PART II

FEASIBILITY STUDY
FOR
REHABILITATION/EXPANSION
OF
ZENGEZA SEWAGE WORKS

PART-II FEASIBILITY STUDY FOR REHABILITATION/EXPANSION OF THE ZENGEZA SEWAGE WORKS

CHAPTER 1 Introduction

Among existing sewage works in the Study Area, Zengeza Sewage Works in Chitungwiza municipality was selected as an urgent project to prepare preliminary sewerage design for the target year of 2000.

The preliminary design of the sewerage system was prepared within the context of the previous sewerage master plan. Planning fundamentals and conditions/assumption for the design of sewerage system were discussed and agreed between the JICA Study Team and the authorities concerned in Zimbabwe side. Basic figures such as frame values and the projected unit sewage quantity and quality in the water pollution control master plan were also consolidated in the Part II.

CHAPTER 2 Feasibility Study for Rehabilitation/Expansion of the Zengeza Sewage Works

2.1 Background

A key component of the Water Pollution Control Master Plan is that the sewerage systems in the study basin be augmented to ensure that the present water quality level be roughly maintained through the future. As part of this plan, priority projects for the year 2000 were studied, incorporating the objectives of conservation of water quality and providing fresh water inflow into the impoundments while maintaining the policy of the Department of Water Development to maximize water reuse and to ensure water supply during time of drought.

The Zengeza Sewage Treatment Works in Chitungwiza Municipality was selected from among the potential projects as being the candidate for urgent rehabilitation and expansion based on technical, environmental improvement, economic and financial aspects.

2.2 Study Area

The study area covers 42 km^2 area that is under the jurisdiction of the Chitungwiza Municipality (refer to Figure 2.1), 60% of which is presently served by the existing sewerage

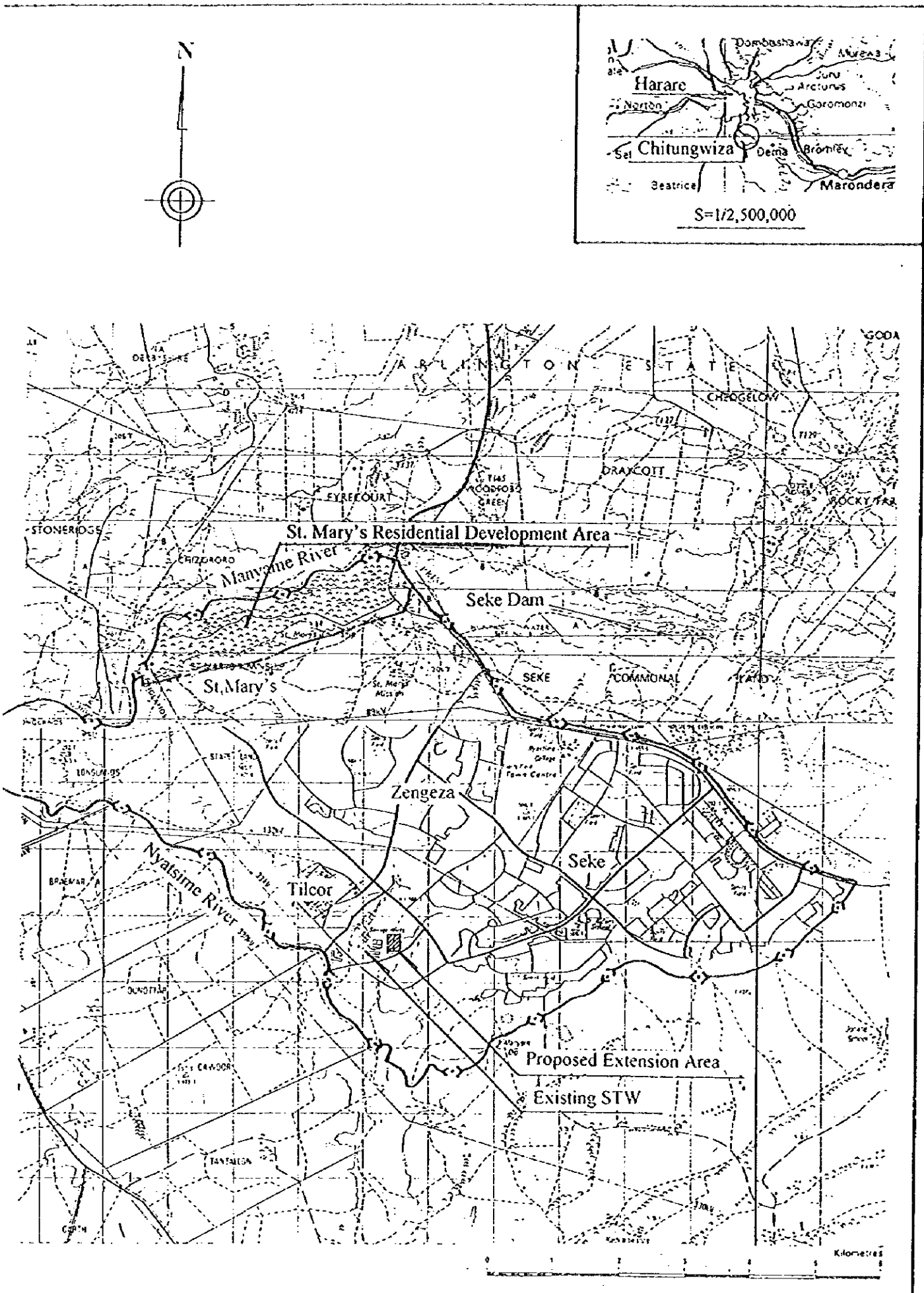


Figure 2.1 Location of theStudy Area S=1/75,000

system. Chitungwiza has a population of over 400,000 and is one of the fastest growing area in Zimbabwe, with an annual grows rate of around 9%.

The proposed site for the extension of the Zengeza STW is owned by the Chitungwiza Municipality and the site lies to the east of the existing STW facilities.

2.3 Existing Conditions of Water Supply and Sanitation/Sewage Works

2.3.1 General

The climate of the study area has three pronounced seasons. "Spring" is from September to November and is hot and dry (avg. daily temperature 22°C ± 6°C). "Summer" is the rainy season, wherein hot and wet conditions (avg. daily temperature 20° C ± 6°C with 80% of the annual mean 820 mm rainfall). The remainder of the year is fairly cold and dry (avg. daily temperature 16°C ± 6°C).

The topography of the area lies at altitudes ranging from 1,390 to 1,460 m above sea level with a gentle slope both from the northwest and the northeast towards the southern center of the municipality, where the STW is located. The ground elevation where the STW is located is 1,400m ± 4 m with a comparatively rich topography.

Geologically, the municipality is underlain by granite. At the STW site, decomposed granite/sand-silt is found from the surface to about 0.5 m down followed by residual decomposed granite to one meter or more.

2.3.2 Water supply

The monthly water demand of Chitungwiza fluctuates between 22,000 m^3/day and 42,000 m^3/day, depending on the season; the annual average (1992) was estimated at 28,900 m^3/day. Servicing this demand is the Morton Jaffray Water Treatment Works through the bulk water supply system of Harare. The Seke service reservoir covers the entire services area of the municipality.

The future water demand of the area (year 2012) has been estimated at being the following figures in the Harare Water Supply Master Plan (assuming a population of 663,000):

- residential: 46,300 m^3/day
- commercial/industrial/institutional: 22,400 m^3/day
- non-revenue water: 7,600 m^3/day

As a reference, the annual average water demand in 1995 was estimated at 34,200 m^3/day assuming the increase of water demand from the year 1992 in proportion to the population increase between the years.

2.3.3 Sewerage

The sole STW for Chitungwiza is the Zengeza plant as shown in Figure 2.2. The Zengeza STW was built over 20 years ago to have a designed treatment capacity of 21,750 m^3/day using the following facilities: screen and grit removal, anaerobic ponds, trickling filters, and a pumping station (refer to Figure 2.3). The effluent is transmitted to a maturation pond to be partially used for irrigation of the Imbgwa farm. The BOD removal rate is approximately 80%, with an average effluent BOD of 180 mg/l (the raw sewerage is 970 mg/l). The service coverage is nearly 100%.

The sewerage system in Chitungwiza is afflicted with the following problems:

- Numerous leakages of raw sewerage from old/ill-maintained facilities
- Highly overloaded - estimated inflow is between 36,000 to 40,000 m^3/day versus the design capacity of 21,750 m^3/day.
- Aging facilities - there are numerous problems with the pumps and other facilities
- Nearby Tilcor anaerobic ponds are ill-maintained and pose health/odor hazards
- Current use of ill-treated effluent for irrigation poses a water pollution hazard

The future sewage volume in Chitungwiza is projected at being 41,500 m^3/day in the year 2000 based on an estimated population of 489,000.

