JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF LOCAL GOVERNMENT,
RURAL AND URBAN DEVELOPMENT
REPUBLIC OF ZIMBABWE

THE STUDY
ON
WATER POLLUTION CONTROL
IN
THE UPPER MANYAME RIVER BASIN
IN
THE REPUBLIC OF ZIMBABWE

VOLUME 2 - II

MAIN REPORT

MARCH 1997

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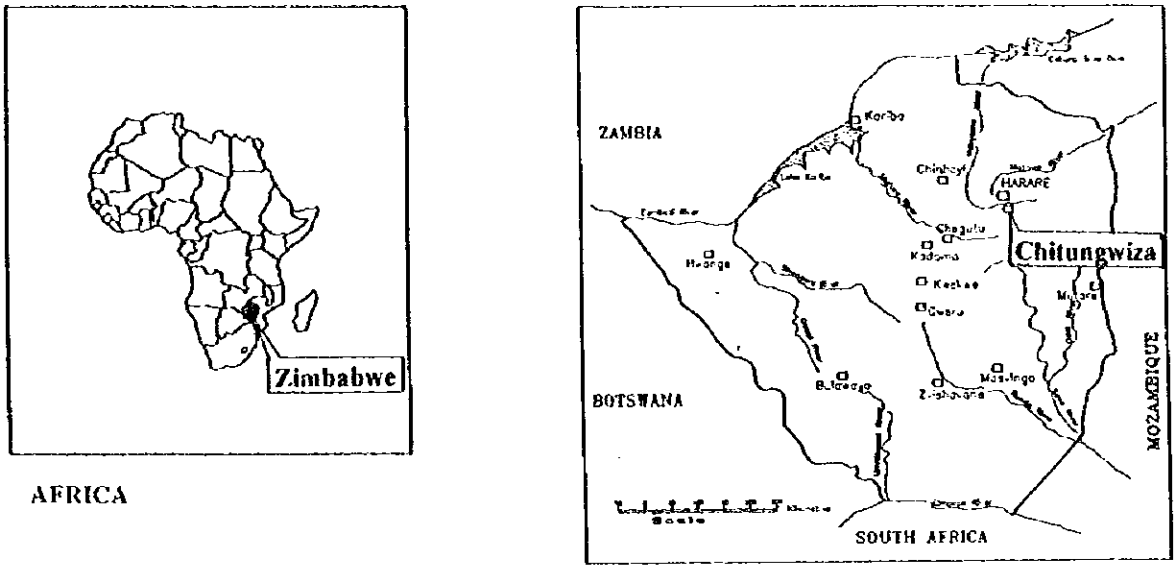

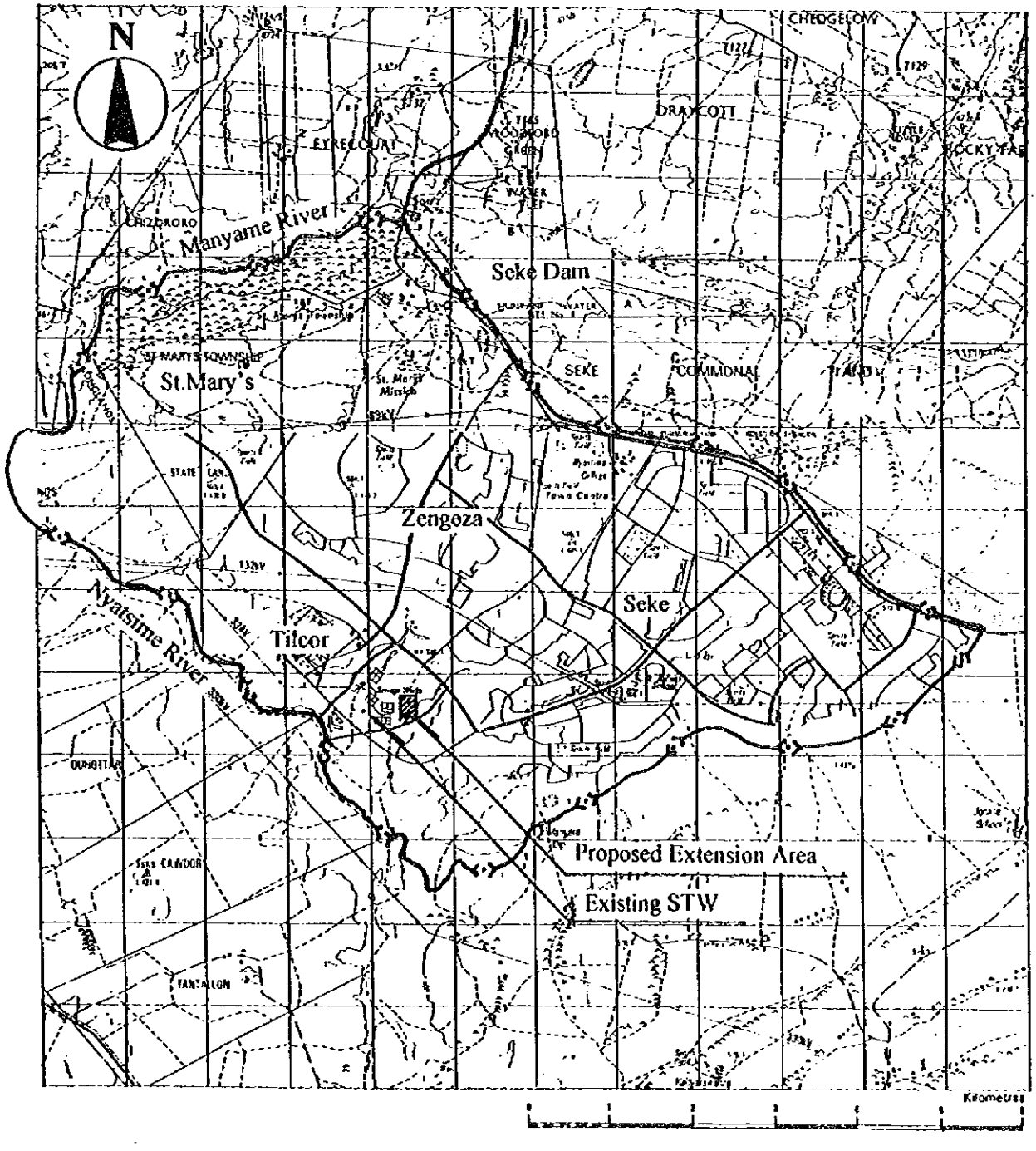

Location Map of the Study Area

WATER POLLUTION CONTROL MASTER PLAN
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ABBREVIATIONS

ADWF	Average Dry Weather Flow
ARDA	Agricultural and Rural Development Authority
BNR	Biological Nutrient Removal
CH	City of Harare
CMC	Chitungwiza Municipal Council
CSO	Central Statistical Office
DANIDA	Danish Development Agency
DDF	District Development Fund
DDPC	Department of Development Planning and Coordination (MLGRUD)
DEHS	Department of Environmental Health Services
DLAA	Department of Local Authorities Administration (MLGRUD)
DNPWM	Department of National Parks and Wildlife Management (MET)
DNR	Department of Natural Resources (MET)
DPP	Department of Physical Planning (MLGRUD)
DW	Department of Works (City of Harare)
DWR	Department of Water Resources (MLWD)
DWSSC	District Water Supply and Sanitation Sub-committee
EHO	Environmental Health Officer
EHT	Environmental Health Technician
ESA	External Support Agencies
EU	European Union
FC	Forestry Commission (MET)
GI	Galvanized Iron and S
GoZ	Government of Zimbabwe
GP	Growth Point
HCC	Harare City Council
HCMP	Harare Combination Master Plan
HHE	Health and Hygiene Education
IEE	Initial Environmental Examination
IES	Institute of Environmental Studies
IRWWS	Integrated Rural Water Supply and Sanitation
IRWSSP	Integrated Rural Water Supply and Sanitation Programme
IWSD	Institute of Water and Sanitation Development
JICA	Japan International Cooperation Agency
LGA	Local Government Area
LGB	Local Government Board
LPA	Local Planning Authority (Local Authority)

LSCF	Large-Scale Commercial Farming (Area)
MA	Ministry of Agriculture
MET	Ministry of Environment and Tourism
MF	Ministry of Finance
MFA	Ministry of Foreign Affairs
MHA	Ministry of Home Affairs
MHCW	Ministry of Health and Child Welfare
MHE	Ministry of Higher Education
MIC	Ministry of Industry and Commerce
MJLPA	Ministry of Justice, Legal and Parliamentary Affairs
MM	Ministry of Mines
MLGRUD	Ministry of Local Government, Rural and Urban Development
MLWR	Ministry of Lands and Water Resources
MNAECC	Ministry of National Affairs, Employment Creation and Cooperatives
MOHCW	Ministry of Health and Child Welfare
MPCNH	Ministry of Public Construction and National Housing
MPSLSW	Ministry of Public Service, Labour and Social Welfare
MTE	Ministry of Transport and Energy
NCU	National Coordination Unit
NEPC	National Economic Planning Commission
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development
NTC	Norton Town Council
NUST	National University of Science and Technology
O & M	Operation & Maintenance
ODA	Overseas Development Agency
OECF	Overseas Economic Cooperation Fund (Japan)
PDD	Planning & Development Division (Department of Works, City of Harare)
PEIA	Preliminary Environmental Impact Assessment
PSIP	Public Sector Investment Programme
RDC	Rural District Council
RLB	Ruwa Local Board
RTCPA	Regional Town and Country Planning Act
SADCC	Southern African Development Coordination Conference
SAZ	Standards Association of Zimbabwe
SDF	Social Development Fund
SEDCO	Small Enterprise Development Corporation
SIDA	Swedish International Development Agency

