CHITUNGWIZA MUNICIPALITY
REPUBLIC OF ZIMBABWE

THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY, SEWAGE AND SOLID WASTE MANAGEMENT IN CHITUNGWIZA IN THE REPUBLIC OF ZIMBABWE

FINAL REPORT

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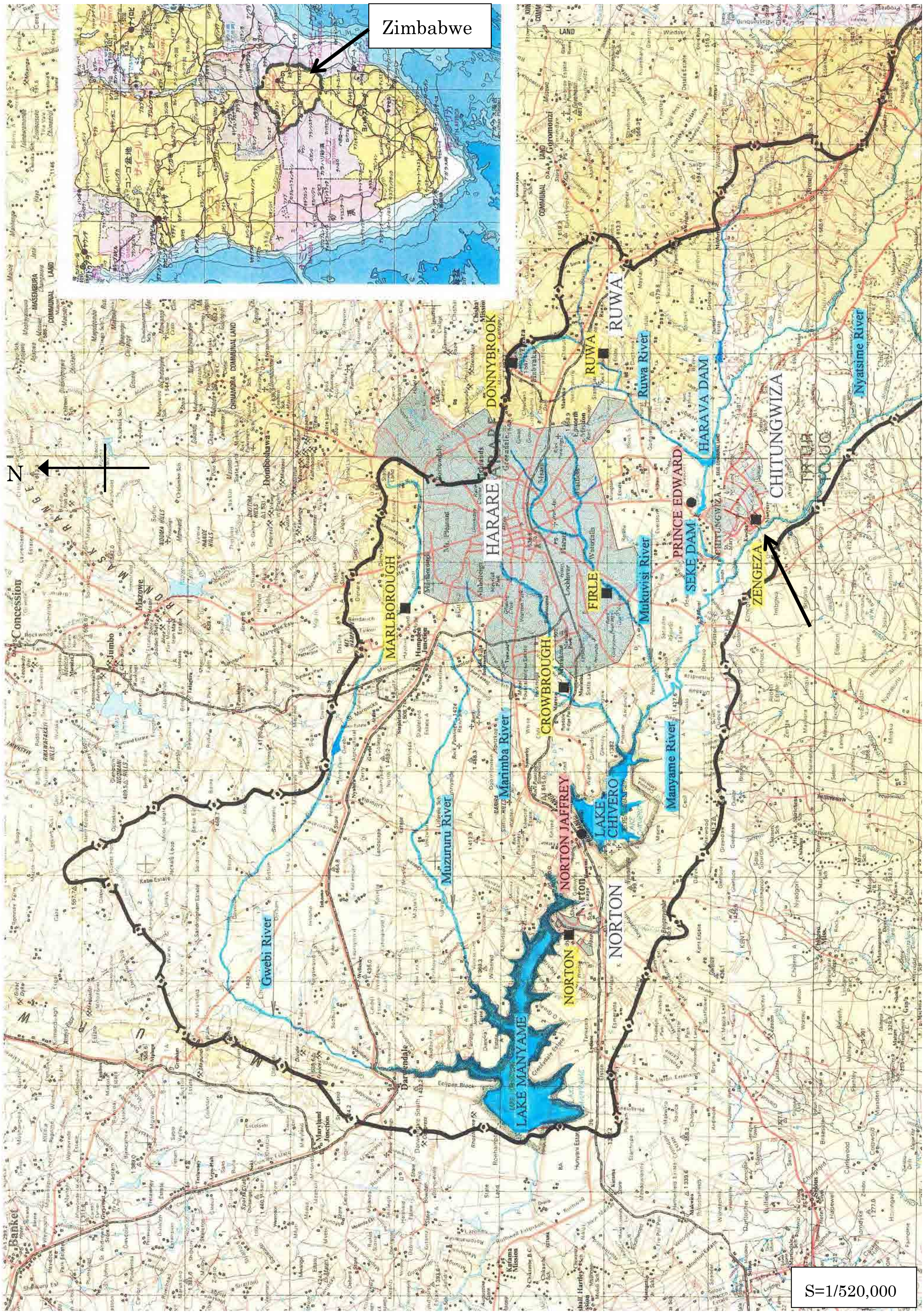
Zimbabwe
N
HARARE
RUWA
DONNYBROOK
MARLBOROUGH
CROWBROUGH
FIRLE
PRINCE EDWARD
SEKE DAM
HARAVA DAM
CHITUNGWIZA
ZENGEZA
NORTON JAFFREY
NORTON
LAKE CHIVERO
LAKE MANYAME
Ruwa River
Nyatsime River
Mukuvisi River
Manyame River
Marimba River
Muzururu River
Gwebi River
S=1/520,000

THE PROJECT
FOR
THE IMPROVEMENT OF WATER SUPPLY, SEWAGE AND SOLID WASTE MANAGEMENT
IN
CHITUNGWIZA IN
THE REPUBLIC OF ZIMBABWE

FINAL REPORT

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FOR THE IMPROVEMENT
OF
WATER SUPPLY, SEWAGE AND SOLID WASTE
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THE PROJECT

FOR THE IMPROVEMENT

OF

WATER SUPPLY, SEWAGE AND SOLID WASTE

MANAGEMENT IN CHITUNGWIZA

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List of Acronyms

ADA	Annual Daily Average
AfDB	African Development Bank
ATP	Ability to Pay
AusAID	Australian Agency for International Development
AWF	African Water Facility
BNR	Biological Nutrient Removal
CIDA	Canadian International Development Agency
CPI	Consumer Price Index
DANIDA	Danish International Development Agency
DFID	Department for International Development of the UK
DGIS	Directorate-General for International Cooperation of the Netherlands
EIRR	Economic Internal Rate of Return
EMA	Environmental Management Agency
ENPV	Economic Net Present Value
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FINNIDA	Finnish International Development Agency
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FPL	Food Poverty Line
F/S	Feasibility Study
GDP	Gross Domestic Product
GNI	Gross National Income
GIZ	German Agency for International Cooperation
GOZ	Government of Zimbabwe
IBNET	International Benchmarking Network for Water and Sanitation Utilities
IDBZ	Infrastructure Development Bank of Zimbabwe
IFAD	International Fund for Agricultural Development
IFRS	International Financial Reporting Standards
ILO	International Labour Organization of the United Nations
IMF	International Monetary Fund
IPSAS	International Public Sector Accounting Standards
JICA	Japan International Cooperation Agency
JPY	Japanese yen
LA	Local Authority
MDG	Millennium Development Goal
MDTF	Multi-Donor Trust Fund
MEPIP	Minister of Economic Planning and Investment Promotion
MF	Ministry of Finance
MIS	Management Information System
MLGURD	Ministry of Local Government, Urban and Rural Development

M/P	Master Plan
MTP	Zimbabwe Medium Term Plan: 2011-2015
MWRDM	Ministry of Water Resources, Development and Management
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NRW	Non Revenue Water
NSP	New Stabilization Pond
NSSA	National Social Security Authority
ODA	Official Development Assistance
O&M	Operation and Maintenance
PAYE	Pay-as-you-earn tax
PDL	Poverty Datum Line
PFM	Public Financial Management
PPP	Public Private Partnership
PSIP	Public Sector Investment Program
SDC	Swiss Agency for Development and Cooperation
SIDA	Swedish International Development Cooperation Agency
STP	Sewage Treatment Plant
STW	Sewage Treatment Works
TA	Technical Assistance
TCPL	Total Consumption Poverty Line
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USD, US$	United States dollar
VAT	Value Added Tax
WASH	Water, Sanitation and Hygiene
WB	World Bank
WHO	World Health Organization
WSSW	Water Supply, Sewerage and Solid Waste Management
WTP	Willingness to Pay
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
ZIMRA	Zimbabwe Revenue Authority
ZIMSTAT	Zimbabwe National Statistic Agency
ZIM$	Zimbabwe dollar
ZINARA	Zimbabwe National Road Authority
ZINWA	Zimbabwe National Water Authority
ZSTP	Zengeza Sewage Treatment Plant

＜PART 1　BASIC STUDY >

CHAPTER 1　INTRODUCTION

1.1　The Background of the Study

In the late 1990s, rapid population growth in the Harare area contributed to a surge in residential and industrial developments. This brought about an increase in wastewater flow generated from the area, which was more than the treatment capacity of the existing wastewater treatment plant. As a result, runoff from the excess wastewater began to pollute the environment and water resources, such as Lake Chivero and Lake Manyame, with water quality worsening as the population grew and the area further developed.

To improve the situation, the government of Japan implemented a grant project for Chitungwiza Municipality and constructed a wastewater treatment plant in “The Project for Improvement of Sewerage Facilities in the Municipality of Chitungwiza”, which was then handed over to the government of Zimbabwe in 2000. However, the economic conditions of Zimbabwe did not get any better in 2000, and the budget for proper infrastructure maintenance and improvements in water supply, sewerage and solid waste management was insufficient, thus making the environmental status worse in spite of the implementation of the project.

As a result of the above-mentioned conditions, the sewerage system has not been functioning properly resulting to a deterioration of the water quality of the water source and the attendant increase in the cost of operation and maintenance of the system. This situation caused the society negative impacts such as the cholera outbreak in the area in 2008.

The political situation in Zimbabwe has improved since 2008 eight years after some European countries and United States of America had imposed economic sanctions due to political reasons. The political stability in Zimbabwe prompted the government of Japan to resume bilateral and humanitarian aid activities. One of these is “The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe” (hereinafter referred to as the Project).

With the economic and political stability in Zimbabwe, JICA conducted in January and February 2011 an investigation and data collection and analysis of the environment conditions in Chitungwiza Municipality in the “Data Collection Study on Improvement of Sanitary Environment of Chitungwiza Municipality”. The report identified the dysfunctional situation not only for the solid waste management and sewerage, but also for the water supply system in Chitungwiza Municipality, upon which, the government of Zimbabwe recognized that improvements were needed to upgrade the living conditions and the environment for the people of Chitungwiza. Consequently, the government of Zimbabwe decided to develop "The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe", which addresses the essential improvements to the municipality's water supply, sewerage and solid waste management, and requested the government of Japan for a technical cooperation to develop the plan.

The government of Japan appointed JICA to start study on the specific plan for the project in June 2011, according to the agreement between the two governments. The Scope of Work of the technical cooperation (S/W) was discussed between JICA, Chitungwiza Municipality and the relevant authorities in Zimbabwe and was finalized on the 25th August 2011.

1.2 Objective of the Study

The objective of the study is to prepare the Master Plan (hereinafter referred to as M/P) and the Feasibility Studies (hereinafter referred to as F/S) for water supply, sewerage and solid waste management in Chitungwiza Municipality. In the F/S, the high priority projects will be selected and studied from the projects in the M/P. At the same time, the study will benefit the local counterparts (C/P) in Zimbabwe by building their capacity for future development planning.

1.3 Study Area and Scope of the Study

The Scope of Works identifies the stipulated study area as whole city area of Chitungwiza Municipality. However, in terms of the necessity of obtaining the detailed information of non-point pollution sources, Lake Chivero, Lake Manyame and its catchment area (including area of City of Harare), although out of the study area in the SW, are included in the area.

The main study area is Chitungwiza Municipality with the entire Upper Manyame Catchment Area and the city of Harare, the largest town in the catchment. In establishing the M/P, the following items were examined – effectiveness of the measure, operation and maintenance of the facility, problems and issues, necessary assistance by residents and Capital Expenditure and Operation Expenditure. Possible countermeasures for said items were also proposed.

An integrated approach was undertaken in this study, where pollution load in dry/wet weather condition, non-point pollution sources, and solid waste management were studied in parallel, considering the fact that all the surface run-off flow into the lakes.

1.4 Issues and Considerations Attended in the Study

Issues and considerations needed for the study are summarised in Table 1.1.

Table 1.1 Issues and Considerations

Items	Issues and Considerations
1. Organization of the study	・Chitungwiza Municipality is the C/P of the study and responsible for preparing M/P and F/S. ・A steering committee shall be established to examine the implementation of the study progress. Representatives from the Ministry of Local Government, Rural and Urban Development (MoLGURD） and the Ministry of Water Resources Development and Management (MoWRDM) shall be actively involved in the steering committee as core members by giving advice/guidance and leading the committee.
2. Phases of the Study	In the first year, the basic data shall be collected and analysed as Phase 1: Basic Investigation, and M/P to be prepared as Phase 2: Determination of M/P. In the second year, F/S shall be implemented as Phase 3: Implementation of Feasibility Study (F/S).
3. Capacity Development of C/P	A detailed work plan shall be prepared to improve C/P capabilities through M/P and F/S preparation and enhance their knowledge in maintenance and operation of the water supply, sewerage and solid waste management.
4. Pilot Project	During the M/P preparation, pilot project will be implemented to improve the capacity of the personnel and organization's strength in the management of water supply, sewerage and solid waste management. The outcomes of the pilot project shall be verified and evaluated be reflected in the final M/P report.
5. Study on Potential Donors to Implement Prioritized Projects	・Implementation of the priority projects by potential donors other than JICA will also be studied. Potential donors shall be researched and identified to cooperate with JICA for the priority projects. ・Meetings shall be held to inform each donor most updated information and progress of the study.
6. Existing Wastewater Treatment Plant	The repair work of the existing wastewater treatment plant constructed by JICA grant shall be studied in terms of methodology of repairs and funding through discussion with C/P and JICA based on the outcome of the Phase 1. The wastewater treatment plant was designed /implemented by NJS Consultants CO., LTD under JICA grant aid.
7. Current regulation/water quality standard for sewage /wastewater /treated effluent in Zimbabwe	Based on the current economic situation and poorly maintained infrastructure in Zimbabwe, the current regulations/standard set forth by the government of Zimbabwe are considered to be difficult to meet and apply on the sewerage system proposed in the study. In the study, these issues will be examined from various aspects and addressed.
8. Activities of AfDB and coordination with AfDB	The detailed information on the water and sewer facility maintenance projects in Chitungwiza Municipality proposed by African Development Bank (AfDB) shall be obtained from AfDB. The way of collaboration will be studied for better outcome through coordination and proposals will be made and included in the study.
9. Proposal of Effective Operation and Performance Indicator	・Necessary information and data shall be collected to establish a quantitative and qualitative performance indicator, which measures effectiveness and performance of the implemented projects. The target performance level will be set for 2 years after the completion of the projects proposed in the M/P. ・The target level shall be established according to future monitoring capability and verification of recipients used in M/P. In addition, indirect effects and impacts by development will be confirmed.
10. Economic and Financial Analysis	Through the discussion with the government of Zimbabwe, Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR) shall be studied for the projects proposed in the M/P.
11. Socio-Environment Consideration Study	・Following JICA socio-environment guidelines, progress of the Environmental Impact Statement, other related documents, and the status of land acquisition /resettlement in the study shall be researched and verified to provide appropriate support and advice. ・In the process of determining the project site, social impacts, such as land acquisition and resettlement shall be carefully considered to provide appropriate advice/recommendation.

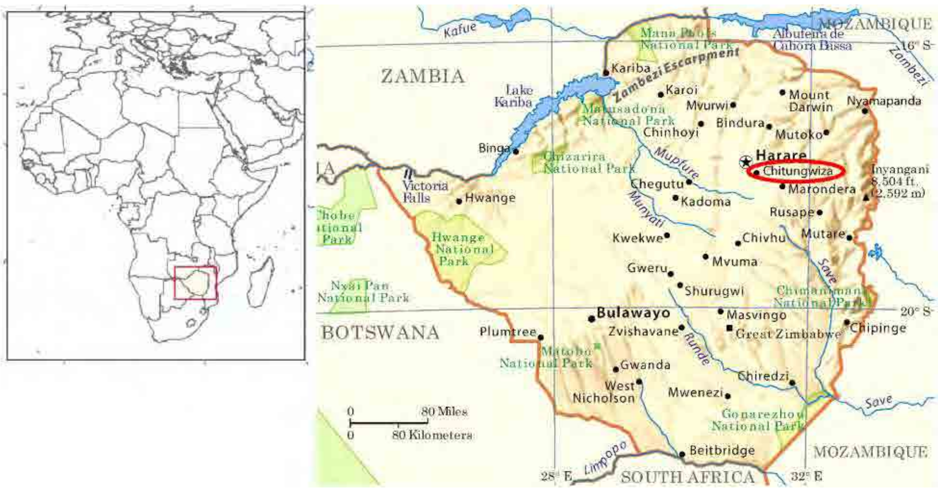
1.5 Feasibility Study in Phase III

In order to guarantee the sustainability of the facilities to be developed in the future, it was decided through the discussion of both sides of Zimbabwe and Japan to put a certain period before the F/S to observe and confirm the financial status of Chitungwiza Municipality. Implementation of F/S will be considered when the restructuring of the municipality shows a certain progress.

CHAPTER 2 SOCIAL AND PHISICAL CHARACTERISTICS IN THE STUDY AREA

2.1 Outline of the Target Area

A topographical map of Zimbabwe is shown in Figure 2.1 and target area of this study is Chitungwiza Municipality as shown in the figure.



Source: Howstuffworks.com

Figure 2.1 Topography Map of Zimbabwe

The area of Zimbabwe is 290,757 km^2, it is slightly larger than Japan, but the longest distance between the western edge and eastern edge is less by 900 km due to its circular configuration. Zimbabwe sits astride the high plateaus between the Zambezi and Limpopo rivers, its main drainage systems. The majority of the country is elevated and relatively flat, 21% being more than 1,200 m above sea level. The target area of Chitungwiza Municipality including Harare Province is located in above area.

The target area has a tropical climate with a rainy season usually from late October to March but the climate is moderated by the high altitude. The average temperatures in major parts of target area (Manyame catchment) are relatively medium, from 12.0C to 20.0 C on average and the rainfall in this region is around 750-900 mm/annum.

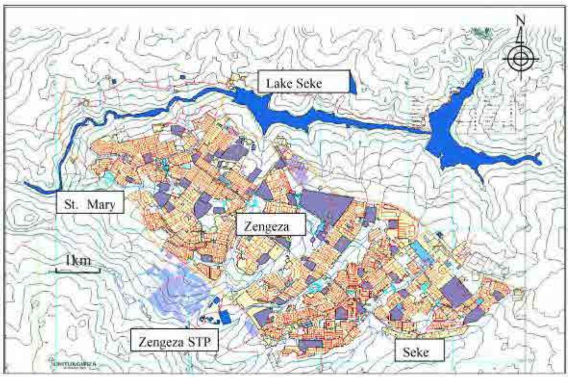


Figure 2.2 Layout of Chitungwiza Municipality

Zimbabwe gained independence as the "Republic of Zimbabwe", is ruled by aboriginal people since 1980 after 57 years of the independence era ruled by while people. After the independence, the country suffered the famous "hyper-inflation" and spreading of various epidemics, such as HIV and cholera. The hyper-inflation was finally solved by giving up of own currency and introduction of US dollar, and epidemics were almost solved by the effort of the National Health Service and various donor organizations. The country is divided into 10 provinces and Harare province is composed of City of Harare as the capital city and some districts including Chitungwiza Municipality. The total population of the country was 11,632,000 according to the 2002 census, and while the average population density is 30 people/ km^2, that of Harare province is 2,174 people/ km^2, very large.

Chitungwiza gained full municipal status in 1981 and most of the municipality area is classified as high density (around 250 people/ha) residential area with a population of 323,000 according to the 2002 census. In the municipality, most of the housing units were connected to water supply network and sewer pipes and in addition there is a garbage collection system with an open dumping site. However, there is a poor condition of water supply, breaking down of STP (Sewage treatment Plant) and PSs (Pump Stations) for sewerage system, and many places of illegal dumping of garbage.

2.2 Relevant Organizations of the Study

In Zimbabwe, the government has 32 ministries. Within these ministries, "Ministry of Local Government Rural and Urban Development" and "Ministry of Water Resources and Development" are the counterpart units. Target area of Chitungwiza Municipality is included in Harare Province as a district. Chitungwiza Municipality has six (6) departments under the mayor and town clerk as shown in Figure 2.3. Water supply and sewerage section are managed by the Engineering Department, and solid waste matters are managed by the Health Service Department.

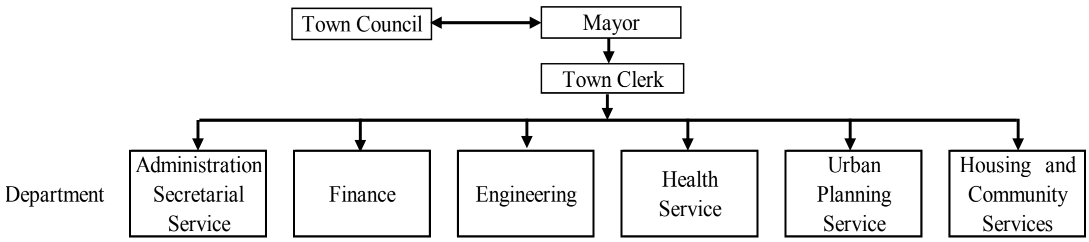


Figure 2.3 Organization Chart of Chitungwiza Town Council

2.3 Relevant Matters for Target Field of the Study

Harare province is located in Sub-zone CH4 [1] included in Upper Manyame Sub-Catchment Area, which provides water source to the province, and almost all waste water derived from the province is

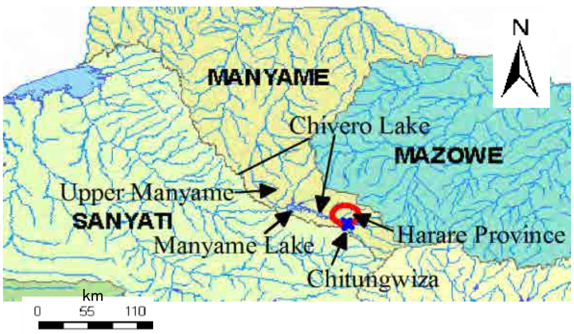


Figure 2.4 Map of Upper Manyame Sub-catchment Area

[1] One of five sub-zones in Upper Manyame Catchment

discharged to the catchment area. The location of major lakes and Chitungwiza in the catchment area is shown in Figure 2.4, and the hydro-geological features of it are shown in Table 2.1.

Table 2.1 Hydro-geological Features of Manyame Sub-Catchment Area

Sub-zoon	Catchment Area(km^2)	Unit yield(mm)	Storage (mil.m^3)	10% Yield (mil.m^3)	Yield in Use (%)	Rainfall (mm/y)	Evaporation (mm/y)
CH4	1,959	83	753	149	91	799	1,631
CH5	1,817	91	90	71	43	821	1,696
Total	3,776		842	220			
Average		87			68	809	1,662

Remarks: CH4 and CH5 are the two of the five subzones in the catchment
Source: JICA Project Team

There are two large lakes, Chivero and Manyame in the sub-zone, which are major water resources of the area. For these lakes, since all waste water with little or no treatment is discharged into these lakes, they have been heavily contaminated.

Historically, Zimbabwe's urban water supply and sanitary services development has been driven by principles of high service levels and standards and universal access for all, making them unique in Africa. However, due to the economical hardship, the conditions have drastically dropped. For instance, access to urban water supply decreased from 97% in 1990 to 60% in 2008 and access to urban sanitation decreased from 99% in 1990 to 40% in 2008. Then the central government, urban authorities and ZINWA stipulated a recovery period which will develop improved institutional options for water services provision including regulation of service delivery, tariffs and dealing with effluent. In order to realize it, the financing of the sector needs to be established through mechanisms such as the ring fencing of water services revenue, incentivizing improved operational efficiency and addressing capital investment financing needs.

2.4 Environmental Status in the Project Area

The state of pollution of the water bodies that are water supply sources is deteriorating since these also serve as final disposal points of some partially treated wastewater from the STPs. Due to intermittent water supply; some residents rely heavily on unprotected shallow wells even for drinking water. These wells among others are causes of the cyclical outbreaks of cholera and typhoid. These are aggravated by the inappropriate drainage and toilet systems and high groundwater level that are most likely to affect groundwater quality. Another issue is garbage that is dump indiscriminately in the designated open dumpsite or in illegal dumpsite with some garbage finding its way to the nearest river that is part of the network that supplies drinking water. At most times, these are malodorous and high fly breeding areas; sometimes human wastes are dumped together with domestic wastes. Significant negative effects associated with this unsanitary method are surface and groundwater pollution, foul odour and air pollution, exposure to hazardous substances and breeding grounds for disease vectors.

Two monitoring programmes are conducted: 1) by EMA for surface water and effluent; and 2) by DOH [2](Chitungwiza) for groundwater. The major challenges that face the present water quality monitoring system are: 1) Both EMA and the DOH have no comprehensive management of the water quality monitoring programmes; 2) No database system for the monitoring programme in both agencies; 3) Enforcement of some provisions in the Acts and SIs (Statutory Instruments) on compliance monitoring has not been fully implemented; 4) Some standards are not yet established; and 5) Absence of microbiological monitoring of effluent from STPs for water reuse such as agriculture/irrigation and livestock farming.

Five water quality monitoring points for years 2007-2012 were established in the Upper Manyame Basin by EMA. Due to the absence of ambient water quality standards, the results were evaluated referring to the effluent standard (SI 6, 2007) using the BLUE classification (Blue criteria - environmentally safe), showed that in areas that failed, river water quality already exhibited the characteristics of an effluent. Indices consistently failing the effluent standards for discharge are: BOD (all points), DO (2 points), TSS (2 points), TDS (I point), PO_4 (2 points), Fe (2 points), and Mn (3 points). In all instances, the points of Seke Bridge and Nyatsime River (after the discharge point of Zengeza STP) consistently failed to meet minimum standards set for these parameters.

Eight wells of the total 35 shallow and borehole wells tested in 2012 were found positive for coliform bacteria. E. coli was present in 3 of these wells. The physical and chemical characteristics of well water tested were all within allowable limits except for the high levels of nitrate in 3 wells.

CHAPTER 3 INSTITUTIONAL, LEGAL AND FINANCIAL FRAMEWORK OF WATER QUALITY MANAGEMENT

3.1 Institutional and Legal Framework for Water Quality Management

There are various agencies involved in water quality management: the national government: provincial offices: local authorities: and statutory (parastatal) and non-governmental bodies. At the national level, there are 4 major agencies which are directly involved in water quality management, and another 2 that are particularly concerned with planning and financial management. Several institutions also train/educate people in the courses directly and indirectly related to water pollution control.

The project financial sources for planning, construction and operation of a sewage treatment system usually come from the Public Sector Investment Programme (PSIP) funds (central government loan fund), own resources of local authorities, open market funds and/or international institutions. For the

[2] Department of Health of Chitungwiza Municipality

construction of a new plant or big rehabilitation or expansion works, funds are mostly raised by means of PSIP and/or financial assistance from foreign country or international institution.

The Government promotes the policy to decentralise the present administration system to local authorities to establish a bottom-up managing system. To achieve socio-economic development, the Government prepared national development plans to outline the economic policies, priorities, projects and programmes for a particular period, the latest is the Medium Term Plan, 2011 -2015. The local development plans prepared by the local authorities provide for orderly planning of regions, districts and local areas. The local authorities are also required to establish an Environmental Action Plan (local) based on the concept of sustainable development and community empowerment.

Both the central government and local authorities are required to comply with the requirements of national policies, law and regulations when executing their legal powers and responsibilities. A number of laws, statutory instruments, regulations and guidelines have been promulgated necessary for the protection of the aquatic environment, maintenance of acceptable quality in lakes, reservoirs, streams, groundwater and public health.

The Environmental Impact Assessment process is applied to projects that are identified by EMA before these are implemented. Public participation is also a requirement of the EIA process and the policy states that the public should participate in the preparation and review of EIA reports. These consultations typically focus on determining the probable impacts and the mitigation measures that will be acceptable to the community involved.

3.2 Financial Framework for Water Quality Management

The central government's expenditure in 2011 was USD 2.7 billion, or about 30% of GDP, indicating that the government is relatively small-sized. A 52% of the expenditure was appropriated for employment cost, followed by other recurrent expenditure (24%) and capital expenditure (22%). On the revenue side, VAT accounted for 33%, followed by personal income tax (21%), corporate income tax (14%) and custom duty (11%). The Government of Zimbabwe (GOZ) adopts the cash budgeting principle whereby its expenditures are contained within its own capacity to finance them by cash. Thus the expenditures and the revenues nearly balance. Borrowing funds from domestic and international lenders is quite difficult for the GOZ due to the lack of creditworthiness. Old foreign debts of the GOZ have been unpaid and Western countries' economic sanction has not been lifted.

The amount of ODA that the GOZ receives is also limited. During the first nine months of 2012, the ODA receipt was about USD 0.4 billion from bilateral sources and USD 0.2 billion from multilateral sources. The bilateral and multilateral assistances to the GOZ are disbursed through trust funds such as Zim Fund (managed by African Development Bank) and Global Fund (by UN). The Water Sanitation and Hygiene (WASH) Cluster in Zimbabwe is coordinated by UNICEF, covering mainly urban water and sanitation rehabilitation.

The fiscal sizes of the GOZ, the City of Harare Council, the Chitungwiza Municipality Council, the water supply accounts, the sewerage accounts and the waste management accounts are comparatively shown in Table 3.1.

Table 3.1 Comparison of Recurrent Budgets 2011

(US$ million, projection or estimation base)

Government		Recurrent revenue	Recurrent expenditure	Surplus / Deficit
Zimbabwe		3,020.4	2,744.9 *	275.5
Harare total		250.4	246.4	4.0
	Water	81.8	103.6	-3.3
	Sewerage	18.5		
	Waste management	20.1	20.1	0.0
Chitungwiza total		20.1	24.5	-4.4
	Water	5.9	4.4	1.5
	Sewerage	2.2	1.6	0.6
	Waste management	2.9	3.1	-0.2

Source: Compiled by JICA Project Team
* Including capital expenditure

Local Authorities (LAs) such as the City of Harare and the Chitungwiza Municipality too operate the cash budget and live within their means. Raising sufficient funding to ensure satisfactory service delivery is big challenges for them. Bank loans are generally difficult to obtain due to the unstable fiscal situation. The Public Sector Investment Programme (PSIP) fund is a loan facility from the central government to LAs which can be used for infrastructure development including water supply and sanitation. The PSIP allocation, however, is very limited reflecting the tight credit situation of GOZ itself. Harare is owed by many of the residents due to the council's service delivery slippage and the residents' impoverishment. Also the state and the business community are their big debtors. Likewise Chitungwiza faces a similar problem of indebtedness by many ratepayers unsatisfied with the council's service delivery. At both councils the employment costs constantly constitute the greatest portion (above 40%) of the recurrent expenditures. This high level of the employment costs crowds out non-wage expenditures in areas such as social service delivery and infrastructure development.

Domestic tariffs and monthly water bills of water, sewerage and refuse collection in Chitungwiza and Harare were computed and compared. Harare has the low density area tariff and the high density area tariff, while Chitungwiza has no such distinction. In terms of water bill, residents of Chitungwiza are charged USD 15.89 per month which is slightly higher than those who live in high density areas of Harare, who are charged USD 15.75. But residents in low density areas of Harare are billed nearly a double (USD 28.65). For both sewerage and refuse collection, Chitungwiza residents are charged much lower bills. The monthly sewerage bill in Chitungwiza is USD 4.51 per connection, while in Harare the bills are USD 5.75 at high density areas and USD 12.65 at low density areas. The refuse collection bill in Chitungwiza is USD 3.36 per residence, while in Harare they are USD 7.48 at high density areas and USD 10.93 at low density areas. Other utility and service bills were also compared with the water, sewerage and refuse collection bills in Chitungwiza. The water bill (USD 15.89) is less than a half of the monthly electricity bill (USD 37.30), LP gas cost (USD 30) and firewood (USD 30). The sewerage bill (USD 4.51) and the solid waste management bill (USD 3.36) are even lesser. The mobile telephone cost (USD 30) is nearly twice the water bill.

The performance comparison of water supply, sewerage and solid waste management between Chitungwiza and Harare was attempted using limited amount of financial data. Although further technical data are needed to complete the analysis, provisional results are summarized in Table 3.2. The following can be said from the results.

- In Chitungwiza both the water supply and the sewerage have achieved nearly the full coverage. The coverage in Harare is relatively high being over 80%. However, it should be noted that even when the water is supplied during limited hours or with limited amounts, the population is regarded to be served.
- The operating cost coverage ratio of water and sewerage is 1.36 at Chitungwiza, being considered favourable as the operating revenues exceed the operating expenses. The same ratio is 0.97 at Harare, meaning that the operating expenses exceed the operating revenues therefore unfavourable. Chitungwiza is a water “deliverer”, as they purchase treated water from Harare and distribute it. While Harare is a water “manufacturer”- cum – “deliverer”, meaning that they treat raw water and distribute the treated water. This difference in business model and the price of treated water are mostly causing the difference of operating cost coverage ratio.
- The operating cost coverage ratio of solid waste management is 1.18 at Chitungwiza and 1.00 at Harare, meaning that Chitungwiza is sound and that Harare is not. In terms of the annual operational cost per served population, Chitungwiza shows USD8.13, which is lower therefore favourable when compared with USD12.49, the same indicator of Harare. This cost difference, however, does not indicate the difference of service level as this information is not clarified.

Table 3.2 Performance Comparison of Harare and Chitungwiza

Indicator	Chitungwiza	Harare
Population in served area	354,500	1,581,900
Water coverage (%)	99	85
Water production (m^3/day)	30,000	640,000
Sewerage coverage (%)	99	80
Total water consumption * (liter/person/day)	64	205
Non revenue water (%)	25	57
Operational cost W&WW (USD/m^3 water sold)	0.73	1.03
Average revenue W&WW (USD/m^3 water sold)	1.00	1.00
Operational cost SWM (USD/served population)	7.57	12.71
Staff per 1000 population served - Water	0.15	0.83
Staff per 1000 population - SWM	0.49	0.65
Collection period W (Days)	766	N/A
Collection ratio W (%)	65	N/A
Operating cost coverage W&WW (ratio)	1.36	0.97
Operating cost coverage SWM (ratio)	1.18	1.00

Source: Compiled by JICA Project Team
* computed as "total water use devided by served population", therefore includes industrial use.
W = water supply, WW = wastewater, SWM = solid waste menagement, N/A = not available

CHAPTER 4 CURRENT STATUS OF WATER SUPPLY, SEWAGE AND SOLID WASTE MANAGEMENT

4.1 Water Supply

4.1.1 Water Supply System of Great Harare Area

Chitungwiza Municipality is distributed bulk water from Harare Water Works, of which supply areas are Harare Urban, Harare Rural, Chitungwiza, Epworth and other surrounding areas. The total population of the service area of Harare Water Works is 1,947,000 in 2002, while that of Chitungwiza is 323,260 according to 2002 census.

Water supply in Harare Province and the surrounding areas relies on surface water withdrawn from Lake Chivero, Harava, Seke and Manyame Dams. All these impoundments are located on the Manyame River System. According to SAPROF study "Harare Water Supply Project" (1993-1996), the total 537,050 m^3/day, 15% of yield from Chivero-Manyame catchment and in addition 163,200 m^3/d of recycled water derived from advanced sewage treatment plants (STPs) can be available by 2005. However, after the infamous hyper-inflation, all advanced treatment processes in STPs in Manyame River System, including Zengeza STP located in Chitungwiza, broke down and stopped operations. It means over 150,000 m^3/d of waste water has directly flowed in the river system. In 2012 march, only around 10% of advanced processes were operational.

There are two water treatment plants (WTPs), Prince Edward (PE) WTP and Morton Jaffray (MJ) WTP, for Harare Water Works in the catchment area. The design production capacity of PE-WTP is 90,000 m^3/d. However, the actual capacity is 55,000 m^3/d in ordinal seasons and 40,000 m^3/d in the dry season, respectively. The WTP is located only several km north of Chitungwiza Municipality and distributes bulk water to the municipality. Raw water for the WTP is taken from Seke and Harava Dams, and the yield capacity of the lakes is not enough to meet the production amount due to the small storage volume of the dams with a total of 12.5 million m^3.

Since the WTP was constructed in 1950 and renovated in 1973, the facilities have deteriorated due to lack of proper rehabilitation. However, replacement of major facilities was done in 2009-2012 by EU and Red Cross even though the replacement was not thorough. The WTP employs sludge blanket type sedimentation basin and rapid sand filter, and inject not only aluminium sulphate, soda ash, chlorine and coagulation aid but also activated carbon powder to improve on the heavily contaminated water condition. When this WTP is stopped due to power failure or lack of water source, water is distributed to Chitungwiza Municipality by gravity from the eastern area of City of Harare, which elevation is much higher than that of the municipality. MJ-WTP is a major water production source of Harare Water Works and the recent actual production amount is said to be 585,000 m^3/d, even though the design capacity is 520,000 m^3/d (less 80,000 m^3/d due to broken down facilities). The raw water is taken from Lake Chivero (60%) and Manyame (40%) Dam, and Chivero Lake is heavily contaminated because almost all waste water discharged from the catchment area is flowing in without treatment.

The Majority of purified water from MJ-WTP is pumped through four transmission mains to the Warren Control P/S (pump station) and distributed to the distribution areas of Harare Water Works. This water distributes to Chitungwiza Municipality only when PE-WTP is stopped through the pipe network of the city.

4.1.2 Water Supply System in Chitungwiza Municipality

As mentioned in the previous section, Chitungwiza Municipality is basically supplied bulk water from PE-WTP, and the average flow rate is 30,000m^3/d based on flow measurement by the Team. Figure 4.1 shows the model of the current water distribution system in the municipality. The system is very peculiar because the majority of water is distributed to the municipality by transmission pump at PE-WTP directly although all water distributed from Harare Water Works should once be transmitted to the ground reservoirs in Seke Reservoir Site, and the water should be distributed to the municipality from ground reservoirs directly or from the elevated tank for high elevation areas.

The ground reservoirs are only used for a pump pit for the lift pump of the elevated tank. It means that the reservoir volume of around 41,000 m^3 is not used for flow regulation and the distribution flow is constant even though the demand changes from time to time.

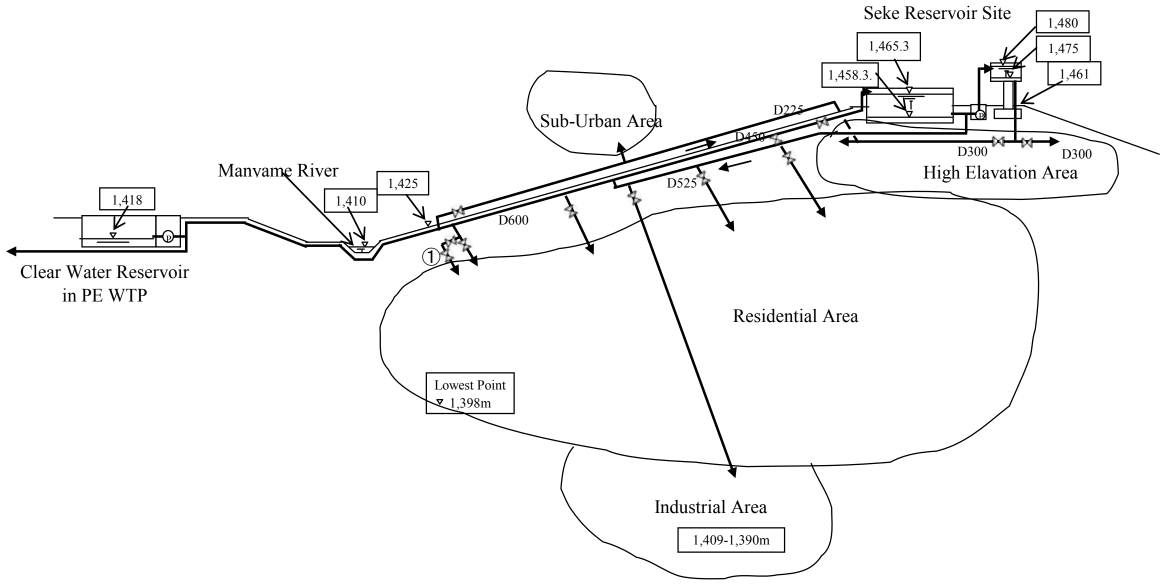


Figure 4.1 Current Water Supply System in Chitungwiza

Because of such kind of uncompleted distribution system and insufficient bulk water supply, water supply condition of the municipality is very poor. Water distribution for the majority of people is limited to less than two days a week.

4.1.3 Population of Distribution Area

The estimated current population of Harare Metropolitan Area is estimated to be 2,213,000 including that of Chitungwiza Municipality of 354,500, although Harare Water Works estimates the total population of the area to be 4.5 million. For the estimation of Chitungwiza population, the number of housing units was counted by Google Map and average number of people per household was actually surveyed.

4.1.4 Water Consumption of Target Area

In Harare Water Works distribution area, current actual production amount of MJ- WTP and PE-WTP is 640,000 m^3/d in normal season, while the water consumption in 2012 was estimated to be 383,000 m^3/d (domestic: 261,000, industrial: 90,000 and commercial/institutional: 32,000). Since the NRW (Non Revenue Water) rate is estimated to be 57% (by Harare Water Works), the distribution amount is required to be 890,000 m^3/d, and therefore the water supply is currently not enough to meet the demand.

Chitungwiza Municipality is supplied bulk water from Harare Water Works, and the average water supply amount of 30,000 m^3/d is simply regulated by Harare Water Works so that it does not meet the demand. The water consumption records of the municipality for domestic use are not reliable because of very little meter readings. However, those for commercial/institutional and industrial use are relatively reliable because the tariff collection is based on the meter reading records. Water consumption of such entities is 2,200 m^3/d (industrial use; 1,100 and other various entities use; 1,100) and it means that the domestic consumption is 20,300 m^3/d (30,000 × (1-0.25(assumed NRW rate)) – 2,200 = 20,300). Per capita consumption of the municipality was determined to be 61.5 lpcd.

However, since the majority of people living in the municipality are never supplied with sufficient water, over 3,000 wells are used for supplemental water supply.

4.2 Sanitation/Sewerage: Service Coverage and Sewerage System

(1) Service coverage

Within the Chitungwiza municipal area of 1,519.5 ha, three townships (St. Mary's, Zengeza and Seke) and the Tilcor industrial area are almost fully served by the public sewerage system. However, there are areas which are not connected to Zengeza STP due to blockage or malfunction of the sewerage system. In St. Mary's, population of some 54,000 are not connected due to breakdown of three pump stations in the area. Also, around 21,300 in Seke north are not connected because of blockages in the trunk sewers; while about 35,900 in Seke-south are not connected due to the breakdown of a pipe bridge discharging the sewage into a channel. Finally, about 7,100 in a part of the Zengeza near the industrial area are not connected, again due to sewer breakdown. From the result of the investigation, about 410 ha and about 120,000 of the areas' population are not connected to the ZSTP. Since the ZSTP is not working, full flow of sewage has been flowing out to both of Nyatsime River and Manyame River. After the completion of the AWF project for sewers and three pump stations, most of the sewage from the municipality will flow into the ZSTP. In this connection, earlier rehabilitation of ZSTP with the commencement of treatment is required. Rehabilitation of ZSTP will be conducted for pre-treatment (screening and grit chamber), three anaerobic ponds, five units of trickling filters and pump stations for irrigation under the AWF project.

(2) Sewer Reticulation

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 employed is the separate system and makes full use of gravity, except for some areas in St. Mary's and the Tilcor industrial area. Clogging of the sewers has been a serious problem in the system. The removal of deposited sand and silt in the sewers is done by using a jet-cleaning vehicle. However, this has not been done since the equipment broke down in 2001. Sand in the sewers and screenings accumulated at the pump stations has to be manually removed. The major trunk sewers are branched to three lines and an independent alignment to the Zengeza STP without joining any other lines on its route. There are four pump stations in St. Mary's (No. 1, 2 and No. 3) and in the Tilcor industrial area due to topographical configuration.

The industrial wastewater from the Tilcor area is discharged to the river instead of draining it into major trunk sewer of Tilcor due to break down of the trunk sewers and manholes. Trunk sewers are considered to have adequate capacity for the flow. However, sewer clogging and sewage spilling out from the manholes have been frequently occurring. They are considered to be the result of the inflow of sand from the outside. The three major trunk sewers are thought to have sufficient capacities against current sewage flow. However, the sewer reticulation (including the trunk sewers) system is not properly maintained as shown from the frequently reported spilling-out from manholes.

As a result of the evaluation of existing sewers, the sewer reticulations have some leeway for the expected flow and rated pump discharge capacities. A major problem has been the sand deposit in the sewer lines due to high sand concentration in the sewage. This unit generation of the sand in the sewers and their origins have been studied in the Pilot Project in this Project and the situation is understood to be serious necessitating drastic countermeasures.

Vandalism against the sewerage system is another issue. Theft of the manhole covers, disposal of the solid waste to the sewer lines have been recorded a lot in Chitungwiza Municipality.

(3) Sewage treatment works

The Zengeza Sewage Works is situated north of Nyatsime River between two tributaries draining the Seke section of the Residential Area. The existing and proposed new Industrial Area lies to the southwest and is unable to gravitate to the Zengeza Works. The present capacity of the Works was designed for about 40,000 m^3/day within the present fenced area. However, all the works are not functioning due to breakdown of the facilities. The Zengeza Sewage Treatment Plant was designed by the City of Harare for an ultimate flow of 27,270 m^3/day. This Works was commissioned late in 1978 and consisted of two sets of anaerobic ponds and two biological filters. In December 1980, biological filter number 3 was commissioned and in June 1981, the third set of anaerobic ponds were in operation with the fourth biological filter being commissioned in September 1986, and the fifth biological filter commissioned in 1987.

The treatment capacity of the old system with trickling filters is 21,750 m^3/day. The present sewage inflow rate is 27,000 to 35,000 m^3/day as assumed in the former section, and the BOD concentration 600 mg/l (estimated figure: 577 mg/l), the SS concentration 650 mg/l (estimated figure: 648 mg/l). The treatment processes employed at the STP include anaerobic ponds for the primary treatment and trickling filters for the secondary treatment, and Biological Nutrient Removal (BNR) facility for advanced treatment as shown below. There is no final sedimentation tank and the treated effluent is sent to farmland for the old system. The regulation to discharge effluent into the river is strict, not allowing for the secondary treated effluent. The effluent is therefore sent to the farmland for further treatment and re-use/disposal under the old system. For the BNR system, effluent from the system was good enough for discharge directly to the river till 2004.

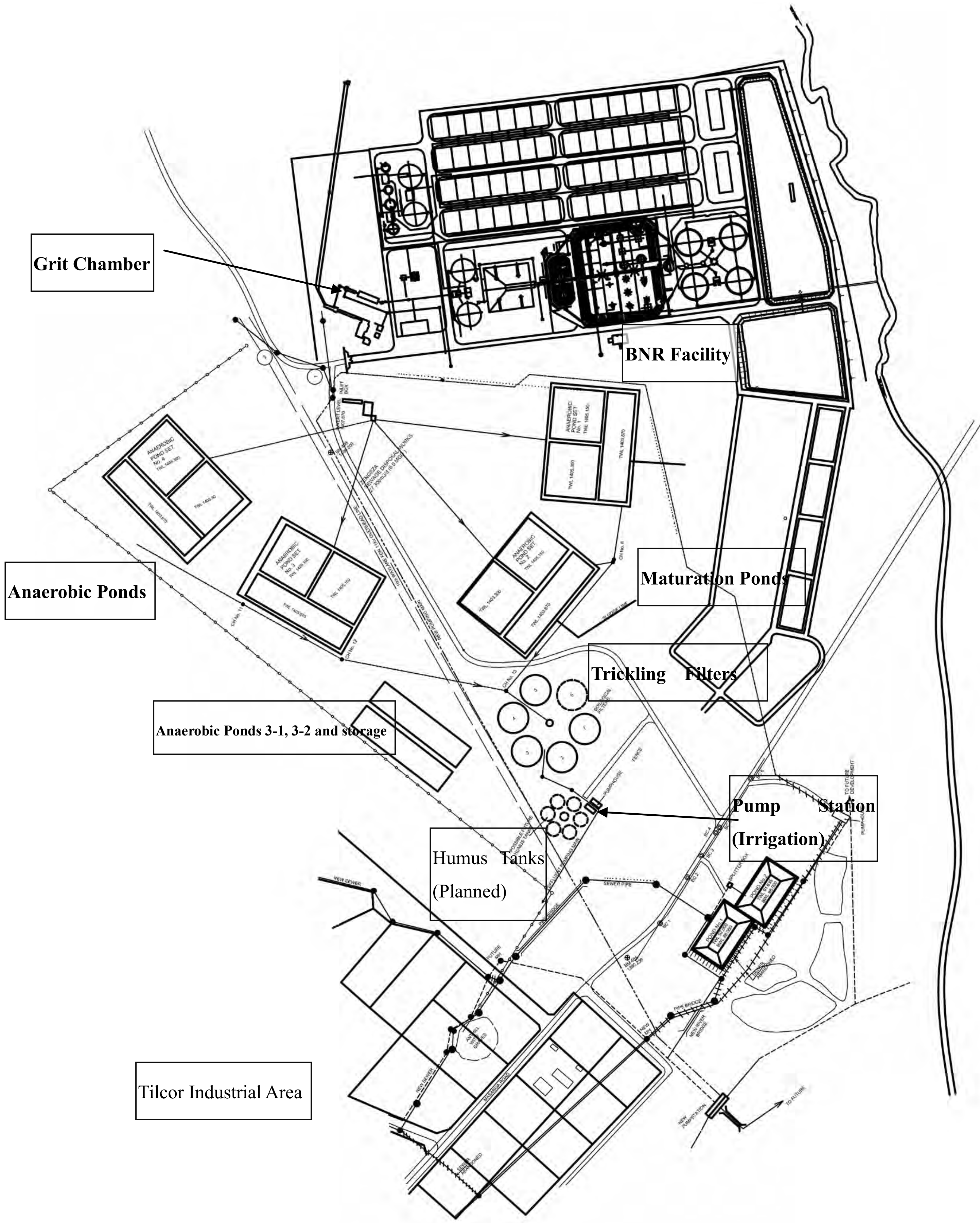


Figure 4.2 Plant Layout of the Zengeza STP Source: JICA Project Team

4.3 Solid Waste Management

4.3.1 Current State on Solid Waste Management in Chitungwiza Municipality

(1) Organization of solid waste management service

Solid waste management in Chitungwiza is currently carried out by the solid waste management section under the Health Department headed by a deputy director.

(2) Collection and transport system

The collection system in Chitungwiza municipality is classified into two systems, 1) house-to house collection method which the municipality's tipper trucks collect the household waste packed with a bag on a road side, and 2) skip-bin method which the municipality's skip loader collect skip bins at shopping areas or markets. The collected wastes are transported to a final disposal site (open dumping), which is located at about 5km from the city center. The municipality's collection service area cover all city areas. However, there are some non-collection service areas in each district of Saint Mary's, Zengeza and Seke. The main cause of non-collection is estimated to be inaccessibility of collection vehicles due to bad road conditions or existence of discharge of sewage on the road leading to the areas.

(3) Final disposal

1) Existing open dumpsite

The existing final disposal site in Chitungwiza Municipality is located at 3 to 5 km from the city centre. The landfill is an open dumping without truck scale, administration office, fence, rainwater drain ditch, leachate treatment facility and impermeable liner for leachate.

2) Future plan on final disposal facility

The Chitungwiza Municipality has a future land use plan which covers a new final disposal site with an area size of 38.1 ha, 4.5 km from the city center and the its ownership of the central government. The site is adjacent to a future housing lot and is not recommend as final landfill site because of its close distance to the housing lot and schools.

(4) Recycling / Intermediate treatment

Recycling business is currently done by one private group in Chitungwiza. They recycle plastics and glass, and do not recycle paper or carton. The group sells these recyclable materials to manufacturers in Harare.

4.3.2 Current State on Solid Waste Management in City of Harare

The solid waste management in City of Harare is operated by waste management and final disposal sections which belong to the Amenity Department. A total of 1,030 staff members are involved in the operation of solid waste management. For the residential area, a house-to-house collection system is provided while the container collection system is used for the commercial and industrial areas.

However, compactor trucks are used to be provided collection service at residential areas.

The final disposal site is located at around 10 to 15 km north from the city centre. The facility is just an open dumping area which has no fence, lining, truck scale, and rainwater drain and leachate treatment facilities. There are waste pickers at the landfill site.

4.3.3 Waste Amount and Composition Survey

(1) Waste generation amount

1) Daily Per Capita Waste Generation or Waste generation Amount per Establishment

The amount of per capita waste generation for residential area is about 0.43 kg/person/day in average; while establishments generate a total average of 2,283.4 kg/establishment of waste daily.

2) Daily generation Amount of waste

The current amount of waste generated on a daily basis in Chitungwiza Municipality is estimated at 176.6 t/day and the most of the waste is generated from residential areas.

(2) Waste composition

Food waste and yard waste make up most of the waste produced by the residential communities. The results show that high and middle income areas produced higher food waste compared to low income areas. On the other hand, the low income areas generated more yard waste compared to other income areas.

4.3.4 Illegal Dumping Survey

The completed survey resulted in the identification of 390 illegal dumpsites throughout the municipality. The majority of the sites are in Zengeza district, followed by Seke South. The sites were visible to the public. A great majority of the sites documented in this report were located in close proximity to streams. The illegal dumping sites cover an estimated area of 100,000 m^2 and have an approximate volume of 60,000 m^3.

CHAPTER 5 EVALUATION OF CURRENT ISSUES

5.1 Water Supply

5.1.1 Harare Metropolitan Area

The major issues for water supply in Harare Metropolitan Area are described below:

(1) Water Resource Shortage and Contamination

Water resources for WTPs, which Harare Water Works is operating are Lake Chivero and Manyame

Dam for Morton Jeffray (MJ) WTP and Seke and Harave Dams for Prince Edward(PE) WTP. The comparisons between the intake amount of WTPs and yield capacities are shown Table 5.1.

Table 5.1 Comparisons between WTP Intake Amount and Yield Capacities

WTP/Item	Intake Amount (1000m^3/d)		Yield Capacity (1000m^3/d)			Capacity (mil.m^3)	Storage Year (year)	
	Design	Actual	4%	10%	20%		Design	Actual
Morton Jaffray	630	643.5[*1]	422.7	559.6	743.1	727.4	3.16	3.62
Prince Edward	95	60-45[*2]	13.9	26.4	31.5	12.6	0.36	0.63

*1: Production amount of 585,000 m^3/d in 2011 × 1.1 = 643.500 m^3/d

* 2: Intake during ordinary season is 60,000m^3/d while during dry season is 45,000 m^3/d

The JICA Project Team recommended that the total yield capacity with 10% risk including recycled water from sewerage for MJ-TWP is 759,600 m^3/d and that for PE-WTP with 20% risk is 31,800 m^3/d. It means that Water source for MJ-WTP is enough and that for PE-WTP falls short.

However, the assumed actual demands of the distribution area are 383,000 m^3/d daily average and 440,000 m^3/d daily maximum, and if 57% of NRW ratio is adapted necessary distribution amounts are 891,000 m^3/d and 1,070,000 m^3/d to the actual production amount of 640,000 m^3/d. Therefore since the water distribution amount to the service area is strictly short, a Kunzwi Dam development plan (Developed yield capacity of around 200,000 m^3/d) is the highest priority plan for Harare Water Works.

The water source of MJ-WTP is Chivero Lake (60%) and Manyame Lake (40%). Chivero Lake receives all discharge water from Harare Metropolitan area, which has been discharged directly through Manyame River without any treatment, while Manyame Lake receives water overflowed from Chivero Lake only during the rainy season and river water from some rivers with less developed catchment areas. These are the reasons why Chivero Lake contamination has been quite extreme but Manyame Lake has not been as much contaminated. Because the urbanization of catchment area of Seke and Harave Lake has not been so heavy, contamination of these lakes is less than that of Chivero and Manyame Lakes. Table 5.2 shows the raw water qualities of MJ-WTP and PE-WTP.

Table 5.2 Raw Water Quality of WTPs (2010)

Items/WTP	MJ Average	PE Average
pH	8	7.3
Total Solids (mg/l)	266	152
Dissolved Solids (mg/l)	258.9	100.1
Suspended Solids (mg/l)	56.4	78.9
Turbidity (NTU)	19.5	3.6
Colour (Hazen Units)	>70	30
Total Hardness (mg/l $CaCO_3$)	152	61
Dissolved Oxygen	1.9	5.9
BOD_5	1.1	1.2
Free NH_3 (N)	0.61	TR
Iron (mg/l Fe)	Nil	Nil
Manganese (mg/l Mn)	0.17	0.135
Conductivity (ms/m)	303	143
Temperature ^{O}C	26.8	24.7

(2) Deteriorated facilities, insufficient repair and replacement

In PE-WTP, from 2009 to 2012, the major facilities have been replaced or repaired, therefore this

WTP can be operated normally with the actual production capacity of 55,000 m^3/d even though the recovery of the automatic and monitoring function of facilities were not implemented.

The facilities of No.1 Plant of MJ-WTP are very old and deteriorated, and the half of facilities has been inoperable, causing severe water shortage. In addition, the deterioration of the rest of facilities has been progressing, and the management of Harare Water Works has formulated a rehabilitation plan and has been trying to acquire necessary funds for the plan even though they have not succeeded. The transmission and distribution pipes and facilities have also heavily deteriorated as shown by the extreme NRW (Non Revenue Water) ratio of 57%, and the management also formulated a plan for the rehabilitations. These severe deteriorations were caused by insufficient maintenance and repair due to lack of adequate budget.

5.1.2 Chitungwiza Municipality

(1) Insufficient supply amount of bulk water

The frequent interruption of the water supply in many areas is caused either on purpose by Harare Water Works, or simply because of the lack of water. If the municipality can acquire 36,000 m^3/d it can distribute water to almost all areas even though it is not at once. The biggest problem is the intentional stoppage or reduction of bulk water by Harare Water Works due to unpaid charge for the bulk water or severe shortage of water for Harare itself.

(2) Uncompleted water transmission and distribution facilities

In the municipality, bulk water is basically distributed to the supply areas from distribution pipes branched from transmission pipes to transmit from PE-WTP to Seke reservoirs, and if it is transmitted to the ground reservoirs a shutting down of branch pipes is required. Because reservoirs should be used for flow regulation to meet fluctuating water demands, this system is incomplete. In addition, some hydraulic evaluation results for the existing pipe network by normal flow of 45,000 m^3/d shows that many pipes have negative pressure, and thus water cannot flow to many areas in the municipality by gravity.

(3) Insufficient maintenance of facilities and low collection rate of water charges

The facilities which the municipality manages are the water transmission and distribution facilities; water transmission lines with various valves, four ground reservoir structures, one small scale P/S, one elevated reservoir and water distribution lines from the diameter of 50 to 525 mm. Within these facilities, the condition of P/S is very poor, some valves have broken down and some old pipe lines are clogged.

In municipality water service section, the account of water charge to consumer is normally USD 5.5-5.7 mil. But, actual collected charges were USD 3.7-3.9 mil. from 2010 to 2011, while the bulk water charge from Harare Water Works was around USD 3.4 mil. Because the other expenses of the water section was around USD 0.6 mil., the actual incomes were not enough to the expenditure of USD 4.0-4.3 mil. The municipality has paid the total of only USD 1.2 mil despite the total of USD 10.3 mil charged from 2010 to 2012. The total amount of overdue to Harare Water Works reached USD 12.7 mil. by February 2013.

