43	2032	337	312	460	321	643	486
44	2033	337	312	460	321	643	486
45	2034	337	312	460	321	643	486
46	2035	337	312	460	321	643	486
47	2036	337	312	460	321	643	486
48	2037	337	312	460	321	643	486
49	2038	337	312	460	321	643	486
50	2039	337	312	460	321	643	486
Present Value		55,311	51,053	75,493	52,605	96,382	81,438

Table 3.3.1 Design Criteria and Standard

1. Dam

   a. Safety factor of stability analysis is 1.2.
      earthquake coefficient is 0.05.
   b. Free board = dh(wave by wind)
      +dh(extraordinary flood)
      +dh(1 m for filltype dam)
      >= 3 m
   c. Dam should be founded on the reliable rock foundation.

2. Diversion tunnel

   a. Design flood : 20 year probable flood
      or recorded maximum flood
      100 year probable flood during
      2nd rainy season
   b. Channel slope : 1/30~1/200
   c. Covering
      in case of rock : 1~2 x Tunnel Diameter
      in case of soil : 2~3 x Tunnel Diameter

3. Spillway

   a. Type : Open channel without gate
   b. Design flood : 1.2 x 200 year probable flood
      PMF(extraordinary flood)

4. Intake/river outlet

   a. Type : Selective water intake

Table 3.3.2 WATER CONSUMPTION RECORDS (1984-1987) PORT LOUIS SYSTEM

Year/Month		Total Amount (m^3/month)	(m^3/day)	Remarks
1984	Jul	1,787,440	57,660	1984:
	Aug	1,302,867	47,630	Max.57,660m^3/d
	Sep	1,458,552	48,620	Min.39,370m^3/d
	Oct	1,449,034	46,740	
	Nov	1,477,039	49,230	
	Dec	1,220,483	37,370	
1985	Jan	1,288,696	41,570	1985:
	Feb	1,183,750	42,280	Avg.35,780m^3/d
	Mar	1,010,801	32,610	Max.42,280m^3/d
	Apr	1,153,524	38,450	Min.30,700m^3/d
	May	1,180,501	38,080	
	Jun	1,103,586	36,790	
	Jul	951,767	30,700	
	Aug	1,073,978	34,560	
	Sep	993,195	32,110	
	Oct	998,967	32,220	
	Nov	1,071,416	35,710	
	Dec	1,030,995	33,260	
1986	Jan	1,255,053	40,490	1986:
	Feb	1,042,981	37,250	Avg.40,570m^3/d
	Mar	1,269,334	40,950	Max.43,920m^3/d
	Apr	1,143,934	38,130	Min.37,250m^3/d
	May	1,361,375	43,920	
	Jun	1,223,951	40,800	
	Jul	1,168,539	37,690	
	Aug			
	Sep	1,252,260	41,740	
	Oct	1,345,682	43,410	
	Nov	1,250,078	41,670	
	Dec	1,245,955	41,190	
1987	Jan	1,463,860	47,220	1987:
	Feb	1,313,703	46,920	Avg.42,370m^3/d
	Mar	1,214,544	39,180	Max.47,220m^3/d
	Apr			Min.39,180m^3/d
	May	1,259,056	40,610	
	Jun	1,200,366	40,010	
	Jul	1,249,064	39,890	
	Aug	1,236,475	39,890	
	Sep	1,260,074	42,000	
	Oct	1,408,949	45,450	
	Nov	1,338,851	44,630	
	Dec	1,235,189	39,840	

These volomes have been obtained by adding the volumes measured for each consumer

Table 3.3.3 (1) CHEMICAL DOSAGE RATE

RAPID SAND FILTRATION

CHEMICALS

Process	Ave. Rate (ppm)	Range (ppm)
Pre-Chlorination	1.0	0.5 - 3.0
Pre-Alkali	-	0 - 30.0
Alum	25.0	15.0 - 100.0
Post-Chlorination	1.0	0 - 2.0
Post-Alkali	10.0	0 - 30.0