SSCF	Small-Scale Commercial Farming (Area)
STW	Sewage Treatment Works
SWLTF	Solid Waste Leachate Treatment Facility
TF	Trickling Filter
UMRBA	Upper Manyame River Basin Authority (proposed in this M/P Study)
VIDCO	Village Development Committee
WARB	Water Act Review Board
WHO	World Health Organization
WPAB	Water Pollution Advisory Board
WPCB	Water Pollution Control Board (proposed in this M/P Study)
WPCCC	Water Pollution Control Coordinating Committee
WPCIC	Water Pollution Control Information Center (proposed in this M/P Study)
WPCS	Water Pollution Control Section (MLWD/DWD)
WPMU	Water Pollution Monitoring Unit (proposed in this M/P Study)
WSP	Wastewater Stabilization Pond
WQCP	Water Quality Checking Point
ZESA	Zimbabwe Electricity Supply Authority
ZIPAM	Zimbabwe Institute of Public Administration and Management

Government of Zimbabwe Fiscal Year

July 1 - June 30

Currency Equivalent (as of December, 1996)

US$ 1.00 = Z$ 10.500

Z$ 1.00 = US$ 0.095

PART II

FEASIBILITY STUDY
FOR
REHABILITATION/EXPANSION
OF
ZENGEZA SEWAGE WORKS

CHAPTER 1

GENERAL

CHAPTER 1 GENERAL

It is recommended in the Water Pollution Control Master Plan that a commensurate augmentation of the sewerage systems in the study basin is a requisite to maintain at least the present water quality level of the impoundments through the future. In this connection, priority projects for the target year 2000 were studied taking into account of not only the conservation of water quality in the water bodies, but also the importance of ensuring fresh water flow into the impoundments along with the Department of Water Development's policy of maximizing water reuse and ensuring water supply during times of drought.

Of the potential sewerage projects, the Zengeza Sewage Treatment Works in Chitungwiza Municipality was selected as an urgent project for its rehabilitation and expansion after a comparative study in terms of the technical, environmental improvement, economic and financial aspects. The implementing capacity of the concerned authorities and the sustainability of the project were initially confirmed.

The existing Zengeza STW is heavily overloaded, being sized for about 21,750 m^3/d but treating an estimated flow of 36,000 - 40,000 m^3/d. The aim of the project is to construct additions to the Zengeza STW, with a capacity of 20,000 m^3/d, which would treat sewage to a high standard and produce an effluent that could be discharged to the Nyatsime River (i.e. the Government Notice No.687 of 1977). The extensions in application of the BNR method used in Harare City would therefore eliminate the present overloaded situation and permit the rest of the plant to operate more efficiently as well. The countermeasures against emergency cases in the breakdown of pump facilities and electric failure were also considered so as not to discharge raw sewage into the river. In addition, the rehabilitation of existing treatment facilities is included in the study.

The study entails the evaluation of the existing sewer systems and the augmentation needs to meet the development for the year 2000, although the sewage treatment facilities are the focus of the feasibility study.

Aside from physical countermeasures, the study covers the strengthening of the institutional capacity for the implementation of the project.

Under the above conditions, the feasibility study covers (1) evaluation of present conditions in the relevant sector, (2) projection of sewage quality and quantity, (3) planning and design concept,

(4) plan and preliminary design of sewerage facilities, (5) institutional and financial studies and (6) project evaluation. A Preliminary Environmental Impact Assessment (PEIA) was also conducted according to the Zimbabwe Environmental Impact Assessment Policy of 1994.

CHAPTER 2

STUDY AREA

CHAPTER 2 STUDY AREA

2.1 Location of the Study Area

The study area covers the present jurisdiction of the Chitungwiza Municipality (42km^2), of which about 60% of the land area is served by the existing sewerage system. The area consists of Seke, Zengeza and St. Mary's since the amalgamation of these three of Harare's former high-density townships in 1978. Figure 2.1.1 presents the study area indicating proposed site for construction of extensions to the Zengeza STW.

The proposed site for the extensions to the Zengeza STW is owned by the Chitungwiza Municipality for the purpose of sewage treatment. The site lies to the east of the existing anaerobic ponds and inlet works. Part of the area was previously used as a borrow pit for road construction materials and the surface has been disrupted. The remainder of the site has a number of termitaria around which small scale agriculture of maize have been practiced and garbage has been illegally dumped due to a lack of fencing.

2.2 Climate, Topography and Geological Conditions

2.2.1 Climate

The climate in the study area is very seasonal with distinct three seasons. According to the data at Belvedere station in Harare City, "spring" from September to November is hot and dry with an average daily temperature of 22°C ± 6°C. In summer, the rainy season with hot and wet conditions is from December to April (average daily temperature is about 20°C ± 6°C). The remaining period of the year is cold and dry with average temperature of 16°C ± 6°C.

Mean annual rainfall is approximately 820 mm in the study area ranging from 440 mm to 1,220 mm, about 80% of which is concentrated in the summer season. The recorded annual wind directions at the airport, closest weather monitoring station to the Zengeza STW is shown in Figure 2.2.1. The prevailing wind direction at the STW is from the east to northeast away from the south residential areas of Seke and the open spaces to the southeast.

