The lagoons will be constructed over a permeable alluvial deposit about 6 meters deep overlying a silty clay (Achocalla Mud Flow). They will be sealed with a clayey soil layer to prevent excessive leakage and groundwater contamination. The clay soil layer should have a permeability of no more than 10^{-4} cm/sec. Experience indicates that under these conditions, the permeability would soon be reduced to about 10^{-6} cm/sec by the sludge deposits. The impermeable soil layer will be covered with a 30 cm layer of more permeable soil (material excavated from the alluvial deposits) and riprap. This granular material, including riprap, would protect the clayey material from erosion and dispersion due to the action of the aerators. A concrete slab would also be provided directly under each aerator. The layer of rip-rap to be provided on the upper part of the slopes is for protection from weather and wave action.

Design criteria for the priority projct are summarized as follows:

Flow :	140,000 m^3/day
Initial BOD :	140 mg/l
Initial SS :	250 mg/l

(2) Projected Performance and Power Requirements

The performance of the aerated lagoon system during the first phase is evaluated in the following paragraphs.

With a maximum depth of 6 meters and interior side slopes of 2:1, the average depth (with respect to the surface area) of the partially aerated lagoons is approximately 4.5 m. The volume of the partially aerated lagoons would be 120,000 x 4.5 = 540,000 m^3. and the detention time would be 540,000/140,000 = 3.86 days

The BOD reduction can be determined (using the equation shown in Ref. E7, page 838) as follows:

$\f(S_n,S_o) = \f(1,\b\bc\[(1 + (kt/n))^n)$

Where:

S_n = Effluent BOD_5 in cell n, mg/l

S_o = Influent BOD_5, mg/l

k = first order reaction constant (0.19 at 10^oC)

t = detention time, days; and

n = number of cells

From which the effluent BOD, Sn, is calculated as follows:

$S_n = 140\ [1/(1 + 0.19 \cdot 3.86/6)]^6 = 70$ mg/l

This corresponds to a 50 percent reduction in the wastewater BOD under initial dry weather conditions. Considering the partial flow and steep slopes in the main interceptor sewer, and resultant aeration during the first stage, it is estimated that the total initial BOD removal will be on the order of 60% (not considering the effects of other mitigation methods). This could be improved by adding aeration equipment to more completely mix the lagoon contents and improve the first phase performance.

It is estimated that 1.2 kg of O_2 is required for each kg of BOD removed. The oxygen requirements are then estimated as follows:

1.2 x (140 - 70) x (140/24) = 490 kg/hr

Using a field transfer rate (FTR) of 0.6 kg O_2/hr, the estimated horsepower requirements for oxygen transfer are 490/0.6=816.7 Hp.

The installed first phase electric power is 1800 Hp, as shown in Section 4 of Appendix D.

7.4.4 Sedimentation Basins

The last cells of both sets of lagoons, serving as sedimentation basins, would have an average depth of 4.7 meters, and a total volume of 40,000 x 4.7 = 188,000 m^3. Of this volume, the top 2 meters (with an average depth of 1.9 meters) would be reserved for sedimentation, and the bottom portion for sludge storage and digestion. The detention time in the sedimentation portion of the basins (upper 2 meters) would be 40,000 x 1.9 / 140,000 = 0.54 days (13 hours), and the overflow rate would be 140,000/40,000 = 3.5 m^3/m^2/day .

In the partially mixed aerated lagoons, a portion of the suspended solids settles to the bottom, and degrades anaerobically. On the other hand, a portion of the BOD is converted to suspended solids. Assuming that the influent SS from the aeration lagoons is relatively unchanged from that of the influent, the SS

reduction in the sedimentation basin would be about 80% and the final SS would be about 50 mg/l.

The mass of sludge that would accumulate in the sedimentation basin each year (not considering anaerobic digestion) is estimated (from Ref. E4, page 612) as follows:

Mass = $[(SS_i - SS_e) / 10^6] \cdot Q \cdot 365 = [(250-50)/106] \cdot 140{,}000 \cdot 365 = 10{,}220$ tons/year

The mass of volatile solids added per year, assuming that VSS = 70% of SS

$$VSS = 10{,}220 \cdot 0.7 = 7154 \text{ tons/year}$$

The mass of fixed solids added per year, assuming that VSS = 0.7 · SS

$$FS = 10{,}220 - 7154 = 3066 \text{ tons/year}$$

It is assumed that the maximum volatile solids reduction is 75%, and that it will occur for all the sludge except that deposited during the last year. Simplifying that the deposited volatile solids undergo a liner decomposition, the following equation (from Ref. E4, page 613) can be used to estimate the amount of volatile solid accumulated at the end of each year:

$$VSS_t = [0.7+0.25 \cdot (t-1)] \cdot 7154$$

where, t = time, yr.

For a 4 year period , $VSS = [(0.7+0.25 \cdot (4-1)] \cdot 7154 = 10{,}373.3$ tons.

For the same 4 year period the mass of fixed solids would be $4 \cdot 3066 = 12{,}264$ tons. The total solids mass deposited in the sedimentation basin during the four year period would then be $10373.3 + 12{,}264 = 22{,}637.3$ tons.

The required depth (for 4 years storage) of sludge is determined as follows:

The accumulated mass of sludge per unit surface area = 22,637.3 / 40,000 =

$$0.5659 \text{ tons/m}^2$$

Assuming that the deposited sludge will compact to an average concentration of 15% solids and that the density of the sludge is 1.06, the required depth is determined as follows:

$0.5659 / d = 1.06 \cdot 0.15$, or

$d = 0.5659 / (1.06 \cdot 0.15) = 3.56$ m

While the required average depth of the storage portion of the sedimentation basins is about 3.5 m, the average depth of the lower 4 meters of the lagoons is only about 2.5 meters, considering the 2:1 side slopes of the basins.

The maximum depth of 6 meters proposed for the sedimentation basins would then provide sufficient depth for less than 4 years of sludge storage. However, depending on the actual suspended solids carryover to the sedimentation basins, the sludge digestion taking place and the operation of the plant during rainy periods, the sludge storage could be 4 years or more. However, it is recommended that sludge hauling begin about 2 years after startup, so that these basins can be readily converted to aerated lagoons during the second phase. It is assumed for purposes of estimating operating costs that the distance to an interim or permanent sludge storage location will be 10 kilometers.

7.4.5 Auxiliary Works and Hydraulics

Auxiliary facilities, including the preliminary treatment works and hydraulic parameters, are discussed in Appendix D. A preliminary hydraulic gradient through the inlet portion of the phase 1 works, is shown in Fig. 7.4.7.

7.4.6 Cost Estimates

Preliminary costs for the first phase construction (priority project), including land acquisition, are estimated at U.S.$ 11.6 Million, as shown in Table 7.4.1. Cross sections used in the calculation of quantities for the lagoons and sedimentation basins are shown in Fig. 7.4.8 (4 sheets).

Preliminary estimates for the first phase operating costs were estimated at US$444,122 per year as shown in Table 7.4.2.

Cost estimates for the other stages are presented in Appendix D.

TABLE 7.4.1 COST ESTIMATE-WASTEWATER TREATMENT PLANT

PRIORITY PROJECT

(U.S.$- 1992 Prices)

	Unit	Quan-tities	Unit Price Local	Unit Price Foreign	Total Local	Total Foreign	Total
Site Preparation (Site 1)							
CompactedFill (general areas)	m3	20000	$5.14		$102,800	$0	$102,800
River & Channel Excavation	m3	10000	$2.00		$20,000	$0	$20,000
Gabions along river & road	ml	3000	$460.00		$1,380,000	$0	$1,380,000
Concrete for drainage channel	ml	1190	$150.00		$178,500	$0	$178,500
Sub-Total					$1,681,300	$0	$1,681,300
Preliminary Treatment Works							
Excavation	m3	1560	$2.00		$3,120	$0	$3,120
Concrete	m3	241.56	$150.00		$36,234	$0	$36,234
Gates	each	2	$4,000	$50,000	$8,000	$100,000	$108,000
Screens	each	2	$1,000	$9,500	$2,000	$19,000	$21,000
Sewer 1200 mm	ml	80	$400.00		$32,000	$0	$32,000
Pipe800 mm	ml	60	$200.00		$12,000	$0	$12,000
SluiceValves 800 mm	each	2	$1,000.00	$11,120	$2,000	$22,240	$24,240
Walkways	each	1	$200.00	$2,000	$200	$2,000	$2,200
Metering Equipt.	each	2	$10,000.00	$40,000	$20,000	$80,000	$100,000
Gravel for surface	m3	4000	$10.00		$40,000	$0	$40,000
Sub-Total					$155,554	$223,240	$378,794
Lagoons(12 ha)							
Excavation	m3	142750	$2.50		$356,875	$0	$356,875
Fill & Compaction	m3	247100	$5.14		$1,270,094	$0	$1,270,094
Pipe (Entrance)800 mm	ml	200	$200.00		$40,000	$0	$40,000
Pipe Between Cells	ml	1600	$200.00		$320,000	$0	$320,000
GateValves	each	24	$1,000.00	$11,120	$24,000	$266,880	$290,880
Fiberglass plugs	each	6	$100.00	$600	$600	$3,600	$4,200
Structures between cells	m3	498.96	$150.00		$74,844	$0	$74,844
Revetment	m3	30000	$12.50		$375,000	$0	$375,000
Gabions under pipe exits	m3	216	$45.00		$9,720	$0	$9,720
Aerators w/floats/slabs	each	24	$3,000.00	$28,000	$72,000	$720,000	$792,000
Gravel for top of berms	m3	2748	$10.00		$27,480	$0	$27,480
Clay layer	m3	24000	$10.00		$240,000	$0	$240,000
Subtotal					$2,810,613	$990,480	$3,801,093
Sedim. Basins(4 Ha)							
Excavation	m3	135000	$2.50		$337,500	$0	$337,500
Fill & Compaction	m3	79923	$5.14		$410,804	$0	$410,804
Pipe (Entrance)	ml	200	$200.00		$40,000	$0	$40,000
Pipe Between Cells	ml	80	$200.00		$16,000	$0	$16,000
GateValves	each	6	$1,000.00	$11,120	$6,000	$66,720	$72,720
Revetment	ml	12000	$12.50		$150,000	$0	$150,000
Control structures - concrete	m3	83.16	$150.00		$12,474	$0	$12,474
Effluent Canal- concrete	m3	320.76	$150.00		$48,114	$0	$48,114
Effluent pipes(800 mm)	ml	100	$300.00		$30,000	$0	$30,000
Valves for canal	each	4	$1,000.00	$11,120	$4,000	$44,480	$48,480
Gravel for top of berms	m3	540	$10.00		$5,400	$0	$5,400
Sludge Pumps w/float	each	3	$3,000.00	$27,000	$9,000	$81,000	$90,000
Tank Trucks	each	3	$2,000.00	$80,000	$6,000	$240,000	$246,000
Clay layer	m3	8000	$20.00		$160,000	$0	$160,000
Subtotal					$1,235,292	$432,200	$1,667,492

	Unit	Quan-tities	Unit Price Local	Unit Price Foreign	Total Local	Total Foreign	Total
Electrical						$0	$0
Electrical and Instrumentation	Lump Sum	1	$80,000.00	$40,000	$80,000	$40,000	$120,000
Subtotal					$80,000	$40,000	$120,000
Operations Building							
800 sq.m.	m2	800	$250.00		$200,000	$0	$200,000
Lab Equipt	Lump Sum	1	$1,000.00	$50,000	$1,000	$50,000	$51,000
Subtotal					$201,000	$50,000	$251,000
Strorage and Maint. Bldg							
300 sq. m.	m2	300	$150.00		$45,000	$0	$45,000
Maintenance Equipment	lump sum	1	$10,000.00	$100,000	$10,000	$100,000	$110,000
Subtotal					$45,000	$100,000	$145,000
Access Road (3.5 km)							
Excavation	m3	10500	$2.50		$26,250	$0	$26,250
Fill/Compaction	m3	20000	$5.14		$102,800	$0	$102,800
Gravel(3.5 km)	m3	4200	$10.00		$42,000	$0	$42,000
Stream Crossings	m2	400	$15.00		$6,000	$0	$6,000
Road Drainage	m2	7000	$15.00		$105,000	$0	$105,000
Subtotal					$282,050	$0	$282,050
TOTAL CONSTRUCTION					$6,490,809	$1,835,920	$8,326,729
Land Acquisition & R.O.W.							
Purchase cultivated area	m2	150000	$14.00		$2,100,000	$0	$2,100,000
Purchase river bed	m2	250000	$5.00		$1,250,000	$0	$1,250,000
Subtotal					$3,350,000	$0	$3,350,000
TOTAL (Construction & Land Acqusition)					$9,840,809	$1,835,920	$11,676,729

TABLE 7.4.2 Estimated Operation Costs for the Priority Project

Staff salary		
Director	1	9,900
Engineers	2	14,520
Laborers	7	11,880
Night watches	2	3,630
Drivers	2	3,960
Lab technician	3	14,850
Elec. Technician	1	4,950
Mech. Technician	2	7,200
Secretary	1	4,620
Admin. staff	1	4,620
Janitor	1	1,980
Subtotal		*74,425*
Equip/Material		
Parts		10,000
Supplies		3,000
Subtotal		*13,000*
Utilities		
Electricity		350,954
Diesel fuel		5,742
Subtotal		*356,696*
Total		444,121

7.5 PROJECT COSTS

7.5.1 Construction Costs

The estimated construction costs for each component for the priority project were indicated in the previous sections. The project costs are estimated by adding indirect costs to the direct construction costs. The indirect costs include engineering and contingencies. The engineering costs will cover survey/investigation works, detailed design and construction supervision by international consultants and are estimated as 10 % of the direct construction costs. The contingency is estimated as 10 % of the total of the direct construction cost and the costs for land acquisition.

The calculated costs are considered lower than those estimated for phased implementation in the Master Plan (Ref. Table 4.4), because the construction costs for main sewer interceptor and aerators are reduced as a result of feasibility study.

TABLE 7.5.1 ESTIMATED CONSTRUCTION COSTS FOR THE PRIORITY PROJECT

(US$million)

Items	Local	Foreign	Total
Construction Costs	**11.49**	**1.82**	**13.31**
Water Intake Facilities	0.05	0.03	0.08
Main Sewer Interceptor	4.95		4.95
Wastewater Treatment Plant	6.49	1.79	8.28
Land Acquisition and ROW	**3.35**		**3.35**
Engineering	**1.15**	**0.18**	**1.33**
Contingency	**1.48**	**0.18**	**1.67**
Total	**17.47**	**2.18**	**19.66**

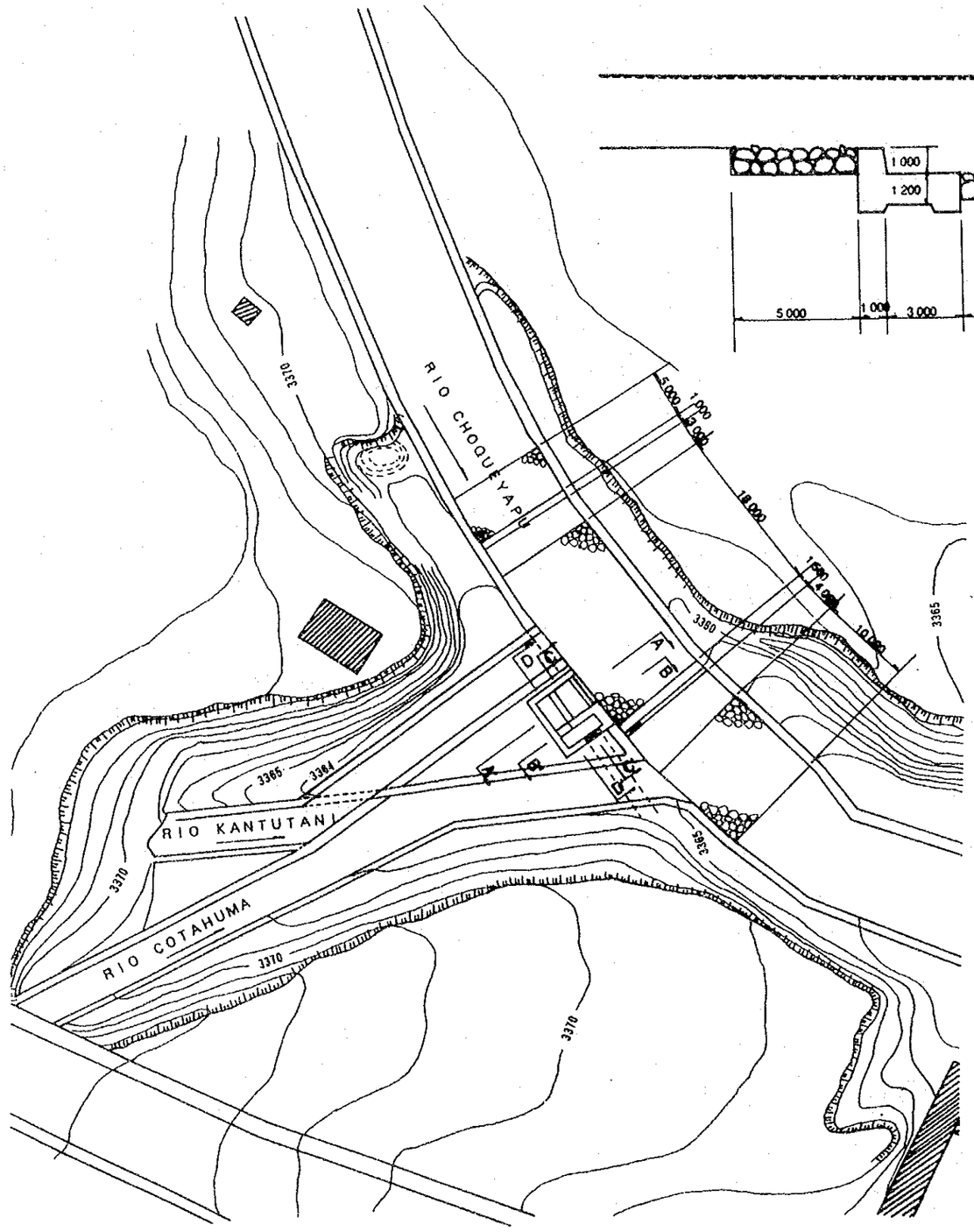
7.5.2 Operating Costs

Operating costs for the Priority Project have been estimated in the previous sections and they are summarized as shown in Table 7.5.2.

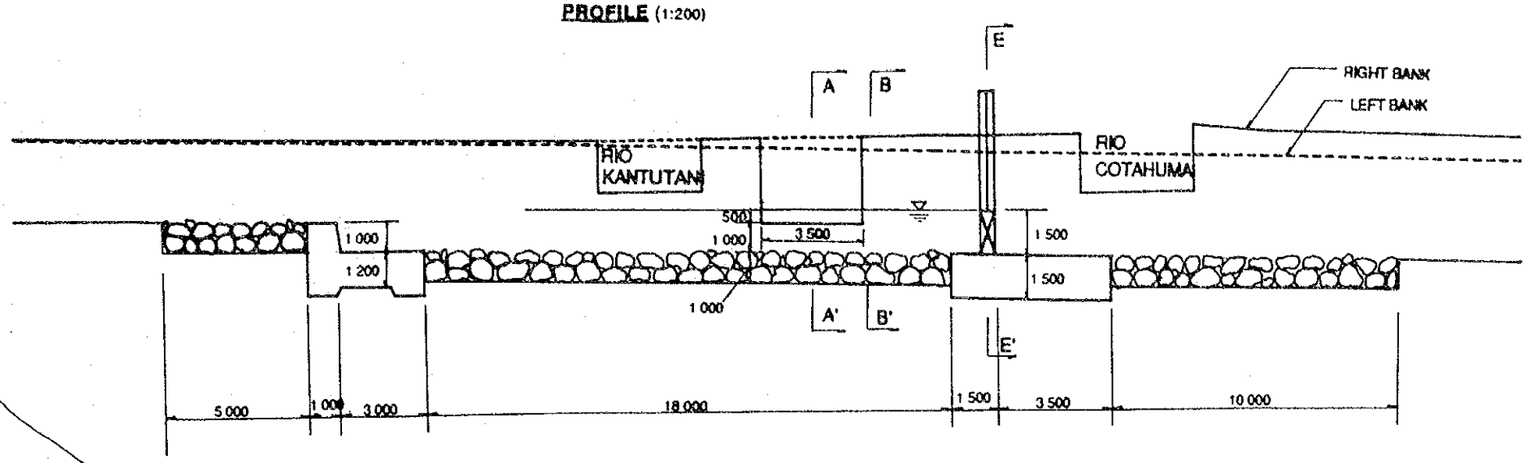
TABLE 7.5.2 ESTIMATED OPERATING COSTS FOR THE PRIORITY PROJECT

	US$/Year
Wastewater collection/transmission	
Personnel Expenses	20,460
Plant operations	
Personnel Expenses	74,425
Materials/Equipment	13,000
Electricity	356,696
Sub-Total	444,121
Total	464,581

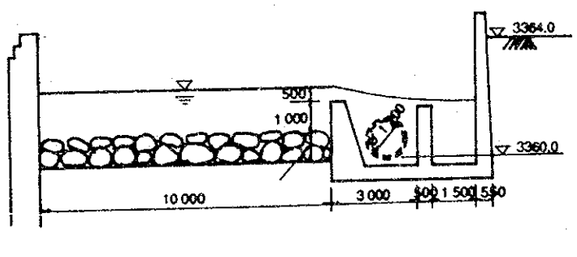
GENERAL LAYOUT (1:500)



PROFILE (1:200)



SECTION A-A' (1:200)



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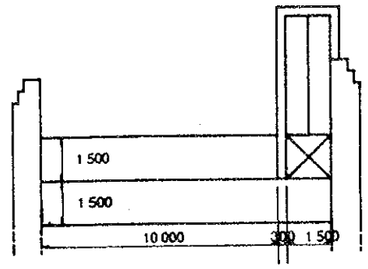

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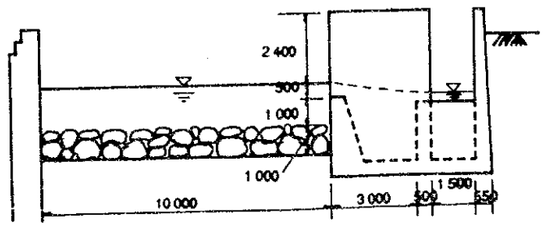

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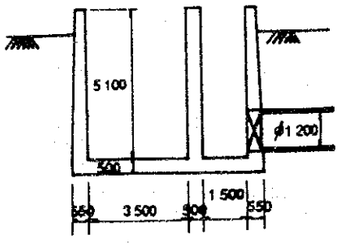

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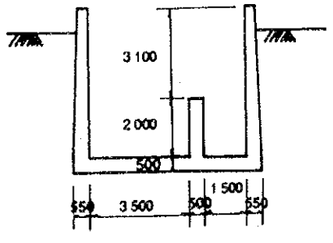