2.3.4 Institutional and Financial Conditions for water Supply

Water consumption of Chitungwiza entirely depends on bulk water supplied from the City of Harare. The augmentation of bulk water supply to Chitungwiza is much owed to updating of

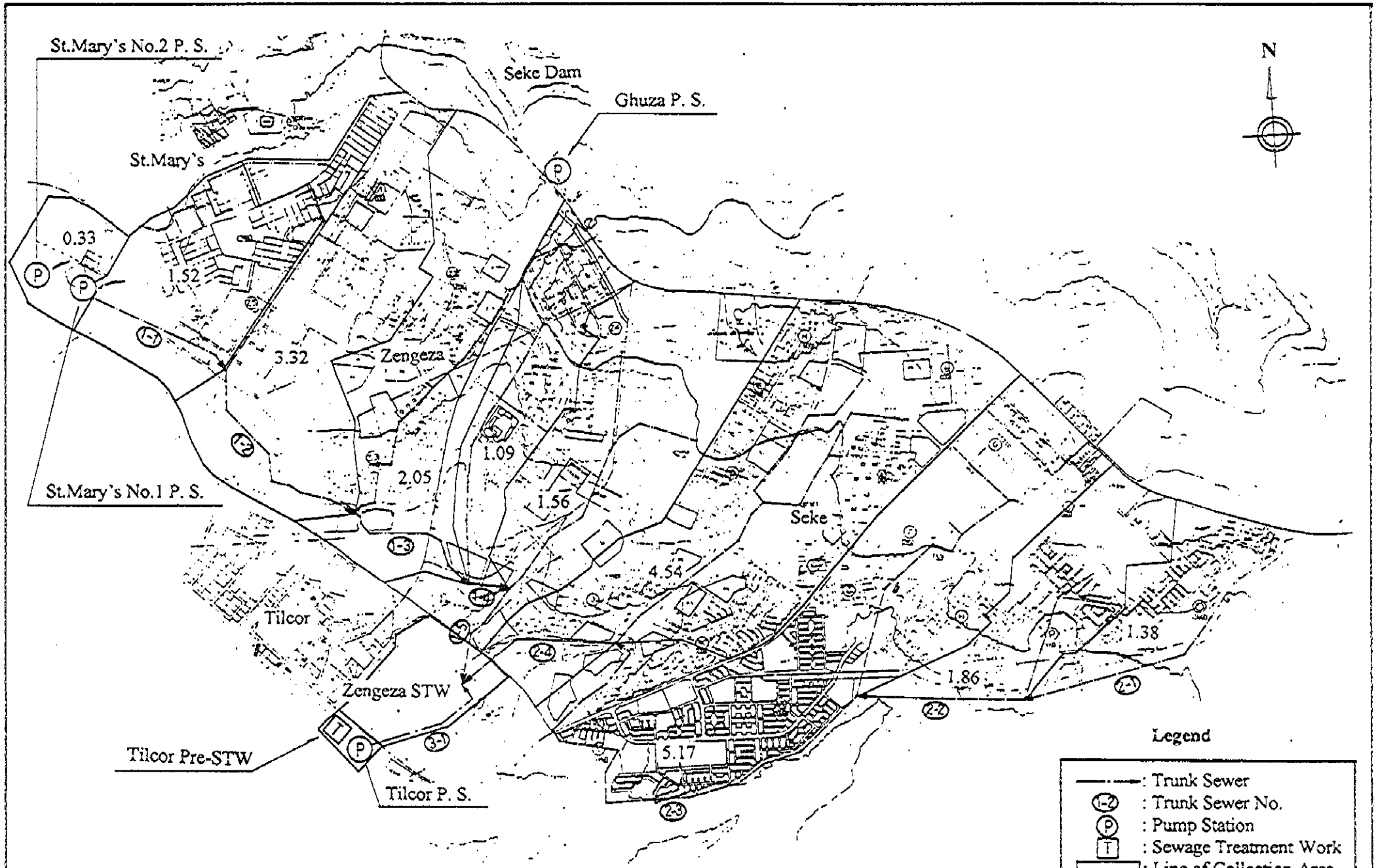


Figure 2.2 Existing Sewerage System (S=1/40,000)

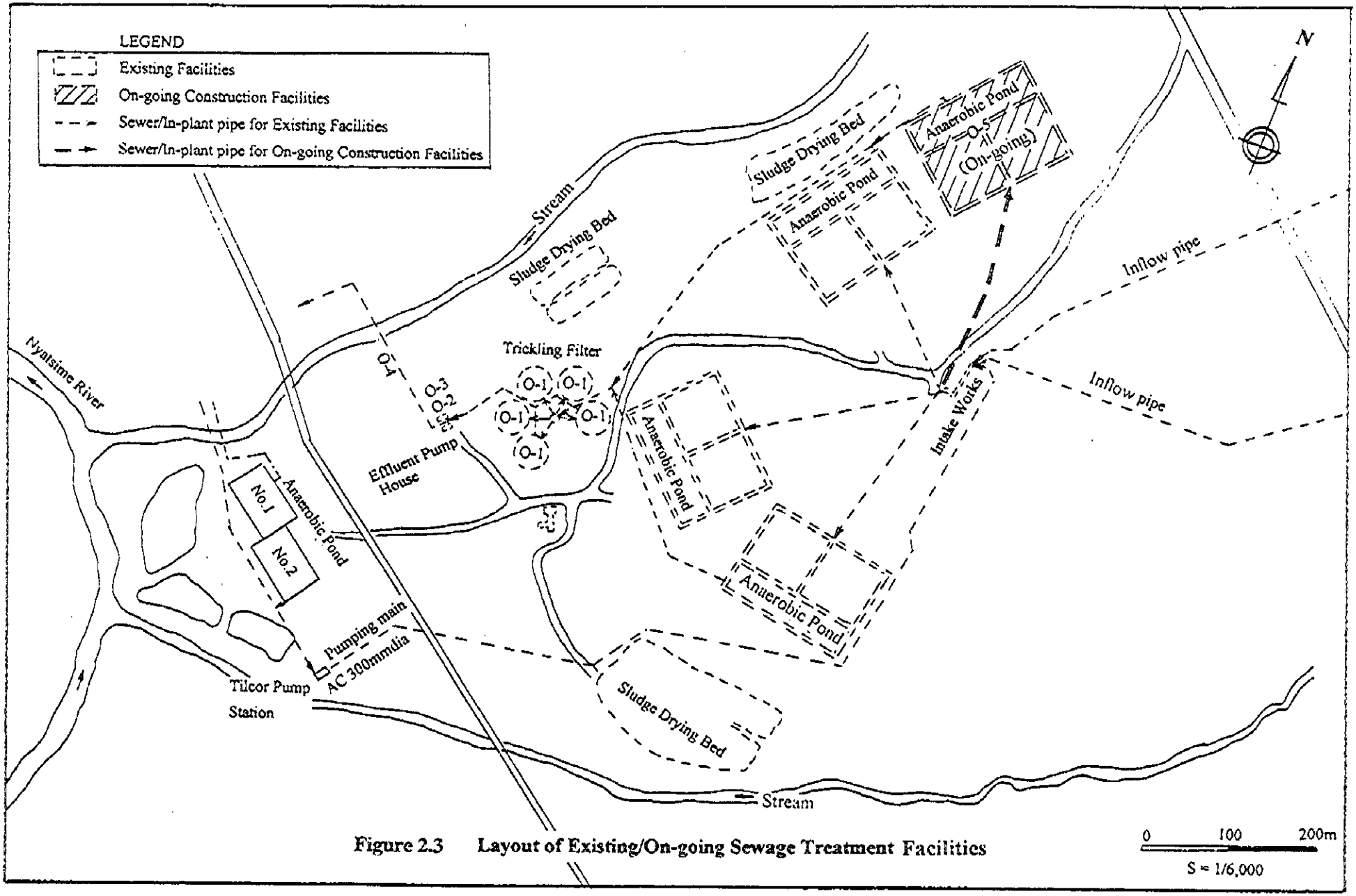


Figure 2.3 Layout of Existing/On-going Sewage Treatment Facilities

both Morton Jaffray WTW and Warren P. S. which is undertaken by the Harare Water Supply Project, Phase 1 and 2. Out of the average daily water consumption (35,000 m^3/day), the reticulation system in Chitungwiza has got an estimated water loss of around 20%, which is 7,000 m^3/day per day. The World Bank assisted Urban II project is scheduled to implement "Water Reticulation Strengthening, Rehabilitation and Replacement" in the financial year 1996/97 onwards.

The water distribution works is managed by the "Water Section" under the Water & Sewerage Division, the Engineering Services Department. Water charges consist of basic and consumption charges collected by the Treasury Department. The basic water charges are billed and collected together with the sewerage and refuse charges, while the "consumption" charges are billed separately. As for legal issues, the existing Water Act fails to address the consistency in the application of standards for monitoring environmental legislation led to serious water pollution in the City of Harare including Chitungwiza municipality.

2.3.5 Institutional and Financial Conditions for Sewerage System

The MLGRUD is responsible for sewerage projects executed by local governments. About Z$ 540 million was invested during 6 years from 1990 to 1996, and Z$ 315 million to be invested for 1996/97 as the sewerage version of PSIP. Chitungwiza implemented the project called "sewerage Augmentation Works" financed by the government loan. These works are expansion of the maturation pond, thereby to prevent the effluent from inflowing into the Nyatsime River, and upgrading of treatment capacity due to the 4th unit of anaerobic pond. The sewerage account previously kept surplus, but became negative in 1995/96 due to the rising debt services of the existing liabilities.

For implementation of the sanitation/sewerage projects, the Council takes the form of the committees which decide on most of matters relating to project planning, management and operations. As for O & M work of the sewerage system, the number of staffs was 81 for the Zengeza STW and 110 for reticulation system. Though Tilcor industrial area depends on the municipal sewerage system, any agreement does not exist between the municipality and industrial area. The establishment of regulation/standards shall be necessary for the quality of industrial wastewater. If necessary, sanction might be imposed on the source in the event of non-compliance. The quality of effluent discharged to the maturation ponds on the Imbgwa farm is well over the standard (70 mg/l) stipulated by the Public Health Regulations. The effluent should be to an acceptable standard, at least complying with the regulations.

2.4 Frame Values and Land Use

The frame values used in the Study area are important as they provide the base upon which many of the design considerations, etc. are based. The frame value concerning the population for the target year was modified to reflect two scenarios as shown below. Using these two scenarios, the design population for the year 2000 was established at 489,000 as an intermediate figure. The land use plan was based on the Master Plan.

2.4.1 Frame Values

The most recent population census in 1992 for the urban areas is in principle the basis for population projection, however, a modification was made for the municipality. The annual average growth rate in the census results between 1982 and 1992 was about 4.8 %, while the actual increase was analysed to be 9 % through the second urban development project. Therefore, the population employed in Harare Combination M/P was employed to meet the current population status.

The frame values for the estimates of population, industrial/commercial figures are summarized in Table 2.1.