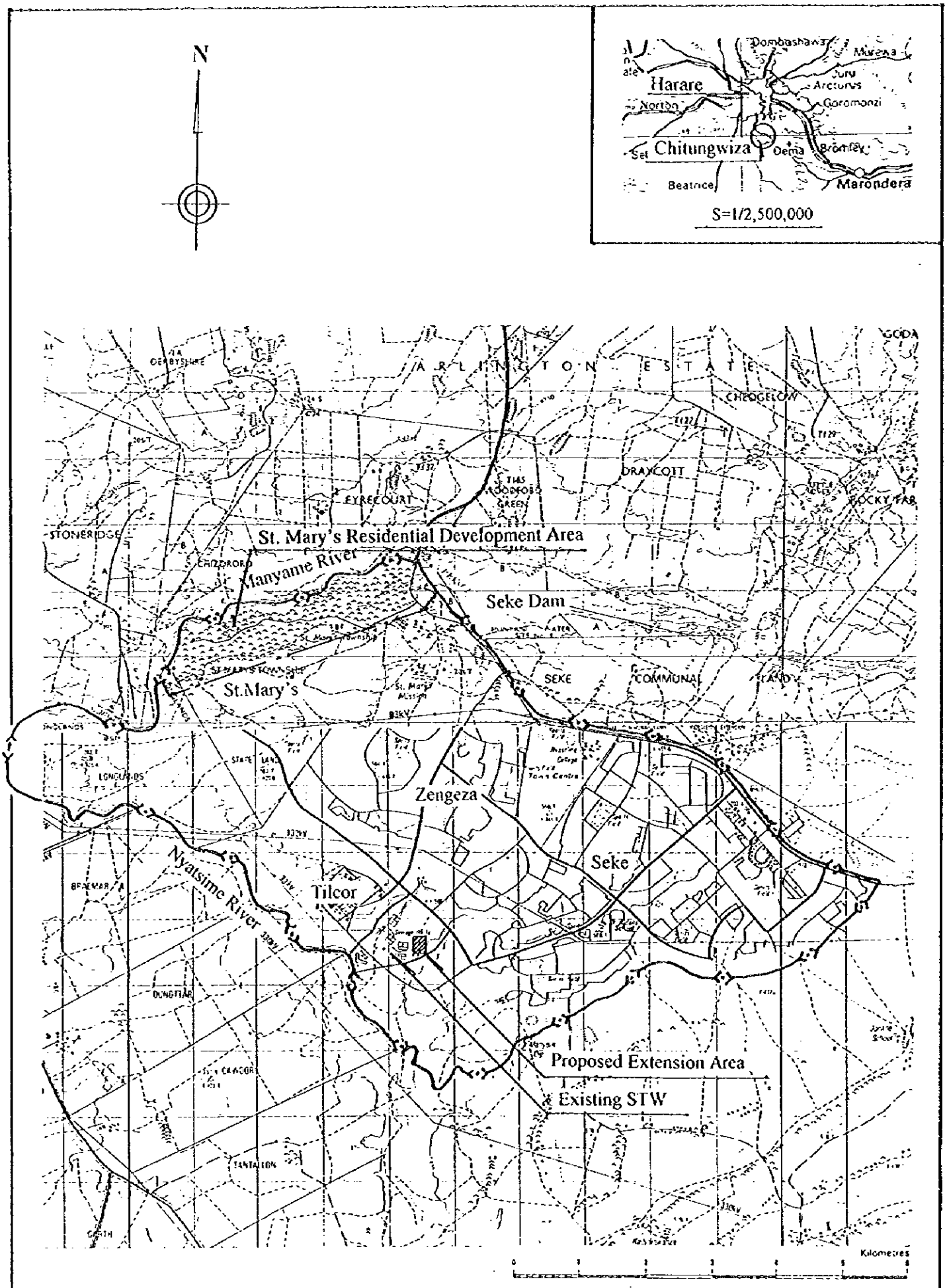


Figure 2.1.1 Location of theStudy Area S=1/75,000

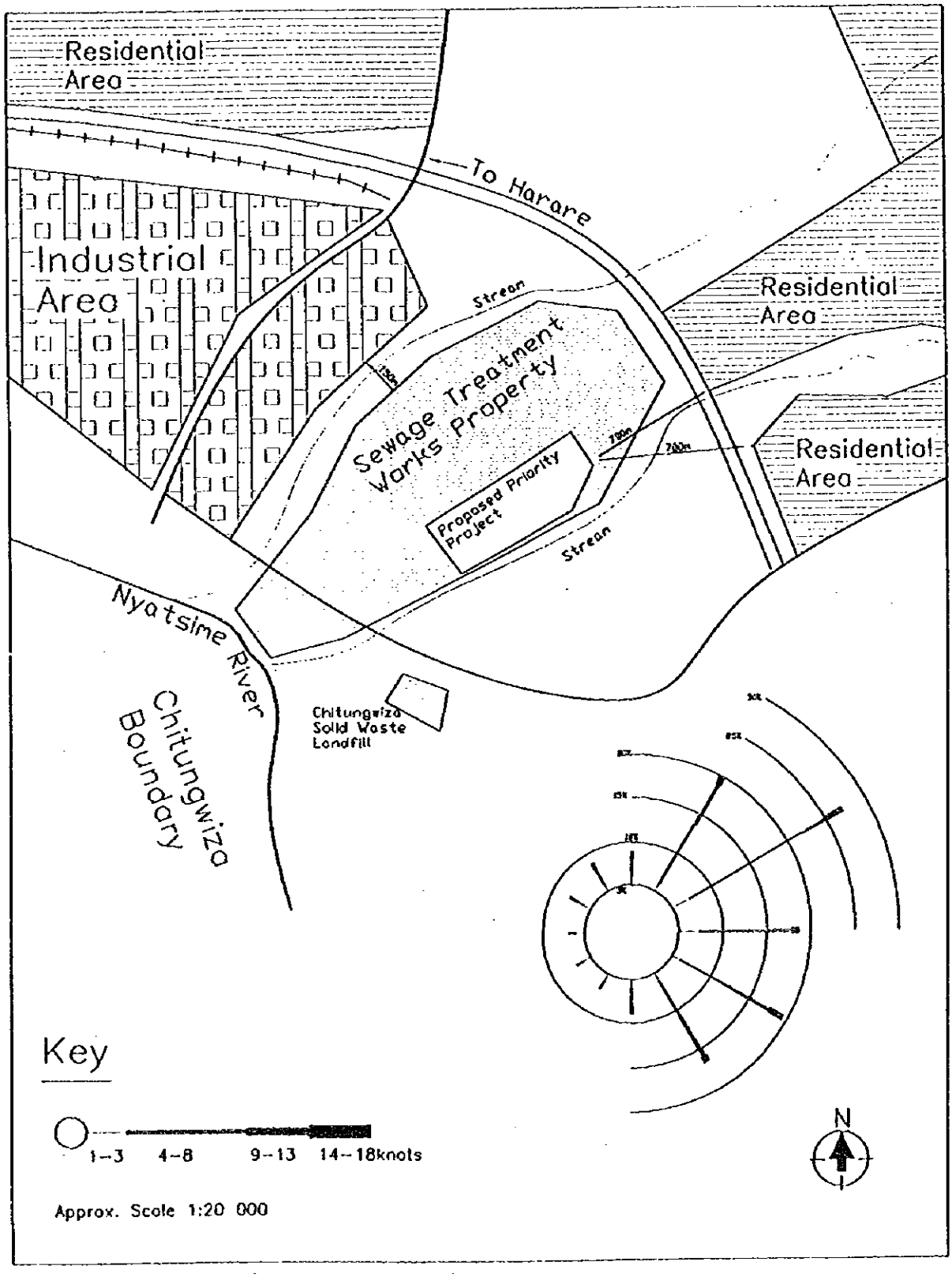


Figure 2.2.1 Annual Wind Direction at Zengeza STW

2.2.2. Topography

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

2.2.3 Geological Conditions

A relatively small part of the upper extremity of the Lake Chivero catchment, where the municipality is situated, is underlain by granite. At the STW site, the decomposed granites/sand silt are found from the surface to about 0.5 meter depth followed by residual decomposed granite to one meter or more depth.

2.3 Socio-Economic Conditions

The study area has an area of 42 km^2 and a population in excess of 400,000 (9500 people /km^2). The Chitungwiza municipality is one of the fastest growing areas in the country. The population growth rate is analyzed at 9% per annum.

Although Seke area does have some light industry, Tilcor, now ARDA, developed an industrial area where Chibuku Breweries and smaller industries exist. Chitungwiza has now an industrial base with an expansion plan to accommodate additional industrial stands. Furthermore, Old Mutual constructed a large shopping complex and some of the larger industrial organizations have started depots in the area.

Social services are being developed to standards normally expected by the residents of a large town. Water supply service is provided by means of bulk water supply through the expansion of Harare City water supply system. Sewerage services also cover almost 100% of the current population. Solid waste collection is practiced both in residential and industrial areas by means of trucks and tractors, although collection frequency is not sufficient. The electricity supply to the municipality is covered by the ZESA.

The Government has approved the introduction of a railway system linked to Chitungwiza and the rest of the towns and cities in the country. In response to this approval, the technical

preparations have been completed, but the financial arrangements have not yet been made. Table 2.3.1 summarises the basic infrastructures in the municipality.

Table 2.3.1 Basic Infrastructure in Chitungwiza Municipality

Item	Unit	Qty.	Item	Unit	Qty.
(1) Roads			**(7) Establishment**		
Total Length	km	63.4	a) Public Market		
Municipal Roads	km	47.5	St Mary's	Number	1
			Zengeza	Number	1
(2) Electricity Service			Seke	Number	5
Coverage (ZESA)	Percent	64	b) Shopping Centres		
			St Mary's	Number	2
(3)Telecommunication			Zengeza	Number	3
Services			Seke	Number	10
a) Available in Municipality	Percent	45			
			(8) Tourism Facilities		
b) Telegraph station	Number	2	Hotels	Number	1
c) Telephone station	Number	1	Recreational Facilitiy	Number	1
(4) Post Office			**(9) Schools**		
Zengeza	Number	1	Elementary (Primary)	Number	26
Seke	Number	1	Junior High (Secondary)	Number	13
			High School	Number	1
			Colleges		
			Tertiary	Number	1
			Vocational	Number	1
(5) Transportation Services	Mode	2 bus			
	Bus	Ter-	**(10) Health Facilities**		
	Taxi	minus			
	Omnibus		Hospitals	Number	1
			Clinics	Number	4
(6) Banking Facilities			**(11) Labor**		
Commercial Banks	Number	5	Employment Rate	Percent	79
Public Bank (POSB)	Number	1			
Building Society	Number	3	**(12) Average Family Income (Z$)**		
			Annual Income	House-hold	10,000

CHAPTER 3

EXISTING CONDITION OF WATER SUPPLY AND SANITATION/SEWAGE WORKS

CHAPTER 3 EXISTING CONDITIONS OF WATER SUPPLY AND SANITATION/ SEWAGE WORKS

3.1 Water Supply at Present and in the Future

3.1.1 Service Coverage and Water Supply System

(1) Present water supply in Chitungwiza Municipality

Water supply for the entire municipality is provided by Morton Jaffray WTW through the bulk water supply system of Harare. The service reservoir at Seke covers the entire service area of the municipality. The annual average water demand in 1992 was analysed in the Harare Water Supply Master Plan using records of the pumping and consumers' meters as follows:

residential area	19,200 m^3/d
Inst./Ind./Comm. area	4,800 m^3/d
Water losses (17%)	4,900 m^3/d
Total demand	28,900 m^3/d

On the other hand, the monthly fluctuation of the demand is reported ranging from 22,00m^3/day to 42,000m^3/day with the ratio (peak month/annual monthly average) of 1.5. As a reference, the annual average water demand in 1995 was estimated assuming that the water demand increased from 1992 in proportion to the increase of population. Using the projected population of Harare Combination Master Plan, the demand arrived at 34,200 m^3/day.