Fig. 7.2.1 GENERAL LAYOUT AND PROFILES OF WATER INTAKE FACILITIES

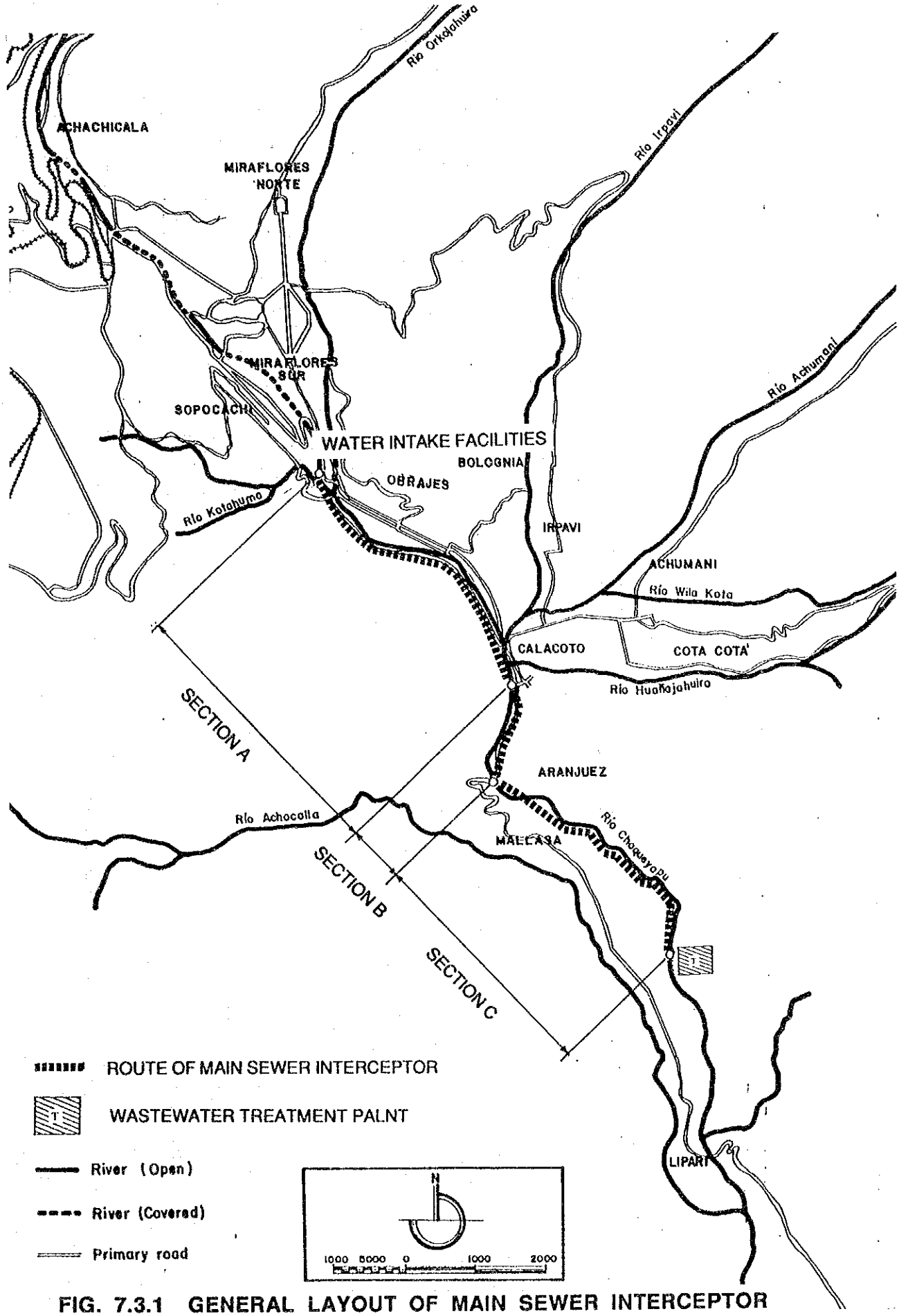


FIG. 7.3.1 GENERAL LAYOUT OF MAIN SEWER INTERCEPTOR

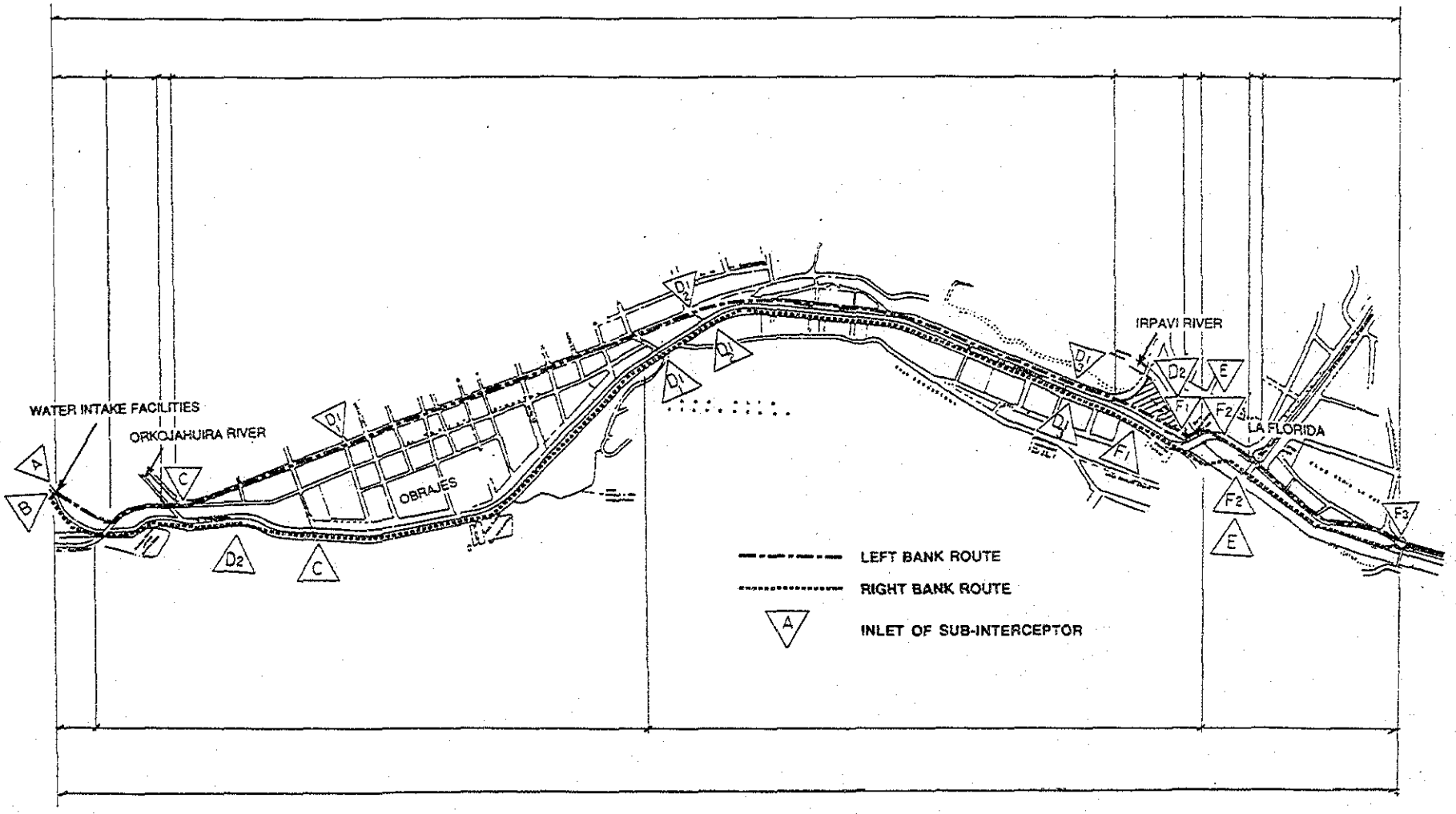


FIGURE 7.3.2 TWO POSSIBLE ROUTES FOR SECTION A

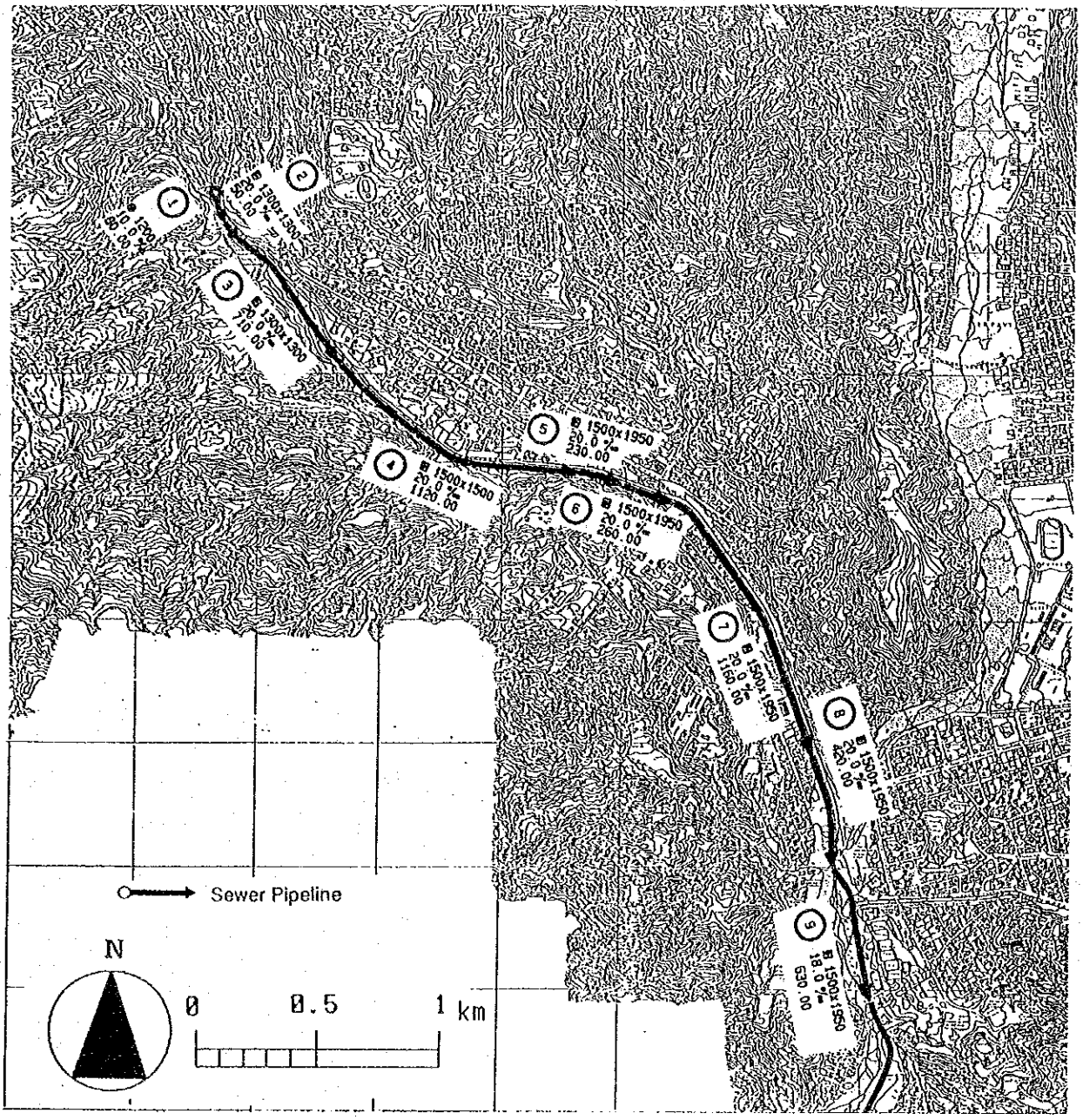


FIG. 7.3.3 PLAN OF PROPOSED MAIN SEWER INTERCEPTOR (1 OF 2)

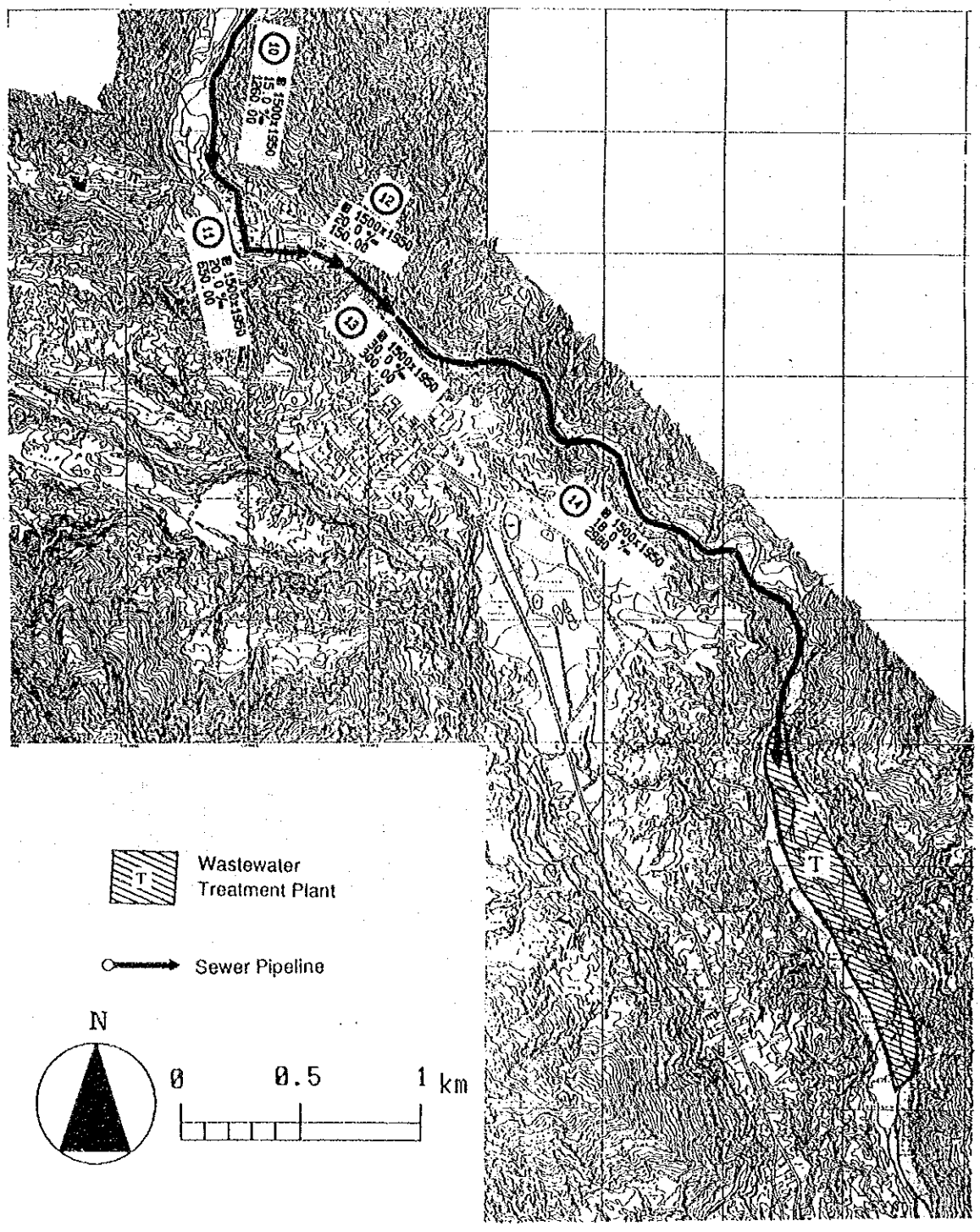


FIG. 7.3.3 PLAN OF PROPOSED MAIN SEWER INTERCEPTOR (2 OF 2)

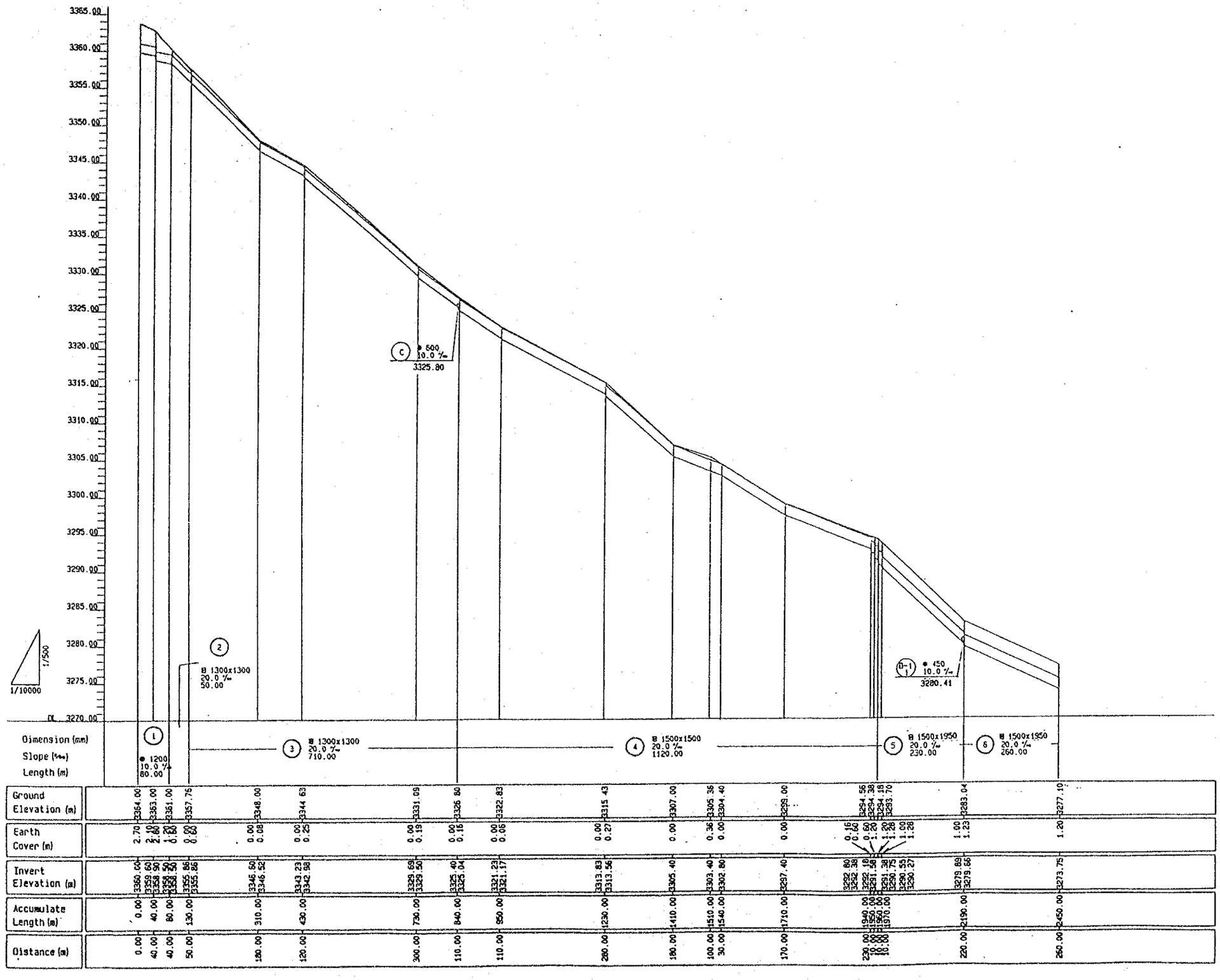


Fig. 7.3.4 LONGITUDINAL PROFILE OF PROPOSED MAIN SEWER INTERCEPTOR (1/4)

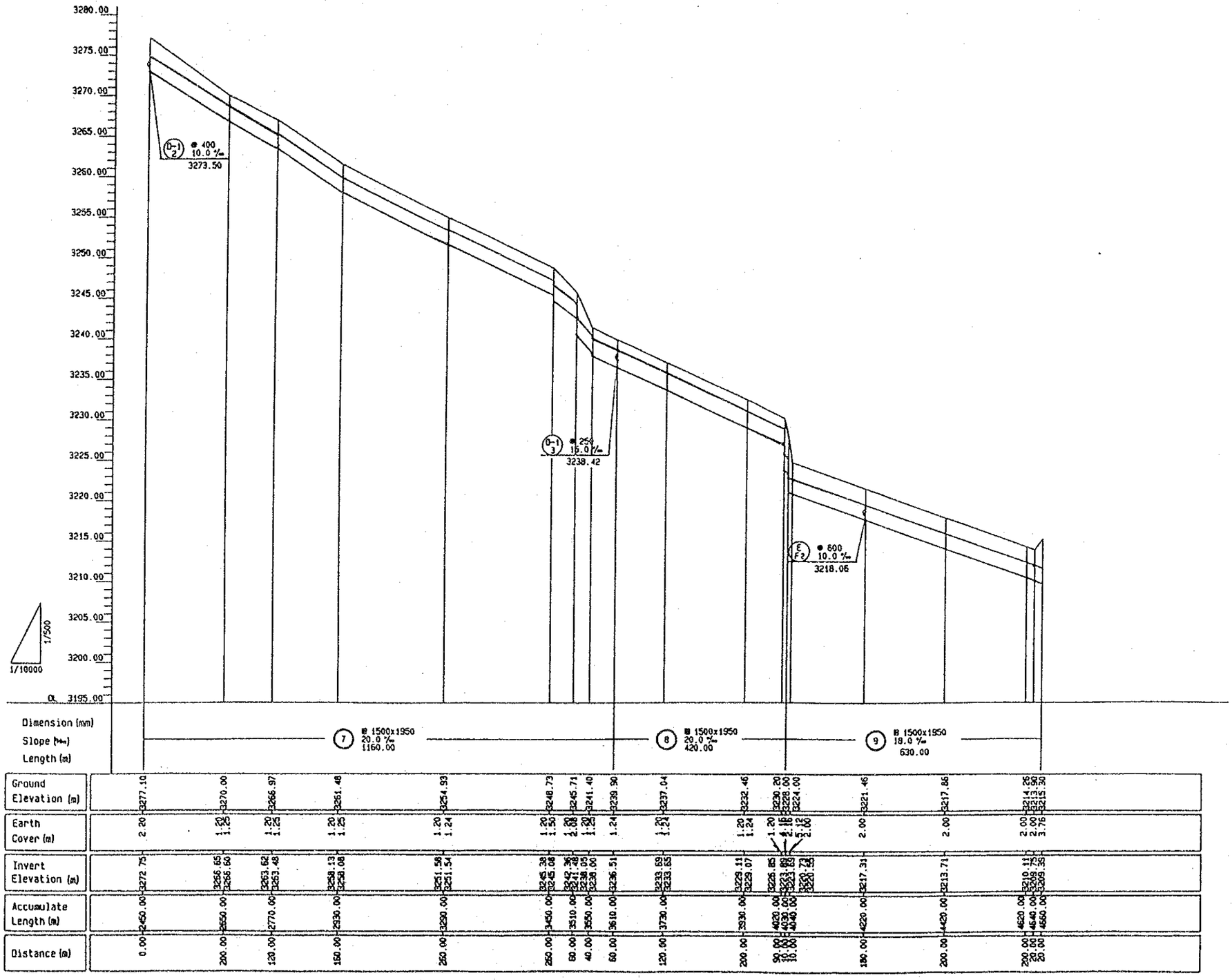


Fig. 7.3.4 LONGITUDINAL PROFILE OF PROPOSED MAIN SEWER INTERCEPTOR (2/4)

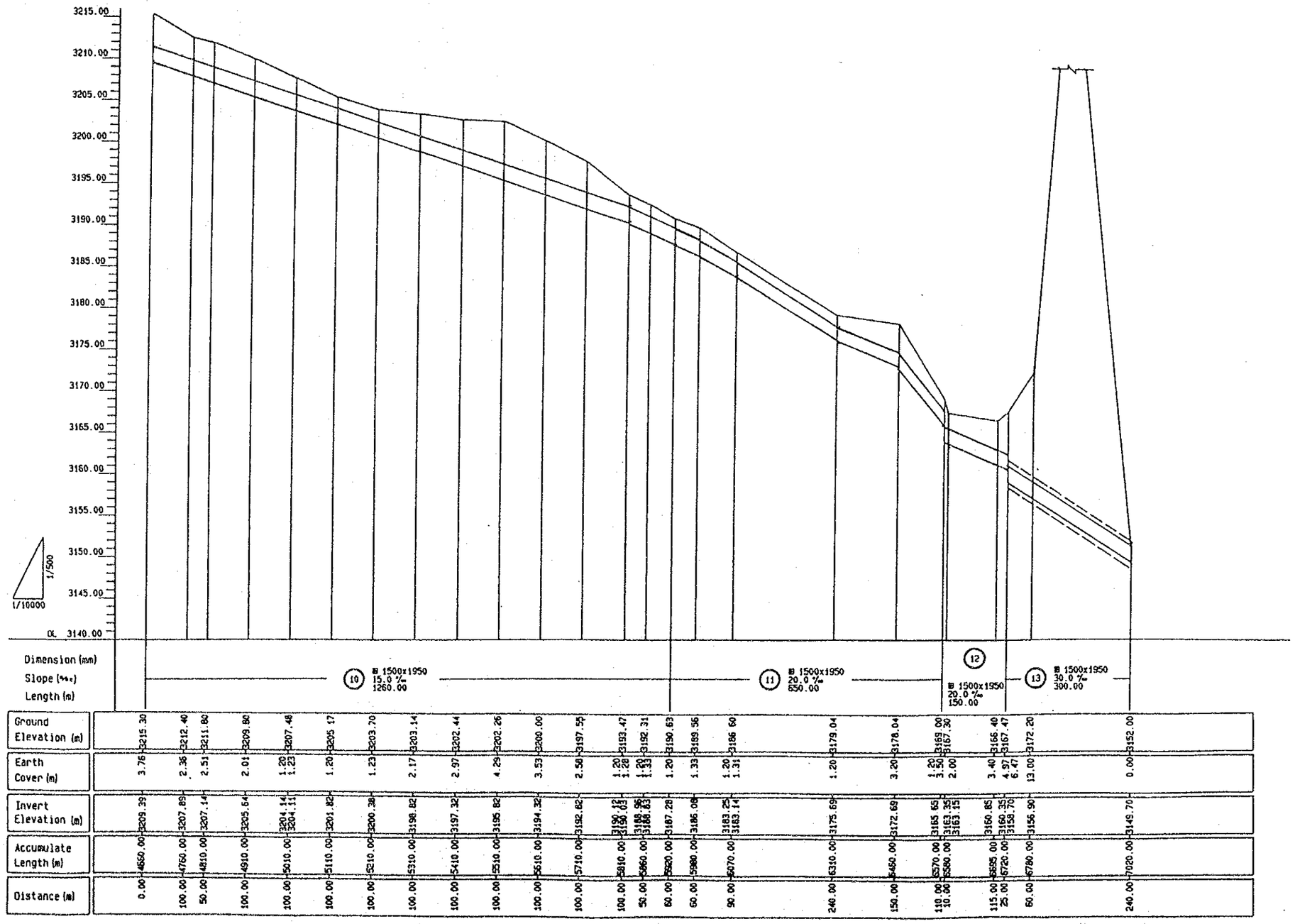
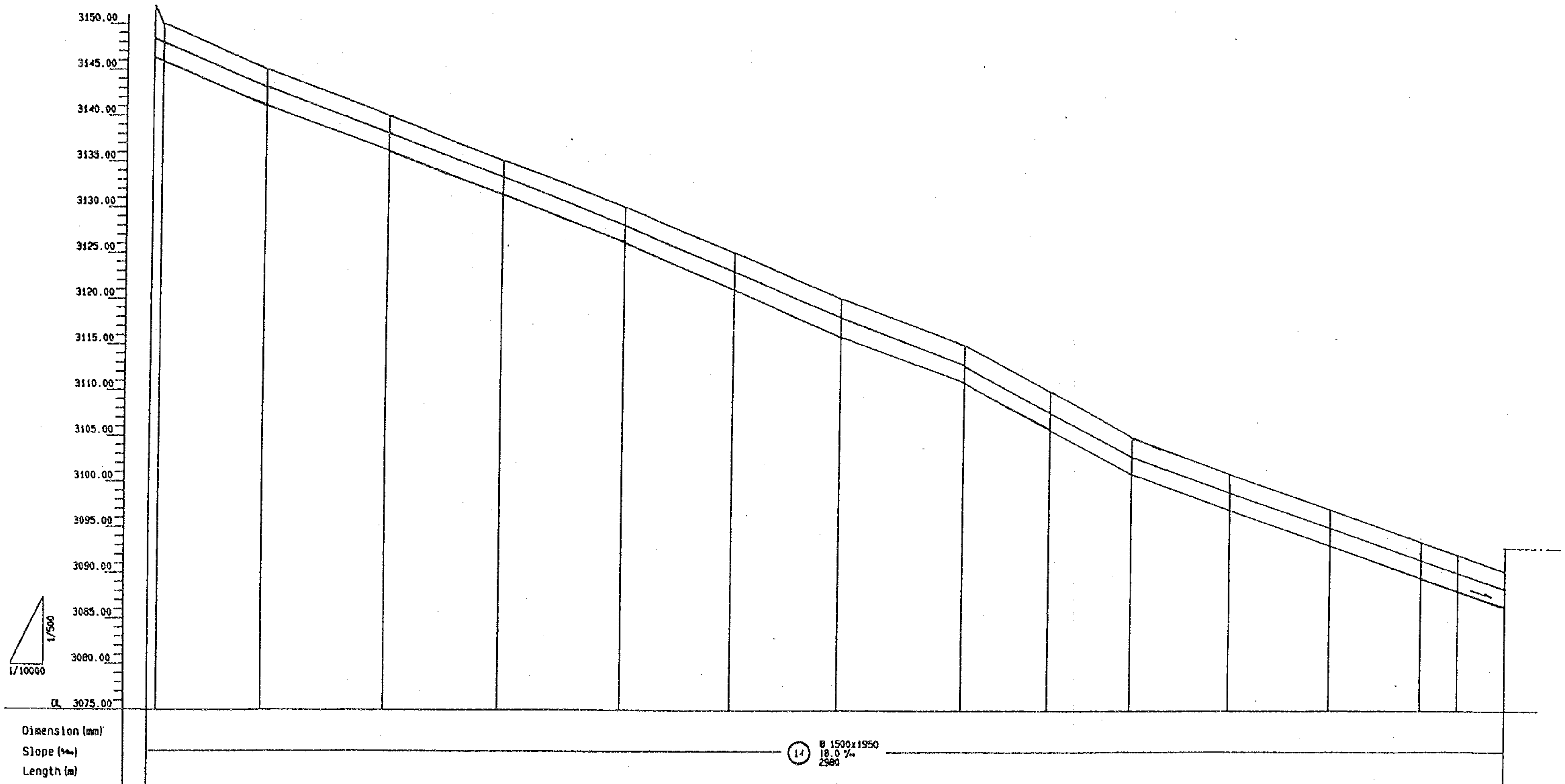


Fig. 7.3.4 LONGITUDINAL PROFILE OF PROPOSED MAIN SEWER INTERCEPTOR (3/4)