Table 3.3.4 TREATMENT PLANT (1/2)

1)	Receiving well and Mixing well (Phase 1)	
	- Dimension	: B 3.0 m x L 5.0 m x H 5.0 m
	- Detention time	: 3.5 minutes
	- Mixing method	: Mixing by flush mixer
2)	Flocculation basin (Phase 1 & 2)	
	- Dimension	: B 10.0 m x L 10.5 m x H 3.5 m x 2 basins
	- Retention metthod	: Vertical and horizontal
3)	Sedimentation Basin (Phase 1 & 2)	
	- Dimension	: B 10.0 m x L 54 m x H 3.5 m x 2 basins
	- Retention time	: 3 hours
	- Type	: Horizontal flow
	- Overflow rate	: 1.16 m^3/m^2/hour (= 27.8 m/day)
	- De-sludge	: Mannual sludge removal
4)	Filter (Phase 1 & 2)	
	- Dimension	: B 4.5 m x L 10.0 m
	- Number of beds	: 6 beds
	- Type	: Constant-rate filtration (Interfilter-washing filter)
	- Filtration rate	: 120 m^3/m^2/day (5 m/hour)
	- Filter sand	: Single media of filter sand, thickness 70 cm
	- Filter gravel	: Thickness 25 cm
	- Washing system	: Surface wash 0.2 $m^3/min/m^2$ Backwashing 0.7 $m^3/min/m^2$
5)	Clear Water Reservoir (Existing)	
	- Capacity	: 24,000 m^3
	- Retention time	: 6 hours for 100,000 m^3/d production

Table 3.3.4 TREATMENT PLANT (2/2)

6) Administration Building (Phase 1)
   - Dimension : B 14.0 m x L 25.0 m, Two-story
   - First floor : Office space, meeting room, Labourtory, etc.
   - Second floor : System control and monitoring room, etc.

7) Chemical Building (Phase 1)
   - Dimension : B 12.0 m x L 30.0 m, Two-story
   - First floor : Alum, lime and chlorine, solution tanks and storage space
   - Second floor : Storage and feeding equipment room

8) Waste water pond (Phase 1)
   - Dimension : B 20.0 m x L 35.0 m x H 2.5 m x 2 basins
   - Pump room : B 7.0 m x L 15.0 m

9) Work Shop and Storage Building (Phase 1)
   - Work Shop : B 8.0 m x L 16.0 m
   - Storage Building : B 8.0 m x L 16.0 m

10) Chemical Feeding Facilities (Phase 1 & 2)
   - Alum system : 3 solution tanks and Elevated tanks, Transfer pumps (3 units 1 standby)
   - Lime system : 2 solution tanks, 3 saturation tanks, Feed pumps (2 units, 1 standby)
   - Chlorine system : Liquid gas chlorine storage 1 unit, Chlorinators (2 units, 1 standby)

11) Electrical Equipment (Phase 1 & 2)
   - Low Voltage Transformer (3,300/380-220 V) : 2 units
   - Emergency Generator (100 kVA) : 2 units

Table 3.4.1 (1) IMPLEMENTATION PROGRAMME FOR PORT LOUIS WATER SUPPLY PROJECT (1/2)