Transmission main No. 4 enroute to Letombo from Warren pump station, installed for the transmission of treated water at Morton Jaffray WTW, is connected to the Seke reservoir in Chitungwiza. It is located in a northwestern part of the municipality. This is the principal supply of water, when the Prince Edward WTW is inoperable due to a lack of raw water in the Seke dam. The Seke ground reservoir made of reinforced concrete with a capacity of 45,600 m^3 (WL 1,464.95 m) is connected by 525 mm dia. pipe (from 1000 mm dia. main from Prince Edward WTW) and 375 mm dia. pipe from the main No. 4. An elevated tank with a capacity of 1,100 m^3 (WL 1,860.6 m) is installed near the ground reservoir to supply its surroundings with a higher ground level (more than 1,460 m). The reticulation system

conveys water from the service reservoirs consisting of primary (greater than 300 mm dia.) and secondary (50 mm - 300 mm dia.) reticulations. The majority of the reticulation system is made of asbestos-cement pipes.

(2) Future water supply

A future water supply augmentation master plan (target year 2012)for the Harare Metropolitan area was prepared in October 1995. Among the options, the future water demand in 2012 was projected in use of the projected population and unit consumption rate for domestic use by category (high-density 80 lpcd, medium-density 250 lpcd and low density 350 lpcd). The total demand for the entire service area arrived at 1,389,000 m^3/day, of which 76,300 m^3/day was allocated to Chitungwiza municipality (broken down into residential 46,300 m^3/day, inst./ind./comm. 22,400 m^3/day and losses 7,600 m^3/day). In regard to this demand projection, the projected population of the municipality for the years 2002 and 2012 are 427,000 and 663,000, respectively.

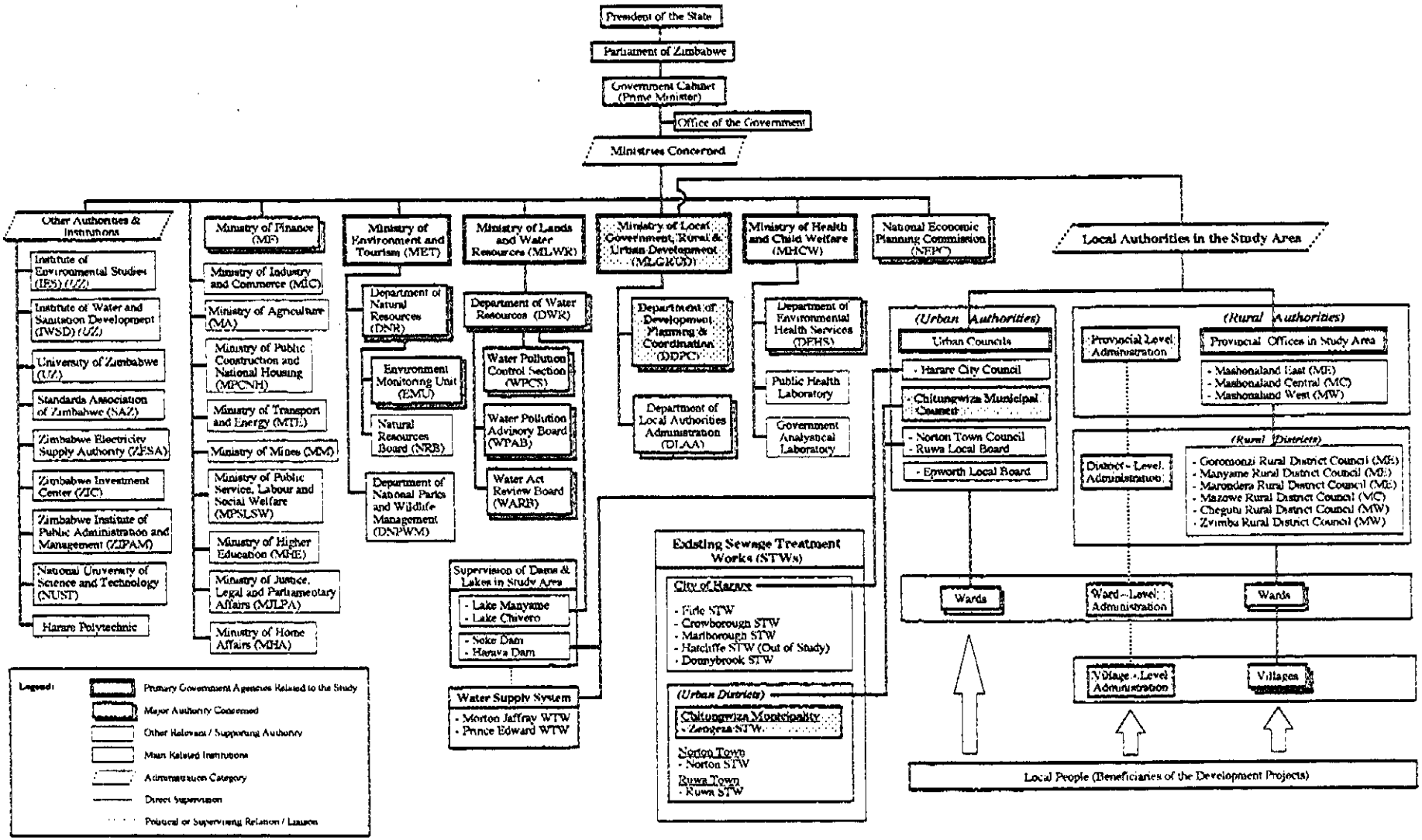
The Department of Water Resources proposed a phased development of Nyagui catchment, some 70km to the northeast of Harare (phase I: 192,000 m^3/day in construction of Kunzwi Dam). An extension of the Seke service reservoir, to increase up to 190,800 m^3 from a current capacity of 144,100 m^3 was proposed under a massive service reservoir construction programme. The uprating of the reticulation system by phases is also required.

3.1.2 Institutional, Legislative and Financial Arrangements

(1) Institutions and System Management for Water Supply

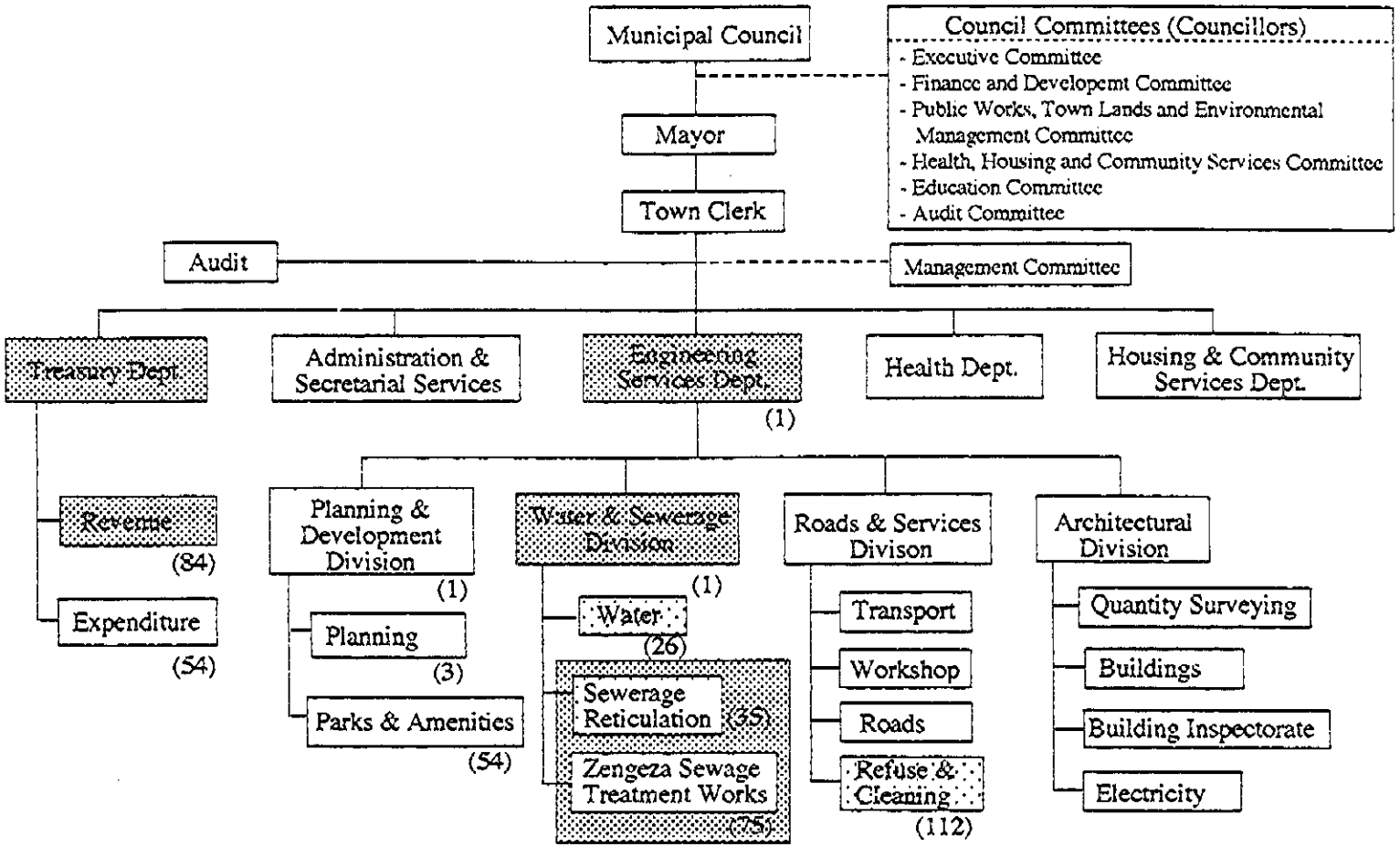
Several central government agencies and local authorities are involving in the water resources development and environmental management to assure the provision of safe water supply to the Chitungwiza Municipality area. Figure 3.1.1 shows institutional relations and position of the Municipality in the overall national structure for water resources development and environmental management.