Table 2.1 Frame Values at Present and in the Future

Population	Present (1992)	1995	2000	2015
Case I:	354,500	405,000	537,800	962,500
Case 2:	as above	as above	439,500	573,100

Comm/Industrial	Present (1992)	2000	2015
Industrial Area (km^2)	1.35	1.35	9.41
Factory Land Area (ha)	108.0	108.0	752.8
No. of Employees/ha	43.48	43.48	43.48
No. of Employees	2,500	3,100	32,800

2.4.2 Land Use

The land use in Chitungwiza was based on the Master Plan. At present 55% or 22.82 km^2 of the municipal area is used for residential purposes and this area is comprised solely of high and medium density areas; the majority being high density (85% or 19.47 km^2). Of the open spaces at present, there are some developments planned including a 1.75 km^2 area of St. Mary's which will include high density, school, commercial establishments and a church. By the year 2015, the left bank of the Nyatsime River is projected to be the area where most of the industrial growth will be concentrated, while the residential areas are projected to expand in other locations. The land use of the municipality through the future is shown in Table 2.2.

Table 2.2 Land Use at Present and in the Future

(Unit: km^2)

Land Use Type		Present	Year 2000	Year 2015
Residential Area	Low Density	0.00	0.00	2.14
	Medium Density	3.35	3.35	8.26
	High Density	19.47	21.22	26.67
	Sub-total	22.82	24.57	37.07
Industrial Area		1.35	1.35	9.41
Commercial Area		0.85	0.85	0.85
Institutional Area		0.74	0.74	0.74
Sewage Treatment Works Area		0.93	0.93	0.93
Open Spaces		15.31	13.56	5.50
Total		42.00	42.00	54.50

2.5 Quantity and Quality of Sewage

The quantity and quality of sewage was based on the figures studied in the Master Plan. The average quantity in the overall service area in 2000 was calculated at 68 lpcd and the wastewater discharged by the commercial/institutional locations was estimated at being 5% of the domestic sewage. The summarized figures are shown in Table 2.3.

Table 2.3 Domestic Sewage Quality/Quantity (ADWF)

Category	Quantity (lpcd)			Quality (gpcd)			
	Present	2000	2015	BOD	SS	TN	TP
High density	60	63	70	44	51	11	1.2
Medium density	210	315	315	47	54	12	1.3
Low density	315	315	315	50	58	13	1.4

Based on the above, the unit quantity and projected population, total inflow of sewage into the STW in the year 2000 was calculated to be about 41,5000 m^3/day (refer to Table 2.4). The design sewage volume of the existing STW, which will treat combined domestic/industrial sewage, was established at 21, 750 m^3/day, while the additional facilities which will treat domestic sewage only, was established at 20,000 m^3/day.

Table 2.4 Sewage Flow in the Year 2000

Type	ADWF (m^3/day)	PWWF (m^3/day)
Domestic	38,240	114,720
Institutional/Commercial	1,912	5,736
Sub-total	40,152	120,456
Industrial	1,387	4,161
Total	41,539	124,617

The pollution load concentration (mg/l) of raw sewage for the existing and the expansion facilities are as follows:

STW	BOD	SS	TN	TP
Rehabilitated Existing	592	644	134	15
New Expansion	564	653	141	15

2.6 Planning and Design Approach for the Urgent Project

2.6.1 Technical Considerations

The planning and design approach for the expansion/rehabilitation of the Zengeza STW was done in consideration of the particulars of the STW, the study area and the financial/technical parameters, whilst keeping in line with the long-term sewerage development plan, as outlined in the Master Plan. The planning and design approach is summarized below.

The existing sewage works will be fully utilized for the expansion of the treatment facilities to meet the future sewage volume. The existing trickling filter will be used within its capacity to treat the combined residential and industrial sewage through the future and a staged construction of additional treatment facilities, using the BNR process, will be undertaken as needed.

The existing sewer reticulation will be used through the future being provided with expansion and rehabilitation. A parallel sewer line to the existing trunk sewer from the St. Mary's is planned to handle the sewage generated by new housing development in that area. These steps will mitigate the severely overloaded condition of the STW. Moreover, all of the facilities will be designed in a manner that will provide safeguards against the possibility of overflows that would contaminate the surrounding water sources.

The sludge generated by the STW will be treated through the use of thickening, anaerobic digestion and drying for reuse as fertilizer. The treated sludge will be promoted for use as a fertilizer to reduce the amounts of sludge to be handled otherwise; a sanitary landfill will be necessary. The sludge storage area will be designed not to flow out during heavy rains in order to prevent water pollution problems.

The construction plan for the new treatment facilities and the existing facilities will be developed for both sewage and sludge treatment. The soil conditions and the groundwater table are major concerns for the design of the facilities. The grade of the facilities and equipment used in the project will be determined based on the experience of Harare as well as the simplicity and ease of the operation of the facilities. The use of local materials and labor intensive arrangements both for the construction and operation and maintenance of the facilities will be considered.

2.6.2 Institutional Reinforcement

The national government agencies should concern itself with major policy and planning issues and with establishing the criteria to be applied by the lower governmental levels in resolving major issues. At each political and administrative level, it is "must" to delineate the authority and responsibility of the organizational structure.

In the Chitungwiza Municipality, the planning and project implementation for rehabilitation/ expansion of the Zengeza Sewage Treatment Works and its operations and management are vested in the Engineering Services Department (ESD). In order to strengthen its organizational structure and improve the system's efficiency as a whole, the increase in personnel and frequent retraining and upgrading of skills are needed.

To ensure the smooth implementation of the priority project, the training programme should be duly carried out for the both administrative and technical personnel, particularly for the staff undertaking the operations & maintenance of the sewage treatment works and water quality monitoring. The training programs should be designed to strengthen the planning and management capacity of middle and senior level professionals working in the sanitation/ sewerage sector and also provide adequately trained personnel for the operation of the relevant treatment works. In addition, it is important to provide training seminars and workshops to disseminate all water pollution related information to the interested people.

2.6.3 Legal Arrangement

To tackle the legislative and administrative problems on water pollution control, the Water Act and relevant water regulations should be reviewed and updated to define the responsibilities of the national government, local authorities and business enterprises, and to clearly formulate the basic principles that should govern the promotion of environmental measures, so as to be able to implement water pollution measures in a comprehensive and unified manner.

In order to deal with imminent and potential problems before they occur or become serious, and also to prepare the water pollution control plan, it is essential to formulate, as quickly as possible, the "Environmental Water Quality Standards".

The trade effluents in the municipal area should be properly controlled in accordance with the "Trade Effluent Control" regulations. In view of their contents and actual applications, it is necessary to review and upgrade them to the status of "by-laws", in order to achieve a given percent reduction and enable charge all pollutants a uniform price, based on the quantity and quality of their discharge.

To expedite the legal and procedural arrangements for the effective water pollution control in the Municipality area, it is advisable to set up a "Task Force" which takes charge of reviewing/ updating the existing regulations & standards, and/or formulating new statutes.

2.6.4 Financial Management

The urban Council of Chitungwiza acts as the executing body in respect of implementation of the Project. The Council is in a position to borrow capital funds from the national government and finance expenditures on operation and maintenance as well. The ultimate objective of financial management is sustainability of the Council's self-finance towards implementation of the Project. Two approaches can be taken into account. One is the role of the government to ease financial burden on the Council. The other is the effective management of sewerage revenue and expenditures to be handled by the Council.

Financial assistance of the government comprises i) identification of donor fund with preferential loan conditions, ii) exemption of foreign exchange premium to lower on-leading rate and iii) mobilization of the government grant to finance administration charge and engineering service in the form of technical assistance. While as the borrower's position the Council will be responsible for increase of sewerage revenue and control on sewerage expenditures. Revenue increase can be achieved by two methods. One is introduction of a new tariff called effluent charge, and the other is the efficient management of revenue bases on which sewerage flat tariffs are imposed. Perhaps management of debt service would be the crucial factor to keep expenditures at the level planned at the time of budgeting. In this regard, loan disbursed from the government is the best source of fund which guarantees regular repayment of debt service.

2.7 Sewage Collection System

2.7.1 Rehabilitation/Modification Plan of Existing Sewer Reticulation

The preventive maintenance of the sewers shall be planned and implemented as annual routine work. The rehabilitation/modification plan for the existing pump stations (St. Mary's No.1, 2 and Tilcor) are prepared for mechanical and electrical facilities. The rehabilitation/modification plan is presented in Sub-section 7.3.

The following are required equipment for each pump station.

(1) St.Mary's No.1 pump station

Pump facility : $150mm^{dia}$ x $2.60m^3$/min x 34.5m x 25.0kw x 3(1) units

Inplant pipe : 1 set (including valve box and flow meter)

Electrical panel : 1 set (including house wiring)

(2) St.Mary's No.2 pump station

Pump facility : $100mm^{dia}$ x $1.20m^3$/min x 12.5m x 5.0kw x 2(1) units

Inplant pipe : 1 set (including valve box and flow meter)

Electrical panel : 1 set (including house wiring)

(3) Tilcor pump station

Pump facility : $150mm^{dia}$ x $2.30m^3$/min x 28.0m x 18.0kw x 3(1) units

Inplant pipe : 1 set (including valve box and flow meter)

Electrical panel : 1 set (including house wiring)

2.7.2 Expansion Plan for Residential Development Area in St.Mary's

New pump station, force main and gravity trunk sewer were also designed for the residential development area in western end of St. Mary's as shown in Figure 2.4. Collected sewage by gravity sewer inflows into new pump station and pumped through force main to the starting point of gravity trunk sewer, in parallel with the existing trunk sewer, then conveyed to the Zengeza STW. Figure 2.5 (1) and 2.5 (2) show the plans of the proposed new pump station. The required equipment and materials are as follows:

(1) New St.Mary's pump station

Screen and grit chamber : 1 set

Pump facility : $150mm^{dia}$ x $3.00m^3$/min x 58.0m x 50.0kw x 3(1) units

Inplant pipe : 1 set (including valve box and flow meter)