5.2 Sanitation and Sewerage

5.2.1 Functional Recovery of the Sewerage System in the Chivero Catchment Area

Harare is the capital city of Zimbabwe and is located in the Lake Manyame catchment area. It discharges STP effluent into the main tributaries of Lake Chivero and also abstracts its raw water from the lake. Wastewater is treated at the two main STPs of Crowborough (capacity 54,000 m^3/d) and Firle (144,000 m^3/d).

These two plants treat about 60% of the raw wastewater using modified activated sludge systems, popularly referred to as biological nutrient removal (BNR) systems, whilst the rest (40%) is treated by means of trickling filters (TF). Effluent from Crowborough STP is discharged to Marimba River and that of Firle STP flows into the Mukuvisi River except for effluent for irrigation. The trickling filter effluent and primary and secondary sludge (after digestion for primary sludge only) are mixed and used for pasture irrigation.

However, the two major STPs are partly broken and overloaded and often discharge partially treated effluent into the main tributaries of Lake Chivero. As a result, water quality of Marimba River and Mukuvisi River has been badly deteriorated in recent years, resulting in serious water quality problems in Lake Chivero. Since both STPs almost discontinued the use of the BNR facility because of budget problems, the direct discharge has polluted Lake Chivero more.

Zengeza STP in Chitungwiza Municipality was treating about 36,000 m^3/day by TF and BNR processes. However, after 2004, both treatments were discontinued because of serious budget problem affecting proper maintenance. At the same time, effluent transmission pump broke down resulting in the direct discharge of the raw sewage into Nyatsime River polluting its tributaries.

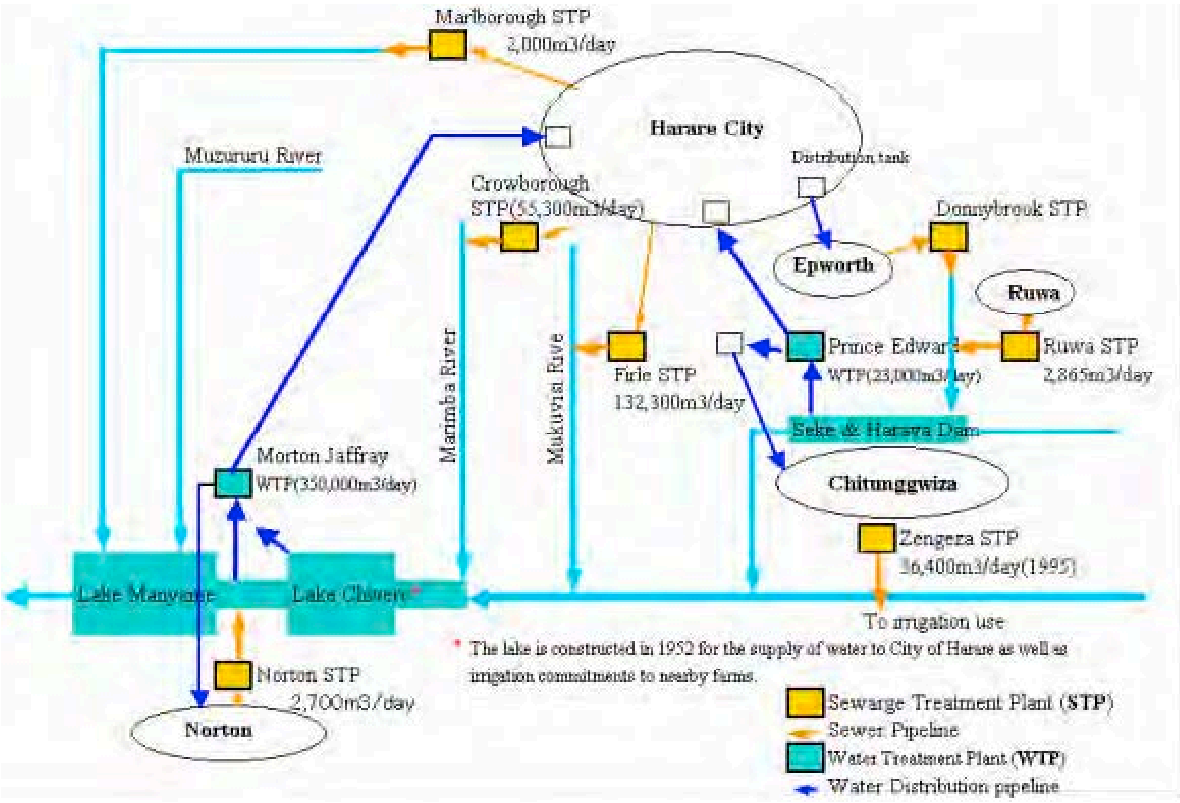


Figure 5.1 Manyame Catchment and WTP/STP Facilities

For Norton, TF process was working till the year of 2000. However, treatment was discontinued also because of budget problems. After the breakdown of the transmission pump to the irrigation farm caused by vandalism, raw sewage has been discharged to the Lake Manyame. In August 2012, the Morton Jaffray WTP partially discontinued water intake from the Lake Manyame due to the water pollution, affecting water supply for the City of Harare. The accident was caused by direct discharge of the raw sewage from Norton STP.

Ruwa STP has a stabilization pond process. However, satisfactory maintenance work such as sludge removal from the anaerobic ponds has not been done by the township. Half treated sewage has been discharged to the Nyatsime River polluting the Lake Chivero. The discharge of partially treated wastewater into rivers is obviously not sustainable in the long-run as it could result in the further deterioration of water quality in Lake Chivero. Polluting the water sources by discharge of unsatisfactory sewage treatment and discharge is obvious from the study.

As shown in the pollution analysis, most of the generated pollution loads are considered as coming from Harare and Chitungwiza. Thus, functional recovery of the sewerage system including irrigation of the farms is urgently needed for the improvement of the environment in the catchment. As presented in the Chapter 6 Pollution Analysis, sewage is the biggest pollution load for the water sources in the catchment area. And improvement of the water quality is projected in the simulation after the rehabilitation of the STPs. Thus, rehabilitation of the sewerage system will be the urgent measure to be taken. AfDB project for the six cities for the rehabilitation of water, sewage and hygiene and AWF project for the Chitungwiza Municipality will be taken as urgent measures for this project, and complementation between this project and AfDB/AWF projects will be required.

All the STPs have the problems for the sewage treatment process. Multi-donor fund under AfDB has been financing the rehabilitation of facilities for City of Harare. AWF project will fund the Zengeza STP aimed at the rehabilitation of five existing units of trickling filters, pump station for irrigation and others for urgent measures. The project will be economically desirable, but not sufficient to improve effluent water quality. It will be required to take supplementary measures to get satisfactory water quality as required by regulations. Norton STP is also broken down. However, there is no specific rehabilitation plan for the STP.

5.2.2 Water Quality Conservation

The main water management problem in the catchment is that wastewater discharges contribute significantly to eutrophication in Lake Chivero and Manyame, although the current extent is not well known. The problem is compounded by the fact that water released from the lake does not take place frequently in years of low rainfall as the dam floodgates are permanently closed. A big problem is that the population in the catchment depends on the water from Lakes Harava, Seke, Chivero and Manyame, until another water source will be developed. The Zimbabwe Government should reconstruct the water quality monitoring system as well as the functional recovery of sewerage system in order to conserve these water sources. The establishment of the water conservation measures is the major point in terms of protecting/ safely securing the water sources and improving the environment by water pollution control. Even if the irrigation is used to alleviate the washout of the pollutant and nutrient for the water body, this might pollute the groundwater and soil in the long run.

5.2.3 Sewer Reticulation

Sewer reticulation in Chitungwiza was roughly confirmed to have capacity required for the future flow till 2030. However, it will need a lot of repair work and rehabilitation. The work includes continuous sand removal. Breakdown of the sewers as well as all the sewage pump stations is found in the Municipality. Sewage spills have been seen around the Municipality. From the standpoint of environment conservation, urgent countermeasures must be taken. To deal this situation, AWF project is underway for rehabilitation of sewer reticulation and three pump stations. Since the budget of AWF project is limited, not all the problematic parts will be covered. For example, Tilcor industrial area is not included in the AWF project. All the sewage from the Tilcor flows into the existing channel in the area thereby polluting Nyatsime River. Then, supplemental measures will be needed in this field as well. The situation of the sewer reticulation is the same in other Municipalities.

5.2.4 Sand Issues

Another issue is the presence of sand in the pipelines and reticulation. Although rehabilitation work has been on-going under the AfDB scheme (Multi donor fund) for city of Harare and Chitungwiza municipalities, clogging problems caused by sand deposit in the pipelines or pump stations are prevalent: Clogging of sewers, sewage spilling out from manholes polluting streets, buried grit chamber in the STP by sand deposit and flooding in the pump station due to inappropriate sand disposal method around the sewage facility. The origin of the sand is thought to be sand used by residents when washing their pots. However, the real reason has not yet been identified. The sand deposit in the sewers is seen to also negatively affect lake capacity. In order to plan the right counter measure for the sand issue, field tests were conducted.

5.3 Solid Waste Management

5.3.1 Evaluation of Current Issues on Solid Waste Management

(1) Illegal dumping

Illegal dumping was identified in and around the Chitungwiza Municipality by the illegal dumping survey. Lack of public awareness, problems of accessibility of the municipality's collection service, lack of the municipality's collection capacity and no comprehensive plan for controlling illegal dumping are estimated as causes of illegal dumping.

(2) Collection & transport

1) Insufficient collection capacity

The municipality's collection vehicles have been used for over 10 years old and most are either malfunctioning or non-functioning. The current collection level to the current waste generation amount is only 38%, which clearly shows the low capacity of the municipality's collection service.

2) Frequency of collection service

The frequency of the municipality's collection service is currently on a weekly basis which presents a problem from the point of view of hygiene, as kitchen waste will have to be stored for the same period in the in household.

3）Lack of capacity of operation and maintenance

In the solid waste management section, fuel or tires are not often supplied. These are necessary for proper operation and maintenance of the vehicles to ensure service vehicles for scheduled solid waste collection. The appropriate budget is not allocated to the normal operation of the solid waste management.

(3) Final disposal

The current final disposal facility is an open dumping which has no fence, truck scale nor function of leachate control system, such as impermeable liner. Soil covering, which is effective for hygiene control such as pest management, is not carried out. In addition, the municipality's facility is not managed appropriately as waste pickers currently operate in the dumping site. The municipality has not done much to improve the existing open dumping site even with the order/ recommendation of EMA.

CHAPTER 6 ANALYSIS OF WATER QUANTITY AND QUALITY IN MANYAME CATCHMENT AREA

6.1 Water Quantity and Quality in Manyame Catchment Area

(1) Water use in the entire study basin

In the upper Manyame river basin, the major impoundments are Lake Manyame, Lake Chivero, Seke Dam and Harava Dam. Several rivers flow into these water bodies. The direct use of river water is minimal due to limited availability during dry season. As for irrigation, about 200 private dams are scattered in the Gwebi and Muzururu catchment area, while the reuse of treated effluent is dominant in the entire Study Area. On the other hand, lakes and dams are utilized for water supply, recreation and commercial fishery purposes. Four impoundments are the most valuable water sources for water supply of metropolitan Harare where presently 467,000 m^3/day are availed of. As for recreational usage, Lake Manyame and Lake Chivero are designated as national recreational parks with a variety of interests including fishing, boating, swimming and game viewing. Commercial fishery is also allowed in both lakes. Since these impoundments are situated at a lower elevation than the urban area and farm land, generated wastewater reach the lakes.

(2) Ambient water quality standards

In Zimbabwe, the regulation of effluent for wastewater has been enacted. However, the ambient water quality standards have yet not been established. To prepare the water pollution control plan for the Upper Manyame Basin, the establishment of the Ambient Water Quality Standard would be primarily required. A proposal for the Ambient Water Quality Standard was made in “the Study on Water Pollution Control in the Upper Manyame River Basin in the Republic of Zimbabwe” (hereinafter the Study 1997), in 1997 conducted by JICA. Since the Study 1997 is considered to be sound for the catchment area, proposed standard will be followed in this study.

The ambient items for rivers as adopted in Japan comprise pH, BOD, SS, DO and a coliform group; and for the lakes Total Nitrogen (T-N) and Total Phosphorus (T-P) were added and COD was replaced by BOD. In view of practicability to the present situation in Zimbabwe, it is deemed appropriate to adopt at least the same items and apply respective values based on WHO standards, while such items, other than the Japanese Standards, shall be subject to be added when they are detected in the subject water body through monitoring and/or being introduced in economic activities.

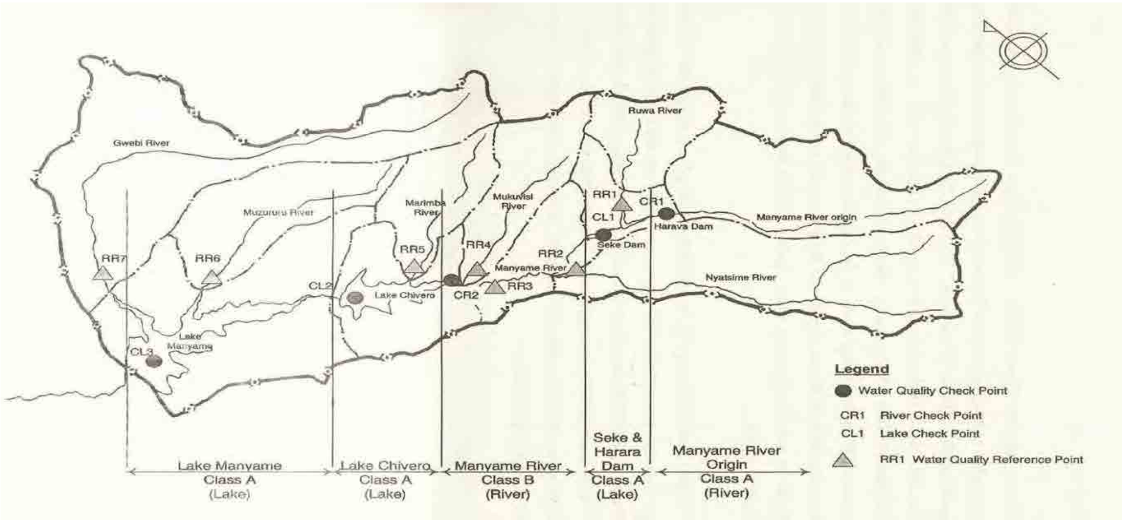


Figure 6.1 Subject of Sub-water Bodies. Source: JICA Project Team

(3) Flow balance in the future

Approximately 1,000,000 m^3/day has been inflowing to the Lake Chivero from the catchment including the effluent from the Firle STP, Crowborough STP, Zengeza STP, Ruwa STP and Norton STP. Around 640,000 m^3/day has been drawn for the water supply from the PW-WTP and MJ-WTP. Water loss by evaporation and others is assumed to be 450,000 m^3/day which is 60% of the total outflow from the Lake Chivero. Lake Manyame has been supplying about 60% of raw water for the MJ-WTP (about 360,000 m^3/day). Inflow from the Lake Chivero averages about 80,000 m^3/day. Water loss by evaporation and others is assumed to be about 250,000 m^3/day. Approximately 930,000 m^3/day has been flowing into Lake Manyame from the catchment with less inflow from the STP.

6.2 Current Water Pollution Analysis

6.2.1 Methodology

(1) Rivers

In the study, the residual ratio of the pollution load of each river was derived through the analysis of self-purification. Reached pollution load was estimated using frame values, unit pollution load and assumed reaching ratio. Run-off load was estimated based on the existing data on flow rate and water quality of rives.

(2) Lakes/Dams

Water quality indices used in the study were T-N, T-P and COD. COD was uti1ised to eliminate the influence of algae in the examination of BOD. The Vollenweider Model was adopted for the water pollution simulation model in terms of T-N, T-P and COD, and the increase of COD caused by elution from sediment in the lake is considered in this concept.

6.2.2 Fundamentals for the Analysis

(1) Domestic/Commercial/Institutional/ Sewage

The pollution load collected from the sewered area will flow into the sewage treatment plant. The pollution load was calculated using existing data at the STPs. BOD load was adopted for the water pollution analysis of rivers; while COD, T-N and T-P load were selected for the pollution analysis of lakes.

(2) Industrial wastewater

1) Industrial wastewater flow

Industrial wastewater flow was examined using the data of industrial wastewater flow per employee and the number of employees.

2) Pollution load

Pollution load was calculated by multiplying the unit pollution load of industrial wastewater per employee and the number of employee at present.

3) Sewered/ Unsewered wastewater

Wastewater flow and pollution load were calculated for sewered/ unsewered by public sewerage system based on the present conditions described below.

6.2.3 Result of the Current Water Quality Analysis

Result of the pollution analysis for the current status is summarised below:

(1) Generated pollution load

The biggest pollution loads in the catchment area are from City of Harare, which is about 110,000 kg-BOD/day. The reached pollution load to the Chivero Lake is assumed to be about 33,000 kg-BOD/day, reducing about 70% of the load in the river. Chitungwiza Municipality comes in second, discharging a pollution load about 13,000 kg-BOD/day. The reached pollution load to the Manyame river is assumed to be 3,900 kg BOD/day reducing about 70% of the load in the river. While the reduction of the pollution load in the river is quite significant, the influence of these loads is still serious as evidenced by the continuing deterioration of water quality in the rivers and lakes as shown in (2). Influence of non-point sources such as natural pollution and pollution from livestock is not significant compared with the load from the urban area.

(2) Status of river pollution

Other than the Upper-Manyame river, the entire aquatic environment is seriously polluted.

Upper-Manyame river:	Clean (1.3 mg BOD/l) with low pollution load
Ruwa river:	Polluted (97 mg BOD/l) with high pollution load from Ruwa
Downstream of Seke:	Clean (1.5 mg BOD/l) with high pollution load from Ruwa
Nyatsime river:	Heavily polluted (118 mg BOD/l) by Chitungwiza pollution load

Manyame River before Chivero: Polluted (40 mg BOD/l) with high pollution load

Lake Chivero: Polluted (5.0 mg BOD/l, 10.8 mg N/l, 0.7mg P/l)

Lake Manyame: Polluted (2.0 g BOD/l, 19.1 mg N/l, 1.5 mg P/l)

Remarks: BOD was used for the Lakes for the simplicity, instead of COD

The rivers receive sewage from Harare and Chitungwiza and are seriously polluted with pollution loads coming from both urban and rural areas. Eutrophication of the lakes is also serious as indicated by concentrations of N and P. One of the problems is the flow rate of the rivers especially in the dry season when flow rate is one-third that of rainy season, and dilution of nutrients does not work effectively.

(3) Purification capability of the lakes

The purification of the rivers and lakes of pollution loads is evaluated to be very effective in the improvement of water quality according to the model. Water quality of the intake for the water treatment plant is actually much better than the computed result. It shows the high performance of the lakes in the water treatment capability.

6.3 Future Water Pollution Analysis

6.3.1 General

Scenario 0 : Same condition with current condition as of 2012 (No improvement)
Scenario 1 : All the STPs operation under condition after the urgent improvement
Scenario 2 : All the STPs operation with 3 STPs upgrading BNR (from TF or WSP to BNR)
Scenario 3 : All the STPs operation with 100% irrigation
Scenario 4 : No improvement for only ZSTP to confirm the influence of pollutant discharge from Chitungwiza Municipality

Analytic models cover both human and natural pollution loads generated for point and non-point sources. The flow model employs the same flow shown in the current analysis of the entire basin for future water pollution analysis. Population projection was conducted for 2020 and 2030 with 1.6% of population increase ratio in Chitungwiza and 1.4% of ratio in other areas after considering the current status and trends.

(1) In the scenario 0, no improvement was considered to predict the worst pollution status.

(2) Scenario 1 took urgent measures for Crowborough STP and Firle STP for Harare (Rehabilitation of BNR and Trickling Filters by Zim Fund), Zengeza STP for Chitungwiza (Rehabilitation of Trickling Filters by AWF project), and rehabilitation of Norton STP by some donor. The Ruwa STP was planned as existing in this case, which is waste stabilization pond.

(3) Scenario 2 is planned to predict the effect of the employment of the BNR process for Firle STP, Crowborough STP and Zengeza STP.

(4) Scenario 3 was planned to evaluate the effect of the irrigation by which the pollution loads can be completely transferred outside of the catchment.

(5) Scenario 4 is excluding the improvement of only Chitungwiza Municipality to evaluate the scale of the effect of the pollutant discharge from the municipality

6.3.2 Discussion and Conclusion

(1) General

Based on the load run-off model established, the concentration of the parameters at water quality checking points of rivers was conducted and projected for each scenario for the years 2020 and 2030.

(2) Rivers

The result of the pollution analysis for the current status in the dry season is summarised below:
Based on the load run-off model established, the concentration of the parameters at water quality checking points of rivers was conducted and projected for each scenario for the years 2020 and 2030.

< Scenario 0, - no improvement >

Reached pollution loads from City of Harare will be 1.5 times, or from the current 110,000 kg-BOD/day to about 160,000 kg-BOD/day in 2030. Load from Chitungwiza will also increase from the current 13,000 kg-BOD/day to 24,000 kg-BOD/day in 2030. Water quality in the Ruwa River, Mukuvisi River, Marimba River will be serious. T-N and T-P show the same tendency.

Ruwa river: Polluted (97 mg BOD/l ⇒530 mg BOD/l)
Nyatsime river: Polluted (118 mg BOD/l⇒218 mg BOD/l)
Manyame river before Chivero:
Polluted (40 mg BOD/l⇒72 mg BOD/l)

Thus, no improvement will bring the disastrous influence to the Lake Chivero and Lake Manyame. The situation must be avoided because Water source for the WTPs will be polluted. Ground water source will be polluted as well by infiltration of sewage into the ground.

< Scenario 1, 2 >

From Harare, generated pollution loads to the rivers will decrease to about 3,400 kg-BOD/day from the current 110,000 kg-BOD/day in scenario 1, 2 in 2030. Chitungwiza Municipality will discharge no pollution loads due to irrigation use. T-N and T-P show the same tendency with the BOD.

Ruwa river: Improved (97 mg BOD/l ⇒6.7 mg BOD/l)
Nyatsime river: Improved (118 mg BOD/l⇒3.9 mg BOD/l) from Chitungwiza
Manyame river before Chivero:
Improved (40 mg BOD/l⇒2.3 mg BOD/l)

Improvement of Sewerage of City of Harare by Zim Fund project and Chitungwiza by AWF project will improve the current status drastically. Followed augmentation/continued effort of maintenance will keep the ambient environment as improved.

< Scenario 3 >

From Harare, generated pollution loads to the rivers will decrease to zero in scenario 3 in 2030. Chitungwiza Municipality will discharge no pollution load due to irrigation use. T-N and T-P show the same tendency with the BOD.

Ruwa river: Improved (97 mg BOD/l ⇒7.6 mg BOD/l)

Nyatsime river: Improved (118 mg BOD/l⇒4.3 mg BOD/l)

Manyame river before Chivero:

Improved (40 mg BOD/l⇒2.4 mg BOD/l)

Generally speaking, the measures of wastewater treatment will be effective for water quality improvement.

< Scenario 4 >

From Harare, generated pollution loads to the rivers will decrease to zero in scenario 4 in 2030. Chitungwiza Municipality will discharge biggest pollution load to Nyatsime River, about 16,000 kg-BOD/day because of no improvement of sewerage. T-N and T-P show the same tendency with the BOD.

Ruwa river: Improved (97 mg BOD/l ⇒7.6 mg BOD/l)

Nyatsime river: Polluted (118 mg BOD/l⇒147 mg BOD/l)

Manyame river before Chivero: Improved (40 mg BOD/l⇒28.5 mg BOD/l)

Nyatsime River will be polluted very badly because of pollutant discharge from Chitungwiza Municipality. Inflowing pollution load to Lake Chivero will be 5,565 kg-BOD/day increased from 3,636 kg-BOD/day which is 1.53 times bigger than Scenario 1. Influence of no-treatment at ZSTP will drastically aggravate the water quality in the Nyatsime River.

(3) Lakes / Dams

The improvement of water quality of lakes/dams from the present status is shown below:

Although the change in water quality will be very slow compared with the case of the river, water quality will become worse in scenario 0 but will see improvement in scenario 1, 2, 3 and 4. Concentration of T-N and T-P is relatively high in every case. In the scenario 2, employing BNR for all facilities will be significant in terms of water cycle. However, water quality in Lake Chivero will be a bit worse than scenario 1 in which irrigation is employed for the facilities other than BNR.

Table 6.1 Water Quality Projection in Seke and Harava Dam

Items	Scenario Number	Water Quality (mg/L)		
		2012	2020	2030
COD	Scenario 0	3.6	3.6	3.7
	Scenario 1		3.5	3.5
	Scenario 2		3.5	3.5
	Scenario 3		3.5	3.5
	Scenario 4		3.5	3.5

Items	Scenario Number	Water Quality (mg/L)		
		2012	2020	2030
T-N	Scenario 0	4.0	4.2	4.5
	Scenario 1		3.7	3.7
	Scenario 2		3.7	3.7
	Scenario 3		3.7	3.7
	Scenario 4		3.7	3.7
T-P	Scenario 0	0.3	0.3	0.4
	Scenario 1		0.3	0.3
	Scenario 2		0.3	0.3
	Scenario 3		0.3	0.3
	Scenario 4		0.3	0.3

Source: JICA Project Team

Table 6.2 Water Quality Projection in Lake Chivero

Items	Scenario Number	Water Quality (mg/L)		
		2012	2020	2030
COD	Scenario 0	9.2	9.5	10.2
	Scenario 1		8.3	8.3
	Scenario 2		8.5	8.5
	Scenario 3		8.1	8.1
	Scenario 4		8.4	8.4
T-N	Scenario 0	9.0	9.1	9.6
	Scenario 1		8.6	8.7
	Scenario 2		8.9	9.0
	Scenario 3		8.4	8.4
	Scenario 4		8.7	8.7
T-P	Scenario 0	0.7	0.7	0.7
	Scenario 1		0.7	0.7
	Scenario 2		0.7	0.7
	Scenario 3		0.7	0.7
	Scenario 4		0.7	0.7

Source: JICA Project Team

Table 6.3 Water Quality Projection in Lake Manyame

Items	Scenario Number	Water Quality (mg/L)		
		2012	2020	2030
COD	Scenario 0	17.5	17.8	18.5
	Scenario 1		16.7	16.7
	Scenario 2		16.9	16.9
	Scenario 3		16.5	16.5
	Scenario 4		16.8	16.8
T-N	Scenario 0	17.8	17.9	18.4
	Scenario 1		17.4	17.4
	Scenario 2		17.6	17.7

Items	Scenario Number	Water Quality (mg/L)		
		2012	2020	2030
	Scenario 3		17.2	17.2
	Scenario 4		17.4	17.5
T-P	Scenario 0	1.5	1.5	1.5
	Scenario 1		1.4	1.4
	Scenario 2		1.4	1.5
	Scenario 3		1.4	1.4
	Scenario 4		1.4	1.4

Source: JICA Project Team

CHAPTER 7 PILOT PROJECT

7.1 Water Supply

7.1.1 Hand Pump Installation

There are over 3,000 wells installed in Chitungwiza Municipality. Almost all these wells utilize a bucket and rope to hoist water; this is quite inefficient and insanitary. The Team thereby planned to improve this inefficient and insanitary condition through installation of hand pumps. The selected area is Unit L as shown in Figure 7.1, where water is distributed for several hours in a week, and in addition, there are many wells with a high yield capacity.

Figure 7.1 Location of Selected Area

Photo 7.1 Elephant Pump

In the target area, 10 wells were selected for installation based on these conditions; the yield capacity is relatively large and people in the housing units surrounding the area are using the well. An “Elephant Pump” is selected as the hand pump because it is prevailing in the municipality and is locally fabricated using common materials. Before and after installation, some questionnaires and public awareness on water quality problems and basic manner of utilizing pump were carried out. Survey results were analyzed numerically and are summarized below including features of families utilizing target wells:

1) The number of families utilizing each well range from 7-30 (average 16.4)
2) The number of sample families selected was 68 out of 164, 41.4%
3) Average number of people in surveyed families was 8.7
4) Average consumption (intake) of well water was 284 litters/day
5) Average spending time of water taken from wells is 55.4 minutes
6) For the hygiene and safety of drinking water, 57% of people use tablets, which can be purchased from the local market and/or distributed for free by donor organizations.

After installation of the hand pumps, changes listed below were observed:

1) Water consumption was slightly increased by 1.17 times (333/284)
2) Spending time was drastically decreased by 0.36 times (19.6/55.4)
3) The rate of using tablets was not marginally changed due to the instructions on distributed leaflets
4) Some families complained about the poor quality of hand pumps, but after modification of these by the manufacturer under the requirement of the Team, these complaints ceased

7.1.2 Water Leakage Survey and Flow Measurement

(1) Methods

For water leakage measurement, night time measurements of two areas were carried out in this pilot project. During the night time, since water consumption by people is little, water flow in a particular area is assumed to be the water leakage. For flow measurement of branch pipes, the flow of branch pipes was measured according to the request of the municipality water supply section. In the water supply system of Chitungwiza Municipality, only one flow meter is measuring the bulk water from PE-WTP to the municipality and this data was of great importance in the analysis of measured results.
Originally, two ultra-sonic flow meters were planned to be used, but unfortunately one of them which was brought from Japan could not be used to measure pipe flow, only one flow meter was then used by a local specialist. The location of measurement points is shown in Figure 7.2, and areas “e” and “f” were selected for water leakage measurement. Distribution pipes are not connected to other areas in these selected areas.
Point ①-⑩ were the originally selected measurement points but actually only ①-⑤ and ⑧ were measured due to the availability of one meter and low flow rate in the measuring week.

(2) Survey results

1) Water leakage survey

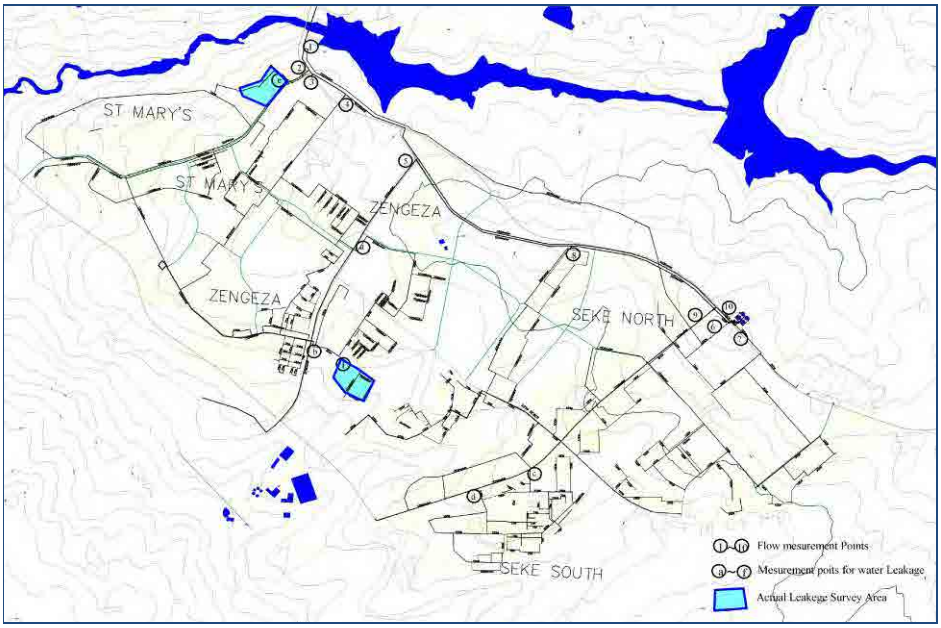


Figure 7.2 Location of Flow Measurement Points

Area “e” is composed of a housing complex, which was constructed in late 1980 and the area has always been distributed compared to the intermittent distribution in other areas. This is due to the fact that the branch valve to regulate the distribution flow broke down under the open condition. However since it was repaired in August 2012, it has only been closed by the municipality if necessary.

Area “f” is composed of the largest hospital in the municipality constructed in 1976 and a housing complex.

Because this area was the first priority area for the municipality to provide a sustainable water supply, Valve ⑤ never fully closes. Measurement results for water leakage survey of area “e” were shown in Figure 7.3. As shown in the figures, in the midnight the water flow apparently decreases, and the average flow was decided by two hour intervals of measurement.

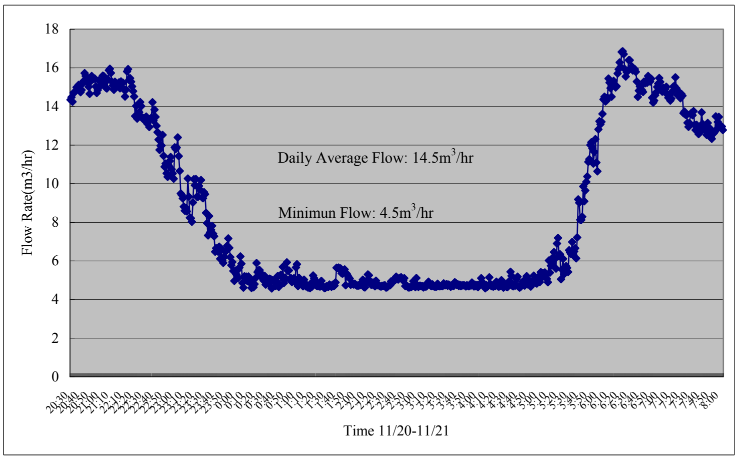


Figure 7.3 Measurement Results of Area “e”

Based on the figures, if water consumption in midnight is assumed to be the water leakage, water leakage ratio of each area is calculated as shown below:

Area “e”: 4.5/14.5=31.0%

Area “f”: 6.5/20.5=31.7%

2) Flow measurement results

During this week, water could not reach reservoirs and places located on high elevation areas due to low water flow. A limited water flow measurement for branch pipes was carried out because Valve ⑤ is never completely closed and in addition, various water flow conditions cannot be made from the operating conditions of valves due to the low water flow. Water flow from City of Harare was around 15,000 m^3/d from Monday to Thursday, and 18,000 m^3/d from Friday. Water flow was maximum 400 m^3/d of pipe ⑤ and 100-300 m^3/d of others.

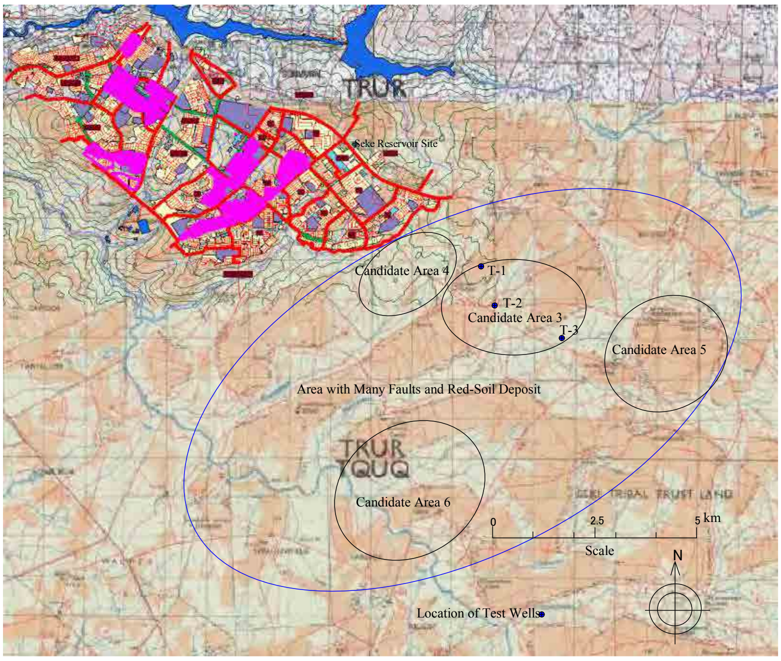


Figure 7.4 Location of Candidate Areas

7.1.3 Groundwater Resource Survey

In Chitungwiza Municipality, there are over 3,000 shallow wells and around 50 boreholes, and these are used by people living mainly in Seke North, Seke South and the eastern part of Zengeza, where piped water is distributed only for several hours in a week. These wells have not dried up by daily consumption even in dry seasons.

Thus, JICA Project Team started to find groundwater resources surrounding the municipality. After the failure of the first stage survey the Team hired another definitive hydro-geologist and restarted the second survey. The hydro- geologist showed some candidate areas as shown Figure 7.4. Within four (4) candidate areas, Area 3 is surveyed by electrical resistance tests, three (3) test wells was installed at the most hopeful points. As shown in Table 7.1, one well was negative but other two well's yield capacities were positive.

Table 7.1 Results of Yield Capacity Tests of Test Wells

No.	Geology	Elevation (m)	Well Depth (m)	Water Level(GL-m)		Yield capacity		
				Initial	Dynamic	L/sec	m^3/hr	m^3/day
T-1	Red-soil	1,458	60	7	33	0.3	1.1	26
T-2	Fault of granite	1,442	60	1.8	24	3.5	12.6	302
T-3	Fault of dolerite	1,440	60	1.4	15	3.9	14.0	337

The water quality analysis results of two positive wells are shown in Table 7.2. The water quality is not so well because of too low pH and high concentration of bacteria/coliform, but these can be easily removed by chlorine and lime injection. However, the hydro-geologist asserted that there is no large scale groundwater resource with yields of over 10,000 m^3/day because of the low recharge capacity of the areas.

Table 7.2 Water Quality Analysis Results of Wells

Item	unit	WHO Standard	T2	T3
pH	---	6.5-8.9	**5.7**	**5.7**
Conductivity	µs/cm	1,600	14	70
TDS	mg/L	1,000	10	49
Alkalinity	mg/L	---	10	20
Hardness	mg/L	250	15	13
Calcium	mg/L	250	3.1	3.2
Turbidity	NTS	5	0.2	0.1
Iron	mg/L	0.3	0.10	0.08
Manganese	mg/L	0.1	0.03	0.05
Copper	mg/L	0.30	0.03	0.02
Zinc	mg/L	0.10	0.02	0.02
Nitrate	mg/L	50	0.93	0.93
Potassium	mg/L	---	1.7	4.6
Magnesium	mg/L	150	1.7	1.2
Sodium	mg/L	200	4.5	6.7
Sulphate	mg/L	250	6	18
Chloride	mg/L	250	6	18
Bacteria	no./ml	100	**2,900**	**110**
Coliform	no./100ml	Nil	**209**	**109**
E-coli	---	Negative	Negative	Negative

His assumption was maximum 5,000 m^3/d of the resource from all four (4) candidate areas and the average yield capacity of wells will be 3-5 m^3/hr (72-120 m^3/day).

7.2 Sewerage

7.2.1 Survey for the Sand Generation

In the pilot project for the sewerage, the survey was conducted with the cooperation of the residents, counter-part and local consultants (under contracts) as follows:

1) Confirmation of Current Status of Manholes and Sewers
2) Unit generation rate of sand in the sewage in Chitungwiza Municipality,
3) Reached unit sand volume to Zengeza STP,

(1) Study on generation of sand in the sewerage

Clogging problems of reticulation by sand deposit or malfunction of pump stations recurrences frequently: Clogging of sewers, sewage spilling out from manholes polluting streets, buried grit chamber・trickling filters in the STP by sand deposit and flooding in the pump station due to inappropriate sand disposal method around the sewerage facility. The origin of the sand has been considered to be a sole reason of pot washing by residents. However, no identification was made for the real reason. In order to plan right counter measures for the sand issue, series of field tests was conducted. A Pilot Project for the sand issue was conducted to identify the unit generation rate of sand in the sewerage to prove the origin of the sand and also to get the detailed information of the sewered area.

(2) Study area

150 residences were selected from the 5 areas in Chitungwiza Municipality for the study.

(3) Sand trap

Prototype sand trap was developed. The structure is similar to the grease trap but it has bottom of sieve to catch the sand. In the survey, effectiveness of the trap and unit sand generation rate per capita were studied. The trap was designed to release fine particles of the sand and silt under 425 micro m going through the sieve to avoid clogging of the devices by the fine particle.

(4) Monitoring

Monitoring was planned to be conducted in the dry season in order to avoid the influence of the rain. The devices were monitored for more than two weeks. Monitoring was not on a daily basis. This is because Chitungwiza Municipality is currently facing serious water supply challenges. Consequently it was noted that behavioural habits of the targeted house- holds have been affected by this intermittent water supply situation. People are more conscious of conserving every drop of water; hence the amount of anticipated sand entering the sewerage network might be small compared with that which would enter the same network during normal water supply periods.

(5) Water Supply Situation

Number of times that the various areas were supplied with water during the monitoring period is checked and found water supply was made only three or four times. As a result of the above, sampling in Areas 4 and 5 were limited to only 3 times due to this problem of water supply. The residents do not drain used water to sewerage without water supply, and then the devices were not used when the tap water was not supplied. In areas 4 and 5 residents rely more on boreholes and wells. Residents normally hoard water when the water is available and use them sparingly thereby distorting the real impact of the amount of sand entering the sewerage network.

7.2.2 Result of the Field Work and Analysis

(1) The amount of sand in the field study

In total about 14,000 ml of sand excluding garbage was monitored through the field work. Since fine particle like silt goes through the pores of the sieve, correction was made.

(2) Unit generation rate of sand from Study Area

Unit sand generation rate was obtained as follows: Per house sand generation 43,863 g/489 houses =

89.7 g/house/day, Per capita sand generation 89.7 g/9.1 residents = 9.86 g/capita/day

The amount is considered to be reasonable from the experience of the field survey of the pot washing.

Unit generation rate of sand was determined as follows:

Per capita sand generation rate: 10 g/capita/day

Per house sand generation rate : 90 g/house/day

Besides, rate of water supplied days during the days of operation was 489/2392.5 = 0.204, which means that days of water supplied is averagely only 1.4 days (7days × 0.204 = 1.43days) through the entire municipality. It can be said that the residents are withstanding severe living condition in the Municipality. Boreholes and shallow wells are considered to be the core water source for the residents.

(3) Findings

Findings were summarised as follows:

1) All the 137 houses selected were using the sand for every washing work regardless of availability of water, which proves the manner as a common manner.
2) Water supply during the period of the study, water was supplied only 3 or 4 times from the taps. Availability of water supply was computed as averagely 20% and it was almost common in all the area.
4) Thus, water from well or stored water was assumed to be used for about 80% of the days from the computation.
5) The sewage after the washing was discharged to the sewerage in the kitchen when water is available, but when unavailable, sewage was disposed in the garden or outside, since the water is not derived from the tap in the kitchen but from outside.
6) About 90 g of sand was averagely used in a house a day by computation from the derived data.
7) Unit sand generation rate per capita was about 10g/capita/day. (Refer to above (4))
8) Soot of the pots was deemed to come from firewood, gas or paraffin, when the electricity is out due to power failure which is confirmed by interviews, observation at the field. However, since using firewood is a traditional way, it might be a regular way even when the residents have power in their houses. Anyhow, power failure is considered to be affecting the pot washing.

From these facts, since the residents have been using the sand for pot washing whether they have water or not, inflow of the sand into the sewers will increase when the water supply is improved. Thus, sand use is independent matter with the water supply. Although sand removal would be done by the municipality as required after the refurbishment and improvement, most desirable way is the stoppage of the use of the sand in the residents to cope with the sand issue.

7.2.3 Zengeza Sewage Works – Inlet Works Grit Survey

(1) Confirmation of sand inflow to ZSTP

In order to validate the results obtained from the household grit survey as extrapolated above, it was proposed to measure the amount of grit reaching the works by gravity. All the sewage pumping stations were not working due to rehabilitation works currently going on at these facilities during the survey. The survey was conducted at the inlet works chamber just before the screens. The survey commenced on 21st of November at 14:30pm, immediately after the cleaning work. The survey ran for two weeks to match the number of days the household grit survey was conducted. The existing gates were throttled as small as possible to make the water level high in the chamber to slow down the velocity. Inflow of sand was assumed to be 3.837 m^3 from the unit generation rate derived in the study, and the volume of the sand deposit during 2 weeks was 4.875 m^3. Since the deposited sand for more than 10 years in the sewers could be washed out reaching the Inlet Chamber in the ZSTP for some reason, it is considered that the both result is showing fairly good consistency.

(2) Findings

1) Assumption of the deposit was 3.8 m^3, while the actual measurement was 4.9 m^3.

2) Although there is a margin of error, computation of sand deposit in the ZSTP was close to the actual deposit in the chamber at the entrance of the inflow.

7.2.4 Projection of Sand Generation in the Future

From the study, it was found that availability of water supply was very much limited to low level of about 20%, although the situation of water supply will be improved in the future. From our survey, volume of the sand inflowing to the ZSTP is directly connected to the availability of water supply as shown above. Then, sand inflow to the ZSTP was assumed as 2.115 m^3/day for 100% water supply. It will be more than 700 m^3 in a year. This seems what is seen in the old facility in the ZSTP, namely buried anaerobic ponds and sand-clogged trickling filters. This indicates usual sand removal work for STP, PS and sewers is very important to maintain the facility, if the sand inflow keeps on.

7.2.5 Educational Activity

On the other hand, educational activity/enlightenment/introduction of penal regulations for the residents is very essential as well. Seminar for the residents, presentation to the schoolboys/girls regarding the sanitary, environment and sewage facility will be very useful to reduce the sand. In the latter part of the project, these activities will be planned and conducted. Introduction of penal regulation must be done in parallel with the providing the alternative to the residents.

7.3 Solid Waste Management

7.3.1 Approach to Implementation of Pilot Project

(1) Selection of project sites

The project sites of the pilot project were selected through identifying the non-collection service area in a map, discussions with the municipality and site inspection of candidate sites. Two communities of Zengeza 4 and Unit J extension of Seke South were selected.

(2) Explanation of Pilot Project to community residents

The local consultants and the municipality's solid waste department visited each household of the project sites on the explanation of the implementation of the pilot project.

(3) Public education

In the proposed pilot project, the public education was carried out.

(4) Proposed combination system of primary and secondary collection

In the non-collection service areas, a primary collection using of manual carts by CBOs (Community based Organizations), their transport to a collection point and another combined collection system of the municipality's secondary collection by using their collection vehicles was proposed.

(5) Monitoring before and after Pilot Project / Stakeholder Meetings

Before and after the implementation of the pilot project, a monitoring through a questionnaire survey was carried out with the municipality (C/P) to verify the process of the activities, validity or efficiency of activities and input, outcome of the pilot project and their evaluation.

Stakeholder meetings were held to share the outcome of the pilot project.

<u>7.3.2 Results of the Pilot Project</u>

(1) Monitoring results

1) Monitoring before Pilot Project

The following results were obtained through the questionnaire survey;

- The majority of the residents (86%) showed concern about issues of solid waste management and the diseases related to improper waste disposal.
- 90% of the respondents were willing to participate in the activities of waste reduction, recycling and composting waste at household level
- Most of the residents replied that the infrastructure development such as roads can be a permanent solution compared to the attempt of the development of collection points since such collection points will become a dumping site if the municipality fails to collect the waste

2) Monitoring results after Pilot Project

The following results were obtained;

- The residents (97% of the respondents) replied that the pilot project was a good attempt
- The majority of the residents replied that they secured a cleaner environment after the pilot project compared to the previous state before the pilot project
- Most of the residents (82% of the respondents) were aware of the fact that a USD20 fine has to be paid for an illegal dumping, but because there is no refuse collection in their communities they are forced to dump their waste illegally.

- Most of the residents (83% of the respondents) were willing to produce craft works from the recyclable materials for earning their income and also for the purpose of waste reduction

(2) Stakeholder Meetings

The followings following opinions were obtained;

- The educational awareness on appropriate discharge of waste should be carried out until there is an attitude change in the people towards waste reduction
- One of NGO groups can play an important role as a partner in public education including source separation
- The municipality's collection service of once a week is not sufficient. The service should be provided twice a week.
- Unit J Extension residents who are close to access roads could take out their waste for Municipal collection on Wednesday when the collection in Unit J is done.

(3) Outcome and challenges identified

The following outcome was obtained through implementation of the pilot project.

- Most of the community residents had concern on the pilot project and they thought that the pilot project was a good attempt.
- Most of the community residents recognized that they secured a cleaner environment after the pilot project compared to the previous state before the pilot project
- Most of the community residents were willing to participate in the activities of waste reduction, recycling and composting waste at household level.
- Most of the residents (83% of the respondents) were willing to produce craft works from the recyclable materials for earning their income generation and waste reduction, at the same time.
- The operators were willing to continue their work of primary collection after the implementation of the pilot project.
- Other communities in the municipality's non-collection areas who were not part of the pilot project expressed concern for the project to be implemented in their communities as well.

The following challenges were identified;

- Some residents discharged human excreta to the operators because many houses have no ablution facilities in the pilot project communities.
- On several days there was no collection service for the secondary collection from collection points by the Municipality due to council strikes, breakdown of collection vehicles and fuel challenges.
- Some residents thought that the pilot project only benefited a minute population of Chitungwiza.

< PART 2 MASTER PLAN >

CHAPTER 8 IMPROVEMENT PLAN FOR WATER SUPPLY

8.1 Demand Projection

The results of population projection, daily average demand projection, and daily maximum demand projection (including NRW [Non Revenue Water]) are shown in Table 8.1.

Table 8.1 Results of Demand Projection

Name	Item	2012	2020	2030
Harare	Population(× 1000)	2,195	2,715	3,949
	Daily ave. demand(× 1000 m^3/d)	382.9	501.2	756.3
	Daily maximum consumption(× 1000 m^3/d)	960.0	858.7	1,135.9
Chitungwiza	Population(× 1000)	330	389.1	440.8
	Daily ave. demand(× 1000 m^3/d)	28.6	34.1	39.3
	Daily maximum consumption(× 1000 m^3/d)	43.8	46.1	52.4

(1) The condition of population projection

Target year of Mater Plan (M/P) is stipulated to year 2030, based on agreement between the Japanese and Zimbabwean Governments. In addition, middle target year of 2020 is stipulated as the target year of Feasibility Study (F/S). Population growth rates are referred to the rate of SAPROF Study, which is 5.5% of City of Harare and 6% of majority of surrounding towns between 2005 and 2020. Chitungwiza Municipality has planned for a new expansion area on the opposite side of Nyatsime River. There are many vacant spaces in municipality developed areas and these spaces will be filled in the population projection by 2020. For the projection of 2030, one ward in above new developing area will be 70% filled.

(2) The condition of daily average water demand projection

The conditions of demand projection of Harare Area from 2012 to 2020 and 2020 to 2030 are; the domestic unit demand (Lpcd) of Harare urban and rural, Epworth, Ruwa and Norton will increase by 10%, the industrial demand will increase by 50%, and the commercial and institutional demand will increase by 20%. Currently, there is a shortage in water distribution flow to Chitungwiza Municipality, and actual water supply cannot meet demand. In the assumption, the current actual unit demand for domestic use is assumed to be 80 Lpcd, and since the whole municipality can be categorized as very high-density area and there are many wells for the supplemental supply, the unit demand is assumed not to increase. The increased demand rates from 2012 to 2020 and from 2020 to 203 are assumed to be 20% for the commercial/institution, and 50% for industry, the same rates as with Harare Area.

(3) The condition of daily maximum water demand projection

The calculation of daily maximum flow for distribution network, daily factor f1 (=daily maximum/daily average) and NRW (Non Revenue Water) must be determined. The NRW rate in Harare Urban and Rural is assumed to be 57%* in 2012, 35%* in 2020 and 20% in 2030, while the NRW rate of bulk water supply is assumed to be 30% in 2012, 20% in 2020 and 15% in 2030. Daily factor of f1 is assumed to be 1.15. *: From Urgent Infrastructure Rehabilitation-India Eximbank

The staffs of the water supply section of Chitungwiza Municipality consider the leakage rate (NRW rate) being very low. The leakage ratio of 0.25 in municipality is estimated to be the difference between the water supply and sewage inflow of Zengeza STP (Sewage Treatment Plant). The daily factor of f1 is assumed to be 1.15 same as Harare Area.

8.2 Evaluation of the balance between Water Resource/Production and Demand

In Harare Area, the available dams for water supply are Chivero, Manyame, Seke and Harava Dams, and their yield capacity is not enough to meet the demand including NRW and then the Kunzwi and Musami projects are planned for the water resources of Great Harare Area. The balance between water demand (including NRW) and water source considering these planned dams is shown in Figure 8.1.

As shown in the figure, currently the water source is outstandingly short, and although after the development of Kunzwi and Musami Dam the source capacity is set to meet the demand, the production capacity cannot meet the demand soon due to rapid increase of demand.

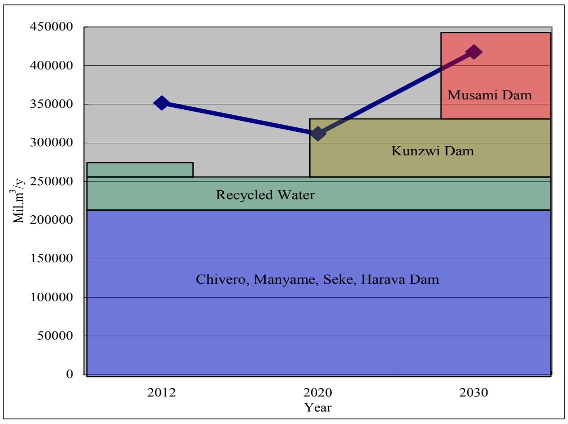


Figure 8.1 Comparisons between Water Demand and Source

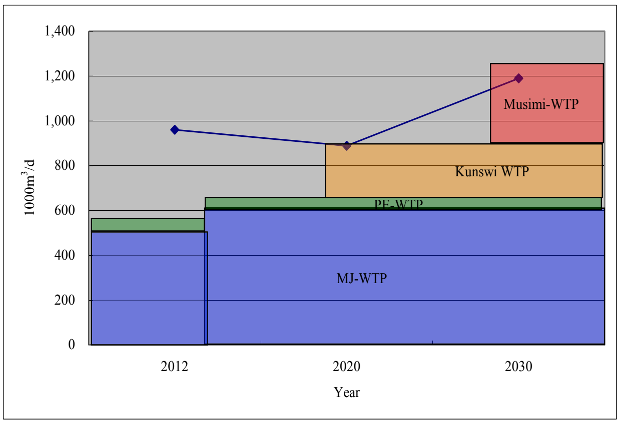


Figure 8.2 Comparisons between Water Demand and Production Capacity

The balance between water production capacity and demand is shown in Figure 8.2 and the tendency is almost similar to that of the water source. Because of insufficient water supply from Harare Water Works, groundwater resources were surveyed. However it was found that a total yield capacity of 5,000 m^3/d is the limit surrounding the municipality. From the results of a test well survey, two (2) hopeful wells with capacity of over 300 m^3/d can be installed, but since these wells cannot be installed nearby each other, the number of wells will be limited.

8.3 Improvement Plan for Harare Water Works

The refurbishment plan formulated by Harare Water Works is urgently required, and a pipe rehabilitation works named “non revenue water reduction project” which targets to reduce NRW from

57% to 35%, is tried to be realized with a budget of 75.3mil.USD. In addition, a comprehensive improvement plan including Kunzwi Dam and WTP, the transmission pipe, expansion of distribution system and rehabilitation of distribution pipes, which are formulated SAPROF Team are also tied to realized with the assumed costs of around USD 350 mil. However, two donors have been found for previous rehabilitation work, but no donor has been found for the current project. As mentioned previously, since Kunzwi Dam will meet the demand only until 2020, Musami Dam and WTP are required by 2030 with the cost of USD 422 mil.

8.4 Improvement Plan for Chitungwiza Municipality

8.4.1 Water Resource Acquisition

As mentioned previously, the groundwater resource surrounding the municipality is not enough for a major water source. However, a development plan for Muda Dam, which lies 30km south of the municipality, can be applied only for the municipality. However, the development plan is quite costly; from the total cost is USD 93 mil. by using the existing Prince Edward(PE) WTP, or USD 109 mil. with the construction of a new WTP, to USD 19 mil. of share of expenses for Kunzwi Dam development. Then the municipality will continuously rely on the bulk water from Harare Water Works.

Accordingly, the municipality must pay the charge of bulk water without delay (currently the total income of water supply section equals the total expense of the section including bulk water) to secure receiving of bulk water. However, since the future water supply to the municipality is predicted unstable due to shortage of water amount to the consumers and frequent breaking down of facilities, the municipality will secure supplemental water from wells.

8.4.2 Improvement of Water Supply System of Municipality

For efficient utilization of limited water source, all bulk water fed from Harare Water Works should be transmitted first to Seke reservoirs, and then distributed to the municipality by gravity from ground reservoirs and the elevated tank. For realization of above, items to be improved for municipality existing facilities are listed below;

1) Transmission pipe of diameter 600 mm should be reinforced from PE-WTP to reservoir
2) The distribution pipe network should be reinforced because of the low flow capacity
3) The lift PS in Seke reservoir site should be replaced because it has already deteriorated
4) The pipes in Seke reservoir site should be remodelled
5) Some old distribution pipes have been clogged and these should be replaced

For supplemental water supply, items stated below should be implemented

1) To develop groundwater resource of 3,000m^3/d, which was found nearby municipality, and to transmit to Seke Reservoirs
2) To utilize existing shallow wells (3,000) and borehole (52) more efficiently with installation of

hand pump (420) and electrical pump(10)

3) To install shallow wells (280) in the area where the number of shallow wells is small, and borehole (51) for some public grounds such as schools and offices.

8.4.3 Improvement Plan for 2030

Water distribution facilities for ward 1 will be required in 2030. In this plan, distribution pipes in the ward will be predicted to be constructed by developers of Wards, but a distribution main from the reservoir to the ward needs to be constructed from the project funds. For this area, water can be distributed from Seke ground reservoir by gravity. Additional water resource for Chitungwiza Municipality will be increased from bulk water of Harare Water Works utilizing developed water from Kunzwi and/or Musami Dam.

8.4.4 Operation and Maintenance

For electricity consumption, target facilities are lift pumps in Seke reservoir site and well pumps with transmission pumps for supplemental well pumps. For chemical consumption for disinfection is caused by supplemental well water in Seke reservoir site. However, these consumption and cost is very small compares with the cost of bulk water (the cost will be raised from 0.25 to 0.3 USD/m^3due to burden of water resource development). The staff of water supply section strongly desire proper meter readings, and then meter reading group should be included within water supply section.

After the completion of the project, staff number of water supply section (59) will be predicted to be increased to be 91 because of increased staff for meter reading.

CHAPTER 9 IMPROVEMENT PLAN FOR THE SEWAGE

9.1 Sewerage Rehabilitation in the Catchment Area

The Master Plan should adopt the rehabilitation of the sewerage system in the catchment area. The on-going Zim-Fund project will rehabilitate the Crowborough and Firle STPs in Harare while the AWF project will be applied for Chitungwiza. These are deemed to be appropriate from the result of pollution analysis. Augmentation of the facility will be needed for the Zengeza STP in 2020. Donors for the Norton Council must be looked for to rehabilitate the treatment plant. Countermeasure for the sand issue will be taken as well. The procurement of heavy equipment to haul away sand removed from the site is indispensable in the sand removal program.

9.2 Sewerage Planning in the Catchment

Sewerage planning was selected as the priority in the catchment. These activities were evaluated essential for water source conservation of the catchment.

Urgent rehabilitation programs in the catchment for Harare and Chitungwiza have been implemented by Zim Fund and AWF project. Since the evaluation of both projects was basically effective, urgent measures for the sewerage in both municipalities are sufficient except for the areas excluded from the project. However, in the above-mentioned project, the Municipality/Council of Ruwa, Epworth and Norton are not included from the Zim Fund or the AWF. The result of the pollution analysis shows that the employment of the advanced BNR system does not have much advantage compared to conventional system in terms of water quality conservation.