In Chitungwiza Municipality, the water supply is managed by the "Water Section" under the Water & Sewerage Division, Engineering Services Department (see Figure 3.1.2). The total number of staff in Water Section is 26 and they are mostly engaged in water distribution works, since water purification works are entrusted to the two Water Treatment Works in



Source : JICA Study Team

Figure 3.1.1 Organization Structure for Water Resources Development and Environmental Management in Zimbabwe
(Main Agencies & Institutions Related to the Implementatin of Water Pollution Control Projects)



Source : Chitungwiza Municipal Council

Notes : Total Number of Staff (permanent of the Council) : 1,633
Figures in parentheses indicate the number of total proper (permanent) staff in the organizations concerned (Data as of December 1996).

Figure 3.1.2 Organizational Chart of the Chitungwiza Municipal Council

the City of Harare. Incidentally, the number of staff working for water supply including water purification works totals to 292 in the Harare Water Supply System.

Major issues in water supply in the Municipality are losses of water mainly due to overage pipes. Replacement of these pipes is now undertaken with the World Bank loan under the Urban II Programme. In managerial aspects, any serious constraints are not pointed out.

Water charges are fixed by the Municipal Council after the written approval of the Minister of Local Government, Rural and Urban Development. Charges are used to be reviewed once a year and go up with effect from July (starting month of the fiscal year). Water charges consist of basic and consumption charges and the both are collected by the staff of Treasury Department of the Municipality assigned in each area office.

But for bills preparation, they are prepared separately. The fixed "basic" water charges are billed and collected together with the sewerage and refuse charges, while the water "consumption" charges are billed separately because of its more complicated calculation. Chitungwiza Municipality has already completed installation of standard software and hardware for its accounting system. The combined billing of the above charges may be realized through introduction of the computerized billing system.

(2) Legal Issues in Water Supply

The Water Act, 1976 provides for the planning of the optimum development and utilization of the water resources of Zimbabwe and for the prevention and control of water pollution. The basic purpose of this Act is to protect water quality, both surface and underground, and to promote conservation of national water resources.

In the area of water resources, the government is implementing a reform programme of the water sector to improve the management of water resources and administration of the Water Act. With this respect, it is pointed out that the Water Act fails to address the problems of consistency in the application of standards for monitoring environmental water quality and controlling water pollution. The environmental law reform process addresses the environmental water quality standards and institutional arrangements of monitoring and enforcing these standards.

In fact, the environmental legislation, policies, standards and guidelines are too much fragmented and lack of comprehensive environmental legislation led to serious water pollution of the source of water supply for the City of Harare and its satellite towns including Chitungwiza Municipality.

As described in the Master Plan Study (Sections 3.3.2 & 12.7.2), environmental laws and regulations are not yet well enacted and the environmental impact assessment (EIA) procedures are not established properly in Zimbabwe. In such circumstances, the environmental water quality law is not yet established as a management and enforcement tool.

For the local authorities (including Chitungwiza Municipality), there are no general requirements of national environmental laws or regulations to be conformed. The quality of water in the Harare Water Treatment System is actually monitored by referring to the WHO drinking water standards (see Table 3.1.1).

To tackle the legislative and administrative problems on water pollution control in order to secure safe drinking water, the Water Act and relevant water regulations should be reviewed and updated to define the responsibilities of the institutions concerned and to clearly formulate the basic principles so as to be able to implement water pollution measures in a comprehensive and unified manner. In addition, it is vital to enact a new "Environmental Management Act" and subsequently establish an "Environmental Water Quality Standards", in order to overcome the legislative deficiencies and fragmentation of existing environmental laws as well.

Upon establishment of legal and institutional framework at national level, the municipal authority is then required to formulate its own "Drinking Water Standards" which replaces the WHO Standards, in consideration of the specific conditions existing in the municipal area.

Table 3.1.1 WHO Drinking Water Standards (WHO Geneva 1986)

Prarameters	WHO Action Levels
pH	6.5 to 8.5
Turbidity	5 NTU
Colour	15 TCU
Total Dissolved Solids	1,000 mg/l
Fluoride (F)	1.5 mg/l
Chloride (Cl)	250 mg/l
Sulphate (SO4)	400 mg/l
Cyanide (CN)	0.1 mg/l
Nitrate (N)	10.0 mg/l
Total Hardness (CaCO2)	500 mg/l
Arsenic (AS)	0.05 mg/l
Cadmium (Cd)	0.005 mg/l
Chromium (Cr)	0.05 mg/l
Lead (Pb)	0.05 mg/l
Mercury (Hg)	0.001 mg/l
Nickel (Ni)	0.05 mg/l
Selemium (Se)	0.01 mg/l
Aluminium (Al)	0.20 mg/l
Copper (Cu)	1.0 mg/l
Iron (Fe)	0.30 mg/l
Manganese (Mn)	0.10 mg/l
Sodium (Na)	200 mg/l
Zinc (Zn)	5.0 mg/l
DDT	0.001 mg/l
2-4-D	0.10 mg/l
Lindane	0.003 mg/l
Chloroform	0.03 mg/l
Coliform becteria per 100 ml	Nil
Faecal Coliform becteria per 100 ml	Nil

Source : Department of Works, City of Harare

(3) Financial Arrangement

1) Public Sector Investment program (PSIP)

PSIP on supply side

Water consumption of Chitungwiza entirely depends on bulk water supplied from the City of Harare. In view of a growing water demand in urban centers of the capital city and suburban areas including Chitungwiza, the mobilization of the massive amount of funds for water augmentation on the supply side (the City of Harare) is the primal and acute concern for the national government and the City of Harare. The upgrading of water augmentation schemes on the supply side consists of the following components.

Components	Detailed schemes	Project/Stage	Fund source
1) Development of raw water source	Construction of Kunzwi Dam in the Nyagui catchment area. Kunzwi Dam whose supply capacity is proposed to be 192,000 m^3/day will be absolutely needed around the year of 2000 as water demand expected (650,000 m^3/day) would probably exceed the existing catchment yield (592,000 m^3/day). The development of this dam is under the jurisdiction of the Ministry of Land and Water Resources.	Completion of F/S.	African Development Bank (ADB)
2) Water Treatment Works (WTW)	Morton Jaffray WTW (a) Construction of the third unit of WTW (treatment capacity is 227,000 m^3/day), and installation of pumping plants which transfer bulk water to Warren PS. with completion of the above project, Morton Jaffray WTW has a production capacity of 614,000 m^3/day in total.	Harare Water Supply Project (HWSP) Phase I (completion)	European Investment Bank (EIB)

Components	Detailed schemes	Project/Stage	Fund source
	(b) Construction of wastewater treatment facility to be completed in July 1997. With completion of this facility, about 38,000 m^3/day will be reused as drinking water.	HWSP Phase 2 (on-going)	Israeli Government
	(c) Rehabilitation of the first unit of WTW built in 1954. With this rehabilitation, the efficiency of water production (the ratio of production to water intake) is expected to increase.	HWSP Phase 2 (on-going)	ADB
3) Bulk transfer facilities	(a) Installation of pipeline (1.300 mm diameter) from Morton Jaffray WTW to Warren PS in order to expand transfer capacity to 600,000 m^3/day.	HWSP Phase I (completion)	ADB
	(b) Uprating of Warren PS to increase its capacity to 600,000 m^3/day.	HWSP Phase 2 (on-going)	ADB
	(c) Provision of central control at Warren PS from which bulk water is to be transferred to Outer and Inner City Ring Transmission Mains to be constructed.	(on-going)	City of Harare
	(b) Uprating of existing booster pumping plants to lift water from ground level reservoirs to elevated reservoirs.	Urban II (on-going)	IBRD and Government
4) Transmission Mains	(a) Construction of a part (20km) of Outer City Ring Mains. This Ring Main was installed in parallel with the existing transmission main No 4 from Warren PS to Letombo reservoir.	HWSP Phase 2 (completion)	ADB

Components	Detailed schemes	Project/Stage	Fund source
	(b) Replacement of old steel pipeline with 750 mm diameter in the distance of 6 km.	Urban II (completion)	IBRD and Government
5) Service reservoirs	Expansion of existing service reservoir storage capacity.	Urban II (on-going)	IBRD and Government
6) Reticulation system	Reinforcement and expansion of reticulation system associated with a future water supply system.	(on-going)	City of Harare

The World Bank-assisted Urban II Project contributes to water augmentation in urban centers of the Harare City. The augmentation of bulk water supply to Chitungwiza is much owed to uprating of both Morton Jaffray WTW and Warren PS, which is undertaken by the Harare Water Supply Project Phase 1 and 2. Thanks to implementation of Outer City Ring Mains (20km) and uprating of Warren PS, the bulk transfer capacity up to around 600,000 m^3/day would be secured. The crucial point is to what extent the efficiency of water production is expected to increase as a result of the discharge from sewage treatment facilities and rehabilitation of the first unit of WTW built in 1954, to be implemented in Phase 2. The current efficiency ratio (the rate of water production to water intake) was about 70 percent in 1995, compared to the same rate of 85 percent of ordinary WTWs. Though such a rate increases up to 85 percent, water production would be around or less than 500,000 m^3/day. The supplier will continue to be constrained by water shortage against a growing water demand.