Ground Elevation (m)	3152.00	3150.00	3145.00	3140.00	3135.00	3130.00	3125.00	3120.00	3115.00	3110.00	3105.00	3100.98	3096.95	3093.29	3091.83	3090.00 / 3093.00
Earth Cover (m)	3.60	2.00 / 2.04	2.00	2.00 / 2.02	2.00	2.00 / 2.03	2.00 / 2.03	2.00	2.00 / 2.08	2.00 / 2.08	2.00	2.00	2.00	2.00	2.00	1.85 / 4.85
Invert Elevation (m)	3146.25	3145.85 / 3145.81	3140.85	3135.85 / 3135.83	3130.85	3125.85 / 3125.82	3120.85 / 3120.82	3115.85	3110.85 / 3110.77	3105.85 / 3105.75	3095.85	3096.83	3092.80	3088.65	3087.58	3086.00
Accumulate Length (m)	7020.00	7040.00	7270.00	7540.00	7790.00	8060.00	8300.00	8540.00	8810.00	9000.00	9180.00	9400.00	9620.00	9820.00	9990.00	10000.00
Distance (m)	0.00	20.00	230.00	270.00	250.00	270.00	240.00	240.00	270.00	190.00	180.00	220.00	220.00	200.00	80.00	100.00

Fig. 7.3.4 LONGITUDINAL PROFILE OF PROPOSED MAIN SEWER INTERCEPTOR (4/4)

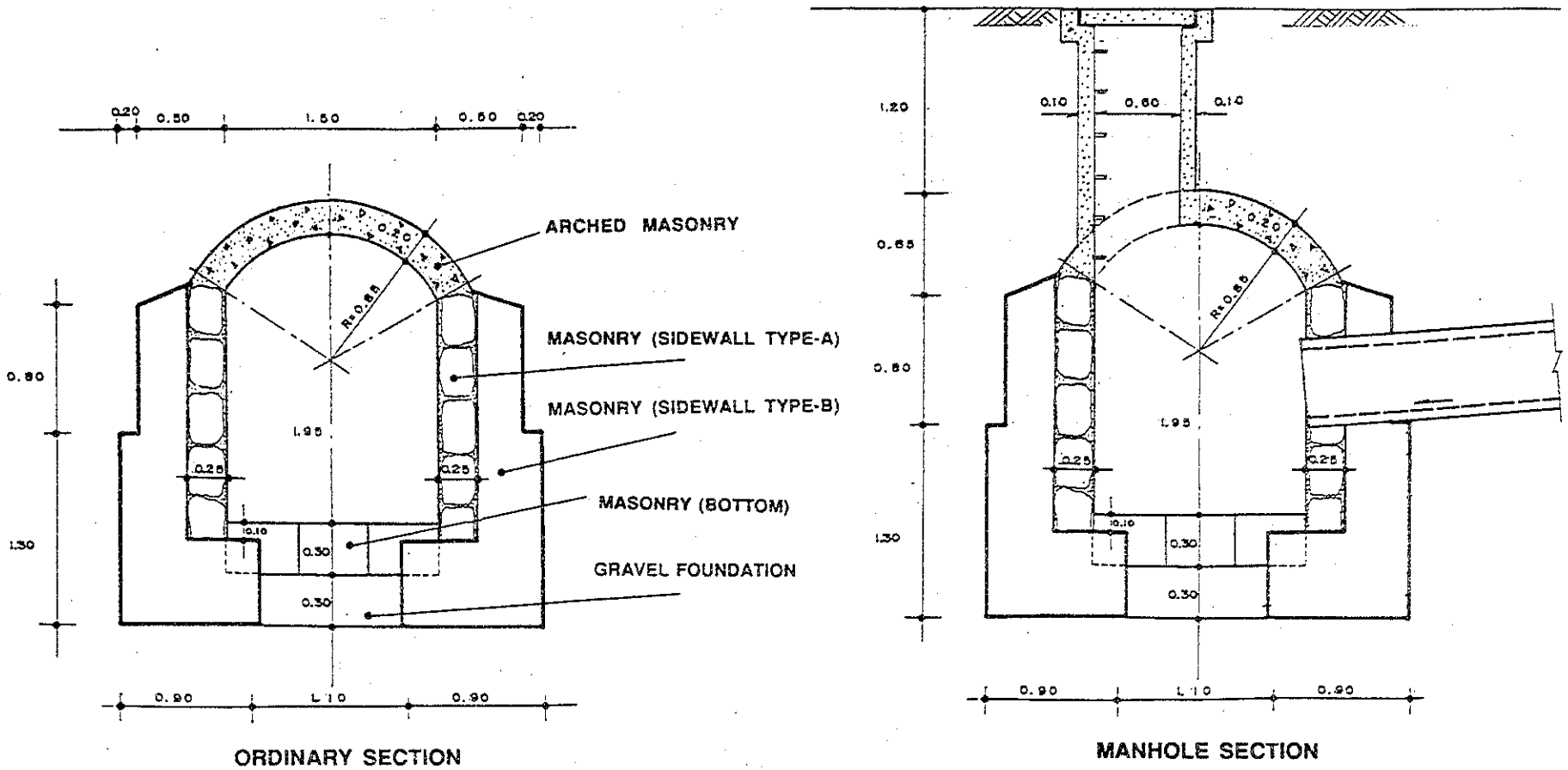
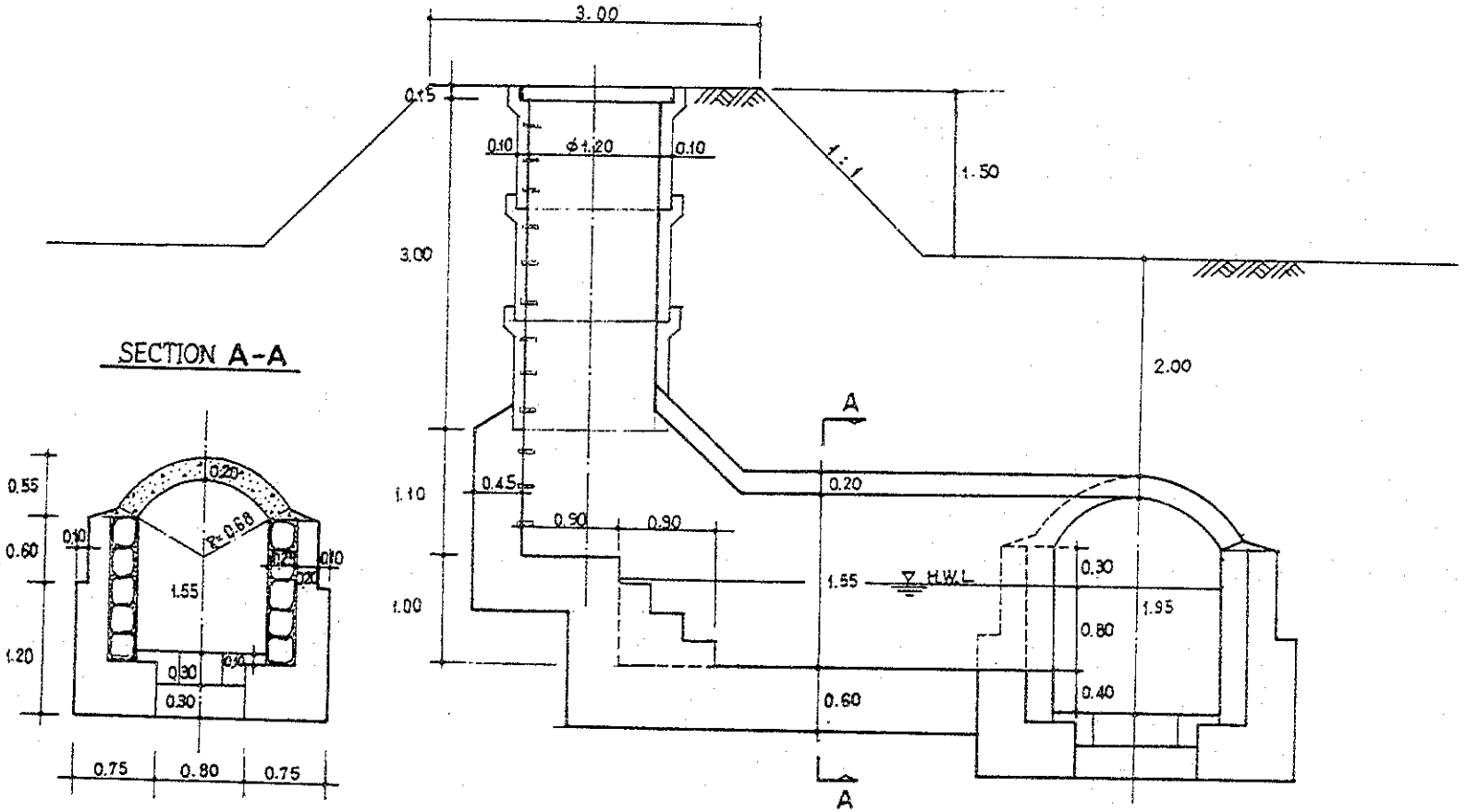


FIGURE 7.3.5 TYPICAL CROSS SECTIONS OF ARCHED MASONRY INTERCEPTOR (1 OF 2)



MANHOLE STRUCTURES UNDER RIVER BED MAINTENANCE ROAD

FIGURE 7.3.5 TYPICAL CROSS SECTIONS OF ARCHED MASONRY INTERCEPTOR (2 OF 2)

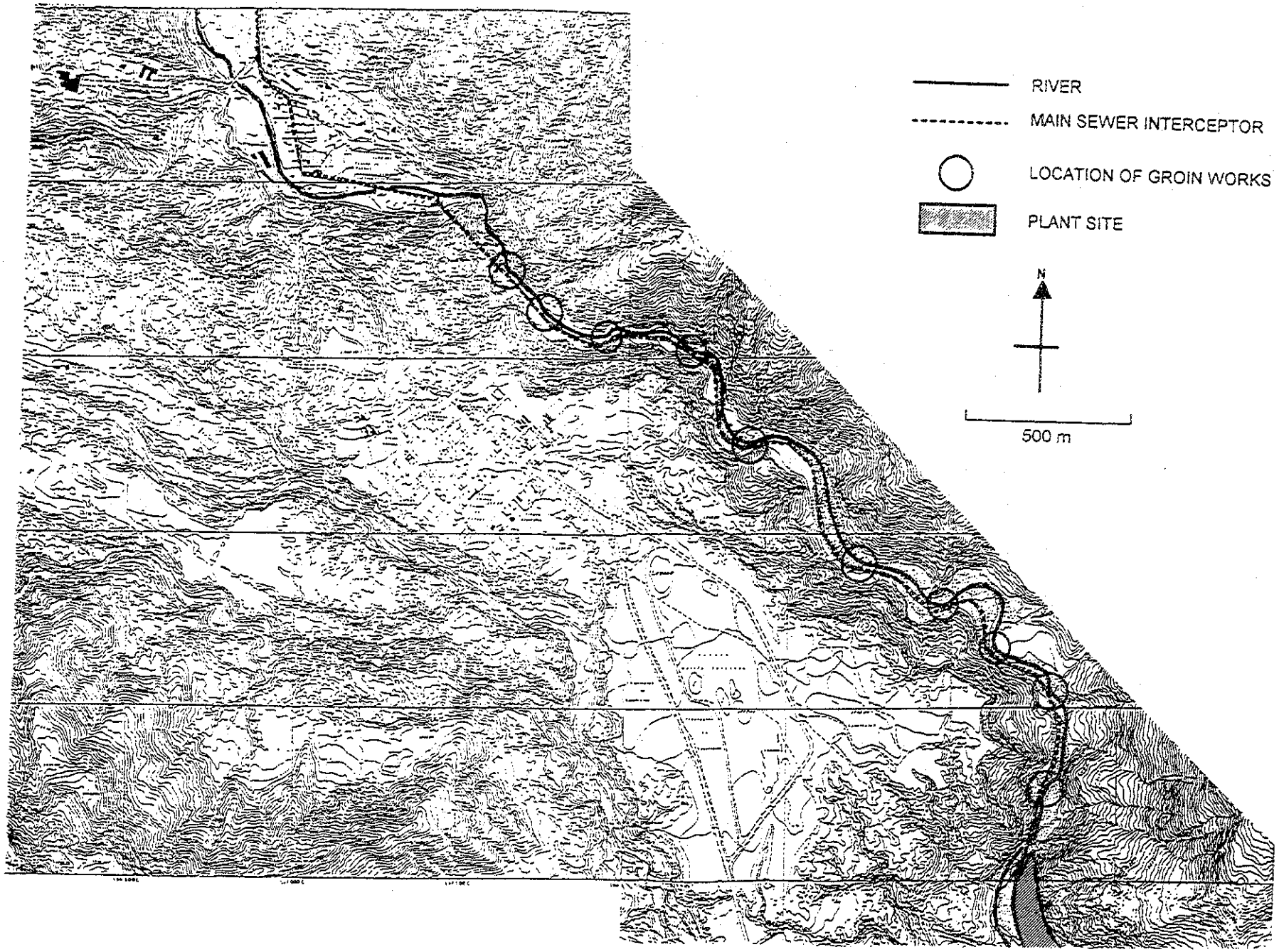
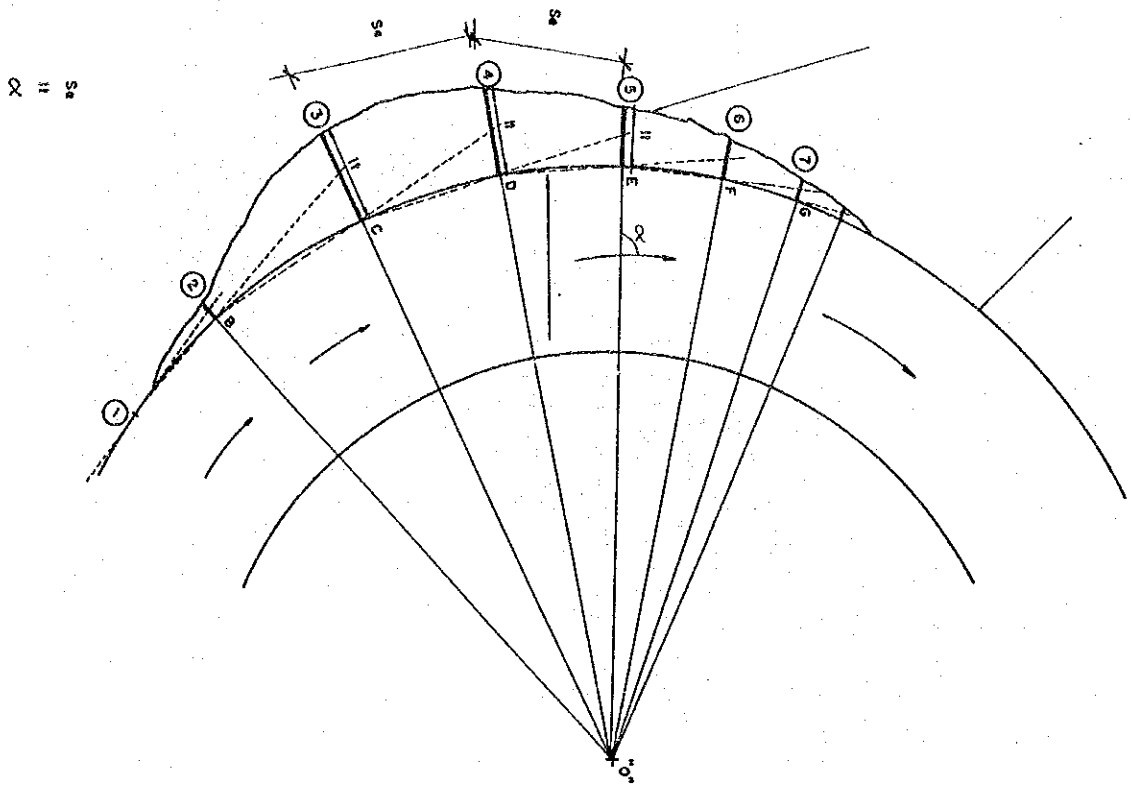
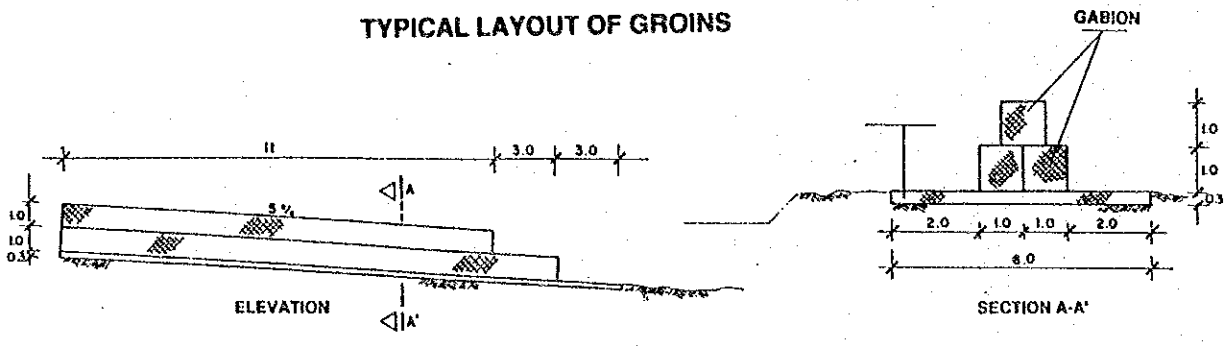
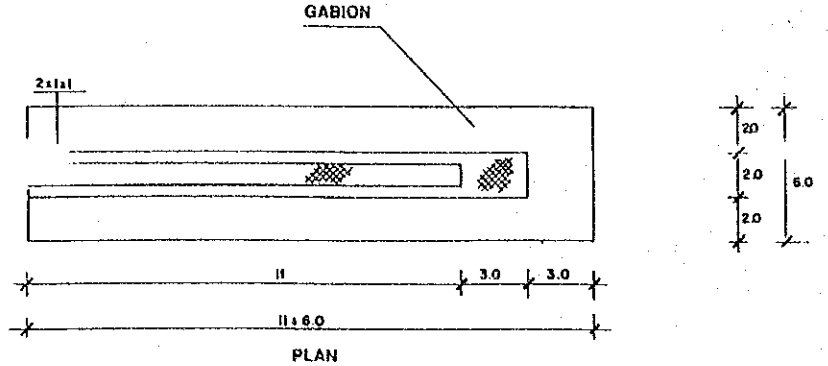


Fig. 7.3.6 LOCATION OF GROIN WORKS



TYPICAL LAYOUT OF GROINS





STRUCTURES OF GABION

FIGURE 7.3.7 LAYOUT AND STRUCTURES OF GROIN WORKS

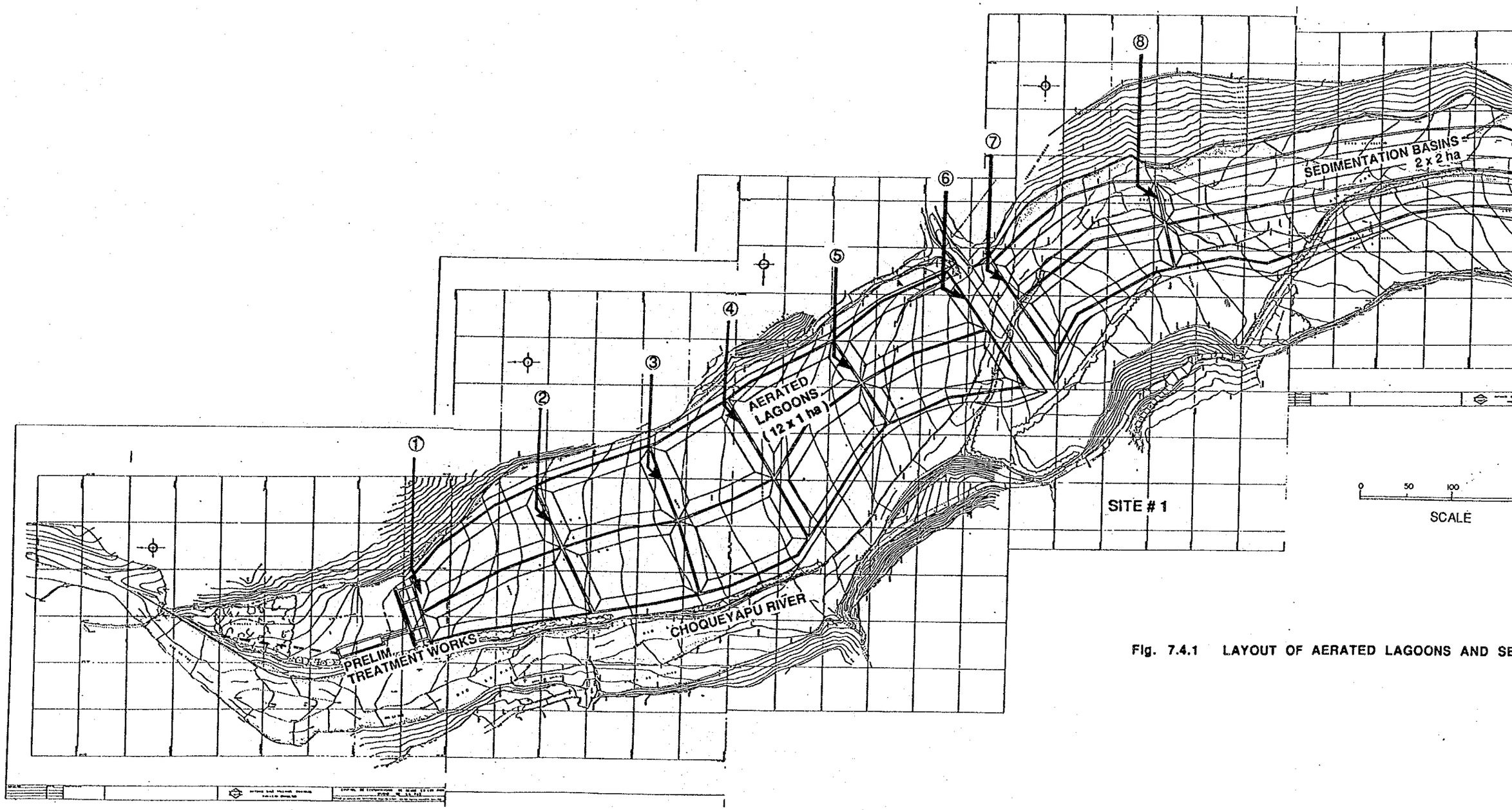


Fig. 7.4.1 LAYOUT OF AERATED LAGOONS AND SE

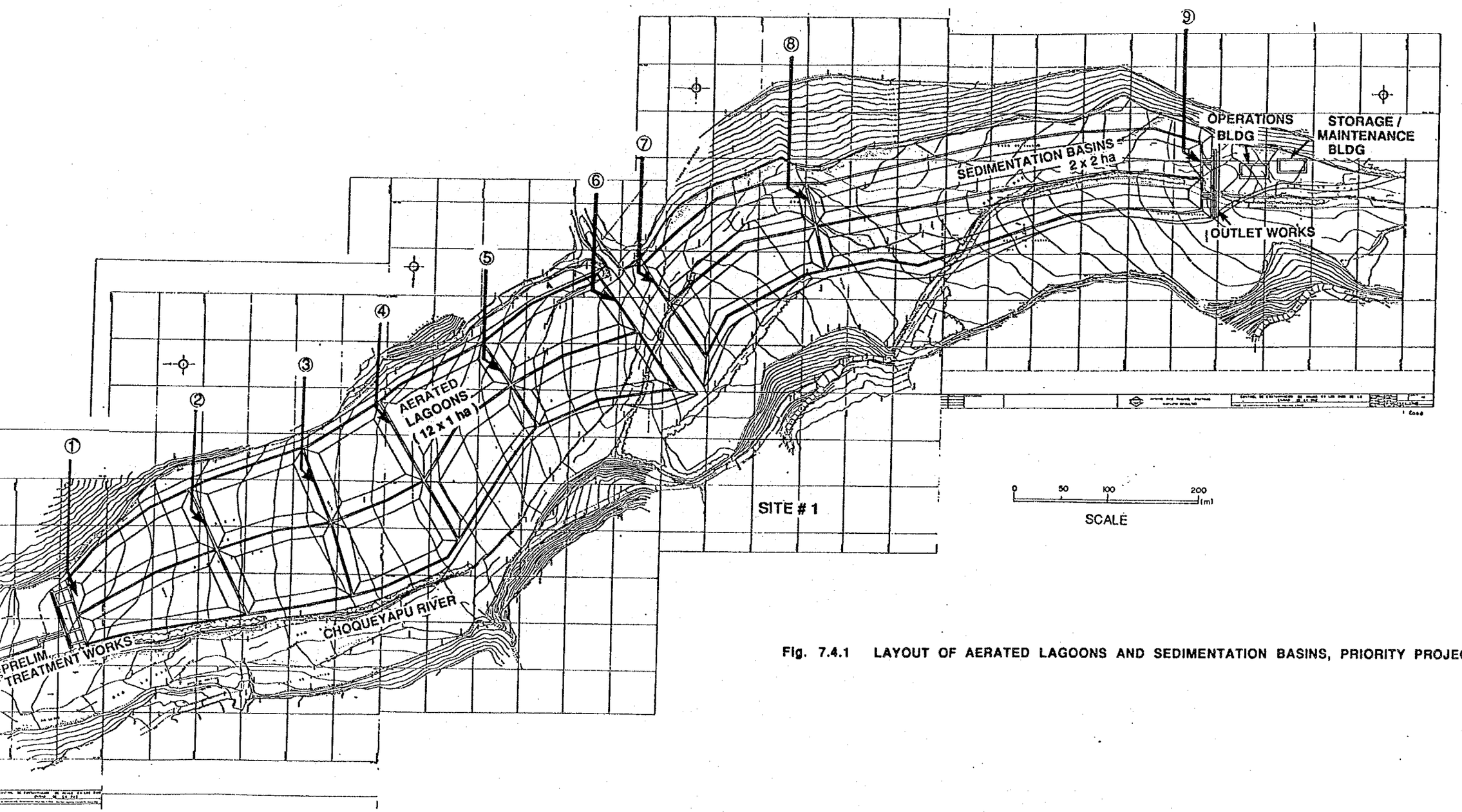
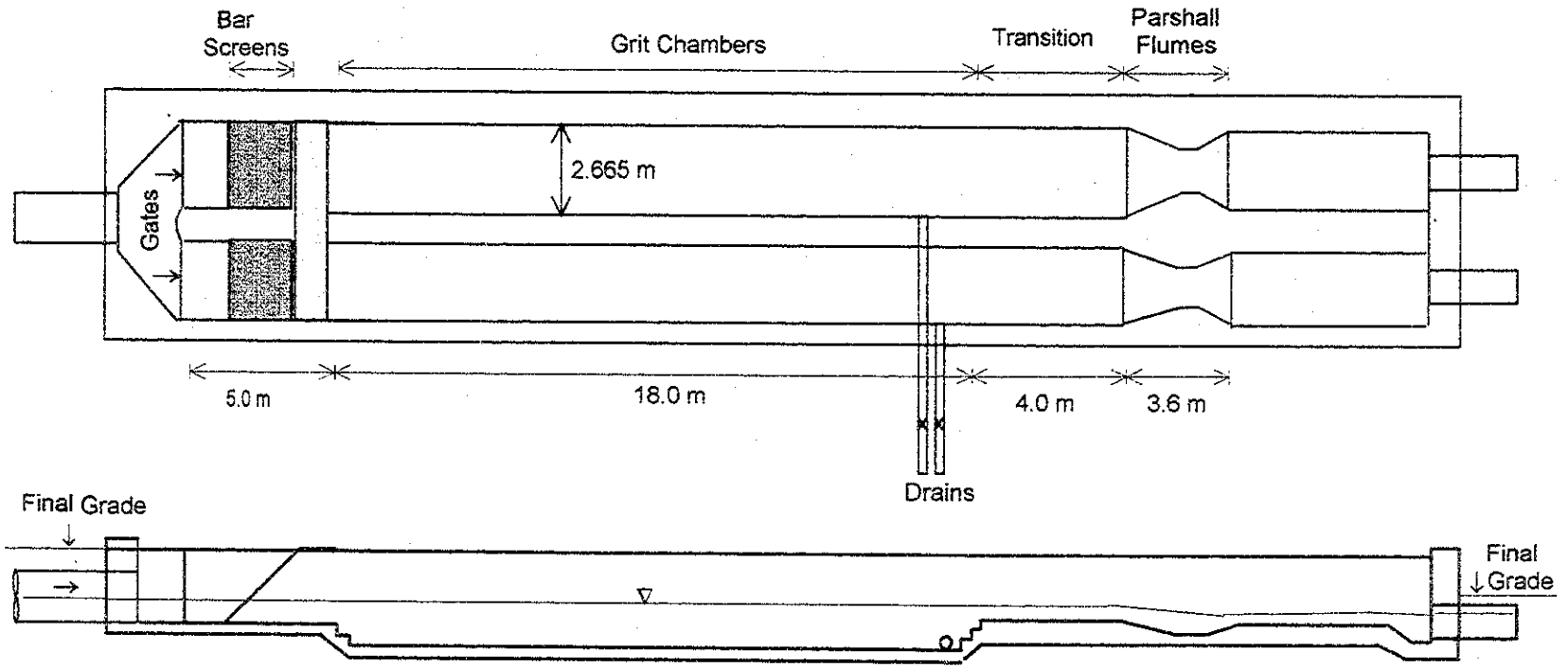