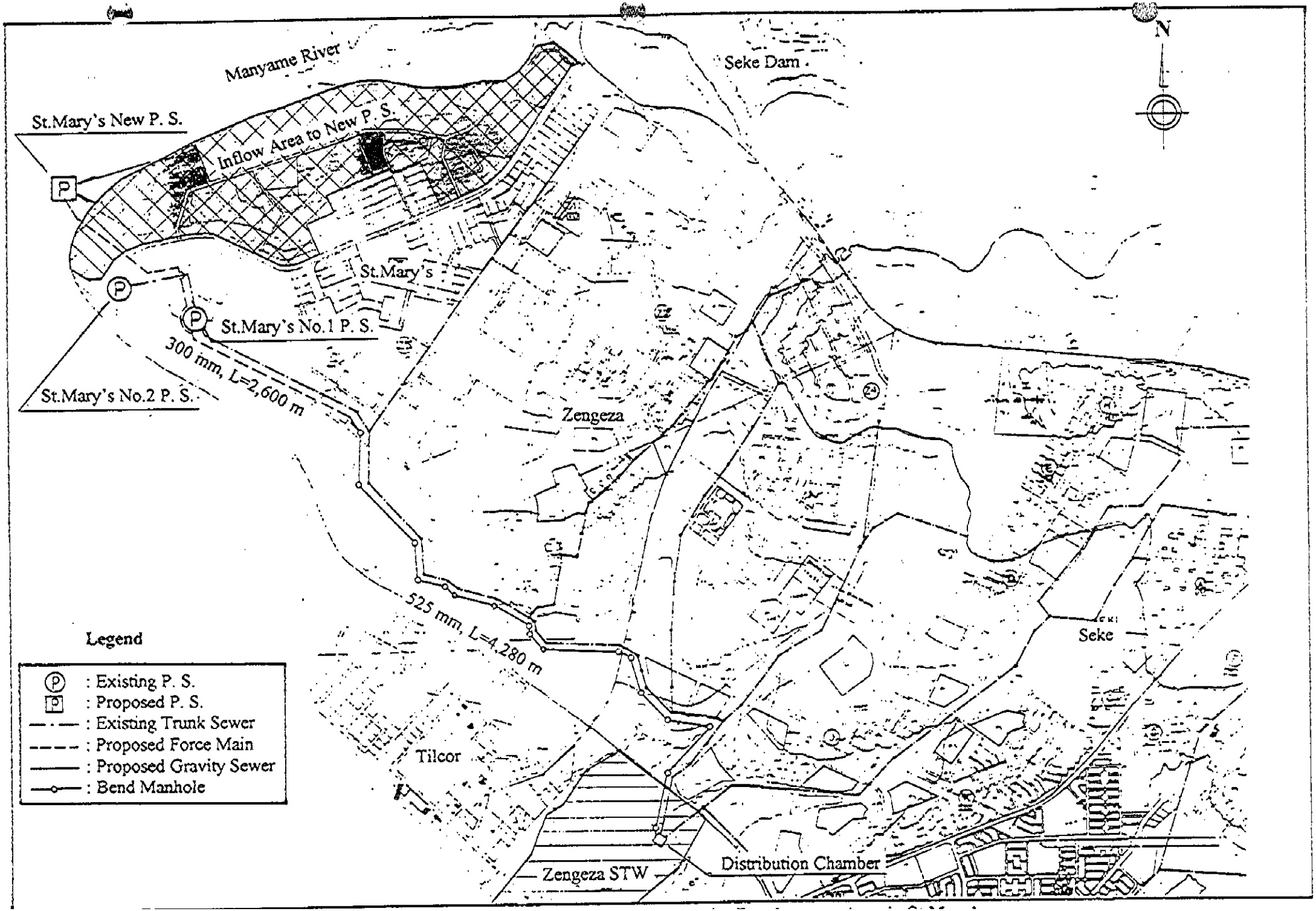
Electrical panel : 1 set (including house wiring)

(2) Force main pipe

Pipe material : AC pipe

Diameter : 300 mm

Total length : 2,600 m


Manyame River
Seke Dam
N
St.Mary's New P. S.
Inflow Area to New P. S.
St.Mary's
St.Mary's No.1 P. S.
300 mm, L=2,600 m
St.Mary's No.2 P. S.
Zengeza
525 mm, L=4,280 m
Seke
Tilcor
Zengeza STW
Distribution Chamber
Legend
: Existing P. S.
: Proposed P. S.
: Existing Trunk Sewer
: Proposed Force Main
: Proposed Gravity Sewer
: Bend Manhole