Under such a circumstance, the necessity of Kunzwi Dam is unquestionably regarded as the City's water lifeline as the other dams are gradually failing to cope with demand. The construction cost of the dam is estimated to be Z$160 million. Because of lack of funds, the dam would be constructed based on the "build own operate transfer" concept. The government headed by the Ministry of Water Resources currently proceeds to negotiation with all interested partners (private companies) to enter into competitive bidding for the best offer. But it is totally unknown whether or not the expected operating revenue accrued from water sale to the City of Harare would satisfy investors in terms of financial indicators such as Rate of Return (ROR).

PSIP on demand site

Chitungwiza locating approximately 20km to the south of Harare, purchases the bulk water from the City of Harare, which is responsible for water intake from the source, treatment and delivery to Chitungwiza. The Council is fully in charge of the water reticulation system within its area. It is stated that out of a daily water consumption (as read from the bulk meter) of 35,000 m^3, the reticulation system has got an estimated water loss of around 20 percent, which is about 7,000 m^3 per day. According to the Engineering Services Department, the reticulation system is oldest and under most strain in St. Mary's, and water losses appear to be substantially high in Seke. A water loss (7,000 m^3 per day) cost the Council Z$3.3 million a year at current tariff (the purchasing price of bulk water, which is Z$1.3 per m^3).

The project proposal was submitted to the MLGRUD by the Council. It contains the existing situation for the water reticulation system, problems, action plan for reducing the overall water loss, sketches of the reticulation system and cost estimates. The proposal was then evaluated in terms of technical and institutional aspects by Programme Coordination and Monitoring Unit (PCMU), which is a special coordination unit exclusive to the World Bank-assisted Urban II, under the Department of Development Planning and Coordination of MLGRUD. The Project was named "Water Reticulation Strengthening, Rehabilitation and Replacement" and listed as one of strongly supported Urban II Programme to be implemented in the financial year 1996/97 onwards.

The following is the essence of the summary of Technical Appraisal prepared by PCMU.

(a) To plan and carryout leakage detection Programme to determine the actual water loss, specify and carry out necessary repair/rehabilitation/replacement of old leaking pipe sections in order to reduce the existing estimated water loss of around 20 percent down to 12 - 15 percent.

(b) Implementation Plan and Project Costs

Work Items	Costs
Phase 1: 9 months	
a) Investigation, monitoring and purchase of equipment including training of Municipal Staffs in leakage Detection Exercise	Z$ 400,000
b) Consultancy fees for strategic plants for reticulation strengthening/rehabilitation/replacement, and detailed design with preparation of tender document	Z$ 600,000
Sub-total	Z$ 1,000,000
Phase 2: 21 months	
c) Short term works to reduce some water loss, improve pressure zones and establish meter zones.	Z$ 1,350,000
d) Pipeline rehabilitation/replacement	Z$ 2,650,000
e) Reticulation strengthening in terms of operation and maintenance including continuous investigation and monitoring	Z$ 2,500,000
Sub-total	Z$ 6,500,000
Total	Z$ 7,500,000

(c) Project Effect

a) Upon reduction of the water losses from 20% to 14%, the annual cost savings calculated by the difference between purchase cost of bulk water and sales amount to consumers may be about Z$1.0 million/year.

b) Elimination of inconveniences caused to consumers by interruption of water supply.

Implementation period is scheduled to be 2 years and 6 months from October 1996 to March 1999. The loan of Z$ 1million (Phase 1) is disbursed in 1996/97.

2) Financial arrangement for water works

Municipal accounts, both for water and sewerage, are managed under the principle cost recovery that can be run by account. The cost recovery enforces the city

treasurer to maintain revenue at planned level to recover expenditures and debt services. This section presents the fundamental issues relating to financial arrangement for water works in Chitungwiza.

Administrative procedure for revenue collection and expenditure account

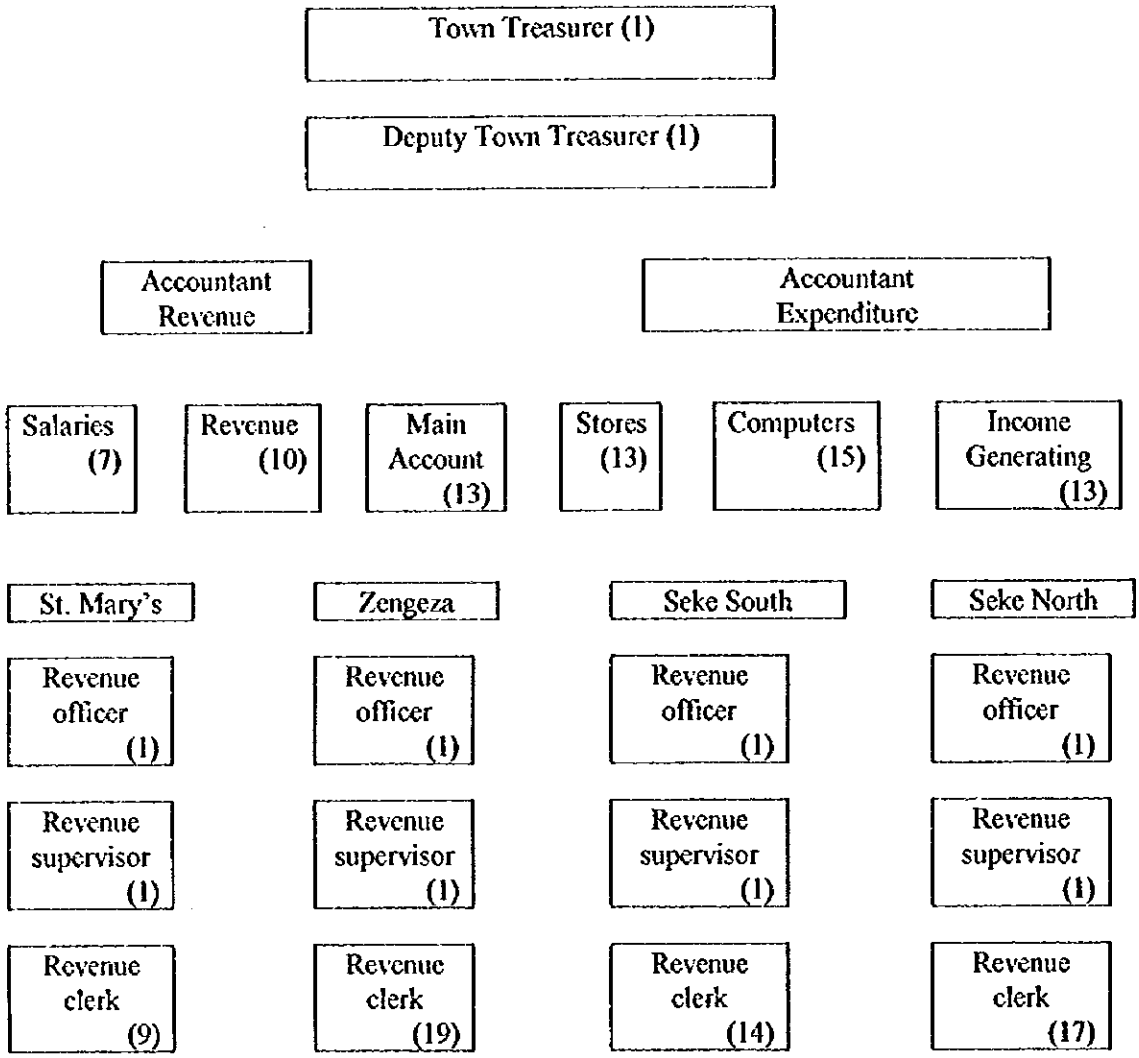
The organizations involved in revenue collection and expenditure account are presented as follows:

	Revenue Collection		Expenditure Account	
	Collection Procedure	Section in charge	Expenditure account procedure	Section in charge
1)	Management of customers' list	Housing & Community Services (Area Offices)	Personnel Expenses	Salaries Section of Accountant Revenue
2)	Meter reading	Housing & Community Services (Area Offices)	Purchase of goods/equipments	Store Section of Accountant Expenditure
3)	Preparation of water charge slip	Revenue Section (Area Offices)	Management of expenditures	Computer Section of Accountant Expenditure
4)	Revenue Collection	Revenue Section (Area Offices)	Accounting of expenditures	Main Account Section of Accountant Expenditure
5)	Accounting	Revenue Section of Accountant Revenue		

The above illustrates both procedures of revenue collection and expenditure account including name of sections in charge. The organizational chart of Town Treasurer including Area Offices is shown in shown in Fig 3.1.3.