Sr No.	Activity	Period required (months)	Expected to be completed by end of
FOR DIVERSION WORKS (Lot I)			
(1)	Approval to JICA Feasibility Report	-	6/'89
(2)	Policy decisions and administrative work up to the stage of award of Consultancy for Detailed Design	6	12/'89
(3)	Detailed design up to the stage of submission of draft tender documents and tender drawings for diversion works only	6	6/'90
(4)	Government decision on (3) above, submission of final tender documents and drawings for diversion works.	3	9/'90
(5)	Invitation of tender for diversion works, receipt of offers, scrutiny and decision regarding diversion works tender	5	2/'91
(6)	Preparatory works at site (for diversion works)	2	4/'91
(7)	Construction of diversion tunnel and other diversion works	13	5/'92
FOR DAM AND RELATED CIVIL WORKS (Lot II)			
(1A)	Detailed design up to the stage of submission of draft tender documents and tender drawings for the main work (dam, spillway, etc.)	7	1/'91
(2A)	Government decision on (1A) above, and submission of final tender documents and drawings for the main work	3	4/'91
(3A)	Invitation of tender for the main work, receipt of offers for the main work, scrutiny and decision regarding tender for the main work	7	1/'92
(4A)	Preparatory works at site (for the main work)	4	5/'92
(5A)	Construction of dam, spillway, etc.	29	10/'94
(6A)	Miscellaneous items and completion	2	12/'94

Table 3.4.1 (2) IMPLEMENTATION PROGRAMME FOR PORT LOUIS WATER SUPPLY PROJECT (2/2)

Sr. No.	Activity	Period required (months)	Expected to be completed by end of
FOR WATER TRANSMISSION AND TREATMENT FACILITIES (Lot III)			
(1B)	Detailed design up to the stage of submission of draft tender documents and tender drawings.	7	1/'91
(2B)	Government decision on (1B) above, submission of final tender documents and drawings	3	4/'91
(3B)	Invitation of tender, receipt of offers, scrutiny and decision for procurement and construction work	9	2/'93
(4B)	Preparatory works at site	3	3/'94
(5B)	Manufacturing and installation of water transmission facilities	22	12/'94
(6B)	Manufacturing and construction of water treatment plant	18	12/'94

Table 3.5.1 CONSTRUCTION COST ESTIMATE FOR DAM AND APPURTENENT FACILITIES

	Construction Cost for Terre Rouge Dam						Crest El.	195
					Foreign Currency		Local Currency	
	WORK ITEM				Unit Cost	Amount	Unit Cost	Amount
			Unit	Quantity	($)	($1,000)	(Rs.)	(Rs.1,000)
1	**PREPARATORY WORKS**					(1,600)		(54,700)
	Access & Service Road		m	5,720	85	486	278	1,590
	Yards		m2					
	Temporary Buildings		L.S.			1,149		53,067
2	**DIVERSION**					(3,900)		(19,500)
	Open Cut	Common	m3	7,900	2.8	22	6	47
		Weathered Rock	m3	10,200	4.4	45	7	71
		Fresh Rock	m3	3,796	9.7	37	28	106
	Structural Concrete		m3	170	72	12	773	131
	Reinforcement Bar		t	158	615	97	3,769	596
	Tunnel	Excavation	m3	20,204	134	2,707	246	4,970
		Lining	m3	5,100	96	491	1,638	8,356
		Steel Supports	t	339	1,018	345	13,307	4,509
		Backfill Grout	m3	201	76	15	1,014	204
	Gate		t	45	3,200	144	10,960	493
3	**DAM**					(20,700)		(71,300)
	Excavation	Common	m3	161,000	2.8	451	6	966
		Weathered Rock	m3	68,000	4.4	299	7	476
		Fresh Rock	m3	29,000	9.7	281	28	812
	Embankment	Rockfill	m3	1,146,000	11	12,606	42	48,132
		Filter	m3	101,000	23	2,323	67	6,767
		Core	m3	238,000	6.2	1,476	15	3,570
	Grout	Curtain	m	23,269	73	1,699	363	8,447
		Blanket	m	1,753	67	117	315	552
	Measuring Instrument		L.S.			1,434		1,551
4	**SPILLWAY**					(7,900)		(50,700)
	Excavation	Common	m3	79,000	2.8	221	6	474
		Weathered Rock	m3	109,000	4.4	480	7	763
		Fresh Rock	m3	284,000	9.7	2,755	28	7,952
	Backfill		m3	43,000	3.5	151	16	688
	Structural Concrete		m3	45,000	72	3,258	773	34,772
	Reinforcement Bar		t	1,350	615	830	3,769	5,088
	Bridge over spillway		m2	213	805	171	4,725	1,006
5	**INTAKE**					(400)		(3,500)
	Excavation	Common	m3	13,900	2.8	39	6	83
		Weathered Rock	m3	2,600	4.4	11	7	18
		Fresh Rock	m3	870	9.7	8	28	24
	Concrere	Culvert	m3	500	41	21	584	292
		Form	m2	2,000	12	24	691	1,382
		Mass	m3	120	41	5	584	70
		Form	m2	1,200	12	14	691	829
	Reinforcement Bar		t	75	615	46	3,769	283
	Sluice Gate		no.	5		241		491
	Direct Cost					**34,500**		**199,700**
6	Compensation		ha	10			20,000	200
7	Engineering &		10% * (1~5)			3,500		25,000
	Administration		2.5% * (1~6)					
8	Physical Contingency		10% * (1~7)			3,800		22,500
9	Price Contingency							
10	**Grand Total**					**41,800**		**247,400**
Exchange rate		Rs						**($18,100)**
	US$1 =	13.7						
	¥1 =	0.105						
Grand Total		**$59,900**				70%		30%