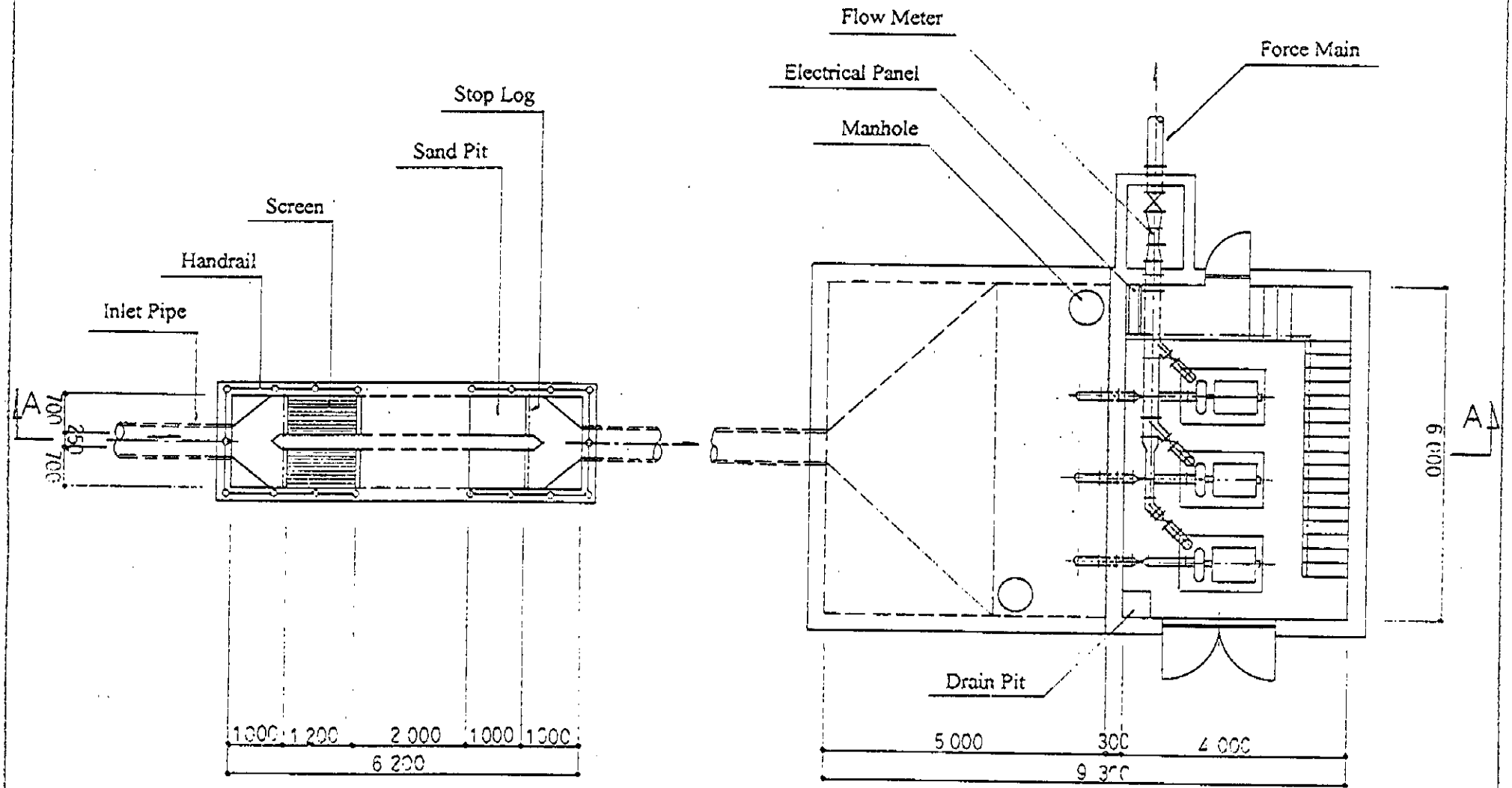


Figure 2.5 (1) Plan of New Pump Station S = 1/100

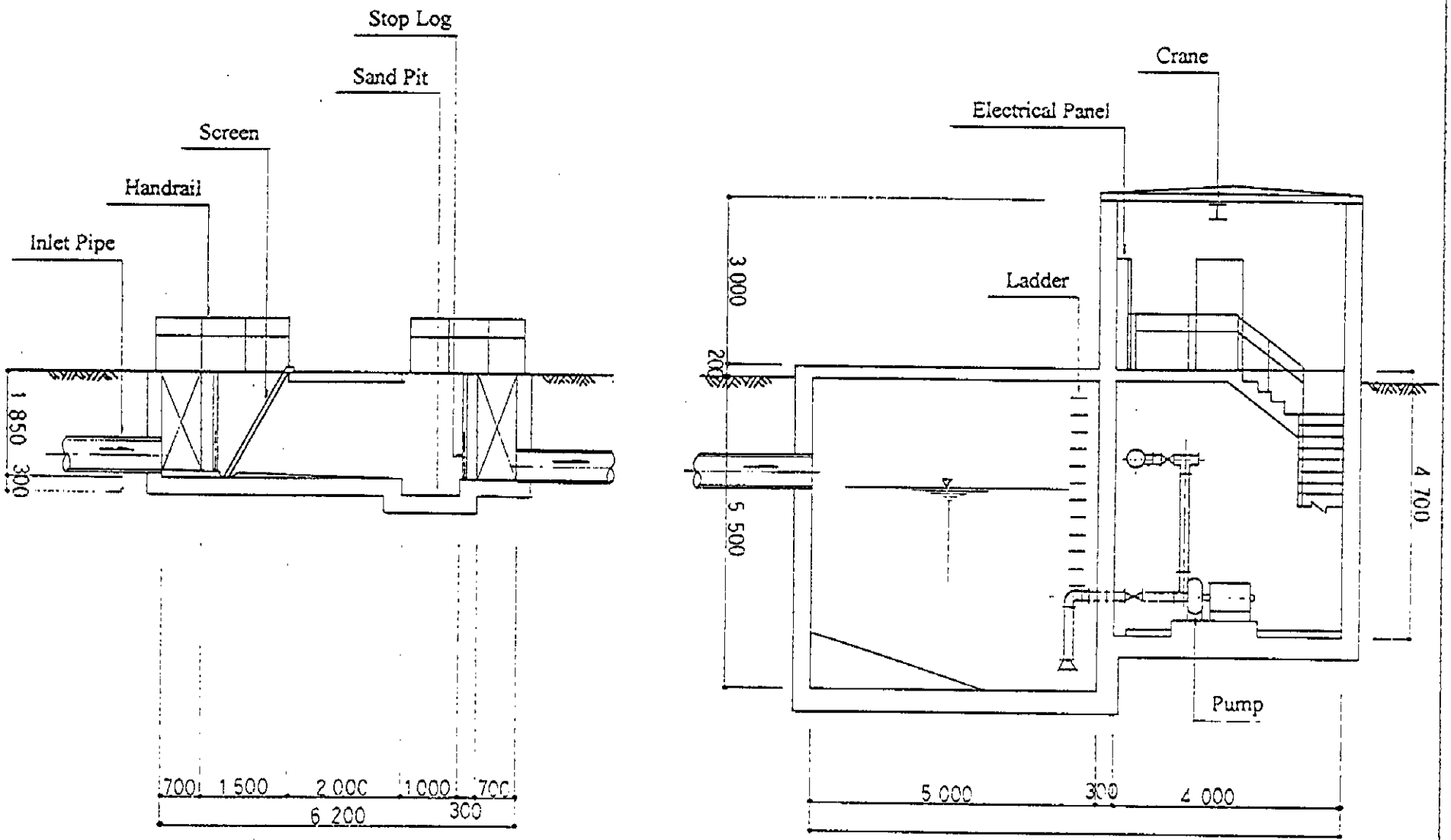


Figure 2.5 (2) Section of New Pump Station (A-A) S = 1/100

(3) Gravity Trunk Sewer

Pipe material : AC pipe

Diameter : 525 mm

Total length : 4,280 m

No. of manhole : 51 units

2.8 Sewage and Sludge Treatment and Disposal

2.8.1 Rehabilitation of Existing Facilities

The Rehabilitation of existing facilities is carried out not only to maximize their functions, but also for the proper O&M through the future.

The rehabilitation works cover 1) Existing Zengeza STW, 2) Effluent Transmission Pump Facility and 3) Tilcor Pre-treatment Facility. Tilcor pre-treatment facility for the trade effluent shall, in principle, be maintained by private sector. However, required works are included in the transition period of the responsibility between local government and relevant factories. The proposed rehabilitation work for these facilities are shown in Table 2.5.

Table 2.5 Proposed Rehabilitation Work for Existing Facilities

Facilities	Rehabilitation Work
Existing STW	Installation of Connection Pipe 650mm dia, AC, 1 unit, L = 30 m (Connect exiting and proposed effluent channel at Grit Chamber)
	Removal of sludge in Anaerobic Ponds, V = 13,600 m^3
	Removal of sludge in Trickling Filter, V = 1,220 m^3
	Construction of sludge disposal pit
	Replacement of flow meters for the Parshall Flumes, 2 units
	Construction of fence, L = 700 m
Effluent transmission pump facility	Replacement of pump facilities Pump : 400 m^3/hr x 1 unit Motor : 185 kW x 1 unit Valve : 1 unit Control Panel : 1 unit
Tilcor Pre-treatment Facility	Removal of sludge, V = 2,200 m^3
	Construction of sludge disposal pit
	Replacement of scum jet nozzle and piping (water will be supplied from proposed treatment plant)
	Rehabilitation of No.3 storage pond as equalization pond in wet season

2.8.2 Expansion of the Zengeza STW

The treated effluent of proposed expansion of STW will be discharged to Nyatsime River as a valuable water source during the time of drought. Thus, the effluent quality shall be stable and be within the effluent quality standards (GN 687/77).

BNR method is employed and the system treats only domestic sewage. A by-pass arrangement at the entrance of the STW is made to allow for the sewage flow into the existing STW in case of accident. Figure 2.6 to Figure 2.8 show the layout plan and hydraulic of the treatment system. Proposed facilities are summarized in Table 2.6.

Table 2.6 Proposed Sewage Treatment Facilities

Facilities	Dimensions
Distribution Chamber	Trunk sewer 675 mm, 2 units 1.8 m^W x 4.0 m^L x 1.16 m^H
Screen & Grit Chamber	Coarse screen (screen gap 40 mm) 1.2 m^W x 1.2 m^H x 2 nos.
	Fine screen (screen gap 14 mm) 0.9 m^W x 1.24 m^H x 2 nos.
	Parshall flume Capacity = 30,000 m^3/day x 2.nos.
	Grit Chamber 1.8 m^W x 6.0 m^L x 7.6 m^D x 2 nos.
Primary Sedimentation Tank	Type : Dortmund tank 12.2 m^{dia} x 11.5 m^D x 6 nos.
BNR Reactor	27.5 m^W x 95.5 m^L x 4.5 m^D x 2 nos.
Final Sedimentation Tank	Type : Clarifier 28.0 m^{dia} x 3.5 m^D x 4 nos.
Outlet Work	1.0 - 3.0 m^W x 5.0 m^L x 1 nos.
Sludge Thickener	Type : Dortmund Tank 11.6 m^{dia} x 11.3 m^D x 2 nos.
Anaerobic Digestion Tank	Type : unheated, recirculation 20.0 m^{dia} x 19.5 m^D x 2 nos.
Sludge Drying Bed	30 m^W x 60 m^L x 6 nos.
Sludge Storage Yard	Yard with Roof 12 m^W x 60 m^L x 1 nos.
Sludge Disposal Pit	100 m^W x 100 m^L x 4 m^D

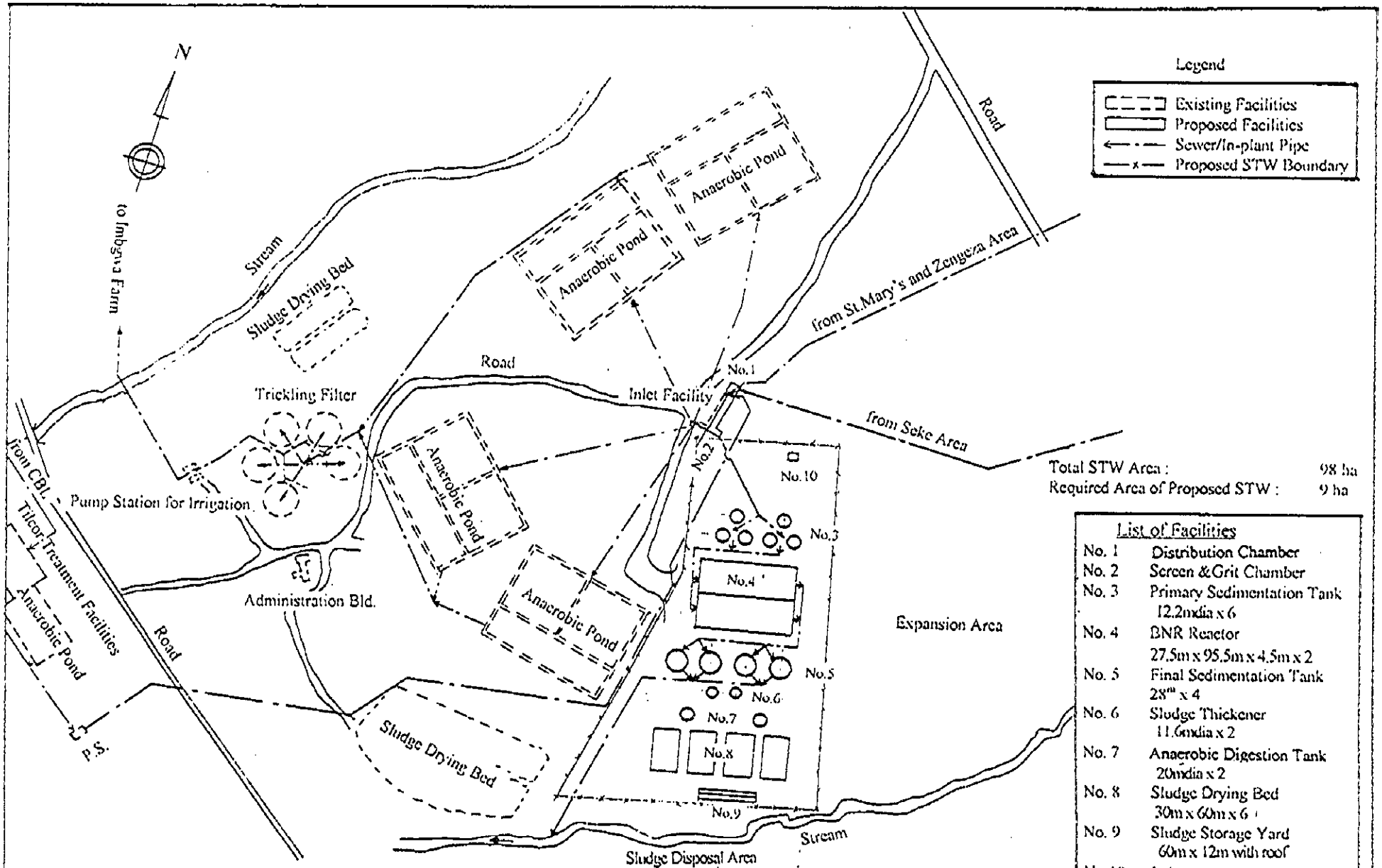


Figure 2.6 Layout of Zengeza Sewage Treatment Works (Capacity : 41,750 m^3/day)