Revenue collection system is more or less identical for all accounts except for meter reading which is exclusively necessary for water charge collection. Chitungwiza is administratively divided into 4 districts, St. Mary's, Zengeza, Seke North and Seke South where the office of administration called Area Offices are located by district.

Figure 3.1.3 Organization chart of Town Tresurer



Source : Chitungwiza Council
Note : ( ) indicates the number of staffs

The Area Offices undertaking the duties of housing and community services, and various revenue collection consist of two sections, Revenue, and Housing and Community Services. The four Area Offices is responsible for meter reading and preparation of water charge bill. Customers are requested to go to each Area Office for payment of water charge.

Water charge for residential stands consists of fixed minimum charge (first block, 9 m^3 or lesser per month), and charge per m^3 (Second block, more than 10 m^3 per month). Two types of bills are issued by Revenue Section of Area Offices. One is called water slip which records water charge of the second block. The other is called cash note which

records the combined fixed charges consisting of water, sewerage surcharge (property tax), rent and others. Customers who regularly pay for those fixed charges including tax recorded in cash note are regarded as legal residents. Otherwise, the failure or delay of payment for those charges sometimes result in removal from rent house and water disconnection. Thus the collection of minimum water charge is almost 100 percent. Nevertheless, the collection rate of the second block water charge per m^3 is somewhat low, around 90 % reported by Revenue Section of Accountant Revenue, Town Treasurer.

The type of expenses is classified into operating expenses and debt services. The former is further divided into personnel expenses and expenditures on goods or equipment purchased. In principle, operating expenditures of all accounts are almost controlled by Accountant Expenditure, Town Treasurer. The so-called petty cash is only allowed to be spent by each account. Thus, goods and equipment including minor items such as stationary are collectively purchased by Stores, Accountant Expenditure, Town Treasurer. The section of Main Account is responsible for accounting works for operating expenses and debt services of major accounts such as rate, water, sewerage, and education. This section is also liable for keeping all expenses at level planned at the time of budgeting.

Water revenue per m^3

Water revenue is basically regarded as the most sustainable income source among main accounts. Revenue surplus is usually transferred to the deficit accounts such as rate, welfare and housing accounts. In order to gain revenue surplus, water revenue per m^3 should be higher than unit cost per m^3. Both water revenue per m^3 and unit cost per m^3 are exemplified below on the basis of yearly water consumption, the proposed tariff and expenditures on water account planned at the time of budgeting in the fiscal year 1995/96.

(a) Water consumption forecast

Use	m^3 per year	m^3 per day
Residential	9,976,460	27,330
Non-residential	2,670,840	7,320
Total	12,647,300	34,650

(b) Current Water tariff

a)	Residential	1st minimum charge	Z$11.37 per month
	(31,134 stands)	(9 m^3 or lesser per month)	
		2nd charge	Z$ 1.71 per m^3
b)	Non-residential		Z$ 5.82 per m^3

Average daily water consumption per stand is 0.9 m^3. Monthly water consumption of a stand per month turns out to be 27 m^3, which exceeds over the requirement (9 m^3 or lesser per month) of 1st minimum charge. Accourdingly all stands (31,134) are supposed to pay for 1 st and 2nd water charges.

(c) Water revenue per m^3

a) Residential 1st charge : Z$11.37 x 31,134 x 12 months = Z$ 4,247,920
2nd charge : Z$ 1.71 per m^3 x 9,976,460m^3 = Z$17,059,750
b) Non-residential : Z$ 5.82 per m^3 x 2,670,840m^3 = Z$ 15,544,290
Total : Z$ 36,851,960
c) Water revenue per m^3 : Z$ 36,851,960 ÷ 12,647,300m^3 =Z$ 2.91 per m^3

(d) Unit cost per m^3

a) Expenses forecast

Salaries	Z$ 607,820
General expenses (including purchase of bulk water)	Z$ 27,518,000
Repair and maintenance	Z$ 67,000
Capital redemption (debt services)	Z$ 157,390
	Z$ 28,250,210

b) Unit cost per m^3

Z$ 28,250,210 ÷ 12,647,300m^3 = Z$ 2.23 per m^3

Obviously water revenue per m^3 (Z$ 2.91) was established higher than unit cost per m^3 (Z$ 2.23). In this respect, water revenue has still the large margin of revenue surplus even after costs are recovered.

Analysis of water account

Table 3.1.2 shows revenue and expenditure of water account from 1991/92 to 1995/96.

Table 3.1.2 Revenue and Expenditure of Water Account

Unit: thousand Z$

	1991/92	1992/93	1993/94	1994/95	1995/96 Budget	1995/96 Actual
Water charges and connection fees	8,541	9,344	24,005	31,309	38,397	32,283
Expenditures	6,022	8,283	9,473	23,361	28,250	21,560
Salaries	236	345	342	540	508	755
General expenses	5,769	7,170	9,114	22,804	27,518	20,362
Repair/maintenance	17	768	17	8	67	18
Debt service	—	—	—	9	157	1,180
Balance	2,519	1,061	14,532	7,948	10,147	10,723

Water account continued to enjoy a substantial amount of revenue surplus during the last 5 years. The contrast of planned (budget) and actual performance is given for the year of 1995/96. Because water saving was enforced during night time due to water shortage, actual revenue turned out to be lower than the budgeted. The unexpected debt service of about Z$ 1.2 million appears on the expenditure side. This is rush repayment of previous government loan borrowed for water reticulation. The net result (balance) is almost identical.

3.2 Sanitation/Sewerage

3.2.1 Service Coverage and Sewerage System

(1) Service coverage

At present, the service coverage of the public sewerage system in the three (3) townships (St. Mary's, Zengeza and Seke) and the Tilcor industrial area are at a high level (almost 100%), excepting eight (8) schools which are utilizing septic tanks. These septic tanks are emptied when they become full.

(2) Sewer Reticulation

1) Present Conditions

The sewer reticulation in the study area consists of major trunk sewer, secondary sewer, lateral sewer, house connections and pump stations. The sewage collection system uses the separate system and makes full use of gravity, except in some areas in St. Mary's, Ghuza and the Tilcor industrial area.

The major trunk sewers are separated in three (3) lines as follows and an individual to the Zengeza STW without joining any other lines on its route.

- The collection line of domestic, institutional and commercial sewerage generated in St. Mary's and Zengeza
- The collection line of domestic and institutional sewage from Seke
- The collection line of industrial wastewater from the Tilcor industrial area

There are two (2) pump stations in St. Mary's (No. 1 and No. 2) and one each in Ghuza (outside of the boundary of Chitungwiza) and in the Tilcor industrial area due to unfavorable topographical conditions.

Figure 3.2.1 shows the existing sewerage system. Table 3.2.1 shows the list of major trunk sewers and Table 3.2.2 the list of pump stations. Figures 3.2.1 to 3.2.3, Section 3.2, Chapter 2, Supporting Report presents the two (2) existing pump stations in St. Mary's and one pump station in the Tilcor industrial area.

Table 3.2.1 List of Major Trunk Sewers

Collection Area	Diameter (mm)	Gradient (1/1000)	Length (m)	Pipe Material
St.Mary's and Zengeza	300 - 675	3.2 - 5.1	5,520	AC Pipe
Seke	300 - 675	2.1 - 10.0	7,900	AC Pipe
Tilcor	300	Force Main	1,040	AC Pipe

The removal of sedimented sand and silt from the sewers, and screenings accumulated at the pump stations is manually done.