< Norton >

After 2000, the sewerage system malfunctioned, and vandals broke the pump station handling effluent water for irrigation purposes. Thus, raw sewage is being directly discharged to Lake Manyame, polluting the lake. Urgent measures must be taken to rehabilitate the facility in order to save the water source. A study on the sewerage plan will be required, and donors must be found to fund this project.

< Ruwa >

It is necessary to rehabilitate/upgrade the existing wastewater stabilization pond. Effluent should be transferred to the farms for irrigation to conserve water quality in Ruwa River. A study on the improvement of the sewerage facilities will be required, and donors must be found to fund this project.

< Epworth >

The municipality does not have sewerage system, but this will be needed in the near future in order to secure the groundwater source. A study on the sewerage plan / system will be required, and donors must be found to fund this project.

9.3 Planning of Chitungwiza Sewerage

(1) Zengeza Sewage Treatment Plant (ZSTP)

For the Zengeza STP, urgent rehabilitation and augmentation in the mid-term are necessary. Urgent rehabilitation has been conducted under AWF project (AfDB, Grant-Aide) for pipelines and pump stations. The Scope of Works is rehabilitation of the old trickling filters for the capacity of about 20,000 m^3/day including pump stations to send the effluent to the Imbwa Farm. It does not include the rehabilitation of existing BNR facility. Even sludge treatment plant will not be needed. Sludge (Humus from Trickling Filters) can be sent to the Imbwa Farm after the stabilization in the maturation ponds. For the urgent measure within five years, rehabilitation of the trickling filters will be adequate for the inflow of about 20,000 m^3/day. However, augmentation of the facility will be needed after five years due to population growth. The existing BNR facility can be used for the augmentation planning.

Alternatives for the Zengeza STP Rehabilitation as follows:

Plan 1 Stabilization Pond: New Construction of Stabilization Ponds

Plan 2 Trickling Filters + Oxidation Ditch:

Rehabilitation of existing TF by Zim Fund Project, Remodelling of the existing BNR

with reuse of existing sludge treatment facility

Plan 3 Trickling Filters + BNR:

Rehabilitation of existing TF by Zim Fund Project,

Full-Rehabilitation of existing BNR

For Plan 1, new construction of stabilization pond, a lot / area of 100 ha must be secured to execute the plan. This facility can be constructed in the existing waste disposal site without any cost for the land. Capital expenditure (CAPEX) for the Stabilization pond will be USD 128 million, although the operation expenditure (OPEX) will be lower, at USD 1,077 thousand per yr.

For Plan 2, CAPEX will be USD 20.1 mil with the OPEX of USD 2,045 thousand per yr.

For Plan 3, CAPEX will be USD 15.4 mil with the OPEX of USD 4,687 thousand per yr.

Plan 2 is recommended, from the standpoint of utilizing the existing BNR facility, having fairly good effluent water quality, economical, and having an aspect of easy operation and maintenance.

(2) New Pump Station and sewers for the development area

New Pump Station with pipelines: Capex: USD 2,592 thousand, and Opex USD 133 thousand per yr

(3)Tilcor Pump Station

Tilcor pump station is a pump station by which industrial wastewater in the industrial area was sent to ZSTP. The pump station and pipelines (2 pipe bridges) before the pump station has been broken down these ten years and all the sewage from the industrial area has been discharged to the Nyatsime River directly.

Rehabilitation of Tilcor Pump Station with pipelines: Capex: USD 384 thousand, Opex USD 77 thousand per yr.

CHAPTER 10 IMPROVEMENT PLAN ON SOLID WASTE MANAGEMENT

10.1 Approach to Formulation of the Improvement Plan

Based on the review of current issues / problems, the results of the pilot project on solid waste management and as well as the requirement of the laws, regulations and national strategies which were collected and identified in the field survey, improvement options are proposed. These options are then evaluated, selected, and prioritized for implementation. The planning framework, such as future waste generation amount, target collection, waste diversion level and the waste stream for the target years, are then set up to put each improvement plan into proper and tangible perspective.

10.2 Potential Improvement Measures on Solid Waste Management

The potential improvement measures are summarized in Table 10.1.

Table 10.1 Summary of Potential Improvement Measures

Solid Waste Management	Problem	Potential Measures for Improvement
Discharge	• Illegal dumping was identified throughout the city which may cause environmental or public health risks • Reduction of waste generation	• Implementation of cleanup activities • Enhancement of enforcement of laws and regulation • Source separation • Home composting
Collection and transport	• Illegal dumping due to the local conditions beyond the municipality's collection service • Insufficient capacity of collection and transport due to breakage and traffic accidents	• Implementation of cleanup activities • Development or procurement plan of equipment for collection and transport operation • Community based collection activity (Primary collection by CBOs)
Intermediate treatment	No concrete action plan for waste diversion / 3Rs or development of intermediate treatment facilities	Development of intermediate treatment facilities for waste diversion (e.g. Home composting, community composting, central composting, material recovery facility, incineration and bio-gasification, etc.)
Final disposal	Open dumping site without appropriate management may cause environmental and public health problems	• Safe closure of existing open dumping • Development of sanitary landfill

10.3 Evaluation and Selection of Technical Options and Proposed Improvement Plan on Solid Waste Management

Taking the time frame of the master plan up to 2030 into consideration, the cleanup of illegal dumping and the procurement of collection / transport equipment should be implemented as high priority. The safe closure of existing open dumpsite and the development of sanitary landfill which is currently recommended by EMA, should follow these components. The intermediate treatment of recyclable waste such as development of MRF (Material Recycle Facility) and central compost facility should be implemented at the phase where a level of SWM maturity has been achieved. Home composting and community composting should be implemented as early as possible in terms of waste reduction at generation source.

10.4 Setup of Planning Framework

10.4.1 Projection of Future Waste Generation Amount

The future waste generation amount at each target year is shown in Table 10.2.

Table 10.2 Future Waste Generation Amount Unit: ton/day

	Year				
	2012	2015	2020	2025	2030
Total Generation Amount	176.3	193.3	225.2	271.6	346.1

10.4.2 Setup of Target Collection and Waste Diversion Level

The target waste collection, waste diversion level and their improvement plan are proposed in Table 10.3.

Table 10.3 Planned Target Waste Collection, Diversion Level and Improvement Plan

Target Improvement Level and Improvement Plan		Target Years			
		2012 (Current)	2020	2025	2030
Improvement of Waste Collection	Target Waste Collection Level (%)	38	100	100	100
	Proposed Improvement Plan	-	• Procurement of Collection Equipment • Procurement of Skip Bins • Implementation of Primary and Secondary Collection	• Procurement of Skip Bins • Implementation of Primary and Secondary Collection	• Procurement of Skip Bins • Implementation of Primary and Secondary Collection
Improvement of Waste Diversion	Target Waste Diversion Level (%)	-	10	15	28
	Proposed Improvement Plan	-	• MRF (2) • Home Composting (3) • Community Composting (5)	• MRF (3) • Home Composting (5) • Community Composting (7)	• MRF (3) • Home Composting (7) • Community Composting (8) • Central Compost Facility (10)

Notes: The figures including those in parenthesis show the target ratio to total generation amount.

10.5 Materials / Equipment Development Plan

Table 10.4 shows the proposed collection system.

Table 10.4 Proposed Collection System by Generation Source

Generation Source		Type of Equipment for Collection	Frequency of Collection
Residential Area	Areas of accessible of municipality's collection service	• Tipper truck (for 50% of target collection volume) • Compactor truck (for 50% of target collection volume)	Twice a week
	Areas of not accessible of municipality's collection service	Primary collection by CBOs (manual carts) + Secondary collection by municipality (multi loader) + Skip Bin	Twice a week
Establishments		Multi loader + Skip Bin	Daily

Notes: CBOs: Community Based Organizations

The estimated quantity of the collection equipment is shown in Table 10.5.

Table 10.5 Estimated Quantity of Collection Equipment

Type of Equipment	Year of Procurement		
	2020	2025	2030
Tipper Truck (10 m^3)	11	-	-
Compactor Truck (8 m^3)	9	-	-
Multi Loader	23	-	-
Container (5 m^3)	432	432	432

10.6 Facility Development Plan

10.6.1 Intermediate Treatment Facility

(1) Home Composting

Home composting will be implemented through promotion activities by facilitators by providing containers and composting seeds. The home composting will commence on launching a pilot activity targeting at 100 households for expanding it.

(2) Community Composting

Community composting will be implemented by developing a small-scale facility with a capacity of 250 kg/day, and equipped with shredder, scale and water jet machine. Its operation will be implemented by CBOs (Community based Organizations) through the construction of 10 pilot facilities in 10 communities.

(3) Central Composting Facility

The major component of the facility is shown in Table 10.6.

Table 10.6 Facility Outline of Central Compost Facility

Item No.	Description	Unit	Quantity
1.	Capacity: 35.0 ton /day	-	-
2.	Location: Existing Open Dump Site	-	-
3.	Land area	m^2	8,200
4.	Process: Windrow method	-	-
5.	Building Area • Compost Building • Administration Building • Receiving Area • Primary Sorting Area • Others	m^2	Approx. 6,300
6.	Equipment for operation • Truck scale • Belt conveyor • Drum Cutter, Screen and Segregation, etc. • Wheel Loader • Open Dump Truck (2 ton , 4 ton)	LS	1

(4) MRF (Material Recovery Facility)

The outline of the MRF is shown in Table 10.7.

Table 10.7 Outline of MRF

Item No.	Description	Unit	Quantity
1.	Capacity: 11.0 ton /day	-	-
2.	Location: Existing Open Dump Site	-	-
3.	Land area	m^2	1,500
4.	Building Area • Operation building (sorting, washing) • Administration Building	m^2	Approx. 420

Item No.	Description	Unit	Quantity
	Other areas: • Temporary storage area for incoming recyclable materials • Truck scale • Storage areas (sorted materials) • Parking areas	m^2	
5.	Equipment for operation • Truck scale • Belt conveyor • Shredder • Wheel Loader • Open Dump Truck (2 ton)	LS	1

10.6.2 Final Disposal Facility

(1) Cleanup of Illegal Dumping Sites

Illegal dumping identified throughout the city should be cleaned up immediately to preserve the urban sanitation landscape. The clean-up of about 840,000 m^3 of the illegally dumped waste (estimated by the subcontracted survey) will be carried out by using the heavy machines of a front-end loader and a dump truck.

(2) Safe Closure of Existing Open Dump Site

The proposed safe closure of the existing open dumping site is composed of a removal / refilling of existing dumped waste in the designated area of the existing land, carrying out of soil covering, and installation of gas vent pipes and drain ditch.

The outline of the safety closure of the existing open dumpsite is shown in Table 10.8.

Table 10.8 Outline of Safety Closure of Existing Open Dumpsite

Item	Description
Land area for safety closure	About 6.0 ha
Removal of existing dumped waste	About 565,000 m^3
Landfilling of waste	About 825,000 m^3
Soil covering	50 cm of soil cover
Rain water drain system	Drain ditch (About 1,300 m)
Fence (H = 2.5 m)	About 1,300 m
Gas vent pipe	40 units

(3) Development Plan of New Sanitary Landfill

1) Evaluation of Candidate Sites of New Landfill

Two candidate sites, one candidate site proposed by the urban planning services of the municipality and another site of the existing open dumping site, were evaluated for the suitability for development of a sanitary landfill. The candidate site proposed by the urban planning services is adjacent to the future lands for schools, housing lots and also to the existing river course, accordingly, the candidate site by the urban planning services is not suitable. Therefore, the existing dumping site should be utilized as a new landfill site

2) Facility Plan of Proposed Sanitary Landfill

The outline of the new landfill is shown in Table 10.9.

Table 10.9 Outline of New Sanitary Landfill

Item	Component
1. Structure	• Excavation of existing open dump site and a construction of an enclosure dike • Estimated land landfill area: 220m × 400m
2. Planned Landfilled Volume	• 1.6 million m^3
3. Landfilling method	• Semi-aerobic landfilling
4. Leachate collection facilities	• Impermeable liner sheet • Leachate collection pipes (main, branch) • Leachate reservoir pit
5. Leachate treatment	Recirculating method using pump
6. Rain water drain system	Rainwater drain ditch
7. Connection Road	Access road / onsite road
8. Groundwater monitoring	Groundwater monitoring wells
9. Weighing system of incoming waste	Truck scale
10. Landfill gas	Landfill gas vent pipes

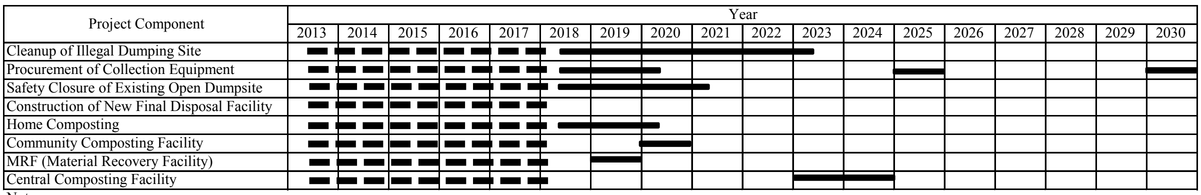
10.7 Cost Estimate

The total estimated cost for proposed solid waste management system is USD 76,478 K. The total operation and maintenance cost, on one hand, is estimated USD 4,674 K at the target year of 2030.

10.8 Implementation Schedule

The implementation schedule is shown in Figure 10.1.

Figure 10. 1 Implementation Schedule of the master Plan on Solid Waste Management



Notes:

1) Preparation (Feasibility Study, Action Programs, Detail Design, Tender Process, etc.)

2) Implementation (Construction, Procurement, etc.)

CHAPTER 11 COST ESTIMATE AND FINANCIAL STUDY

11.1 General

The following conditions are assumed to prepare the cost estimation for this project

Exchange Rate USD 1 = 77.98 yen

Taxes

1) VAT : 15% of the expenditure

2) Import Tax Average 10% of the expenditure for civil -elated works according to Zimbabwe Revenue Authority

Others

1) Consulting Services 7 % of the direct cost

2) Physical Contingency 5 % of the direct cost and consulting services

3) Price Contingency 5% of the direct cost and consulting services

11.2 Estimated Costs for Proposed/ Recommended Improvements

11.2.1 Construction Cost

(1) Water Supply Facilities

In Chapter 9, Plan 1 was selected as the recommended option for the water supply improvements for this project. The following table is a summary of the estimated construction cost for Plan 1 Water Supply Facility improvements for the existing water supply system in Chitungwiza.

Table 11.1 Estimated Construction Cost for Water Supply Facilities (Target year of 2020)

Sub-No	Facility	Brief Work Description	Total Cost (K USD)
1.1.1	Distribution Pipes	To increase the current water supply distributed by the existing water distribution system, install and supply the following new facilities to the existing: • New DI pipes with a diameter of 350 to 700 mm • New uPVC pipes with a diameter of 160 to 355 mm • New gate valves with a size of 100 to 700 mm	12,551
1.1.2.	Seke Reservoir Site	To utilize the capacity of the existing Seke Reservoir ground reservoir more efficiently for the water demand, install and supply: • Reinforced transmission pipe with diameter of 600 mm • Refurbishing of P/S • Construction of disinfection and neutralization facilities • Refurbishing of pipes works in the site with flow meter	13,494
1.1.3	Well Group	To take well water from surrounding areas • Three group of boreholes and transmission facilities • Transmission pipes	3,726
		Grand Total	29,771

Table 11.2 Estimated Construction Cost for Water Supply Facilities (Target year of 2030)

Sub-No	Facility	Brief Work Description	Total Cost (K USD)
1.2.1	Distribution Pipes for Future Development	To increase the current water supply distributed by the existing water distribution system, install and supply the following new facilities to the existing: • New DI pipes with a diameter of 400 mm • New gate valves with a size of 400 mm • Mechanical works	13,116

Table 11.3 Estimated Construction Cost for Supplemental Water Supply Facilities (Urgent)

Sub-No	Facility	Brief Work Description	Total Cost (K USD)
1.3.1	Supplemental Water Supply	To take supplemental water and rehabilitate distribution network • To install shallow wells with hand pumps and borehole • To rehabilitate clogged pipes	2,747

(2)Sanitation/Sewerage Facilities

Prior to the target year of 2020, the existing trickling filters in the old Zengeza STP will be rehabilitated by AfDB and planned construction will commence in early 2013 and be completed by the end of 2014. This plan has been approved based on the obtained information. In this M/P, the construction cost of each of the five alternative options for the sewage facilities is compared for review. Therefore, each option has a different implementation plan. In addition, the construction of a new sewage pump station and installation of sewer pipes are proposed to facilitate the anticipated sewage from the future development area as one improvement for the target year of 2030.

Table 11.4 Cost Estimations for Recommended Improvement Plans

<table>
<tr><th colspan="2" rowspan="2">Facility</th><th rowspan="2">Brief Work Description</th><th rowspan="2">Estimated Capacity m^3/day</th><th colspan="3">Implementation Plan</th><th rowspan="2">Total Cost (K USD)</th></tr>
<tr><th>Facility</th><th>Comen.</th><th>Comp</th></tr>
<tr><td rowspan="5">ZENGEZA STP (2020)</td><td>OPTION 1 New Stabilization Pond</td><td>Construction of new ponds</td><td>36,000</td><td>NSP</td><td>2018</td><td>2019</td><td>128,619</td></tr>
<tr><td rowspan="2">OPTION 2
Ex TF + Oxidation Ditch</td><td rowspan="2">Modification to the existing BNR with the replacement of the existing Anaerobic Anoxic Basins with oxidation ditch, and usage of the existing TF</td><td rowspan="2">20,000 + 21.750 (Ex. TF) = 41,750</td><td>Ex TF</td><td>2013</td><td>2014</td><td rowspan="2">20,121</td></tr>
<tr><td>BNR</td><td>2020</td><td>2022</td></tr>
<tr><td rowspan="2">OPTION 3
Ex TF+ BNR</td><td rowspan="2">Rehabilitation to the existing BNR and usage of the existing TF</td><td rowspan="2">20,000 + 21.750 (Ex. TF) = 41,750</td><td>Ex TF</td><td>2013</td><td>2014</td><td rowspan="2">15,377</td></tr>
<tr><td>BNR</td><td>2020</td><td>2022</td></tr>
</table>

Facility	Brief Work Description	Total Cost (K USD)
Pump Station (2030)	Installation of $3.3m^3$/min ×30kW ×3 pumps in the building	2,592
Tilcor Industrial Area (Urgent)	Installation of 27 kW × 3 pumps in the building Steel Pipe dia 200 mm with RC Pipe support×2, L=100 m ACP dia 300 mm ×2, L=100 m	384

(3)Solid Waste Management Facilities

The following table is a summary of the estimated construction cost for the recommended solid waste management improvements in Chitungwiza.

Table 11.5 Cost Estimations for Solid Waste Management System

Sub-No.	Facility	Brief Work Description	Total Cost (K USD)
3.1.1	Cleanup of Illegal Dumping Site	Cleanup of the existing illegal dump sites by equipment	5,602
3.1.2	Procurement of Collection Equipment	Purchasing new heavy duty equipment and bins: 16 tripper trucks, 12 compactor trucks, 32 multi-loaders, and 1,515 skip bins	20,878
3.1.3.	Safety Closure of Existing Open Sump Site	Modification to the existing disposal sites with construction of gas exhausts, operation roads, drainage ditches, and fences	20,261
3.1.4.	Construction of New Final Disposal Facility	Construction of the new final disposal facility including administration and warehouse buildings, disposal sites with leachate collection facilities, reservoir pit, leachate treatment ponds, drainage, ground monitoring wells, and fences and purchasing new equipment	18,588
3.1.5.	Home Compost	Pilot Project: demonstrating and educating local people about home composting by instructors and providing plastic containers.	88
3.1.6.	Community Compost Plant	Pilot Project: construction of a new community compost plant including compost proceeding building, guard house, and providing equipment.	199
3.1.7.	MRF (Material Recovery Facility)	Construction of a new material recovery facility including MRF and administration buildings, and providing equipment	1,485
3.1.8.	Central Composting Facility	Construction of a new central compost centre including compost and administration buildings, receiving, sorting, treatment, process and storage areas and providing equipment.	9,377
		Ground Total	76,478

(4) Total

The summary table of the estimate construction costs for the urgent provision and proposed improvements for the target year of 2020 and 2030 is provided below.

Table 11.6 Construction Costs for Urgent Provision

Item	Cost (K USD)
Water Supply	2,747
Sewage	384
Total	3,131

Table 11.7 Construction Costs for a Target Year of 2020 and 2030 (K USD)

Improvements	Option1			Option2			Option3		
Target Year	2020	2030	Total	2020	2030	Total	2020	2030	Total
Water Supply	29,771	13,116	42,887	29,771	13,116	42,887	29,771	13,116	42,887
Sewage	128,619	2,582	131,211	20,121	2,592	22,713	15,377	2,592	17,969
Solid Waste	55,006	21,472	76,478	55,006	21,472	76,478	55,006	21,472	76,478
Total	**213,396**	**37,180**	**250,576**	**104,898**	**37,180**	**142,078**	**100,154**	**37,180**	**137,334**

11.2.2 Operation and Maintenance Cost

(1)Water Supply Facilities

Annual operation and maintenance cost for water supply facilities is estimated USD 6,983 thousand per year for 2020 and USD 7,803 thousand per year for 2030.

(2)Sanitation/ Sewerage Facilities

The O&M cost for each alternative option of the sanitation/ sewer facilities as below:

Zengeza STP Option1: USD 1,077 thousand per year, Option 2: USD 2,405 thousand per year, Option 3: USD 4,687 thousand per year

Pump station and sewer network: USD 133 thousand per year

Tilcor industrial area: USD 77 thousand per year

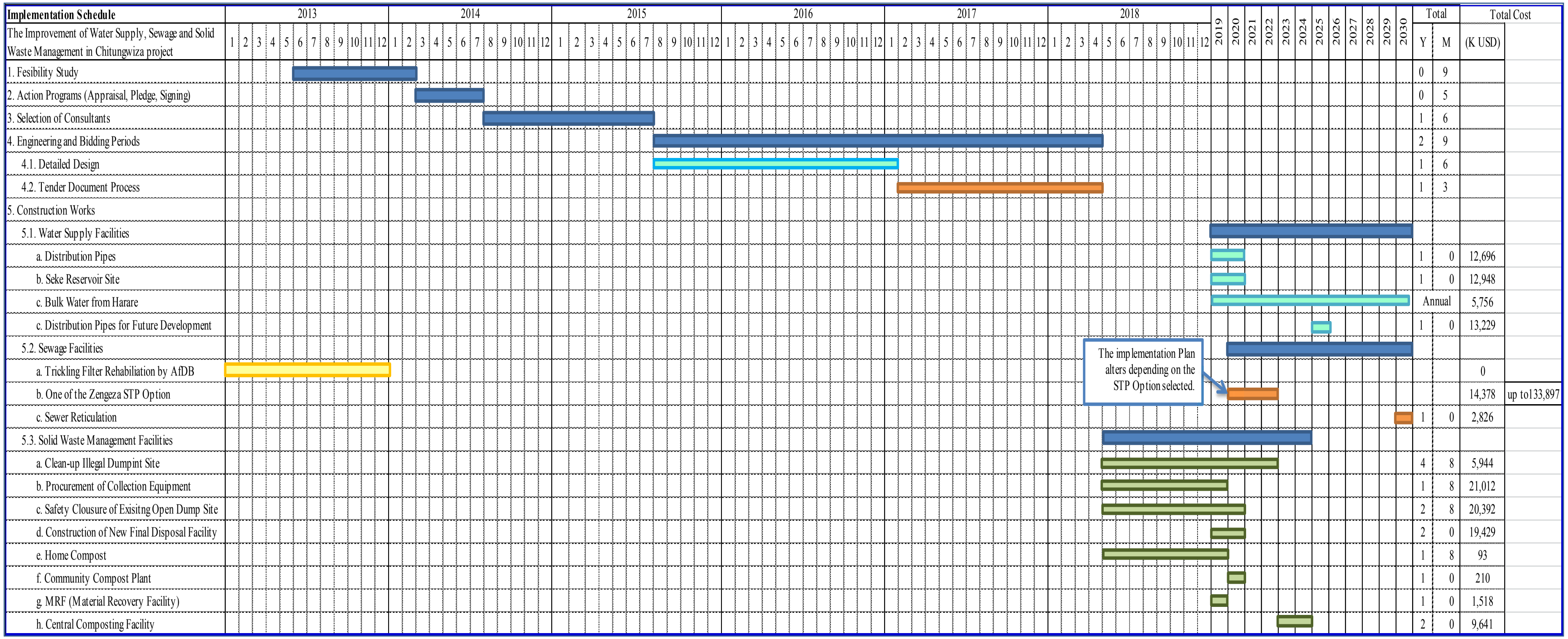
(3)Solid Waste Management

Annual operation and maintenance cost for solid waste management is estimated USD 3,910 thousand per year for 2030.

11.3Implementation Plan

The Implementation plan for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza project is prepared in this M/P for discussion purpose. More detailed implementation plan will be discussed in the future Feasibility Study.

Figure 11.1 Implementation Schedule



CHAPTER 12 FINANCIAL AND ECONOMIC ANALYSIS

Financial analyses of the M/P projects were conducted using the cost data estimated by JICA Project Team. The revenue data used for the analyses were constructed mostly based on the current tariff and billing situations. The population forecast prepared by JICA Project Team was also used. The financial net present value (FNPV) and the financial internal rate of return (FIRR) were computed and the results were analyzed in comparison with the weighted average cost of capital of 2.8%.

Main economic benefits taken up in the economic analysis were disability adjusted life years (DALYs) and willingness to pay (WTP). Economic costs identified in the economic analysis were computed through conversion from the financial costs. The economic net present value (ENPV) and the economic internal rate of return (EIRR) were computed and the results were analyzed in comparison with the economic opportunity cost of capital of 12%.

Resultant IRRs and NPVs of each M/P project are summarized in Table 12.1. None of the M/P projects is financially viable. The financial viabilities of the M/P projects could be obtained by external assistance such as grant from foreign development partners or subsidy of the GOZ.

Table 12.1 IRRs and NPVs of M/P Projects

	FIRR	FNPV (USD million)	EIRR	ENPV (USD million)
Water supply	-5.2%	-33.5	28.9%	31.7
Sewerage (Option 2)	-17.1%	-41.4	23.8%	15.5
Solid waste management	-13.3%	-92.2	4.8%	-15.4
Hurdle rate	2.8%		12.0%	

However, from the viewpoints of economical viability, the M/P projects are worth implementing. The water supply project and the sewerage project show an EIRR higher than the hurdle rate of 12%. The solid waste management project has a lower but still positive EIRR. The low EIRR of the solid waste management project can be reinforced by combining it with water supply and sewerage projects. The combined water supply, sewerage and solid waste management project shows 18.5% EIRR and USD 31.7 million ENPV, which satisfy the economic viability requirement.

CHAPTER 13 CONCLUSION AND RECOMMENDATION

13.1 Background

- Zengeza STP was constructed by Japanese ODA project and transferred in 2000. Operation of the facility was suspended in 2004 due to O&M problem and its budget.

- Data Collection Study on Improvement of Sanitary Environment of Chitungwiza City was conducted during January and February in 2011. As a result of the investigation, it was recognized that a comprehensive approach is needed for water supply and solid waste management as well as sewage for the improvement of sanitary condition in Chitungwiza.
- The government of Japan appointed JICA to start the study on technical corporation for development for two years from April 2012: Phase I Basic Study, Phase II Establishment of Master Plan, Phase III Feasibility Study. (Conducted by NJS Consultants Co. Ltd.)
- City of Harare has been developing the "Greater Harare Water and Sanitation Strategic Plan" with the assist by WB to improve water supply and sanitation services for City of Harare and 4 municipalities (Chitungwiza, Ruwa, Epworth and Norton) by September 2013.
- Since investors meeting will be held in the project above, it is expected that various investors will be involved for the project for concerned municipalities.

13.2 Analysis of current condition for Water Supply

- The actual production capacity of Harare Water Works in 2012 is around 640,000m^3/day, while the water demand was estimated to be 383,000m^3/day. The production capacity is considered not to enough because the necessary capacity is estimated 890,000m^3/day due to 57% of the NRW (Non-Revenue Water) of Harare distribution area.
- Chitungwiza Municipality (354,000 of population by 2012 census) almost completely depends on the bulk water distributed by Harare Water Works. The normal distributed flow is 30,000m^3/day, but it is frequently reduced to 12,000-15,000m^3/day.
- There are reservoirs with 41,000m^3 of volume in Chitungwiza, however these are not used for water supply regulation. Water distribution to Chitungwiza is pumped up constantly from Prince Edward WTP even though the water demand is fluctuated.
- Chitungwiza Municipality only paid 10% to the balk water bill to Harare Water Works; 1.2mil.USD out of total balk water bill of 12.7mil.USD for past three (3) years were paid on February 2013
- Water supply of balk water to Chitungwiza Municipality is restricted due to unpaid bill, and shortage of water amount and frequent breakdown of facilities of Harare Water Works. Thus total over 3,000 of wells are used for supplemental water supply in the municipality

13.3 Current Status of Sewerage

- Raw sewage has been discharged to Manyame catchment area from City of Harare and the Municipalities.
- There are two sewage treatment facilities in Chitungwiza : Old facility of trickling filters constructed in 1978 with the capacity of 20,000m^3/d and latest facility of BNR with the capacity of 20,000m^3/d constructed by Japanese ODA.
- A part of St.Mary area, Seke North area and Seke South area in Chitungwiza were not covered due to break down of pump stations, clogging of sewers. One of the cause of the break down is the deposit of sand in the sewers. Residents have been using the sand for the pot washing. The sand in the sewer was cleaned by Jet Cleaning Machine before. After the breakdown of the cleaning machine it was made by manually after 2001.
- In the AWF project under AfDB, sewers and pump stations were rehabilitated, which will enable the whole sewage reach to the STP. Existing old Trickling filters in Zengeza STP will be rehabilitated by Zim Fund as well.

13.4 Analysis of current condition for Solid Waste Management

- Method is House–to-house collection of waste bags and collection of skip bin. Collected wastes are transported to the dumping site about 5km away from the municipality by truck once a week.
- Currently, the system cannot cover whole the area due to bad road condition.
- Wastes have been disposed in the open dumping site without any control.
- 390 Illegal dumping sites were found in the study with the total wastes amount of 60,000m^3.

13.5 Current Status of Water Cycle and Aquatic Environment

- Daily inflow to Lake Chivero is approx. 1,000,000m^3/d. Approx. 640,000m^3/d is taken as raw water for the water supply.
- Population of City of Harare is around 1,600,000 with two major STP of Crowborough （54,000m^3/d）and Firle（144,000m^3/d）. About 60 % of the sewage was treated by BNR process while rest of sewage was treated by trickling filter process. However, BNR process is not working because of breakdown.
- Total sewage generated in the Manyame catchment area is about 230,000 m^3/d, with the 90 % share of Harare (approx. 200,000m^3/d) and 10% share of Chitungwiza (22,000 m^3/d).
- BOD loading for the catchment from Harare is 110,000kg-BOD/d, and that of Chitungwiza is 13,000kg-BOD/d （12% of Harare)

13.6 Current Status of Flow and Water Quality and Future Projection

- Worsening of every parameter of water quality was confirmed in the analysis.
- Since the catchment area has characteristics with low specific run-off and large variation of annual rainfall, it will not be easy to secure ample surface water. Then construction of sewerage and its appropriate operation & maintenance is essential to the environmental management on the premises of water cycle in the closed system.
- AWF project and ZIM Fund project in the catchment area were evaluated effective to the environmental improvement in the pollution analysis. Appropriate operation & maintenance and augmentation for the increase of wastewater flow.
- For the improvement of the water environment of the catchment, priority is the treatment of the sewage from City of Harare regardless of process employed.

13.7 Alternatives for Water Supply

- By increasing the capacity of distribution, coping with the demand can be executed. Even if the total distribution flow to the municipality is not enough, distribution will be made equally to all consumers. The plan will be affected by Harare Water Works. The municipality must pay the water bill constantly.
- By construction of well group, even though the intake capacity of 3,000m^3/day is small, it will enable to supplement the water supply when the reduction of water supply takes place.
- When alternatives above are implemented, all municipality will have equal water supply even though the water supply from Harare Water Works is unstable due to the water shortage . Then shallow wells for the areas where allocation of wells was few will be installed and some clogged old pipes will be replaced by the items of 1.3.1.

13.8 Alternatives for Sewerage

- Refurbishing the existing BNR facility to Oxidation Ditch system with lower O&M cost and easier maintenance is most appropriate plan in terms of engineering and economic aspects. However, it is not urgent issue since rehabilitation project of old system (Existing trickling filters) is under way by Zim Fund (As of July, 2013).
- After the rehabilitation of Zengeza STP, expenditure for the operation & maintenance will be minimum since the process is trickling filters which require less power than other processes.
- Chitungwiza municipality must take care of the facilities for the sanitation of the residents in the municipality. Revision of tariff for the sewage or securing another income will be needed for the operation & maintenance. One of the promising income sources is selling the treated water for the irrigation. Appropriate unit rate will be important.

- For the augmentation of the facility in the mid-term, redesign of the existing BNR to Oxidation Ditch system will be the best plan in terms of cost and operation & maintenance.

13.9 Alternatives for Solid Waste Management

- Closing of the existing disposal site, new construction of the sanitary land fill and procurement of collection equipment were planned.

13.10 Financial Analysis

- FIRR and EIRR were examined for the analysis on Project Cost, O&M Cost for project life of 40 yrs
- Negative FIRRs were shown although the EIRRs were positive.
- Selling of treated water to irrigation has some possibility to improve the FIRR of sewage part.

13.11 Feasibility Study in Phase III

- Through the study of Phase I (Basic Study) and Phase II (Master Plan), JICA Project Team found that the main issue in Chitungwiza was not present in the sewage part but rather in the water supply. The improvement work of the sewerage in Chitungwiza (Urgent rehabilitation) was already on-going and from the result of the pollution analysis, the improvement work is deemed to benefit the improvement of the environment. Further, it was clarified that the main pollutants for the water source have been coming from City of Harare rather than Chitungwiza Municipality

- During the course of the project, JICA Project Team also encountered another problem of Chitungwiza Municipality as well as Zimbabwe Government, namely financial problem. The financial issue has been affecting every part of the domestic life and public administration.

- In order to guarantee the sustainability of the facilities to be developed in the future, it was decided through the discussion of both sides of Zimbabwe and Japan to put a certain period before the F/S to observe and confirm the financial status of Chitungwiza Municipality. Implementation of F/S will be considered when the restructuring of the municipality shows a certain progress.

PART I BASIC STUDY

CHAPTER 1 INTRODUCTION

1.1 The Background of the Study

In the late 1990s, rapid population growth in the Harare area contributed to a surge in residential and industrial developments. This brought about an increase in wastewater flow generated from the area, which was more than the treatment capacity of the existing wastewater treatment plant. As a result, runoff from the excess wastewater began to pollute the environment and water resources, such as Lake Chivero and Lake Manyame, with water quality worsening as the population grew and the area further developed.

To improve the situation, the government of Japan implemented a grant project for Chitungwiza Municipality and constructed a wastewater treatment plant in "The Project for Improvement of Sewerage Facilities in the Municipality of Chitungwiza", which was then handed over to the government of Zimbabwe in 2000. However, the economic conditions of Zimbabwe did not get any better in 2000, and the budget for proper infrastructure maintenance and improvements in water supply, sewerage and solid waste management was insufficient, thus making the environmental status worse in spite of the implementation of the project.

As a result of the above-mentioned conditions, the sewerage system has not been functioning properly resulting to a deterioration of the water quality of the water source and the attendant increase in the cost of operation and maintenance of the system. This situation caused the society negative impacts such as the cholera outbreak in the area in 2008.

The political situation in Zimbabwe has improved since 2008 eight years after some European countries and United States of America had imposed economic sanctions due to political reasons. The political stability in Zimbabwe prompted the government of Japan to resume bilateral and humanitarian aid activities. One of these is "The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe" (hereinafter referred to as the Project).

With the economic and political stability in Zimbabwe, JICA conducted in January and February 2011 an investigation and data collection and analysis of the environment conditions in Chitungwiza Municipality in the "Data Collection Study on Improvement of Sanitary Environment of Chitungwiza Municipality". The report identified the dysfunctional situation not only for the solid waste management and sewerage, but also for the water supply system in Chitungwiza Municipality, upon which, the government of Zimbabwe recognized that improvements were needed to upgrade the living conditions and the environment for the people of Chitungwiza. Consequently, the government of Zimbabwe decided to develop “The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe”, which addresses the essential improvements to the municipality’s water supply, sewerage and solid waste management, and requested the government of Japan for a technical cooperation to develop the plan.

The government of Japan appointed JICA to start study on the specific plan for the project in June 2011, according to the agreement between the two governments. The Scope of Work of the technical cooperation (S/W) was discussed between JICA, Chitungwiza Municipality and the relevant authorities in Zimbabwe and was finalized on the 25th August 2011.

1.2 Objective of the Study

The objective of the study is to prepare the Master Plan (hereinafter referred to as M/P) and the Feasibility Studies (hereinafter referred to as F/S) for water supply, sewerage and solid waste management in Chitungwiza City. In the F/S, the high priority projects will be selected and studied from the projects in the M/P. The study is expected to be utilized in the future implementation of the projects identified in the M/P that will be aided and/or funded by the government of Japan, and by other countries as well. At the same time, the study will benefit the local counterparts (hereinafter referred to as C/P) in Zimbabwe by building their capacity for future development planning.

A major objective of this project is to establish a sustainable plan of water quality conservation of safe water supply in the catchment area. Countermeasures against the water pollution in the rivers and lakes are subordinate objectives. Therefore, problems and issues for achieving sub-objectives will be clarified to set methodologies and approaches for solutions as a prerequisite to the water quality conservation plan of MP. Figure 1.2.1 shows the whole catchment area of Lake Manyame, Lake Chivero, major rivers, lakes and sewage treatment plants.

Figure 1.2.2 shows the schematic diagram of the water cycle in the catchment area, indicating the water source for the catchment area which comes from the catchment area itself and wastewater from both cities returns to the water source by surface run-off or discharge from STPs in the catchment. Most of the STPs in the catchment area have not been working, and then the influence of the wastewater to the water source is considered to be critical. Since current status of the water pollution and its specific causes are not clear, a water quality conservation plan will be formulated after basic investigation and study work. Countermeasures will be proposed in the plan and the specific facility plan will be examined in terms of the cost-benefit aspects.

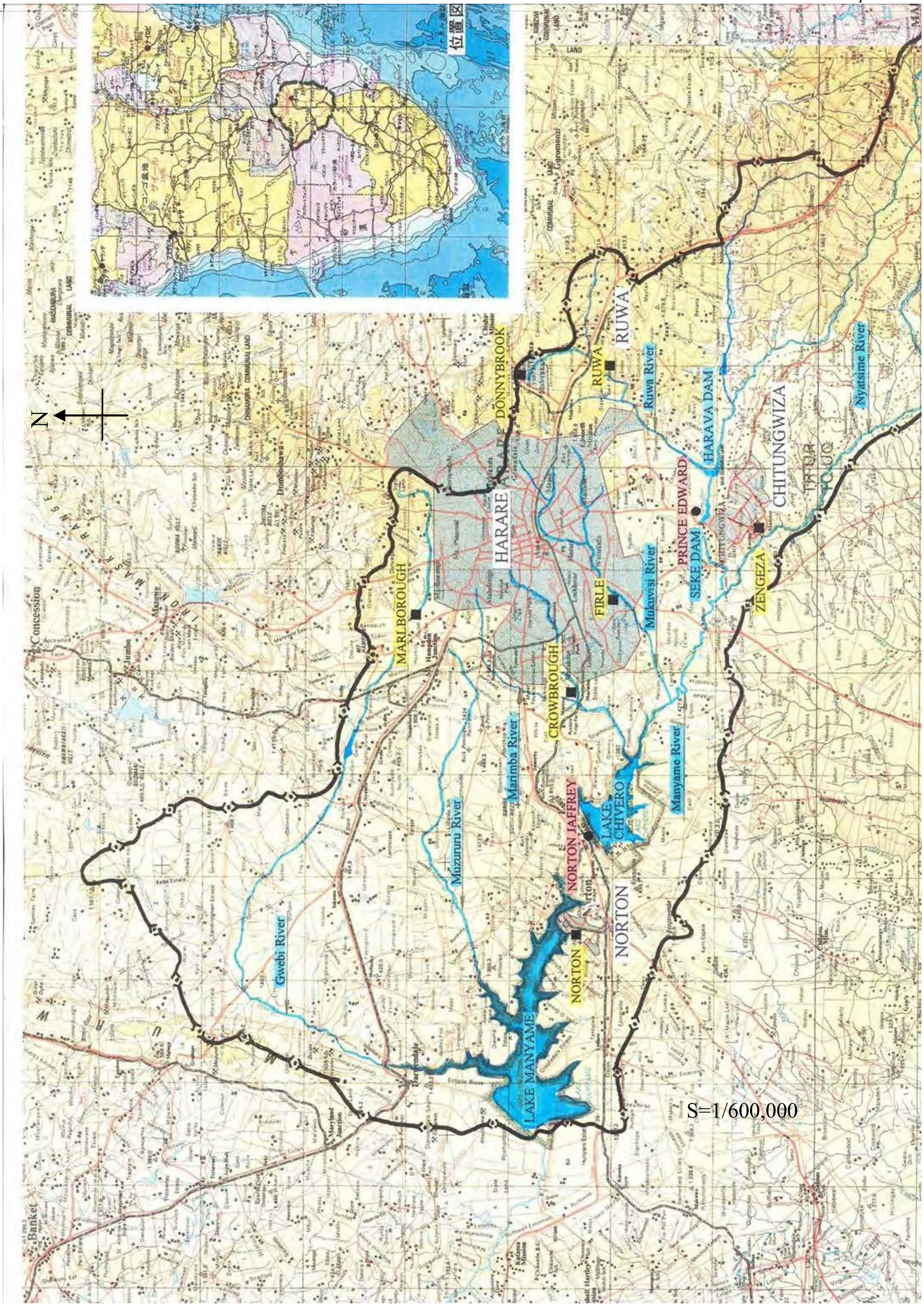


Figure 1.2.1 The Lake Manyame Catchment Area

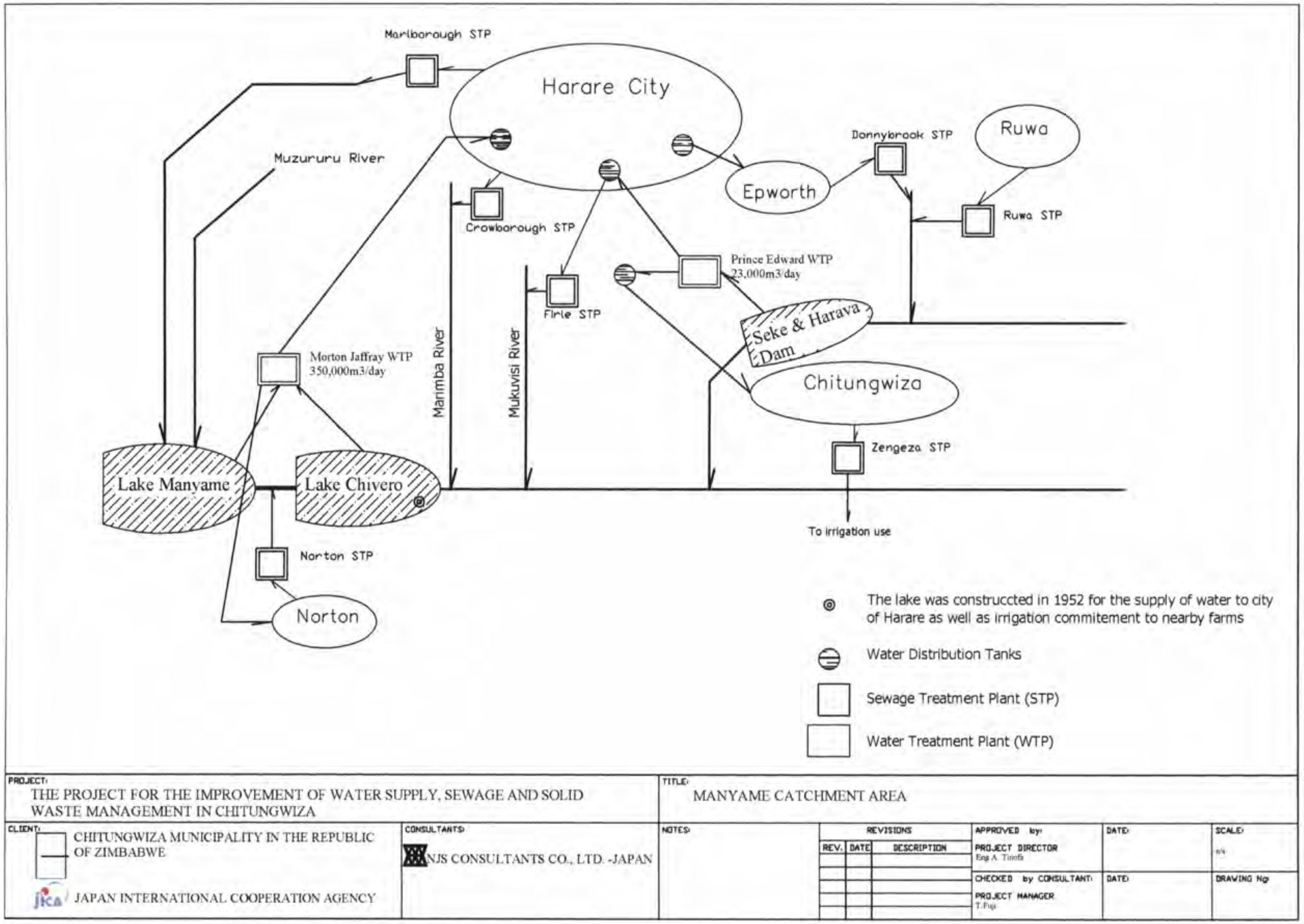


Figure 1.2.2 The Schematic Diagram of the Water Cycle in the Catchment Area

1.3 Study Area and Range of the Study

The Scope of Works identifies the stipulated study area as whole city area of Chitungwiza city. However, in terms of the necessity of obtaining the detailed information of non-point pollution sources, Lake Chivero, Lake Manyame and its catchment area (including area of City of Harare), although out of the study area in the SW, are included in the area. For this reason, study area for Phase 1: Collection of Fundamental information and Phase 2: Master Plan was set to include the whole catchment area of upper Manyame.

The main study area is Chitungwiza municipality with the entire upper Manyame catchment area and the city of Harare, the largest town in the catchment. The Manyame catchment has a surface area of about 3,600 km^2 (Department of Water Development records), consisting of approximately 10% urban and 90% rural developments. The latter consists of communal and commercial farming lands in nearly equal proportions (Magadza, 1997).

The Lake Chivero, created by a dam constructed in 1952, is located about 35 km southwest and downstream of Harare. It has a full capacity surface area of 26.3 km^2, a volume of 257,181,000 m^3, and a mean depth of 9.8 m, with the deepest point measuring about 27 m. Its full supply level is 1,363 m above mean sea level. It receives water from the Manyame, Mukuvisi and Marimba Rivers. The Ruwa and Nyatsime Rivers feed into the Manyame and these drain into the towns of Ruwa and Chitungwiza, respectively. The Marimba and Mukuvisi Rivers drain into most parts of Harare. Five wastewater treatment works and two water treatment works are operating in the catchment (Fig 1.2.2).

The Lake Manyame is the largest lake in the Manyame catchment area located downstream of the lake Chivero. It is one of the water sources of HARARE WATER. Information on water depth of the lake has not been updated, however, water depth investigation will be conducted by using the sounding method, in consideration of the water sources in the Harare Metropolitan area. Measures to address various pollution sources were studied, in addition to lake pollution.

In establishing the M/P, the following items were examined – effectiveness of the measure, operation and maintenance of the facility, problems and issues, necessary assistance by residents and Capital Expenditure and Operation Expenditure. Possible countermeasures for said items were also proposed.

An integrated approach was undertaken in this study, where pollution load in dry/wet weather condition, non-point pollution sources, and solid waste management were studied in parallel, considering the fact that all the surface run-off flow into the lakes.

1.4 Frame of the Study

1.4.1 Capacity Building

The issue of environmental degradation in Chitungwiza is now in the residents' consciousness. It has also become an organizational issue despite originating from an eco-political problem. Therefore, it is equally important to provide adequate information on the project to the residents, utilizing appropriate communication approaches such as seminars, workshops and donor meetings involving C/P, PMU, the local government, leaders of the district and the involved families.

1.4.2 Establishment of Collaboration Works with Related Sectors and Organization

There are local governments and other governmental organizations involved in this study. It is important that the government stakeholders perform their roles according to their mandates in collaboration with one another: Chitungwiza City with the role of C/P, MoLGURD with the role of a management agency of the local infrastructures, and WoWRDM having the role of a management agency of the water and sewer systems.

The close cooperation among all those involved in the project will ensure that the study will be effectively and efficiently conducted. For this reason, not only exchanges of the opinion and sharing of problems are made, but also more importantly, solutions are generated. A steering committee was organized with members from MoLGURD and MoWRDM to provide recommendations and guidance to this study.

1.4.3 Enlightenment of the Residents Regarding Sanitation and Housework

Sand, which is traditionally used to wash pots in kitchens for housework in Zimbabwe, flows into the sewer pipes and clogs the pipe. There is a need to provide information to the residents on the detrimental result of using such cleaning/ housework methods on the sewer system so that water quality at the water sources do not deteriorate, and that sanitation can be maintained. Seminar or workshop to enlighten the residents led by a community leader would be effective.

Sewer pipe clogging, breakdown of pump stations, and malfunction of the grit chamber by sand in STP have been occurring frequently in the pump stations and Zengeza STP. The lifestyle of the residents is thought to have caused the accidents, and this is attributed to particular characteristics in customs and tradition of the residents. It may take years to change the lifestyle and behaviour of the residents on this aspect. Therefore, each facility should be designed to avoid the breakdown of the facility by the sand deposit in the system.

1.4.4 Issues and Considerations Attended in the Study

Issues and considerations needed for the study are summarised in Table 1.4.1. In addition, specific plans and corresponding measures to the points are described in CHAPTER 6.

Table 1.4.1 Issues and Considerations

Items	Issues and Considerations
1. Organization of the study	・Chitungwiza City is the C/P of the study and responsible for preparing M/P and F/S. ・A steering committee shall be established to examine the implementation of the study progress. Representatives from the Ministry of Local Government, Rural and Urban Development (MoLGURD) and the Ministry of Water Resources Development and Management (MoWRDM) shall be actively involved in the steering committee as core members by giving advice/guidance and leading the committee.
2. Phases of the Study	In the first year, the basic data shall be collected and analysed as Phase 1: Basic Investigation, and M/P to be prepared as Phase 2: Determination of M/P. In the second year, F/S shall be implemented as Phase 3: Implementation of Feasibility Study (F/S).
3. Capacity Development of C/P	A detailed work plan shall be prepared to improve C/P capabilities through M/P and F/S preparation and enhance their knowledge in maintenance and operation of the water supply, sewerage and solid waste management.
4. Pilot Project	During the M/P preparation, pilot project will be implemented to improve the capacity of the personnel and organization's strength in the management of water supply, sewerage and solid waste management. The outcomes of the pilot project shall be verified and evaluated be reflected in the final M/P report.
5. Study on Potential Donors to Implement Prioritized Projects	・Implementation of the priority projects by potential donors other than JICA will also be studied. Potential donors shall be researched and identified to cooperate with JICA for the priority projects. ・Meetings shall be held to inform each donor most updated information and progress of the study.
6. Existing Wastewater Treatment Plant	The repair work of the existing wastewater treatment plant constructed by JICA grant shall be studied in terms of methodology of repairs and funding through discussion with C/P and JICA based on the outcome of the Phase 1. The wastewater treatment plant was designed /implemented by NJS Consultants CO., LTD under JICA grant aid.
7. Current regulation/water quality standard for sewage /wastewater /treated effluent in Zimbabwe	Based on the current economic situation and poorly maintained infrastructure in Zimbabwe, the current regulations/standard set forth by the government of Zimbabwe are considered to be difficult to meet and apply on the sewerage system proposed in the study. In the study, these issues will be examined from various aspects and addressed.
8. Activities of AfDB and coordination with AfDB	The detailed information on the water and sewer facility maintenance projects in Chitungwiza City proposed by African Development Bank (AfDB) shall be obtained from AfDB. The way of collaboration will be studied for better outcome through coordination and proposals will be made and included in the study.
9. Proposal of Effective Operation and Performance	・Necessary information and data shall be collected to establish a quantitative and qualitative performance indicator, which measures effectiveness and performance of the implemented projects. The target performance level will be set for 2 years after the

Items	Issues and Considerations
Indicator	completion of the projects proposed in the M/P. ・The target level shall be established according to future monitoring capability and verification of recipients used in M/P. In addition, indirect effects and impacts by development will be confirmed.
10. Economic and Financial Analysis	Through the discussion with the government of Zimbabwe, Economic Internal Rate of Return (EIRR) and Financial Internal Rate of Return (FIRR) shall be studied for the projects proposed in the M/P.
11. Socio-Environment Consideration Study	・Following JICA socio-environment guidelines, progress of the Environmental Impact Statement, other related documents, and the status of land acquisition / resettlement in the study shall be researched and verified to provide appropriate support and advice. ・In the process of determining the project site, social impacts, such as land acquisition and resettlement shall be carefully considered to provide appropriate advice/ recommendation.

1.4.5 Feasibility Study in Phase III

In order to guarantee the sustainability of the facilities to be developed in the future, it was decided through the discussion of both sides of Zimbabwe and Japan to put a certain period before the F/S to observe and confirm the financial status of Chitungwiza Municipality. Implementation of F/S will be considered when the restructuring of the municipality shows a certain progress.

1.5 Implementation Schedule

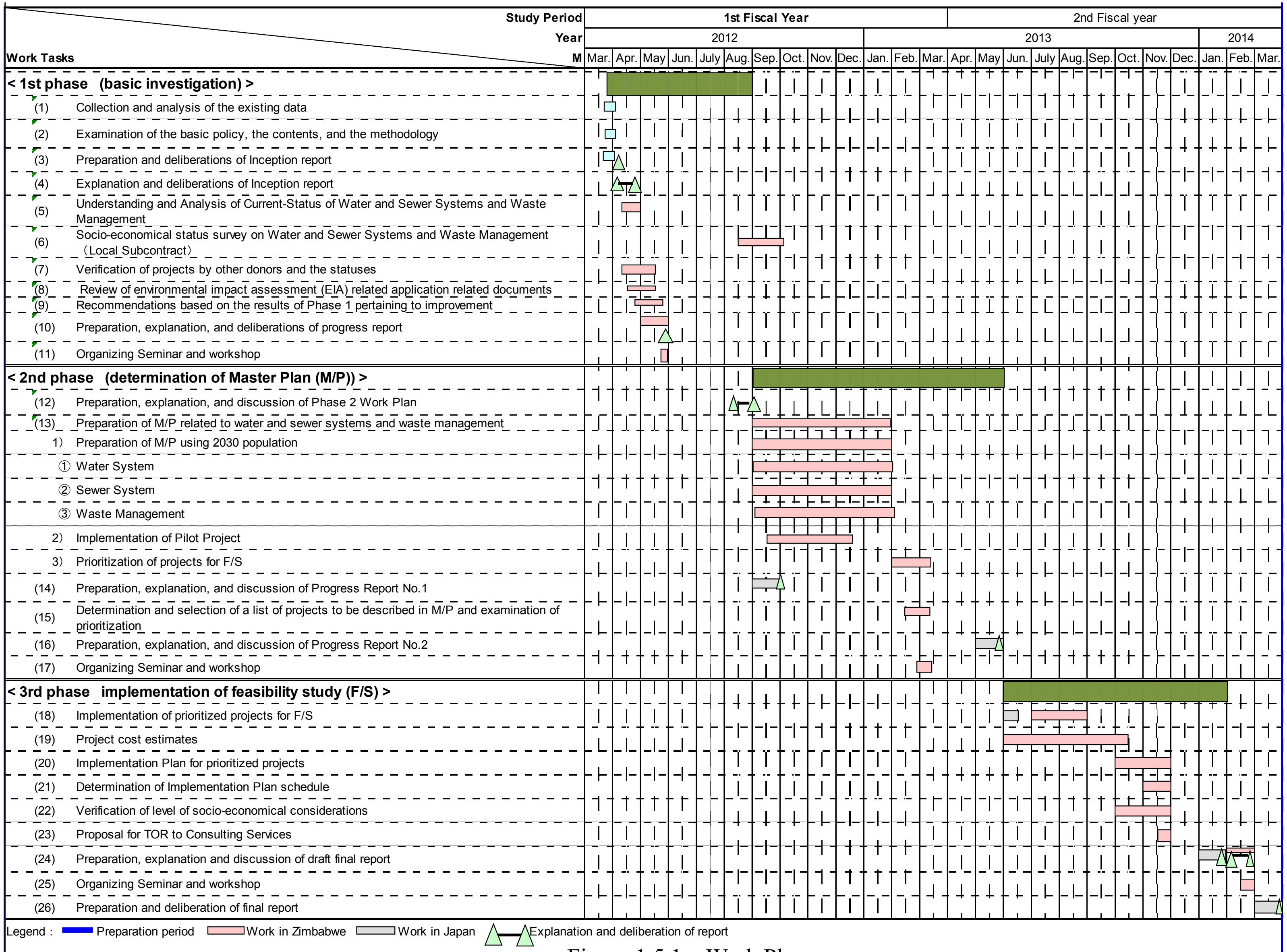


Figure 1.5.1 Work Plan

PART I BASIC STUDY

CHAPTER 1 INTRODUCTION

1.1 The Background of the Study

In the late 1990s, rapid population growth in the Harare area contributed to a surge in residential and industrial developments. This brought about an increase in wastewater flow generated from the area, which was more than the treatment capacity of the existing wastewater treatment plant. As a result, runoff from the excess wastewater began to pollute the environment and water resources, such as Lake Chivero and Lake Manyame, with water quality worsening as the population grew and the area further developed.

To improve the situation, the government of Japan implemented a grant project for Chitungwiza Municipality and constructed a wastewater treatment plant in "The Project for Improvement of Sewerage Facilities in the Municipality of Chitungwiza", which was then handed over to the government of Zimbabwe in 2000. However, the economic conditions of Zimbabwe did not get any better in 2000, and the budget for proper infrastructure maintenance and improvements in water supply, sewerage and solid waste management was insufficient, thus making the environmental status worse in spite of the implementation of the project.

As a result of the above-mentioned conditions, the sewerage system has not been functioning properly resulting to a deterioration of the water quality of the water source and the attendant increase in the cost of operation and maintenance of the system. This situation caused the society negative impacts such as the cholera outbreak in the area in 2008.

The political situation in Zimbabwe has improved since 2008 eight years after some European countries and United States of America had imposed economic sanctions due to political reasons. The political stability in Zimbabwe prompted the government of Japan to resume bilateral and humanitarian aid activities. One of these is "The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe" (hereinafter referred to as the Project).