Fig. 7.4.1 LAYOUT OF AERATED LAGOONS AND SEDIMENTATION BASINS, PRIORITY PROJECT

FIGURE 7.4.2

PRELIMINARY TREATMENT WORKS

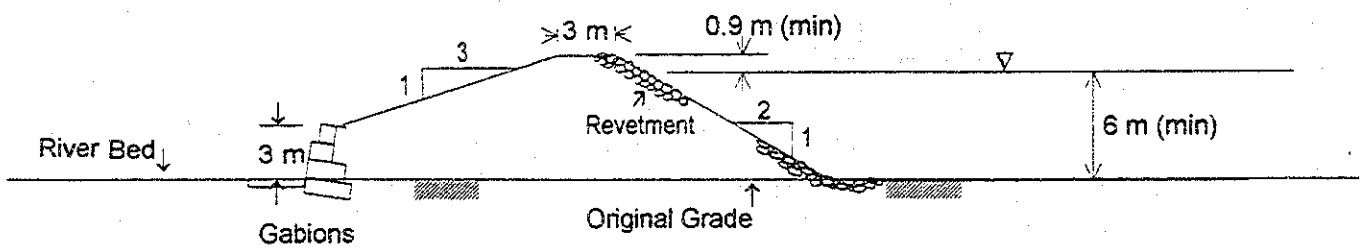
PRIORITY PROJECT



file prewks

SECTION A - A

(Refer to Figure 7.4.5)



File: lagsec2.drw

Fig. 7.4.3 LAGOON CONSTRUCTION

FIGURE 7.4.4
PROFILE OF LAGOONS
SITE 1 - PRIORITY PROJECT

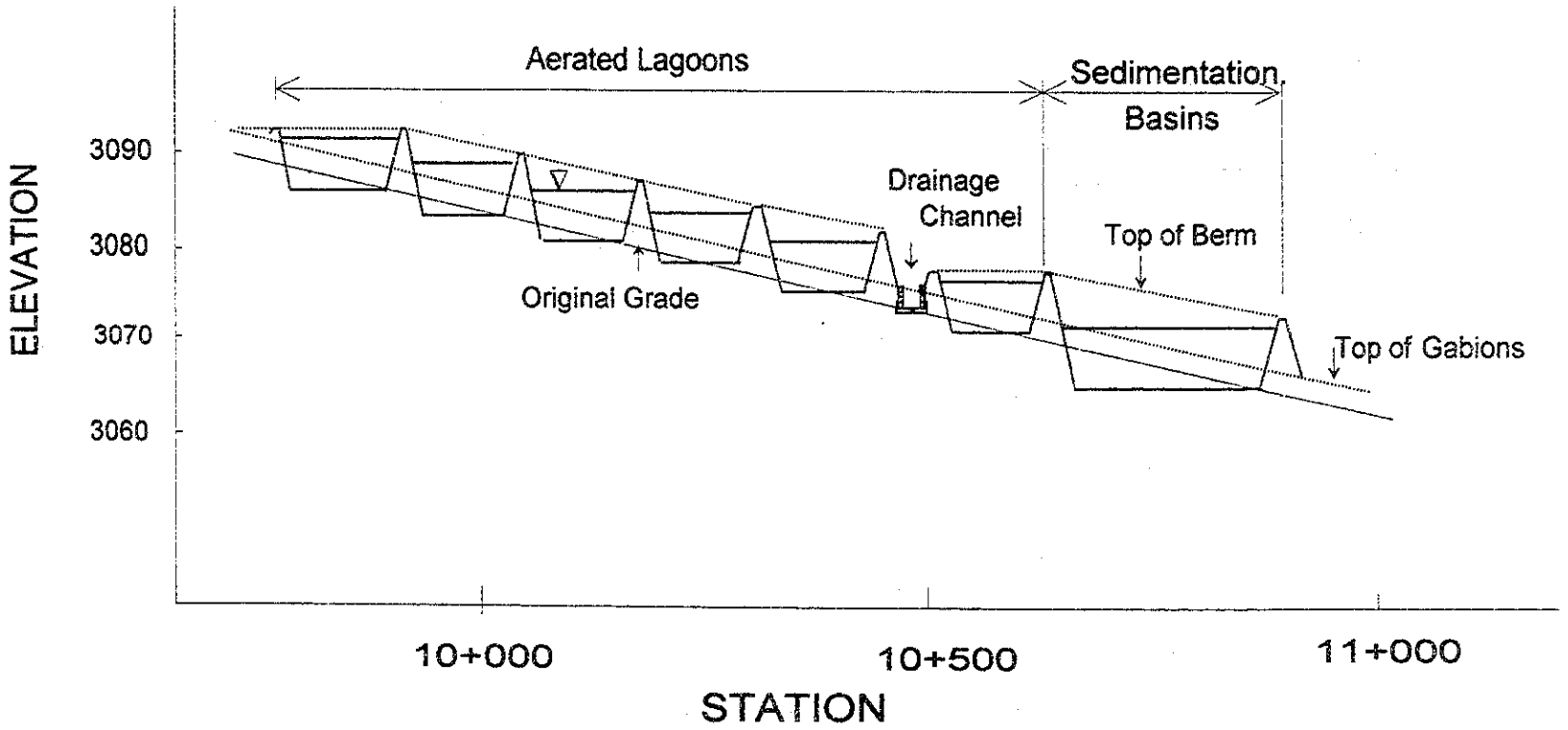


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FIGURE 7.4.5

PLAN - INLET WORKS AND PIPING

SITE 1 - PRIORITY WORKS

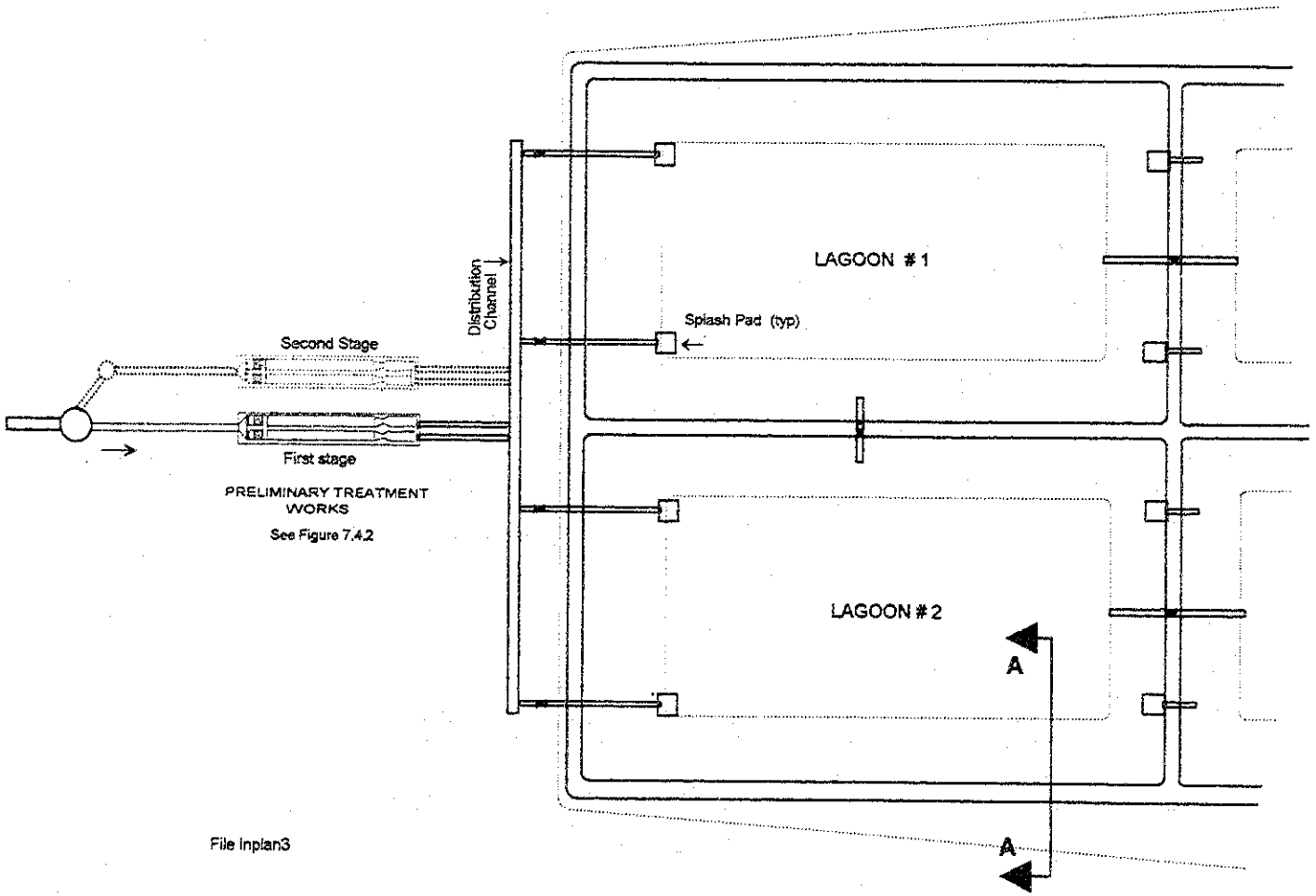
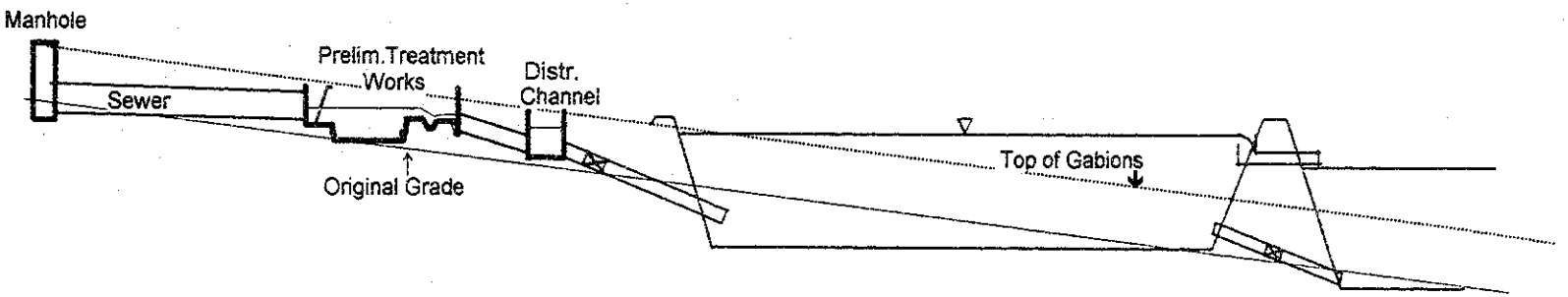


FIGURE 7.4.6

PROFILE - INLET WORKS AND PIPING
SITE 1 PRIORITY PROJECT



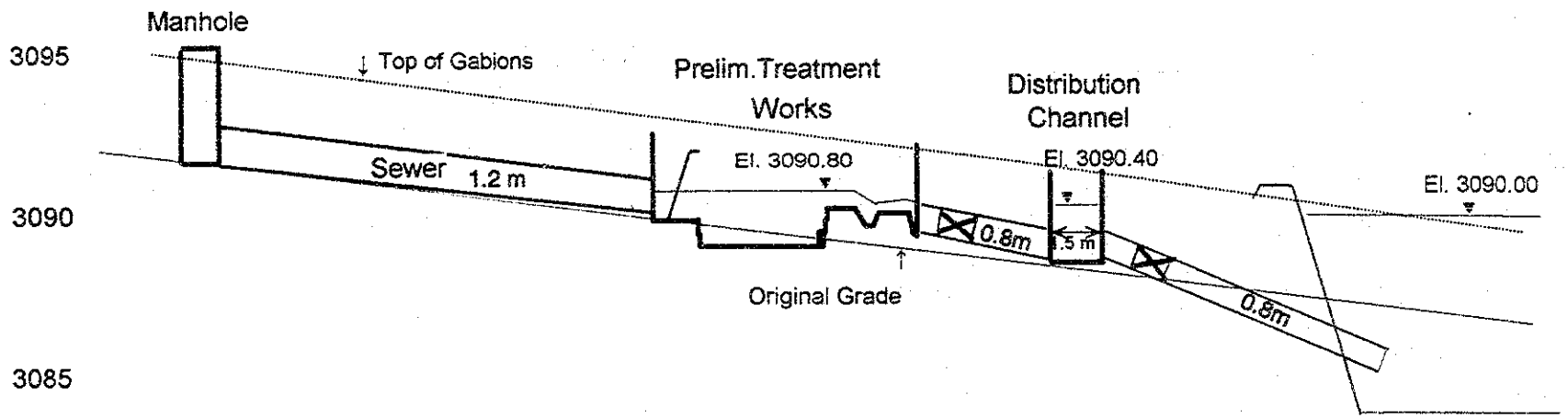
File: INLAG.DRW

FIGURE 7.4.7

HYDRAULIC GRADELINE - INLET WORKS

(Final Design Flow - All Units Operating)

SITE 1 - PRIORITY PROJECT



FILE: HYDGRAD

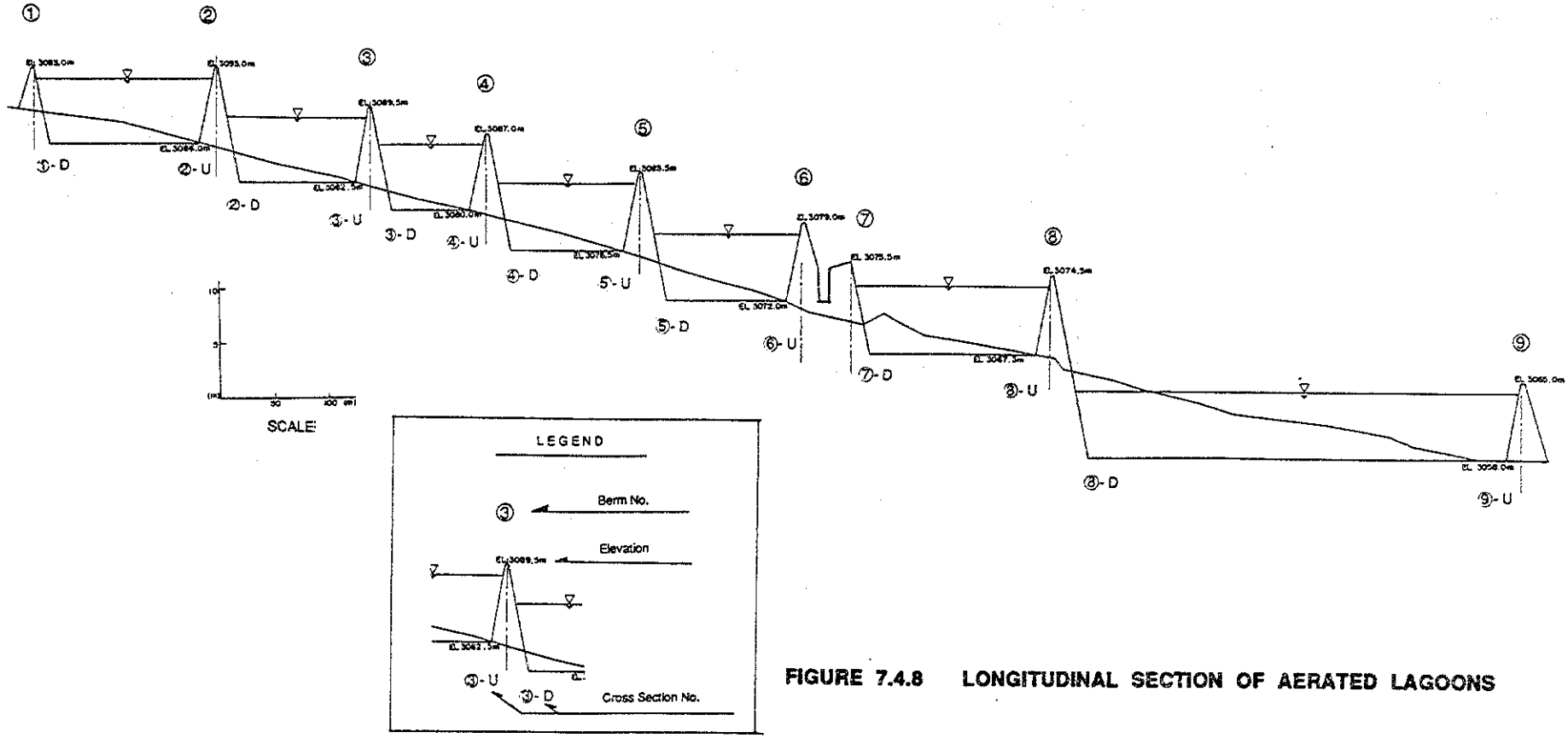
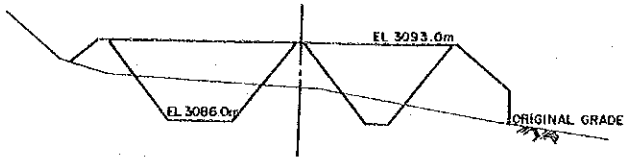


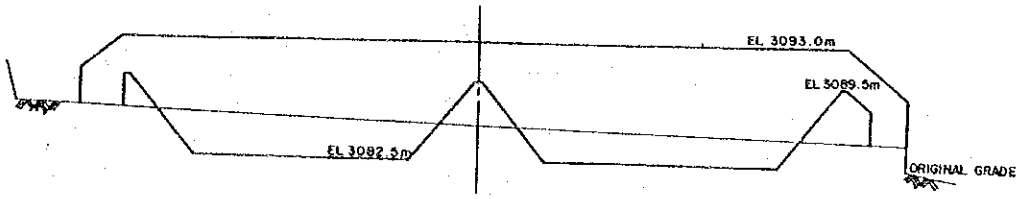
FIGURE 7.4.8 LONGITUDINAL SECTION OF AERATED LAGOONS

LOCATIONS OF CROSS SECTIONS
ARE SHOWN IN FIGURE 7.4.8
AND FIGURE 7.4.1

①- D



②- D



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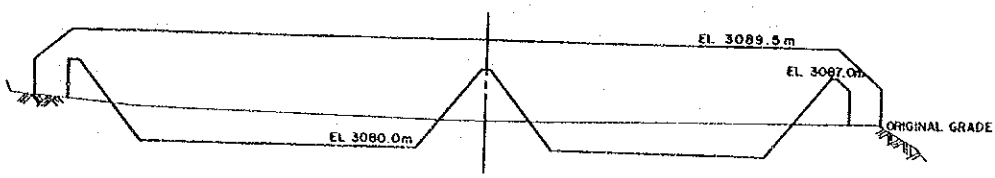

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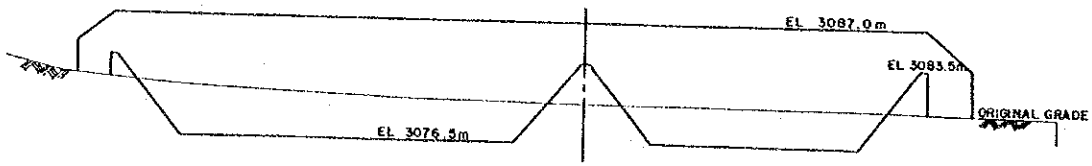
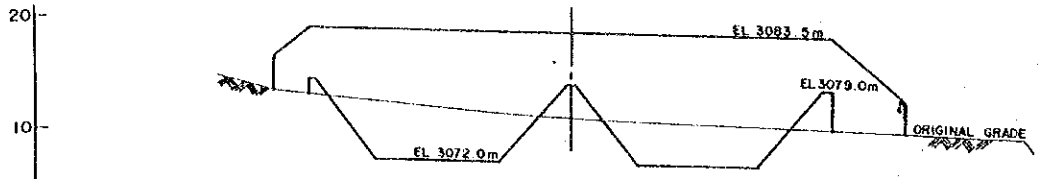


⑤- D



SCALE

FIGURE 7.4.9 CROSS SECTIONS OF AERATED LAGOONS (1 OF 3)

LOCATIONS OF CROSS SECTIONS
ARE SHOWN IN FIGURE 7.4.8.
AND FIGURE 7.4.1

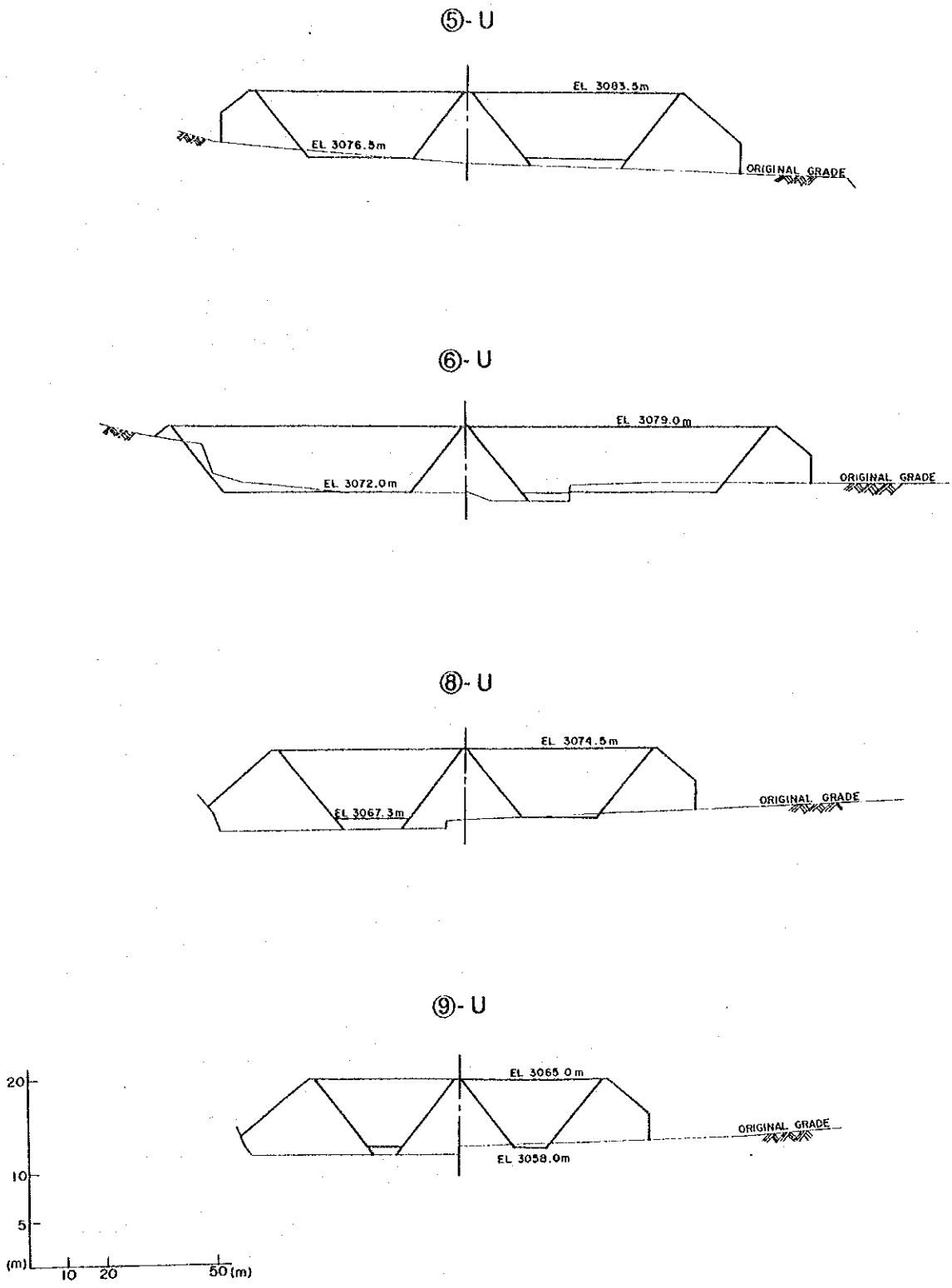
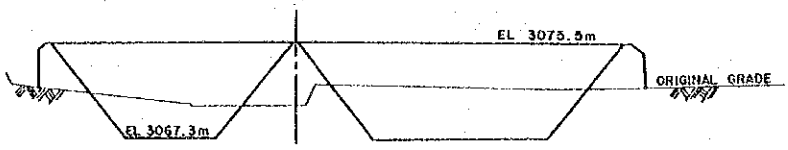


FIGURE 7.4.9 CROSS SECTIONS OF AERATED LAGOONS (2 OF 3)

LOCATIONS OF CROSS SECTIONS
ARE SHOWN IN FIGURE 7.4.8
AND FIGURE 7.4.1

⑦- D



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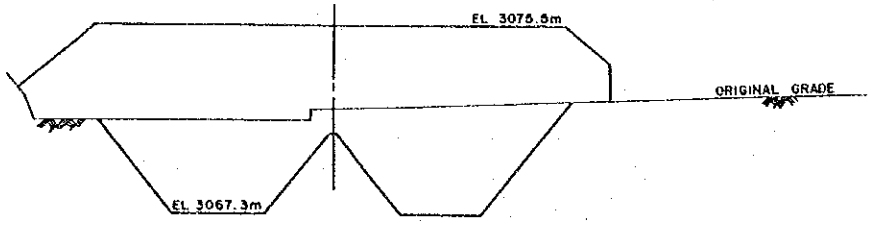

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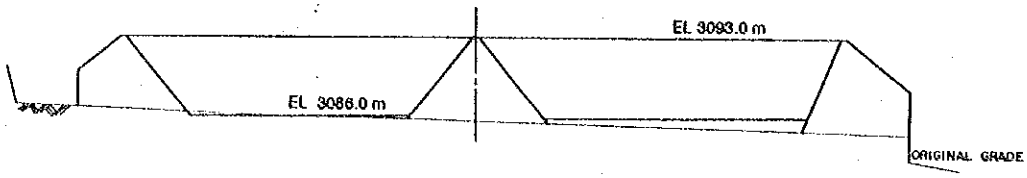

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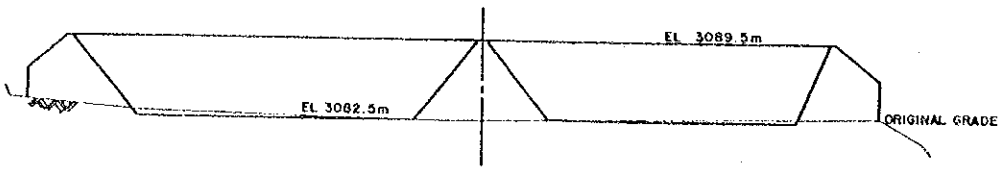

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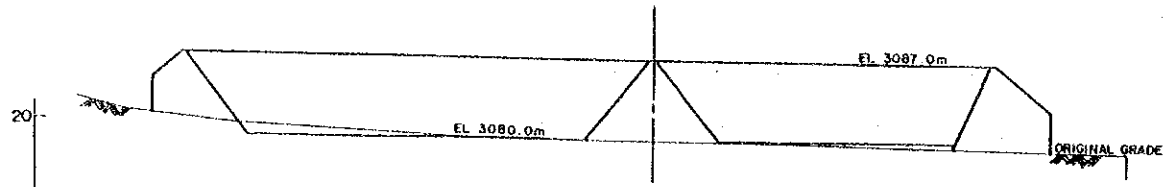


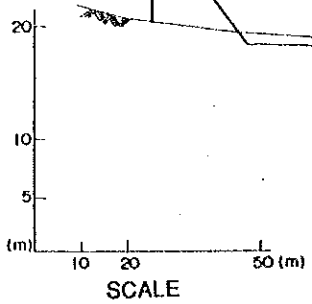


FIGURE 7.4.9 CROSS SECTIONS OF AERATED LAGOONS (3 OF 3)

CHAPTER 8

IMPLEMENTATION PROGRAM

8.1 PROJECT SCHEDULING

To improve the present river water quality urgently, the priority project is planned to be completed within three years. The project can be divided into two major portions; the main sewer interceptor including the water intake facilities and the wastewater treatment plant. Since most works of both portions consist of civil works, construction could take a relatively long time. Consequently, it would be difficult to divide the project into stages for implementation.