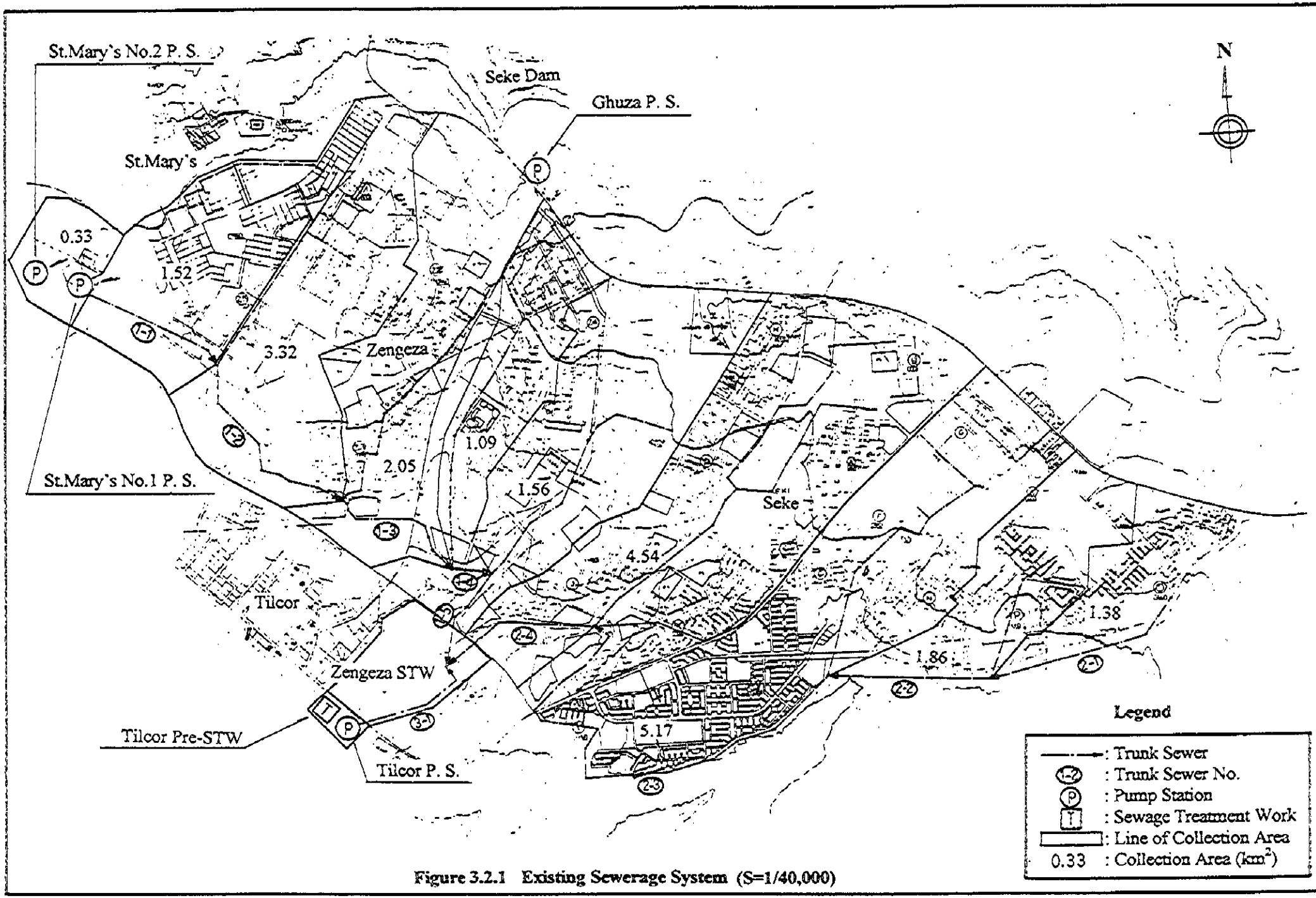


Figure 3.2.1 Existing Sewerage System (S=1/40,000)

Table 3.2.2 List of Sewage Pump Station in Chitungwiza

Name of Pump Station			Irrigation P. S.	St.Mary's P. S. No.1	St.Mary's P. S. No.2	Ghuzha P. S.	Tilcor P. S.
Location			Zengeza Sewage Treatment Works	St.Mary's	St.Mary's	At Ghuzha Shopping Complex	Zengeza Sewage Treatment Works
Influent pipe	Pipe diameter	(mm)	N.A	300	150	150	300
Bar Screen			N.A	Width 1.0 m Height 1.6 m	N/A	Width 0.56 m Height 1.5 m	Width 0.5 m Height 1.6 m
Grit Chamber			N.A	N/A	N/A	Width 0.6 m Length 7.2 m Number 2 Channel	N.A
Pump Pit			N/A	2.7 m x 6.8 m x 1.95 m (depth)	2.0 m x 2.0 m x 3.5 m (depth)	N/A	7.27 m x 2.3 m x 1.7 m (depth)
Force main	Pipe material	-	Asbestos cement pipe class 24	Asbestos cement pipe	Asbestos cement pipe	N/A	Asbestos cement pipe
	Pipe diameter	(mm)	675	300	150	N/A	300
Pump	Number of pumps	no.	3	3 (including 1 standby)	2 (including 1 standby)	2 (including 1 standby)	2 (including 1 standby)
	Capacity	-	850 m^3/hr	88.3 l/sec	32 l/sec	N/A	177 m^3/hr
	Discharge of pumps in parallel work	-	1700 m^3/hr	176.6 l/sec	32 l/sec	N/A	177 m^3/hr
	Total head	(m)	44.5 (Max)	34.5	12.5	N/A	N/A
	Pump manufacture	-	CURO	N/A	N/A	N/A	HOWDEN ATTACK
	Type	-	Horizontal spindle	Horizontal spindle	Submersible	Submersible	Horizontal spindle
Motor	Motor type	-	Squirrel cage induction motor	N/A	N/A	N/A	Squrrel cage induction motor
	Motor output	(kw)	150	45	5.85	N/A	37
	Speed	(rpm)	1,500 Nominal	1,450	1,450	N/A	1,458
	Voltage	volt/3ph/ 50Hz	380	380	380	N/A	390
Building			N/A	3.9 m x 6.8 m x 3.2 m (Height)	N/A	N/A	7.27 m x 3.8 m x 3.35 m (Height)
Remarks			-	Year 1977			mid. of 1970

Note : N.A Not applicable
: N/A No information available

2) Evaluation of the existing sewer reticulation

The three lines of major trunk sewers (St. Mary's and Zengeza, Seke and Tilcor) and three (3) pump stations (St. Mary's No. 1, No. 2 and Tilcor) were evaluated from the viewpoint of pipe flow and pump capacities, while the Ghuza pump station was not evaluated due to a lack of data. In the study of the major trunk sewers with no pipe gradient data, their flow capacities were estimated using the gradients of ground levels. The sewage volume (PWWF) to evaluate in reference to the existing sewer flow capacity was calculated as being 1.5 times that of ADWF in consideration of the fluctuation of the water supply and the limited inflow of storm water into the sewer under the adopted separate system.

a) Sewage volume by major trunk sewer line

The sewage volume in 1995 was estimated as included in Section 3.2, Chapter 2, Supporting Report. The volume by sewage type is shown as follows:

- Domestic and institutional/commercial sewage : 33,255 m^3/day
- Industrial wastewater : 1,118 m^3/day

Total : 34,373 m^3/day

Domestic and institutional/commercial sewage is collected by two lines from St. Mary's and Zengeza and Seke, so that the sewage volume by line was calculated with the proportional distribution of each residential area. Table 3.2.3 shows the domestic and institutional/commercial sewage volume by line, and Table 3.2.1, Section 3.2, Chapter 2, Supporting Report shows the residential area by line and ward.

Table 3.2.3 Domestic and Institutional/commercial Sewage Volume by Line

Line Name	Residential Area * (km^2)	Percentage (%)	Sewage Volume (m^3/day)
St.Mary's and Zengeza	9.87	43	14,300
Seke	12.95	57	18,955
Total	22.82	100	33,255

Note: * measured by the Study Team

The industrial wastewater from the Tilcor area is discharged to the major trunk sewer of Tilcor.

The sewage volume by major trunk sewer and type of sewage are summarized as shown in Table 3.2.4 and Figure 3.2.2 shows the flow diagram of the sewage volume by line.

Table 3.2.4 Sewage Volume by Line and Type of Sewage

(ADWF)

Type of Sewage	St.Mary's & Zengeza (m^3/day)	Seke (m^3/day)	Tilcor (m^3/day)	Total (m^3/day)
Domestic & Institutional/Commercial	14,300	18,955	0	33,255
Industrial	0	0	1,118	1,118
Total	14,300	18,955	1,118	34,373

(PWWF)

Type of Sewage	St.Mary's & Zengeza (m^3/day)	Seke (m^3/day)	Tilcor (m^3/day)	Total (m^3/day)
Domestic & Institutional/Commercial	21,450	28,433	0	49,883
Industrial	0	0	1,677	1,677
Total	21,450	28,433	1,677	51,560

The generated sewage volume by line was calculated based on the unit value per area (km^2) as shown below.

St.Mary's & Zengeza Line : 21,450 / (9.87 x 86,400) = 0.0252 (m^3/sec/km^2)
Seke Line : 28,433 / (12.95 x 86,400) = 0.0254 (m^3/sec/km^2)

b) Evaluation of current sewage volume comparing the capacities of major trunk sewers

The sewage flow calculation and evaluation to the flow capacities of the three (3) major trunk sewers were made as shown in Table 3.2.5.

The three major trunk sewers have sufficient flow capacities to the current sewage volume. However, the sewer reticulation (including the trunk sewers) systems are not properly maintained as frequent overflows from manholes are reported.