With the economic and political stability in Zimbabwe, JICA conducted in January and February 2011 an investigation and data collection and analysis of the environment conditions in Chitungwiza Municipality in the "Data Collection Study on Improvement of Sanitary Environment of Chitungwiza Municipality". The report identified the dysfunctional situation not only for the solid waste management and sewerage, but also for the water supply system in Chitungwiza Municipality, upon which, the government of Zimbabwe recognized that improvements were needed to upgrade the living conditions and the environment for the people of Chitungwiza. Consequently, the government of Zimbabwe decided to develop “The Project for the Improvement of Water Supply, Sewage and Solid Waste Management in Chitungwiza in the Republic of Zimbabwe”, which addresses the essential improvements to the municipality’s water supply, sewerage and solid waste management, and requested the government of Japan for a technical cooperation to develop the plan.

The government of Japan appointed JICA to start study on the specific plan for the project in June 2011, according to the agreement between the two governments. The Scope of Work of the technical cooperation (S/W) was discussed between JICA, Chitungwiza Municipality and the relevant authorities in Zimbabwe and was finalized on the 25th August 2011.

1.2 Objective of the Study

The objective of the study is to prepare the Master Plan (hereinafter referred to as M/P) and the Feasibility Studies (hereinafter referred to as F/S) for water supply, sewerage and solid waste management in Chitungwiza City. In the F/S, the high priority projects will be selected and studied from the projects in the M/P. The study is expected to be utilized in the future implementation of the projects identified in the M/P that will be aided and/or funded by the government of Japan, and by other countries as well. At the same time, the study will benefit the local counterparts (hereinafter referred to as C/P) in Zimbabwe by building their capacity for future development planning.

A major objective of this project is to establish a sustainable plan of water quality conservation of safe water supply in the catchment area. Countermeasures against the water pollution in the rivers and lakes are subordinate objectives. Therefore, problems and issues for achieving sub-objectives will be clarified to set methodologies and approaches for solutions as a prerequisite to the water quality conservation plan of MP. Figure 1.2.1 shows the whole catchment area of Lake Manyame, Lake Chivero, major rivers, lakes and sewage treatment plants.

Figure 1.2.2 shows the schematic diagram of the water cycle in the catchment area, indicating the water source for the catchment area which comes from the catchment area itself and wastewater from both cities returns to the water source by surface run-off or discharge from STPs in the catchment. Most of the STPs in the catchment area have not been working, and then the influence of the wastewater to the water source is considered to be critical. Since current status of the water pollution and its specific causes are not clear, a water quality conservation plan will be formulated after basic investigation and study work. Countermeasures will be proposed in the plan and the specific facility plan will be examined in terms of the cost-benefit aspects.

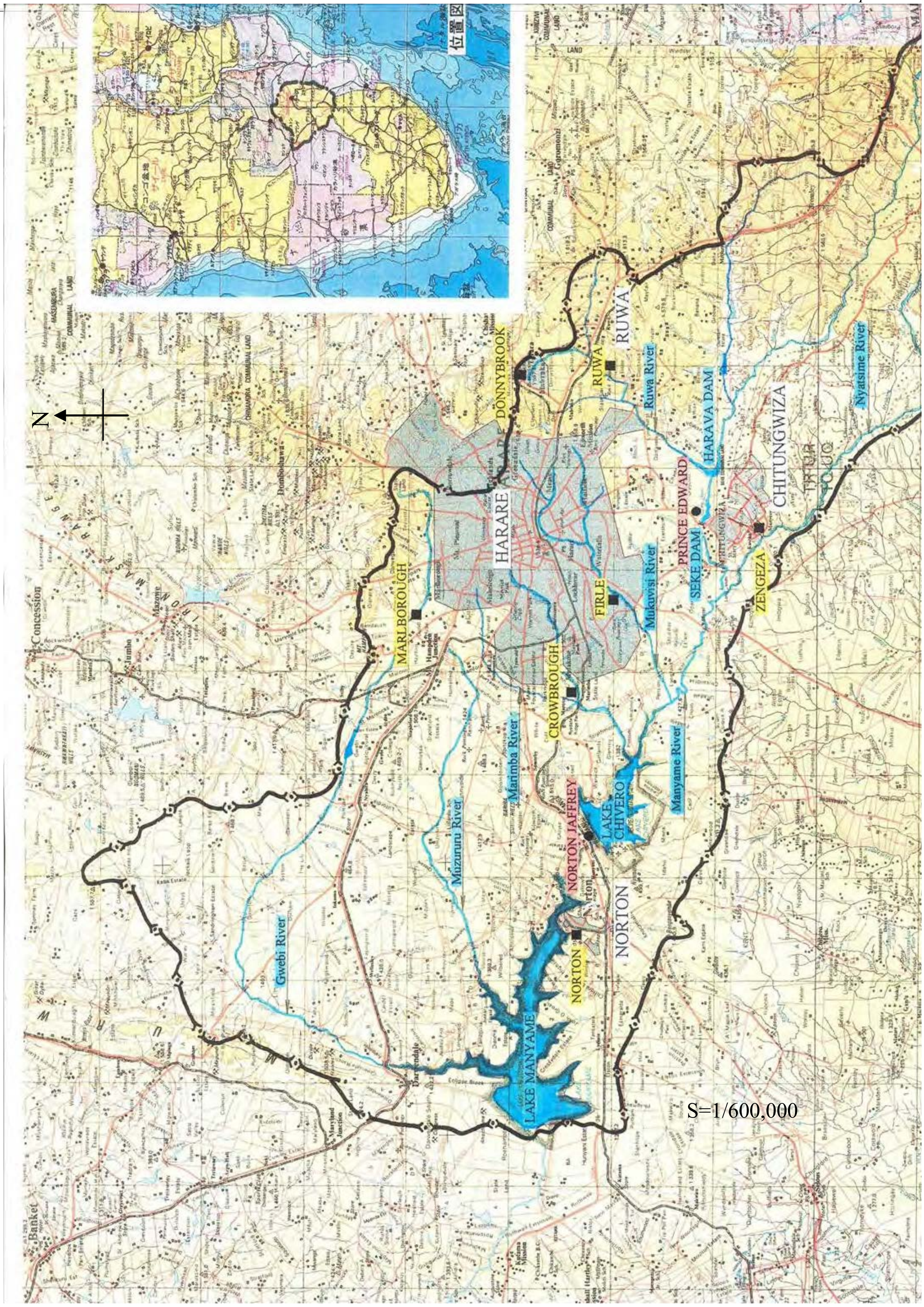
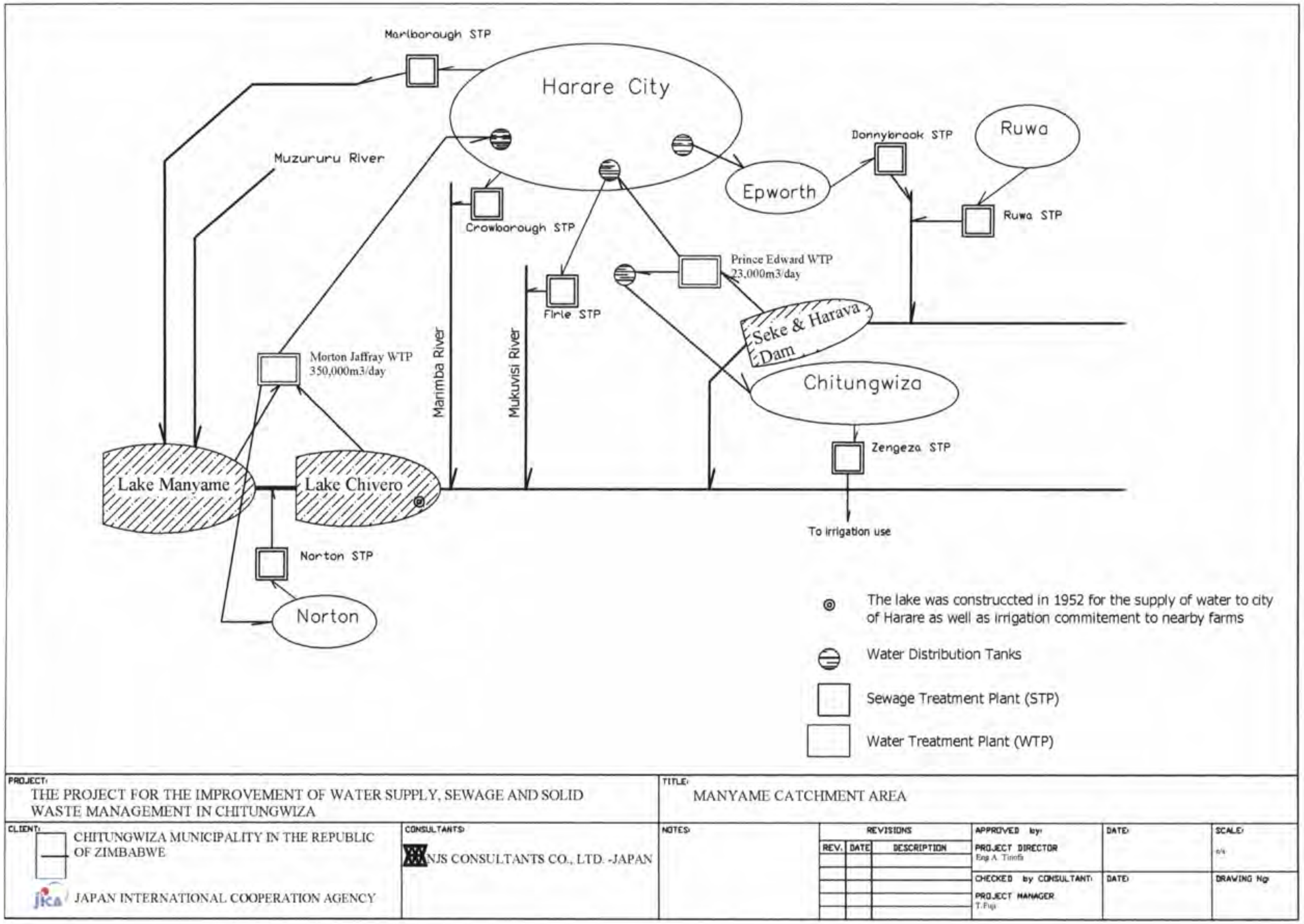


Figure 1.2.1 The Lake Manyame Catchment Area



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1.4.5 Feasibility Study in Phase III

In order to guarantee the sustainability of the facilities to be developed in the future, it was decided through the discussion of both sides of Zimbabwe and Japan to put a certain period before the F/S to observe and confirm the financial status of Chitungwiza Municipality. Implementation of F/S will be considered when the restructuring of the municipality shows a certain progress.

1.5 Implementation Schedule

Study Period: 1st Fiscal Year (2012: Mar., Apr., May, Jun., July, Aug., Sep., Oct., Nov., Dec.; 2013: Jan., Feb., Mar.) | 2nd Fiscal year (2013: Apr., May, Jun., July, Aug., Sep., Oct., Nov., Dec.; 2014: Jan., Feb., Mar.)

	Work Tasks
	< 1st phase (basic investigation) >
(1)	Collection and analysis of the existing data
(2)	Examination of the basic policy, the contents, and the methodology
(3)	Preparation and deliberations of Inception report
(4)	Explanation and deliberations of Inception report
(5)	Understanding and Analysis of Current-Status of Water and Sewer Systems and Waste Management
(6)	Socio-economical status survey on Water and Sewer Systems and Waste Management （Local Subcontract）
(7)	Verification of projects by other donors and the statuses
(8)	Review of environmental impact assessment (EIA) related application related documents
(9)	Recommendations based on the results of Phase 1 pertaining to improvement
(10)	Preparation, explanation, and deliberations of progress report
(11)	Organizing Seminar and workshop
	< 2nd phase (determination of Master Plan (M/P)) >
(12)	Preparation, explanation, and discussion of Phase 2 Work Plan
(13)	Preparation of M/P related to water and sewer systems and waste management
1)	Preparation of M/P using 2030 population
①	Water System
②	Sewer System
③	Waste Management
2)	Implementation of Pilot Project
3)	Prioritization of projects for F/S
(14)	Preparation, explanation, and discussion of Progress Report No.1
(15)	Determination and selection of a list of projects to be described in M/P and examination of prioritization
(16)	Preparation, explanation, and discussion of Progress Report No.2
(17)	Organizing Seminar and workshop
	< 3rd phase implementation of feasibility study (F/S) >
(18)	Implementation of prioritized projects for F/S
(19)	Project cost estimates
(20)	Implementation Plan for prioritized projects
(21)	Determination of Implementation Plan schedule
(22)	Verification of level of socio-economical considerations
(23)	Proposal for TOR to Consulting Services
(24)	Preparation, explanation and discussion of draft final report
(25)	Organizing Seminar and workshop
(26)	Preparation and deliberation of final report

Legend : Preparation period; Work in Zimbabwe; Work in Japan; Explanation and deliberation of report

Figure 1.5.1 Work Plan

CHAPTER 2 SOCIAL AND PHYSICAL CHARACTERISTICS IN THE STUDY AREA

2.1 Outline of Chivero Catchment Area

Zimbabwe is one of the few African Countries that have been able to provide water and sanitation to over 90% of its urban population (WHO/UNICEF, 2001). By law, all households are compelled to have an acceptable sanitation system before an occupation certificate is issued (Urban Councils Act, Chapter 29,15; Regional Town and Country Planning Act, Chapter 29.6). Onsite systems like bucket systems and pit latrines are not allowed in urban areas of Zimbabwe (Taylor and Mudege, 1997) and only flushing toilets with either septic tanks or conventional sewerage are permitted. It is estimated that more than 92% of urban households are connected to the sewerage system.

Urban councils are the water authorities in Zimbabwe, and this includes responsibilities for sanitation services according to the Urban Councils Act. Recent strict effluent treatment standards (Government of Zimbabwe, Statutory Instrument 274 of 2000) have increased financial pressures on councils by prescribing tougher effluent standards and high penalties for non-compliance; a situation that encourages tertiary treatment instead of reuse. Problems relating to serious water pollution are more pronounced in Harare, the capital city, located in the Lake Chivero catchment area.

Lake Chivero was constructed in 1952 and is located 35 km south-west and downstream of Harare. It is the major water source for the city providing most of its needs and the neighbouring towns of Epworth, Norton, Chitungwiza and Ruwa. Water for Chitungwiza Municipality has been supplied from Prince Edwards WTP and Morton Jaffray WTP. All the municipalities are located in the catchment area.

The mean annual rainfall is 830 mm (JICA, 1996; Luxemburg, 1996) and the mean annual runoff is about 140 mm (Department of Water Development, 1995). The results of the 2002 census estimated that the population in the Harare metropolitan area was about 1,900,000. Water consumption in Harare averages 430,000 m^3/d and 304,000 m^3/d is collected as wastewater. Only 23,800 m^3/d of wastewater is treated onsite.

Two main wastewater treatment plants (WTP) serve the city: the Firle (capacity 144,000 m^3/d) and the Crowborough (54,000 m^3/d) wastewater treatment plants. Treatment was mainly conducted by trickling filters (TF) and activated sludge systems incorporating Biological Nutrient Removal (BNR). About 70% of this effluent was reused for pasture irrigation whilst the rest was discharged into the Mukuvisi and Marimba Rivers which flow into Lake Chivero.

There are also two waste stabilisation pond systems in Marlborough and Donnybrook with combined treatment capacity of 7,500 m^3/d and a new extended aeration plant in Hatcliffe with a capacity of 2,500 m^3/d. Most of these plants have not been working due to economic reasons flowing out raw sewage to the rivers or farmland for irrigation.

Because of the poor quality of the STP effluent discharges, runoff and seepage intrusions from pasture irrigation, and other upstream point and non-point sources of pollution, Lake Chivero is heavily polluted. Previous research by JICA (1996) focusing on the lake found it to be eutrophic by which wastewater was reported as the major problem. Research focusing on Mukuvisi River (Zaranyika, 1997; Moyo and Worster, 1997; Machena, 1997; Kamudyariwa, 2000) also revealed numerous sources and causes of pollution like industrial discharges, solid waste dumps and WTP effluent. In studies on the Marimba River by JICA (1996), the mean concentrations of total nitrogen (TN) and the phosphorus (TP) in Lake Chivero were 0.51 mg/l and 0.27 mg/l respectively.

In the past years, a number of developments such as the expansion of Crowborough and Firle wastewater treatment plants failed to take place. A harsh economic environment, characterised by lack of foreign currency and electric power cuts have also been affects the proper functioning of these plants. The water quality problems in the Chivero catchment have been exacerbated by rapid industrialisation and high population growth rates in the urban areas.

The main water management problem in Harare has been that wastewater discharges contribute significantly to eutrophication in Lake Chivero. Spillway discharges normally take place only from January to April, meaning that the lake acts as a sink for pollutants for most of the year. As the population increases, the lake will increasingly receive a higher fraction of WTP effluent whilst raw water abstraction will also increase, posing a water quality and quantity problem. Nutrient concentrations in the lake are higher than the allowable limits of <0.3 mg/l TN and <0.01 mg/l TP for drinking water taken from lakes (Mandaville, 2000). This has led to excessive primary productivity and related problems in the lake. Nitrogen and phosphorous inputs need to be controlled to avoid further deterioration in water quality.

2.2 Outline of the Study Area

The study area covers the upper Manyame Catchment Area and present jurisdiction of City of Harare, the Chitungwiza Municipality and other townships concerned. Although the Chitungwiza Municipality (42 km^2) is the main municipality for this study, upper Manyame Catchment area was included for the study because of the significance of the area for the water supply, sanitation and hygiene for the municipality as previously stated in the section 2.1.

Manyame catchment is among the seven major river basins that constitute the Zimbabwean hydrological water management systems shown in figure 2.2.1. This catchment sources in Marondera and drains into the Zambezi River downstream of the Kariba Dam and upstream of the Cabora Bassa dam to the northern part of the country. Geographically, the Manyame catchment lies between the 18.320S (latitude) and the 15.590S (latitude) and between the 28.740E longitude and the 32.040E longitude.

The catchment also straddles over four administrative provinces namely Harare Metropolitan, Mashonaland East, Mashonaland West and Mashonaland Central covering the areas which all drain into the Manyame river system. Mazowe catchment borders it to the east, to the southeast by Save catchment and to the west, by Sanyati catchment. It has a total estimated catchment area of 40,497 km^2 and is characterised by Agro ecological region-II and low veld climatic conditions, with good red soils from Banket to below the Zambezi Escarpment and sand veld climatic conditions above the escarpment. Figure 2.2.1 shows location of province and rivers in Zimbabwe.

The lake's catchment area also includes the towns of Chitungwiza, Epworth and Ruwa. The Chivero Catchment is also a sub-catchment of the larger Upper Manyame catchment, which includes the town of Norton. The entire Chivero catchment has an estimated population of about 2.5 million people from the result of Census 2002 and covers a surface area of about 2,220 km^2 (Department of Water Records), consisting of approximately 10% urban and 90% rural developments. The latter comprises communal and commercial farming lands in nearly equal proportions.

A detailed study of water and nutrient flows in the Chivero catchment was done by Nhapi et al. (2006). The major highlight from this study is that the total nitrogen (TN) and total phosphorus (TP) levels in Lake Chivero have reached critical levels considering that the lake supplies drinking water to a very large population. Some of the water is abstracted, treated and used in towns after which it returns to the lake as sewage effluent. About 30% of lake inflows are abstracted for urban use. The rest either evaporates or flows downstream where some of it is abstracted for agricultural irrigation. Raw water is also abstracted from the immediately downstream Lake Manyame. The lake water level shows that the volume of water in Lake Chivero goes down considerably during low rainfall years, posing a potential threat to water security in the area.

Figure 2.2.1 Location of Chitungwiza in Zimbabwe

Chitungwiza gained full municipal status in 1981. According to the 2002 Population Census, the municipality had a population of 321,782. Most of the people work in Harare, as there is very little industry in Chitungwiza.

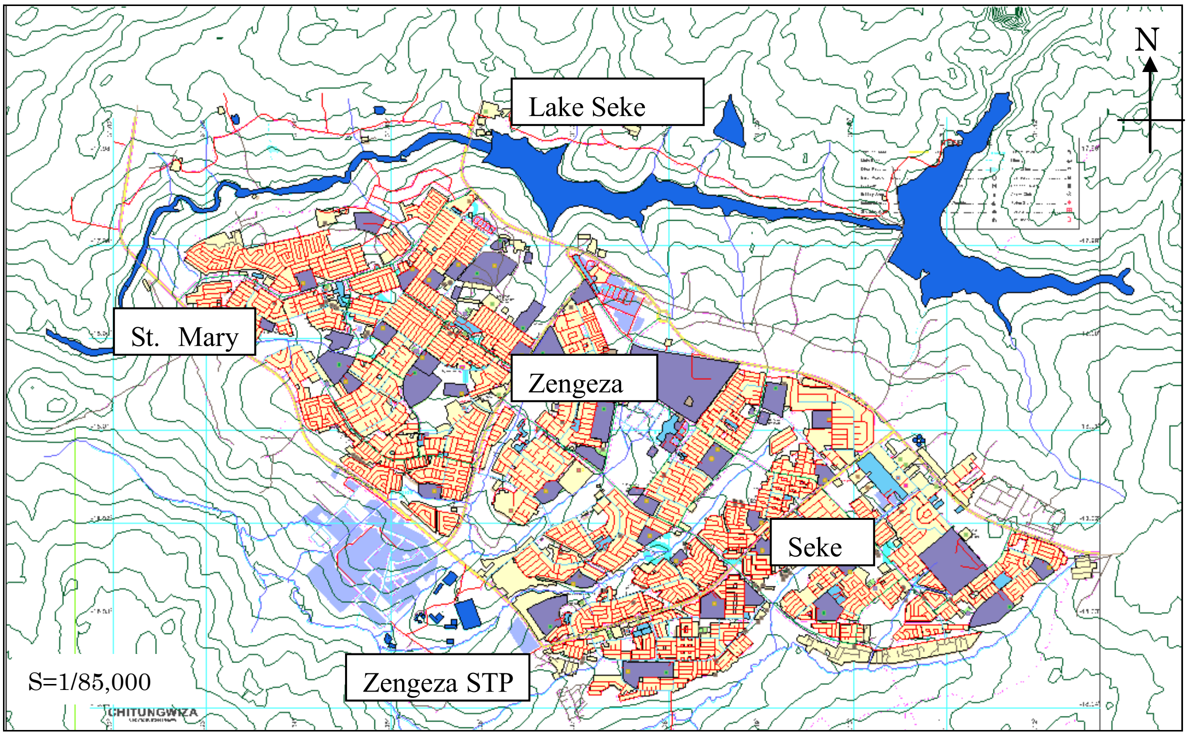
Chitungwiza has several suburbs, namely Seke, Zengeza and St. Mary. Seke is an aggregation of many sections whilst Zengeza is composed of 5 different sub-sections; Zengeza 1 to 5. Zengeza 4 is near the Chitungwiza Shopping Complex which is popularly known as the "Town Centre". In Seke there is "Makoni" which is a smaller shopping centre which houses several flea markets and a bus depot. There are more than 15 different housing estates in Seke which are named after the alphabet. There is Units ;A, B, C, D, E, F, G, H, J, K, L, M, N, O, and P. The houses are mostly high density detached units of single storey with a small yard that is generally used for growing vegetables and during the summer rainy season also maize known locally as the meal.

There is one main highway that connects the town to Harare. All public transport services tend to be overcrowded throughout the day.

About 60% of the land area of Chitungwiza Municipality is served by the existing sewerage system. The area consists of Seke North, Seke South, Zengeza, St. Mary's and proposed Nyatsime Suburbs, since the amalgamation of these former high-density townships of City of Harare in 1978. However, the sewerage system has not been operated since 2004 due to economic problem of the municipality.

The site of the Zengeza STP is owned by the Chitungwiza Municipality for the purpose of sewage treatment. The existing facility consists of the BNR facility and sludge treatment process which was commissioned from Japanese Government in 2000, and old anaerobic ponds and inlet works.

A part of the area of the Zengeza STP has also been used as a pre-treatment process for sewage from Tilcor industrial area in Chitungwiza. The process consists of a series of anaerobic ponds for pre-treatment and a pump station to send sewage to the headwork of the STP.



Source: JICA Project Team

Figure 2.2.2 Chitunguwiza Municipality Map

2.3 Local Socio Condition of the Study Area

2.3.1 Local Socio Overview

(1) History of Zimbabwe

Zimbabwe was formerly known as Southern Rhodesia (1923), Rhodesia (1965), and Zimbabwe Rhodesia (1979). The name *Zimbabwe* was introduced from ca. 1960 in the context of the potential name of the country once independent, and used by the African nationalist factions in the Rhodesian Bush War, the most major of which were the Zimbabwe African National Union (led by Robert Mugabe from 1975), and the Zimbabwe African People's Union, led by Joshua Nkomo from its founding in the early 1960s.

In 1965 the government unilaterally declared its independence, but the UK did not recognize the act and demanded more complete voting rights for the black African majority in the country (then called Rhodesia). UN sanctions and a guerrilla uprising finally led to free elections in 1979 and independence (as Zimbabwe) in 1980.

Land re-distribution campaign, which began in 2000, caused an exodus of white farmers, crippled the economy, and ushered in widespread shortages of basic commodities. The regime rigged the 2002 presidential election and the ruling ZANU-PF party won in the March 2005 parliamentary election, allowing it to amend the constitution and re-create the Senate. The regime in June 2007 instituted price controls on all basic commodities. General elections held in March 2008 left the problem upon many key outstanding governmental issues.

(2) Social economic transition

1) Economy

In spite of having once had a well-developed infrastructure and financial systems, Zimbabwe’s economy declined rapidly from the late 1990s, as a direct result of the poor governance of the Mugabe regime. GDP fell by half from 1998 to 2008 and hyper-inflation reached historic levels. Since the formation of the inclusive Government and the appointment of Tendai Biti as Minister of finance in February 2009, there has been a significant reversal of the relentless economic decline that had marked the previous decade. ”Dollarisation” in 2009 brought inflation down to single digit and sound macro-economic management has enabled the economy to grow by an average of 7.5% per year, anchored on strong performance in the mining and agriculture sectors and buoyed by high world commodity prices

Zimbabwe was previously an exporter of maize but has become a net importer. Tobacco exports and other exports of crops have also declined sharply. Mineral exports, agriculture, and tourism are the main foreign currency earners of Zimbabwe. The mining sector, such as platinum, diamond and etc.

remains very lucrative. They have the potential to improve the fiscal situation of the country considerably. Tourism was an important industry for the country, but has been failing in recent years. One of the reasons is that 60% of Zimbabwe's wildlife was estimated to have died since 2000 due to poaching and deforestation.

Hyperinflation was experienced between 2003 & 2009. Inflation rose from an annual rate of 32% in 1998, to an official estimated high value of 11,200,000% in August 2008 according to the country's Central Statistical Office. Zimbabwe's inflation crisis was in 2009 the second worst where inflation doubled every 15.6 hours. By 2005, the purchasing power of the average Zimbabwean had dropped to the same levels in real terms as 1953. Local residents have largely resorted to buying essentials from neighbouring Botswana, South Africa, and Zambia.

In an effort to combat inflation and foster economic growth the Zimbabwean Dollar was suspended indefinitely on 12 April 2009. Zimbabwe now allows trade in the United States Dollar and various other currencies such as the South African Rand, Euro, Sterling, and Botswana pula.

Since the formation of the Unity Government in 2009, the Zimbabwean economy has been on the rebound. GDP grew by more than 5% in the year 2009 and 2011. Growth is forecast to reach 8% in 2010, buoyed by high mineral prices and the improving agriculture sector. Refer to materials of Embassy of Zimbabwe

2) Health

The National Health Service in Zimbabwe is established at four levels i.e. Primary, Secondary, Tertiary and Quaternary. Primary Health Care is the main vehicle through with health care programmes in the country. The main components of primary Health Care (PHC) include: maternal and child health services; health education; nutrition education and food production: expanded programme in immunization; communicable diseases control; water and sanitation; essential drugs programme and the provision of basic and essential preventive and curative care. The majority of health services in Zimbabwe are provided by the public sector (Ministry of Health and Child-Welfare and Local Government) both in the rural and urban areas. Government services are complimented by Mission (Church related) and private facilities. Health services in Zimbabwe are integrated, so that is both curative and preventive services. Thus all health services offer maternal and child services (MCH), including family planning.

Zimbabwe was one of first countries in the world to recognize HIV/AIDS and offer protective measures. Sentinel surveillance for HIV shows that 17-25% of antenatal patients were positive in 1993. This figure rose dramatically in the first half of the 1990s peaking and stabilizing at around 29%, in 2002 and 24.6 in 2005. Since the late 1990s the HIV prevalence rate in Zimbabwe has been on the decline making Zimbabwe one of the first African countries to witness such a trend. The current adult prevalence rate is reported to be 20.1%. HIV/AIDS has thus remained the number one health problem in the country. Refer to MTP (Middle Term Plan of Zimbabwe)

3) Education

Zimbabwe has an adult literacy rate of approximately 90%+/- which is amongst the highest in Africa. Since 1995 the adult literacy rate of Zimbabwe had steadily decreased, a trend shared by other African countries. In 2010, the United Nations Development Programme (UNDP) found that Zimbabwe's literacy rate had climbed to a high of 92% and had, once again, become the highest in Africa. The education department has stated that 20,000 teachers have left Zimbabwe since 2007 and that half of Zimbabwe's children have not progressed beyond primary school.

School education was made free in 1980, but since 1988, the government has steadily increased the charges attached to school enrolment until they now greatly exceed the real value of fees in 1980. Zimbabwe's education system consists of 2 years of pre-school, 7 years of primary and 6 years of secondary schooling before students can enter university in the country or abroad. There are seven public universities as well as four church-related universities in Zimbabwe that are fully internationally accredited. Refer to materials of Ministry of Higher and Tertiary Education

2.3.2 Local Administrative Overview

(1) Government administrative organization

The organization of government is shown in Figure 2.3.1 and it has 31 ministries with each minister.

Zimbabwe has a centralized government and is divided into eight provinces and two cities (Harare and Bulawayo City) with provincial status, for administrative purposes as shown in Figure 2.3.2 and Table 2.3.1. Each province has a provincial capital from where official business is usually carried out. Each province is headed by a Provincial Governor, appointed by the President.

The provincial government is run by a Provincial Administrator, appointed by the Public Service Commission. Other government functions at provincial level are carried out by provincial offices of national government departments. The provinces are subdivided into 59 districts and 1,200 wards (sometimes referred to as municipalities). Each district is headed by a District Administrator, appointed by the Public Service Commission. There is also a Rural District Council, which appoints a Chief Executive Officer.

President
Vice President

Prime Minister
Deputy Prime Minister

No.	Ministry
1	Agriculture, Mechanization and Irrigation Development
2	Constitutional and Parliamentary Affairs
3	Defense
4	Economic Planning and Investment Promotion
5	Education, Sport, Arts and Culture
6	Energy and Power Development
7	Environment and Natural Resources Management
8	Finance
9	Foreign Affairs
10	Health and Child Welfare
11	Higher and Tertiary Education
12	Home Affairs
13	Housing and Social Amenities
14	Industry and Commerce
15	Justice and Legal Affairs
16	Labour and Social Welfare
17	Local Government Rural and Urban Development
18	Lands and Rural Resettlement
19	Media, Information and Publicity
20	Mines and Mining Development
21	Public Service
22	Public Works
23	Regional Integration and International Co-operation
24	Science and Technology
25	Small and Mediun Enterprises and Co-operative Development
26	State Enterprises and Parastatals
27	Tourism and Hospitality Industry
28	Transport and Infrastructural Development
29	Water Resources and Development
30	Women's Affairs, Gender and Community Development
31	Youth Development, Indigenisation and Empowerment

Figure 2.3.1 Organization Chart of Government
Refer to website of Government of Zimbabwe

The Rural District Council is composed of elected ward councillors, the District Administrator and one representative of the chiefs (traditional leaders appointed under customary law) in the district. Other government functions at district level are carried out by district offices of national government departments.

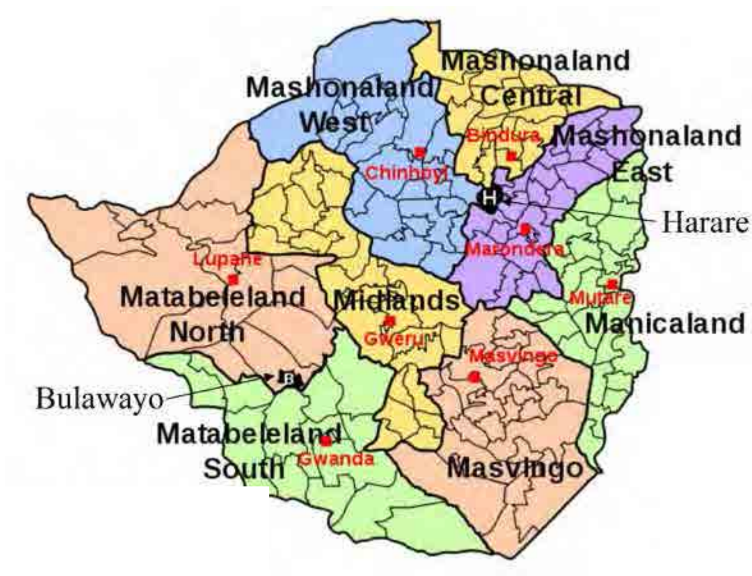


Figure 2.3.2 Provinces and the Capitals
Source: Google Image Map

Table 2.3.1 List of Province

Province	Capital	Area (km^2)	Population	Population Density ($/km^2$)
Bulawayo	Bulawayo	479	676,650	1,413
Manicaland	Mutare	36,459	1,568,930	43
Mashonaland Central	Bindura	28,347	995,427	35
Mashonaland East	Marondera	32,230	1,127,413	35
Mashonaland West	Chinhoyi	57,441	1,224,670	21
Matabeleland North	Lupane	75,025	704,948	9
Matabeleland South	Gwanda	54,172	653,054	12
Midlands	Gweru	49,166	1,463,993	30
Masvingo	Masvingo	56,566	1,320,438	23
Harare	Harare	872	1,896,134	2,174
Total		390,757	11,631,657	30

Source: 2002 Census

For the water use, Zimbabwe National Water Authority under Ministry of Water Resource Development and Management is in charge, however the role is limited to be comprehensive matter. The major organization charts of the ministry and the authority are shown Figure 2.3.3 and 2.3.4, respectively. Under the Authority's operation director, seven (7) catchment Boards were established.

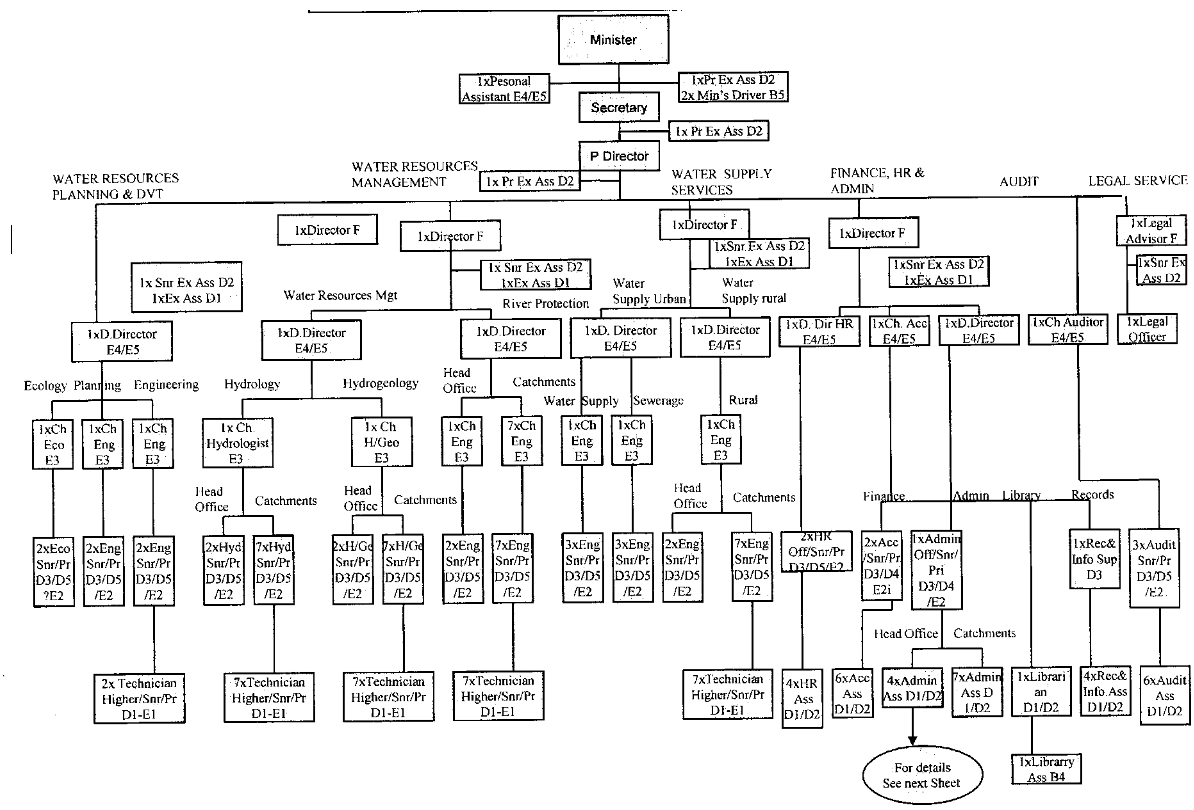


Figure 2.3.3 Ministry of Water Resource Development and Management

Source: ZINWA

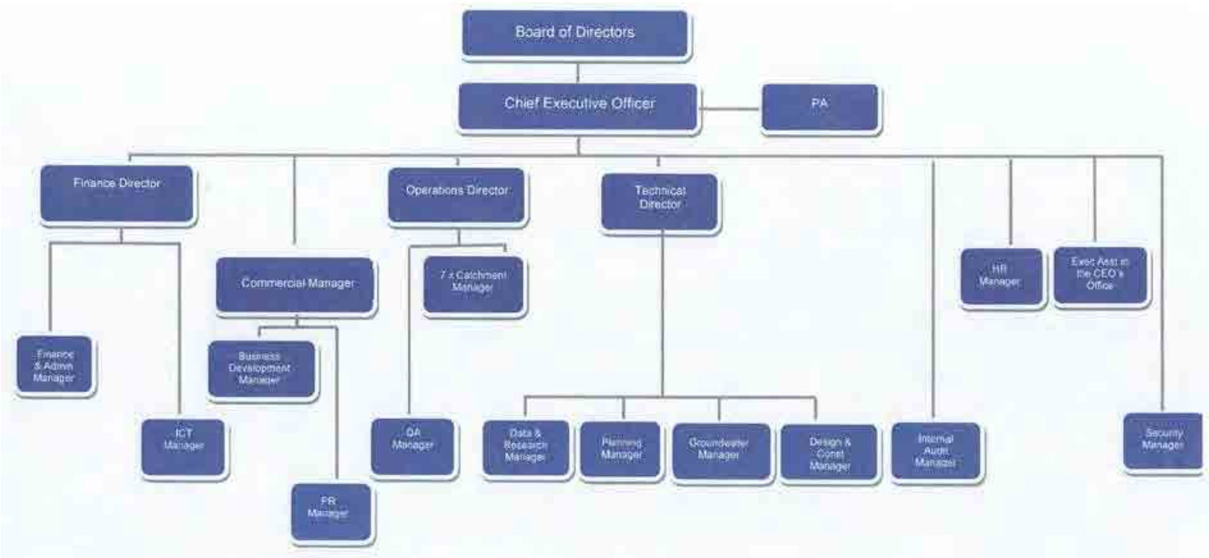


Figure 2.3.4 Zimbabwe National Water Authority Management Structure

Source: ZINWA Data

(2) Administrative organization of the Target Area

Harare Province is composed by City of Harare, Chitungwiza District (Municipality) and Epworth District, and it has a provincial government with the governor. The provincial government is governing the city and districts under the Governor. Figure 2.3.5 shows the organization chart of City of Harare.

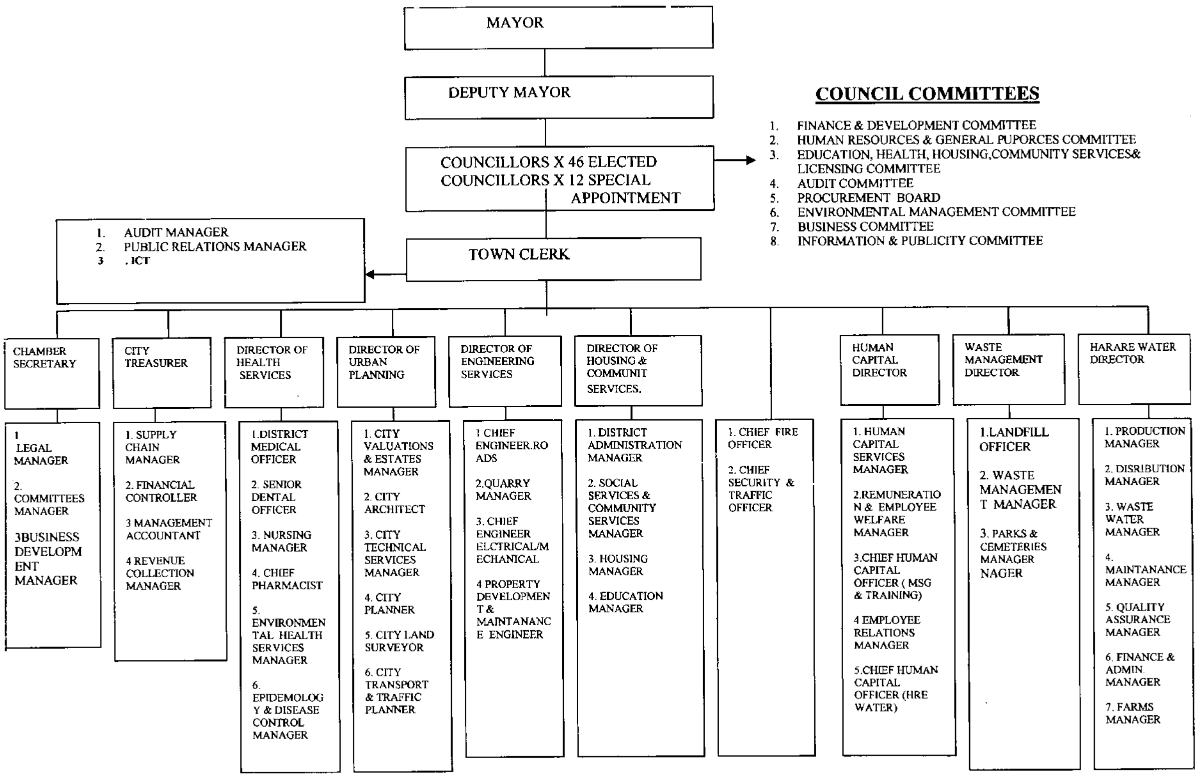


Figure 2.3.5 Organization Chart of City of Harare

Source: City of Harare

Figure 2.3.6 (1) shows the organization chart of whole Chitungwiza Municipality and each department of Administration Secretarial Service, Finance, Engineering, Health Service, Urban Planning Service and Housing and Community Services shown as Figure 2.3.6 (2) - (7). The number of staff of each department is 360 of Administration Secretarial Service, 72 of Finance, 342 of Engineering, 192 of Health Service, 17 of Urban Planning Service and 328 of Housing and Community Service, respectively.

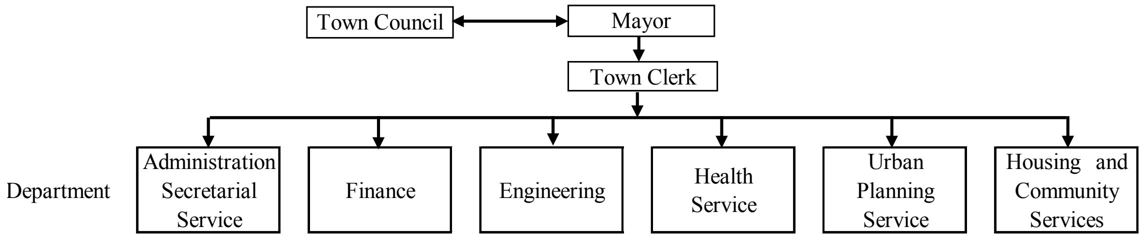
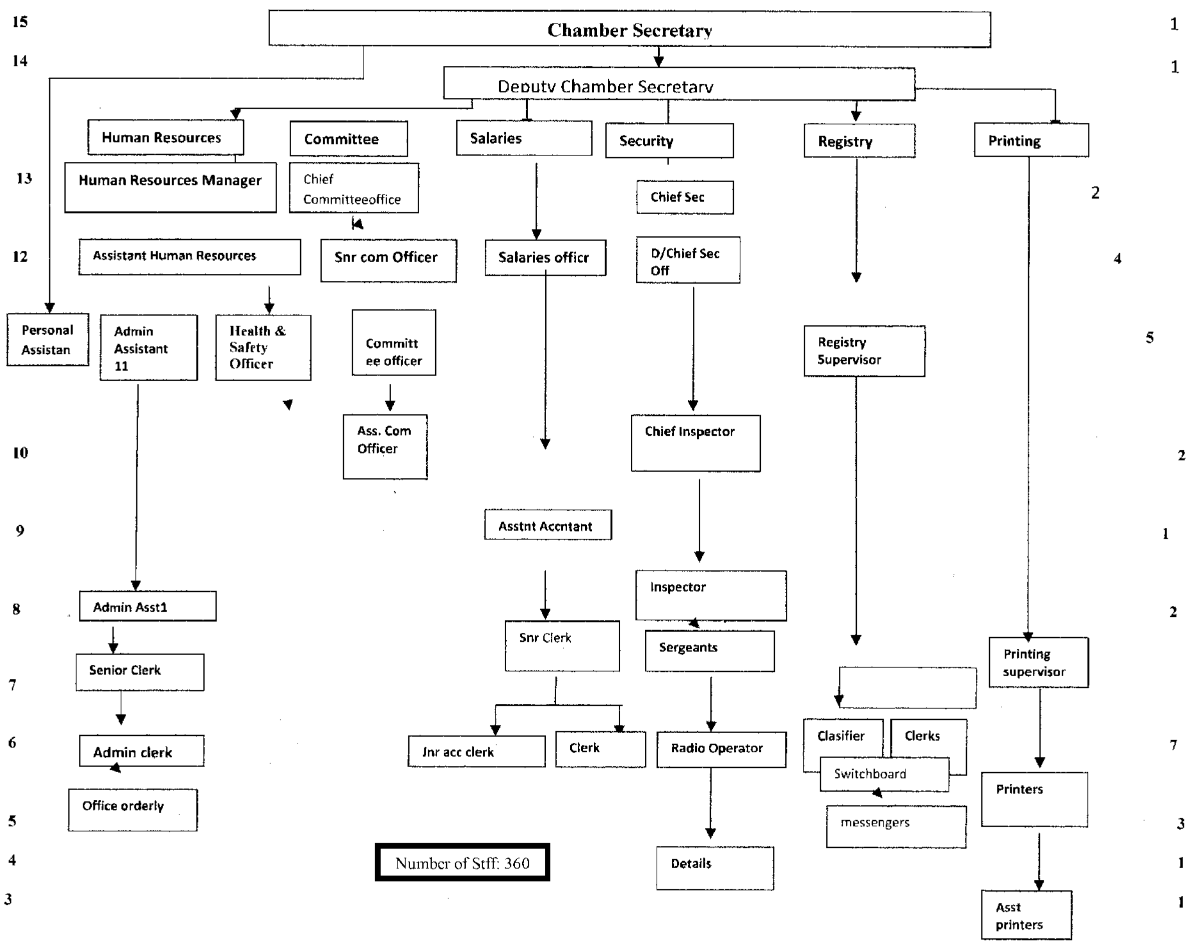
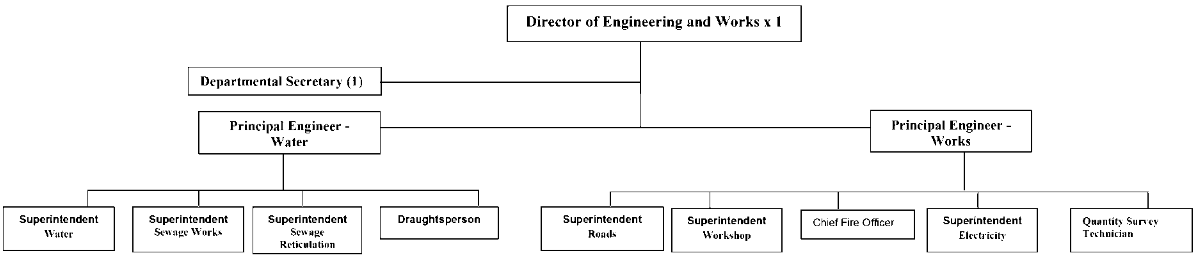


Figure 2.3.6 (1) Organization Chart of Chitungwiza Municipality Council



Sources: Chitungwiza Municipality

Figure 2.3.6 (2) Organization Chart of Department of Administration Secretarial Service



	Establishment	Actual	Vacant
Executive	1	1	0
Personal Assistant	1	0	1
Principal Engineer	2	0	2
Water Section	60	45	15
Sewage Works Section	129	46	83
Sewage Reticulation Section	96	89	8
Draughtsperson	1	0	1
Roads Section	103	54	49
Workshop Section	26	27	5
Fire Brigade Section	44	36	8
Electricity Section	11	9	9
Quantity Survey Technician	126	35	91

Number of Staff :342

Figure 2.3.6 (3) Organization Chart of Department of Engineering

Source: Chitungwiza Municipality

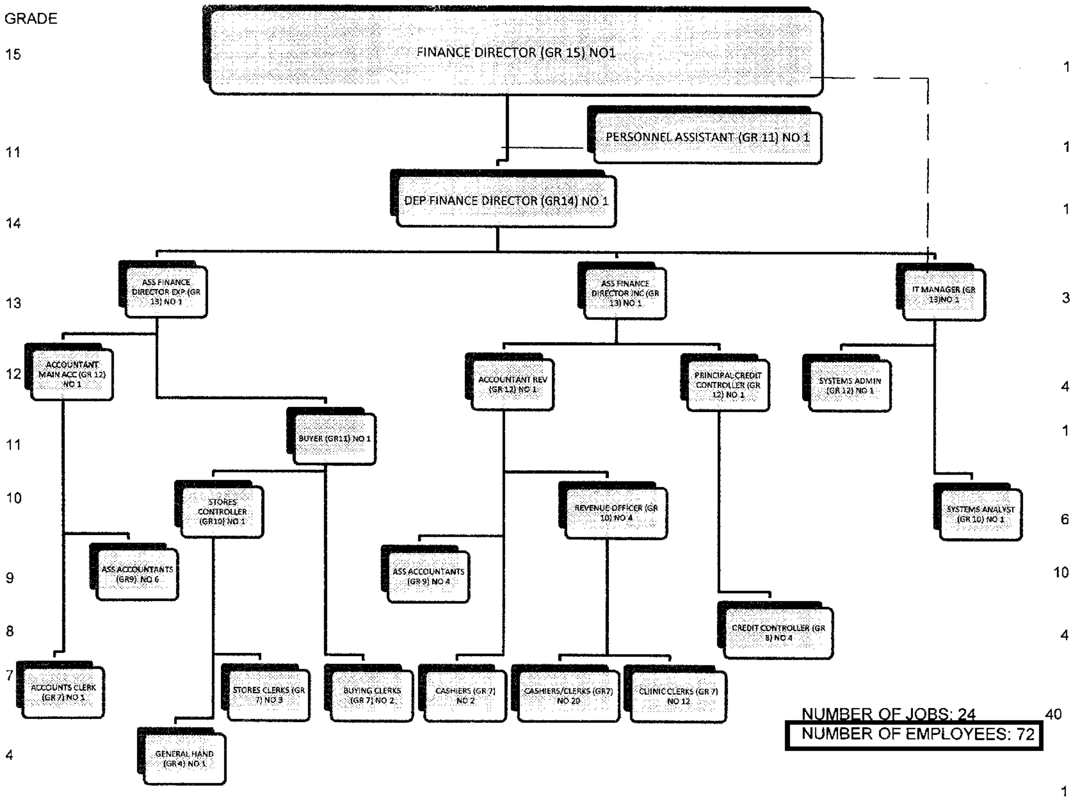


Figure 2.3.6 (4) Organization Chart of Department of Finance
Source: Chitungwiza Municipality

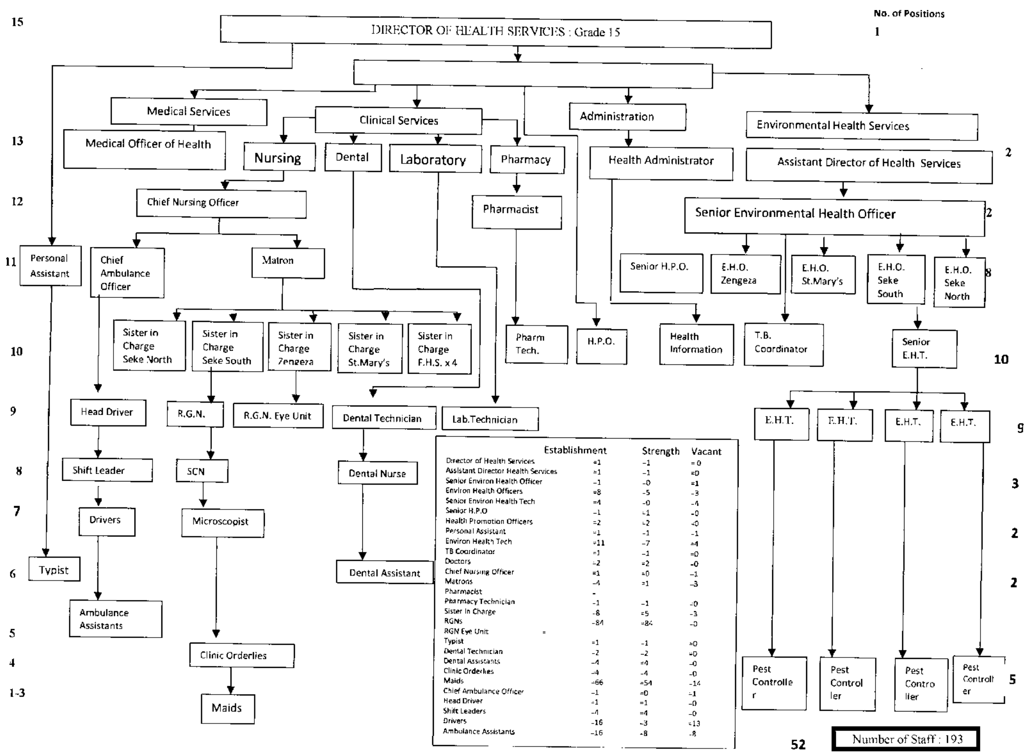


Figure 2.3.6 (5) Organization Chart of Department of Health Service

Source: Chitungwiza Municipality

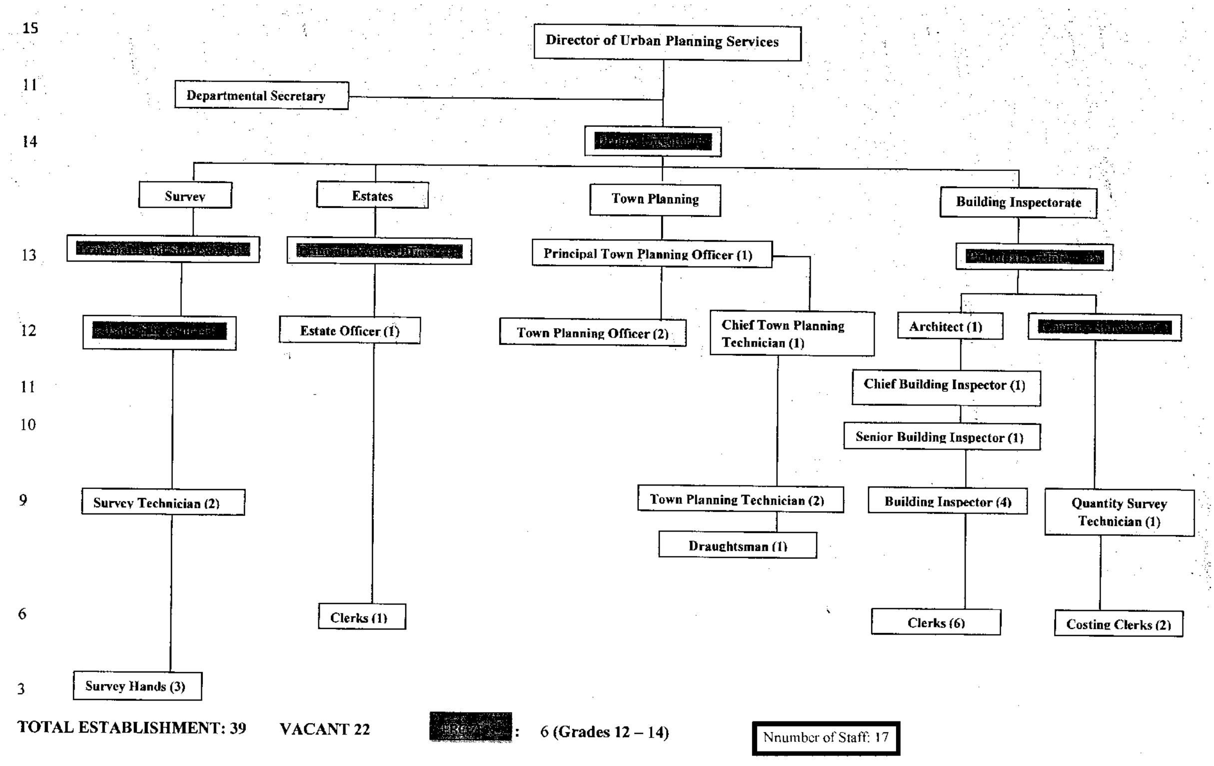


Figure 2.3.6 (6) Organization Chart of Department of Urban Planning Service

Source: Chitungwiza Municipality

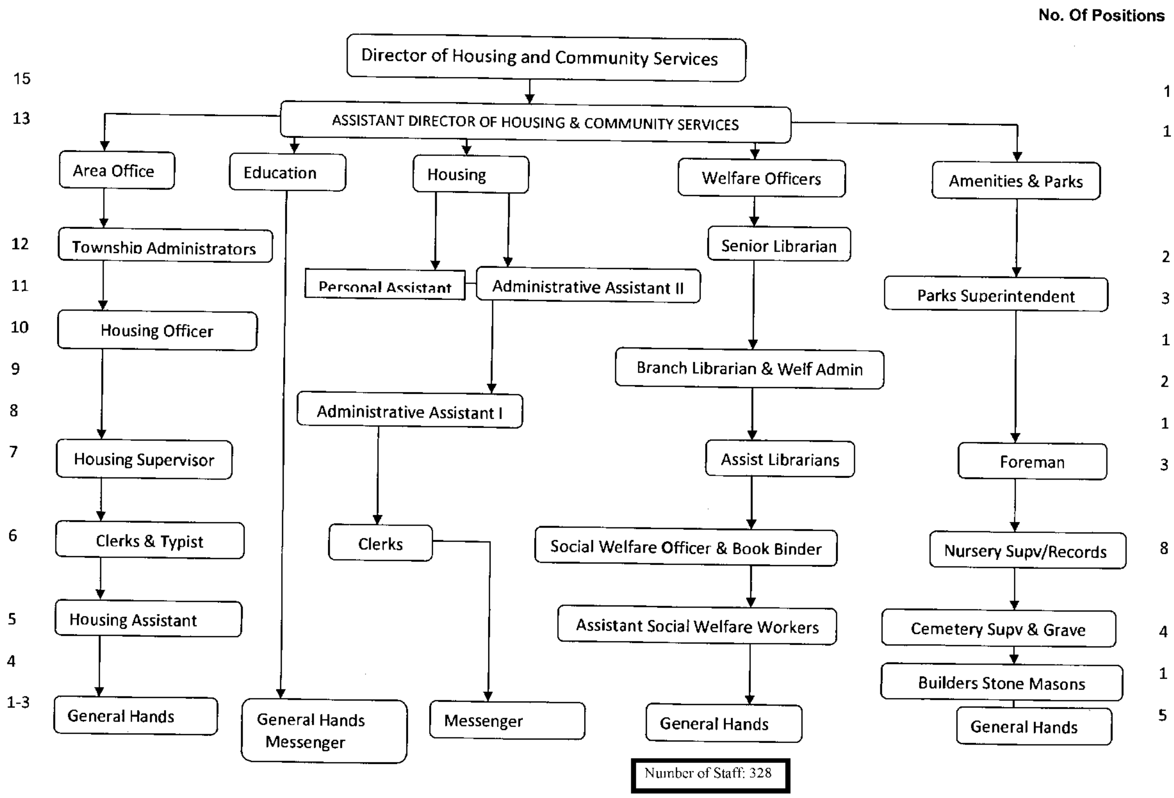


Figure 2.3.6 (7) Organization Chart of Department of Housing and Community Services
Source: Chitungwiza Municipality

Further, Sections of Water and Sewage Service are shown in Figure 2.3.6 (8).