Major works in both portions include the works in or near the river, which might be difficult to construct during the rainy season. Those works should be scheduled for the dry season.

Considering these constraints, the proposed time schedule of the priority project is as shown in Fig. 8.1.1.

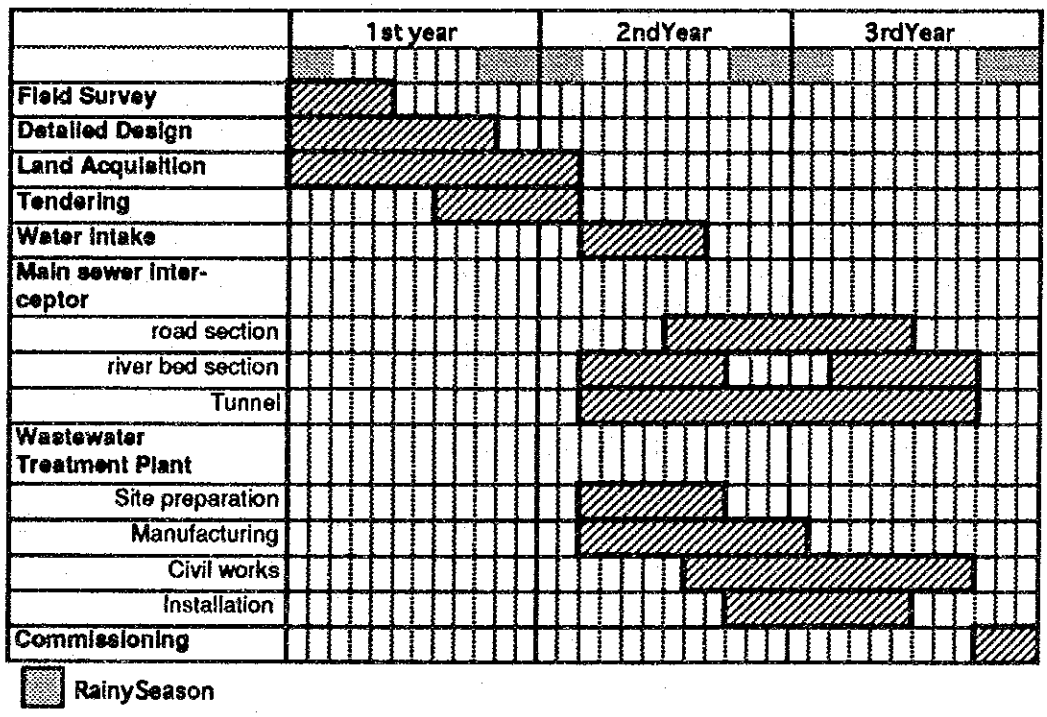


FIGURE 8.1.1 IMPLEMENTATION SCHEDULE FOR THE PRIORITY PROJECT

8.2 ORGANIZATIONAL REQUIREMENTS

8.2.1 General

Non-structural measures required in the management of water pollution control in the City of La Paz were proposed in Section 5.4.3. Each measure should be implemented with appropriate timing in relation to the progress of implementation of the priority project. Among them, organizational reinforcement of the sewerage sector of SAMAPA is vitally important particularly for operation and maintenance of the developed sewerage facilities.

As discussed in Section 5.4.3, Management of Engineering and Project (GIP), would be the responsible unit for the implementation stage of the priority project, and Management of Operation and Maintenance (GOM) would be in charge of operation and maintenance of the developed sewerage system.

An increase of several personnel would be necessary in GIP for the implementation stage of the priority project rather than a substantial increase.

On the other hand, operation and maintenance of the new sewerage facilities would require a considerable number of personnel.

8.2.2 Organization for Operation and Maintenance of Sewerage System

Within SAMAPA's GOM, the Department of Sewerage Operations should be created as soon as possible for general management of operation and maintenance of the existing and newly developed sewerage facilities including those in the priority project and those in El Alto currently being developed.

Table 8.2.1 shows the proposed number of personnel for operation and maintenance of the facilities to be developd in the priority project.

Since operations and maintenance of these facilities require certain skills, training of personnel is essential. A training program should be prepared by the Authority.

The number of personnel should be increased corresponding to completion of subsequent projects proposed in the Basic Plan.

TABLE 8.2.1 PERSONNEL REQUIREMENT FOR OPERATION AND MAINTENANCE OF THE PRIORITY PROJECT SEWERAGE SYSTEM

Facility	Type of Personnel	Number of Personnel	Remark
Wastewater collection and transport facilities	**Water intake and interceptor**		Personnel engaged in O & M of the existing facilities are not included.
	Operator/Engineer	1	
	Laborers	5	
	Night watch	1	
	Drivers	2	
	Sub-total	9	
Wastewater Treatment Plant	**Supervision**		Stationed in the office of the wastewater treatment plant
	Director	1	
	Operators/Engineers	2	
	Preliminary works		
	Laborers	2	
	Mecanical technician	1	
	Aerated lagoons		
	Laborers	5	
	Night watch	2	
	Lab technicians	3	
	Electric technician	1	
	Mechanical technician	1	
	Drivers	2	
	Operations building		
	Administrative staff	1	
	Secretary	1	
	Janitor	1	
	Sub-total	23	
Total		32	

CHAPTER 9

PROJECT EVALUATION

9.1 SOCIAL AND ECONOMIC EVALUATION

9.1.1 Social Evaluation

(1) Consciousness of Inhabitants and Entrepreneurs

Sewerage systems are expensive public facilities and directly influence living conditions of people and businesses. Because of its high initial cost and operating cost, these system sometimes causes friction with the beneficiaries such as inhabitants and entrepreneurs. This is because of the following problems: 1) sewage treatment plants are disliked by people since the plant are thought to pollute the surroundings, and 2) beneficiaries have to bear the expenses of system operation and maintenance as well as capital costs.

People usually give their approval to the introduction of such systems, but they would reject it if the treatment plant is built next to their houses. If sewerage tariffs are much higher than expected, people might also reject the system. Hence, understanding of the system by the beneficiaries and entities concerned would be quite important to be implemented with success. The system might be enthusiastically received by them so long as there is a general consensus of opinion among them.

(2) Changes of Agricultural Production

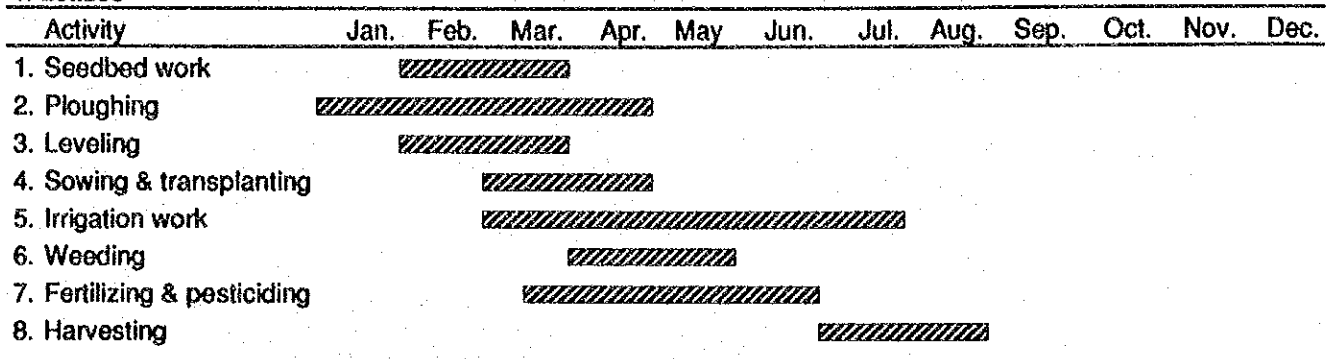
The selected wastewater treatment plant sites are located in the flood plain of the Choqueyapu River. Although these lands are publicy owned, some are privately cultivated for crop production. However, it is not known exactly how large the cultivated areas are, because there are no land use maps for the zone.

According to the questionnaire survey at the plant sites in November 1992, it was found that the following crops are cultivated in the farm lands: horticulture such as gladiolus, daisies and carnations; cereal such as potatoes and maize; and vegetables such as lettuces, carrots, radish and silverbeet. Table 9.1.1 shows the result of the interview survey. The products are transported by wholesalers and consumed in the markets of La Paz City.

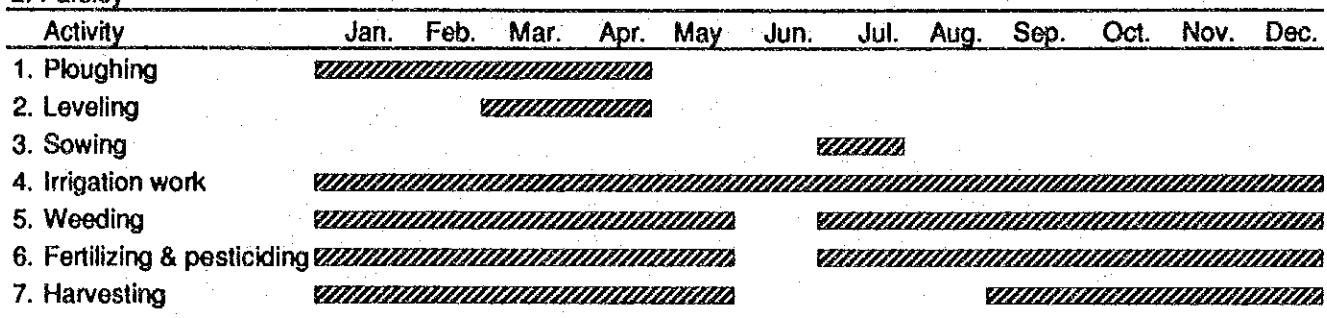
Research by MACA (Ref. J8) in March 1992 reports on the present conditions of agricultural activities in the lower Choqueyapu River basin just after the cholera

TABLE 9.1.1 CROPPING PATTERN OF AGRICULTURAL PRODUCTS CULTIVATED AT SELECTED PLANT SITES OF PRIORITY PROJECT

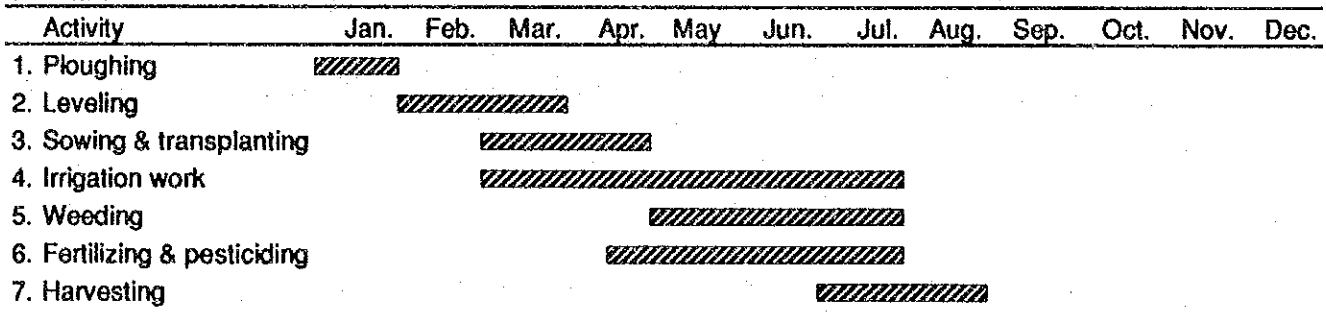
1. Lettuce



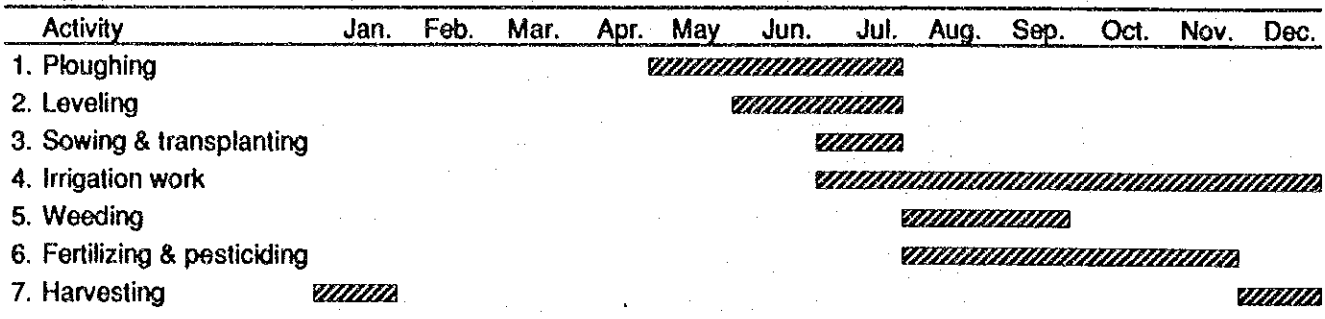
2. Parsley



3. Potato



4. Maize



Source: Ref.J8 (Alternativas de Produccion Agricola y Pecuaria en la Region de Rio Abajo, Provincia Murillo del Departamento de La Paz, March 1992, MACA)

scare. Table 9.1.2 shows the distribution of cultivated lands by product and community. Table 9.1.3 shows cropping patterns of typical products in the basin. The selected plant sites are mainly located near the community of Lipari. During and after the cholera scare, farmers in the community stopped producing vegetables because they were losing marketability. They had to change from vegetables to other products such as flowers and cereals, as mentioned earlier.

Hence, the plant sites and their surrounding crop producing areas are supplying fresh vegetables and flowers at present. Although farmers in the basin were affected by the cholera scare and changed their products, they will remain as food suppliers because of their convenient location to the markets. Thus, if the selected lands were to be converted to treatment plant sites, the lower basin areas might compensate for the crop production for the markets previously supplied by the plant sites.

(3) Stimulation of Regional Economy

Construction materials and labor would be essential to build the sewerage system proposed in the priority project. The construction work of the sewerage system would then stimulat the regional economy in the La Paz area. The effects of these economic impacts are discussed in this section.

The effect on the regional economy is measured through a Leontief inverse matrix. The inverse matrix is calculated on the basis of an input-output table. In this study, however, the national input-output table must be applied to estimate the regional effect, because there is no regional input-output table for La Paz Department.

The latest input-output table was prepared in 1991. The table was prepared as competitive import type. In the table, the domestic production part indicates the inter-industrial intermediate relation of the national domestic market. The table is useful to measure economic effects of project investment in the national economy. Table 9.1.4 shows the input-output table for Bolivia in 1991.

Table 9.1.5 indicates a coefficient of input from the production sectors, which is compiled through Table 9.1.4. As shown in Table 9.1.5, when one unit of public funds is invested in the construction sector (sector 23 in the table) of the national market, approximately 56.3% of intermediate goods and services would be procured from the domestic market. Of the total domestic procurement of 56.3%,

TABLE 9.1.2 DISTRIBUTION OF FARMLANDS CULTIVATING CROPS CONSIDERED TO BE CARRIERS OF CHOLERA IN LOWER CHOQUEYAPU RIVER

(Unit: ha)

Comunity	Lettuce	Tomato	Celery	Parsley	Radish	Total
1. Lipari	3	0	0	2.5	0	5.5
2. Valencia	4	4	0	0	10	18
3. Mecapaca	8	0	0	0	0	8
4. Huayuasi	20	7	0	10	5	42
5. Avircato	8	5	0	0	0	13
6. Palomar	50	0	0	20	40	110
7. Millucato	15	25	5	6	3	54
8. Huricana Alto	15	15	0	0	30	60
9. Huricana Bajo	5	5	0	0	0	10
10. Tahuapalca	10	6	3	10	0	29
11. Tirata	19	60	5	0	0	84
12. Chaja	1	6	0	0	0	7
Total	158	133	13	48.5	88	440.5

Source: Ref.J8

TABLE 9.1.3 SAMPLE HEARING SURVEY OF CROPPING PATTERN AT SELECTED PLANT SITES OF PRIORITY PROJECT

1. Survey Point A: 1,000 sq.m. of Cultivated Land

Crop	Area (sq.m.)	1991 Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	1992 Apr.	May	Jun.	Jul.	Aug.	Sep.
1. Flower*1	1,000												
2. Parsley & Silverbeet	500												
3. Maize	500												
4. Potatoes	500												

Note: *1 Daisies and gladiolus
*2 Farmgate prices Daisy: Bs.12 per 1 dozen Parsley: Bs.1 per piece
Silverbeet: Bs.1 per 3 pieces Corn: Bs.40 per 160 pieces
Potatoes: Bs.13-15 per arroba (25 pounds)

2. Survey Point B: 600 sq.m. of Cultivated Land

Crop	Area (sq.m.)	1991 Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	1992 Apr.	May	Jun.	Jul.	Aug.	Sep.
1. Flower (gladiolus)	300												
2. Carrots & Lettuces	300												
3. Potatoes	300												
4. Maize	300												

Note: Farmgate prices Flower: Bs.2 per 1 dozen Carrots: Bs.18 per arroba (25 pounds)

3. Survey Point C: 1,500 sq.m. of Cultivated Land

Crop	Area (sq.m.)	1991 Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	1992 Apr.	May	Jun.	Jul.	Aug.	Sep.
1. Potatoes	1,500												
2. Beetroot	750												
3. Lettuces	750												

Note: Farmgate prices Potatoes: Bs.13-15 per arroba (25 pounds)
Beetroot: Bs.30 per 1 bag Lettuces: Bs.20 per 100 pieces

4. Survey Point D: 1,000 sq.m. of Cultivated Land

Crop	Area (sq.m.)	1991 Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	1992 Apr.	May	Jun.	Jul.	Aug.	Sep.
1. Lettuces	400												
2. Radish	300												
3. Flower (gladiolus)	300												
4. Flower (daisies)	300												
5. Flower (carnations)	300												
6. Silverbeet	400												

Table 9.1.4(1) INPUT-OUTPUT TABLE OF BOLIVIA: 1991

	Receiving Sector										
Delivering Sector	1	2	3	4	5	6	7	8	9	10	11
1 Agriculture	2099	663	0	0	0	26	0	3256	1382	484	221
2 Livestock	30	46	0	0	0	3710	334	22	0	0	0
3 Forestry & Fishery	24	7	0	0	130	0	0	7	4	0	0
4 Crude Oil & Gas	0	0	0	0	0	0	0	0	15	1	0
5 Mining & Quarrying	0	0	0	0	0	0	0	0	0	0	0
6 Mear Products	0	0	0	0	0	87	0	86	0	35	0
7 Daily Products	0	0	0	0	0	0	78	7	0	0	0
8 Flour & Breads	0	0	0	0	0	5	0	2228	3	177	25
9 Sugar & Confectionery	0	5	0	0	0	0	42	84	39	29	219
10 General Foods	0	339	0	0	0	43	4	278	1	306	96
11 Beverages	0	0	0	0	0	0	0	0	0	0	444
12 Tobacco	0	0	0	0	0	0	0	0	0	0	0
13 Textile & Garment	34	0	1	10	77	0	0	103	98	33	1
14 Wood Products	1	0	0	0	21	0	0	5	3	0	1
15 Paper Products	0	0	0	0	0	2	2	85	4	7	0
16 Chemical Products	512	106	2	2	410	4	20	83	38	107	119
17 Petroleum Refinery	185	5	8	1	107	40	26	101	64	28	47
18 Ceramics, Non-Metal Products	25	0	1	0	49	0	2	0	4	5	194
19 Basic Metal Products	0	0	0	0	32	0	0	0	0	0	12
20 Metal, Machinery, Electric.	96	0	6	156	341	33	6	55	194	61	59
21 Other Manufacturing	0	0	0	2	4	0	0	3	3	3	13
22 Elec. gas & Water Supply	0	0	0	0	513	15	2	72	51	56	61
23 Construction	6	0	0	31	15	0	0	0	0	0	1
24 Trade & Catering	0	0	0	0	0	0	0	0	0	0	0
25 Transport	313	0	52	525	344	280	10	156	345	93	49
26 Communication	0	0	0	2	15	1	0	6	4	1	3
27 Financial Services	52	5	1	553	158	2	6	20	77	19	96
28 Housing Services	0	0	0	0	0	0	0	0	0	0	0
29 Social Services	12	1	0	15	32	0	0	7	6	0	18
30 Personal Services	0	0	0	0	0	0	0	0	0	0	0
31 Government Services	0	0	0	0	0	0	0	0	0	0	0
Total Input	3389	1177	71	1297	2248	4248	532	6664	2335	1445	1679
Total Output	24162	6723	663	9247	13606	5628	846	8655	4364	1782	5272
Gross Value Added	20773	5546	592	7950	11358	1380	314	1991	2029	337	3593

Source: Ref.A17

Table 9.1.4(2) INPUT-OUTPUT TABLE OF BOLIVIA: 1991

	Receiving Sector										
Delivering Sector	12	13	14	15	16	17	18	19	20	21	22
1 Agriculture	10	87	0	0	0	0	0	0	0	0	0
2 Livestock	0	39	0	0	0	0	0	0	0	0	0
3 Forestry & Fishery	0	16	172	0	119	0	0	41	0	0	0
4 Crude Oil & Gas	0	0	0	0	0	2545	16	0	0	0	203
5 Mining & Quarrying	0	0	0	0	8	0	110	3380	0	2	0
6 Mear Products	0	87	0	0	4	0	0	0	0	0	0
7 Daily Products	0	0	0	0	0	0	0	0	0	0	0
8 Flour & Breads	0	0	0	0	0	0	0	0	0	0	0
9 Sugar & Confectionery	0	0	0	0	1	0	0	0	0	0	0
10 General Foods	0	0	0	0	9	0	0	0	0	0	5
11 Beverages	0	0	0	0	6	0	0	0	0	0	0
12 Tobacco	90	0	0	0	0	0	0	0	0	0	0
13 Textile & Garment	0	1052	17	0	3	0	0	0	0	26	5
14 Wood Products	0	5	181	0	0	0	0	2	10	0	15
15 Paper Products	18	0	0	256	31	0	63	0	0	0	11
16 Chemical Products	14	149	29	77	410	34	61	8	24	20	35
17 Petroleum Refinery	0	22	6	0	37	130	330	53	1	1	306
18 Ceramics, Non-Metal Products	0	0	0	0	15	2	142	0	2	0	41
19 Basic Metal Products	0	0	0	0	16	0	0	203	143	30	0
20 Metal, Machinery, Electric.	0	10	11	7	31	4	74	35	103	2	92
21 Other Manufacturing	3	36	1	4	2	2	0	3	0	0	5
22 Elec. gas & Water Supply	1	24	5	0	16	34	90	23	4	1	5
23 Construction	0	0	0	0	0	2	0	0	0	0	12
24 Trade & Catering	0	0	0	0	0	0	0	0	0	0	0
25 Transport	0	16	30	7	39	752	60	32	5	0	8
26 Communication	0	2	0	1	7	12	2	3	0	0	11
27 Financial Services	2	46	0	13	26	165	16	174	12	2	151
28 Housing Services	0	0	0	0	0	0	0	0	0	0	0
29 Social Services	0	11	2	0	10	9	0	2	1	0	34
30 Personal Services	0	0	0	0	0	0	0	0	0	0	0
31 Government Services	0	0	0	0	0	0	0	0	0	0	0
Total Input	138	1602	454	365	790	3691	964	3959	305	84	939
Total Output	636	2595	878	652	1285	5643	2122	5359	618	253	2180
Gross Value Added	498	993	424	287	495	1952	1158	1400	313	169	1241