Table 3.5.2 PIPE MATERIAL COST OF TRANSMISSION FACILITIES

Item	Unit	Q'ty	Unit Cost (Rs.)	Amount (Rs.)	Breakdown (Rs.)	
					F/C Portion	L/C Portion
A: Supply of straight pipes (φ800 mm Ductile Iron Pipe : DIP)						
A1) CIF (*1)	m	2,100	5,300-	11,130,000-	11,130,000-	—
A2) Inland cost (*2)				890,000-	—	890,000-
Total (A)				12,020,000-	11,130,000-	890,000-
B: Supply of fittings and valves (for φ800 mm DIP)						
B1) CIF of fittings (*1)(*3)	L.S.			2,226,000-	2,226,000-	—
B2) CIF of gate valve : φ800 mm (*1) with operation stand	Nos.	2	242,000-	484,000-	484,000-	—
B3) CIF of butterfly valve : φ800 mm(*1)	No.	2	308,000-	616,000-	616,000-	—
B4) Inland cost for aboves (*2)				266,000-	—	266,000-
Total (B)				3,592,000-	3,326,000-	266,000-
Total (A+B)				Rs. 15,612,000-	Rs. 14,456,000-	Rs. 1,156,000-

Note : (*1) = Foreign currency portion (F/C)
(*2) = Local currency portion (L/C) : 8 % of CIF
(Banking charge, docks charge, port charge, transportation)
(*3) = Assumed 20 % of straight pipes

Foreign Exchange Rate :
US$ 1.00 = Mauritian Rupees (Rs.) 13.70
US$ 1.00 = Japanese Yen (¥) 130.50
¥ 1.0 = Rs. 0.105

Table 3.5.3 CONSTRUCTION COST OF TRANSMISSION FACILITIES (1)