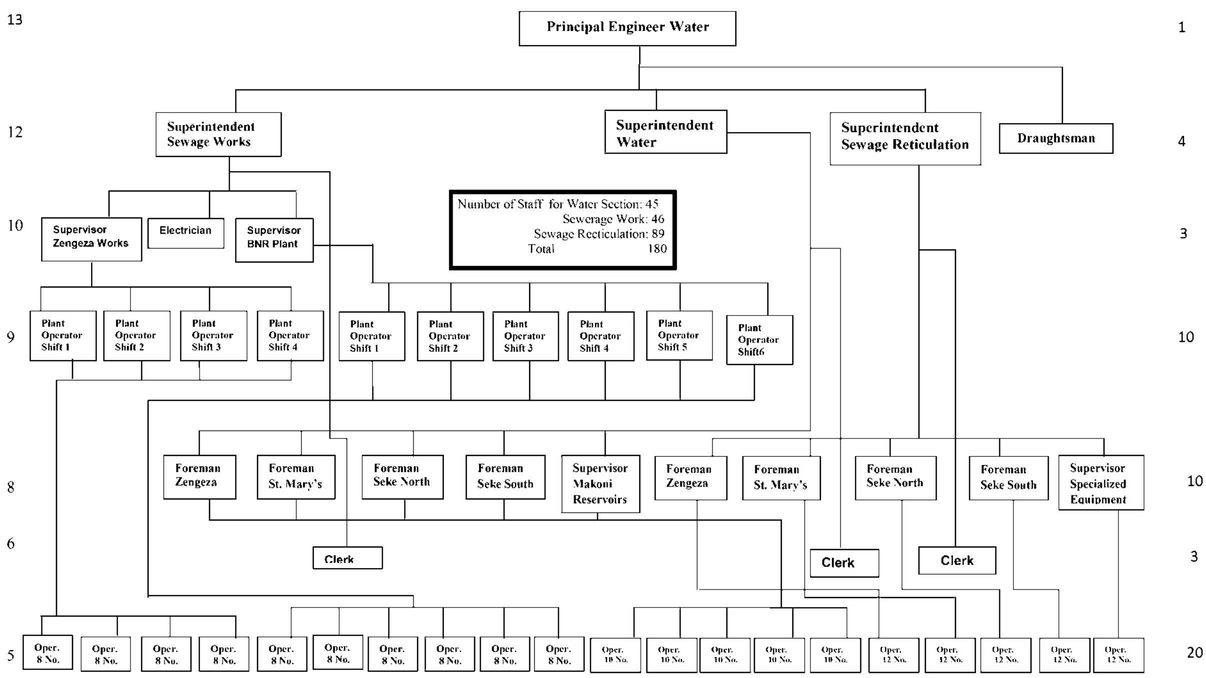


Figure 2.3.6(8) Organization Chart of Sections of Water and Sewage Service
Source: Chitungwiza Municipality

2.3.3 Socio-Economic Profile

Socio-Economic indicators of Zimbabwe are summarized in Table 2.3.2. Zimbabwe's economy performed reasonably well during the 1980s, averaging 5% GDP growth per year and 4.3% through the 1990s. However, initiatives taken by the government to create a market economy were unsuccessful. Material supply shortages and wild inflation resulted in a decade-long contraction of the economy during the period 1999 to 2008. Zimbabwe's involvement in the war in Congo, mismanagement and corruption contributed to the haemorrhage of hundreds of billions of dollars from the economy.

Since the inception of a coalition government in February 2009, Zimbabwe has been recovering from a low economic base, supported by a strong recovery of domestic demand and government consumption. However real GDP growth decelerated to 6.8% in 2011, from 9.0% in 2010 and is projected to decelerate further to 4.4% in 2012. Nominal GDP in 2011 is estimated at USD 9.9 billion, with GDP per capita at USD 698.

Agriculture contributes 17.4% to GDP, while industry provides 29.2% and the highest contributor, services, is at 53.4%. Of Zimbabwe's 3.86 million labour force, 66% is involved in agriculture, 10% is employed by industry and manufacturing and 24% is in services. The true unemployment rate is unknown but the underemployment was estimated at 95% in 2009.

Inflation is estimated at 5.3% in 2011, up from 3.1% in 2010. It is projected to rise to 6.5% in 2012 and 6.7% in 2013. Inflationary developments in the short to medium term will continue to be influenced by the US dollar/ South African rand exchange rate, inflation developments in South Africa, international oil prices and local utility charges.

Table 2.3.2 Socio-Economic Indicators of Zimbabwe

Poverty and Social Ratios	
Population (millions, mid year 2010)	12.6
GNI per capita (US$ current, 2010)	460
GNI (US$ billion current, 2010)	5.8
Population growth (%, 2004-2010 average)	0.0
Labor force growth (%, 2004-2010 average)	0.0
Most recent estimate (latest year available, 2004-2010)	
Poverty (% of population below national poverty line)	..
Urban population (% of total population)	38
Life expectancy at birth (years)	50
Infant mortality (per 1,000 live births)	51
Child malnutrition (% of children under 5)	14
Access to an improved water source (% of population)	80
Literacy (% of population age 15+)	92
Gross primary enrollment (% of school-age population)	..
Male	..
Female	..

Key Economic Ratios	Y 2009	Y 2010	Y 2011
GDP (US$ billion current)	5.9	8.3	10.0
GDP per capita (US$ current)	468	658	698
Real GDP growth	5.4	8.1	9.3
Gross capital formation/GDP	2.2	3.0	
Exports of goods and services/GDP	30.8	48.3	
Gross domestic savings/GDP	-25.9	-18.5	
Current account balance/GDP	-24.2	-23.1	
Interest payments/GDP	0.6	0.6	
Total debt/GDP	82.3	67.1	
Total debt service/exports	4.8	3.6	
Total debt/GDP	82.3	67.1	

Structure of Economy (% of GDP)	Y 2009	Y 2010
Agriculture	17.9	17.4
Industry	29.0	29.2
Manufacturing	17.0	14.9
Services	53.0	53.4
Household final consumption expenditure	116.4	107.7
General Gov't final consumption expenditure	13.3	19.1
Imports of goods and services	62.7	78.0
Prices and Government Finance		
Consumer price inflation (average, % change)	6.5	3.1
Current revenue (% of GDP)	16.5	29.5
Current budget balance (% of GDP)	10.5	8.1
Overall surplus/deficit (% of GDP)	-3.1	-2.7
Trade (US$ millions)		
Total exports (fob)	5,700	6,214
Tobacco	784	841
Gold	829	993
Manufactures	1,487	1,561
Total imports (cif)	7,019	7,482
Food	488	496
Fuel and energy	2,171	2,311
Capital goods	2,036	2,183
Balance of Payments		
Exports of goods and services (US$ millions)	1,798	3,608
Imports of goods and services (US$ millions)	3,662	5,831
Current account balance (US$ millions)	-1,426	-1,719
Reserves including gold (US$ millions)	..	376
Total debt outstanding and disbursed (US$ billions)	4,801	5,016
Total debt services (US$ billions)	101	109

2.4 Physical Characteristics in the Study Area

2.4.1 Natural Characteristics

(1) Meteorology

Zimbabwe has a tropical climate with a rainy season usually from late October to March but the climate is moderated by the high altitude. The average of monthly major meteorological index, such as temperature, sunshine hour, rainfall, evaporation and wind speed between 2004 and 2012 is shown in Figure 2.4.1 and Figure 2.4.1(2) shows annual rainfall and evaporation from 2005 to 2010, while evaporation was not measured from 2010. Above data was obtained in Airport as shown in Figure 2.4.1, and Zimbabwe Meteorological Service Department is managing other three (3) stations in Harare area as also shown in the figure.

Table 2.4.1(1), (2) shows average meteorological data of the observation records of four (4) stations in Harare area, the average data of the four stations was calculated, daily and monthly average readings were also calculated. Total, maximum and minimum values were also calculated. As shown in figure and tables, the meteorological features in target areas are described below:

The monthly average temperature fluctuates from 21.5 to 12 ℃, quite mild due to the high elevation of 1400-1500 m. However, daily temperature differences reach 15 degrees, relatively large, while the yearly maximum and minimum temperature was over 30 and around 0 ℃.

It is clearly a dry season from June to September, and annual rainfall amount is largely fluctuating. Annual evaporation largely exceeds rainfall amount, and it means that evaporation from water surface is huge.

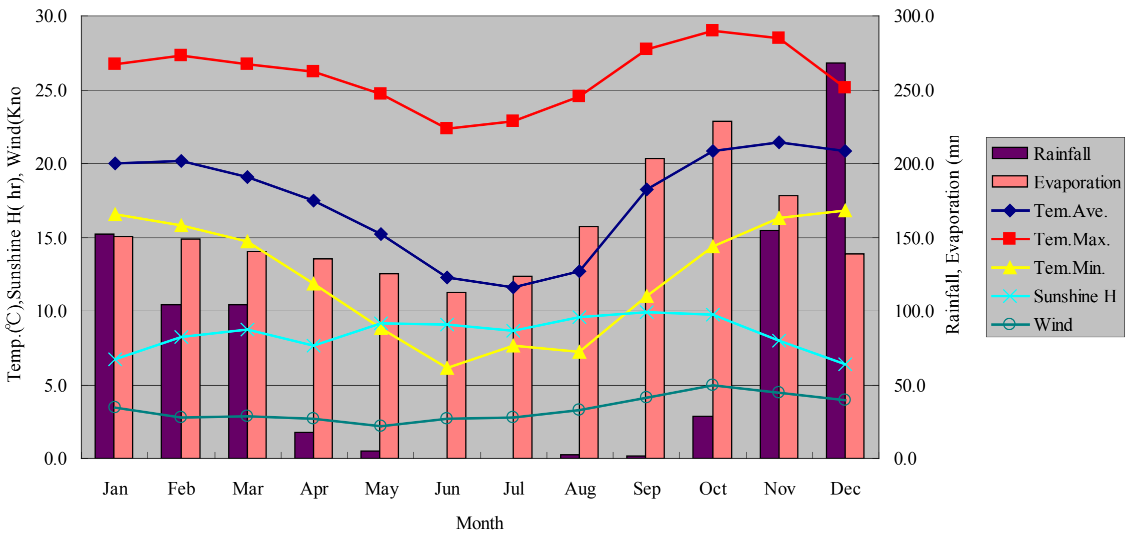


Figure 2.4.1(1) Annual Fluctuation of Meteorological Data at Airport

Data Source: Zimbabwe Meteorological Service Department

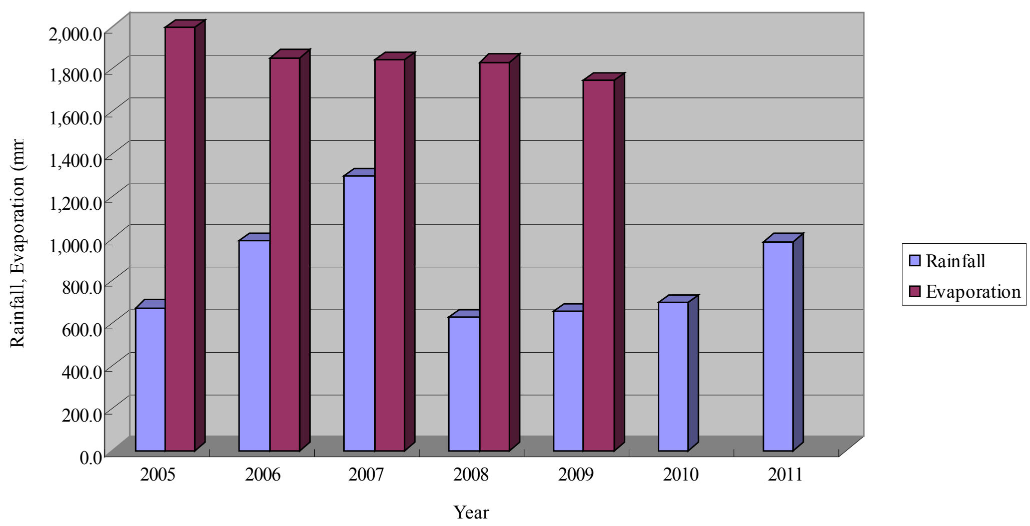


Figure 2.4.1(2) Yearly Rainfall and Evaporation Fluctuation in Airport
Data Source: Zimbabwe Meteorological Service Department

- Annual averages sunshine hours exceed 8 hours, quite long, especially in dry season.
- Average wind speed is 2.5-5m, relatively high, but the maximum speed was not so high, around 10 knots.

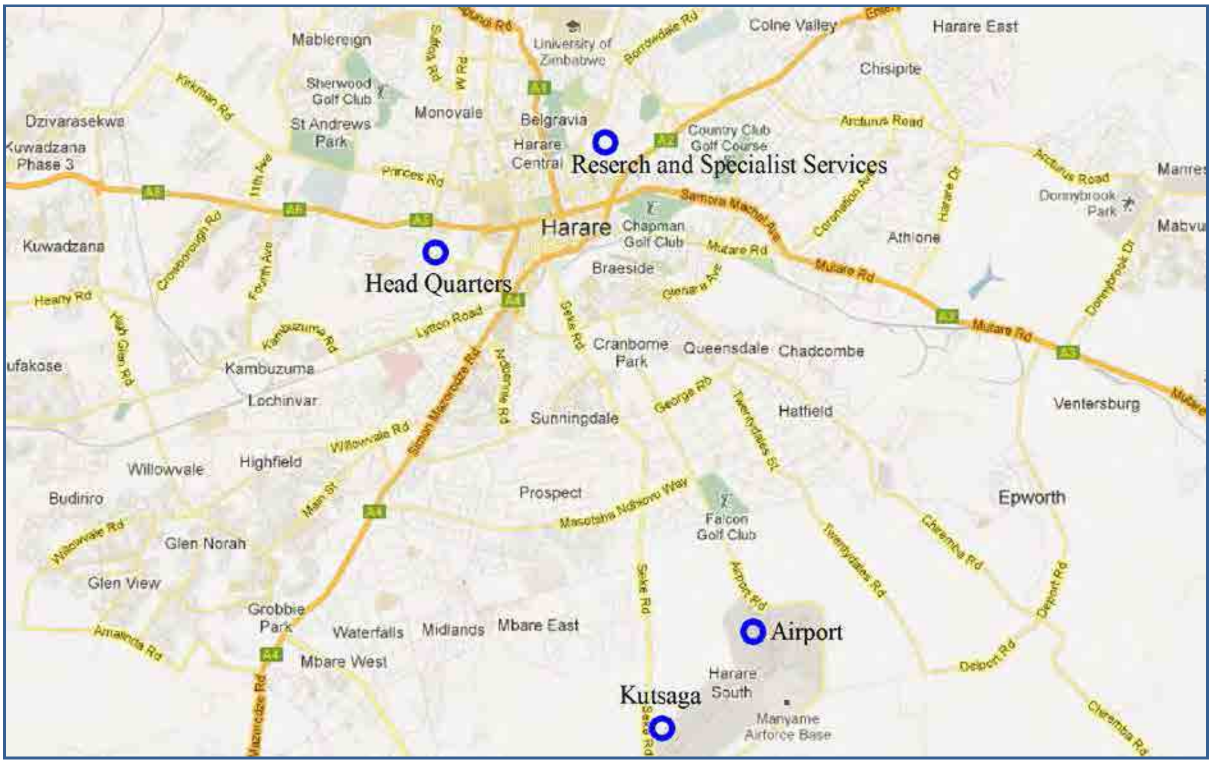


Figure 2.4.2 Location of Meteorological Observation Station
Base Map; Google Map

Table 2.4.1(1) Meteorological Data in Harare Area: Year 2010

Month	Item	Ave. (℃)	Max (℃)	Min (℃)	Rainfall (mm)	Wind (knots)	Sunshine (Hours)	Month	Item	Ave. (℃)	Max (℃)	Min (℃)	Rainfall (mm)	Wind (knots)	Sunshine (Hours)
Jan	Ave.	21.3	28.3	17.0	4.7	3.2	7.7	Jul	Ave.	12.0	21.3	7.4	0.0	3.5	7.3
	Total	-	-	-	144.4	-	239.3		Total	-	-	-	1.1	-	227.6
	Max	23.5	30.3	-	28.5	3.7	12.3		Max	13.7	24.5	-	1.1	6.7	10.7
	Min	18.5	-	15.7	0.0	0.9	0.3		Min	8.3	-	3.0	0.0	2.2	0.0
Feb	Ave.	20.4	27.0	17.0	5.2	3.7	6.5	Aug	Ave.	13.4	28.6	6.9	0.0	3.8	9.8
	Total	-	-	-	146.9	-	183.0		Total	-	-	-	0.0	-	303.4
	Max	23.5	31.2	-	68.0	8.6	12.3		Max	18.3	24.5	-	0.0	10.4	11.2
	Min	18.5	-	13.5	0.0	0.5	0.3		Min	9.0	-	3.5	0.0	2.0	2.7
Mar	Ave.	19.6	26.3	15.8	3.7	2.9	6.9	Sep	Ave.	18.1	27.8	10.4	0.0	4.6	10.4
	Total	-	-	-	115.5	-	213.2		Total	-	-	-	0.0	-	312.3
	Max	22.1	29.4	-	67.0	5.3	10.9		Max	21.5	31.5	-	0.0	7.8	11.3
	Min	16.0	-	11.0	0.0	0.3	0.2		Min	14.5	-	4.1	0.0	2.3	7.6
Apr	Ave.	18.5	26.5	14.9	1.6	3.7	7.8	Oct	Ave.	22.0	30.3	15.1	1.2	4.6	10.2
	Total	-	-	-	48.5	-	235.2		Total	-	-	-	36.9	-	316.1
	Max	22.1	29.4	-	26.7	6.2	11.1		Max	21.5	31.5	-	18.6	7.6	11.6
	Min	16.0	-	11.0	0.0	2.3	1.7		Min	14.5	-	4.1	0.0	3.1	4.9
May	Ave.	20.8	25.4	9.8	0.0	3.1	9.1	Nov	Ave.	21.3	28.5	16.8	4.3	4.5	8.1
	Total	-	-	-	0.1	-	273.1		Total	-	-	-	127.9	-	251.5
	Max	19.7	28.7	-	0.1	5.1	10.9		Max	21.5	31.5	-	39.2	7.7	12.4
	Min	13.0	-	8.0	0.0	1.5	5.6		Min	14.5	-	4.1	0.0	3.0	3.4
Jun	Ave.	11.6	21.7	6.0	0.0	3.3	8.5	Dec	Ave.	20.2	25.5	16.5	4.1	3.6	5.3
	Total	-	-	-	0.0	-	254.4		Total	-	-	-	126.1	-	163.7
	Max	16.0	24.5	-	0.0	5.6	10.7		Max	23.4	29.3	-	29.0	7.1	11.1
	Min	7.3	-	0.2	0.0	1.5	0.6		Min	18.1	-	14.9	0.0	3.0	0.0
								Annual	Ave.	18.3	26.4	12.8	2.1	3.7	8.1
									Total	-	-	-	747	-	2,973
									Max	23.5	31.5	-	68.0	10.4	12.4
									Min	7.3	-	0.2	0.0	0.3	0.0

Data Source: Chitungwiza Municipality

Table 2.4.1(2) Meteorological Data in Harare Area: Year 2011

Month	Item	Ave. (℃)	Max (℃)	Min (℃)	Rainfall (mm)	Wind (knots)	Sunshine (Hours)	Month	Item	Ave. (℃)	Max (℃)	Min (℃)	Rainfall (mm)	Wind (knots)	Sunshine (Hours)
Jan	Ave.	19.8	25.8	16.4	10.5	3.3	5.8	Jul	Ave.	10.9	21.8	5.3	0.1	3.5	9.2
	Total	-	-	-	326.0	-	180.3		Total	-	-	-	1.7	-	284.7
	Max	21.9	29.2	-	63.0	5.3	11.2		Max	14.1	26.3	-	0.0	6.8	10.9
	Min	17.7	-	13.0	0.0	2.0	0.0		Min	8.0	-	2.3	0.0	1.8	2.3
Feb	Ave.	19.3	26.6	15.2	5.5	3.1	7.4	Aug	Ave.	13.3	24.1	6.3	0.0	4.6	10.2
	Total	-	-	-	153.9	-	219.4		Total	-	-	-	0.0	-	316.7
	Max	21.3	28.7	-	83.2	4.3	12.2		Max	16.5	32.2	-	0.0	6.9	11.0
	Min	17.2	-	12.0	0.0	2.0	0.0		Min	8.5	-	3.0	0.0	1.8	6.4
Mar	Ave.	19.7	26.8	15.0	57.9	3.1	8.1	Sep	Ave.	18.4	27.6	10.5	0.0	4.3	10.4
	Total	-	-	-	57.9	-	251.3		Total	-	-	-	0.0	-	312.6
	Max	21.3	28.7	-	83.2	4.3	12.2		Max	16.5	32.2	-	0.0	6.9	11.3
	Min	17.2	-	12.0	0.0	2.0	0.0		Min	8.5	-	3.0	0.0	1.8	6.8
Apr	Ave.	18.2	26.6	13.3	1.1	3.3	8.4	Oct	Ave.	20.9	29.1	14.7	1.1	4.5	10.0
	Total	-	-	-	1.1	-	251.5		Total	-	-	-	33.7	-	308.5
	Max	22.0	30.4	-	18.3	8.4	10.9		Max	16.5	32.2	-	10.7	6.9	11.0
	Min	14.0	-	12.0	0.0	1.9	0.0		Min	8.5	-	3.0	0.0	1.8	6.4
May	Ave.	15.5	25.0	9.7	0.0	2.9	9.3	Nov	Ave.	21.8	28.6	16.7	4.0	4.4	8.1
	Total	-	-	-	0.0	-	287.4		Total	-	-	-	119.4	-	244.4
	Max	18.5	27.5	-	0.0	9.5	10.9		Max	26.0	33.6	-	48.3	6.7	12.9
	Min	13.0	-	12.0	0.0	1.8	0.0		Min	15.3	-	13.0	0.0	2.3	0.1
Jun	Ave.	12.2	23.5	6.0	0.1	2.9	9.6	Dec	Ave.	20.9	27.6	16.7	8.3	3.4	7.9
	Total	-	-	-	0.1	-	287.5		Total	-	-	-	256.9	-	246.4
	Max	16.8	25.5	-	0.0	6.9	10.6		Max	24.5	31.9	-	57.9	5.5	12.6
	Min	7.5	-	0.6	0.0	1.8	0.0		Min	16.2	-	12.5	0.0	2.4	2.4
								Annual	Ave.	17.6	26.1	12.1	7.4	3.6	8.7
									Total	-	-	-	951	-	3,191
									Max	26.0	33.6	-	83.2	9.5	12.9
									Min	7.5	-	0.6	0.0	1.8	0.0

Data Source: Chitungwiza Municipality

(2) Topography and geology with ecosystem

Figure 2.4.3 Topography Map of Zimbabwe

Source: howstuffworks.com

The Republic of Zimbabwe as shown in Figure 2.4.3 is a landlocked country in southern Africa, covering an area of 390,757 km^2, of which land occupies 386,670 km^2, and water occupies 4,087 km^2 (Data Source Zimbabwe Tourism Authority). Zimbabwe is bounded on the north and northwest by Zambia (797 km), southwest by Botswana (813 km), Mozambique (1,231 km) on the east, South Africa (225 km) on the south, and Namibia's Caprivi Strip touches its western border at the intersection with Zambia. The country is slightly larger than Japan, but the longest distance between western edge and eastern edge is less than 900 km due to its circular configuration.

Zimbabwe sits astride the high plateaus between the Zambezi and Limpopo rivers, its main drainage systems. Majority of the country is elevated, 21% being more than 1,200 m above sea level. The topography consists of 4 relief regions. The high veld (an open, grassy expanse) rises above 1,200 m and extends across the country from the northeast narrowing towards the southwest. The middle veld, lying between 900 and 1,200 m above sea level, flanks the high-veld, mostly extending towards the northwest. The low veld stands below 900 m and occupies the Zambezi basin in the north and the more extensive Limpopo and Sabi-Lundi basins in the south and southeast. Victoria Falls, one of the world's biggest and most spectacular waterfalls, is located in the country's northwest as part of the Zambezi River. The eastern highlands have a distinctive mountainous character, rising above 1,800 m, and include Mount Inyangani (sometimes called simply Inyangani), standing at 2,592 m above sea level. Refer to "http://www.nationsencyclopedia.com/economies/Africa/Zimbabwe"

(3) Hydrology and hydrogeology

1) Water sources

Water is a core development issue in Zimbabwe. It is central to agriculture, rural, urban and industrial development. Water is a key input in mining and energy sectors and it is fundamental for navigation, fisheries, national parks, natural ecosystems, recreation and assimilating wastes from urban, industrial, mining and agricultural sources of pollution. Available estimates suggest that agriculture accounts for

82% of surface water use while domestic and industrial use accounts for about 15% and mining 3%, according to 2007 estimates. Current estimates of different uses are not available although water demand for irrigation has dropped drastically.

Zimbabwe has limited water resources with much of the country being semi-arid and characterized by highly variable low rainfall averaging 657 mm/year. Rainfall varies spatially from the eastern highlands (1,100 mm/year) to low lying areas in the south and west (400 mm/year). Temporal and inter annual variability is high, impacting on availability and reliability. The country has invested heavily in the construction of storage works and currently Zimbabwe has a total storage capacity of 8,700 mil.m^3 with a yield of 3,670 x10^3 mil.m^3 from over 8,000 dams. This yield, together with groundwater and recycled water, is adequate to meet current water demands, except for the City of Bulawayo. At 1,547 m^3/capita/ year, Zimbabwe's renewable water resource is 25% of the average of Sub-Saharan Africa. With about 8,000 small, medium and large dams, Zimbabwe has the second highest per capita water storage capacity in Southern Africa.

Zimbabwe shares trans-boundary water courses with neighbouring countries in the following river systems; the Zambezi, Pungwe, Buzi, Save, Limpopo and Nata rivers. Being mostly upstream in the catchments of the rivers limits the ease with which these resources can be developed. However the country is engaged in developing joint venture approaches with its neighbours e.g. the Batoka dam and hydropower scheme between Zimbabwe and Zambia. The Zambezi alone has an estimated average mean annual runoff of 40,000 mil.m^3 at Victoria Falls (nearly twice the mean annual runoff of the internal rivers) hence the Zambezi comprises an important source of water for the cities of Bulawayo and Harare, for irrigation of the Zambezi Valley and for hydro and thermal power stations.

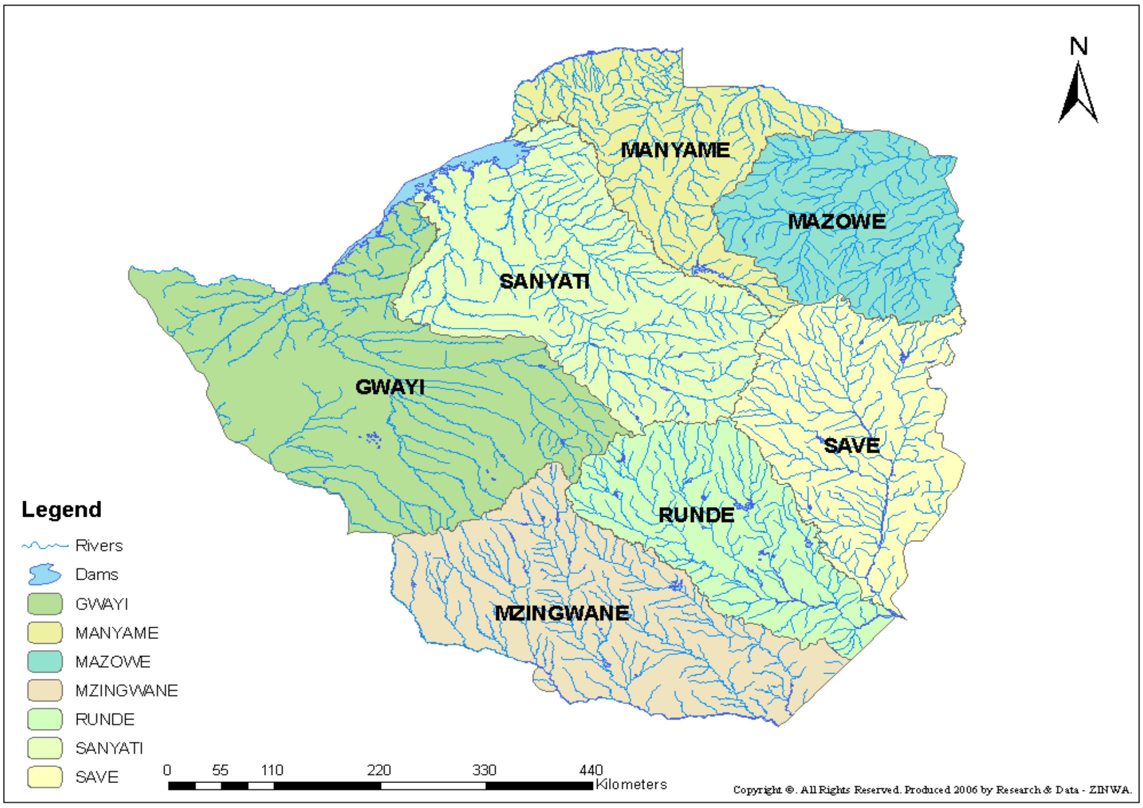
Groundwater use is estimated to be 1,000 mil.m^3 out of an estimated potential of 3,000 mil.m^3. These figures require more investigation as this source is no longer just supplying water to the rural population but is currently also a major source in urban areas.

Zimbabwe considers treated wastewater as an important additional source of water. The former Department of Natural Resources together with the then Ministries of Agriculture and of Water Development spearheaded the use of treated waste water for irrigation during 1964 to 1968 following the success by the City of Bulawayo in using treated wastewater for industrial and irrigation development. An estimated 365 mil./annum (equivalent to Mazvikadei Dam) of treated waste water from major and large urban areas is potentially available for use as raw water for irrigation or source for domestic water supply. Refer to Zinwa materials

2) Manyame catchment

i) Characteristics of the catchment area

From the necessity to improve the management of water resources, the Government of Zimbabwe instituted a Water Sector reform process that culminated in the promulgation of the New Water Act, Chapter (20:24) of 1998 and the ZINWA Act, Chapter(20:25). Based on these Acts, the country is divided into seven Catchment areas as show in Figure 2.4.4



Source: Zinwa

Figure 2.4.4 River system of Zimbabwe

Manyame Catchment Area shown in Figure 2.4.4 is the target area of this study, thus the location, topography, climate surface/ground water assessment for the Manyame Catchment area are described in this section.

The source of this catchment is Marondera and flows into the Zambezi river downstream of the Kariba Dam and upstream of the Cabora Bassa dam to the northern part of the country. Total catchment area is 40,497 km^2 and it is characterised by Agro ecological region-ll with low rainfall conditions. Figure 2.4.5 shows the Manyame catchment and its sub-catchments.

Topographically, the Manyame slopes generally towards the northern direction showing the direction of the Manyame river, which flow into the Zambezi river basin. The whole catchment can be divided into roughly three mains plains based on the spatial distribution of the catchment. The upper parts of the catchment is 1,800 m above sea level while the lower parts lies 300 m above sea level.

The average temperatures in major part of Manyame catchment are relatively medium to high, from 24.0℃ to 32.0 ℃. Rainfall in this region is around 750-900 mm/annum.

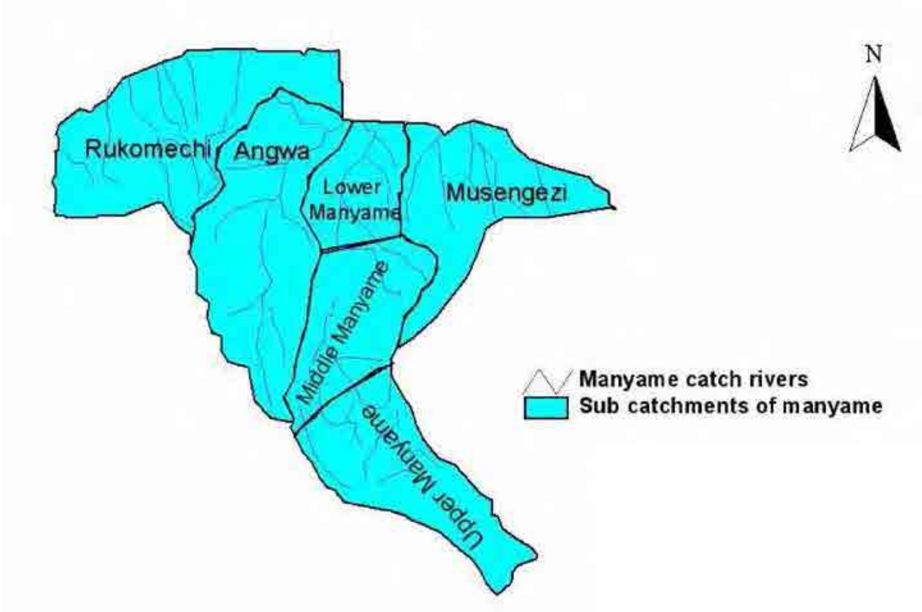


Figure 2.4.5 Manyame Sub-Catchment Area
Source: ZINWA

Manyame catchment covers areas that are dischrged by three main rivers of Manyame, Musengezi and Angwa. Upper Manyame, where the project area is located, is composed by subzones CH4 and CH5. The various indication of Manyame catchment area is shown in Table 2.4.2. The aquifer types found in Manyame catchment are crystalline (igneous/metamorphic rocks), consolidated and unconsolidated sedimentary aquifers. The upper Manyame catchment area's recharge capacity is very limited as shown in Table 2.4.3 because the area is dominated by impermeable surface which hinders the infiltration of water to underground. As shown in Table 2.4.3, Utilization of groundwater resource is limited.

Table 2.4.2 Various Indication of the Manyame Catchment Area

Catchement	Sub-zone	Area (km^2)	M.A.R. (mm)	Unit Yield (mil. m^3)	Storage (mil. m^3)	10% Yield (mil. m^3)	Yield in Use (%)	Rainfall (mm/year)	Evaporation (mm/year)	B.F.I.
Upper Manyame	CH4	1,959	126	83	752.6	149.48	91.0	798.6	1,631	0.25
	CH5	1,817	135	91	89.8	70.85	42.8	820.5	1,696	0.30
	Total	3,776	261	174	842.4	220.33	133.8	1,619.1	3,327	-
	Average	1,888	131	87	421.0	110.00	67.0	810.0	1,664	0.28
Middle Manyame	CH3	4,245	123	78	982.2	285.00	85.4	802.3	1,781	0.30
Lower Manyame	CH1	4,018	66	38	249.6	94.04	61.8	780.3	2,330	0.07
	CH2	2,290	126	82	112.0	78.03	41.5	821.3	1,855	0.80
	Total	6,308	192	120	361.6	172.07	103.3	1,601.6	4,185	-
	Average	3,154	96	60	180.8	86.04	51.7	800.8	2,093	0.44
Total		14,329	576	372	2,186.2	677.40	322.5	4,023.0	9,293	-
Average		2,866	115	74	437.2	135.48	64.5	804.6	1,859	0.34

Note) M.A.R: Mean Average Rainfall, B.F.I.: Base Flow Index

Table 2.4.3 Groundwater Recharge and Demand

Manyame Catchment	Recharge(mil.m^3/y)		Sectral Demand			
	Total	Urban	Urban Use to Recharge(%)	Industrial (mil.m^3/y)	Agriculture (mil.m^3/y)	Agricultural use to Recharge(%)
Upper	59.1	1.617	2.74	0.43	9.2	15.6
Middle	72.1	0.077	0.11	0	1.84	2.5
Lower	138.6	0.035	0.03	0	0.93	0.7

Source: ZINWA

3) Hydrogeological condition of Manyame catchment

Groundwater is a slow-moving, viscous fluid; many of the empirically derived laws of groundwater flow can be alternately derived in fluid mechanics from the special case of Stokes flow. The mathematical relationships used to describe the flow of water through porous media are the diffusion and Laplace equations, which have applications in many diverse fields. Steady groundwater flow has been simulated using electrical, elastic and heat conduction analogies. Transient groundwater flow is analogous to the diffusion of heat in a solid; therefore some solutions to hydrological problems have been adapted from heat transfer literature.

Traditionally, the movement of groundwater has been studied separately from surface water, climatology, and even the chemical and microbiological aspects of hydrogeology. As the field of hydrogeology matures, the strong interactions between groundwater, surface water, water chemistry, soil moisture and even climate are becoming clearer.

ii) Upper Manyame sub-catchment hydrology

Upper Manyame sub-catchment is bounded by Upper Mazowe sub-catchment to the north. Middle Manyame to the NW, Sanyati catchment to the SW, Nyagui sub-catchment and Save catchment to the east and south east respectively. Seke district to the west and Maronderqa are ordered to the SE.

The general geology upper Manyame sub-catchment consists of green-stones of the Bulawayo Group, older gneisses and granites of the Basement Complex, Great dyke mafics and ultra-mafics, doleritic and gabbroic dykes. The varied nature of the geology is easily discernible, from the persistent stretches in the soil pattem. The geological units of the sub-catchment are described as follows.

a) Harare greenstone belt

The greenstone belt occupies the central part of the sub-catchment and is a succession consisting of tightly folded, extremely sheared, matamorphosed volcanic and voicaniclasic or sedimentary rocks of the Bulawayan Group. These are usually fissured and fractured in the most of central part of the sub-catchment. These secondary structures enhance their groundwater potential yields vary from 0.5-30 l/s. However, most of the values are usually associated with highly fractuered/faulted zone and dolerite dyke contacts. Borehole depths range from 30 - 60 m and water strikes vary from 10 - 40 m, with values being less than 50 m. Groundwater levels range from 1 - 20 m and are mostly less than 10 m.

b) Gneisses and granites

Granitic rocks are more abundant than any other rock type in the sub-catchment and stretch from NW to the SE part of the sub-catchment. They are varied in age and range from older gneissic rocks to younger granites. These rocks have poor groundwater potential as they have no primary permeability and porosity. These rocks cover the largest part of the UMSC. Groundwater yield is controlled by the development of secondary structures such as faults, fractures and regolith. Groundwater potential under such conditions is invariable related to the amount of rainfall, fracture pattern distribution and regolith development. Borehole depths in containing gneisses and granites range.

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Refer to Manyame River System Outline Plan

(4) Natural environment and ecology

The climate is moderated by the altitude. The country is mostly savanna, although the moist and mountainous east supports tropical evergreen and hardwood forests. Trees include teak and mahogany, knob thorn, msasa and baobab. Among the numerous flowers and shrubs are hibiscus, spider lily, lotus, cassia, tree wisteria and dombeya.

Mammals include Hippopotamus, Rhinoceros, Baboon, Okapi, Giraffe, Kudu, Sable, Zebra, Warthog, Porcupine, Badger, Otter, Hare and many more. In all, there are around 350 species of mammals. Snakes and lizards abound. The largest lizard, the water monitor, is found in many rivers, as are several species of crocodile. More than 500 species of birds like the Ant-thrush, Barbet, Bee-eater, Bishop Bird, Bulbul, Bush-warbler, Guinea fowl, Emerald cuckoo, Grouse, Gray lourie, and Pheasant. Not forgetting the insect kingdom.

Zimbabwe has quite an incredible biodiversity. However, it contains a large amount of the conventional tropical flora and the African fauna. Mostly blanketed with savanna grasslands, its mountains nevertheless consist of evergreen forests. The chief animals of the country are the Big Five game, a few Primates and Antelope. A diverse variety of freshwater and avian fauna is also to be found amongst the 131 species of fish; the tiger fish is a specialty. Refer to Zimbabwe Wildlife Management

2.4.2 Industries and Infrastructures

(1) Major industries

Zimbabwe has a substantial and diverse manufacturing base, which is partly a legacy of the international sanctions imposed over the five years prior to independence. Industry accounted for only 14% of GDP in 2000, however. Manufacturing was at its lowest level in 15 years in 2000 due to civil unrest. Food and beverages, minerals processing, chemical and petroleum products, and textiles account for the majority of the value added by manufacturing. Lower levels of consumer demand because of high prices have affected producers of many household goods, clothing, footwear, drink, and tobacco products.

The Zimbabwe Iron and Steel Corporation (ZISCO) were operating at 30% in 1996, and supplied 60% of local need. The Zimchem chemical refinery processes a range of chemical products. Cement is produced in large quantities. Zimbabwe also has a substantial cotton and textile industry. The textiles industry has lost some 17,000 jobs in recent years to foreign competition from South Africa, which used subsidies, export incentives, and tariff protection to support its textiles industry. The gold mining industry faced collapse and closure in 2000 because of a lack of foreign exchange. Gold output dropped by half in that year and 46,000 jobs were in peril. The tobacco industry was also in danger of foreclosure due to farm repatriation. As of 2002, the dire condition of the economy (a severely problematic balance of payments situation, devaluation of the currency, desperate foreign currency shortage, high inflation, very high interest rates, a fall in exports, and fuel shortages) was damaging the operations and viability of the manufacturing, construction, and mining sectors, in addition to agriculture. In 2000, manufacturing contracted at least 10.5%. Refer to "www.infrastructureafrica.org"

(2) Agriculture and irrigation

Currently major agricultural products in Zimbabwe are corn, cotton, tobacco, wheat, coffee, sugarcane and peanuts from cultivated land, and sheep, goats and pigs from stockyards. There has been a significant reduction in water utilization in the agricultural sector. In particular irrigation in A1 and A2 farms is under-utilizing developed water resources. The capacity of ZINWA and Catchment Councils to undertake water development and management largely depends on revenues derived from agricultural water sales. The revenues realized from the sales depend on the health of the irrigation sector that in turn relies on the level of investments in irrigation rehabilitation and development. The security of tenure of A1 and A2 farms is viewed by farmers and creditors as being inadequate to meet security or collateral requirements to underpin the risk of investing in rehabilitation or development. Although at one time 82% of the country's water resources were used by agriculture through irrigation, in particular commercial irrigation, commercial irrigation has since dropped to an estimated 20% in most catchment areas, except Runde and Save. The decline in water use has resulted in the collapse of the financial viability of ZINWA and Catchment Councils and substantially undermined their capacity to undertake water resources development and management.

A further problem is the lack of clear policy and regulations on how farmers should share irrigation infrastructure such as dams, boreholes, water abstraction systems, pumping plants and water conveyance systems which existed on the previous commercial farms which have become A1 and A2 farms under the new system.

The financial viability and affordability of rehabilitation of the irrigation infrastructure on previous commercial farms needs careful consideration, given that the majority of the A1 farmers and some A2 farmers do not have the skills and capacity to operate and maintain such irrigation schemes. Rehabilitated schemes which will not be commercially viable will rapidly fall back into disrepair, wasting the financial resources applied to rehabilitate them. The depressed water utilization on resettled farms results in limited revenue to ZINWA, Catchment Councils and sub-Catchment Councils which in turn results in loss of human resources and an inability to perform their proper functions. As a result inadequate information is being collected and analysed on agricultural infrastructure and water uses, and water resources are being inadequately managed. Zimbabwe places very high priority on irrigation development. The total developed irrigated area with formal irrigation infrastructure in Zimbabwe was estimated at between 160,000 and 180,000 ha in 2000. Additionally informal gardens accounted for an estimated 20,000 ha, although the figure could be higher. It is estimated that internally renewable water resources can command an extra 250,000 to 300,000 ha at 10% risk, if appropriate technologies are deployed to utilize the water. The use of trans-boundary water for irrigation will boost this figure several-fold. A key step to start reviving irrigated agriculture is to prioritize selective rehabilitation of non-functional irrigation schemes. Refer to National Water Policy

(3) Environmental destruction and pollution

According to all Africa Global Media, animal waste, fertilizers, municipal, industrial and mining wastewater, urban storm water and runoff from agricultural, livestock and poutry operations have impaired the Zimbabwe National Water Authority's capacity to meet the growing demand of water in Harare and surrounding towns. Unusual outbreaks of bloody diarrhoea are killing young children, the herald reports. According to the Herald, industry discharges a variety of pollutants in their waste water, for instance resin pellets, organic toxins, pathogens. These are released directly into the water body and in this case, into Nyatsime River all the way down to Lake Chivero via Manyame River. Lake Chivero is the source of water for Harare and surrounding towns like Chitungwiza and Norton. "Water treatment costs has risen sharply in recent years because of excessive pollution. Passing the real cost to the consumer has been difficult as the majority cannot afford to pay market rates". Basically Zinwa is failing to provide potable water to residents all the time.

Point source pollution from urban waste water treatment works, solid waste, and alluvial gold panning is continuing un-abated in river systems such that pollution levels have reached heights causing serious concern. Manyame, Gwayi and Odzi river systems are cases in point. Acid/alkaline mine water drainage into public streams is on the increase. With respect to effluent discharge, receiving waters are unable to self-purify causing eutrophication as well as the deposition of harmful chemicals, leading to high water treatment costs. This scenario implies that current regulations, penalties and enforcement practices have not been effective.

Another water pollution accidents were caused by mining. The Marange diamond fields in eastern Zimbabwe have been an infamous example. Refer to All Africa Global Media

(4) Power supply

Zimbabwe Electricity Supply Authority, (ZESA) officially called ZESA Holdings (Pvt) LTD., is a state-owned company whose task is to generate, transmit, and distribute electricity in Zimbabwe. It has organized this task by delegation to its subsidiaries, the energy generating company Zimbabwe Power Company (ZPC) and the Zimbabwe Electricity Transmission and Distribution Company (ZETDC). Other subsidiaries are investment branch ZESA Enterprises (ZENT) and internet provider PowerTel Communications (Pvt) ltd. ZESA is the only electricity generator and supplier for the public grid. In many years the company has failed to produce enough energy to meet demands. ZESA produced an estimated 8.89 bill kWh (101 mil/kW/hr) in 2007, while demand was estimated to 10.89 bill kWh (1.24 mill/kW/hr). ZESA represents Zimbabwe in the Southern African Power pool.

Table 2.4.4 List of Power Station

Division	Station Name	Capacity (MW)
Hydro	Kariba	750
Thermal	Hwange	920
	Harare	100
	Bulawayo	90
	Munyati	100
Total		1,960

Data Source; MTP

It is said that Zimbabwe needs 2,200 MW of electricity at peak but generates just 1,300 MW even though the total design capacity of power stations is over 2,000 MW and imports the remainder from Zambia, Mozambique and Namibia. In addition, imported power is frequently stopped due to outstanding unpaid electricity charge of produced country. Under this condition, power failures in almost all areas of country are caused almost every day.

Table 2.4.5 Tariff table of Electricity

Categories	Mining, Industrial, Commercial & Pumping Works				Agriculture		Institutions		
	Low Voltage	11kV	33kV	Second-ary	11kV	33kV	Low Voltage	11kV	33kV
a) Fixed Monthly Charge(US$)	0	0	0	0	0	0	0	0	0
b) A monthly capacity charge（US$/Demand)	---	6.93	5.08	3.25	6.93	5.08	N/A	6.93	5.08
c) An interruptable demand charge(US$/Demand)	---	N/A	N/A	2.44	N/A	N/A	N/A	N/A	N/A
d) On-Peak Energy charge（US$/kWh）	---	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
e) Standard Energy charge（US$/kWh）	---	0.07	0.07	0.07	0.07	0.07	0.12	0.07	0.07
f) Off-Peak Energy charge（US$/kWh）	---	0.05	0.05	0.05	0.05	0.05	0.12	0.05	0.05
Energy Charge(US$/kW)	0.12	---	---	---	---	---	---	---	---

Data Source: ZPC

(5) Traffic

The road network of Zimbabwe is shown in Figure 2.4.6.

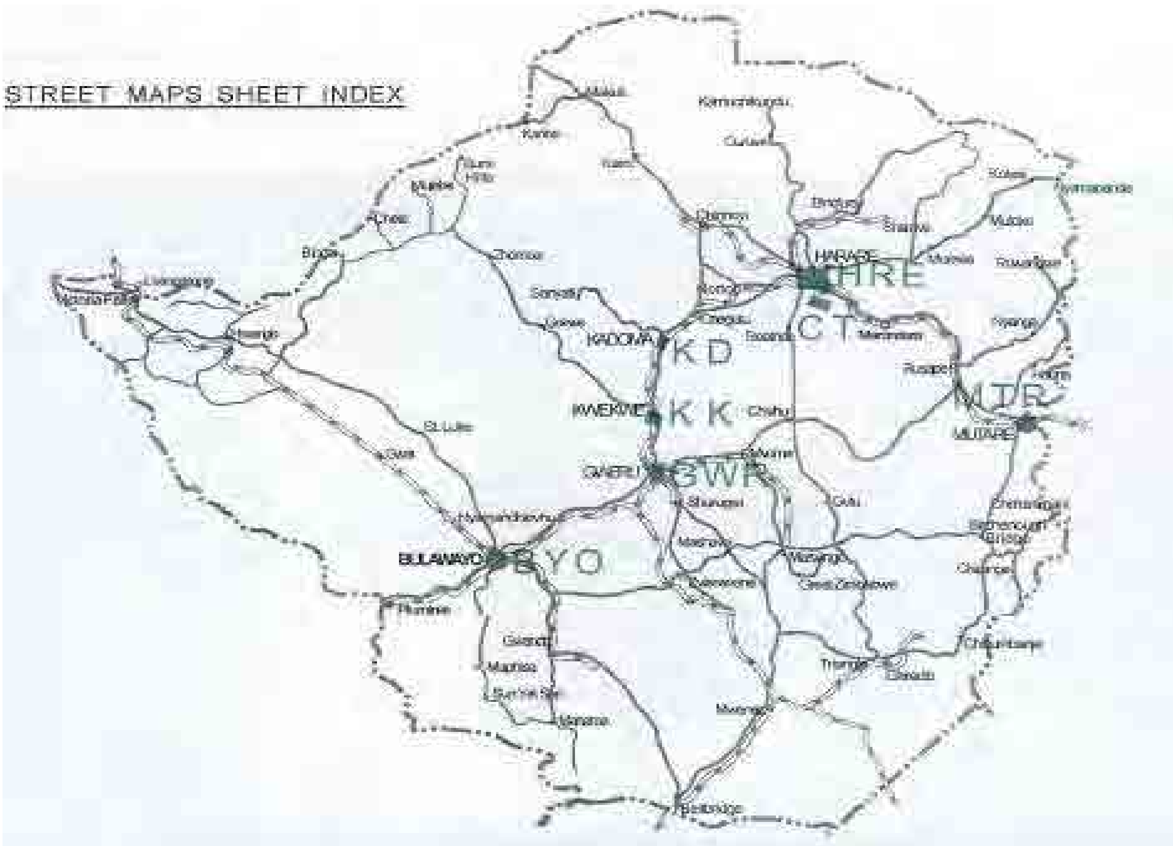


Figure 2.4.6 Road and Railroad Network of Zimbabwe

Source: City of Bulawayo Streets Guide

The total length of Zimbabwe roads is 88,300 km and that of paved loads is 15,000 km. These are composed by primary and secondary roads of18, 430 km with management by the Department of Roads in the Ministry of Transport and Communications (MoTC), urban roads of 8,530 km with management by Urban Councils (UC), Core network of tertiary roads of 26,000 km with management by the District Development Fund (DDF) in liaison with local authorities and Other tertiary roads of 35,370 km with management by Rural District Councils (RDC).

Network of Zimbabwe railway is also shown in Figure 2.4.4 and the total length of railway is 3,077 km (2002) with narrow gauge (1,067 mm). The number of airport is over 400, however most of them are located in farmlands and only 19 of them have paved runway.

Refer to "http://www.ifrtd.org/en/regions/country_pages/Zimbabwe.php"

(6) Water supply and sanitation

1) Urban Water Supply and Sanitation

Historically, Zimbabwe's Urban WSS services development has been driven by principles of high service levels and standards and universal access for all, making them unique in Africa. It was mandatory that construction and legal occupation of urban houses be preceded by the development of service roads, water supply and sewerage services. This approach ensured that service delivery kept pace with housing development. The parallel development process in which wealthier sections of urban areas subsidized the development of the poorer section of urban areas, advanced principles of universal access to all. However, like all other sectors of Zimbabwe's economy, urban water supply and sanitation services have faced serious challenges over time due to population pressure and economic challenges of the past decade. The challenges led to highly degraded services that pose a serious health threat to urban inhabitants. The more than 4,000 deaths related to cholera, inadequate and erratic water supply and sanitation, poor quality of water availed to residents and dire state of infrastructure are cases in point.

This situation has to be rectified as a matter of urgency. It calls for bold decisions on whether it is practicable to maintain the high standards of urban housing services while at the same time achieving universal access for all under the current economic circumstances, where evidence of the past decade has shown otherwise. The first option is to maintain high standards and call for a moratorium on new un-serviced housing developments during the 5-year recovery period at the risk of faultering on universal access to all. The second option is to prioritize universal access for all over high standards during the recovery period, followed by a full resumption of high standards during normal development phase. The state of deterioration of urban water supply and sanitation services in Zimbabwe is estimated as follows:-

- Access to urban water supply decreased from 97% in 1990 to 60% in 2008,

- Access to urban sanitation decreased from 99% in 1990 to 40% in 2008,
- Hours of water supply per day dropped to between 6 and 12
- Costs exceeded tariffs in 50% of urban local authorities as of 2012.

Increasingly, revenues from water services have been used to cover the costs of a wide range of non-water services and not to maintain water infrastructure, leading to a progressive collapse in water services. Cost recovery has dropped significantly due to billing and collection challenges, including faulty or non-existent meters and reduced willingness and ability to pay for unreliable and low quality services. Low revenues have resulted in large financial deficits in funding operation and maintenance, rehabilitation and the expansion of infrastructure.

On the water supply side, this has led to aging infrastructure including storage, treatment facilities, pumps and conveyance systems, giving rise to high water losses. On the waste-water side it has resulted in overloaded, aged and in some cases non-functioning sewage treatment plants. In addition to these challenges, as a result of the overall economic collapse, power outages are frequent and lengthy, impacting on service delivery as pumping is interrupted and both clear water and sewerage treatment plants are unable to operate. As a result of widespread skills flight, human resources in the sector have been critically reduced.

This situation raises a range of issues which need to be addressed including clarifying the role of central government, urban authorities and ZINWA, and developing improved institutional options for water services provision which includes regulating service delivery, tariffs and dealing with effluent. Affordable and sustainable technical norms and standards need to be adopted especially during the recovery phase. Most importantly the financing of the sector needs to be established through mechanisms such as the ring fencing of water services revenue, incentivizing improved operational efficiency and addressing capital investment financing needs. Refer to National Water Policy

2) Rural water supply and sanitation

The Government's desire to raise the living standards of communal people after independence, coupled with the commitment to fulfil the UN General Assembly's declared "Drinking Water and Sanitation Decade, 1981 - 90" resulted in a supply driven accelerated borehole drilling and deep well sinking programme in communal lands. The NAC adopted the Type 'B' Bush Pump as a standard national hand pump and the private sector was lured into mass production of the pump, resulting in poor standards creeping in. Because of poor workmanship in the production of fittings which were not compatible with the standard design, the communities could not replace and maintain hand pumps resulting in widespread breakdowns. There is currently widespread collapse of rural WSS, confirming the vulnerability of services built on the basis of state and donor subsidies. Services decline was triggered by the collapse of the economy and donor flight. Continued dependence of communities on external assistance and inadequate mechanisms for sustainability will perpetuate the vulnerability of services and create a dependence syndrome and loss of sense of ownership in community infrastructure.