Table 9.1.4(3) INPUT-OUTPUT TABLE OF BOLIVIA: 1991

	Receiving Sector									
Delivering Sector	23	24	25	26	27	28	29	30	31	Total Inter-mediate Use
1 Agriculture	0	0	0	0	0	0	314	0	216	8,760
2 Livestock	0	0	0	0	0	0	6	0	4	4,195
3 Forestry & Fishery	5	0	0	0	0	0	0	0	3	534
4 Crude Oil & Gas	0	0	0	0	0	0	0	0	0	2,788
5 Mining & Quarrying	268	0	0	0	0	0	0	0	0	3,778
6 Mear Products	0	0	0	0	0	0	428	0	29	768
7 Dally Products	0	0	0	0	0	0	20	0	3	122
8 Flour & Breads	0	0	0	0	0	0	41	0	42	2,537
9 Sugar & Confectionery	0	0	0	0	0	0	17	0	10	464
10 General Foods	0	0	0	0	0	0	34	0	20	1,155
11 Beverages	0	0	0	0	0	0	2916	0	0	3,388
12 Tobacco	0	0	0	0	0	0	0	0	0	114
13 Textile & Garment	0	64	46	8	11	0	6	0	382	2,003
14 Wood Products	393	0	86	11	0	0	2	0	68	832
15 Paper Products	3	90	26	58	134	0	4	0	81	905
16 Chemical Products	286	88	1138	9	23	0	249	0	63	4,152
17 Petroleum Refinery	1	94	2121	3	19	0	25	0	475	4,270
18 Ceramics, Non-Metal Products	1386	0	8	13	0	0	7	0	285	2,217
19 Basic Metal Products	579	0	90	0	0	0	0	0	0	1,143
20 Metal, Machinery, Electric.	1126	203	1339	98	66	0	29	0	1253	5,530
21 Other Manufacturing	5	30	9	28	44	0	94	0	24	360
22 Elec. gas & Water Supply	1	172	8	121	32	0	81	0	48	1,480
23 Construction	0	2	0	32	5	300	0	0	73	525
24 Trade & Catering	0	0	0	0	0	0	0	0	0	48
25 Transport	32	5198	273	50	70	0	32	0	408	9,229
26 Communication	0	641	11	8	206	0	19	0	444	1,451
27 Financial Services	240	917	1589	318	1186	53	77	0	153	6,183
28 Housing Services	0	0	0	0	0	0	0	0	0	56
29 Social Services	5	60	252	50	127	0	51	0	20	783
30 Personal Services	0	0	0	0	0	0	0	0	0	60
31 Government Services	0	0	0	0	0	0	0	0	52	114
Total Input	4330	7559	6996	807	1923	353	4452	0	4156	68,952
Total Output	7694	24016	16078	2496	5737	10682	8310	742	15182	194,106
Gross Value Added	3364	16457	9082	1689	3814	10329	3858	742	11026	125,154

Table 9.1.5(1) INPUT COEFFICIENT TABLE OF DOMESTIC INTERMEDIATE SECTORS: 1991

Delivering Sector	Receiving Sector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Agriculture	0.0869	0.0986	0.0000	0.0000	0.0000	0.0046	0.0000	0.3762	0.3167	0.2716	0.0419	0.0157	0.0335	0.0000	0.0000	0.0000
2 Livestock	0.0012	0.0068	0.0000	0.0000	0.0000	0.6592	0.3948	0.0025	0.0000	0.0000	0.0000	0.0000	0.0150	0.0000	0.0000	0.0000
3 Forestry & Fishery	0.0010	0.0010	0.0000	0.0000	0.0096	0.0000	0.0000	0.0008	0.0009	0.0000	0.0000	0.0000	0.0062	0.1959	0.0000	0.0926
4 Crude Oil & Gas	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5 Mining & Quarrying	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0062
6 Mear Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0155	0.0000	0.0099	0.0000	0.0196	0.0000	0.0000	0.0335	0.0000	0.0000	0.0031
7 Daily Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0922	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8 Flour & Breads	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.2574	0.0007	0.0993	0.0047	0.0000	0.0000	0.0000	0.0000	0.0000
9 Sugar & Confectionery	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0496	0.0097	0.0089	0.0163	0.0415	0.0000	0.0000	0.0000	0.0000	0.0008
10 General Foods	0.0000	0.0504	0.0000	0.0000	0.0000	0.0076	0.0047	0.0321	0.0002	0.1717	0.0182	0.0000	0.0000	0.0000	0.0000	0.0070
11 Beverages	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0842	0.0000	0.0000	0.0000	0.0000	0.0047
12 Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1415	0.0000	0.0000	0.0000	0.0000
13 Textile & Garment	0.0014	0.0000	0.0015	0.0011	0.0057	0.0000	0.0000	0.0119	0.0225	0.0185	0.0002	0.0000	0.4054	0.0194	0.0000	0.0023
14 Wood Products	0.0000	0.0000	0.0000	0.0000	0.0015	0.0000	0.0000	0.0006	0.0007	0.0000	0.0002	0.0000	0.0019	0.2062	0.0000	0.0000
15 Paper Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0024	0.0098	0.0009	0.0039	0.0000	0.0283	0.0000	0.0000	0.3926	0.0241
16 Chemical Products	0.0212	0.0158	0.0030	0.0002	0.0301	0.0007	0.0236	0.0096	0.0087	0.0600	0.0226	0.0220	0.0574	0.0330	0.1181	0.3191
17 Petroleum Refinery	0.0077	0.0007	0.0121	0.0001	0.0079	0.0071	0.0307	0.0117	0.0147	0.0157	0.0089	0.0000	0.0085	0.0068	0.0000	0.0288
18 Ceramics, Non-Metal Products	0.0010	0.0000	0.0015	0.0000	0.0036	0.0000	0.0024	0.0000	0.0009	0.0028	0.0368	0.0000	0.0000	0.0000	0.0000	0.0117
19 Basic Metal Products	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0000	0.0000	0.0125
20 Metal, Machinery, Electric.	0.0040	0.0000	0.0090	0.0169	0.0251	0.0059	0.0071	0.0064	0.0445	0.0342	0.0112	0.0000	0.0039	0.0125	0.0107	0.0241
21 Other Manufacturing	0.0000	0.0000	0.0000	0.0002	0.0003	0.0000	0.0000	0.0003	0.0007	0.0017	0.0025	0.0047	0.0139	0.0011	0.0061	0.0016
22 Elec. gas & Water Supply	0.0000	0.0000	0.0000	0.0000	0.0377	0.0027	0.0024	0.0083	0.0117	0.0314	0.0116	0.0016	0.0092	0.0057	0.0000	0.0125
23 Construction	0.0002	0.0000	0.0000	0.0034	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
24 Trade & Catering	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25 Transport	0.0130	0.0000	0.0784	0.0568	0.0253	0.0498	0.0118	0.0180	0.0791	0.0522	0.0093	0.0000	0.0062	0.0342	0.0107	0.0304
26 Communication	0.0000	0.0000	0.0000	0.0002	0.0011	0.0002	0.0000	0.0007	0.0009	0.0006	0.0006	0.0000	0.0008	0.0000	0.0015	0.0054
27 Financial Services	0.0022	0.0007	0.0015	0.0598	0.0116	0.0004	0.0071	0.0023	0.0176	0.0107	0.0182	0.0031	0.0177	0.0000	0.0199	0.0202
28 Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29 Social Services	0.0005	0.0001	0.0000	0.0016	0.0024	0.0000	0.0000	0.0008	0.0014	0.0000	0.0034	0.0000	0.0042	0.0023	0.0000	0.0078
30 Personal Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31 Government Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.1403	0.1751	0.1071	0.1403	0.1652	0.7548	0.6288	0.7700	0.5351	0.8109	0.3185	0.2170	0.6173	0.5171	0.5598	0.6148

Table 9.1.5(2) INPUT COEFFICIENT TABLE OF DOMESTIC INTERMEDIATE SECTORS: 1991

Delivering Sector	Receiving Sector 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	mediate
1 Agriculture	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0378	0.0000	0.0142	0.0451
2 Livestock	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0003	0.0216
3 Forestry & Fishery	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0028
4 Crude Oil & Gas	0.4510	0.0075	0.0000	0.0000	0.0000	0.0931	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0144
5 Mining & Quarrying	0.0000	0.0518	0.6307	0.0000	0.0079	0.0000	0.0348	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0195
6 Mear Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0515	0.0000	0.0019	0.0040
7 Daily Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0000	0.0002	0.0006
8 Flour & Breads	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0000	0.0028	0.0131
9 Sugar & Confectionery	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0007	0.0024
10 General Foods	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0000	0.0013	0.0060
11 Beverages	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3509	0.0000	0.0000	0.0175
12 Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
13 Textile & Garment	0.0000	0.0000	0.0000	0.0000	0.1028	0.0023	0.0000	0.0027	0.0029	0.0032	0.0019	0.0000	0.0007	0.0000	0.0252	0.0103
14 Wood Products	0.0000	0.0000	0.0004	0.0162	0.0000	0.0069	0.0511	0.0000	0.0053	0.0044	0.0000	0.0000	0.0002	0.0000	0.0045	0.0043
15 Paper Products	0.0000	0.0297	0.0000	0.0000	0.0000	0.0050	0.0004	0.0037	0.0016	0.0232	0.0234	0.0000	0.0005	0.0000	0.0053	0.0047
16 Chemical Products	0.0060	0.0287	0.0015	0.0388	0.0791	0.0161	0.0372	0.0037	0.0708	0.0036	0.0040	0.0000	0.0300	0.0000	0.0041	0.0214
17 Petroleum Refinery	0.0230	0.1555	0.0099	0.0016	0.0040	0.1404	0.0001	0.0039	0.1319	0.0012	0.0033	0.0000	0.0030	0.0000	0.0313	0.0220
18 Ceramics, Non-Metal Products	0.0004	0.0669	0.0000	0.0032	0.0000	0.0188	0.1801	0.0000	0.0005	0.0052	0.0000	0.0000	0.0008	0.0000	0.0188	0.0114
19 Basic Metal Products	0.0000	0.0000	0.0379	0.2314	0.1186	0.0000	0.0753	0.0000	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059
20 Metal, Machinery, Electric.	0.0007	0.0349	0.0065	0.1667	0.0079	0.0422	0.1463	0.0085	0.0833	0.0393	0.0115	0.0000	0.0035	0.0000	0.0825	0.0285
21 Other Manufacturing	0.0004	0.0000	0.0006	0.0000	0.0000	0.0023	0.0006	0.0012	0.0006	0.0112	0.0077	0.0000	0.0113	0.0000	0.0016	0.0019
22 Elec. gas & Water Supply	0.0060	0.0424	0.0043	0.0065	0.0040	0.0023	0.0001	0.0072	0.0005	0.0485	0.0056	0.0000	0.0097	0.0000	0.0032	0.0076
23 Construction	0.0004	0.0000	0.0000	0.0000	0.0000	0.0055	0.0000	0.0001	0.0000	0.0128	0.0009	0.0281	0.0000	0.0000	0.0048	0.0027
24 Trade & Catering	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
25 Transport	0.1333	0.0283	0.0060	0.0081	0.0000	0.0037	0.0042	0.2164	0.0170	0.0200	0.0122	0.0000	0.0039	0.0000	0.0269	0.0475
26 Communication	0.0021	0.0009	0.0006	0.0000	0.0000	0.0050	0.0000	0.0267	0.0007	0.0032	0.0359	0.0000	0.0023	0.0000	0.0292	0.0075
27 Financial Services	0.0292	0.0075	0.0325	0.0194	0.0079	0.0693	0.0312	0.0382	0.0988	0.1274	0.2067	0.0050	0.0093	0.0000	0.0101	0.0319
28 Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
29 Social Services	0.0016	0.0000	0.0004	0.0016	0.0000	0.0156	0.0006	0.0025	0.0157	0.0200	0.0221	0.0000	0.0061	0.0000	0.0013	0.0040
30 Personal Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
31 Government Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034	0.0006
Total	0.6541	0.4543	0.7388	0.4935	0.3320	0.4307	0.5628	0.3147	0.4351	0.3233	0.3352	0.0330	0.5357	0.0000	0.2737	0.3603

18.0% is from the manufacturing sector of non-metallic products such as cement and ceramics, and 14.6% is from the manufacturing sector of metal products and machinery, as shown in the table.

On the basis of Table 9.1.5, the Leontief inverse matrix of Bolivia is calculated as shown in Table 9.1.6. This matrix indicates the effects induced by the investment. When one monetary unit is invested in the construction sector (sector 23), 2.06 units of the investment effects would be induced in the regional economy. This includes one unit for the construction sector as a direct effect and 1.06 units through the other economic sectors as indirect effects. Thus, these components show direct and indirect positive economic effects on respective production sectors. On the other land, if the relative sectors do not have the reserve production capacity to support the new investment, it might simply raises the prices of construction materials.

9.1.2 Economic Evaluation

(1) Basic Points of Economic Evaluation

In estimating the economic costs and benefits, the economic values are estimated under the following conditions and assumptions, which are the almost the same items enumerated in Section 5.3.5. Hence, since only the points which are different from the items listed in the Basic Plan stage are enumerated below. Other points should be referred to the items in Section 5.3.5.

1) In the economic analysis, all goods and service included in the project costs and benefits are estimated on the basis of real economic value. In terms of non-tradable goods and services in local market, the following points are considered in converting their financial values to economic ones: (a) internal transfer payment such as taxes including value added taxes and (b) the shadow wages of unskilled labour in particular, taking unemployment and underemployment conditions into account. In this section, the economic value of these goods and services are converted from the financial values by using a conversion rate of 0.85. On the other hand, the tradable goods and services are estimated based on the international market prices, so their values reflect real economic ones. The financial value of these goods and services is used as their economic value without any conversion.

Table 9.1.6(1) LEONTIEF INVERSE MATRIX OF DOMESTIC INTERMEDIATE SECTORS: 1991

	Receiving Sector															
Delivering Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Agriculture	1.0957	0.1316	0.0004	0.0005	0.0011	0.0973	0.0791	0.5821	0.3528	0.4409	0.0786	0.0204	0.0723	0.0026	0.0017	0.0076
2 Livestock	0.0016	1.0082	0.0002	0.0003	0.0007	0.6753	0.4388	0.0159	0.0023	0.0204	0.0010	0.0002	0.0646	0.0020	0.0010	0.0042
3 Forestry & Fishery	0.0047	0.0045	1.0018	0.0014	0.0155	0.0042	0.0066	0.0078	0.0066	0.0156	0.0053	0.0047	0.0263	0.2547	0.0280	0.1399
4 Crude Oil & Gas	0.0059	0.0029	0.0114	1.0045	0.0136	0.0096	0.0211	0.0165	0.0210	0.0282	0.0144	0.0015	0.0147	0.0128	0.0078	0.0313
5 Mining & Quarrying	0.0021	0.0015	0.0038	0.0053	1.0089	0.0035	0.0045	0.0051	0.0119	0.0145	0.0092	0.0018	0.0077	0.0067	0.0112	0.0324
6 Mear Products	0.0003	0.0016	0.0003	0.0004	0.0008	1.0171	0.0012	0.0162	0.0018	0.0282	0.0012	0.0003	0.0587	0.0020	0.0014	0.0061
7 Daily Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.1016	0.0012	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8 Flour & Breads	0.0001	0.0083	0.0000	0.0001	0.0001	0.0081	0.0046	1.3540	0.0011	0.1628	0.0104	0.0001	0.0010	0.0002	0.0004	0.0020
9 Sugar & Confectionery	0.0001	0.0019	0.0001	0.0001	0.0002	0.0015	0.0562	0.0143	1.0092	0.0218	0.0464	0.0001	0.0005	0.0002	0.0004	0.0020
10 General Foods	0.0004	0.0620	0.0002	0.0002	0.0007	0.0511	0.0338	0.0542	0.0010	1.2166	0.0251	0.0005	0.0061	0.0009	0.0027	0.0135
11 Beverages	0.0007	0.0005	0.0008	0.0019	0.0021	0.0009	0.0011	0.0017	0.0022	0.0028	1.0945	0.0005	0.0049	0.0025	0.0033	0.0135
12 Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.1648	0.0000	0.0000	0.0000	0.0000
13 Textile & Garment	0.0030	0.0028	0.0032	0.0028	0.0106	0.0027	0.0042	0.0317	0.0405	0.0454	0.0046	0.0014	1.6878	0.0430	0.0039	0.0086
14 Wood Products	0.0004	0.0002	0.0010	0.0013	0.0035	0.0009	0.0008	0.0021	0.0033	0.0029	0.0013	0.0001	0.0049	1.2611	0.0011	0.0021
15 Paper Products	0.0020	0.0022	0.0016	0.0041	0.0041	0.0032	0.0084	0.0258	0.0057	0.0194	0.0064	0.0567	0.0089	0.0042	1.6612	0.0639
16 Chemical Products	0.0377	0.0352	0.0159	0.0110	0.0545	0.0333	0.0623	0.0577	0.0448	0.1491	0.0514	0.0499	0.1576	0.0779	0.2976	1.4993
17 Petroleum Refinery	0.0128	0.0058	0.0250	0.0097	0.0217	0.0200	0.0451	0.0332	0.0359	0.0515	0.0270	0.0028	0.0284	0.0265	0.0159	0.0641
18 Ceramics, Non-Metal Products	0.0019	0.0009	0.0020	0.0011	0.0060	0.0010	0.0042	0.0022	0.0028	0.0076	0.0446	0.0008	0.0029	0.0019	0.0043	0.0206
19 Basic Metal Products	0.0028	0.0019	0.0057	0.0080	0.0130	0.0052	0.0061	0.0073	0.0182	0.0208	0.0104	0.0022	0.0100	0.0097	0.0142	0.0348
20 Metal, Machinery, Electric.	0.0088	0.0057	0.0208	0.0293	0.0392	0.0180	0.0209	0.0251	0.0696	0.0739	0.0271	0.0032	0.0198	0.0331	0.0363	0.0597
21 Other Manufacturing	0.0002	0.0003	0.0003	0.0011	0.0010	0.0004	0.0006	0.0016	0.0019	0.0038	0.0034	0.0060	0.0244	0.0025	0.0113	0.0038
22 Elec. gas & Water Supply	0.0009	0.0028	0.0010	0.0015	0.0400	0.0055	0.0062	0.0152	0.0147	0.0447	0.0179	0.0028	0.0195	0.0096	0.0056	0.0236
23 Construction	0.0003	0.0001	0.0001	0.0035	0.0014	0.0001	0.0002	0.0003	0.0003	0.0006	0.0005	0.0000	0.0003	0.0001	0.0002	0.0005
24 Trade & Catering	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25 Transport	0.0185	0.0081	0.0852	0.0616	0.0341	0.0610	0.0315	0.0466	0.0962	0.0938	0.0258	0.0036	0.0282	0.0723	0.0342	0.0735
26 Communication	0.0006	0.0005	0.0008	0.0035	0.0027	0.0010	0.0014	0.0023	0.0031	0.0039	0.0026	0.0007	0.0043	0.0013	0.0064	0.0110
27 Financial Services	0.0079	0.0053	0.0159	0.0863	0.0283	0.0136	0.0230	0.0205	0.0451	0.0472	0.0374	0.0087	0.0520	0.0170	0.0584	0.0624
28 Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29 Social Services	0.0014	0.0008	0.0020	0.0048	0.0049	0.0019	0.0020	0.0036	0.0052	0.0054	0.0060	0.0007	0.0106	0.0055	0.0046	0.0153
30 Personal Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
31 Government Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.2108	1.2955	1.1996	1.2443	1.3088	2.0364	1.9654	2.3443	1.7970	2.5219	1.5526	1.3346	2.3163	1.8503	2.2132	2.1958

Table 9.1.6(2) LEONTIEF INVERSE MATRIX OF DOMESTIC INTERMEDIATE SECTORS: 1991

	Receiving Sector														
Delivering Sector	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1 Agriculture	0.0009	0.0008	0.0009	0.0009	0.0082	0.0031	0.0010	0.0012	0.0026	0.0026	0.0028	0.0000	0.0806	0.0000	0.0206
2 Livestock	0.0005	0.0004	0.0006	0.0005	0.0071	0.0011	0.0006	0.0007	0.0014	0.0014	0.0014	0.0000	0.0377	0.0000	0.0036
3 Forestry & Fishery	0.0036	0.0080	0.0188	0.0170	0.0163	0.0063	0.0249	0.0042	0.0140	0.0047	0.0027	0.0007	0.0071	0.0000	0.0053
4 Crude Oil & Gas	0.4745	0.0991	0.0153	0.0094	0.0086	0.1645	0.0232	0.0186	0.0678	0.0126	0.0057	0.0007	0.0107	0.0000	0.0213
5 Mining & Quarrying	0.0064	0.0668	0.6633	0.1866	0.0916	0.0128	0.1263	0.0077	0.0236	0.0127	0.0055	0.0036	0.0067	0.0000	0.0193
6 Mear Products	0.0006	0.0006	0.0007	0.0007	0.0066	0.0015	0.0007	0.0009	0.0018	0.0018	0.0019	0.0000	0.0537	0.0000	0.0039
7 Daily Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0027	0.0000	0.0002
8 Flour & Breads	0.0001	0.0002	0.0001	0.0002	0.0003	0.0007	0.0002	0.0002	0.0004	0.0004	0.0004	0.0000	0.0116	0.0000	0.0041
9 Sugar & Confectionery	0.0002	0.0002	0.0001	0.0002	0.0002	0.0005	0.0002	0.0002	0.0006	0.0005	0.0006	0.0000	0.0189	0.0000	0.0009
10 General Foods	0.0005	0.0009	0.0006	0.0009	0.0018	0.0035	0.0009	0.0005	0.0015	0.0009	0.0008	0.0000	0.0174	0.0000	0.0023
11 Beverages	0.0033	0.0020	0.0021	0.0025	0.0020	0.0080	0.0022	0.0038	0.0090	0.0102	0.0117	0.0001	0.3872	0.0000	0.0018
12 Tobacco	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
13 Textile & Garment	0.0027	0.0022	0.0075	0.0036	0.1752	0.0063	0.0047	0.0070	0.0074	0.0094	0.0067	0.0002	0.0060	0.0000	0.0444
14 Wood Products	0.0021	0.0024	0.0031	0.0257	0.0013	0.0109	0.0691	0.0027	0.0097	0.0085	0.0012	0.0019	0.0012	0.0000	0.0090
15 Paper Products	0.0060	0.0580	0.0048	0.0061	0.0071	0.0162	0.0168	0.0130	0.0142	0.0477	0.0521	0.0007	0.0065	0.0000	0.0138
16 Chemical Products	0.0327	0.0733	0.0410	0.0854	0.1412	0.0418	0.0920	0.0373	0.1250	0.0289	0.0251	0.0027	0.0712	0.0000	0.0280
17 Petroleum Refinery	1.0502	0.1912	0.0274	0.0168	0.0164	0.1564	0.0446	0.0389	0.1489	0.0168	0.0104	0.0013	0.0194	0.0000	0.0450
18 Ceramics, Non-Metal Products	0.0018	1.0745	0.0042	0.0066	0.0026	0.0228	0.1960	0.0015	0.0034	0.0104	0.0018	0.0055	0.0178	0.0000	0.0225
19 Basic Metal Products	0.0095	0.0169	1.0508	0.2944	0.1310	0.0175	0.1279	0.0116	0.0359	0.0181	0.0081	0.0036	0.0083	0.0000	0.0281
20 Metal, Machinery, Electric.	0.0319	0.0629	0.0365	1.2161	0.0216	0.0654	0.1987	0.0389	0.1151	0.0614	0.0252	0.0057	0.0194	0.0000	0.1108
21 Other Manufacturing	0.0017	0.0012	0.0017	0.0010	1.0031	0.0040	0.0018	0.0028	0.0026	0.0137	0.0112	0.0001	0.0130	0.0000	0.0031
22 Elec. gas & Water Supply	0.0085	0.0514	0.0314	0.0184	0.0122	1.0074	0.0176	0.0109	0.0066	0.0526	0.0108	0.0005	0.0181	0.0000	0.0087
23 Construction	0.0022	0.0008	0.0011	0.0004	0.0003	0.0064	1.0004	0.0007	0.0006	0.0135	0.0018	0.0281	0.0003	0.0000	0.0054
24 Trade & Catering	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
25 Transport	0.1733	0.0695	0.0326	0.0255	0.0141	0.0407	0.0315	0.2309	1.0513	0.0299	0.0211	0.0010	0.0217	0.0000	0.0409
26 Communication	0.0063	0.0040	0.0042	0.0030	0.0023	0.0101	0.0035	0.0305	0.0074	1.0103	0.0464	0.0003	0.0043	0.0000	0.0311
27 Financial Services	0.1005	0.0453	0.0648	0.0538	0.0296	0.1180	0.0656	0.0889	0.1523	0.1781	1.2764	0.0082	0.0315	0.0000	0.0337
28 Housing Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
29 Social Services	0.0080	0.0043	0.0050	0.0053	0.0033	0.0204	0.0046	0.0094	0.0219	0.0261	0.0302	0.0003	1.0097	0.0000	0.0043
30 Personal Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
31 Government Services	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0034
Total	1.9279	1.8368	2.0188	1.9810	1.7039	1.7463	2.0552	1.5629	1.8248	1.5730	1.5621	1.0655	1.8829	1.0000	1.5154

2) Regarding contingencies, price contingency is not considered as an economic costs. However, the physical contingency is included as an economic cost, and must be converted through the above procedure.

3) Plant sites which are utilized as farm land at present are evaluated as negative annual benefits.

(2) Economic Costs

Considering the above conditions and assumptions for the conversion of financial costs to economic costs, these costs were estimated as shown in Table 9.1.7. The costs were summarized as follows:

(Unit: US$ million in 1992 prices)

Cost Item	Financial Cost	Economic Cost
Construction Cost	19.66	16.49
Annual O&M Cost	0.46	0.40

(3) Economic Benefits

The procedure for estimating benefit for the priority project is the same as that in Section 5.3.5. However, the priority project is not the final scheme, so its benefits are considered as a percentage of the matured effects. It is difficult to estimate the extent of these partial benefits as compared to the matured benefit. The objective measurement of this dimension is not possible. Hence, the following assumptions were considered to deduce this ambiguous portion from the total benefit:

(a) Even after implementation of the basic plan, people could feel that the improved environment is far below their expectations, so the benefit to be realized by the basic plan is assumed to be 50% of the benefit expect by the people.

(b) The benefit by the priority project is assumed to be about 60% of the matured benefit, which approximately corresponded to the ratio of the BOD reduction by the priority project to the BOD reduction by the entire projects in the basic plan.

Based on these assumptions, benefit by the priority project was estimated to be US$591 thousand per annum. In 2010, the benefit will increase to US$905 thousand per annum, because of population increases.

Table 9.1.7 FINANCIAL COST AND ECONOMIC COST OF PRIORITY PROJECT

(Unit: US$ million in 1992 prices)

Cost Item	Financial Cost			Economic Cost		
	Local	Foreign	Total	Local	Foreign	Total
I. Initial Construction Works						
1. Construction Works						
a. Water Intake Facilities	0.05	0.03	0.08	0.04	0.03	0.07
b. Main Sewer Interceptor	4.95	0.00	4.95	4.21	0.00	4.21
c. Wastewater Treatment Pla	6.49	1.79	8.28	5.52	1.79	7.31
Sub-total	11.49	1.82	13.31	9.77	1.82	11.59
2. Land Acauisition and R.O.W.	3.35	0.00	3.35	2.85	0.00	2.85
3. Engineering	0.00	1.33	1.33	0.00	1.33	1.33
4. Contingency						
a. Physical Contingency	0.74	0.09	0.83	0.63	0.09	0.72
b. Price Contingency	0.74	0.09	0.83	0.00	0.00	0.00
Sub-total	1.48	0.18	1.67	0.63	0.09	0.72
Total	16.32	3.33	19.66	13.25	3.24	16.49
II. Operation and Maintenance Works						
1. Staff Saraly						
a. Wasterwater Collection	0.02	0.00	0.02	0.02	0.00	0.02
b. Plant Operation	0.07	0.00	0.07	0.06	0.00	0.06
Sub-total	0.09	0.00	0.09	0.08	0.00	0.08
2. Equipment/Material	0.00	0.01	0.01	0.00	0.01	0.01
3. Utilities	0.36	0.00	0.36	0.30	0.00	0.30
Total	0.45	0.01	0.46	0.38	0.01	0.40

The treatment plant site includes some crop lands. After starting the construction, the lands will no longer produce any crops. Thus, this reduced or foregone production is considered as a negative benefit: The assumed activities at the plant sites are shown in Table 9.1.8. The products grown are following four crops: lettuce, parsley, potato and maize. The farm gate prices of respective crops are shown in Table 9.1.9. Table 9.1.10 shows the production cost and unit yield of the respective crops. Finally, Table 9.1.11 shows the economic value added per unit area (ha) on average in the site.