S = 1/6,000

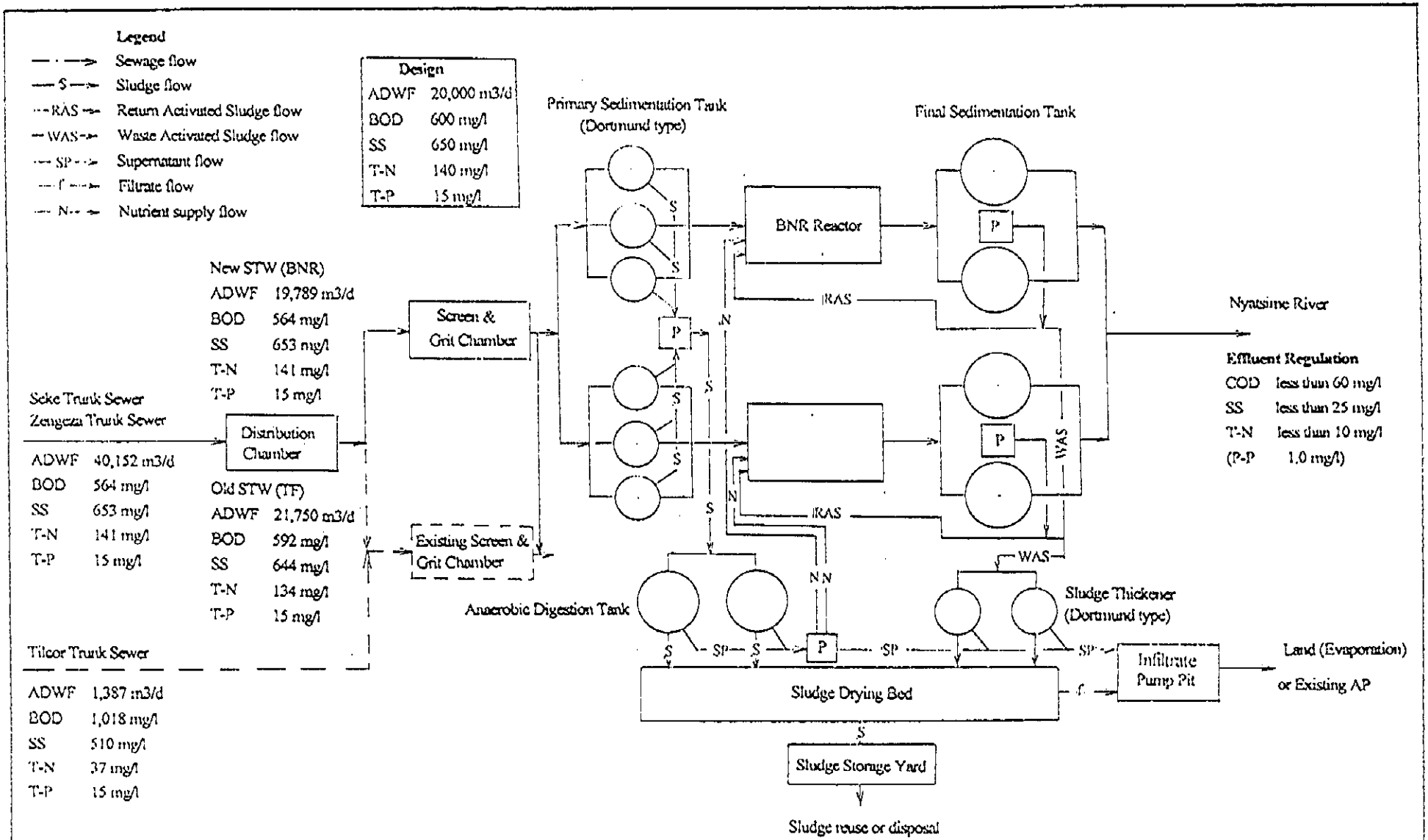


Figure 2.7 Flow Diagram of Zengeza Sewage Treatment Works (BNR 20,000m3/d)

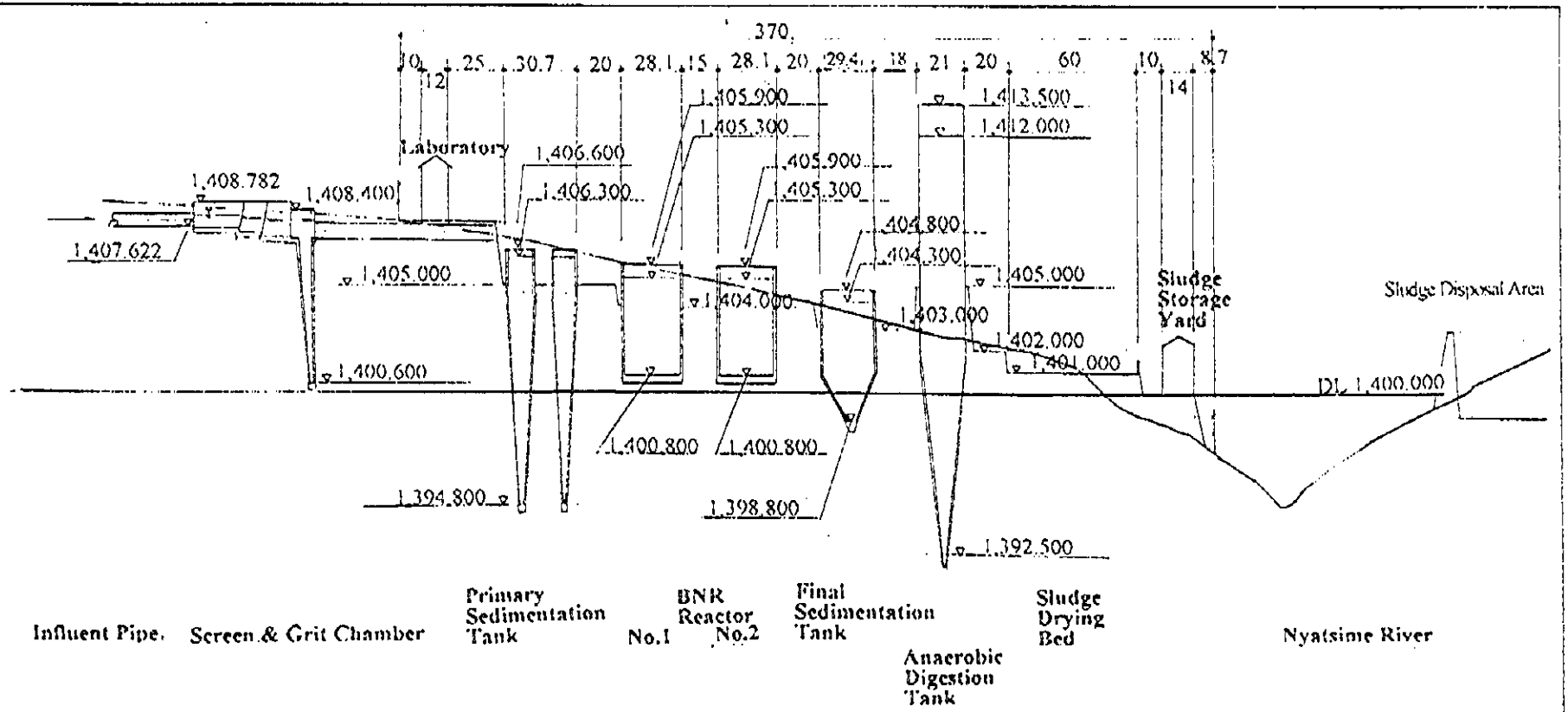


Figure 2.8 Hydraulic Profile of Zengeza Sewage Treatment Works (BNR, 20,000 m^3/day)

Facilities	Dimensions
Laboratory and other rooms	Total area = 12 m^W x 24 m^L = 288 m^2
Inplant Pipe	Total length = 3.2 km

2.9 Construction Plan, and Operation and Maintenance

2.9.1 Construction Plan

All the construction sites are situated on a flat land or a gentle slope. The access to the sites are easy from the municipality road and the existing residential road. It takes about 30 minutes from Harare City to each site using asphalt pavement road.

The workable days are assumed to be 21 days per month in average, as a result of analysis of suspended day due to rainfall, Saturday and holidays. The daily rainfall data were obtained from Belvedere gaging station in Harare City.

The number of local contractors available is sufficient for the sewerage construction works including mechanical and electrical works based on the experience by the previous sewage projects and interview result with civil contractors (including CIFOZ registered contractors).