Rural water supply development has stagnated since 1990. Maintenance and repairs virtually ceased as government failed to provide financing for these activities and donors shunned the country. In 2004, WASH inventory estimated that 75% of the estimated 47,000 hand pumps were non-functional. A 2009 report indicated that 48% of Zimbabwe's rural population did not have a toilet facility and therefore used bushes for open defecation, threatening the health of communities and degrading the environment. There is therefore an urgent need to repair and rehabilitate non-functional infrastructure. Demographic changes brought about by the land reform program have opened up new areas of need where safe drinking water and sanitation services have also deteriorated. The affordability of rural WSS services remains a major hurdle given the state of the economy as a whole and the levels of rural poverty. Expertise which in previous decades ensured that Zimbabwe was a leading country in Africa in addressing rural WASH has largely been lost, resulting partially in the centralization of WSS services. Opportunities for private sector investment and participation in rural WSS have been missed.
Refer to National Water Policy

3) Dam structure in the lake Chivero and Manyame

Refer to Dams of Zimbabwe by Zimcold (Zimbabwe National Committee on Large Dams)

1. Chivero Dam- MANYAME POORT DAM

1.1 General

River:	Manyame
Catchment area :	2,230 km^2
Mean annual runoff:	323, 000 thousands m^3
Construction date:	1950 -1952
Purpose:	Water supply and irrigation

1.2 Dam

Type:	Earthfill
Height:	40.0 m
Crest length:	201 m
Volume:	780,000 m^3

1.3 Spillway

Type:	Side channel
Discharge capacity:	2,150 m^3/s

1.4 Reservoir

Max. water depth:	30.9 m
Effective capacity:	247,180 thousands m^3

Area at F.S.L. : 2,630 ha

Yield: 89,300 thousands m^3/y

1.5 Owner: Zimbabwe Government

1.6 Engineer: Ministry of Energy and Water Resources and Development

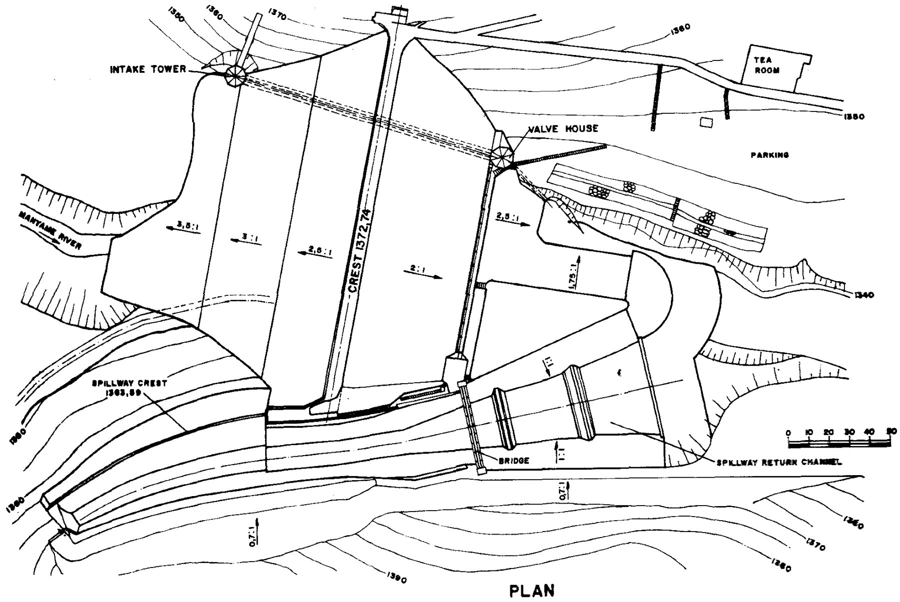


Figure 2.4.7 Plan of Manyame Poort Dam (Chivero Dam)

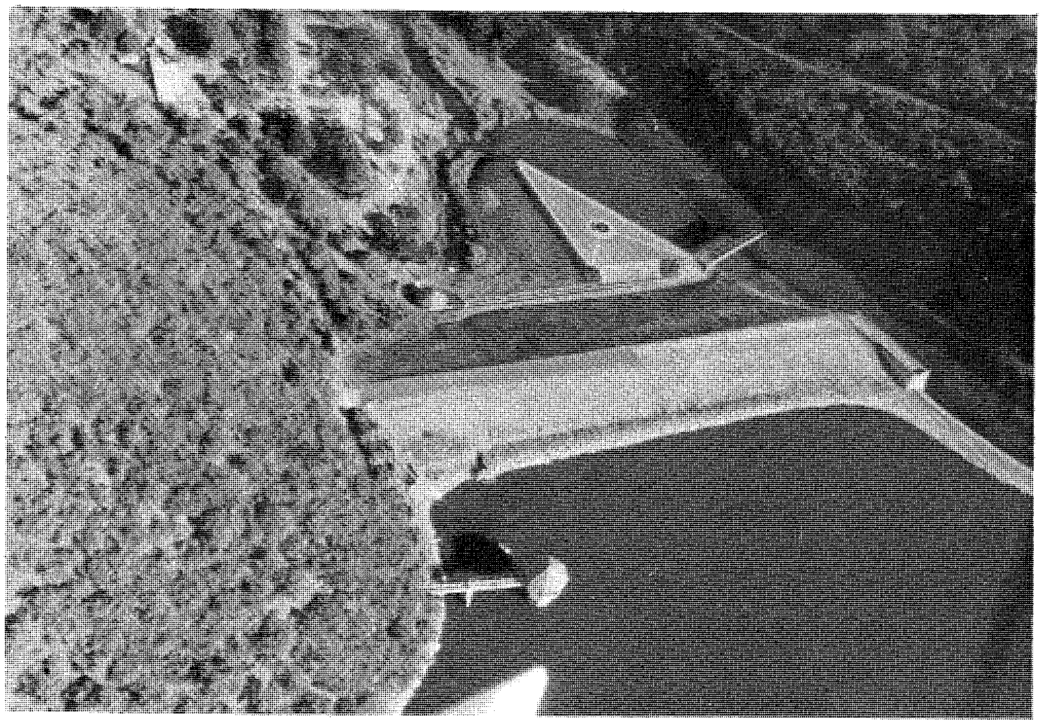


Photo 2.4.1 View of the Dam

Chivero (Manyame Poort) Dam in the Lake Chivero forms the main supply source for the City of Harare, augmented by Darwendale (Manyame) Dam further downstream on the same river. The embankment is of zoned earthfill, with the shell constructed from the decomposed banded ironstone that forms the foundations of the dam. The spillway has a side channel crest against the right abutment hillside, with a concrete-lined return channel leading back to the river.

The original outlets were in a conduit' below the embankment on the left flank, but a new outlet system was constructed in 1974. This comprises a control tower that was built from pontoons in the reservoir and gradually sunk until it penetrated the bed material, connected to a tunnel that passes under the lake and the range of hills on the shoreline, leading directly to the purification works.

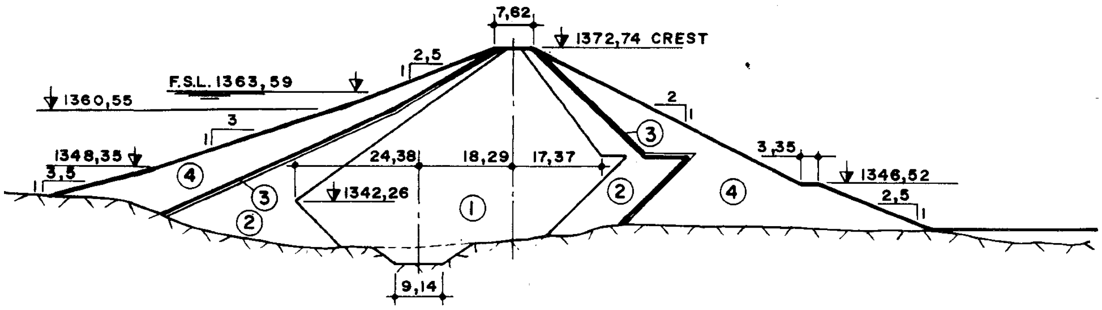


Figure 2.4.8 Cross Section of Manyame Poort Dam (Chivero Dam)

2. Manyame Dam- DARWENDALE DAM

2.1 General

River:	Manyame
Catchment area :	3,790 km^2
Mean annual runoff:	549, 000 thousands m^3
Construction date:	1973 -1976
Purpose:	Water supply and irrigation

2.2 Dam

Type:	Earth-Rockfill
Height:	27.5 m
Crest length:	1,200 m
Volume:	450,000 m^3

2.3 Spillway

Type:	3 No. × 13,7m × 6.1 m gate
Discharge capacity:	2,190 m^3/s

2.4 Reservoir

Max. water depth:	23.6 m
Effective capacity:	480,200 thousands m^3
Area at F.S.L. :	8,100 ha
Yield:	107,220 thousands m^3/y

2.5 Owner: Zimbabwe Government

2.6 Engineer: Ministry of Energy and Water Resources and Development

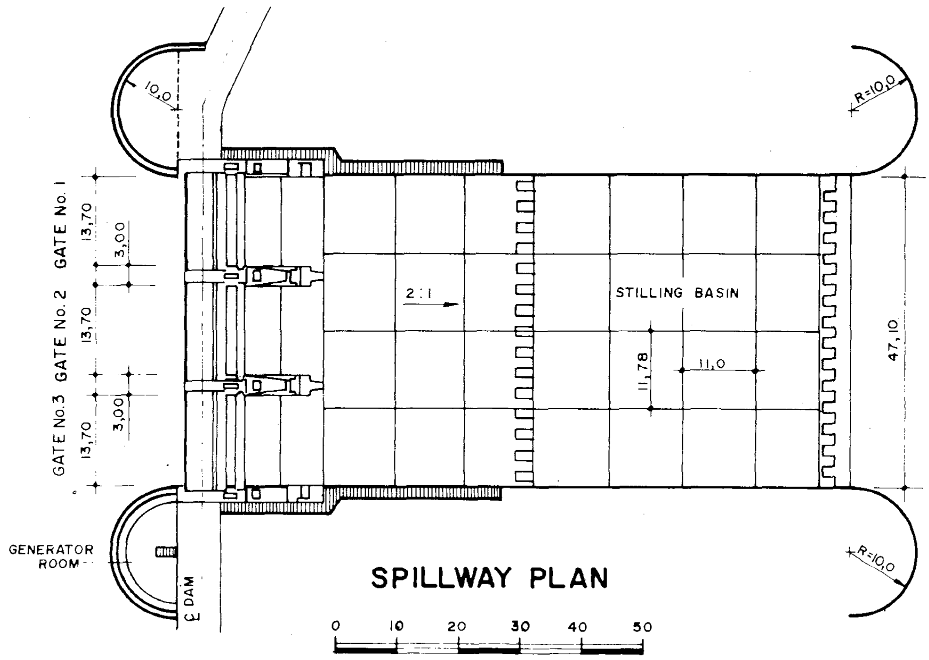


Figure 2.4.9 Spillway Structure of Manyame Dam

Photo 2.4.2 Spillway of Manayame Dam

Manyame (Darwendale) Dam in the Lake Manyame was constructed principally to augment the water supply to the City of Harare, but water is also supplied to other urban centres and for irrigation use downstream. The dam is on the Manyame River, a short distance downstream of Manyame Poort Dam in the Lake Chivero, and has an independent catchment area of 1,590 km^2.

The dam embankment consists of a wide central impervious core, with the downstream section of earthfill and the upstream section of rockfill won from excavation of the spillway chute. The foundations are mainly pyroxenite and the dam has a positive cut-off with a grout curtain, but on the left flank where the foundation material is decomposed gabbro to a considerable depth, an upstream blanket was constructed and the cut-off trench omitted.

The spillway is a gated structure with the water discharging down the glacis into a concrete-lined stilling basin. Gate operation is activated by electrode sensors at successive levels, and opening is electric powered with diesel engine and manual standby. The dam outlets comprise twin 1,200 mm pipes in a trench in the foundation rock, but drawoff for Harare water supply is via a tower in the reservoir and the Darwendale Tunnel which conveys the water to an underground pump station at the Morton Jaffray Water Treatment Works.

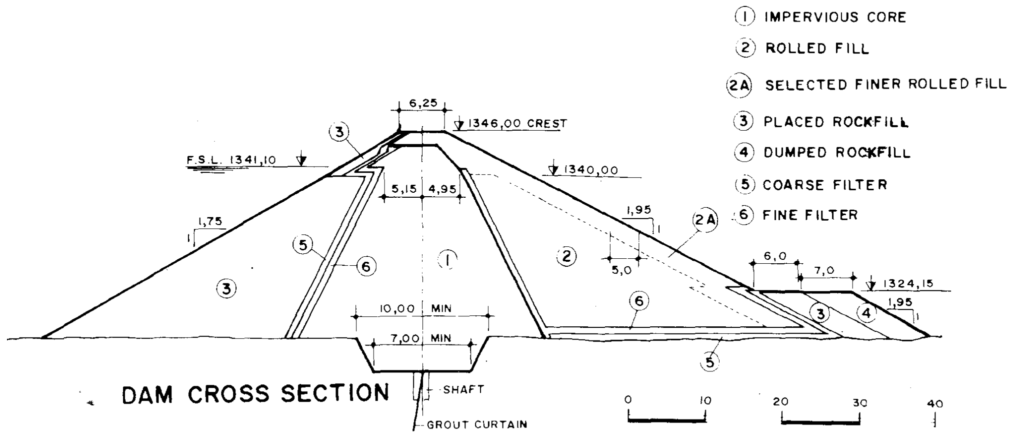


Figure 2.4.10 Cross Section of Manyame (Darwendale) Dam

2.4.3 General Description of Water Quality Change in the Catchment

The water quality in 1996 and 2011 were compared for the understanding of outline of the current status and change of the catchment. Table 2.4.6 shows the water quality data. For the data in 1996, the Study 1996 by JICA (12 points in the catchment) was referred and for 2011, water quality data derived from EMA (5 points in the catchment) was used. Locations of the point for the water quality are shown in the Figure 2.4.5. For the comparison close 5 points from those two data were picked up as shown in the table and figure: Up stream of Harava Dam -STN 21, Harava Dam - STN 59, After Seke Dam-STN 71, Nyatsime after ZSTP- STN 61 and Morton Bridge after Manyame Dam. Water quality in the Lake Manyame was compared with the STN 28 (After spillway of the Manyame for the convenience).

From these data, a change is observed in water quality in the catchment. At the upstream of Harare Dam, BOD was 1.1 mg/l in 1996, it was 51.5 mg/l in 2011. For the BOD at the 5 spots, they were 0.6 to 2.1 mg/l in 1996 however they were 39.1 to 57.4 mg/l in 2011. At the Nyatsime point in particular, BOD was 51.4 mg/l, CODcr 460 mg/l and TSS 176.3 mg/l. This point is most polluted in the points and assumed to be affected by the raw sewage discharged from the ZSTP. The current status of the pollution in the catchment is considered to be serious.

However, it must be noted that these water quality in the lakes is different from the water intake for water treatment plant. Water quality from the intake of water treatment plants were shown in Table 2.4.6. The water quality of the intake was not so bad as observed in the records.

Table 2.4.6 Water Quality in the Catchment area in 1996 and 2011 (Unit: mg/l)

Location/Point	BOD	CODcr	TSS	Remarks
Effluent Regulation	30.0	-	25.0	By EMA
Upstream of Harava Dam	1.1		31.2	1996
	51.5	36.8	1.9	2011, STN 21
Harava Dam	-	9.5	5.2	1996
	39.1	36.8	2.7	2011, STN 59
Seke after Seke Dam	0.6	-		1996
	52.1	70.2	59.0	2011, STN 71
Nyatsime after ZSTP	2.1	-	26.6	1996
	51.4	460.0	176.3	2011, STN 61
Morton Bridge after Lake Manyame	-	(18.9)	(2.7)	1996 Lake Manyame
	57.4	62.3	31.3	2011, STN 28

Remarks: Data in upper line is derived from the Study 1996 and Data in lower line is the average of the 2011 from EMA.
Source: Water quality in 1996 is referred the Study 1996 (Jica) And Water quality in 2011 is average in 2011 by EMA

Both results, however, are recorded fact. The water quality in the lake is considered to be uneven affected by the underwater configuration of the intake spot and hydraulic characteristics in the specific location, unlike river water having turbulent flow for the most of the section of the flow. Sedimentation effect can be expected where water velocity is slow in the lake purifying the water. Further, water intake is designed to get cleaner water in the lake examining the optimum location, topographic configuration for the intake. While the sampling of the water in the lake for water quality analysis is usually done in the spot average water quality can be got. These may be the reason of the difference of the water quality. Latest raw water quality at Prince Edwards WTP (PE-WTP) and Morton Jaffray WTP (MJ-WTP) is shown in Table 2.4.7.

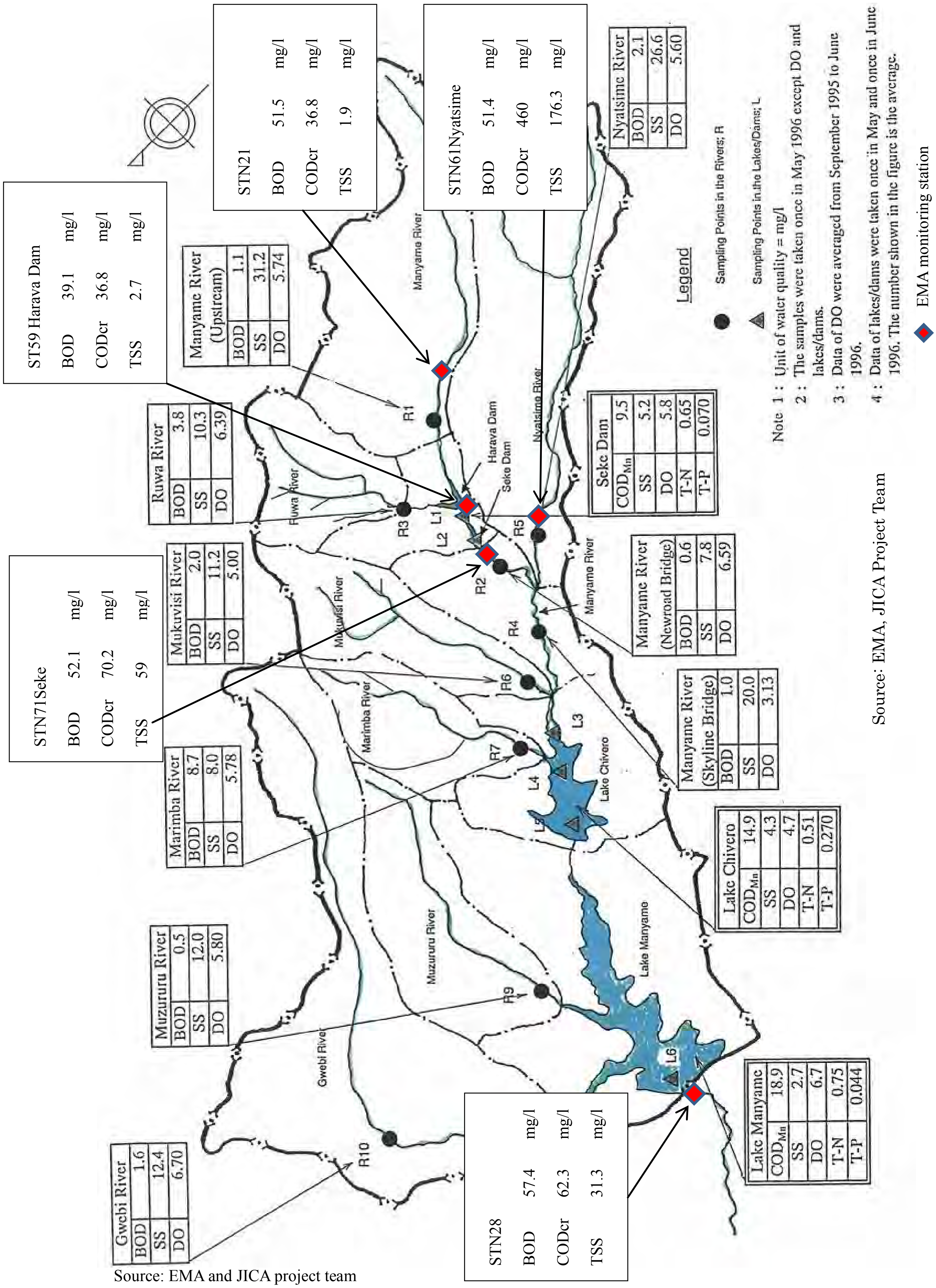
The cause of the environment deterioration will be attributed to malfunction of the sewerage system in the catchment. All the sewage flow of Chitungwiza Municipality has been discharging to the rivers due to no treatment at the ZSTP and spilling out of sewage due to clogging by sand. Since sewerage service coverage in Chitungwiza Municipality is 100%, without refurbishing the sewerage facility, the pollution observed at the Nyatsime point will not be solved. Trickling filters in Norton STP is also broken down discharging raw sewage into Lake Manyame directly. The raw sewage from Norton STP affected the water intake of the Morton Jaffray WTP in August 2012. It resulted to the limitation of water supply distribution for Harare City. Nutrient such as N and P is also inflowing to the both lakes advancing the eutrophication. Detailed discussion of the cause of the pollution is discussed in the Chapter 4.

Table 2.4.7 Raw Water Quality at the intakes of PE-WTP and MJ-WTP

(Unit: mg/l)

WTP	SS	CODcr	BOD_5
PE-WTP (2011)	13.2	ND	2.3
MJ-WTP (2011)	30.0	-	3.4

Source: Harare Water



Source: EMA and JICA project team

Figure 2.4.11 Water Quality of Various Points

2.5 Environmental Status in the Project Area

The rapid urban growth in the City of Harare has expanded to its neighbouring towns including Chitungwiza Municipality. This has imposed huge stresses on the environment in relation to water resources. The stresses exist both in terms of quantity and quality of the resources. Material fluxes from many urban wastes (liquid, solid, industrial, etc.) are, in particular, so large that they are not easily addressed even in the immediate vicinity leading to the pollution of rivers and aquifers.

The field of environmental sanitation, which comprises water supply, excreta and wastewater management, solid waste management, storm water drainage and agricultural run-off, is assessed to present the environmental status in the project area, particularly in the Direct Influence Area (DIA), the Municipality of Chitungwiza and how these services affect water quality. A DIA is where the proposed project/development will be located.

(1) Water supply

In such populated urban areas, the impact of pollution is seriously recognized. The existing sewerage systems in the areas are inappropriately operated and maintained, and need to be expanded or replaced completely, as they became too small for the anticipated workloads. The state of pollution of the water bodies that are sources of water supply is deteriorating. Also, access to a continuous water supply is not available to all residents with some residents relying heavily on unprotected shallow/dug wells even for drinking supply use. These wells are prone to contamination and oftentimes the cause of water-related diseases including the two cholera outbreaks in 2008 and 2009 and the recent typhoid outbreak (2012-2013). These are exacerbated by the inappropriate drainage and toilet systems and high groundwater level that is most likely to affect groundwater quality.

Photo 2.5.1 Residents queue to get water from a borehole due to unreliable supply.

(2) Excreta and wastewater management

Sewerage system is also not functioning well. Only primary treatment of effluent (grit chamber) is being done and directly discharged to Nyatsime River that flows to join Manyame River. Final discharged point of this river is Lake Chivero that connects to Lake Manyame. These two lakes are sources of drinking water. Considering the natural absorptive capacity of these two man-made lakes to purify these organic substances, the effect should not have cause high negative result; however, the

STP of Chitungwiza is not the only STP that discharges partially treated wastewater into the river system. Hence, proliferation of filamentous green algae occurs, an indication of eutrophication, especially in Lake Chivero. The river system is also choked up with water hyacinths in which when these die-off contribute to the organic pollution of the system.

Photo 2.5.2 Sewage from burst pipes often finds its way to open canals posing health threats to the residents.

There are 48 public toilets located in Chitungwiza. These public toilets are disaggregated into male and female toilet. For the male toilet, each toilet has urinal with only half functioning, the rest are either out of order due to blockages or vandalized, and squat pans with a high 75% non-functional. Female toilet has squat pans with only 23% functioning.
Charging a user fee is one way to have funds available for the maintenance.

(3) Solid waste management

The practice of open dumping results to an unsanitary condition of the dumpsite. Garbage is being dump indiscriminately within the dumpsite with some garbage finding its way to the nearest water body, a river that is part of the network that supplies drinking water. It is important to note that at present there is minimal segregation of waste and hazardous waste may be present in the dumpsite.

In spite of the signage put up by the Municipality on illegal dumping, this problem persists. A number of illegal dumping areas can be found even on the main streets of the Municipality. At most times, it is malodorous and a high fly breeding activity could be observed. This is compounded by the presence of human wastes that is being dumped together with the domestic wastes in some areas. This usually happens in areas that have problems with blocked sewage connections (sewage burst). Some significant negative effects associated with this unsanitary method are surface and groundwater pollution, foul odour and air pollution, exposure to hazardous substances and breeding grounds for disease vectors.

Photo 2.5.3 Collection and disposal will become even more critical as garbage production continues to increase with population growth and development.

(4) Storm water drainage

Some drainage facilities are open canals or ditches. The rivers function as the main drainage system.

These rivers receive the domestic wastewater and storm water collected by the segmented drainage facilities. Because of the clogged sewer pipelines/burst sewers in some areas, human feces can be found in these open canals, another major water pollution source. Untreated domestic wastewater is simply allowed to discharge into nearby water channels. These rivers must be protected and conserved for their intended use such as for drinking.

(5) Agricultural run-off

One of the sources of non-point pollution is agricultural run-offs. Contamination is anticipated from agricultural activities especially with reference to fertilizers and pesticides. Agricultural activities are identified as one of the potential pollution sources if no control measures are in place. A well has been tested by the study team for nitrates and was found to have a very high level, above 40 mg/liter (refer also to Table 2.5.1 for the groundwater quality (well water) monitoring of Chitungwiza).

2.5.1 Concerned Agencies Undertaking Water Quality Examination and Monitoring

There are two (2) notable monitoring programmes conducted within the project area that clearly give indication of the water quality of the water bodies.

- monitoring programme by the Environmental Management Agency (EMA) for physical and chemical indices of water bodies, usually ambient and in some cases, effluent sampling from industries. EMA maintains its laboratory, the Central Laboratory for Environmental Quality Monitoring (CLEQM).
- monitoring programme done by the Department of Health (DOH) Municipality of Chitungwiza for micro-bacteriological examination mostly from groundwater sources of drinking water (well water). In some cases the tests also include physical and chemical indices. This Department utilizes the laboratories of both the Public Health Laboratories and the Government Analyst Laboratory for analyses. It also undertakes water quality examination for industries including the quality of generated sewage upon request of the industries.

The major problems of the present water quality monitoring system are:

- Both EMA and the DOH have no comprehensive management of the water quality monitoring programmes. Water quality is periodically monitored; however their frequency, sampling points and water quality indices of monitoring are not consistent. For example, monitoring of microbiological parameters of sources of drinking water is to be done fortnightly but at present the manner in which samples are taken is generally reactive, mostly during summer and winter when health problems occur.

- There is a large quantity of data from the water quality monitoring programme in both agencies which has not been analysed and there has been no database system for the monitoring programme.
- The Acts and their SIs on compliance monitoring have long been mandated but up to now they are not yet fully implemented. EMA has full legal authority and a complete array of regulatory instruments for a comprehensive enforcement strategy; however, EMA is able only to inspect and monitor a few industrial establishments. The universe of regulated establishments has not been established and there is no prioritization of facilities to be inspected.
- Some standards/guidelines are not yet established, e.g., the ambient water quality and the classification of major rivers by beneficial or intended use; adequate guidelines in the use of recycled wastewater for irrigation; and guidelines to control non-point source pollution from agricultural and urban run-off. Ambient water quality is the general amount of pollution present in a broad area which is distinguished from discharge measurements (effluent) taken at the source of pollution.
- Microbiological monitoring of effluent from STWs for water reuse such as agriculture/irrigation and livestock farming.

2.5.2 Ambient Water Quality Monitoring by EMA

(1) Ambient water quality monitoring at major pollution points by EMA

Monitoring Points

There are five established water quality monitoring points in the Upper Manyame Basin that directly affects the quality of water in the project area. These are:

- Station 21: upstream of the Harare Dam (CR 21)
- Station 59: Harava Dam (CR 5 9)
- Station 71: Seke Bridge, St. Mary’s (CR 71)
- Station 61: Nyatsime River; after discharge point of Zengeza Sewage Treatment Plant (CR 61)
- Station 28: Morton Bridge, after Lake Chivero (CR 28)

Figure 2.5.1 shows the water quality monitoring points of EMA in the project area. It was noted that the water being sampled were not really effluent samples but rather for ambient water quality samples. At present, the country has yet to establish ambient water quality standards. Monitoring has been conducted every couple of months since 2007. Water quality indices for the monitoring are as follows: BOD, DO, TSS, TDS, PO_4, Fe, Mn and Coliform.

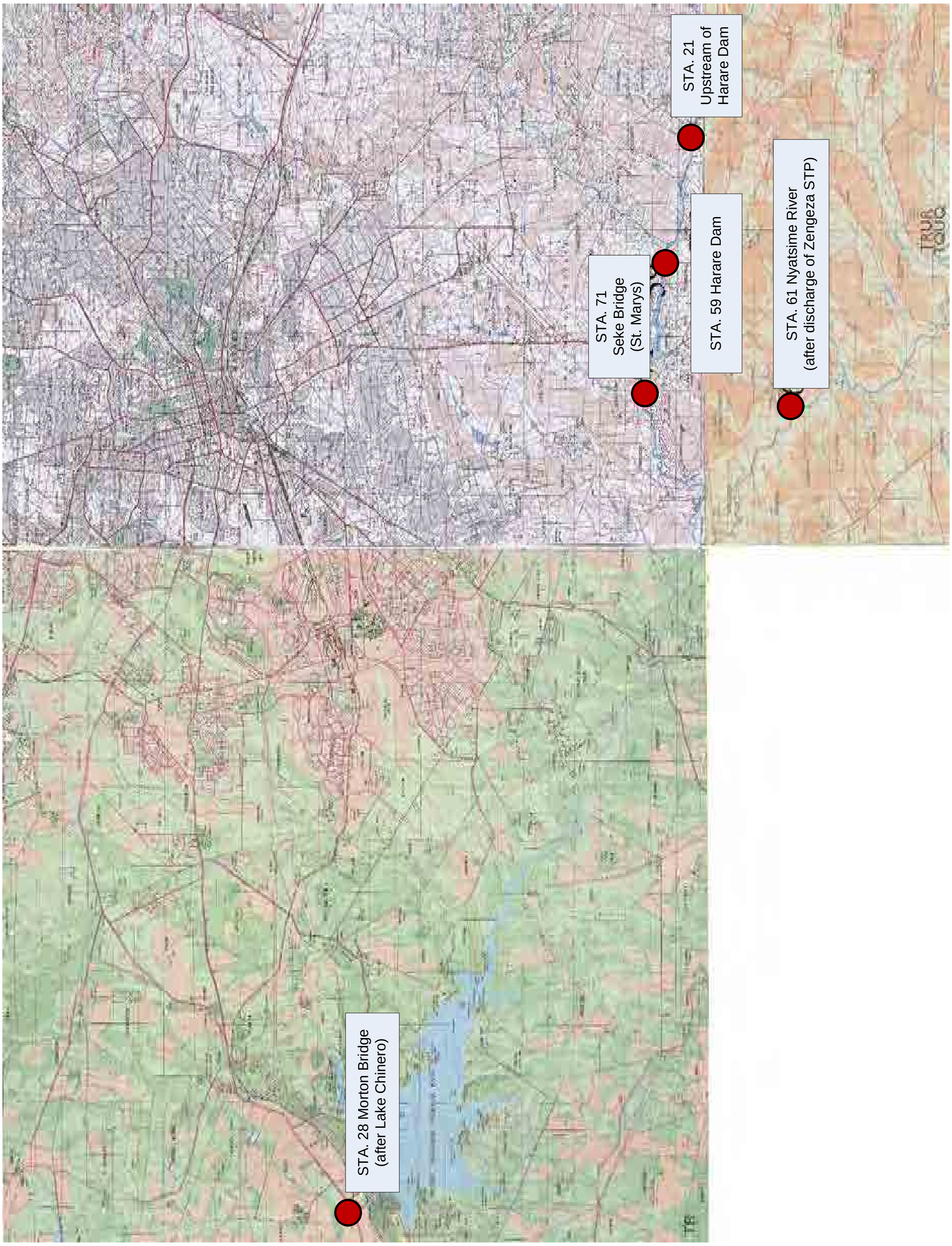


Figure 2.5.1 Water Quality Monitoring Stations

Source: JICA Project Team (Basic source of data: EMA)

(2) Results of the ambient water quality monitoring by EMA, 2007 to 2012

At present, because of the absence of ambient water quality standards, the results were evaluated referring to the effluent standard (SI 6, 2007) using the BLUE classification (Blue criteria - environmentally safe). This means that in areas that failed, river water quality already exhibited the characteristics of an effluent.

Indices consistently failing the effluent standards for discharge:

Bio-chemical Oxygen Demand (BOD)

BOD levels in all 5 sampling points monitored from 2009 to 2012 exceeded standards set for effluent discharge (Blue classification). Highest BOD levels were recorded in Nyatsime River (after discharge of STW) at 81.2 mg/l in 2009 and in Morton Bridge (after Lake Chivero) at 80.2 mg/l in 2011. Following figures showed the BOD levels above the blue line exhibited exceedances. Fluctuations were observed in all stations with significant drops in BOD levels in Nyatsime River (Figures 2.5.2 to 2.5.6).

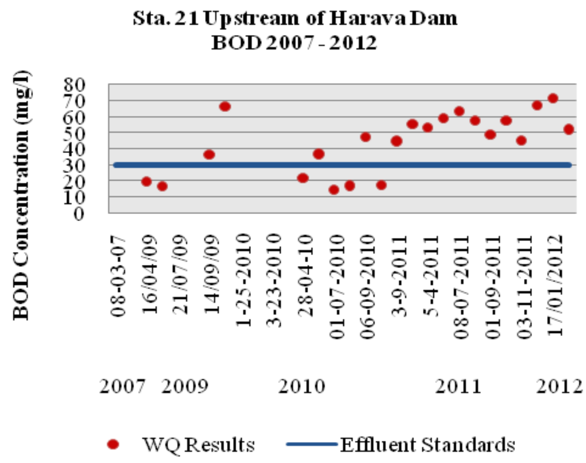


Figure 2.5.2 Water Quality (BOD), Upstream of Harava Dam 2007-2012 Source: EMA

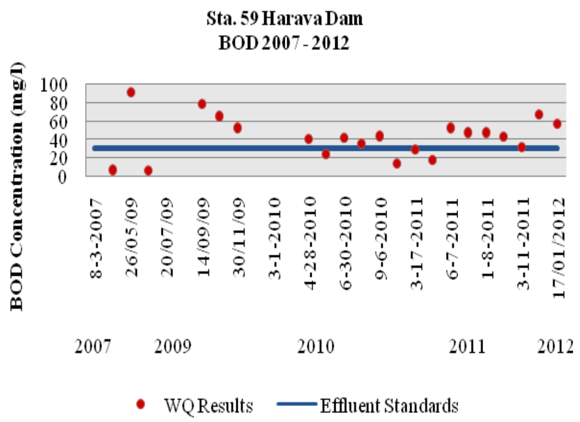


Figure 2.5.3 Water Quality (BOD), Harava Dam 2007-2012 Source: EMA

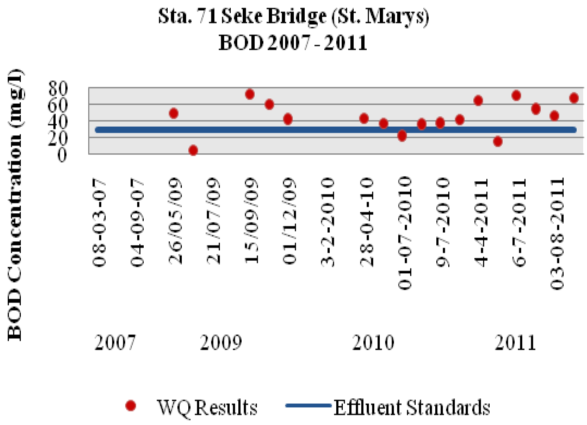


Figure 2.5.4 Water Quality (BOD), Seke Bridge 2007-2011 Source: EMA

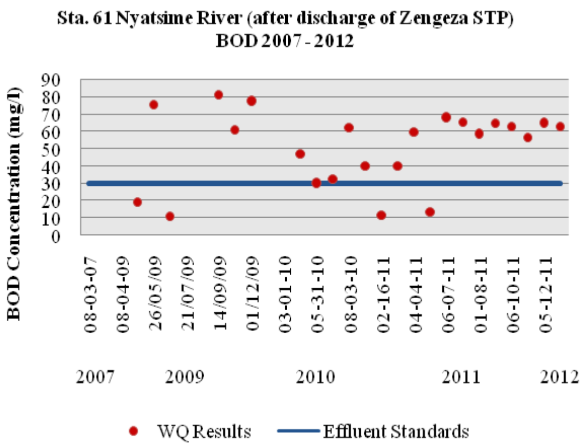


Figure 2.5.5 Water Quality (BOD), Nyatsime River 2007-2012 Source: EMA

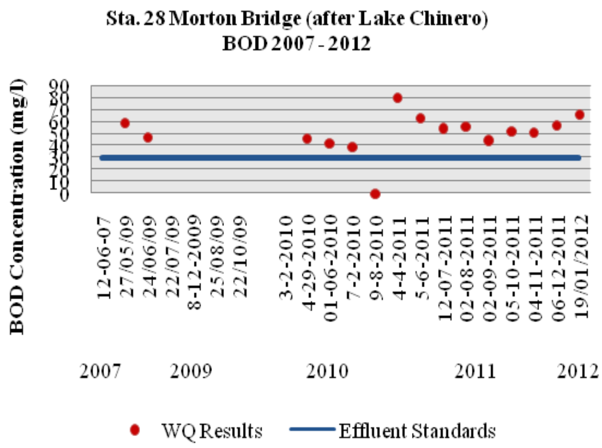
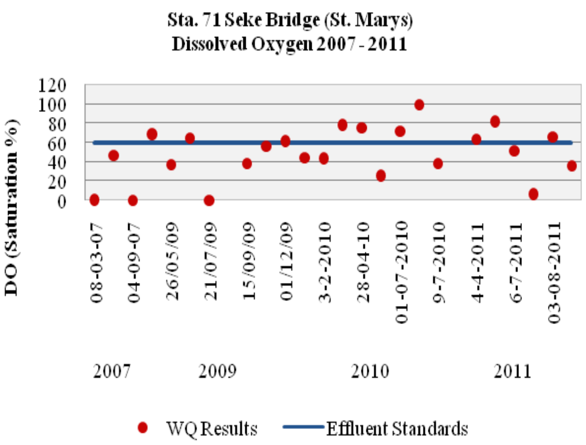


Figure 2.5.6 Water Quality (BOD), Morton Bridge 2007-2012 Source: EMA

Dissolved Oxygen (DO)

DO concentrations for the two sampling points, Seke Bridge and Nyatsime River consistently failed to meet the minimum concentration of 60% saturation from 2007 to 2012. Lowest concentrations were recorded in Nyatsime River at 0% saturation for years 2007 and 2009 (Figures 2.5.7 to 2.5.8). At this concentration, river water is considered "biologically dead". Low DO levels may be found in areas where organic material (dead plant and animal matter) is decaying, as bacteria require oxygen to decompose organic waste, thus, depleting the water of oxygen. Areas near sewage discharges sometimes have low DO levels due to this effect.



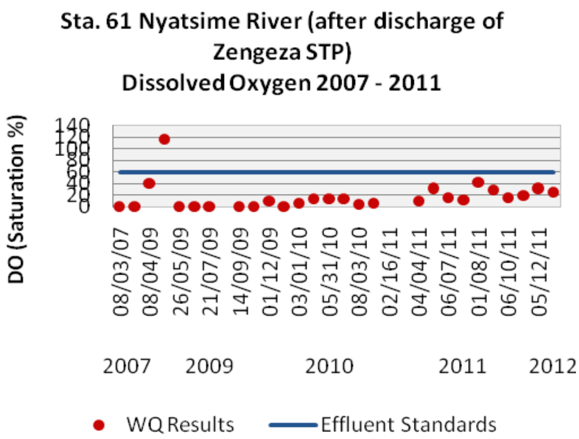


Figure 2.5.7 Water Quality (DO), Seke Bridge 2007-2011 Source: EMA

Figure 2.5.8 Water Quality (DO), Nyatsime River 2007-2-11 Source: EMA

Total Suspended Solids (TSS)

High TSS levels were observed in 2 sampling points, Seke Bridge and Nyatsime River. Highest recorded level was at 450 ml/l in Nyatsime River (October 2009) way above the minimum standard of equal or less 25 mg/l (Figures 2.5.9 to 2.5.10). The 3 other points had fair water quality. TSS measures the amount of un-dissolved solid particles in water such as level of siltation, domestic and industrial wastes, and decaying plant and animal matter. Figure 2.5.10 showed an outlier value of 836 mg/l TSS in Nyatsime River (April 2011) and therefore not considered in the assessment.

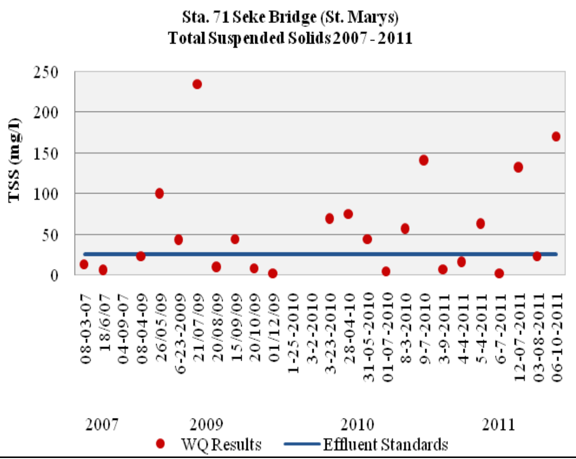


Figure 2.5.9 Water Quality (TSS), Seke Bridge 2007-2011 Source: EMA

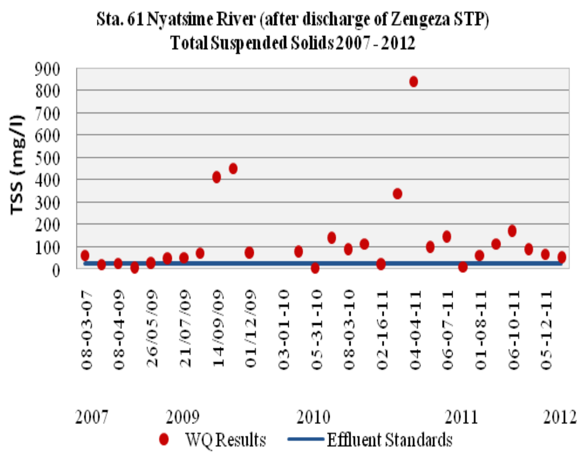


Figure 2.5.10 Water Quality (TSS), Nyatsime River 2007-2012 Source: EMA

Total Dissolved Solids (TDS)

Of the 5 monitored sampling points, exceedances were observed only in Nyatsime River in sampling years 2009 – 2011. Highest recorded concentration was at 990 mg/l in 2009 beyond the standard set of equal or less than 500 mg/litre (Figure 2.5.11). TDS is generally used as an aggregate indicator of the presence of a broad array of chemical contaminants. The primary sources of TDS in receiving waters are from agricultural runoff, leaching of soil contamination, and point source water pollution from domestic sewage or industrial waste.

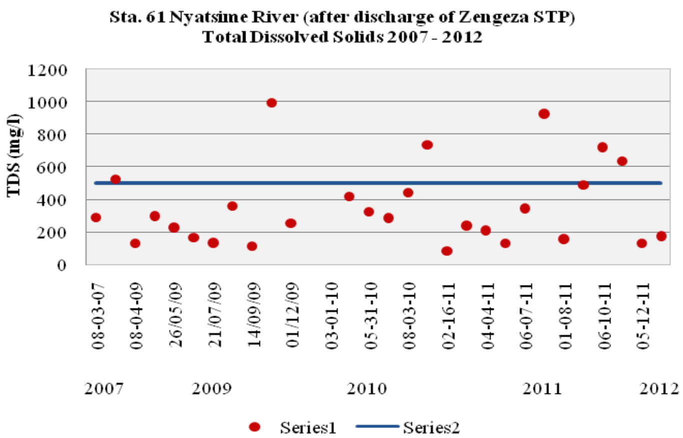


Figure 2.5.11 Water Quality (TDS), Nyatsime River 2007-2012 Source: EMA

Phosphates (PO_4)

Seke Bridge and Nyatsime River had phosphate concentration ranging from 0.56 to 17.73 mg/l exceeding the set limit of equal or less 0.5 mg/l (Figures 2.5.12 to 2.5.13). Surface run-offs of phosphates from excessively fertilized farmland (pasture and croplands) can be a cause of phosphate pollution in surface waters, leading to eutrophication (algal bloom) and consequent oxygen deficit, leading to (anoxia) for fish and other aquatic life in the same manner as phosphate-based detergents. Other sources include seepage from individual sewage treatment systems, partially treated sewage from STW and urban runoffs. Figure 2.5.13 showed another outlier value of 64 mg/l PO_4 in Nyatsime River (December 2009) and therefore not considered in the assessment

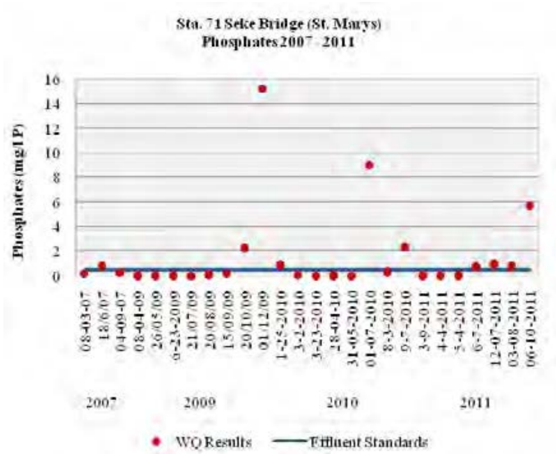


Figure 2.5.12 Water Quality (PO_4), Seke Bridge 2007-2011 Source: EMA

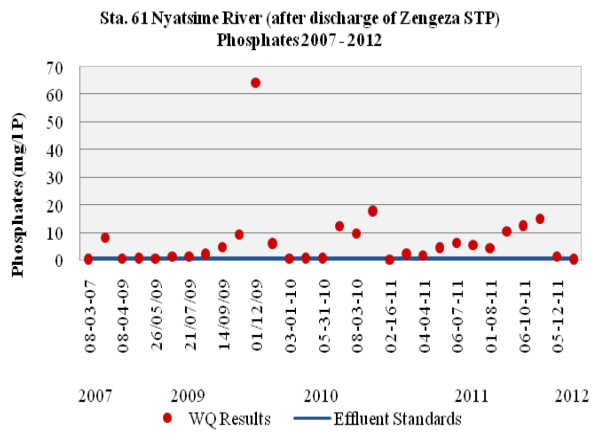


Figure 2.5.13 Water Quality (PO_4), Nyatsime River 2007-2012 Source: EMA

Iron (Fe) and Manganese (Mn)

Samples at the 2 points, Seke Bridge and Nyatsime River exceeded the allowable limits for iron of equal or less 1.0 mg/l while for manganese, the 2 points including Morton Bridge exceeded the limits of equal or less 0.1mg/l. For iron and manganese, highest concentrations were recorded in Seke Bridge at 3.83 mg/l in (October 2011) and 1.36 mg/l (August 2011), respectively (Figures 2.5.14 to 2.5.18). Fe and Mn occur naturally in rocks and soils. Micronutrient soil additions to agricultural crops may also include iron and manganese.

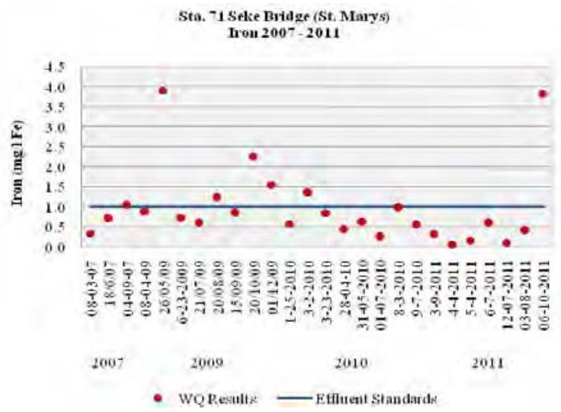


Figure 2.5.14 Water Quality (Fe), Seke Bridge 2007-2011 Source: EMA

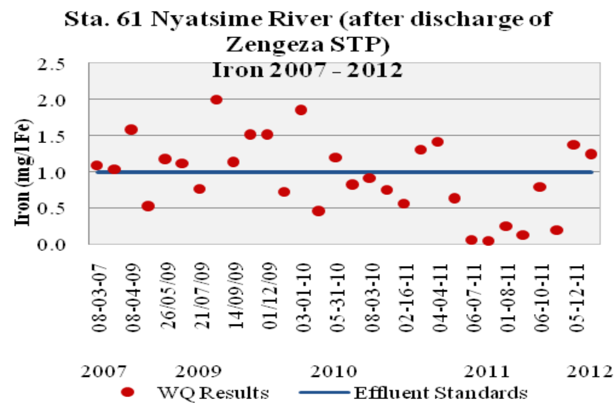


Figure 2.5.15 Water Quality (Fe), Nyatsime River 2007-2012 Source: EMA

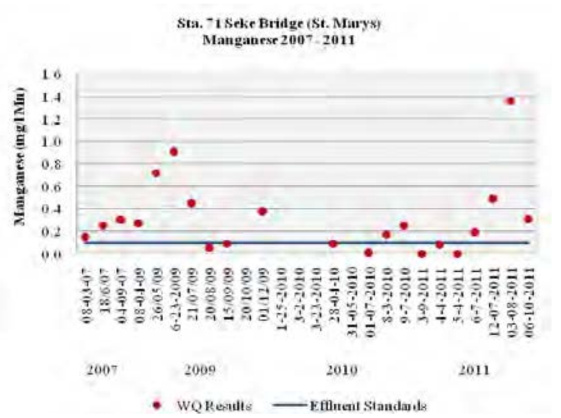


Figure 2.5.16 Water Quality (Mn), Seke Bridge 2007-2011 Source: EMA

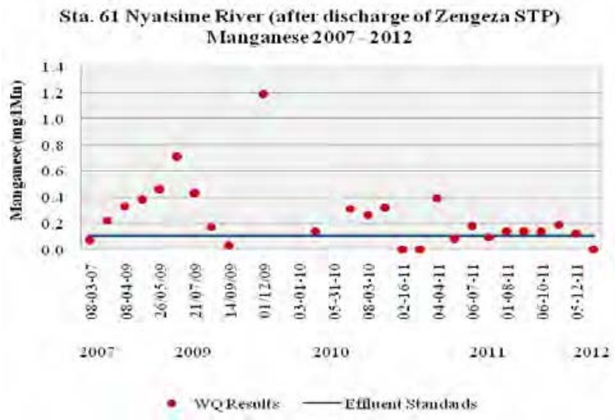


Figure 2.5.17 Water Quality (Mn), Nyatsime River 2007-2011 Source: EMA

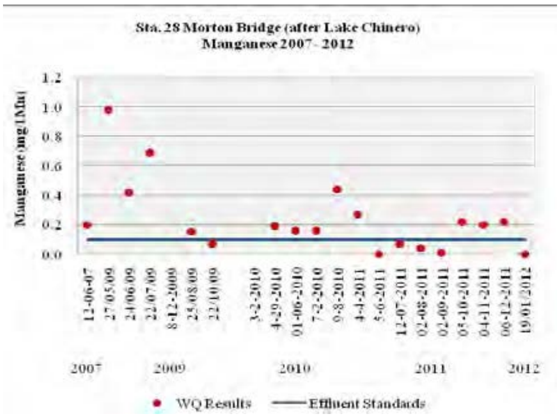


Figure 2.5.18 Water Quality (Mn), Morton Bridge 2007-2012 Source: EMA

Other Parameters

Monitoring results of the 5 sampling points for years 2007 to 2012 indicated that the river water met the criteria most of the time for total hardness, chloride, sulphates, zinc, copper and nickel. Though the effluent standard does not contain nitrates and chemical oxygen demand, EMA's sampling protocol includes such analysis.

2.5.3 Groundwater Quality Monitoring by DOH Chitungwiza

Groundwater quality monitoring of both shallow and borehole wells used for drinking water is conducted by the Department of Health Chitungwiza Municipality. Water for domestic use (drinking and cooking) must be free from odour, colour, chemical hazards and disease-causing organisms (viruses, bacteria, protozoa and helminthes). It should meet the guidelines set in the 2011 WHO Guidelines for Drinking-water Quality now being used by the Ministry of Health and Child Welfare in the absence of an updated one.

From the data provided by the DOH, of the total 35 wells (shallow and borehole) tested in 2012, eight (8) wells were found positive for coliform bacteria. E. coli (Escherichia coli), a common type of fecal coliform bacteria commonly found in the intestine of warm-blooded animals and humans, was found in one (1) borehole and two (2) shallow wells. Presence of faecal coliform is attributed to domestic wastewater or animal wastes contamination (Table 2.5.1). The physical and chemical characteristics of well water tested were all within allowable limits except for the high levels of nitrate in three (3) wells (2 boreholes and 1 shallow well).

Pollution of groundwater resources such as untreated wastewater discharges affects human health through the spread of disease-causing organisms. These affect work force productivity and income losses to households. A number of water-related diseases, both for morbidity and mortality were noted for the years 2010 and 2011. Common causes of morbidity and mortality included diarrhoea/ gastro-enteritis, skin diseases (scabies, ringworms) and conjunctivitis (water washed) and malaria (water-vector related). In both years, outbreaks of cholera and typhoid were not reported. There is no differentiation however, if the causes of these water-borne illnesses are related to water or by food handling.

Table 2.5.1 Microbiological and Chemical Groundwater Quality Monitoring, Chitungwiza, 2012

No.	Location	Source	Sampling Date	Total coliform (cfu/ml)	E.coli (cfu/ml)	Salmonella (cfu/ml)	Shigella (cfu/ml)	pH	Turbidity(NTU)	Total Hardness(mg/L)	Alkalinity(mg/L)	TDS (mg/L)	Nitrate (mg/L NO_3)	Copper (mg/L)	Lead (mg/L)	Fluoride (mg/L)	Iron (mg/L)
				Water Quality Parameters													
				2011 WHO Guidelines													
				0/100ml	0/100ml	0/100ml	0/100ml	6.5 9.5	5	500		1,000	50	2	0.01	1.5	0.3
1	Surface Investments Premises	Borehole	31.05.12	NG	NG	NG	NG	8	0	120.3	17.6	316.5	ND	0.04	ND	0.02	0.1
2	Zengeza 3 Extension	Borehole	26.06.12	NG	NG	NG	NG	5.9*	0	90.0	33.0	170.2	31.9	0.002	ND	0.02	1.0*
3	TelOne-Zengeza 2	Borehole	26.06.12	NG	NG	NG	NG	5.9*	0	140.0	44.0	246.3	73.6*	0.001	ND	0.02	0.28
4	Cnr Hombarume/Chigunguru-Zengeza 2	Borehole	26.06.12	NG	NG	NG	NG	5.3*	0	90.0	44.0	176.7	57.9*	0.001	ND	0.003	0.3
5	Chidodo-Zengeza 4	Borehole	26.06.12	NG	NG	NG	NG	5.8*	0	88.0	66.0	119.9	46.6	0.001	ND	0.06	0.09
6	SouthMed-Zengeza 4	Borehole	26.06.12	NG	NG	NG	NG	6.2*	0	88.0	66.0	115.8	18.2	0.001	ND	0.2	0.11
	Chicken Inn (Makoni)	Borehole	22.03.12	NG	NG	-	-	6	0	120.0	66.0	449.9	67.9	4.5	ND	0.06	ND
7	Chicken Inn	Borehole	26.06.12	NG	NG	NG	NG	6.0*	0	200.0	44.0	236.3	80.4	1.1	ND	0.02	0.04
	Seke 6 Primary-Unit B	Borehole	22.03.12	33	15	-	-	7.6	50	92.1	176.0	345.7	ND	0.02	ND	0.5	2.9
8	Seke 6 Primary-Unit B	Borehole	26.06.12	NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
9	Chigumba/Zanoremba Housing Scheme	Borehole	04.07.12	NG	NG	NG	NG	7.2	0	144.0	154.0	121.1	2.5	0.04	0.1*	0.3	ND
10	Stand 27509 Unit L	Shallow well	04.07.12	-	-	-	-	6.4*	0	200.0	154.0	221.1	7.5	0.04	0.1*	ND	ND
11	Stand 19128 Unit L	Shallow well	04.07.12	-	-	-	-	6.8	45*	176.0	110.0	235.2	30.2	0.04	0.01	0.04	ND
12	Stand 19117 Unit L	Shallow well	04.07.12	-	-	-	-	6.4*	0	150.0	88.0	197.7	32.9	0.04	0.01	0.05	ND
13	Stand 19112 Unit L	Shallow well	04.07.12	-	-	-	-	6.6	10*	186.0	110.0	232.8	14.4	0.04	ND	0.08	ND
14	Seke 13 Primary School	Borehole	18.07.12	1*	NG	NG	NG	6.4	0	158.0	88.0	267.9	15.0	0.007	0.01	0	0.04
15	Stand 27616 Unit L-Typhoid Fever Area	Shallow well	18.07.12	TNTC	NG	NG	NG	6.3	30	70.0	67.1	153.9	25.0	0.004	0.01	0	0.05
16	Stand 23372 Unit L-Typhoid Fever Area	Shallow well	18.07.12	84*	NG	NG	NG	6.8	0	120.0	132.0	285.5	24.2	0.006	0.01	0	0.009
17	Stand 19021 Unit L-Typhoid Fever Area	Shallow well	18.07.12	4*	NG	NG	NG	6.2	0	52.0	33.0	137.5	23.2	0.005	0.01	0.02	0.01
18	Stand 13335 Unit L-Typhoid Fever Area	Shallow well	27.07.12	NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
19	Stand 12273 Unit N-Typhoid Fever Area	Shallow well	27.07.12	5*	3*	NG	NG	-	-	-	-	-	-	-	-	-	-
20	Stand 20909 Unit A-Typhoid Fever Area	Shallow well	27.07.12	NG	NG	NG	NG	7.57	5	180.0	121.0	668.1	58.9*	0.007	ND	0.11	0.02
21	Cnr Hombarume/Chigunguru-Zengeza 2	Borehole	06.08.12	NG-	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
22	Zanoremba/Chigumba 2	New Borehole*	06.08.12	NG	NG	NG	NG	7.4	30	90.0	121.0	251.0	10.1	0.007	0.0	0.5	0.03
23	NOP	New Borehole*	06.08.12	54	NG	NG	NG	7.5	60.0	50.0	110.0	173.2	ND	0.01	0.01	0.5	0.09
24	Unit L-Garikai Housing Scheme	New Borehole*	06.08.12	10	NG	NG	NG	7.2	40	12.0	110.0	195.4	ND	0.01	ND	0.3	0.09
25	Unit M-Jambanja	New Borehole*	06.08.12	NG	NG	NG	NG	7.4	80.0	80	77	165.0	ND	0.01	0	0.2	0.1
	Unit L Community Hall	Borehole	28.08.12	TNTC	0	0	0	7.7	0.0	88.0	143.0		1.4	0.003	ND	0.3	0.1
26	UB/21/3/3 Unit B Flats	Borehole	22.03.12	NG	NG	-	-	7.8	0.0	97.7	187	227.0	ND	ND	ND	0.3	ND
27	F133/12	Well water		TNC	3	NG	NG	-	-	-	-	-	-	-	-	-	-
28	F109/12 MAP	Borehole		NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
29	F110/12 Z3H	Borehole		NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
30	F111/12 NZ4	Borehole		NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
31	F112/12 HQ	Borehole		NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
32	F113/12 UH	Borehole		NG	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
33	F10/12	Well water		7	NG	NG	NG	-	-	-	-	-	-	-	-	-	-
34	SK87/12/1	Borehole	07.03.12	-	-	-	-	7.6	5.0	236.8	129.9	218.8	ND	0.50	ND	0.3	0.70
35	SNC7.12/5	Borehole	07.03.12	-	-	-	-	6.0	ND	52.6	21.6	112.9	6.9	0.19	ND	ND	0.1

Note:ND-Not Detected   _Not Done   NG-No Growth   TNTC-Too Numerous To Count   *-Unsatisfactory Results

Sample 24-Zinc=14.6/3.0   Units-mg/l

Sample 25-Zinc=5.6/3.0

Source:DOH, Chitungwiza

Remark-

1. Out of the 4 boreholes(B/H) - the water was found to be turbid and all the boreholes to be flushed and sample 24 and 25 have Zinc above permissible levels
Health effects of Zinc above pemissible levels include (a) anaemia (b) damage of the pancreas (c) decrease in levels of high density lipoprotein(HDL) cholesterol.

2.Sample 23 and 2 be flushed and disinfected using chlorine

3.The remaining Unit L Community Hall B/H results are still pending

4.We recommend commissioning of the B/Hs after flushing

CHAPTER 3 INSTITUTIONAL, LEGAL AND FINANCIAL FRAMEWORK OF WATER QUALITY MANAGEMENT

3.1 Present Institutions for Water Quality Management

3.1.1 Institutional Framework for Water Quality Management

In Zimbabwe, the government control is exercised at three separate political levels:

- National : Central government agencies
- Provincial : Provincial offices
- Local : Local authorities: urban councils including cities and municipalities, towns, local boards and rural district councils

(1) National organisation

The national agency concerns itself with major policy and planning issues and with establishing the laws, regulations and criteria to be applied by the lower governmental levels in resolving major issues. The national or provincial agencies provide varying degrees of regulation, supervision and assistance, while sewage disposal is essentially a local function.