Assuming that the unit area (ha) is utilized as follows, the value added accruing from unit farm land is estimated as follows:

Crop	Unit Value Added (US$/ha)	Cultivated Area (ha)	Value Added (US$ in unit area)
Lettuce	2,014	2/3	1,342.7
Parsley	9,197	2/3	6,131.3
Potato	1,423	1/3	474.3
Maize	1,802	1/3	600.7
Total			8,547.0

As a result, the production loss was estimated at US$8,550 per ha in economic terms. Since 8.2 ha of the total area of farm land is transferred to the plant site, the annual value amounts to US$70,000. Thus, this amount will be considered as annual negative benefit corresponding to production foregone.

(4) Economic Evaluation

The economic evaluation for the priority project was examined in terms of the following parameters: economic net present value (NPV), benefit-cost ratio (B/C), and economic internal rate of return (EIRR). The economic cost and benefit stream is shown in Table 9.1.12. As shown in the table, NPV discounted at 10% was a negative US$11.1 million and the B/C was 0.31. EIRR also worked out to be negative. Thus, the priority project is not viable from economic point of view because of the difficulty in quantifying the economic benefits of improved environmental conditions as described earlier. However, this type of project should not be expected like other economic development projects. Rather, the project should be considered in terms of fulfilling basic human needs with regard to environmental conditions.

TABLE 9.1.8 LAND UTILIZATION OF PROPOSED PLANT SITE

(Unit: ha)

Crop Cultivated	Plant Site Site #1
1. River Bed	14.8
2. Crop Land	8.2
Simplified Cropping Pattern	
Vegetable (Lettuce)	5.5
Vegetable (Parsley)	5.5
Potato	2.7
Maize	2.7
3. Total	23.0
	Priority Project

Note: Cropping pattern is assumed as follows:
(1) Two crops of lettuce and parsely are harvested in the same vegetable fields.
(2) Two crops of potato and maize are harvested in the same cereal fields.

TABLE 9.1.9 FARM GATE PRICE OF AGRICULTURAL PRODUCTS CULTIVATED AT PROPOSED PLANT SITE : 1991

Month	*1 Lettuce	*2 Parsley	Potato *3	Maize
	Bs./100 pieces	Bs./100 packets	Bs./arroba	Bs./100 pieces
January	43	-	11	34
February	25	-	10	38
March	20	-	12	30
April	30	-	12	32
May	38	-	13	35
June	36	-	15	35
July	44	-	15	41
August	41	-	16	43
September	22	-	16	34
October	20	-	15	41
November	16	-	15	51
December	10	-	15	57
Average	29	35	14	39

Source: Ref.J8

No *1 A farm gate price in February 1992 was Bs.36 per 100 pieces.
*2 A farm gate price was Bs.15 per 100 packets in October 1991 and Bs.50 in February 1992.
*3 1 arroba = 25 pounds

TABLE 9.1.10 UNIT PRODUCTION COST AND YIELD OF AGRICULTURAL PRODUCTS CULTIVATED AT PROPOSED PLANT SITE

Item	Unit	Lettuce			Parsley		
		Quantity	Unit Cost	Total Cost	Quantity	Unit Cost	Total Cost
1. Labour							
1.1 Seeding work	Man-day	5	7	35	-	-	-
1.2 Land preparation	Man-day	45	7	315	110	7	770
1.3 Sowing and transplanting	Man-day	20	7	140	20	7	140
1.4 Cultivation	Man-day	106	7	742	484	7	3,388
1.5 Harvesting	Man-day	64	7	448	380	7	2,660
2. Input Supplies							
2.1 Seed	Pound	2	90	180	15	45	675
2.2 Urea	50kg	4	90	360	10	90	900
2.3 Manure	Liter	5	17	85	10	17	170
2.4 Insecticide	Liter	6	40	240	-	-	-
2.5 Bactericide	kg	-	-	-	8	45	360
2.6 Herbicide	Liter	-	-	-	5	14	70
3. Others							
3.1 Tractor	Contract	2	750	1,500	3	750	2,250
3.2 Animal	Animal-day	-	-	-	-	-	-
4. Total	Bs./ha			4,045			11,383
5. Yield		45,000 pieces/ha			150,000 packets/ha		

Item	Unit	Potato			Maize		
		Quantity	Unit Cost	Total Cost	Quantity	Unit Cost	Total Cost
1. Labour							
1.1 Seeding work	Man-day	-	-	-	-	-	-
1.2 Land preparation	Man-day	15	7	105	45	7	315
1.3 Sowing and transplanting	Man-day	6	7	42	8	7	56
1.4 Cultivation	Man-day	144	7	1,008	139	7	973
1.5 Harvesting	Man-day	60	7	420	50	7	350
2. Input Supplies							
2.1 Seed	46kg	35	60	2,100	2	80	160
2.2 Urea	50kg	5	90	450	3	90	270
2.3 Fertilizer	50kg	7	102	714	7	102	714
2.4 Organic manure	Truck	2	300	600	1	300	300
2.5 Insecticide	Liter	10	48	480	10	40	400
2.6 Bactericide	kg	10	12	120	-	-	-
2.7 Herbicide	Liter	5	260	1,300	3	260	780
3. Others							
3.1 Tractor	Contract	4	750	3,000	3	750	2,250
3.2 Animal	Animal-day	4	25	100	-	-	-
4. Total	Bs./ha			10,439			6,568
5. Yield		1,200 arroba(=25 pound:			37,500 pieces/ha		

Source: Ref.J8

TABLE 9.1.11 CROP PRODUCTION AND VALUE ADDED THROUGH AGRICULTURAL ACTIVITIES IN PROPOSED PLAN SITE

Item	Lettuce	Parsley	Potato	Maize
1. Yield	45,000	150,000	1,200	37,500
Unit	pieces/ha	packets/ha	arroba/ha	pieces/ha
2. Production Cost	4,045	11,383	10,439	6,568
Unit	Bs./ha	Bs./ha	Bs./ha	Bs./ha
3. Farm-gate Price	29	35	14	39
Unit	Bs./100 pieces	Bs./100 packets	Bs./arroba	Bs./100 pieces
4. Production	13,050	52,500	16,800	14,625
Unit	Bs./ha	Bs./ha	Bs./ha	Bs./ha
5. Value Added (VA)	9,005	41,117	6,361	8,057
Unit	Bs./ha	Bs./ha	Bs./ha	Bs./ha
Value Added (VA)*1	2,370	10,820	1,674	2,120
Unit	US$/ha	US$/ha	US$/ha	US$/ha
6. VA Rate	69	78	38	55
Unit	(%)	(%)	(%)	(%)
7. Economic Value Added	2,014	9,197	1,423	1,802
Unit	US$/ha	US$/ha	US$/ha	US$/ha

Source: Ref.J8
Note: *1 Foreign exchange rate: Bs.3.80/US$ at the survey time

Table 9.1.12 ECONOMIC COST AND BENEFIT STREAM OF PRIORITY PROJECT

(Unit:US$ 1000)

No.	Year	Cost			Benefit			Balance
		Construction	O/M	Total	Positive	Negative	Total	
1	1993	2968	0	2968	0	0	0	-2968
2	1994	6761	0	6761	0	70	-70	-6831
3	1995	6761	0	6761	0	70	-70	-6831
4	1996	0	400	400	591	70	521	121
5	1997	0	400	400	677	70	607	207
6	1998	0	400	400	696	70	626	226
7	1999	0	400	400	715	70	645	245
8	2000	0	400	400	735	70	665	265
9	2001	0	400	400	750	70	680	280
10	2002	0	400	400	766	70	696	296
11	2003	0	400	400	782	70	712	312
12	2004	0	400	400	798	70	728	328
13	2005	0	400	400	815	70	745	345
14	2006	0	400	400	832	70	762	362
15	2007	0	400	400	850	70	780	380
16	2008	0	400	400	868	70	798	398
17	2009	0	400	400	886	70	816	416
18	2010	0	400	400	905	70	835	435
19	2011	0	400	400	905	70	835	435
20	2012	0	400	400	905	70	835	435
21	2013	0	400	400	905	70	835	435
22	2014	0	400	400	905	70	835	435
23	2015	0	400	400	905	70	835	435
24	2016	0	400	400	905	70	835	435
25	2017	0	400	400	905	70	835	435
26	2018	0	400	400	905	70	835	435
27	2019	0	400	400	905	70	835	435
28	2020	0	400	400	905	70	835	435
29	2021	0	400	400	905	70	835	435
30	2022	0	400	400	905	70	835	435
31	2023	0	400	400	905	70	835	435
32	2024	0	400	400	905	70	835	435
33	2025	0	400	400	905	70	835	435

Present Value discounted at 10%

Cost (US$1000) :	16198	NPV (US$1000):	-11314
Benefit(US$1000):	4885	B/C :	0.30
		IRR :	-2.1%

9.2 ENVIRONMENTAL EVALUATION

9.2.1 Initial Examination

The social and environmental impacts of implementing the Priority Project were examined as shown in Table 9.2.1.

TABLE 9.2.1 CHECKLIST FOR SOCIAL/ENVIRONMENTAL IMPACT PRIORITY PROJECT

Phase of Activity	During construction	During facility operation		
Activities that may have impact on the environment	Construction activities	Occupation of spaces	Facility operation	
Negative or Positive impact	Negative	Negative	Positive	Negative
Social Environment				
1. Transportation	xx	--	--	--
2. Water use	--	--	xx	--
3. Public health/sanitation	--	--	xx	--
4. Solid waste	-		--	xx
Natural Environment				
1. Stream flow	--	xx	--	--
2. Plants/animals	--	x	--	--
3. Landscape	--	x	--	--
Pollution				
1. Water pollution	--	--	xx	--
2. Noise/vibration	x	--	--	--
3. Odors	--	--	xx	--

Note: xx : Some extent of impact x : Small impact -- : No impact

Table 9.2.1 is a modified version of the checklist for the Basic Plan (Alternative 2C) in Table 5.3.7 in Section 5.3.4. The modifications were made to account for the following conditions in the priority project:

- The Priority Project requires only Site #1 for wastewater treatment instead of the two sites in the Basic Plan, although Site #2 would be acquired in the Priority Project. Therefore, the impacts to plants/animals would be smaller.

- The Priority Project deals with the wastewater from the Central Zone only. Therefore, the positive impacts on water use, public health/sanitation, water pollution and odors would be smaller than that in the case of the Basic Plan.

- Although sewage sludge (solid waste) would be contained in the sedimentation basins for several years after the start of operation, it will be hauled thereafter for ultimate disposal. Therefore, the conditions are basically the same as for the Basic Plan.

- The impact to agriculture has been considered in Section 9.1.1, and is not reported here.

9.2.2 Impacts During Construction

(1) Transportation

Part of the total length of the main sewer interceptor would be constructed under existing roads. Therefore, traffic would be hindered during the construction period. However, inconveniences can be minimized by planning the sequence of construction so as to secure alternative routes.

(2) Noise and Vibration

A certain degree of noise and vibration would be unavoidable during the construction of the road sections of the main sewer interceptor. However, the impact can be minimized by selecting low-noise type construction equipment as far as practicable.

9.2.3 Impacts During Facility Operation

(1) Water Use

Improvement of the river water quality below the treatment plant will contribute to the beneficial use of the river water for irrigation.

(2) Public Health and Sanitation

Diversion of the polluted river water to the treatment plant and the reduced BOD concentration below the water intake point would result in improved public health and sanitation.

It should be noted, however, that since the dry season river flow rate would be drastically reduced below the intake point, the flushing capacity of the river would be also reduced. The flushing of dumped solid wastes would therefore be reduced, and as recommended in Section 5.4.3, control of solid wastes dumping into river is very important.

(3) Solid Waste

In several years after the start of operation of the treatment plant, hauling of sewage sludge accumulated in the sedimentation basins at Site 1 would have to begin. An ultimate sludge disposal site must be selected and prepared by that time.

(4) Stream Flow

The water intake facility at the Kotauma confluence, if not properly maintained, may become an obstacle to the smooth flow of the river at times of flood, e.g., due to clogging. At the treatment plant site and along the interceptor access road, the river section would be reduced from the present. Although these structures have been designed so as not to present undo obstacles, they should be paid regular attention and maintained properly.

(5) Plants and Animals

Transformation of the existing farmland into a treatment plant site would make the environment less favorable to wild life. However, the existence of endangered plants or animals has not been reported, and there are other similar habitats for animals in the vicinity. Therefore, negative impacts to wild life is considered to be small. The impacts can be minimized by planting trees in appropriate spaces at the treatment plant site.

(6) Landscape

The negative effect of the wastewater treatment plant to the landscape would be minimal since there are only limited locations from where the plant can be viewed.

(7) Water Pollution

By treating wastewater from the Central Zone, the river water quality below the treatment site will be improved considerably as described in Section 6.2. The BOD concentration in the section below the water intake point will be also reduced. However, the SS concentration in this section would be increased unless the control of SS in the Cotahuma and the Orkojahuira is made. Therefore, as described in Section 5.4.3, control of erosion and control of disorderly human activities in the rivers are recommended.

(8) Odors

Because of the diversion of polluted river water, obnoxious odors along the Choqueyapu in the South Zone of the City would be considerably reduced subject to proper control of solid waste dumping into the river.

9.3 FINANCIAL EVALUATION

9.3.1 Financial Evaluation

(1) Procurement of Funds

The total cost of the proposed priority project is US$19.66 million. This project might be implemented within three years. According to the discussion in Section 5.4.7, the total invertment ceiling of SAMAPA during the same period, 1993 to 1995, was estimated at US$4.99 million. The project cost is almost 4 times of the total ceiling. Thus, the project could not be implemented without procurement of fund from outside financial organizations. Some parts of the total amount could be procured through the same conditions for Case 1-A (hard loan) or Case 1-B (soft loan) described in Section 5.4.7. The rate of procurement is assumed to be 80% of the total project costs in this section. Then, the amount procured through a foreign loan would amount to US$15.73 million and the local portion would be US$3.93 million.

In addition to Case 1-A and Case 1-B, Case 2 (foreign grants) may be also possible as considered in Section 5.4.7. In this case, the total capital cost would be covered by foreign grant. Thus, the authority concerned would not have any capital repayment in the future for these costs.

(2) Reimbursement Schedule

Payment schedules for Case 1-A and Case 1-B, including both reimbursement and interest payment of foreign loan (80% of the total cost) and procurement of local portion (20% of the total cost), are tabulated in Table 9.3.1 and 9.3.2, respectively. The local portion was assumed to be procured by the governmental public account. Then, the largest investment by public account was US$1.59 million in 1994 and 1995. This amount is lower than the expected investment (US$1.8 million, as shown in Table 5.4.6) for sewerage projects by SAMAPA in 1995. From the financial point of view, SAMAPA could afford to implement the local portion of this project without the assistance of central or municipal governments.

In Case 1-A, the maximum payment occurs in the third year (1995) after the beginning of construction. Its amount would be US$3.32 million, broken down into US$1.73 million for the foreign portion and US$1.59 million for the local portion, as shown in Table 9.3.1. This amount exceeds the annual investment budget of SAMAPA which is estimated at US$1.8 million in the same year, as mentioned above. The total payment would be about 1.8 times the investment budget of SAMAPA.

In Case 1-B, the maximum payment also occurs in the third year after the beginning of construction. Its amount would be US$2.06 million, broken down into US$0.47 million for foreign portion and US$1.59 million for local portion, as shown in Table 9.3.2. This amount also exceeds the annual investment budget of SAMAPA. However, the total payment would be only 14% more than the investment budget of SAMAPA. Thus, if SAMAPA gets a low interest loan, with terms similar to typical OECF loans, it might be able to implement the proposed project with more active assistance from the central government.

In Case 2, SAMAPA would not have to reimburse any interest or repayment to foreign lending institutions. Accordingly, once the foreign grant for the project is obtained, the priority project would be financially feasible.

TABLE 9.3.1 REPAYMENT SCHEDULE OF LOANS: CASE 1-A

(Unit: US$ million)

No.	Year	Foreign Loan		Repayment of Foreign Loan Portion and Interest Payment			Local Portion	Total Payment
		Annual Total	Accumu-lation by Phase	Interst	Reim-bursement	Total		
1	1993	3.02	3.02	0.33		0.33	0.76	1.09
2	1994	6.35	9.38	1.03		1.03	1.59	2.62
3	1995	6.35	15.73	1.73		1.73	1.59	3.32
4	1996			1.73	0.00	1.73		1.73
5	1997			1.73	1.12	2.85		2.85
6	1998			1.61	1.12	2.73		2.73
7	1999			1.48	1.12	2.61		2.61
8	2000			1.36	1.12	2.48		2.48
9	2001			1.24	1.12	2.36		2.36
10	2002			1.11	1.12	2.24		2.24
11	2003			0.99	1.12	2.11		2.11
12	2004			0.87	1.12	1.99		1.99
13	2005			0.74	1.12	1.86		1.86
14	2006			0.62	1.12	1.74		1.74
15	2007			0.49	1.12	1.62		1.62
16	2008			0.37	1.12	1.49		1.49
17	2009			0.25	1.12	1.37		1.37
18	2010			0.12	1.12	1.25		1.25
	Total	15.73		17.80	15.73	33.53	3.93	37.46

TABLE 9.3.2 REPAYMENT SCHEDULE OF LOANS: CASE 1-B

(Unit: US$ million)

No.	Year	Foreign Loan		Repayment of Foreign Loan Portion and Interest Payment			Local Portion	Total Payment
		Annual Total	Accumu-lation by Phase	Interst	Reim-bursement	Total		
1	1993	3.02	3.02	0.09		0.09	0.76	0.85
2	1994	6.35	9.38	0.28		0.28	1.59	1.87
3	1995	6.35	15.73	0.47		0.47	1.59	2.06
4	1996			0.47	0.00	0.47		0.47
5	1997			0.47	0.00	0.47		0.47
6	1998			0.47	0.00	0.47		0.47
7	1999			0.47	0.00	0.47		0.47
8	2000			0.47	0.00	0.47		0.47
9	2001			0.47	0.00	0.47		0.47
10	2002			0.47	0.00	0.47		0.47
11	2003			0.47	0.00	0.47		0.47
12	2004			0.47	0.00	0.47		0.47
13	2005			0.47	0.79	1.26		1.26
14	2006			0.45	0.79	1.23		1.23
15	2007			0.42	0.79	1.21		1.21
16	2008			0.40	0.79	1.19		1.19
17	2009			0.38	0.79	1.16		1.16
18	2010			0.35	0.79	1.14		1.14
19	2011			0.33	0.79	1.12		1.12
20	2012			0.31	0.79	1.09		1.09
21	2013			0.28	0.79	1.07		1.07
22	2014			0.26	0.79	1.05		1.05
23	2015			0.24	0.79	1.02		1.02
24	2016			0.21	0.79	1.00		1.00
25	2017			0.19	0.79	0.98		0.98
26	2018			0.17	0.79	0.95		0.95
27	2019			0.14	0.79	0.93		0.93
28	2020			0.12	0.79	0.90		0.90
29	2021			0.09	0.79	0.88		0.88
30	2022			0.07	0.79	0.86		0.86
31	2023			0.05	0.79	0.83		0.83
32	2024			0.02	0.79	0.81		0.81
	Total	15.73		10.04	15.73	25.77	3.93	29.70

(3) Sewage Tariff

The costs of Priority Project were estimated as follows: US$19.66 million for capital costs and approximately US$0.46 million for annual O&M. The total capital cost was annualized by means of a capital recovery factor, which was explained in Section 5.4.7.

In Case 1-A, the annualized capital cost was calculated as US$2.09 million. Then, the total annual cost, that is, the annualized capital cost plus O&M cost was estimated at US$2.55 million.

The total volume of sewage in the priority project area in 1995 was estimated at about 105,000 m^3/day, or 38.5 million m^3/annum. Then, the average unit cost could be estimated at US$0.066 m^3; US$2.55 million divided by 38.5 million m^3.

According to the analysis in Section 5.4.7, the present sewage charge was estimated at US$0.073/$m^3$. The above unit cost is a little less than the present unit charge. However, if this unit cost is recovered and included in a new tariff, this charge might be newly added to the present unit charge. Accordingly, the unit charge would be US$0.139/$m^3$, almost 2 times of the present one. This case approximately corresponds to the above Case 1-A.

In Case 1-B, the capital recovery factor was calculated as 0.05102. The capital cost was US$19.66 million, so the annualized capital cost is estimated at US$1.00 million. Then, the total annual cost would be US$1.46 million. This corresponds to US$0.038/$m^3$ of new sewage service portion. In the same manner, the total charge including the present one would be US$0.111/$m^3$.

If the costs of the project is granted and not included in the depreciable assets, only O&M cost could be recovered by the service charge. Since the total annual cost, that is, O&M cost, was estimated at US$0.46 million/annum, the average unit cost could be estimated at US$0.012/$m^3$; US$0.46 million divided by 38.5 million m^3. In this case, the total sewage service rate was US$0.085/$m^3$. This corresponds to the "O&M cost recovery policy". This charge (US$0.085/$m^3$) would be about 16% higher than the present charge of US$0.073/$m^3$.

9.3.2 Household Budget for Sewerage Charge

The household income and expenditure were discussed in Section 2.2.4. Their future values was projected in Section 5.4.7. In this projection, the household expenditure for sewage was estimated at US$6.2 in 1995.

In Case 1-A, the flat sewage service rate was estimated at US$0.139/$m^3$. When the annual discharge of sewage by a household was assumed to be 165 m^3, the total annual charge of sewage would amount to US$22.9. This amount corresponds to about 3.7 times of the expected household expenditure of US$6.2.

In Case 1-B, the flat sewage service rate was estimated at US$0.111/$m^3$. Then, the annual total charge for sewage service would amount to US$18.3. This amount corresponds to about 3.0 times of the expected household expenditure of US$6.2.

In Case 2, only O&M cost should be covered by the sewage service charge, so the annual charge was estimated at US$0.085/$m^3$. Then the annual charge became to US$14.0, corresponding to 2.3 times of the household expenditure.

As discussed in Section 5.4.7, the above charge of US$6.2 may be too small for the best estimate of the actual rate of return. Nevertheless, this charge accounts for only 27% of the estimated charge (US$22.9) of Case 1-A, 34% of the charge (US$18.3) of Case 1-B, and 44% even in Case 2. Thus, this amount would become a burden for the people in the project area. In the case of introduction of the project, the careful consideration should be given by the authorities concerned.

9.3.3 Financial Status

To examine the financial status after the implementation of the priority project, the financial cash stream is made for the above fund cases. The financial conditions were assumed as the same as mentioned in Section 5.4.7(4).

Table 9.3.3 to 5 show the financial stream of Case 1-A, Case 1-B and Case 2, respectively. In Case 1-A, the revenue balances were negative till 2006, as seen in the tables. Furthermore, the cash balance would continue till 2009, so the management might be very difficult without financial support from the outside. Otherwise, the rates should be reconsidered to manage the sewerage system soundly. In Case 1-B, the management situation might be almost the same as Case 1-A, although it seemed to be more optimistically from the financial point of view. In Case 2, the cash balance was quite simple. The total balance for 30 years was US$33.51 million, which could cover the capital costs of US$19.66

million. This means that the undertaker would not have to procure any grant and loan for replacement of the first phase facilities after the economic life of 30 years.

9.3.4 Conclusion

For financial procurement Case 1, as discussed in the section 9.3.1, the capital investment for the priority project would be a burden on SAMAPA's financial management. Particularly in Case 1-A, the annual payment including reimbursement and interest exceeds the limits of SAMAPA's annual investment capabilities. Even in Case 1-B, the reimbursement might somewhat exceed the limits of SAMAPA's repayment capability. Thus, SAMAPA should attempt to obtain foreign grant assistance for the Priority Project.

From the point of view of affordability, the sewage service charge might be a burden on people's budgets, even if the authorities concerned are able to the obtain a foreign grant aid as in Case 2. Thus, to implement the sewerage system successfully, it is most important for the authorities to foster understanding of the beneficiaries and rate payers as well as to pursue low cost fund.