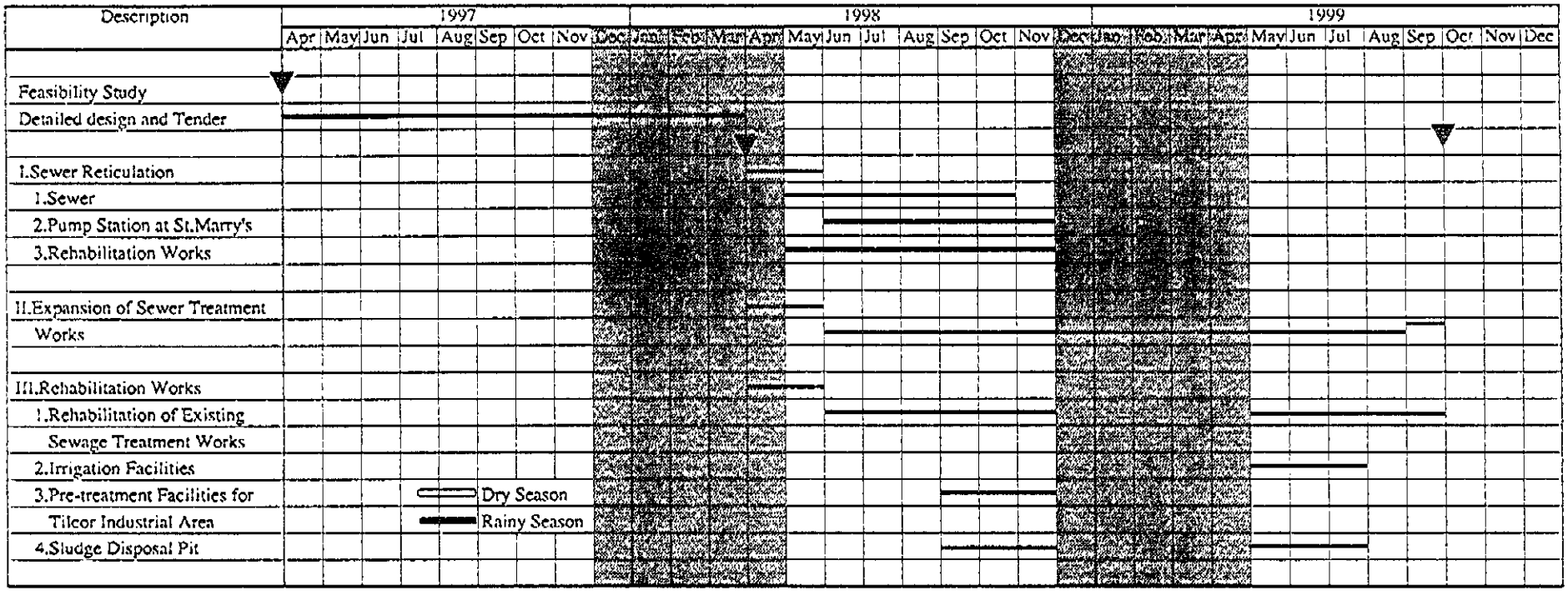
Labor will be supplied from the subcontractors and special contractors. The operator, driver and assistant labor will be included in the hiring equipment charges.

Most of the construction materials are produced in Zimbabwe. The imported materials are also available from the local market. There are many manufacturers, suppliers and sales agents in Harare.

The construction period is planned to be 18 months (1.5 years) considering meteorological conditions (rainy season), availability of Zimbabwe contractors and equipment supply conditions (refer to Figure 2.9). The construction sites are dotted and each work will be carried out in parallel employing many subcontractors and special contractors.

The sewer pipelines and pump stations will be constructed during dry season in principle. The expansion work for the sewage treatment facilities will be done within 1.5 years covering bulk excavation, structure construction , mechanical installation.

Figure 2.9 Construction Schedule for Rehabilitation/Expansion of Zengeza Sewage Works



2.9.2 Operation and Maintenance of Sewerage Facilities

Proper O&M is indispensable to extend durable years of the facilities and equipment.

(1) Sewer Reticulation

Sewer

There are 3 kind of O&M work for sewer as follows:

Site Investigation	: 3 person/team x 1 team
Pipe Cleaning	: 6 person/team x 4 teams
Rehabilitation	: 2 persons for construction supervision and 4 contractors

Each work is carried out by O&M team and their activities shall be daily recorded.

Pump Station

There are 2 kind of O&M work for pump station as follows:

Daily O&M	: 24 hours, 3 shifts (4 person including stand-by)/pump station
Periodical O&M	: Removal of scum from pump pit (every 6 months),
	Overhaul of pump (every 5 - 10 years)

Each work is carried out by resident workers and their activities shall be daily recorded.

(2) Sewage Treatment Works

Existing STW

One of the four units of Anaerobic Pond shall be kept open for emergency and maintenance purpose. Desludge is needed at least once a year for every pond. For other facilities, usual O&M work shall be conducted.

New STW

- Primary Sedimentation Tank

  Twice a day, the sludge shall be removed and pumped to anaerobic digestion tank.
- BNR Reactor

  The required level of nutrient concentration shall be maintained for effective treatment. In a wet season, supplemental nutrient may be supplied in use of supernatant.
- Sludge Drying Bed and Sludge Storage Yard

  The dried sludge shall be manually gathered and loaded on the truck to carry to the storage yard.

2.10 Cost Estimates

2.10.1 Construction Cost

The construction cost is estimated based on the preliminary quantity estimates. The information on material supplier, hiring company and contractors is taken into account to establish unit prices. The required cost is divided into foreign and local portions.

The price level is to be December 1996 and the exchange rate is US$1.00 = Z$ 10.5 = J.Yen 115.

The construction cost comprises direct cost, indirect cost, administration expenses, engineering fee, and physical and price contingencies. The cost of land acquisition and compensation is not included, since the land for construction use is owned by the Municipality. The total cost required is shown in Table 2.7.

Table 2.7 Construction Cost Requirements

	Description	Foreign (Z$)	Local (Z$)	Total (Z$)	Total (US$)
I.	Direct Construction Cost	105,040,937	78,140,785	183,181,722	17,445,878
II.	Land Acquisition and Compensation	0	0	0	0
III.	Administration Expenses	0	4,000,000	4,000,000	380,952
IV.	Engineering Services	14,013,402	2,472,953	16,486,355	1,570,129
	Total (I,II,III and IV)	119,054,339	84,613,738	203,668,077	19,396,960
V.	Physical Contingency	11,905,434	8,461,374	20,366,808	1,939,696
	Total (I,II,III,IV and V)	130,959,773	93,075,112	224,034,885	21,336,656
VI.	Price Escalation	7,688,000	51,588,000	59,276,000	5,645,333
	Grand Total	138,647,773	144,663,112	283,310,885	26,981,989

Note:Foreign - imported materials and equipment

Local - indigenous materials and labor

Direct Construction Cost - including direct, indirect (overhead and profit) construction cost

2.10.2 Operation and Maintenance Cost

(1) Sewer Reticulation

The annual O&M cost for sewer reticulation is estimated at Z$ 3,646,000/year.

(2) Sewage Treatment Works

The annual O&M cost for the Zengeza STW is Z$ 9,069,000/year including both existing and expansion facilities.

2.11 Institutional, Legislative and Financial Study

2.11.1 Institutional Development

Under the supervision of the MLGRUD (strictly speaking its DDPC), Chitungwiza Municipality is empowered to implement development projects including the priority project.

To support substantially the decision-making functions of the municipal administrative system, there is a need to strengthen the managerial capabilities of the existing "Management Committee". Then, it is proposed to create newly a "Project Coordination Committee (PCC)" which is to exclusively deal with the matters/issues of the priority project.

For smooth implementation of the project, it is recommended to establish a "Project Management Office (PMO)" under the Director of the Engineering Services Department (ESD) (refer to Figure 2.10). Consequently, the Director of ESD will be appointed as a Project Director of the project. The PMO will be headed by a Project Manager and composed of technical and administrative specialists with enough experiences in each field.

To assure the efficient O&M of the project facilities, it is important to consolidate the Sewerage Sections, especially in terms of manpower and monitoring. With a view to strengthen its monitoring capacity, it is strongly recommended to construct a "Chemical Laboratory" for water quality analyses. Besides, it is proposed to establish an operational unit to be called as the "Waste Water Inspectorate (WWI)" under the Laboratory for efficient enforcement of the Trade Effluent Control By-laws.

With regard to the human resources development, the properly organized and designed training programs should be carried out for both the administrative and technical and the existing and new staffs.

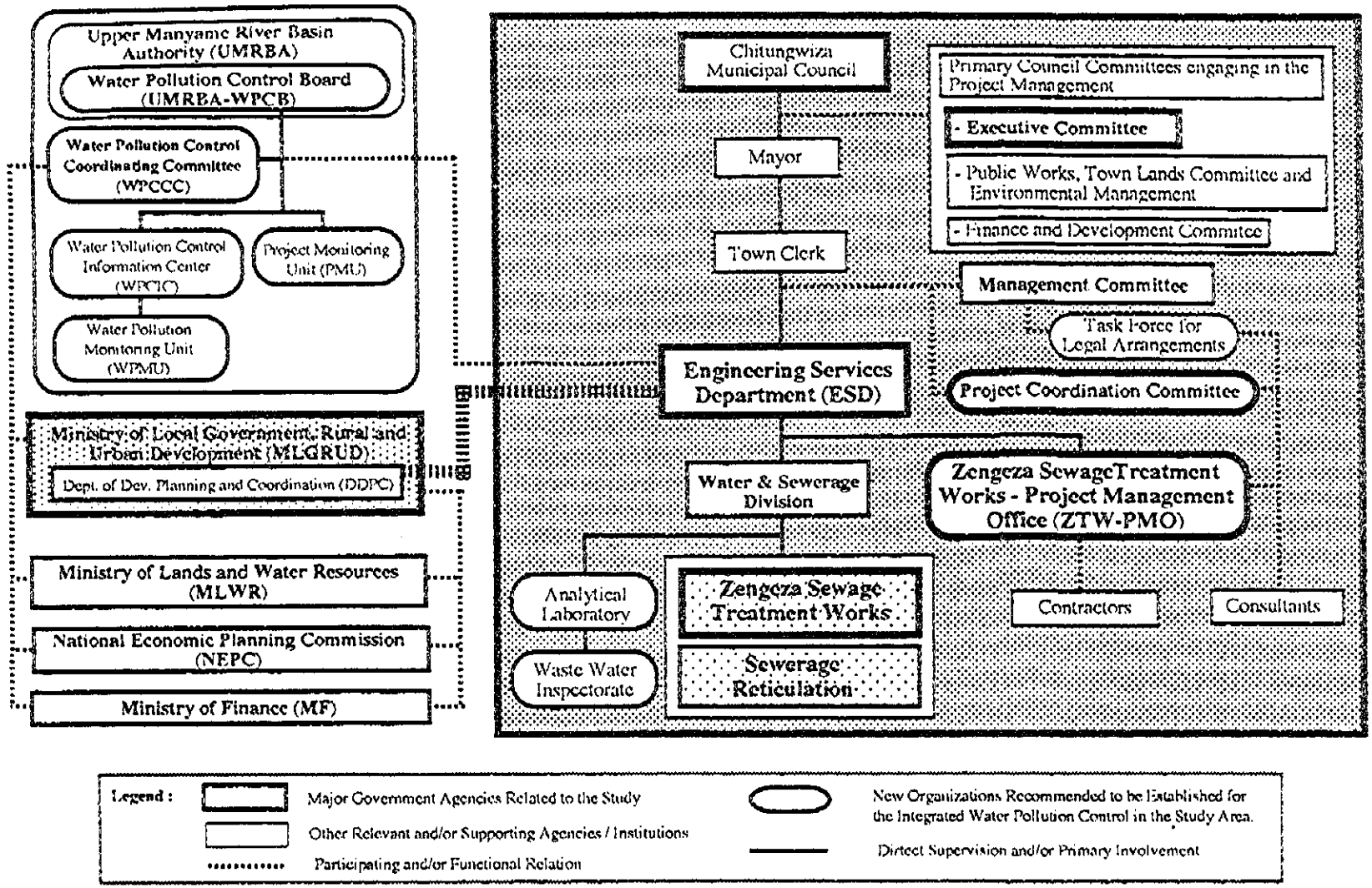


Figure 2.10 Proposed Organizational Framework for Implementatoin of the Priority Project : Rehabilitation and Expansion of the Municipal Sewerage System

2.11.2 Legal Arrangement

In order to ensure effective and efficient environmental management and water pollution control, the legal arrangements proposed in the Master Plan are expected to be carried out as soon as possible, within the (Short-Term) Action Plan period up to the Year 2000.