Item	Unit	Q'ty	Unit Cost (Rs.)	Amount (Rs.)	Breakdown (Rs.)	
					F/C Portion	L/C Portion
A: Preparatory/temporary work						
A1) Deliver and transportation of pipes/ fittings/valves of φ800mm DIP to site (before-river sites)	m	1,115	63-	70,200-	35,100-	35,100-
A2) -ditto- (after-river sites)	m	985	126-	124,100-	37,200-	86,900-
A3) Stockyard construction at riverside	L.S.			756,000-	75,900-	683,100-
A4) Worksite transportation facilities	L.S.			745,000-	372,500-	372,500-
A5) Gorge wall protection work for safety Wire-net; 180m x 30m	m²	5,400	650-	3,510,000-	3,159,000-	351,000-
A6) Rehabilitation of existing pipelines	L.S.			1,000,000-	100,000-	900,000-
A7) Miscellaneous work (6,205,300x10%)				620,700-	377,900-	239,800-
Total (A)				6,826,000-	4,157,600-	2,668,400-
B: Improvement-construction of intake chamber						
B1) Underwater excavation (Rock)	m³	55	1,520-	83,600-	33,400-	50,200-
B2) Underwater bedding concrete	m³	31	2,015-	62,500-	28,100-	34,400-
B3) Sheet-piling for water-shuttering	m²	80	2,800-	224,000-	179,200-	44,800-
B4) H-shaped steel for supporting above	ton	5.5	8,500-	46,800-	37,400-	9,400-
B5) Dewatering	L.S.			80,000-	40,000-	40,000-
B6) Demolishing existing concrete	m³	42	1,000-	42,000-	8,400-	33,600-
B7) Concrete work	m³	22	1,780-	39,200-	19,600-	19,600-
B8) Steel bars	ton	2.1	11,200-	23,500-	16,500-	7,000-
B9) Formwork	m²	39	360-	14,000-	2,800-	11,200-
B10) Bar screen	Set	1		54,000-	48,600-	5,400-
B11) Mortar work	L.S.			11,500-	5,800-	5,700-
B12) Dredging	L.S.			100,000-	50,000-	50,000-
B13) Repair of the existing chamber	L.S.			100,000-	50,000-	50,000-
B14) Miscellaneous work (881,100x10%)				88,900-	52,000-	36,900-
Total (B)				970,000-	571,800-	398,200-

Table 3.5.4 CONSTRUCTION COST OF TRANSMISSION FACILITIES (2)

Item	Unit	Q'ty	Unit Cost (Rs.)	Amount (Rs.)	Breakdown (Rs.) F/C Portion	Breakdown (Rs.) L/C Portion
C: Pipe installation work at Sites of (1),(2),(4),(5),(6),(7) & (8) (L = 769.5 M)						
C1) Excavation (Rock/manual)	m³	938	400-	375,200-	75,000-	300,200-
C2) Excavation (Soil/manual)	m³	235	150-	35,300-	7,100-	28,200-
C3) Backfilling (Soil excavated)	m³	230	75-	17,300-	3,500-	13,800-
C4) Concrete	m³	963	1,780-	1,714,100-	857,100-	857,000-
C5) Formwork	m²	1,089	360-	392,000-	78,400-	313,600-
C6) Pipelaying work (φ800mm DIP)	m	770	270-	207,900-	41,600-	166,300-
C7) Miscellaneous work (2,741,800x10%)				274,200-	106,300-	167,900-
Total (C)				3,016,000-	1,169,000-	1,847,000-
D: Pipe installation work at Sites of (10),(11),(12),(13),(14),(15),(16),(17) & (18) (L = 802.0 M)						
D1) Excavation (Rock)	m³	1,413	250-	353,300-	70,700-	282,600-
D2) Excavation (Soil)	m³	353	100-	35,300-	7,100-	28,200-
D3) Backfilling (5mm basalt aggregate)	m³	193	450-	86,900-	17,400-	69,500-
D4) Backfilling (Soil excavated)	m³	610	75-	45,800-	22,900-	22,900-
D5) Cutting and disposal (Rock)	m³	3,034	250-	758,500-	379,300-	379,200-
D6) Cutting and disposal (Soil)	m³	759	100-	75,900-	38,000-	37,900-
D7) Slope protection work	m²	1,762	290-	511,000-	51,100-	459,900-
D8) Concrete	m³	450	1,780-	801,000-	400,500-	400,500-
D9) Formwork	m²	179	360-	64,400-	12,900-	51,500-
D10) Pipelaying work (φ800mm DIP)	m	802	270-	216,500-	43,300-	173,200-
D11) Miscellaneous work (2,948,600x10%)				294,400-	104,100-	190,300-
Total (D)				3,243,000-	1,147,300-	2,095,700-