(2) Provincial organisation

Provincial interests in water quality management are also important. The provincial government's responsibility is central, especially designated to undertake pollution control in rural areas. The provincial government has varying degrees of authority delegated to them by the national government. However, all authorities generally repose in the national government.

(3) Local organisation

The local organisation is a political or administrative entity established by law for the purpose of acquiring, constructing, improving, maintaining and operating projects for the public use, including sewage collection and treatment facilities.

In urban areas, water quality management functions are vested in the independent local authorities (urban councils) or assigned to their departments (such as engineering or public works). The organisation for managing the sewage collection and disposal systems takes many forms and depends upon local circumstances in each local government area.

3.1.2 Primary Ministries and Institutions for Water Quality Management

In Zimbabwe, no one agency has the sole responsibility for water quality management. At the national level, there are four (4) major government agencies which are directly involved in water quality management, and another two (2) that are particularly concerned with planning and financial management.

The various central government, local government, statutory and non-governmental bodies responsible for or professionally interested in water quality management in Zimbabwe in general and the Study Area in particular are shown in Figure 3.1.1.

The primary central and local government agencies/institutions which are involved in water quality management planning and management are the following:

Central Government Agencies

1) Ministry of Local Government, Rural and Urban Development (MLGRUD)
2) Ministry of Environment and Natural Resources Management (MENRM)
3) Ministry of Water Resources Development and Management (MWRDM)
4) Ministry of Health and Child Welfare (MHCW)

(Supporting Government Agencies in Planning and Financing)

5) Ministry of Economic Planning and Investment Promotion (MEPIP)
6) Ministry of Finance (MF)

Local Authorities

1) Provincial and District Offices
2) Urban Councils (including Cities, Municipalities, Towns and Local Boards)
3) Rural District Councils

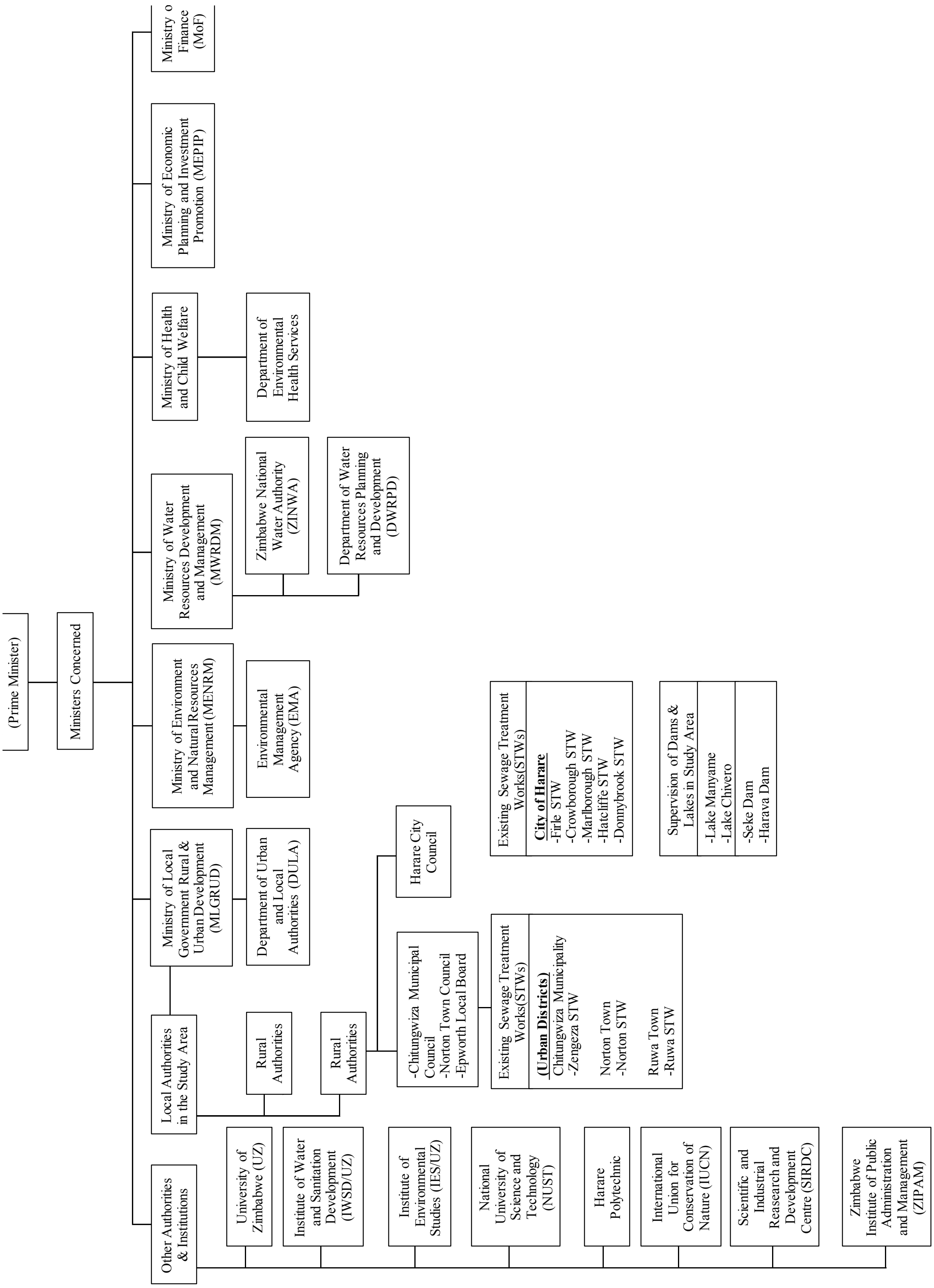


Figure 3.1.1 Agencies Directly Involved in Water Quality Management
Source: JICA Project Team

The following are the major agencies/ institutions involved in water quality management in the Study Area and their respective responsibilities and functions:

(1) Ministry of Local Government, Rural and Urban Development (MLGRUD)

The MLGRUD is responsible for supervising local authorities and regional development including both the rural and urban areas with the following main functions:

- to develop grassroots local administrative and consultative structure to enable the devolution of self-governing powers;
- to foster infrastructural and human resources development at local level to enhance the capacity of local organizations, specially local authorities in order for them to assume the full responsibility of planning for their own development as well as developing administrative and management skills;
    - • to evolve the policies aiming at:
        - correcting developmental and administrative imbalances amongst local authorities,
        - providing infrastructural development assistance to local authorities,
        - planning for spatial development of the country,
        - administering urban and rural statelands, and
        - providing for and administering proper land settlement in rural areas; and
    - • to approve the development plans and their amendments.

The organisational chart of the MLGRUD is shown in Figure 3.1.2.

The MLGRUD consists of ten (10) departments: Department Rural Local Authorities, Urban Local Authorities, Traditional Leadership Support Services, Civil Protection, Physical Planning, Provincial Administration, Human Resources, Legal Services, Finance and Administration and Audit Services. Among the departments, the Urban Local Authorities and the Provincial Administration are deeply involved in this Master Plan Study.

The Department of Urban Local Authorities (DULA) together with the Rural Local Authorities Department are mandated:

- to promote sound local governance by encouraging public participation in governance that brings about community ownership of public works and programmes undertaken in the local authority area;
- to organise and co-ordinate mobilisation of resources and activities of government ministries, non-governmental organisations [NGOs] and other stakeholders providing development and services to local authority areas;
- to create sound legal framework for smooth operations of local authorities to enable them to deliver quality service to communities; and
- to monitor local authorities.

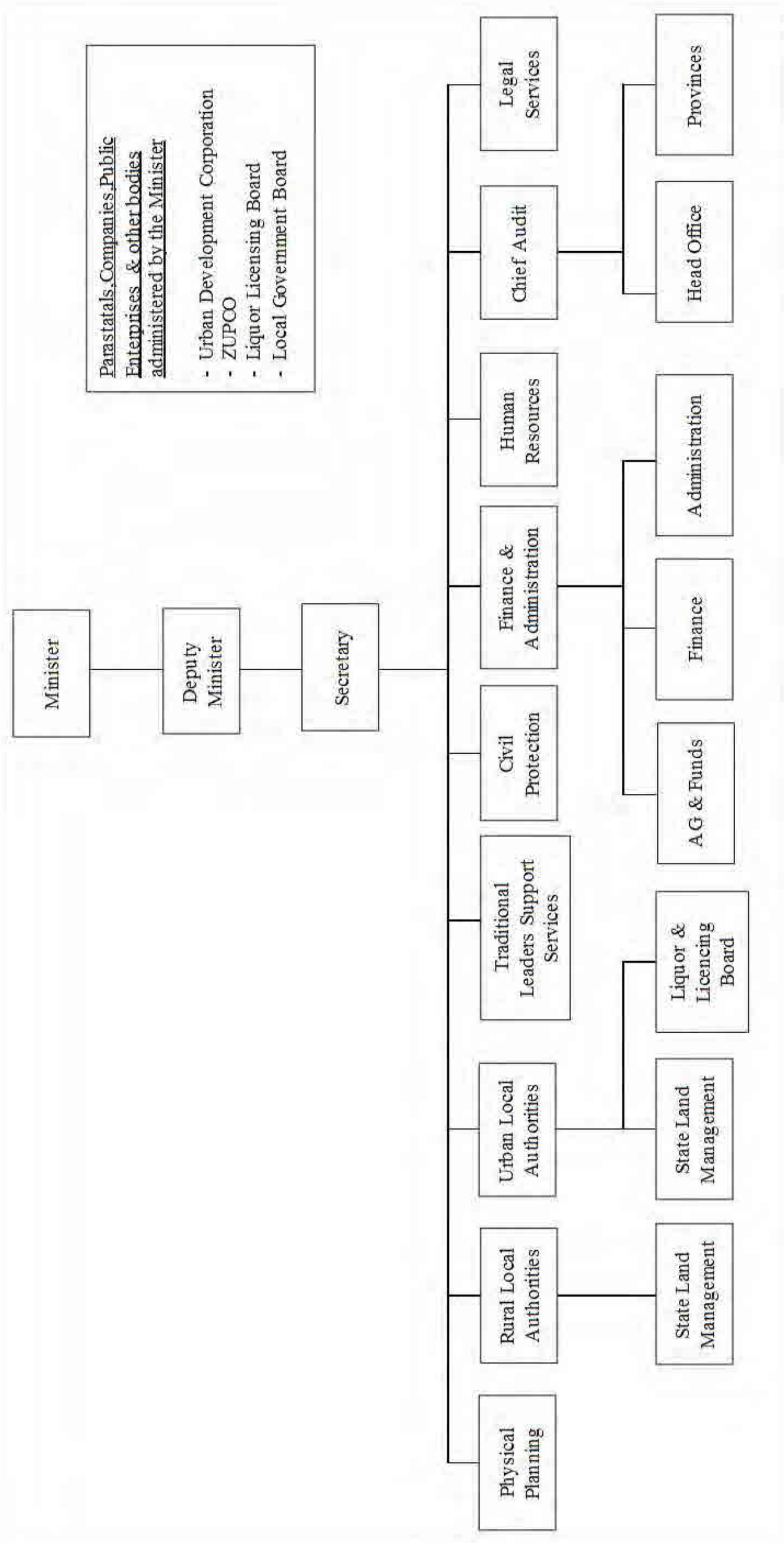


Figure 3.1.2 Organisational Chart of MLGRUD

Source: MLGRUD

The MLGRUD is one of the most vital government agencies, since its sole mission is to supervise all the local authorities decentralised, which take direct charge of environmental protection and management including water quality management.

In conjunction with the Ministry of Finance (MF), the MLGRUD also determines the nature of local finance. Officials from the MLGRUD are found in every part of the country. Provincial Administrators, being MLGRUD's officials influence the nature of local development programme.

The MLGRUD refers pollution matters to the Environmental Management Agency (EMA) of MENRM, according to the:

- Regional, Town and Country Planning Act, 1976 (Section 27)
- Regional Town and Country Planning (Development) Regulations, 1976 (GN 927 of 1976) subparagraph (ii) of Section 6 (i) (b).

Through these instruments, MLGRUD controls the kind of development occurring so as not to jeopardise the quality of the water and the environment as a whole. A memorandum on the control of development was also produced by the then Water Pollution Control Section of the Zimbabwe National Water Authority (ZINWA) and a handbook to assist Local Planning Authorities with pollution control.

(2) Ministry of Environment and Natural Resource Management (MENRM)

The Ministry of Environment and Natural Resources Management (MENRM) has the general responsibility to provide sustainable management of natural resources and protection of the environment; and the prevention of pollution and environmental degradation in terms of the Environmental Management Act of 2002 (Cap.20:27). In the course of the implementation of this Act, the Minister shall, among others:

- regulate the management of the environment and to promote coordinate and protection of the environment and the control of pollution;
- monitor the environment and trends in the utilization of natural resources and the impact of such utilization on the environment;
- coordinate the promotion of public awareness and education on environmental management
- impose penalties in terms of the Act on any persons who cause harm to the environment; and
- ensure that persons or institutions that are responsible for causing environmental harm will meet the cost of remedying that harm.

The organisational chart of the MENRM is shown in Figure 3.1.3.

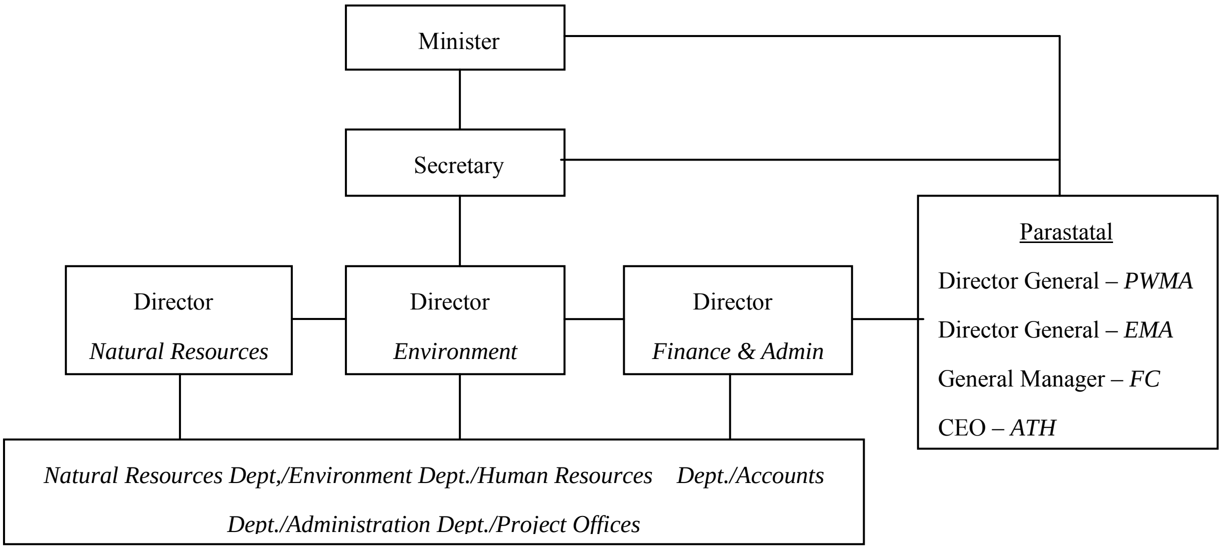


Figure 3.1.3 Organisational Chart of MENRM

Source: MENRM
Notes: PWMA: Parks and Wildlife Management Authority EMA: Environment Management Agency
FC: Forestry Commission, ATH: Allied Timbers Holding, CEO: Chief Operating Officer

A parastatal established in terms of the Environmental Management Act is the Environmental Management Agency (EMA) of the MENRM and has the mandate to promote sustainable management of natural resources and the protection of the environment with stakeholder participation as well as to enforce the effluent discharge standards set in the Environment Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007. The creation of EMA is to harmonize all actions of all government agencies involved in environmental management. EMA was formed when the former Department of Natural Resources was merged with the Water Pollution Control Unit from the Zimbabwe National Water Authority, the Air Pollution Control Unit and the Hazardous Substances Control Unit, both from the Ministry of Health and Child Welfare. EMA only became fully operational in 2007. The organisational structure of EMA is shown in Figure 3.1.4.

EMA has three (3) departments: Environmental Management Services (EMS), Environmental Protection (EP), and Finance and Administration. The EMS department is responsible for publicity, environmental education and awareness, and planning and implementation of community projects and programs. The Environmental Protection (EP) department is responsible for enforcing the law. The EP also serves as the inspectorate and regularly monitors the water quality of surface waters as well as effluent discharges of both domestic and industrial wastewaters. Other roles of the inspectors and other officers are to ensure through monitoring that:

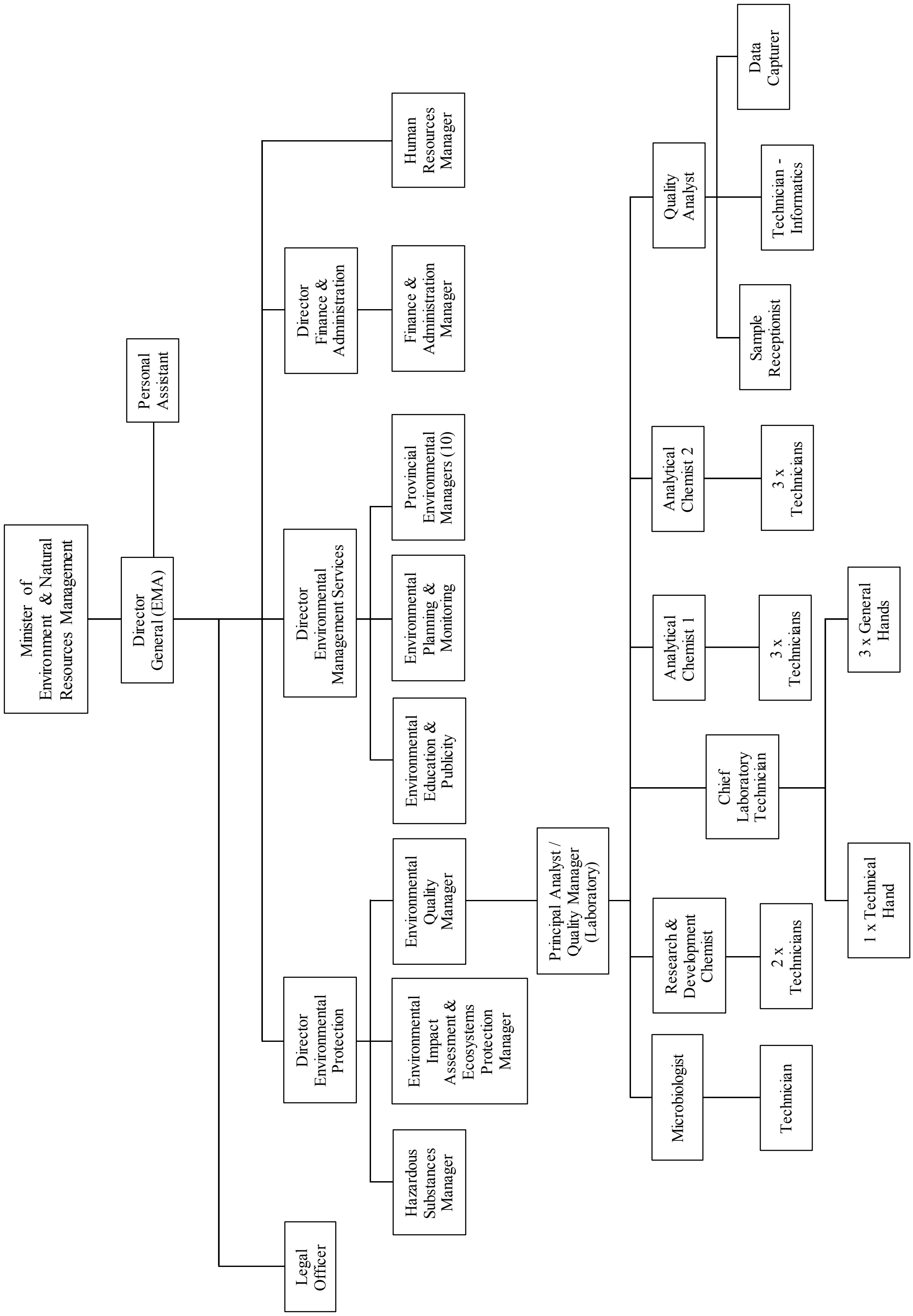


Figure 3.1.4 Organisational Chart of EMA

- environmental management plans are prepared by the local authority for the area under its jurisdiction;

- the following actions, situations and circumstances are avoided, minimized, managed or regulated;
  - the disturbance of ecosystems, and loss of biological diversity
  - pollution and degradation of land, air and water, and
  - the disturbance of landscapes and sites that constitute the nation's cultural heritage
- waste is re-used and recycled where possible and otherwise disposed of in a responsible manner;
- policies and programmes in respect of land, air, water and soil pollution and hazardous waste management are co-ordinated;
- environmental quality standards are co-ordinated and adhered to; and
- any activity that may have an adverse effect on the environment is avoided.

To achieve the above objectives of EMA, parts of its functions are delegated to provincial and local district Environmental Officers who do parallel works with its central counterparts. One provincial environmental office can cover about 6 to 9 district environmental offices.

The EP has established a water quality laboratory, the Central Laboratory for Environmental Quality Monitoring (CLEQM), an ISO-1705 certified for laboratory competence in Harare to service the whole country's requirement. Samples are transported to the laboratory by the central, provincial and district staff for chemical and biological parameters tests.

Test services available at the EMA laboratory includes chemical and microbiological tests for

- Domestic water (tap, borehole, treated)
- Mineral water
- Mining effluent (incl. monitoring boreholes)
- Sewage effluent
- Industrial effluent
- Agricultural effluent
- Ambient (river, dam, lake)

At present, the laboratory does not undertake pesticide analysis, although it has already a Gas Chromatography. In instances where there are cases/complaints, EMA accesses private laboratories to do pesticide analysis. EMA however, has no system of accreditation for these private laboratories.

Three hundred twenty six (326) monitoring points were established for the regular monthly monitoring in major rivers of the country for ambient water quality. Quarterly compliance monitoring is conducted for industries and STPs of local authorities to validate the results of the self-monitoring reports of industries and STPs.

At present, the laboratory needs to be upgraded to better respond to the demands for an effective water quality management. Due to the large number of samples to be analysed, the laboratory is faced by the problems of inadequate manpower, equipment and skills. The operations of EMA is controlled and governed by the Environment Management Board established by the Environment Management Act (Part V, Section 11).

A “National Environment Council” was set-up relative to the Environmental Management Act. The Act states that the Minister shall designate the chairman of the Council and shall comprise of experts coming from the government, academe, research institutions, business community and local non-government organizations. The functions of the Council, among others are:

- to advice on policy formulation and give directions on the implementation of the EM Act;
- to advice on national goals and determine policies and priorities for the protection of the environment;
- to review and recommend guidelines for environmental management plans and environmental action plans; and
- to review and recommend incentives for the protection of the environment.

(3) Ministry of Water Resources Development and Management (MWRDM)

The Ministry of Water Resources Development and Management with its departments is the most important central agency responsible for the development of the country’s water resources. The departments include the: (a) Departments of Water Resources Management; (b) Water Resources; (c) Planning and Development; (d) Finance, Administration and Human Resources; and (e) Audit.

Effectively, the Department of Water Resources Management implements the mandate of the Ministry and oversees water management of the country. The Department of Water Resources, Planning and Development among its functions are: (a) to formulate policies for planning, development and management of water resources and wastewater and sewerage; and (b) to prepare plans to meet present and future water demands as well as wastewater and sewerage disposal requirements for growth points, rural service centres and urban areas. The Department also coordinates with the water resources infrastructural development in the country (refer to Figure 2.3.3 for the organizational chart of MWRDM).

A parastatal organization of the Ministry is the Zimbabwe National Water Authority (ZINWA) which was established in 2000 through the water amalgamation of the Regional Water Authority and the Department of Water Development of the then Ministry of Rural Resources and Water Development. The Authority is mandated to manage the water resources of the country and to ensure its sustainable development and equitable distribution at an affordable price.

(4) Ministry of Health and Child Welfare (MHCW)

The Ministry of Health and Child Welfare (MHCW) is responsible in promoting the health and quality of life of the people of Zimbabwe. There are four (4) parastatals of the Ministry: (a) the National Aids Council of Zimbabwe (NAC); (b) the Zimbabwe National Family Planning Council (ZNFPC); (c) the Medicines Control Authority of Zimbabwe (MCAZ); and (d) the National Pharmaceutical Company (NATPHAM).

The Ministry has three (3) services: (a) the Curative Services; (b) the Policy, Planning, Monitoring and Evaluation; and (c) the Preventive Services. Under the Preventive Services is the Department of Environmental Health with two (2) deputies: one is responsible for Water, Sanitation and Waste Management, and the other is for Port Health and Food Safety. The Department has officers delivering the environmental public health services to the community at national, provincial, district, Ports of entry, ward, village and household levels in rural areas and small towns. The main functions of the department are to prevent ill-health among the population through community education and regulatory mechanism, to promote a healthy living and working environment, and to safeguard community health and quality of life.

Specific functions include among others:

- Water quality inspections. Sanitary inspections are conducted on drinking water sources and water samples are collected for analysis using field techniques and laboratory techniques. The chemical, bacteriological and aesthetic quality of all drinking water is ascertained through these inspections and sample analysis. The Public Health Laboratories and the Government Analyst Laboratory are used for water quality examination.
- Water and Sanitation Promotion. Acts as the representative of the Ministry in the NAC on Water and Sanitation. The Department also provides technical know-how on the construction and maintenance of the Blair Ventilated Pit latrine and the upgraded shallow wells through participatory hygiene education and technical know-how. They train the builders and support community efforts in water and sanitation projects.
- Disease Prevention and Control. The Department is responsible for investigating cases of infectious diseases and tracing contacts of these diseases. It is also responsible for disease epidemic preparedness and control for priority diseases i.e., epidemic prone diseases, diseases targeted for elimination, and diseases of Public Health of International Concern (PHEIC).
- Health and Hygiene Promotion. Education on disease prevention, nutrition, food hygiene and safety, personal and general hygiene, and on waste disposal through participatory and other health education techniques is provided by the Department. This is to influence positive change behaviour, attitudes and practices on health issues.

The Department administers the Public Health Act of 1924 (with series of amendments) and the

Public Health (Effluent) Regulations, 1972 in terms of water pollution control. It informs the Environmental Management Agency of any contaminated discharges into rivers, streams, dams & reservoirs or seepage into the groundwater. It is also concerned with good housekeeping, e.g. of sewage works, and with the quality of non-piped water supply facilities which is laid down under the Public Health (Effluent) Regulations, 1972 specifically for microbiological quality. The organisational chart of the MHCW is shown in Figure 3.1.5.

(5) Ministry of Economic Planning and Investment Promotion (MEPIP)

The Ministry of Economic Planning and Investment Promotion (MEPIP) is the lead agency in formulating, coordinating and monitoring the implementation of national development programmes, including the formulation of provincial plans and programmes to achieve a balanced regional development.

The MEPIP is also responsible for mobilizing financial resources to finance Government programmes, as well as to facilitate and participate in the negotiations related to domestic and international mobilization of resources.

(6) Ministry of Finance (MF)

The Ministry of Finance (MF) is a financing agency which both directly and indirectly affects the activities in the central government agencies/institutions as well as local government areas. It appropriates central funds for the provincial administration and local authorities of all forms. Budget approved for central line agencies under various ministries are spent in local government areas. The MF is responsible for determining external assistance requirements together with the MEPIP.

Public Sector Investment Programme (PSIP) is a three-year (rolling) investment program which is in principle an integral element of the fiscal budget processes, in which MEPIP indicates the most efficient allocation of resources to achieve development objectives and the MF appropriates said budget.

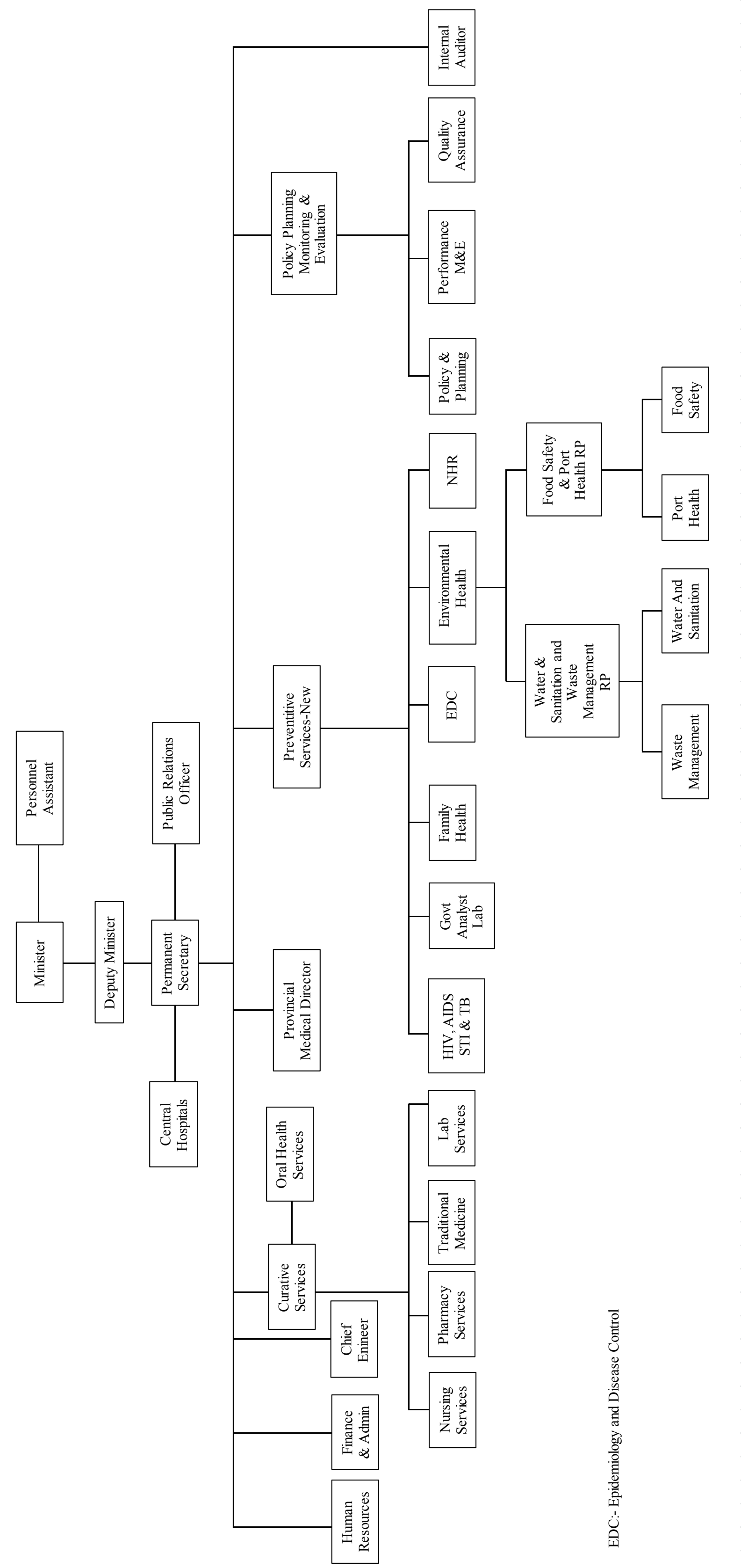


Figure 3.1.5 Organisational Chart of MHCW

Source: MHCW

(7) Department of Works (DOW) of the Harare city council

Local authorities are empowered by the Minister of Environment and Natural Resources Management (MENR) under the Environmental Management Act to report pollution matters in their areas of jurisdiction to the Environmental Management Agency (EMA). Under the Act, the local authorities operating a sewerage system can only discharge any effluents or other pollutants into the environment if an effluent discharge licence has been issued by the Environment Management Board (Environmental Management Act, 2002, Part IX, section 59 and 60). The organisational chart of Harare Council is referred to in Section 3.4, Financial Arrangements.

Prior to the implementation of the Environmental Management Act, the main local authority in the Study Area, the Harare City Council, has set up a Trade Waste Inspectorate, who controls industrial effluent discharges in terms of by-laws under the Urban Councils Act (1995), Section 180, in order to protect sewer systems, the treatment plants and water courses. They also provide advisory services to industry and sample for tariff purposes. The staff complement of the four (4) Sewage Treatment Works concerned in the city of Harare is referred to in Section 3.4, Financial Arrangements.

(8) Town engineer's departments; Chitungwiza municipal council, norton town council, and Ruwa and Epworth local boards

These local authorities are responsible for the collection, treatment and disposal of sewage and industrial effluents within their boundaries in a similar manner as with the city of Harare.

Chitungwiza, Norton and Ruwa have sewage works, while Epworth at present still relies on pit latrines since it was developed from an informal settlement. The organisational chart of Chitungwiza Municipal Council is referred to in Section 3.4, Financial Arrangements.

(9) Sewage treatment works

The existing sewage treatment works in the Study Area became generally too small for the anticipated workloads and are inappropriately operated and maintained. Major institutional and organisational issues in each sewage treatment works concerned are: 1) lack of qualified and experienced personnel; and 2) poor training.

With regard to the operation and maintenance of the existing sewage treatment works, their costs are barely covered by the revenues within the “sewerage accounts” of each Council. Operation and management are apt to fall into a kind of vicious cycle as shown below (Figure 3.1.6):

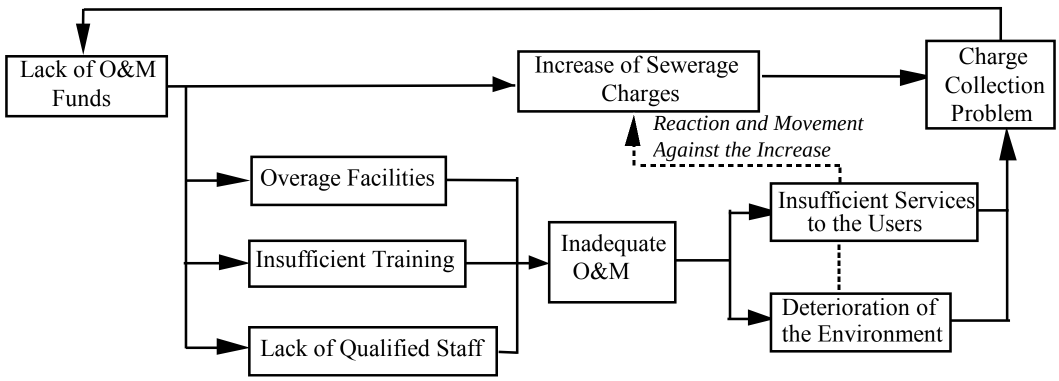


Figure 3.1.6 Cycle of Issues in Operation and Management of STW
Source: JICA Project Team

The staff components of the respective sewage treatment works concerned are referred to in Section 3.4, Financial Arrangements. To sum up, the institutional framework for water pollution control with the ministries/institutions concerned and their functions and responsibilities can be broadly defined as follows:

Table 3.1.1 Jurisdiction and Functions for Water Quality Management of Ministries and Institutions

	Agencies / Institutions	Functions & Responsibilities
1)	Ministry of Local Government, Rural and Urban Development (MLGRUD)	- Construction and /or rehabilitation of wells, rural roads and community centres under DDF scheme - Supervision of local development plans - Co-ordination of regional (rural & urban) development programs and projects
2)	Ministry of Environment and Natural Resource Management	- Environmental management and control (Water quality)
3)	Ministry of Water Resources Development and Management (MWRDM))	- Management of water - Security of water sources for agriculture, hydropower generation , water supply, etc. - Irrigation development - Water resources planning for basins and zones - Formulation of water resources development investigation projects - Water resources management
4)	Ministry of Health and Child Welfare (MHCW)	- Water quality inspections and monitoring - Water and sanitation promotion - Health and Hygiene promotion

	Agencies / Institutions	Functions & Responsibilities
5)	Ministry of Economic Planning and Investment Promotion (MEPIP)	- Planning and monitoring of the national economic development Mobilizes and facilitates domestic and international financial resources to finance - government programmes
6)	Ministry of Finance (MF)	- Appropriation of central funds - Determination of external assistance requirements
7)	Local Authorities	- Planning and management are decentralised to local authorities, which increase autonomy and responsibilities - Water and Sewerage Services

Source: JICA Project Team

As described above, several authorities are involved in water quality management/pollution control in the Upper Manyame River Basin. Their involvement in water quality management are summarised in terms of jurisdiction/ functions in the above table.

3.1.3 Training and Manpower Development

In Zimbabwe, there are various institutions which train/educate people in the courses directly and indirectly related to water pollution control. The following are the major institutions which contribute to the human resources development in this sector:

(1) University of Zimbabwe (UZ)

- Department of Civil Engineering: This offers degree courses which are related and are applicable to water pollution control. Direct liaison with EMA would help establish relevant courses in this degree.
- The Geography Department has water pollution control courses on offer to its students.
- The B.Sc. General Degree has various courses which are directly applicable to water pollution control like chemistry, biology, microbiology, which are basic requirements for water pollution control officers in the civil service.
- The Postgraduate Programme offers a Master’s Degree (MSc.) in Integrated Water Resources Management.

(2) Institute of Water and Sanitation Development (IWSD/UZ)

The IWSD was developed from the Training Centre for Water and Sanitation (TCWS), a project of the UNDP-World Bank Programme hosted by the Department of Civil Engineering, UZ. The Institute aims at addressing issues of sustainable development in water resources, waste management, environmental integrity, poverty reduction and gender equality through capacity development.

The Institute located in the UZ offers training through short and medium duration courses, some of which are commissioned courses held at the request of sector agencies and organisations. The courses vary from management of water supplies and sanitation to waste management.

The Institute collaborates with international training institutions to host specific training needs of the Southern African region. Not only the training for technical, managerial and planning issues form the major part of the training but also training of trainers and the use of participatory approaches are being emphasised. The Institute also offers research opportunities in the waste management sector within and beyond the borders of Zimbabwe. The participants are drawn from local and regional institutions and companies.

(3) Institute of Environmental Studies (IES/UZ)

The main function of the Institute is to facilitate inter-disciplinary collaboration in research and education on environmental issues, and stimulates new initiatives in these fields.

The Institute also provides a forum for the exchange of information and ideas (e.g. organising seminars, funding publications); assists in obtaining funds for research and studentships, disseminates information about environmental issues, provides consultancy services, including policy analysis and advice on environmental issues, and helps maintain a national environmental database.

(4) National University of Science and Technology (NUST)

The NUST offers degrees in applied chemistry and water engineering which are relevant to pollution control.

(5) Harare polytechnic

The Polytechnic fosters civil engineering technicians and various subjects are applicable to water pollution control. It also offers courses in chemistry, biology and microbiology for technicians, who can work directly as pollution control technicians.

Prior to the enactment of the Environmental Management Act, the institute was in liaison with the then Water Pollution Control Section of the Department of Water Resources to establish a water and wastewater management technician course with the help of Canadian funding. These technicians will be employed as water pollution control technicians by the concerned agencies, local authorities and other industries who have environmental sections in their establishments.

(6) International Union for the Conservation of Nature (IUCN)

The Union holds courses, workshops and seminars on environmental issues such as Human and Social Perspectives in Natural Resources Management. The groups are normally middle level managers in water management and natural resources sectors.

(7) Scientific and Industrial Research and Development Centre (SIRDC)

The SIRDC has an Environment and Remote Sensing Institute, which is involved in training people in environmental courses. It has sponsored some master level courses, and now involved in environmental research.

The Environmental Unit intends to provide structured courses, workshops, in-house training and external courses. In conjunction with the Cleaner Production Centre, the Unit carries out environmental impact audits and process analysis in order to identify processes that have minimum negative environmental impacts. The centre is also involved in public awareness, organisation of seminars and symposia, giving advice on aspects of controlling air, water and soil pollution and assessing environmental impairment.

(8) Harare city council

Training is offered in-house to sewage treatment plant operators, trade waste inspectors and water scientists. Laboratory staff sponsored to the Harare Polytechnic College for technicians, operators and inspectors courses takes the water and environmental management operators courses which is in three parts:

- Part 1 and 2 are City of Harare certificates
- Part 3 is a Chartered Institute of Water and Environment Management certificate

(9) Zimbabwe Institute of Public Administration and Management (ZIPAM)

The ZIPAM is a premier institution responsible for designing and implementing training, consultancy and research for the civil service, local authorities and parastatal. It was established within the Ministry of Public Service, Labour and Social Welfare (MPSLSW) in 1984 to contribute to the development of the new nation by helping to build a dynamic, performance-oriented public service. In 1993, ZIPAM became a fully fledged parastatal enterprise and its functions were broadened to cater for private sector requirements.

Currently, ZIPAM training and research programmes include:

- policies and strategic studies;
- public sector management and covers courses on internal auditing, procurement management, prevention of fraud and corruption, and finance for non-finance management;
- management development studies including health and focuses largely on health administration;

- business/ private sector management; and others.

It is reported that since its establishment, over 4,500 managers and dignitaries have had the opportunity to attend its training programmes.

3.1.4 System for Implementing the Water Pollution Control Project

The project financial sources for planning, construction and operation of a sewage treatment system usually come from the Public Sector Investment Programme (PSIP) funds (central government loan fund), own resources of local authorities, open market funds and/or international institutions.

For the construction of a new plant or big rehabilitation or expansion works, funds are mostly raised by means of PSIP and/or financial assistance from foreign country or international institution. At central government level, planning and financing the water pollution control projects are administered by three government agencies: Ministry of Economic Planning and Investment Promotion (MEPIP) for planning, Ministry of Finance (MF) for financing and MLGRUD for supervising the local authorities and co-ordinating their development activities.

In the event that the local authority has recourse to the funds from international agencies, most of activities for project implementation will necessarily be carried out through inter-agency coordination. To promote a water pollution control project, the local authority should submit its development plan to MLGRUD for approval.

3.2 Present Policies and Countermeasures for Water Quality Management

The Government of Zimbabwe promotes the policy to decentralise the present administration system to local authorities to establish a bottom-up managing system. Decentralisation of the administration system aims to allow greater participation of provincial administration and local governments in the annual planning and budgeting process and link regional development needs to national decision-making processes. However, this policy does not seem to be thoroughly put into practice.

3.2.1 National Development Plans

Since independence in 1980, the Government of Zimbabwe implemented the following national development plans as an instrument for achieving socio-economic development.

- Transitional National Development Plan, 1982/83 - 1984/85
- First Five-Year National Development Plan, 1986-1990
- Second Five-Year National Development Plan (SFYNDP), 1991-1995
- Short Term Emergency Recovery Programme (STERP), 2009
- Medium Term Plan, 2011 -2015

The Medium Term Plan, 2011 - 2015 outlines the economic policies, priorities, projects and programmes that will guide the country for the next five years. The goal of the MTP is “to raise the country’s production potential, create decent employment and reduce poverty.” This entails diversification of sources of growth, and investment in new technologies, technology transfers and institutional transformation.

The growth of the key sectors of the economy, namely agriculture, manufacturing and mining will be driven by an aggressive investment strategy that will increase capital flows into the economy, raise productivity and expand opportunities for employment creation. The MTP will pay particular attention in addressing the key enablers, that is, Electricity, Water, Transport and ICT among others.

Since most of the infrastructure has since exceeded their economic lives, the need for rehabilitation and replacement is paramount. The capital budget complemented by innovative Private Sector driven initiatives including PPPs arrangements will strive to create the basic infrastructures that guarantee basic services delivery to both industry and domestic users as a catalyst for economic growth. In the initial phase of the MTP, emphasis will be more on rehabilitation and improvement of existing infrastructure and completion of outstanding projects, before commencing new projects.

For the MTP, a robust infrastructure is a key enabler for economic recovery, growth and transformation. The infrastructure priorities are: Energy, Water and Sanitation, Transport, Housing and Construction, Information, Communication and Technology (ICTs); Science, Technology and Innovation and SME infrastructure.

Since 2009, the Government of Zimbabwe has achieved the first goal of macroeconomic stability; maintaining this stability is a prerequisite to sustainable economic growth. The second goal of economic growth will be realized through among others, sustained delivery of quality services such as health care, education, road, transportation, energy, water and sanitation. These goals have to be achieved through the MTP.

The MTP is guided by the following Government key priorities as agreed in STERP and subsequently in the Government Work Program (GWP):

i. Promote economic growth and ensure food security;
ii. Provide basic services and infrastructural development;
iii. Strengthen and ensure the rule of law and respect for property rights and promote gender rights;
iv. Advance and safeguard basic freedoms through legislative reforms and the Constitution;
v. Re-establish international relations; and
vi. Employment creation.

Of these objectives, the most crucial in environmental management and water pollution control is: item ii) Provide basic services and infrastructural development.

One of the key objectives of the Plan with respect to infrastructure is to restore basic services and to provide an efficient and reliable infrastructure network to facilitate smooth business and social operations, stimulate economic growth and socio-economic development. An efficient infrastructural network and service delivery is critical for Zimbabwe to achieve global competitiveness.

As outlined in the MTP, the Government will invite the Private Sector to become an important partner either in Public-Private Partnership (PPP) or in independent projects, commission sectoral projects in the areas of electricity, transport, water, and ICT. The PPPs will be effectively facilitated and promoted with the implementation arrangements guided by a transparent and competitive process. This will tap into financial resources and expertise from the Private Sector for the rehabilitation and development of key infrastructure projects.

Meanwhile, the African Development Bank had prepared in 2011 a report on the Infrastructure and Growth in Zimbabwe – An Action Plan for Sustained Strong Economic Growth to help fill the gap created by the absence of master plans for the development of the four (4) sectors: transport, electric power, information and communication technologies (ICT), and water and sanitation. The report provides a detailed assessment of the current status of infrastructure and services associated with these sectors. Also included are the proposed policy options and action plans that can be pursued in order to strengthen these sectors.

3.2.2 Local Development Plans

The "Regional, Town and Country Planning Act, 1976" provides for the preparation of local development plan by Local (Planning) Authority. The main objective of this Act is to provide for orderly planning of regions, districts and local areas with the objective of conserving and improving the physical environment in order to promote health, safety, order, amenity, convenience and efficiency as well as economy in the development of land and related purposes.

In terms of Part III of the Act, local authorities are empowered to:

- prepare development plans;
- amend development plans;
- determine planning applications submitted to the Authority; and
- take enforcement action, where there has been a breach of planning regulations.

Specifically, in the urban areas, the spatial extent and population have increased tremendously resulting in significant challenges for local authorities to ensure their sustainable development and provide comprehensive and reliable services throughout the areas. To tackle such issues, every local authority starts to prepare their own urban planning and/or project study reports with a view to improve their basic infrastructure.

The major critical issues pointed out in most of the plans and reports concern the water supply, sewerage and solid waste/refuse disposal and their management. A most crucial trend in the development over the years is that the urban local authorities failed to provide efficient and reliable services because of inadequate financial resources to make investments in the basic urban infrastructure.

Numerous studies were carried out by the planning & development division of each local authority in order to establish the type and extent of future developments and the likely population growth within the area. These reports provide a framework for the layout and development of the designated planning areas.

The (urban) local authorities in the Project area have the following development plans and/or project & study reports especially on the water pollution control:

City of Harare

1) Harare Combination Master Plan (Report of Study & Written Statement), August 1992;
2) Harare Water Supply Study (Raw Sources Pre-Feasibility Report), September 1993 (Revision July 1994), Department of Water Development, Ministry of Lands, Agriculture and Water Development;
3) Master Plan for Water Distribution, Volume 5: Pre-Feasibility Study on Water Treatment Processes (Report A - Desk Studies), March 1994, Department of Works, City of Harare;
4) Crowborough Sewage Treatment Works, Discussion Document on the Proposed Growth within Crowborough Catchment and the Sizing of Future Extensions to Crowborough Sewage Treatment Works, August 1994, Department of Works, City of Harare;
5) Harare Sewerage Firle V Project, Report on Subsidiary Sewers in the Firle Catchment Area, November 1994, Department of Works, City of Harare;
6) Master Plan for Water Distribution, Appendix A: Development Planning & Population Growth, June 1995, Department of Works, City of Harare;
7) Master Plan for Water distribution, Volume 3: Existing Supply Area, October 1995, Department of Works, City of Harare;
8) Crowborough Sewage Treatment Works, Volume 1 - Catchment Study (Final Report), October 1995, Department of Works, City of Harare.

Chitungwiza Municipality

1) Chitungwiza Town Council 5-Year Financial Performance Programme, 1993/94 to 1997/98;
2) Urban Development Projects
   - Zengeza Sewage Treatment Woks and Sewer Reticulation Development Project (Phase I)
   - Second Urban Development Project (Sewerage Augmentation Scheme: Phase II), February 1996

Norton Town

1) Norton Master Plan (The Study Report and Written Statement), October 1995, Norton Town Council;
2) Report on the Feasibility Study for New Sewage Treatment Works, May 1996, Norton Town Council;
3) Report on the Rehabilitation of Norton Sewage Treatment Works and Sewage Pump Station, May 1996, Engineering Department, Norton Town Council.

Ruwa Local Board

Ruwa Local Development Plan, March 1996, Ruwa Local Board

Epworth Local Board

Socio-Economic Study, Epworth Local Government Area, 1989, (actually Epworth Local Board)

Urban Local Authorities

Zimbabwe Urban Solid Waste Management Study (Final Report), August 1995, MLGRUD

Among the development plans enumerated above, the Harare Combination Master Plan is a comprehensive study report which provides a strategic land use policy framework at regional and sub-regional level for the development and control of the physical environment in the Greater Harare. As a finding of the study, the report points out that the potential for development in both Harare and Chitungwiza depends on the availability of public utility infrastructure such as water, sewage, electricity, traffic and transportation systems. The report also indicates the urgent need to introduce the environmental impact assessment for major development projects and to conserve the river courses and water supply sources.

3.2.3 Environmental Action Plans

The local authority plays an essential role in the management of the environment and natural resources including water. Along this line, the Environmental Management Act, 2002 (Part X, section 87 to 96) requires the local authorities to prepare an Environmental Action Plan (local) based on the concept of sustainable development and community empowerment.

- Every local authority shall prepare an environmental action plans for the area under its jurisdictions in accordance with such directions as the Minister may give.
- The Minister, after consultation with the Minister responsible for local government, shall prescribe the contents of the plans to be prepared in terms of subsection (1) and the procedure for their preparation.
- The local authority shall
    - place on public exhibition a copy of the environmental action plan with a statement indicating the time within which representations in connection with the plan may be made to that authority; and
    - give public notice of the place or places at which and the period for which the plan will be exhibited in terms of paragraph (a) and the time within which representations in connection with the plan may be made to the authority.

The local authorities involved in this study have yet to comply with this requirement. As per the Act, in a summary judgement letter to Chitungwiza Municipality of 15 December 2011, EMA directed the local authority to produce/submit a Local Environmental Action Plan (LEAP) by May 2012. Corollary to this request is for Chitungwiza to produce a work plan for the production of the LEAP by 31 December 2011. So far, the Municipality has not submitted a LEAP or the work plan.

3.3 Laws and Regulations on Water Quality Management

The effectiveness of measures for water quality management depends on the enactment of comprehensive and realistic laws and statutes, coupled with their prudent administration and management and the commitment of adequate financial and other resources.

In Zimbabwe, a new revised edition of the "Statute Law of Zimbabwe" is published in five (5) volumes. This contains the Constitution and all current Acts of Parliament in a revised, amended and updated form, including all Acts passed by Parliament up to March, 1996. Since then, no new edition has come out.

Both the central government and local authorities are required to comply with the requirements of national policies, law and regulations when executing their legal powers and responsibilities.

3.3.1 Water Pollution Control

Control of water pollution is necessary for the protection of the aquatic environment, maintenance of acceptable quality in lakes, reservoirs, streams, groundwater and public health. The first step to be taken in determining the degree of treatment and other measures required for control purposes is the establishment of environmental water quality standards.

During the '70s under the regime of Rhodesia, Zimbabwe had turned to establishing and/or strengthening its legal structures as a means of more effectively controlling water quality. A principal provision of these statutes was the promulgation of the following water regulations:

1) Water Act, 1976 (amended in 1984, 1989, 1993, 1998 and 2002)
2) Environmental Management Act, 2002
3) Water Pollution Control (Waste and Effluent Water Standards) Regulations, 1971
   - Repealed and replaced by 4) Water Regulations, 1977
4) Water (Effluent and Wastewater Standards) Regulations, 1977 (repealed and replaced by 5) Environmental Management Regulations, 2007
5) Environmental Management (Effluent and Solid Waste Disposal) Regulations, 2007
   - Dealing with the environmental quality standards and enforcement and covers the effluents that may be discharged into natural water courses.
6) Environmental Management (Hazardous Substances, Pesticides and Other Toxic Substances) Regulations, 2007
   - Sets the standards and enforcement for disposal of hazardous substances, pesticides and other toxic substances.

7) Environmental Management (Hazardous Waste Management) Regulations, 2007
    - Dealing with the management of generation, storage, use, recycle, treatment, transportation or disposal of hazardous waste.
8) Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations, 2007
    - Provides guidelines in the preparation of an environmental impact assessment (EIA) including identification of projects that require EIA prior to implementation.
9) Public Health Act, (amended in 1930, 1938, 1945, 1948, 1953, 1957, 1963, 1964, 1968, 1969, 1973, 1974, 1976, 1977, 1985, 1988, 1991, 1997, 2000 and 2004)
    - Relating to sanitation, housing and water supplies relating to sanitation, housing and water supplies. This is currently being revised and may likely result in new public health regulations.
10) Public Health (Effluent) Regulations, 1972
    - Sets guidelines for wastewater irrigation including sludge used in agriculture.
11) Urban Councils Act, 1995 / 1996 (amended 1997, 2000, 2001, 2002, 2005, 2008)
    - Relating to households being compelled to have an acceptable sanitation system before an occupation certificate is issued.
12) Rural District Councils Act, 1988 (amended 1992, 1997, 1998, 2001 and 2002)
    - Relating to sewerage and drainage within any urban land that are conferred upon town councils by Part XII of the Urban Councils Act (section 72). Sections 88 to 89 also empowers the Rural Development Councils to make by-laws covering the maintenance in good order of sanitary fixtures generally and the maintenance of health, cleanliness and good order of all council houses and buildings.

(Note: Regulations currently in effect are underlined.)

(1) Water act, 2002 (Chapter 20:24)

The preamble of the Water Act states that the legislation is "to provide for the protection of the environment and the prevention and control of water pollution”. The Act is assigned to the Minister of Water Resources and Development, now the Minister of Water Resources Development and Management.

This Act consists of 12 parts covering such administrative matters as the powers of the Minister and the Secretary or the National Water Authority, the establishment of water boards, the water court and its powers and procedures, the making of regulations and offences and penalties and water matters specially. Part VI of the Act titled Water Quality Control and Environmental Protection has been repealed by Act 13 of 2002 including the section on the discharge or disposal of water not in conformity with the set standards. The enactment of the Environmental Management Act, 2002 repealed this part.

(2) Environmental management act, 2002 (Chapter 20:27)

The Act mandates the State to pursue for the "sustainable management of natural resources and protection of the environment; the prevention of pollution and environmental degradation; the preparation of a National Environment Plan and other plans for the management and protection of the environment". The Act also authorizes the establishment of an Environmental Management Agency and an Environment Fund.

Under this Act, environmental quality standards for different water uses including drinking water will have to be established. Effluent (industrial/trade wastes to be discharged into the sewerage system and effluent discharge (including sewerage) to the environment are required to have an effluent discharge license. The Act also includes prohibitions and standards with regard to air, waste, noise and other pollutive substances. Projects that require an EIA report are identified in this Act.

(3) Effluent standards

The effluent disposal is governed by two (2) sets of regulations:

- Discharge to surface water and land is controlled by the Environmental Management (Effluent and Solid Waste Disposal) Regulations, (SI 6, 2007 of Environmental Management Act, 2002).
- Microbiological quality of wastewater is controlled by the Public Health (Effluent) Regulations (GN 638/72), issued under the Public Health Act, 1924. Due to obsolescence, the standard currently in used now by the Department of Environmental Health Services is the 2008 WHO Guidelines for Drinking-water Quality, though WHO had already issued the 2011 guidelines.

The important provisions of the Environment Management Regulations are summarised:

- the requirements of and application for licence for effluent and solid waste disposal; its classification and issue or rejection of licence; identification of sensitive areas; sampling procedures, and others;
- provides for licence classification criteria, and effluent standards for discharge for each classification;
- for each generator of wastes to prepare, implement and adhere to the waste management plan and waste prevention targets set by the EMA;
- local authorities should designate suitable sites and facilities for waste treatment and public collection sites, and regulations in regard to the licensing of waste management enterprise not operated or operated by or on behalf of local authorities; and
- management of landfills, littering, mining and mining waste, sludge, agricultural waste, and accidental spillages.

These regulations provide a basis for legal management and control of the discharge of effluent or wastewater, although complete prevention of any discharge of effluent or wastewater is practically impossible, and in extreme conditions, even from well-designed systems, occasional discharges of raw or partially treated sewage /wastewater have to be expected. Tables 3.3.1 to 3.3.6 provide regulations on water quality management.

Table 3.3.1 Reasons for Classification of Effluent Discharged into Surface Water

Licence Classification Criteria		
Reasons for classification of effluent discharged into surface water		
Classification	Risk	Reason for classification
Blue	Safe	Complies with blue standards.
Green	Low hazard	Water meets green standard or blue licence conditions not being met.
Yellow	Medium hazard	Water meets yellow standard or green licence conditions not being met.
Red	High hazard	Water meets red standard or yellow licence conditions not being met.

Source: Environmental Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007.

Table 3.3.2 Classification of Land Disposal of Effluent-Suggested Factors

Classification of land disposal of effluent suggested factors		
Classification	Risk	Reasons for classification
Blue	Safe	- Irrigation at acceptable rates, provision for system failures - Rapid infiltration meets soil percolation tests; total N < 50 mg/l - No evidence of runoff or groundwater contamination - Trace elements meet long-term targets
Green	Low hazard	- Irrigation or rapid infiltration at acceptable rates but no provision for system failures - Runoff /seepage identified at green standard - Blue licence conditions not being met
Yellow	Medium hazard	- Runoff/seepage identified at yellow standard - Rapid infiltration meets soil percolation tests but total N > 50 mg/l - Trace elements meet short-term targets - Green licence conditions are not being met
Red	High hazard	- Runoff/seepage identified at red standard - Ground water contamination identified - Yellow licence conditions not being met

Source: Environmental Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007.