Table 9.3.3 STREAM OF INCOME AND EXPENDITURE: CASE 1-A

(Unit: US$ Million)

No.	Year	Capital Balance					Revenue Balance					Cash Balance *1
		Income		Expenditure		Balance	Income	Expenditure			Balance	
		Foreign Loan	Local Portion *1	Construction Cost	Repayment of Loan		Sewerage Treatment Service	M&O Expenses	Depreciation	Interest of Loan		
1	1993	3.02	0.76	3.78		0.00				0.33	-0.33	-0.33
2	1994	6.35	1.59	7.94		0.00				1.03	-1.03	-1.03
3	1995	6.35	1.59	7.94		0.00				1.73	-1.73	-1.73
4	1996					0.00	1.45	0.46	0.66	1.73	-1.40	-0.74
5	1997				1.12	-1.12	1.46	0.46	0.66	1.61	-1.26	-1.73
6	1998				1.12	-1.12	1.48	0.46	0.66	1.48	-1.13	-1.59
7	1999				1.12	-1.12	1.49	0.46	0.66	1.36	-0.99	-1.46
8	2000				1.12	-1.12	1.50	0.46	0.66	1.24	-0.86	-1.32
9	2001				1.12	-1.12	1.51	0.46	0.66	1.11	-0.72	-1.19
10	2002				1.12	-1.12	1.52	0.46	0.66	0.99	-0.58	-1.05
11	2003				1.12	-1.12	1.54	0.46	0.66	0.86	-0.45	-0.92
12	2004				1.12	-1.12	1.55	0.46	0.66	0.74	-0.31	-0.78
13	2005				1.12	-1.12	1.56	0.46	0.66	0.62	-0.18	-0.64
14	2006				1.12	-1.12	1.57	0.46	0.66	0.49	-0.04	-0.51
15	2007				1.12	-1.12	1.59	0.46	0.66	0.37	0.10	-0.37
16	2008				1.12	-1.12	1.60	0.46	0.66	0.25	0.23	-0.23
17	2009				1.12	-1.12	1.61	0.46	0.66	0.12	0.37	-0.10
18	2010				1.12	-1.12	1.63	0.46	0.66	0.00	0.51	0.04
19	2011					0.00	1.63	0.46	0.66	0.00	0.51	1.16
20	2012					0.00	1.63	0.46	0.66	0.00	0.51	1.16
21	2013					0.00	1.63	0.46	0.66	0.00	0.51	1.16
22	2014					0.00	1.63	0.46	0.66	0.00	0.51	1.16
23	2015					0.00	1.63	0.46	0.66	0.00	0.51	1.16
24	2016					0.00	1.63	0.46	0.66	0.00	0.51	1.16
25	2017					0.00	1.63	0.46	0.66	0.00	0.51	1.16
26	2018					0.00	1.63	0.46	0.66	0.00	0.51	1.16
27	2019					0.00	1.63	0.46	0.66	0.00	0.51	1.16
28	2020					0.00	1.63	0.46	0.66	0.00	0.51	1.16
29	2021					0.00	1.63	0.46	0.66	0.00	0.51	1.16
30	2022					0.00	1.63	0.46	0.66	0.00	0.51	1.16
31	2023					0.00	1.63	0.46	0.66	0.00	0.51	1.16
32	2024					0.00	1.63	0.46	0.66	0.00	0.51	1.16
33	2025					0.00	1.63	0.46	0.66	0.00	0.51	1.16
	Total	15.72	3.94	19.66	15.72	-15.72	47.45	13.94	19.66	16.06	-2.21	

Note: *1 (Capital balance)+(Revenue balance)+(Depreciation)

Table 9.3.4 STREAM OF INCOME AND EXPENDITURE: CASE 1-B

(Unit: US$ Million)

No.	Year	Capital Balance					Revenue Balance					Cash Balance *1
		Income		Expenditure		Balance	Income	Expenditure			Balance	
		Foreign Loan	Local Portion *1	Construction Cost	Repayment of Loan		Sewerage Treatment Service	M&O Expenses	Depreciation	Interest of Loan		
1	1993	3.02	0.76	3.76		0.00				0.09	-0.09	-0.09
2	1994	6.35	1.59	7.94		0.00				0.28	-0.28	-0.28
3	1995	6.35	1.59	7.94		0.00				0.47	-0.47	-0.47
4	1996					0.00	1.45	0.46	0.66	0.47	-0.14	0.52
5	1997					0.00	1.46	0.46	0.66	0.47	-0.13	0.53
6	1998					0.00	1.48	0.46	0.66	0.47	-0.12	0.54
7	1999					0.00	1.49	0.46	0.66	0.47	-0.10	0.55
8	2000					0.00	1.50	0.46	0.66	0.47	-0.09	0.56
9	2001					0.00	1.51	0.46	0.66	0.47	-0.08	0.58
10	2002					0.00	1.52	0.46	0.66	0.47	-0.07	0.59
11	2003					0.00	1.54	0.46	0.66	0.47	-0.06	0.60
12	2004					0.00	1.55	0.46	0.66	0.47	-0.04	0.61
13	2005					0.00	1.56	0.46	0.66	0.47	-0.03	0.63
14	2006				0.79	-0.79	1.57	0.46	0.66	0.45	0.01	-0.12
15	2007				0.79	-0.79	1.59	0.46	0.66	0.42	0.04	-0.09
16	2008				0.79	-0.79	1.60	0.46	0.66	0.40	0.08	-0.05
17	2009				0.79	-0.79	1.61	0.46	0.66	0.38	0.12	-0.02
18	2010				0.79	-0.79	1.63	0.46	0.66	0.35	0.15	0.02
19	2011				0.79	-0.79	1.63	0.46	0.66	0.33	0.18	0.05
20	2012				0.79	-0.79	1.63	0.46	0.66	0.31	0.20	0.07
21	2013				0.79	-0.79	1.63	0.46	0.66	0.28	0.22	0.09
22	2014				0.79	-0.79	1.63	0.46	0.66	0.26	0.25	0.12
23	2015				0.79	-0.79	1.63	0.46	0.66	0.24	0.27	0.14
24	2016				0.79	-0.79	1.63	0.46	0.66	0.21	0.29	0.16
25	2017				0.79	-0.79	1.63	0.46	0.66	0.19	0.32	0.19
26	2018				0.79	-0.79	1.63	0.46	0.66	0.17	0.34	0.21
27	2019				0.79	-0.79	1.63	0.46	0.66	0.14	0.36	0.23
28	2020				0.79	-0.79	1.63	0.46	0.66	0.12	0.39	0.26
29	2021				0.79	-0.79	1.63	0.46	0.66	0.09	0.41	0.28
30	2022				0.79	-0.79	1.63	0.46	0.66	0.07	0.44	0.30
31	2023				0.79	-0.79	1.63	0.46	0.66	0.05	0.46	0.33
32	2024				0.79	-0.79	1.63	0.46	0.66	0.02	0.48	0.35
33	2025				0.79	-0.79	1.63	0.46	0.66	0.00	0.51	0.38
	Total	15.72	3.94	19.66	15.72	-15.72	47.45	13.94	19.66	10.04	3.81	

Note: *1 (Capital balance)+(Revenue balance)+(Depreciation)

Table 9.3.5 STREAM OF INCOME AND EXPENDITURE: CASE 2

(Unit: US$ Million)

No.	Year	Capital Balance			Revenue Balance			Cash Balance *1
		Income	Expenditure	Balance	Income	Expenditure	Balance	
		Foreign Grant	Const-ruction Cost		Sewerage Treatment Service	Operation & Maintenance Expenses		
1	1993	3.78	3.78	0.00			0.00	0.00
2	1994	7.94	7.94	0.00			0.00	0.00
3	1995	7.94	7.94	0.00			0.00	0.00
4	1996			0.00	1.45	0.46	0.99	0.99
5	1997			0.00	1.46	0.46	1.00	1.00
6	1998			0.00	1.48	0.46	1.01	1.01
7	1999			0.00	1.49	0.46	1.02	1.02
8	2000			0.00	1.50	0.46	1.03	1.03
9	2001			0.00	1.51	0.46	1.05	1.05
10	2002			0.00	1.52	0.46	1.06	1.06
11	2003			0.00	1.54	0.46	1.07	1.07
12	2004			0.00	1.55	0.46	1.08	1.08
13	2005			0.00	1.56	0.46	1.10	1.10
14	2006			0.00	1.57	0.46	1.11	1.11
15	2007			0.00	1.59	0.46	1.12	1.12
16	2008			0.00	1.60	0.46	1.14	1.14
17	2009			0.00	1.61	0.46	1.15	1.15
18	2010			0.00	1.63	0.46	1.16	1.16
19	2011			0.00	1.63	0.46	1.16	1.16
20	2012			0.00	1.63	0.46	1.16	1.16
21	2013			0.00	1.63	0.46	1.16	1.16
22	2014			0.00	1.63	0.46	1.16	1.16
23	2015			0.00	1.63	0.46	1.16	1.16
24	2016			0.00	1.63	0.46	1.16	1.16
25	2017			0.00	1.63	0.46	1.16	1.16
26	2018			0.00	1.63	0.46	1.16	1.16
27	2019			0.00	1.63	0.46	1.16	1.16
28	2020			0.00	1.63	0.46	1.16	1.16
29	2021			0.00	1.63	0.46	1.16	1.16
30	2022			0.00	1.63	0.46	1.16	1.16
31	2023			0.00	1.63	0.46	1.16	1.16
32	2024			0.00	1.63	0.46	1.16	1.16
33	2025			0.00	1.63	0.46	1.16	1.16
	Total	19.66	19.66	0.00	47.45	13.94	33.51	

Note: *1 (Capital balance)+(Revenue balance)+(Depreciation)

CHAPTER 10

RECOMMENDATIONS - PRIORITY PROJECT

1. In either case that the priority project would be implemented through foreign loans or grants, the present sewerage service charge would have to be increased considerably only to cover the costs for operations and maintenance of the project facilities. The increased charge might be a burden on the citizens. Thus, it is very important that the citizens understand the necessity of water pollution abatement and the need of fairly sharing the costs among the beneficiaries. Therefore, the relevant authorities should make their best to promote the understanding of the citizens as well as to pursue low-cost funds.

2. It is recommended that the industrial wastewater discharge regulation be enforced as soon as possible especially for large wastewater dischargers, and that a new regulation be established to obligate newly developing communities to install their own wastewater treatment facilities.

3. Implementation of the priority project would achieve the target BOD concentration which is not to exceed 50 mg/l at the Lipari bridge and downstream. This quality is suitable for irrigating the downstream farmlands to produce ordinary crops. However, such quality is still not suitable for the production of freshly eaten vegetables which requires the BOD concentration not to exceed 5 mg/l. Even implementation of the entire projects of the Basic Plan could not achieve such a water quality goal. Therefore, if production of freshly eaten vegetables, that were common in the areas before the cholera incident, are intended in the downstream farmlands, it is necessary to develop other water sources. It is recommended to conduct a study on this subject including groundwater development for irrigation.

4. It has been frequently mentioned in La Paz that construction of a dam in the upper Choqueyapu basin may be a practical measure to mitigate water pollution of the Choqueyapu river by discharging dilution water from the dam. Having no reliable information to support this idea, the JICA Study Team examined its possibility and effect on the water quality based on their best assumptions, and concluded that it was not an adequate measure. However, it may be worthwhile that the appropriate authorities conduct a preliminary study on this possibility.

REFERENCES

REFERENCES

Field Category

A. Statistics of INE.

B. Geography, Hydrology and Meteorology.

C. River Water Quality.

D. Wastewater.

E. Wastewater Treatment.

F. Sewerage.

G. Water Supply.

H. Urban Sanitation and Public Health.

I. National Plan, City Plan and Population.

J. Economy and Finance.

K. Institution.

L. Conference Report, Annual Report.

A. Statistics of Instituto National de Estadística (INE).

A1. BOLIVIA EN CIFRAS 1989.

A2. RESULTADOS DEL CENSO ZONAL EN LA CIUDAD DE LA PAZ (EIH-89), May 1989.

A3. CUENTAS NACIONALES DEFINITIVAS 1978-1986, December 1989.

A4. BOLIVIA - ENCUESTA NACIONAL DE POBLACIÓN Y VIVIENDA 1988, July 1989.

A5. ENCUESTA NACIONAL DE DEMOGRAFÍA Y SALUD 1989, January 1990.

A6. INDICADORES INDUSTRIALES, 3rd Quater of 1991.

A7. ESTADÍSTICA DE TURISMO, ANUARIO 1989, July 1991.

A8. ENCUESTA INTEGRADA DE HOGARES 1989, August 1989.

A9. DIRECTORIO INDUSTRIAL - La Paz, Cochabamba, Santa Cruz, July 1991.

A10. RESULTADOS DEL CENSO ZONAL CIUDAD DE LA PAZ Y EL ALTO, March 1992.

A11. BOLETIN DE CUENTAS NACIONALES NUMERO 8 PRODUCTO INTERNO BRUTO TRIMESTRAL, January 1992.

A12. COMPONENTES DE LA PRESION INFLACIONARIA, BOLETÍN No. 4, 1990.

A13. INDICADORES DE COYNUTUR No. 4, August 1991.

A14. RESUMEN DEL BALANCE ESTADÍSTICO.

A15. ÍNDICE DE COSTO DE LA CONSTRUCCIÓN DE VIVIENDAS (CIUDAD DE LA PAZ), MARCH 1991.

A16. RESULTADOS DEL CENSO NACIONAL DE POBLACION Y VIVIENDA 1976, VOLÚMEN 11.

A17. BOLETIN DE CUENTAS NACIONALES No. 7, 1992.

A18 CUENTAS REGIONALES DE BOLIVIA POR ACTIVIDAD ECONOMICA (SERIE 1980 - 1986) No. 2, April 1992.

A19. RESULTADOS DE LA PRODUCCIÓN AGRÍCOLA 1988-1989, 1990.

A20. RESULTADOS ENA AÑO AGRÍCOLA 89 - 90, August 1991.

B. Geography, Hydrology and Meteorology.

B1. Montes, I.O., GEOGRAFÍA Y RECURSOS NATURALES DE BOLIVIA, 2nd ed., June 1989.

B2. DESBORDAMIENTO DEL RIO CHOQUEYAPU, H. Consejo Municipal Comision Técnica, July 1991.

B3. Nogales, G.Q., Rosguellas, R.E., and Montesinos, G. R., NUEVA GEOGRAFÍA DE BOLIVIA, 3rd ed., 1991.

B4. MEMO on Run off Calculation for the Choqueyapu River, Dir. de Estudios y Proyectos, HAM-LP.

B5. Daily Precipitation Data at Central La Paz (1976-1985) (Excel File), SENAMHI.

B6. Geological Map 'LA PAZ' (Scale 1:100,000), Servicio Geológico de Bolivia, 1967.

B7. Meteorological Data (Daily and Monthly: Atmospheric Pressure, Temperature, Precipitation, Evaporation, Relative Humidity and Wind) for 13 Stations (Central La Paz, San Calixto, El Alto, Achachicala, Milluni, Millipunku, Chicani, Chuquiaguillo, Obejuyo, Plaza Villarroel, Calacoto, Hampaturi and Incachaca), SENAMHI, ASSANA, HAM-GTZ, 1918-1992.

B8. River Flowrate Data (Daily and Weekly) for 6 Stations (Achachicala, Holguin, Obrajes, Chicani, Achumani, Aranjuez), SENAMHI, HAM-GTZ, 1980-1992.

B9. PROYECTO DE EXPLOTACIÓN DE ÁRIDOS Y ARCILLAS, H.A.M.-G.T.Z. Depto. Geología, January 1991.

B10. Dolbrovolny, E., Slope Stability of Selected Sites in the La Paz Valley, Bolivia, U. S. Geological Survey, April 1976.

C. River Water Quality

C1. Paz, O. R. and Rivera, G. B., EVOLUCIÓN DE CALIDAD DEL RIO CHOQUEYAPU, IIS-UMSA, 1991.

C2. Arce, C. E. L. and Espinoza, G. C. H., ESTUDIO DE LA CONTAMINACIÓN DEL RÍO CHOQUEYAPU DESDE LA CIUDAD DE LA PAZ HASTA LIPARI, Carrera de Ciencias Químicas, UMSA, 1986.

C3. Vargas, W. P. B., "APLICACIÓN DE MODELOS PARA EL SANEAMIENTO DE RÍOS ESTUDIO DE CASO: MODELO SIMOD EN LA CIUDAD DE LA PAZ," Seminario Sobre Políticas de Saneamiento en las Cuencas de los Ríos Choqueyapu y Orkojahuira, October 1991.

C4. Machicao, E. and Justiniano, R. M. A., ESTUDIO DE TENSOACTIVOS EN EL RIO CHOQUEYAPU, Tesis de Grado, Facultad de Farmacia y Bioquímica, UMSA, October 1986.

C5. ANÁLISIS DE LAS AGUAS DE LOS CURSOS RECEPTORES DE AGUAS NEGRAS, RIO CHOQUEYAPU Y ORKOJAHUIRA, IIS-UMSA, March 1977.

C6. Peñaranda, W. C., Bascon, R. C. and Cuaguira, L. S., DETERMINACIÓN DEL GRADO DE CONTAMINACIÓN DE LOS RÍOS CHOQUEYAPU Y ORKOJAHUIRA DE LA CIUDAD DE LA PAZ, Proyecto de Grado, Facultad de Ingeniería Civil, UMSA, March 1975.

D. Wastewater

D1. Díaz, J. B. and Paz, O. A. R., DETERMINACIÓN DE LAS CARGAS DE DEMANDA BIOQUÍMICA DE OXÍGENO (D.B.O.) PER CAPITA, PARA LA CIUDAD DE LA PAZ, Proyecto de Grado, Ingeniería Civil, UMSA, 1986.

D2. Paz, O. R., CARACTERIZACIÓN DE DESCARGAS LÍQUIDAS INDUSTRIALES EN LAS CIUDADES DE LA PAZ Y EL ALTO (1a. etapa), IIS-UMSA, 1990.

D3. Villanueva, H. V., CARACTERIZACIÓN Y REMOCIÓN DE CONTAMINACIÓN DEL EFLUENTE LÍQUIDO DEL MATADERO MUNICIPAL DE LA CIUDAD DE LA PAZ, Proyecto de Grado, Carrera de Ingeniería Civil, UMSA, 1991.

D4. Diaz, J. B., LEVANTAMIENTO DE DATOS DE RESIDUOS INDUSTRIALES LÍQUIDOS EN LA CIUDAD DE LA PAZ Y SU APLICACIÓN AL REGLAMENTO NACIONAL, IIS-UMSA, 1986.

D5. Casonovas, L. M. S. and Peñaranda, W. C., ESTUDIO DE CONTAMINACIÓN DE EFLUENTES INDUSTRIALES TEXTILES, Proyecto de Grado, Facultad de Ingeniería Civil, UMSA, 1986.

D6. Peñaranda, W. and Montes, R. S. R., CONTAMINACIÓN POR DESCARGA DE RESIDUOS INDUSTRIALES EN LA CIUDAD DE LA PAZ, Proyecto de Grado, Facultad de Ingeniería Civil, UMSA, 1976.

D7. Paz, O. A. R., DETERMINACIÓN DE LA BIODEGRADABILIDAD DE LOS DETERGENTES DE USO DOMESTICO EN LA CIUDAD DE LA PAZ, IIS-UMSA, 1987.

D8. García, F. A. and Bustios, J. L. R., CARACTERIZACIÓN Y REUTILIZACIÓN DE DESECHOS EN MATADERO FRIGORIFICO PARA LA CIUDAD DE LA PAZ, Proyecto de Grado, Facultad de Ingeniería Civil, September 1984.

D9. Peñaranda, W. and Urquizo, R. A. A., ESTUDIO DE LA CONTAMINACIÓN DE LAS AGUAS INDUSTRIALES EN LA CIUDAD DE LA PAZ, Proyecto de Grado, Facultad de Ingeniería Civil, UMSA, 1974.

D10. SAMAPA, Results of Water Quality Analysis on Factory Wastewater by IIS-UMSA, December 1989 - March 1990.

E. Wastewater Treatment.

E1. Vega, L. R. R. and Díaz, J. A. B., LAGUNAS DE ESTABILIZACIÓN COMO ALTERNATIVA PARA EL TRATAMIENTO DE AGUAS RESIDUALES EN ALTITUDES MAYORES A 3000 METROS SOBRE EL NIVEL DEL MAR, Proyecto de Grado, Carrera de Ingeniería Civil, UMSA, 1991.

E2. Bascon, R. C., and Garcia, F. A., DETERMINACIÓN DE PARÁMETROS DE DISEÑO PARA UNA PLANTA DE TRATAMIENTO DE LODOS ACTIVADOS POR MEDIO DE UNA PLANTA PILOTO, Proyecto de Grado, Facultad de Tecnología, Ingeniería Civil, UMSA, December 1976.

E3. Irazoque, I. A. T. and Mendizábal, H., ESTUDIO COMPARATIVO DE SISTEMAS DE TRATAMIENTO DE AGUAS RESIDUALES EN URBANIZACIONES Y PEQUEÑAS COMUNIDADES, Proyecto de Grado, IIS-UMSA, December 1980.

E4. Metcalf & Eddy, Wastewater Engineering: Treatment, Disposal and Reuse: Third Edition, McGraw Hill, Inc., New York, N.Y., 1991.

E5. Steel/McGhee, Water Supply and Sewerage, McGraw-Hill, Inc. New York, N.Y., 1979.

E6. Martin/Martin, Technologies for Small Water and Wastewater Systems, Van Nostrand, Reinhold, New York, N.Y., 1991.

E7. WEF Manual of Practice No. 8 (ASCE Manual and Report on Engineering Practice No. 76 "Design of Municipal Wastewater Treatment Plants, Volumes I and II)" WEF/ASCE, 1992.

E8. Fair,Geyer,Okun, "Water and Wastewater Engineering, Volume 2. Water Purification and Wastewater Treatment and Disposal" John Wiley and Sons, Inc., New York, 1968.

E9. U.S. Environmental Protection Agency; Design Manual, Municipal Wastewater Stabilization Ponds, October 1983.

F. Sewerage.

F1. SAMAPA/GTZ, Alcantarillado Sanitario y Pluvial, Tratamiento de Aguas Servidas, La Paz, PLAN MAESTRO DE ALCANTARILLADO DE LA CIUDAD DE LA PAZ, TOMO 1, MEMORIA DESCRIPTIVA, January 1982.

F2. Ditto, TOMO 2, ANEXO: MEMORIA DESCRIPTIVA, January 1982.

F3. Ditto, TOMO 3, ESTUDIO HIDROLOGICO, RIO LA PAZ - RIO SECO, January 1982.

F4. Ditto, TOMO 4, ANEXO: ESTUDIO HIDROLÓGICO, RIO LA PAZ - RIO SECO, January 1982.

F5. Ditto, TOMO 5, MEMORIA DESCRIPTIVA DE LA RESTITUCION, SISTEMA DE DESAGUE DE LA ZONA CENTRAL, January 1982.

F6. Ditto, TOMO 6, PRECIOS UNITARIOS, January 1982.

F7. SAMAPA/GTZ, Alcantarillado Sanitario y Pluvial, Tratamiento de Aguas Servidas, La Paz, ESTUDIO DE FACTIBILIDAD DE LA PLANTA DE TRATAMIENTO DE LA CIUDAD DE LA PAZ, ESTUDIO DE ALTERNATIVAS PARA LA DISPOSICIÓN DE AGUAS SERVIDAS, TOMO 1, MEMORIA DESCRIPTIVA, January 1982.

F8. Ditto, TOMO 2, ANEXO: MEMORIA DESCRIPTIVA, January 1982.

F9. SAMAPA/GTZ, Alcantarillado Sanitario y Pluvial, Tratamiento de Aguas Servidas, La Paz, DISEÑO DE SANEAMIENTO, ALCANTARILLADO SANITARIO Y PLUVIAL DE LA CIUDAD DE LA PAZ - ZONA CENTRAL, TOMO 1, MEMORIA DESCRIPTIVA, January 1982.

F10. Ditto, TOMO 2, ESPECIFICACIONES TÉCNICAS DE DETALLE, January 1982.

F11. Ditto, TOMO 3, PLANILLA DE VOLUMENES Y COSTOS, January 1982.

F12. SAMAPA/GTZ, Drawings, PLAN MAESTRO ALCANTARILLADO PLUVIAL Y SANITARIO DE LA PAZ, Primera Parte (hasta Plano 9.3-2/26).

F13. Ditto, Segunda Parte (Plano 10.11-1/1 - 11.3.3-1/1).

F14. SAMAPA/GTZ, Drawings, DISEÑO DE SANEAMIENTO ALCANTARILLADO SANITARIO Y PLUVIAL, LA PAZ/ZONA CENTRO.

F15. SAMAPA/GTZ, Drawings, ESTUDIO DE FACTIBILIDAD DE LA PLANTA DE TRATAMIENTO DE LA CIUDAD DE LA PAZ, Estudio de Alternativas para la disposición de Aguas Servidas.

F16. SAMAPA, Unit Construction Costs for Sewer Pipes by Diameters 6" - 24".

F17. SAMAPA, List of Potential Sites for Wasterwater Treatment Plant.

G. Water Supply

G1. SAMAPA, List of Large Water Consumers and their Consumption, 2nd Half of 1991.

G2. SAMAPA, Water Consumption Data by Months, Zones (Barrios) and Consumer Categories, 2nd Half of 1991.

G3. SAMAPA, Map of Water Supply Area by Supply Modes, 1992.

G4. SAMAPA, Result of Survey on Diurnal VAriation of Water Supply, 1992.

G5. SAMAPA, Data on Monthly Water Levels of the Three Water Reservoirs, 1992.

G6. SAMAPA, List of Tariff System for Potable Water, 1992.

H. Urban Sanitation and Public Health.

H1. Iñigues, M. T. A. and Gracia, F. A., ENTEROBACTERIAS PATÓGENAS EN HORTALIZAS IRRIGADOS CON AGUAS DEL RIO CHOQUEYAPU, XVIII Congreso Interamericano de Ingeniería Sanitaria Ambiental, Panama, 1982.

H2. HAM de La Paz/World Bank, PROYECTO FORTALECIMIENTO MUNICIPAL, AREA 5. SANEAMIENTO URBANO, SUB-PROYECTO 5.5 CONTROL DE LA CONTAMINACIÓN AMBIENTAL, January 1987.

H3. HAM de La Paz/World Bank, PROYECTO FORTALECIMIENTO MUNICIPAL, AREA 5. SANEAMIENTO URBANO, SUB-PROYECTO 5.1 MEJORAMIENTO DE LOS SERVICIOS DE RECOLECCIÓN Y DISPOSICIÓN FINAL DE LA BASURA, January 1987.

H4. WHO, EPIDMIA DE COLERA EN EL DISTRITO LA PAZ, REPÚBLICA DE BOLIVIA CONSIDERACIONES Y REFLEXIONES, November 1991.

I. National Plan, City Plan and Population.

I1. Ministerio de Asuntos Urbanos, "PROGRAMA AGUA PARA TODOS," PLAN NACIONAL DE AGUA POTABLE Y SANEAMIENTO 1992-2000, February 1992.

I2. H. Municipalidad de La Paz, Regulations for Urban Development.

(1) REGLAMENTO DE USOS DE SUELO Y PATRONES ASENTAMIENTO July, 1987.

(2) REGLAMENTO DE CENTRO URBANO, May 1987.

(3) REGLAMENTO DE URBANIZACIONES Y PARTICIÓN DE TIERRAS.

I3. Municipalidad de La Paz, CIUDAD DE LA PAZ, MAPA DE USOS DEL SUELO Y PATRONES DE ASENTAMIENTO, 1983.

I4. Ministerio de Planeamiento y Coordinación, ESTRATEGIA DE DESARROLLO ECONÓMICO Y SOCIAL 1989-2000, April 1989.

I5. Unidad Sanitaria La Paz, POBLACIÓN POR DISTRITOS URBANOS, February 1992.

J. Economy and Finance.

J1. World Bank, Bolivia: Updating Economic Memorandum, Report No. 8623-BO, August 30, 1990.

J2. World Bank, Project Completion Report, Bolivia: Urban and Rural Communities Water Supply and Sewerage Project (Loan 1324-BO), September 16, 1987.

J3. The Government of Bolivia, Economic Policy Framework Paper for 1989-92, Report presented by the Government of Bolivia for the meeting of the consultative group for Bolivia, Paris, October 1989.

J4. World Bank, Staff Appraisal Report, Bolivia: La Paz Municipal Development Project, July 8, 1987.

J5. Banco Central, BOLETIN ESTADISTICO No 272, December 1991.

J6 Banco Central, INDICADORES ECONOMICOS, INFORMACIÓN MENSUALIZADA, No. 23, 1991.

J7 HAM de La Paz, DIRECCIÓN GENERAL DE FINANZAS MUNICIPALES BALANCE GENERAL 1989.

K. Institution.

K1. PROYECTO DE LEY GENERAL DEL MEDIO AMBIENTE, Propuesta de Version Final, Honorable Cámara de Diputados.

K2. LEY GENERAL DE AGUAS (Draft of General Water Law).

K3. REGLAMENTO SOBRE LANZAMIENTO DE DESECHOS INDUSTRIALES EN CUERPOS DE AGUA, Ministro de Urbanismo y Vivienda, Dirección Nacional de Infraestructura Urbana, 1990.

K4. Cuellar, J. C., ALTERNATIVAS INSTITUCIONALES EN EL PROCESO DE DEPURACIÓN DE CUENCAS EN LA CIUDAD DE LA PAZ, Seminario: Políticas de Saneamiento en las Cuencas de los Ríos Choqueyapu y Orkojahuira, October 1991.

K5 UNDP/World Bank, ESTUDIO DE LAS POLÍTICAS Y DEL MACRO INSTITUCIONAL DEL SUBSECTOR SANEAMIENTO BÁSICO RURAL EN BOLIVIA, September 1991.

K6. UNDP, DIAGNÓSTICO DE LA COOPERACIÓN EXTERNA PARA AGUA Y SANEAMIENTO EN BOLIVIA, October 1991.