Table 3.5.5 CONSTRUCTION COST OF TRANSMISSION FACILITIES (3)

Item	Unit	Q'ty	Unit Cost (Rs.)	Amount (Rs.)	Breakdown (Rs.)	
					F/C Portion	L/C Portion
E: Pipe installation work at Sites of (19),(20) & (21) (L = 312.0 M)						
E1) Excavation (Rock)	m³	1,421	450-	639,500-	127,900-	511,600-
E2) Excavation (Soil)	m³	355	180-	63,900-	12,800-	51,100-
E3) Backfilling (5mm basalt aggregate)	m³	125	450-	56,300-	11,300-	45,000-
E4) Backfilling (Selected material)	m³	394	210	82,700-	41,400-	41,300-
E5) Backfilling (Excavated soil)	m³	1,086	75-	81,500-	40,800-	40,700-
E6) Pipe laying work (ϕ 800mm DIP)	m	312	540-	168,500-	33,700-	134,800-
E7) Miscellaneous work (1,092,400x10%)				109,600-	26,900-	82,700-
Total (E)				1,202,000-	294,800-	907,200-
F: Pipe installation work at Sites of (3) & (9) (River crossing : L=87.8+127.4= 215.2 M)						
F1) Underwater evcavation (Rock)	m³	1,574	760-	1,196,200-	478,500-	717,700-
F2) Underwater backfilling	m³	1,211	150-	181,700-	36,300-	145,400-
F3) Underwater concrete	m³	255	2,015-	513,800-	231,200-	282,600-
F4) Riverbed protection concrete	m³	184	2,015-	370,800-	185,400-	185,400-
F5) Formwork	m²	559	360-	201,200-	40,200-	161,000-
F6) Pipe laying work (ϕ 800mm DIP)	m	215	1,080-	232,200-	46,400-	185,800-
F7) Concrete abutment	Nos.	4	150,000-	600,000-	120,000-	480,00-
F8) Miscellaneous work (3,295,900x10%)				329,100-	113,800-	329,100-
Total (F)				3,625,000-	1,251,800-	2,373,200-
Total (A+B+C+D+E+F)				Rs. 18,882,000-	Rs. 8,592,300-	Rs. 10,289,700-
Overhead and others (25%)				4,720,000-	2,148,000-	2,572,000-
Grand Total				23,602,000-	10,740,300-	12,861,700-

Table 3.5.6 CONSTRUCTION COST FOR WATER TREATMENT FACILITIES (30,000 M^3/D)

Unit: Rs. 1000

Facilities	F.C.	L.C.	Total
1. Receiving & Mixing Well	270	270	540
2. Flocculation & Sedimentation Basin	3,300	2,200	5,500
3. Filter Beds	4,500	3,000	7,500
4. Yard Piping & Landscaping	4,430	2,950	7,380
5. Mecha. & Elect. Equipment includ. Chemical Equipment	31,900	7,980	39,880
6. Buildings	2,750	2,750	5,500
7. Miscellaneous, Site Preparation & Others	1,140	4,560	5,700
Total	48,290	23,710	72,000

Table 3.5.7 DISBURSEMENT SCHEDULE OF CONSTRUCTION COST

(Unit : Rs.1,000)