The primary arrangements necessary for legislative framework consolidation related to water pollution control include the following : 1) review of "Water Act", 2) enactment of "Environmental Management Act", 3) establishment of "environmental Water quality Standards" 4) amendment of the existing "Effluent Regulations", and 5) review of updating of other legislation relating to water pollution control.

In order to control the water pollution in the Municipality area, specially the trade effluents form the industrial area, it is recommended to enact the "Trade Effluent Control By-laws" as quickly as possible. Since the enactment of laws & regulations are really complex tasks, it is proposed to set up a "Task Force for Legal Arrangements". The primary assignments of this Task force will include the drafting works of the following laws and regulations : Trade Effluent Control By-laws, Model Building By-laws, Waste Management By-laws and others.

2.11.3 Financial Study and Implementation Plan

The financial study aims to evaluate the Council's self-financing condition under implementation of the Project. The condition of self-finance could be checked by the balance between projected revenue and expenditures consisting of operating expenses and debt service, as expressed by the following equation.

Balance = Revenue - O & M cost - debt service

Sewerage revenue comprising both sewerage charges based on flat tariffs and trade effluent charges to be introduced is projected taking into account two factors; expansion of revenue base and the real growth of income. O & M costs estimated are classified into those for the existing and proposed facilities. Debt services the Council would have to repay are composed of the scheduled repayment committed by the existing liabilities and new repayment to be borne by implementation of the Project.

The four alternative financial schemes are assumed in order to estimate debt services relating to the Project.

Alternative Case	Type of Fund		Premium
	GOZ	Donor	
Base	Loan	Loan	Charge
Alt. 1	Grant	Loan	Charge
Alt. 2	Loan	Loan	Subsidy
Alt. 3	Grant	Loan	Subsidy

Donor is assumed to be most concessionary bilateral fund with the lending rate of 3% per annum. Premium, the difference between lending and on-lending rates is assumed to be 8%.

Base : The loan scheme with premium

Alt 1 : A combination of GOZ's grant and donor's loan with premium

Alt 2 : The loan scheme without premium

Alt 3 : A combination of GOZ's grant and donor's loan without premium

Balance is estimated by alternative case with the following results.

unit: Z$ million

Balance	2000	2010	2020
Base case			
Annual in the target year	-34	12	57
Accumulated	-70	-189	270
Alt 1			
Annual in the target year	-31	-15	60
Accumulated	-62	-150	339
Alt 2			
Annual in the target year	-18	28	72
Accumulated	-24	11	625
Alt 3			
Annual in the target year	-15	31	75
Accumulated	-16	50	694

Revenue would be sufficient to recover operating expenditures and the scheduled repayment of the existing liabilities, but not large enough to cover new debt service even for Alt 3 which is the most preferential financial scheme for the municipality. This implies that the project implementation on a loan basis is virtually impossible in terms of cost recovery.

Implementation plan of the Project encompasses physical development plans, institutional development, legal and financial arrangements. Action Programs entail all preparatory works for various measures proposed for implementation of the Project. Figure 2.11 shows the implementation plan of the project.

(1) Institutional

1) Preparation for a "Water Pollution Control Coordinating Committee",
2) Preparation for a "Project Coordination Committee",
3) Preparation for a "Project Management Office", and
4) Preparation for operation and maintenance works to be strengthened.

(2) Legal

1) Legal measures relating to the existing Acts, Regulations and Standards.
2) Preparation for a " Task Force for Legal Arrangements " which is principally designed to enact the "Trade Effluent Control By-law" at the Council's level.

(3) Financial arrangement

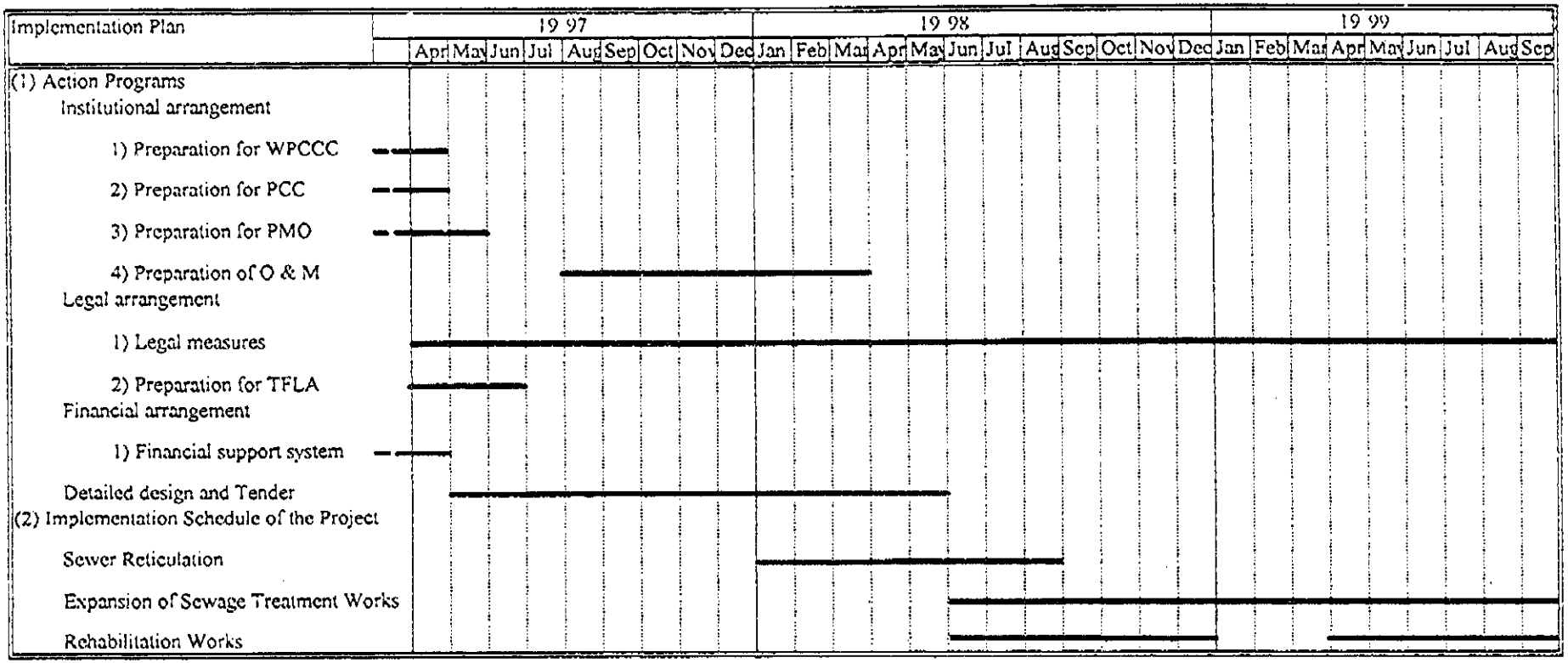
1) Preparation for the government financial assistance to alleviate financial burden on the Council.

(4) Detailed design

Immediately after the completion of the Feasibility Study in March 1997, implementation period is broadly divided into three stages.

- First stage : Most of Action Programs covering institutional, legal
(April to June, 1997) : and financial arrangements should be carried out.
- Second stage : Implementation of detailed design
(April 1997 to March 1998)
- Third stage : Construction of the Project
(April 1998 to Sep. 1999)

Figure 2.11 Implementation Plan



2.12 Project Evaluation

The project evaluation was made for the Zengeza Sewage Works as an urgent project for the target year 2000. The evaluation entailed urgency of the project, benefits/effects and viability for the project implementation to finally come up with comprehensive feasibility of the project.

The urgency of the project was confirmed both in technical and environmental aspects. The benefits derived from the projects were summarised in eight major items as follows:

(1) Contribution to mitigate eutrophication problem of the impoundments
(2) Prevention of emergency case of raw sewage discharge into the water body
(3) Conservation of water environment in the receiving water body and replenishment to water sources
(4) Functional recovery of existing sewage treatment facilities and a proper reuse of treated effluent
(5) Improvement of sanitation condition
(6) Sludge reuse
(7) Provision of the opportunities for sustainable organization and management through the future
(8) Provision of employment opportunities

From financial view point, revenue would be sufficient to recover O & M expenses. However, the difficulty was identified in project implementation on a loan basis even under the most preferential loan condition.

It is difficult to prove the economic viability quantitatively, however, socio-economic justification would be secured taking into account the variety of benefit. While, competent capability of the council was confirmed to execute the project.

As a result of comprehensive evaluation, the serious constraint was identified in financial aspect.