Item	Summary		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Preparatory Works	21,900	54,700			8,213	20,513	10,950	27,350	2,738	6,838				
2. Civil Works														
2.1 River Diversion	53,400	19,500			9,709	3,545	43,691	15,955						
2.2 Dam	283,400	71,300					21,478	5,175	118,295	29,325	107,720	27,600	35,907	9,200
2.4 Spillway	108,200	50,700									108,200	50,700		
2.5 Intake	5,500	3,500											5,500	3,500
2.6 Transmission Pipeline	25,200	14,000							7,228		12,598	7,587	5,370	6,431
2.7 Treatment Plant	48,300	23,700									41,049	17,780	7,241	5,930
Sub-total of 2.	524,000	182,700	0	0	9,709	3,545	65,169	21,130	125,523	29,325	269,567	103,667	54,018	25,061
Sub-total 1. to 2.	545,900	237,400	0	0	17,922	24,058	76,119	48,480	128,261	36,163	269,567	103,667	54,018	25,061
3. Land Acquisition and Compensation		200		200										
4. Administration Expenses		5,900		1,475		448		904		674		1,932		467
5. Engineering Services	54,500	23,800	15,733	6,667	1,194	1,606	8,715	5,136	9,048	2,935	16,080	6,104	3,730	1,352
Sub-total 1. to 5.	600,400	267,300	15,733	8,342	19,115	26,113	84,834	54,519	137,308	39,771	285,647	111,704	57,748	26,880
6. Physical Contingency	60,000	26,700	1,573	814	1,912	2,611	8,483	5,452	13,731	3,977	28,565	11,170	5,775	2,688
Sub-total 1. to 6.	660,400	294,000	17,307	9,156	21,027	28,724	93,317	59,971	151,039	43,748	314,212	122,874	63,523	29,568
7. Price Contingency	98,300	99,300	554	659	1,367	4,285	9,248	13,909	20,281	14,027	53,596	51,080	13,215	15,306
Grand Total	758,700	393,300	17,860	9,815	22,394	33,009	102,565	73,880	171,320	57,775	367,808	173,954	76,738	44,873

TABLE 3.5.8 COST OF EACH PROJECT COMPONENT

Disbursement Schedule of The Port Louis Water Supply Project

(Unit : Rs1,000)

Item	Summary	
	F.C.	L.C.
1. Detailed Design	15,700	6,700
1.2. Administration Expenses		1,500
1.4. Physical Contingency	1,600	800
1.5. Price Contingency	600	600
Sub-total	17,900	9,600
2. Preparatory Works	21,900	54,700
2.1. Land Acquisition and Compensation	0	200
2.2. Administration Expenses		600
2.3. Engineering Services	2,000	4,800
2.4. Physical Contingency	2,400	6,000
2.5. Price Contingency	2,400	14,200
Sub-total	28,700	80,500
3. River Diversion (Excluding Diversion Closure Work)	53,400	19,500
3.2. Administration Expenses		600
3.3. Engineering Services	5,600	1,900
3.4. Physical Contingency	5,900	2,200
3.5. Price Contingency	6,000	5,200
Sub-total	70,900	29,400
4. Dam (Including Diversion Closure Work)	283,400	71,300
4.2. Administration Expenses		1,800
4.3. Engineering Services	19,700	5,000
4.4. Physical Contingency	30,300	7,800
4.5. Price Contingency	51,500	32,100
Sub-total	384,900	118,000
5. Spillway	108,200	50,700
5.2. Administration Expenses		800
5.3. Engineering Services	6,500	3,000
5.4. Physical Contingency	11,500	5,500
5.5. Price Contingency	21,500	25,000
Sub-total	147,700	85,000
6. Intake	5,500	3,500
6.2. Administration Expenses		100
6.3. Engineering Services	400	200
6.4. Physical Contingency	600	400
6.5. Price Contingency	1,300	2,100
Sub-total	7,800	6,300
7. Transmission Pipeline and Rehabilitation of Municipal Dyke	25,200	14,000
7.2. Administration Expenses		200
7.3. Engineering Services	1,600	800
7.4. Physical Contingency	2,700	1,500
7.5. Price Contingency	5,000	7,700
Sub-total	34,500	24,200
8. Treatment Plant	48,300	23,700
8.2. Administration Expenses		400
8.3. Engineering Services	2,900	1,400
8.4. Physical Contingency	5,100	2,500
8.5. Price Contingency	9,900	12,400
Sub-total	66,200	40,400
Grand Total	758,700	393,300