Table 3.3.3 Classification Table Using Effluent Standards for Discharge

(Measurements are mg/L unless otherwise stated)

Parameter	Blue		Green	Yellow	Red
	Sensitive	Normal			
Alkalinity	*	*	*	*	*<500
Aluminium	*	*	*	*	≤5
Ammonia (N)	≤0.5	≤0.5	≤1.0	≤1.5	<2.0
Arsenic (As)	≤0.05	≤0.05	≤0.1	≤0.15	<0.3
Barium (Ba)	≤0.1	≤0.5	≤1	≤1.5	<2
BOD	≤15	≤30	≤50	≤100	<120
Boron (B)	≤0.5	≤0.5	≤1.0	≤1.5	<2
Ca+Mg	*	*	*	*	*
Cadium (Cd)	≤0.01	≤0.01	≤0.05	≤0.1	≤0.3
Chloride (Cl)	≤200	≤250	≤300	≤400	≤500
Chlorine residual (free chlorine)	Nil	≤0.1	≤0.2	≤0.3	≤0.5
Chromium (Cr (hex))	≤0.05	≤0.05	≤0.1	≤0.2	≤0.5
Chromium, total (Cr)	≤1.0	≤1.0	≤1.2	≤1.6	≤2
Cobalt (Co)	*	*	*	*	≤2
COD	≤30	≤60	≤90	≤150	≤200
Colour (TCU)	≤15	≤15			
Conductivity (μS/cm)	≤200	≤1000	≤2000	≤3000	≤3500
Copper (Cu)	≤1.0	≤1.0	≤2.0	≤3	≤5
Cyanides and related compounds (CN)	≤0.07	≤0.07	≤0.1	≤0.15	≤1
Cyanide (as free CN)	≤0.07	≤0.07	≤0.1	≤0.15	≤0.3
Detergents***	≤0.2	≤1.0	≤2	≤3	≤5
DO % saturation	≥75	≥60	≥50	≥30	≥15
Faecal coliform (No/100ml)**	≤1000	≤1000	>1000	>1500	≤2000
Flouride (F)	≤1	≤1	≤2	≤4	≤6
Grease and oil	Nil	≤2.5	≤5	≤7.5	≤10
Helminth eggs (No/100ml)	≤1000	≤1000	>1000	>1000	≤2000
Iron (Fe)	≤0.3	≤1	≤2	≤5	≤8
Lead (Pb)	≤0.05	≤0.05	≤0.1	≤0.2	≤0.5
Manganese (Mn)	≤0.1	≤0.1	≤0.3	≤0.4	≤0.5
Mercury (Hg)	≤0.01	≤0.01	≤0.02	≤0.03	≤0.05
Nickel (Ni)	≤0.3	≤0.3	≤0.6	≤0.9	≤1.5
Nitrite Nitrogen (NO_2)	≤1	≤3	≤5	≤8	≤10
Total Nitrogen (N)	≤10	≤10	≤20	≤30	≤50
Oxygen Absorbed	≤5	≤10	≤15	≤25	≤40
pH (pH units)	6.0-7.5	6-9	5-6 : 9-10	4-5: 10-12	0-4: 12-14
Phenolic cpds (phenol)	≤0.01	≤0.01	≤0.04	≤0.06	≤0.1
Total Phosphates (P)	≤0.5	≤0.5	≤1.5	≤3	≤5
Potassium (K)	*	*	*	*	≤500
Selenium (Se)	≤0.05	≤0.05	≤0.1	≤1.5	≤3
Sodium (Na)	≤200	≤200	≤300	≤500	≤1000

Parameter	Blue		Green	Yellow	Red
	Sensitive	Normal			
Sulfate (SO_4)	≤100	≤250	≤300	≤400	≤500
Sulphide (S)	≤0.05	≤0.2	≤0.3	≤0.4	≤1
TDS	≤100	≤500	≤1500	≤2000	≥3000
Temperature deg C	<25	<35	<40≤	≤40	≤45
Total heavy metals	≤1.0	≤2.0	≤4	≤10	20≤
TSS	≤10	≤25	≤50	≤100	≤150
Turbidity (NTU)	≤5	≤5			
Zinc (Zn)	≤0.3	≤0.5	≤4.0	≤5.0	≤15

Source: Environmental Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007.
Manyame Catchment Area is categorized in the Normal in Blue for effluent water quality

Notes and abbreviations

* No prescribed limits currently exist for these parameters.

** The faecal coliform limit shall be based on the average of the plate counts of the sample taken

*** Monaxol-OT=Sodium Dioctyl Sulphosuccinate

BOD: Biochemical Oxygen Demand; COD: Chemical Oxygen Demand; DO: Dissolved Oxygen; μS/cm: MicroSiemens per centimetre; NTU: Nephelometric Turbidity Units; TCU: True Colour Units; TDS: Total Dissolved Solids; TSS: Total Suspended Solids.

Other environmental quality standards in the regulations are for: 1) blacklisted pesticides and pesticides not registered in Zimbabwe; and 2) pesticides registered in Zimbabwe and those not on EU blacklist. The management of agricultural waste is also included in the regulations.

Table 3.3.4 Blacklisted Pesticides and Pesticides not Registered in Zimbabwe

Compound	Maximum Concentration (ppb)
Aldrin	0.30
Dieldrin	0.30
Endrin	0.05
Total DDT	0.50
Pp'-DDT	0.30
Hexachlorobenzene	0.30
Any other pesticide not registered in Zimbabwe	0.30

Source: Environmental Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007.

Table 3.3.5 Pesticide Registered in Zimbabwe and those not on EU Blacklist

Compound	Maximum Concentration (ppm)	Compound	Maximum Concentration (ppm)
Alachlor	1.0	Formothion	1.0
Aldicarb	1.0	Glyphosphate	1.0
Atrazine	1.0	Heptachlor	0.3
Azinphos-Methyl	1.0	Lindane	1.0
Betomyl	1.0	MCPA	0.2

Compound	Maximum Concentration (ppm)	Compound	Maximum Concentration (ppm)
Carbaryl	1.0	Metaxachlor	0.1
Carbendazim	1.0	Metolachlor	1.0
Carbofuran	1.0	Methidathion	0.6
Chlordane	1.0	Methomyl	0.6
Chlorfenvinphos	0.3	Methoxychlor	1.0
Chlorpyrphos	0.4	Monochrotophos	0.2
Dalapon	1.0	Oxamyl	1.0
Demeton	1.0	Paraquat	1.0
Diazinon	1.0	Parathion	1.0
Dicamba	1.0	Pendamethalin	1.0
Dichlorprop	1.0	Permethrin	1.0
Dichlorvos	1.0	Pichloran	1.0
Dicofol (related to DDT)	1.0	Pirimicarb	1.0
Dimethoate	1.0	Propargite	1.0
Dinoseb	0.7	Simazine	0.4
Diquat	1.0	Thiram	1.0
Disulphoton	0.6	Toxaphene (ppb)	0.3
Endosulfan	1.0	Trichlorphon	1.0
EDB	0.01	Trifluralin	1.0
Fenchlorphos	1.0	TCDD Dioxin(ppb)	0.003
Fenitrothion	1.0	2,4,5-T	0.01
Fenvalerate	1.0	2, 4-D	1.0
Fluometuron	1.0		

Source: Environmental Management (Effluent and Solid Waste Disposal) Regulations, SI 6 of 2007.

Up to this time, however, Zimbabwe does not have ambient water quality standards/guidelines nor has it classified its bodies of water into intended or beneficial uses.

Monitoring of the microbiological parameters of sources of drinking water is to be done fortnightly but at present the manner in which samples are taken is generally reactive, mostly during summer and winter when health problems occur.

(4) Trade effluent control

The Urban Councils Act (Chapter 214) prescribed the "Trade Effluent Control" and all stipulations are now incorporated in the Urban Councils Act (No.24), 1995, even though their Section numbers are changed. In this Act of 1995, Section 180 stipulates the "projection of public sewers and public drains". There are 19 types of industry in Zimbabwe, and 8 types were confirmed in the catchment as follows: Chemical, Processed Foodstuffs, Ceramics/Stone & Clay Products, Pulp/Paper, Plastic Products, Metal Products, Transportation Equipment and Other Industry Products.

In terms of Section 180 (1) (c), (d) and (e) of the Urban Councils Act, 1995, no person shall, except for the consent of the Council and subject to such conditions, it may impose:

1) discharge or put into or permit to enter a public sewer or public drain any solid, liquid or gaseous substance which the council, by notice in writing to the person concerned, has prohibited from being discharged into that sewer or drain on the grounds that it is likely to injure or damage that sewer or drain, interfere with the free flow of sewage or storm-water or cause a nuisance or involve danger to the health of persons entering that sewer or drain or employed at the sewage works or to endanger, destroy or be injurious to the structure of any public sewer, public drain, sewage works or land or to the processes used therein or thereon; or
2) discharge or put into or permit to enter a public sewer any storm water; or
3) discharge or put into or permit to enter a public drain any sewage.

In terms of 1) above, every Urban Councils Act has set the following limits on effluents which are discharged into each sewerage system provided that the council shall not discharge or permit the discharge of any sewage in contravention of Part X of the Water Act [*Chap 20:22*]. Part X of the Water Act is now repealed by Environmental Management Act [Chap 20:27]. The Urban Councils may also impose limits <u>on any other substances which are not listed below</u> as it deems necessary for the protection of public sewers or drains.

Table 3.3.6 Limits on Effluents Discharged into Sewerage System

Parameters	Limits
pH (pH units)	6.8 - 9.0
Settleable solids (mg / l)	less than 10.0
Fats (mg / l)	less than 400.0
Mineral Oils	Nil
Organic Oils	Nil
Individual Heavy Metals (mg / l)	less than 50.0
Calcium Carbide	Nil
Bitumen	Nil
Cyanides	Nil
Temperature (°C)	less than 60

Source: Urban Councils Act (No.24), 1995

With respect to 2), storm-water is prohibited from entering the sewerage system from any source within the premises including:

a) unroofed structures including wash bays, etc.,

b) broken or low sewer inlet gullies,
c) broken sewer manhole covers, and
d) broken sewer pipes, etc.

With respect to 3), wastewater that arises from any process or activity carried out in the factory or premises are considered as sewage and must not be allowed to enter the public storm-water drains. All such water should enter the sewerage system.

The contents of the regulations on "trade effluent control" are the same in every urban councils and being applied in controlling trade effluent from industries.

(5) Effluent for irrigation

Microbiological quality wastewater shall comply with the current requirements of the “Public Health (Effluent) Regulations of 1972” if effluent is intended for re-use” such as in irrigation (Part 1, Fourth Schedule) of the SI 7 2007.

Table 3.3.7 Public Health (Effluent) Regulations GN 638/72 of 1972

Type	Conventional Works Effluent	Pond System Effluent
(A) Surface irrigation of non-edible crops, pastures and orchards/plantations.	BOD < 70 mg/l	DO > 1 mg/l at all times
(B) Spray irrigation of ditto	BOD < 30 mg/l	BOD < 30 mg/l
(C) Surface or spray irrigation of the of the above plus pastures for dairy cattle, & cut flowers	BOD < 10 mg/l	DO > 1 mg/l at all times
	E. coli <10/100 ml	E, coli <10/100 ml
(D) Public Amenities, Playing fields, etc., same standards as (C) above, plus chlorination		

Source: Public Health (Effluent) Regulations GN 638/72 of 1972

The main problem with irrigation is the acceptable effluent quality which varies from wet season to dry season. A major problem is the eutrophication in effluent storage dams. The "Guidelines for the Disposal of Sewage and Sewage Effluent in Wet Weather", issued by the former Ministry of Water Development (MWD, 1978 took into account this problem by allowing direct discharge of treated effluent in excess of 1 average dry weather flow (ADWF) to rivers in periods of prolonged wet weather.

The factors to be used to determine the design of effluent irrigation schemes are the following:

- quantity of effluent,
- rainfall amount and pattern,
- soil type and permeability,

- subsoil drainage (if any),
- method of irrigation, and
- crop type.

The crop is often pasture grass or gum trees, both of which can withstand extreme variations in irrigation rate, and a rule of thumb for sizing schemes is:

- to provide 35 ha/1,000 m^3/day ADWF

Source: Sanitation Manual Design Procedures, Technical Manuals and Guidelines for Infrastructure Projects (Manual 5), December 1990.

(6) Construction of building and sewerage work

In terms of Section 183 of the Urban Councils Act (Chapter 214), as read with Section 83A of the Rural Councils Act (Chapter 211), the then Minister of Local Government and Housing made the following by-laws: The "Model Building By-laws", 1977 (amended in 1980 and 1981).

These By-laws include twelve (12) chapters, and Chapter 3 and the subsequent chapters are primarily concerned with providing technical information on the standards to which building and sewerage work shall be undertaken. The provision of these by-laws do not cover all administrative matters associated with building and sewerage work, and each local authority is likely to have further by-laws which it has made or adopted concerning: a) applications for and the supply of water, b) applications for connections to public sewers and the making of such connections; and others.

Chapter 9 is titled "Drainage and Sewerage" and consists of the following 7 parts:

- Part I : General requirements in respect of sewerage and plumbing work
- Part II : Quality and design or sanitary fittings, piping and accessories
- Part III : Construction and fixing of soil-pipes and waste-pipes and fittings
- Part IV : Construction and laying of private and combined private sewers
- Part V : Septic tanks and private disposal plants
- Part VI : Storm-water drainage and use of sewers
- Part VII: Cleaning, inspection and testing

In terms of Part V, Section 78 (1), "no person shall, on any premises, construct or use any septic tank and appurtenant disposal works for the treatment and disposal of sewage without the written consent of the local authority". Section 79 (1) stipulates that "every septic tank shall be sited, designed and constructed to the approval of the local authority, and in accordance with small domestic septic tank installations".

(7) Solid waste management

The legal system on solid waste management in Zimbabwe is covered with the Environmental

Management Act of 2002), Regulations on Environmental Management (Wastewater and Solid Waste Disposal 2007), and Regulations on Environmental Management (Hazardous Waste, 2007). Other relevant legislations, the Rural District Council's Act (Chapter 29:13, 1998 - 2002), the Urban Councils Act (Chapter 29:15, Chapter 214, 1995 - 2005), the Water Act (Chapter 20:24, 1998 - 2002), the Public Health Act (19 of 1924) and the By-laws stipulate several regulations on solid waste management. As a superordinate program or strategy in solid waste management sector, the government has prepared a draft of National Waste Management Strategy and is currently waiting for its approval by the government.

1) Environmental management act

The law provides a sustainable management of natural resources, environmental preservation protection, pollution control and prevention of environmental destruction as a fundamental law. The law was established in 2002.

The law sets the following provisions;

- Establishment of a Standards and Enforcement Committee for controlling pollution (Section 55 and 56)
- Standards for waste (Section 69):

  The Standards and Enforcement Committee shall recommend to the Board: a) measures necessary to identify materials and processes that are dangerous to human health and the environment; b) the issuance of guidelines and the prescribing of measures for the management of the materials and processes identified under paragraph (a); c) the prescribing of standards for waste, their classification and analyses, and advise on standards of disposal methods and means for such waste; and d) the prescribing of measures for the handling, storage, transportation, segregation and destruction of any waste.
- Prohibition against discharge of wastes (Section 70):

  such a manner as to cause pollution to the environment or ill health to any person. 1) No person shall transport any waste other than a) in accordance with a valid license to transport wastes issued by the Board, and b) to a wastes disposal site established in accordance with a license issued by the Board. 3) Every person whose activities generate waste shall employ measures essential to minimize wastes through treatment, reclamation and recycling. 4) The Minister or an inspector may by order issued in terms of section one hundred and seventeen or one hundred and eighteen as the case may be, require a person referred to in subsection (3) to take such measures as are specified in the order to minimize wastes through treatment, reclamation and recycling. 5) Any person who a) discharges or disposes of any wastes in contravention of any measure or standard prescribed in terms of section sixty-nine; or b) transports any waste otherwise than in accordance with a valid license issued in terms of in terms of paragraph (a) of subsection (1), or otherwise than to a licensed wastes disposal site; shall be guilty of an offence and shall be liable to imprisonment for a period of not more than five years or to a fine of not more than five million dollars or to both such fine and such imprisonment.

- Application for waste license (71)
    - Any people who intend to transport wastes within Zimbabwe, or to operate a wastes disposal site or plant or to generate hazardous waste of a prescribed type or quantity, shall prior to doing so, apply to the Board for the grant of an appropriate waste license.
    - An application for a waste license shall be made in the prescribed form and be accompanied by the prescribed fee.
    - Where the Board rejects an application made under this section it shall within twenty one days of its decision, notify the applicant of the decision specifying the reasons therefor.
    - Any person, who, at the commencement of this Act, owns or operates a waste disposal site or plant or generates hazardous waste, shall apply to the Board for a waste license under this section within six months after the commencement of this Act,.
- Hazardous waste (72)

  The Standards and Enforcement Committee shall, in consultation with the Agency, recommend to the Board standard criteria for the classification of hazardous wastes with regard to determining;
    - hazardous waste;
    - corrosive waste;
    - flammable waste;
    - toxic waste;
    - radioactive waste;
    - Any other category of waste the Board may consider necessary.

2) Regulations on environmental management (Wastewater and Solid Waste Disposal)

The regulation was established in 2007 and covers wastewater and waste disposal.
The following are the main points.

<u>Obtaining of License</u>

The regulation states that the Environmental Management Agency (EMA) controls and regulates the disposal and discharge of the solid waste and wastewater which may affect the environment, and grant a license for their disposal and discharge through giving advice to public and establishments in terms of pollution control. Any person cannot discharge their wastewater and dispose of their waste without the license to be granted by EMA. Whoever discharges or disposes of his wastewater or waste has to pay a prescribed fee and apply for the license in blue, green and red color. The person with a license who wants to renew or change his license has to apply for another license.

The regulation states that the disposal of waste (solid waste and effluent) uses "polluter pays principle" through licensing which is according to the following four classes

- Blue: in respect of a disposal which is considered to be environmentally safe.
- Green: in respect of disposal that is considered to present a low environmental hazard
- Yellow: in respect of a disposal which is considered to present a medium environmental hazard and
- Red: in respect of a disposal that is considered to present a high environmental hazard.

Establishment of Solid Waste Management Plan

Every generator of wastes (except at household level) shall, not later than the 31st of December of each year prepare implement and adhere to waste management plans consisting of;

- Inventory of the waste management situation specifying
  - quantity of waste produced and
  - the components of such waste, and
  - Specific goals for
    - The adoption of cleaner production technologies
    - Reduction of waste quantities and pollutant discharges of wastes
  - Recycling and sorting of waste wherever practical, of wastes in an environmentally safe form and manner
  - Safe transportation and disposal of wastes that can neither prevented nor recycled
  - Adoption of environmentally sound management of waste

Every local authority shall, not later than 31st December of each year, prepare a waste management plan which shall consist of the matters specified in subsection (1) in relation to waste generated by or in the possession of the local authority, and in preparing its plan the local authority may request in writing that generators of waste within its jurisdiction shall submit to it their own waste management plans.

EMA may prepare a national waste management plan providing for the strategic location of the facilities required for the treatment of wastes and the distribution of those waste among such facilities and in preparing the national waste management plan EMA may request in writing that local authorities and other generators to submit to it, or prepare and submit to it, their own waste management plans, within thirty days of receiving the request.

The Regulations allow EMA to set waste prevention targets with regard to the emission and disposal of waste by any generator of waste. These may relate to:

- Acceptable levels of emissions and disposal of waste
- Design of products containing few pollutants
- Development of products in such a form that residuals can be recycled

- The incorporation of recycled materials in the manufacture of certain products
- The creation of distribution modes that reduce residual waste to a minimum
- The consumption of products such that little waste is generated
- The preferential procurement by government agencies of products that cause little pollution after consumption or on becoming waste

Collection and Transport

Every local authority shall designate suitable sites as waste collection sites within its area of jurisdiction for the management of waste and ensure a waste collection frequency that minimizes accumulation and avoids decomposition of waste on collection sites.

In determination what sites to designate for the purposes of waste collection, the local authority shall commission a report by any person qualified to make such reports assessing the anticipated impact on the environment of any facilities referred to waste collection.
Above report shall include:

- An evaluation of collection sites and also taking into consideration of the following peculiarities of the sites;
  - Geology
  - Hydrograph
  - Climate
  - Topography
  - Physical infrastructure
  - Other features that may impact on the welfare of any animal, plant or human life in the vicinity of the site
- An evaluation of the suitability of any site in relation to the purpose and scope of any facility proposed to be located there;
- A description of the measures necessary to prevent, limit or otherwise compensate any major negative effects on the environment arising from the location of specified facilities in specified sites.

Every person, other than a local authority or agent of local authority, operating or proposing to operate a waste collection enterprise shall, no later than thirty days from the date of the publication of these regulations, or before the commencement of the undertaking, as the case may be, apply for a waste collection enterprise license. The above mentioned subsection shall not apply to the collection, recovery, sorting or storage by a generator of wastes of its own wastes and waste oils, unless it is notified in writing by the Agency or the local authority having jurisdiction over the area where such person operates or will operate and, where applicable, transmit to the local authority a report.

Waste Disposal

No one shall dispose general or hazardous waste at any other place except in a licensed landfill or hazardous waste landfill. With the effect from the date of publication of the regulations, all new disposal facility shall be lined with an appropriate lining specific to the nature of the environmental risk, whether it is an industrial, domestic, mining or any type of solid waste. No one shall continue to use an old unlined solid waste disposal site for more than five (5) years from the date of the publication of the regulations.

Prohibition of Littering

Any person found throwing litter on any land or water surface, street, road or site in or any place except in a container provided for that purpose or at a place specially designed for that purpose shall be guilty of an offence and liable to a fine not exceeding level three or to imprisonment for a period not exceeding six months or to such fine and such imprisonment unless any by-laws within the area of jurisdiction of the local authority concerned provides for offence in question. Any operator of a public passenger conveyance shall put in place sufficient bins within the vehicle for uses by the passengers. Any operator of a public passenger conveyance who fails to provide sufficient bins within the vehicle for use by the passengers shall be guilty of an offence and liable to pay a fine not exceeding level fourteen or imprisonment for a period not exceeding one year or to both such fine and imprisonment.

3) Regulations on environmental management (Hazardous Waste)

The regulation established in 2007, provides the licensing for generation, storage, use, recycling, treatment, transportation or disposal of hazardous waste. Generators of hazardous waste are also required to prepare waste management plans and targets. The Statutory Instrument also regulates waste collection and management by local authorities. The importation and exportation of hazardous waste and waste oils is also regulated by this Statutory Instrument.

Obtaining of License

Any person cannot discharge, store, sell, utilize, recover and discharge their hazardous waste and dispose of their waste without the license which was granted by EMA. Who discharges or disposes of his hazardous waste has to pay a prescribed fee and apply for the license in blue (in respect of a disposal which is considered to be environmentally safe), green (in respect of disposal that is considered to present a low environmental hazard), yellow (in respect of a disposal which is considered to present a medium environmental hazard) and red (in respect of a disposal that is considered to present a high environmental hazard) color. The person with a license who wants to renew or change his license has to apply for another license for his renew and change.

Requirement on Final Disposal of Hazardous Waste

The disposal of hazardous waste except the final disposal facility is prohibited.

The final disposal facility of hazardous waste shall have the following facilities or equipment;

- Lining with corrosion durability which was approved by EMA
- Facility which collects, measures and treats leachate water
- Drainage system of rain water
- Monitoring facilities of surface, ground water, air pollutants as a final discharge or emission
- Place of sampling which can be monitored by EMA
- A facility which can treat only hazardous waste separately from general waste

Establishment of Management Plan of Hazardous Waste and Management Goals

Every local government shall, not later than the 31st of December of each year prepare implement and adhere to hazardous waste management plans consisting of;

- an inventory of the waste management situation specifying
  - quantity of waste produced and
  - the components of such waste, and
- specific goals for
  - The adoption of cleaner production technologies
  - Reduction of waste quantities and pollutant discharges of wastes
  - Recycling and sorting of waste wherever practical, of wastes in an environmentally safe form and manner
  - Safe transportation and disposal of wastes that can neither prevented nor recycled
  - Adoption of environmentally sound management of waste

Every local authority shall, not later than 31st December of each year, prepare a waste management plan which shall consist of the matters specified in subsection (1) in relation to waste generated by or in the possession of the local authority, and in preparing its plan the local authority may request in writing that generators of waste within its jurisdiction shall submit to it their own waste management plans.

EMA has to set prevention targets of hazardous waste with regard to the emission and disposal of waste by any generator of waste same as general waste.

Collection and Management of Waste Oil and Hazardous Waste

Waste oil can be recyclable if its purpose is to use for cleaning and producing mineral oil and energy. The hazardous waste and waste oil should be collected, transported and disposed of separately from general waste.

Import and Export of Hazardous Waste and Waste Oil

The import and export of hazardous waste and waste oil is prohibited in accordance with Basel

Convention.

4) Rural district councils act (Chapter 29:13, 1998 - 2002)

This Act empowers Rural District Councils (RDCs) to regulate activities taking place in their areas of jurisdiction. Section 88 of the Act allows RDCs to make By-laws covering sewerage, effluent, the destruction of insects and vermin, and the removal of refuse and vegetation. The by-laws which may be made for issues relating to waste removal and disposal are specified as below.

The removal or disposal of:

- Human waste
- Effluent, water or refuse, whether trade, domestic or otherwise
- Decaying and other offensive or unhealthy matter and requiring the use by persons of any system or undertaking provided by the council for the collection, removal or disposal thereof.

The specification of the type of container to be used by the owner or occupier of any premises for the storage of refuse pending removal and the supply of such type of container in circumstances where such containers are not provided in sufficient numbers or of adequate size or construction. The regulation of the positions where containers referred to in subparagraph (2) shall be placed. The prohibition or regulation of the arrangement, construction and siting of any building or appliance appertaining to the disposal of human waste or domestic or trade effluent is provided in this act. Provisions are made in Section 75 of this Act, for the Council to charge an amount to a stand owner / user where service for the removal of refuse has been made available by the Council to any stand, lot, premises, or other area, whether with or without improvements. This Act therefore ensures that people pay for refuse removal. The strength of this Act is that it does not mention the monetary value of the charge; hence it provides room for council to make adjustments to the charges whenever they are uneconomic.

5) Urban councils act (Chapter 29:15, 1995 - 2005)

This Act is similar to the Rural District Councils Act in a number of ways. While the former regulates waste management in centers administered by RDCs, the Urban Councils Act regulates activities taking place in urban centers. Section 218 (b) of this Act makes provision for the council to charge for the removal of refuse where this service will have been provided. Collection of waste charge is not mentioned in the Act. However, whenever a council drafts its budget, it is supposed to be approved by the payers of waste charge. This may mean that even if council would want to charge market related values for its services sometimes it may not be able to do so. Urban councils fall under the Ministry of Local Government, Public Works and urban Development, who may not approve council, budgets if considered to be too heavy a burden on ratepayers. This usually leaves cash strapped urban authorities with very little resources that may not allow for the frequent collection of refuse. Although there is a section that empowers councils to charge for refuse removal, just as in the RDCs Act, nothing is mentioned in the Act as to what use the service fees collected will be put to.

In terms of Section 180 of the Act (Chapter 214), the local authorities are required to enact appropriate by-laws pertaining to issues such as sanitation, refuse collection, its transportation and disposal.

6) Water act (Chapter 20:24, 1998 - 2002)

The Water Act addresses the issue of waste management in Section 68 (1) where it prohibits the discharge or disposal of any organic and inorganic matter into any surface or groundwater, either directly or indirectly so as to cause pollution of the water. This is important, as it ensures that whoever disposes of waste, including local authorities, should do so in a manner that does not cause pollution to surface and groundwater resources. Local authorities are required to construct and manage waste disposal sites so as to avoid causing pollution. The Act requires polluters to pay the costs of cleaning up polluted water resources. Some local authorities in the country have already been fined for contravening sections of this Act, while others have pending court cases.

7) Public health act (19 of 1924)

This Act, under Section 68 (1) (b), provides for the Minister of Health and Child Welfare to make regulations prohibiting / regulating the erection of dwellings, sanitary conveniences, stables, cattle pens, pigsties, poultry farm, latrines, factories or other works likely to cause risk of harmful pollution of water supply or prohibiting or regulating the deposit in the vicinity of, or draining into any such place, of manure, filth or noxious or offensive thing. The Public Health Act therefore addresses the issue of waste that comes from livestock and ensues that it is taken care of. The Act also prohibits nuisances, under Section 82 where it declares that:

“No person shall cause a nuisance or shall suffer to exist on any land owned or occupied by him, or of which he is in charge, any nuisance or other condition that is likely to be dangerous or injurious to health.” Section 85 describes what a nuisance is and includes, in paragraph (e): “Any accumulation or deposit of refuse, offal, manure, or other matter whatsoever which is injurious or dangerous to health”.

8) By-laws

In terms of Section 180 of the Urban Councils Act (Chapter 214) and the Public Health Act, the local authorities are required to enact appropriate by-laws pertaining to issues such as sanitation, refuse collection, its transportation and disposal. For example, the Harare City Council applies the Harare Waste Management By-laws of 1979 as the major legal instrument for its solid waste management.

These By-laws are adopted in most of urban councils for solid waste management and main provisions are almost the same. However, the provisions of these by-laws do not cover the current waste management practices, and the urban local authorities are increasingly failing to provide efficient and reliable refuse removal and its management, because of spatial extent and rapid population growth in the urban areas.

These By-laws consist of the following fourteen (14) Sections:

- Section 1 : Title and date of operation
- Section 2 : Application
- Section 3 : Interpretation of terms
- Section 4 : Regular removal of domestic waste
- Section 5 : Provision of waste-receptacles
- Section 6 : Use of waste-receptacles
- Section 7 : Removal of excess domestic waste and garden waste
- Section 8 : Control of deposit of waste
- Section 9 : Sanitary services
- Section 10 : Disposal of industrial waste
- Section 11 : Waste-disposal sites
- Section 12 : Charges for services
- Section 13 : General
- Section 14 : Repeals

As pointed out in the final report on "Zimbabwe Urban Solid Waste Management Study" in August 1995, there is need for a "National Waste Act" which provides the necessary legal framework for a co-ordinated solid waste management. Ordinances and regulations regarding littering and improper disposal of solid waste and penalties for violation should be formulated and responsibilities of enforcement agencies must be clearly delineated.

Major constraints in the solid waste management of the urban local authorities can be summarised as follows:

- lack of finance,
- aged equipment,
- lack of knowledge to run the disposal sites,
- insufficient manpower development, and
- lack of awareness to the public.

9) National strategy on solid waste management

A national strategy on solid waste management was established in 2010. The objective of the National Solid Waste Management Strategy is to control pollution, improve waste management to prevent environmental degradation and ensure that waste is managed sustainably. The strategy sets out the strategy approach of Zimbabwe to managing waste for the period 2009 to 2020. The target wastes covered by this strategy are domestic wastes including garden wastes, commercial wastes, institutional wastes (markets, schools, hospitals, public offices, etc.), street sweeping and grass cutting wastes, wastes collected from drains, industrial solid wastes which are or can be accepted in municipal landfills (toxic and hazardous wastes are excluded).

a) Vision and principles

The national strategy has the following vision and guiding principles.

Vision: To have a clean Zimbabwe through sustainable waste management by 2020 through involving all citizens.

Guiding principles: Above vision is implemented and supported through the following six (6) guiding principles:

Cradle to Grave:

All waste will be controlled from its generation (cradle) to its final disposal (grave). This is a holistic approach which extends from planning, through waste prevention and minimization as well as generation, storage, collection, transportation, treatment and final disposal.

Integrated Waste Management

The waste hierarchy will be followed and used as guideline to:

- Reuse of waste,
- Recycling or composting waste and by-products
- Treatment of waste,
- Ensuring safe disposal of residual and non-recoverable waste

Implementation of a consistent approach to regulation

The regulation should be maintained to be effective, transparent, responsive and flexible in the following points:

- Continuous development of the regulatory framework including guidelines and standards with consideration to the changing environment
- Actual enforcement according with its compliance and enforcement guidelines
- Support and implementation of a *Polluter Pays* principle.

Precautionary Principles

All unknown waste will be treated as extremely hazardous until identified and classified.

Stakeholder Involvement

Major stakeholders will be engaged in the development and implementation of solid waste management because this strategy requires the participation of every citizen and the following approach will be used to mobilize their cooperation and support through:

- Creation of working groups and regular consultation to involve all stakeholders.

- Conduct education and awareness programme for communities and all stakeholders
- Setting up committees for waste and environmental management
- Setting up School waste and Environmental Committees to get involved in social mobilization.
- Publication of waste management schedules

Partnerships

This strategy will be hinged on Partnerships with major stakeholders who will be engaged as follows:

- Continual engagement with the Private and Informal Sector, Non-Governmental Organizations, etc.
- Setting up public Partnerships Forum
- Partnerships to form 3Rs
- Assistance to recycling Industries
- Good incentives for industries implementing good waste and environmental management
- Utilization of private sectors as a thinking pad for local government

b) Goals for implementation of the strategy

The goals of the implementation of the strategy are shown as below.

Goal 1: Conduct an education and enhance public awareness in sustainable waste management to all the Citizens of Zimbabwe.

The guiding principles require continual promotion to ensure that with time they become part of people's thinking and habits.

Goal 2: Review and assess the Current Policies and legal Framework in light of the National Solid Waste Management Strategy

The existing policies and legal framework will be used appropriately rather than develop new ones. The existing laws will also include and support the development of institutional framework as well as funding mechanisms for the implementation of the National Solid Waste Management Strategy. The legislation must also be reviewed to include a sound material recycling system through 4Rs for containers and packaging material, home appliances, construction materials, end of life vehicle and industrial waste.

Goal 3: Develop a well-managed and reliable database and guidelines for the waste information systems

With no information on waste it will be difficult to implement the National Solid Waste Management Strategy. Knowledge of quantity and composition (i.e. both physical and chemical characteristics) of the waste streams is important because it helps to: Determine the type, classification and size of storage facilities to use, plan routes to follow during and frequency of waste collection, select appropriate refuse trucks to use etc., plan waste recovery, reuse and recycling programmes, and decide suitable disposal methods to employ.

Goal 4: Minimize waste generation by maximizing Reduction, Reuse, Recycling and Material Recovery at source.

Source reduction prevents the generation and 4 R"s will be one of the preferred methods of waste management, reusing products or materials where possible. This is better because the items do not have to be reprocessed before it can be used again. Recycling turns waste materials into valuable resources. It also generates environmental, financial and social benefits.

Goal 5: Reliable, effective and efficient collection of waste in all settlements.

Proper waste collection service should be provided at all major sources of residential, industrial, construction, commercial, institutional and agricultural areas.

Goal 6: Invest, develop and maintain new landfill sites

Detailed site selection, topographic, the potential environmental impacts, costs and other issues will be looked into. Stakeholder participation in the planning process will be maximized. Major stakeholders and the local community will be made aware of, and be given the opportunity to comment on any proposed developments which if implemented may impact upon them or their activities.

Goal 7: Establish a long term financial plan which supports the delivery of the National Solid Waste Management Strategy.

Operational costs over the next 11 years will be estimated, taking account of expected investment service coverage, schedules of waste management charges and changes in demand for service. A series of financial targets and performance measures will be developed.

Goal 8: Develop mechanisms for on site management of waste

All stakeholders will be expected to integrate waste management in all their day to day activities that is developing mechanisms for onsite waste management.

Goal 9: Promote, monitor and evaluate the impacts of waste management activities in relation to climate change

Climate change is the greatest challenge facing the globe at the moment. The impacts of waste management activities to it will have to be managed.

c) Objectives and targets

The strategy will be implemented through goals, objectives and action plans. Action plans are not part of this document .They will be presented in a separate document with the involvement of the technical waste experts from local government, related government ministries, NGOs, academic institutions. The objectives of the national strategy are divided into those of three phases of Phase 1 (2009 -2012), Phase 2 (2013 – 2016) and Phase 3 (2017 -2020), and their details are shown in Table 3.3.8 to Table 3.3.10.

Table 3.3.8 National Waste Strategies, Phase 1: 2009 – 2012

National Targets	Strategy
Expected period of development on SWM	11 years
Expected period of financial targets and measures on SWM	11 years
Development of SWM data	Production of waste management database, requirements and guidelines.
Education of urban population	Education of 85% of the urban population on the requirements of sustainable waste management.
Education of urban population rural, growth points, farms and mines population	Education of 85% rural, growth points, farms and mines population and introduce awareness programmes to primary, secondary schools and Tertiary colleges.
Review of policy and legal framework	Review of the current policy and legal framework and address the inherent gaps
Alignment with national legislation	To align local authorities by-laws for waste management with the relevant national legislation.
Education of laws, policies and by-laws	Education of the public, industry and local authority staff on the provisions of the laws, policies and by-laws governing waste management
Enforcement of laws	Promotion of efficient and effective enforcement of laws.
Collection and incineration of hospital waste	Collect and incinerate 40% of all medical waste generated in all hospitals and other relevant institutions producing medical waste.
Collection, classification, treatment and disposal of solid waste in settlements	Collect, classify, treat and dispose 40% of total solid waste generated in all settlements.
Littering and unauthorized waste disposal	Littering and unauthorized waste disposal shall be punished by fines to recover collection and disposal costs.
Existing final landfill	Properly manage existing landfill sites.
MDG targets	Promotion, monitoring and evaluation on solid waste management to meet MDG targets
Information disclosure to public	Information disclosure to public on solid waste management to the public.
Development of legal framework	Development of legal framework on solid waste management

Table 3.3.9 National Waste Strategies, Phase 2: 2013 – 2016

National Target	Strategy
Collection and incineration of hospital waste	Collect and incinerate 90% of all medical waste generated in all hospitals and other relevant institutions producing medical waste.
Collection, classification, treatment and disposal of solid waste in settlements	Collect, classify, treat and dispose 90% of total solid waste generated in all settlements.
Promotion of 4Rs	Introduction and implementation of the concept of 4Rs through partnering with the private sector.
Development of waste management enterprises	Development of waste management enterprises among CBOs and industries.
Recycling center	Introduce at least 1 recycling center in all settlements.

National Target	Strategy
Recycling and composting	Development of facilities and services to achieve recycling and composting.
Source separation	Introduction of incentives for waste prevention and reuse to encourage greater participation by residents and industry in separation and collection services.
Education of urban population	Education of 100% of the urban population on the requirements of sustainable waste management.
Education of urban population rural, growth points, farms and mines population	Education of 100% rural, growth points, farms and mines population and introduce awareness programmes to primary, secondary schools and Tertiary colleges.
MDG targets	Promotion, monitoring and evaluation on solid waste management to meet MDG targets

Table 3.3.10 National Waste Strategies, Phase 3: 2017 – 2020

National Target	Strategy
New landfill	Development and maintenance of new landfills in all settlements.
Existing landfill	Closure and rehabilitation of all existing landfills and dumpsites.
Promotion of 4Rs	Introduction and implementation of the concept of 4Rs through involvement of all stakeholders
Collection and incineration of hospital waste	Collect and incinerate 100% of all medical waste generated in all hospitals and other relevant institutions producing medical waste.
Collection, classification, treatment and disposal of solid waste in settlements	Collect, classify, treat and dispose 100% of total solid waste generated in all settlements.
Collect, classify, treat and dispose 100% of total solid waste generated in all settlements.	Collect, classify, treat and dispose 100% of total solid waste generated in all settlements.
MDG targets	Promotion, monitoring and evaluation on solid waste management to meet MDG targets

10) National policy or strategy on 3Rs and recycling

As mentioned in the national strategy which was mentioned in relation to the objectives for each phase in solid waste management sector, the necessity on 3Rs or recycling was established. However, their specific figures on target recycling ratio have not been mentioned.

(8) Livestock pollution

With regard to the livestock (farm) pollution, there are no specific regulations. This problem may be regulated in terms of water pollution and/or solid waste, as discussed above.

According to the interview survey, droppings (dung or excrement) of domestic animals become part of the soil organic matters. Some may enter the stream directly but these are in very small quantities.

There are no slaughterhouses (cows & pigs) in the farms. Most of the livestock are sent directly to established abattoirs in towns, namely; Marondera and Chinhoyi.

3.3.2 Environmental Conservation and Management

Previous to the enactment of the Environmental Management Act of 2002, the environmental legislation, policies, standards and guidelines in Zimbabwe are too much fragmented and overlapping. This Act repeals the Natural Resources Act (Chap 20:13), the Atmospheric Pollution Prevention Act (Chap 20:03), the Hazardous Substances and Articles Act (Chap 15:05) and the Noxious Weeds Act (Chap 19:07.) Other than the Act, presently, there are seven (7) major pieces of government legislation and policies relevant to environmental protection and management administered by the Ministry of Environment and Natural Resource Management (MENRM). The Ministry regulates the activities of all government agencies and other agencies to the extent that their activities impact on the environment (Section 5, Environmental Management Act, 2002).

(1) Legislation

Acts administered by the MENRM:

1) Environmental Management Act (Chap 20:27), 2002
2) Forest Act (Chap 19:05) Chap 19:05), revised 1996
3) Parks and Wild Life Management Act (Chap 20:14), 1975 (amended 1990)
4) Communal Lands Forestry Produce Act (Chap 19:07), 1987
5) Prevention of Cruelty to Animals Act (Chap 19:09), 1967
7) Rhodes Estate Act (Chap 20:17), 1978 (amended 1986)

(2) Policies administered by the MENRM

These regulations are significant in that they operationalize the Act in the sectors which they cover. They provide for the specific procedures to be followed in complying with the provisions of the Act. More importantly, they incorporate the modern principles of environmental management such as polluter pays, public participation, preventive principle, environmental rights and others.

1) National Environmental Policy

The policy what the Government will do so as to avoid irreversible environmental damage, maintain essential environmental processes and preserve the broad spectrum of biological diversity so as to sustain the long term ability of natural resources to meet the basic needs of people, enhance food security, reduce poverty and improve the general standard of living of the people.

2) National waste management strategy

The strategy aims to reduce both the generation and the environmental impact of waste. It presents a plan for ensuring that the socio-economic development of the country, the health of the people and the quality of its environmental resources are no longer adversely affected by uncontrolled and uncoordinated waste management'

3) Forestry based land reform policy

The Policy for Forest-based Land Reform policy seeks to engage the people in forest management so that they may benefit from the products and services from forests and to engage in afforestation in their respective districts and provinces.

4) Wildlife based land reform policy

The Wildlife based Land Reform Policy is an integral part of the Government's overall land reform policy on land with limited agricultural potential. The basic requirement is that the ownership of conservancies and game ranches must change to reflect objectives of the land reform programme and in doing so business and conservation issues must guide operations.

The impact of pollution has long been recognised. Many Environmental Impact Assessment (EIA) studies have been carried out, some as early as the mid-1970s. However, the role of laws in controlling environmental quality has only recently been established.

Government is responding to such priority problems as deforestation, soil erosion, loss of biodiversity, air and water pollution and climate change through a number of statutory instruments, policies, programmes and projects. Zimbabwe's environmental legislation is contained in over 18 different statutes and administered by at least eight (8) different ministries.

During the implementation of the Second Five-Year Development Plan (1991-1995), it was specified that EIA be undertaken before projects are implemented; however, there was no formal Government procedure. In December 1993, according to a clear directive from the Cabinet, the then Ministry of Environment and Tourism (MET) commenced to develop the necessary legislation and policy to implement effective environmental management and sustainable development in the country.

Consequently, an "Environmental Impact Assessment Policy (EIA Policy)" was developed in 1994 and being implemented by the then Ministry of Environment and Tourism for application to development projects likely to have significant environmental consequences. However, this EIA Policy was established on a trial basis. Its design and further application is to be reviewed annually until it is superseded by a formal legislation requiring an EIA.

The enactment of the Environmental Management Act is a response to address fragmentation or the lack of a coherent and comprehensive environmental law framework. It aims to harmonize and co-ordinate institutional, policy and legislative framework for delivery on a national level.

Policies and laws relating to environmental/water quality management and sustainable development and the institutions responsible is shown in Table 3.3.11.

Table 3.3.11 Policies and Laws Relevant to Environmental Management/Water Quality Management

Act or policy	Key elements	Implementing authority
Environmental Management Act (2002)	The Act has repealed: - The Natural Act Resources Act (Chap 20: 13) - The Atmospheric Pollution Prevention Act (Chap 20:03) - The Hazardous Substances and Articles Act (Chap 15:05) - The Noxious Weeds Act (Chap 19:07) The Act creates a framework for environmental management, make provisions for the formulation of environmental quality standards, (e.g. air, water, noise, effluents, waste and hazardous substances, and develop the national environmental action plan Requires EIAs to be undertaken for prescribed activities, and specifies procedures for the administration of the EIA process.	Ministry of Environment and Natural Resources Management (MENRM)
EIA Policy, 1997	The policy requires that the responsible agencies should not grant permits to projects that are prescribed for EIA before such EIA has been undertaken, reviewed and accepted by the Environmental Management Agency. EIA is regarded as part of the project planning. The policy is supported by Environmental Guidelines for various sectors, and led to the promulgation of the Environmental Management Act (Chap 20:27)	MENRM
National Environmental Policy. 2003	This policy will complement and enhance the Environmental Management Act (Chap 20:27). It establishes National Environmental Policy goals and principles for environmental conservation, social and economic issues as well as providing for environmental management and organizational responsibilities and institutional arrangements.	MENRM
Water Act, 2002 (Chap 20:24)	The Act regulates the planning and development of water resources, and provides a framework for allocating water permits.	Ministry of Water Resources Development and Management
Forest Act, 1949 (Chap 19:05)	The Act provides for demarcating forests and natural reserves, conserving timber resources, regulating trade in forest produce, and regulating the burning of vegetation.	MENRM
Parks and Wildlife Act, 1975 (Chap 20:14)	The Act establishes national parks, botanical reserves and gardens, sanctuaries, safari areas and recreational parks; provides for the conservation and control of wildlife, fish and plants; and designate specially protected animals and indigenous plants.	MENRM
Communal Land Forest Produce Act, 1988 (Chap 19:04)	The Act controls the use of wood resources within communal land. Such resources in communal land should be used for domestic purposes by the residents only.	MENRM
Rural District Councils	The act allows for the establishment of Rural District Councils	Ministry of Local

Act or policy	Key elements	Implementing authority
Act, 1989 (Chap 29:13)	responsible for initiating and regulating development in rural areas	Government, Urban and Rural Development
Fertiliser, Farm Feeds and Remedies Act, 1953 (Chap 18:12)	The Act provides for the registration of fertilizers, farm feeds and sterilizing plants. It also regulates the importation and sale of fertilizers and farm seeds.	Ministry of Agriculture, Mechanisation and Irrigation Department (MAMID)
Mines and Mineral Acts, 1961(Chap 21:05)	The Act regulates the acquisition of mining rights, prospecting for and extraction of minerals and decommissioning of mining works.	Ministry of Mines and Mining Development
Trapping of Animals (Control) Act, 1974 (Chap 20:21	The Act prohibits making, processing or using certain types of traps, and specifies the purposes for which animal trapping is permitted.	MENRM
Locust Control Act, 1971 (Chap 19.06)	The Act controls locusts.	MAMID
Plant Pests and Diseases Act, 1959 (Chap 19:08)	The Act provides for the eradication and prevention of the spread of plant pests and diseases.	MAMID
Prevention of Cruelty to Animals Act, 1960 (Chap 19:09)	The Act prohibits activities considered cruel to animals.	MENRM

Source: JICA Project Team

3.3.3 Environmental Impact Assessment

(1) Legal and policy framework

According to the Environmental Management Act Chapter 20:27, Section 97 prescribes all activities that require an Environmental Impact Assessment (EIA) before these are implemented. Such activities include mining and quarrying, forestry, agriculture, transport, energy, water, urban infrastructure, tourism and waste management. Specifically, the Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations (SI 7 of 2007) deal with the regulation of the Environmental Impact Assessment (EIA) process and protection of ecosystems.

1) EIA procedural framework

The EIA decision making process is shown in Figure 3.3.1. The types of projects which require an EIA to be carried out are shown in Table 3.3.12. These are listed in the First Schedule of the Environmental Management Act, 2002.

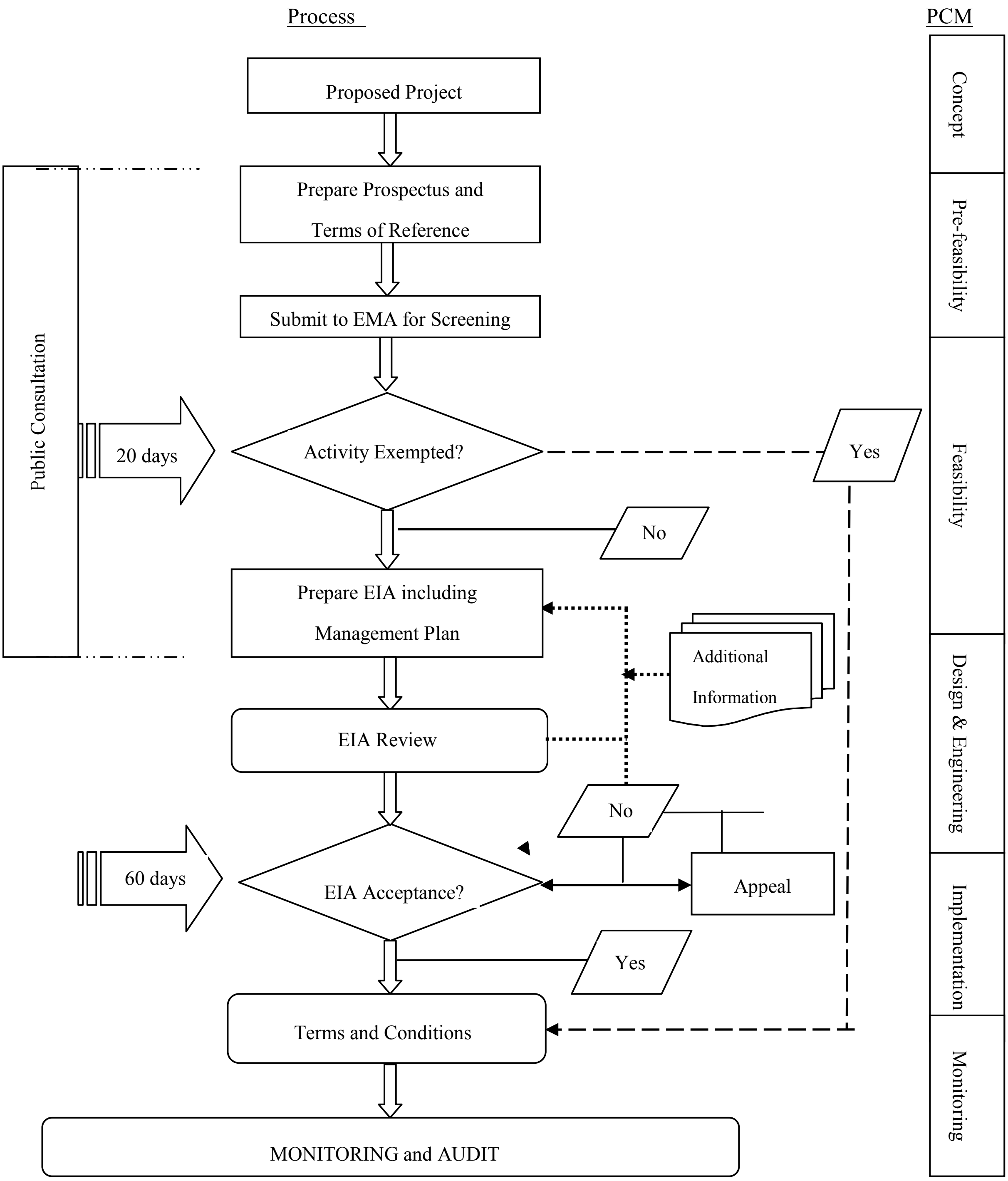


Figure 3.3.1 EIA Process Flow in Zimbabwe in the Context of Participatory Approach and PCM

Decision point by authority =
External process points by project proponent =
Review and monitoring points =

Source: JICA Project Team (Basic source of information: SI 7 of 2007)

Table 3.3.12 List of Projects that Require an EIA

1. Dams and man-made lakes a) Forestry a) within the catchment area of 2. Drainage and irrigation a) Drainage of wetland or wild life habitat b) Irrigation schemes	8. Petroleum production, storage and distribution a) Oil and gas exploration and development b) Pipelines c) Oil and gas separation, processing, handling and storage facilities d) Oil refineries
3. Forestry a) Conversion of forest land to other use b) Conversion of natural woodland to other use within the catchment area of reservoirs used for water supply, irrigation or hydropower generation or in areas adjacent to the parks and wild life estate	9. Power generation and transmission a) Thermal power station b) Hydropower schemes c) High- voltage transmission lines
4. Housing development	10) Tourist resort and recreational developments a) Resort facilities and hotels b) Marinas c) Safari operations
5. Industry a) Chemical plants b) Iron and steel smelters and plants c) Smelters other than iron and steel d) Petrochemical plants e) Cement plants f) Lime plants g) Agro- industries h) Pulp and paper mills i) Tanneries j) Breweries k) Industries involving the use, manufacture, handling, storage, transport or disposal of hazardous or toxic materials	11. Waste treatment and disposal a) Toxic and hazardous waste, incineration plants, recovery plants (off-site), waste water treatment (off-site), landfill facilities, storage facilities (off-site) b) Municipal solid waste, incineration composting and recovery/ recovery plants landfill facilities c) Municipal sewage, waste treatment plants, outfalls into aquatic systems, effluent water schemes
6. Infrastructure a) Highways b) Airports and air facilities c) New railway routes and branch lines d) New towns or townships e) Industrial sites for medium and heavy industries 7. Mining and quarrying a) Mineral prospecting b) Mineral mining c) Ore processing and concentrating d) quarrying	12. Water supply a) Ground water development for industrial, agricultural or urban water supply b) Major canals c) Cross-drainage water transfers d) Major pipelines e) Water withdrawals from rivers or reservoirs

Source: Environmental Management Act, 2002

Before carrying out the EIA for a prescribed activity, the developer must submit a prospectus to the Director-General containing information regarding the EIA and the project. However as there are no size or magnitude specified for any of the prescribed activities, the EIA policy requires any developer to submit a prospectus so that the Director-General of the Agency can determine whether or not an EIA is required. The prospectus serves an initial EIA and must contain the following information:

- A description of the proposed project;
- The current status of the project whether it is at the feasibility planning, design or implementation stage; and
- A description of the known or predicted environmental impacts.

The Director-General will then review the prospectus and on completion may ask the developer to submit any further information that the Director-General may require. The Director-General may either:

- approve the prospectus provided that he is satisfied that the proposed EIA is capable of evaluating the project's impact on the environment and will ask the developer to proceed with the proposed EIA; or
- reject the prospectus and request a new one if he is not satisfied that the EIA adequately addresses the environmental impacts of the project.

(2) Contents of the EIA report

If the Director-General approves the prospectus he may also set out certain conditions relating to the scope of the assessment, including the appointment of an independent expert in environmental assessment to prepare the EIA Report. The developer is required to comply with these conditions. EIA Reports must contain the following information:

- A detailed description of the proposed project and the activities which will be undertaken during its implementation;
- Reasons for the selection of the proposed site of the project;
- A detailed description of the direct, indirect, cumulative short- and long-term impacts the project will have on the various sections of the environment;
- Specification of the measures proposed for eliminating reducing or mitigating the anticipated adverse effects of the project;
- Identification and description of methods for monitoring and managing the adverse environmental effects;
- An indication of whether the environment of any other country is likely to be affected by the project and the measures that will be taken to minimise any damage to that environment;
- How the developer plans to integrate biological diversity into the project (where applicable); and

- A concise description of the methodology used by the developer when compiling the EIA report.

There are certain projects that may be deemed to be exempt from an EIA after the Agency has reviewed the prospectus according to their screening guidelines. A project will be considered to be exempt from undergoing an EIA if:

- It does not utilise natural resources to such an extent that current and future use of those resources will be affected;
- The potential environmental impacts are minor and can be easily managed;
- The type of project, its environmental impacts and measures for managing these impacts are clearly understood in Zimbabwe;
- The environmental impacts and the measures for managing them have already been clearly incorporated into the project design;
- It will not displace a significant number of people;
- It is not undertaken in environmentally sensitive areas such as national parks, wetlands, productive agricultural lands, sites protected by legislation or sites with rare or endangered species;
- It will not result in significant emissions of pollutants or release of waste materials whose disposal is not covered by existing legislation.

The size of the project and the potential for the displacement of people are considered particularly important criteria.

Every developer shall take all reasonable measures to prevent or mitigate any adverse or undesirable impacts on the environment that may arise through the implementation of the project. The measures taken shall be reported to the Director-General unless they are already contained within the EIA report.

(3) Considerations of EIA report and issuance of certificates

The Agency will review the final EIA Report or, if the Agency does not have adequate expertise in a particular area they may ask other government departments to review the report. On reviewing the report the Agency can:

- Approve the project to which the EIA report relates;
- Require the developer to conduct a further EIA for part or the whole of the project
- Request the developer to supply additional information or complete such as other tasks as the Director-General considers necessary.

The Director-General will consider the following when deciding whether or not to approve a project's EIA:

- The likely impacts of the proposed project as well as the actual impacts on the environment of any existing similar projects;
- The extent to which the project complies with the National Plan as well as any LEAPs;
- Any consultations with any authorities' organisations, communities, agencies or persons which in his opinion has an interest in the project.

If the project is approved then the Director General will issue the developer a *Certificate* which:

- Identifies the project;
- Contains the name and address of the developer, or if the developer is a company the registered office of the company;
- States the date of issue of the certificate and the date of expiry of the certificate;
- Sets out any conditions imposed by the Director-General;
- Sets out any other matters deemed necessary by the Agency or the Director-General.

Once a Certificate has been issued, the developer may then approach the relevant authorities for a *permit* to implement a new project. The certificate is valid for two years from the date of issue. It may be extended by not more than a year for a project that has commenced, but is not completed within the stipulated period. However if the project is not commenced within the two year period then the validity of the Certificate expires and a new certificate will need to be applied for. The Director-General will keep a register of Certificates which is open to inspection by the public. Transfer of Certificates between people is prohibited without prior approval of the Director-General.

The Director-General is also able to amend, suspend or cancel a Certificate if new information is provided which indicates that the project is a potential source of pollution or any other threats to the environment which require a new EIA to be conducted. The Director-General may also amend the Certificate or any of the conditions under which the certificate was issued including directions on minimising or preventing threats to the environment in the planning, execution and monitoring of the project. The developer must also inform the Director-General if the project is not implemented of if the project is altered within the period of the certificate's validity.

The EIA policy states that the review should be completed within *60 days*. If this deadline is not met, then it can be assumed that the EIA Acceptance has been granted. However larger projects and developers seek to obtain official EIA Acceptance in order to safeguard against possible future repercussions. In the case of the project being rejected the developer has *10 days* in which to lodge and appeal with the Ministry.

(4) Public consultation process

Public participation is a requirement of the EIA process and the policy states that the public should participate in the preparation and review of EIA reports. However in practice public participation has been more or less limited to consultation with the affected communities. These consultations typically focus on determining the probable impacts and the mitigation measures that will be acceptable to the community involved. Consultation methods include questionnaire surveys, group discussions and informal and formal meetings through Focus Group Discussions (FGDs) with community, or local leaders through Key Informants Interviews (KIIs).

3.4 Financial Arrangements

3.4.1 Financial Status of Central Government

The government of Zimbabwe adopts the cash budgeting principle where total expenditures are basically contained within available budget revenues. Table 3.4.1 shows summary of the budgets from 2009 to 2012.

Table 3.4.1 Budgets of Central Government

(USD million and % of GDP)

	2012 Projection		2011 Projection		2010 Estimate		2009 Actual	
Total Revenue	4,000	34%	3,020	30%	2,339	28%	974	17%
Revenue (Tax and Non Tax)	3,400	29%	3,020	30%	2,339	28%	933	16%
Other revenue	600	5%	0	0%	0	0%	0	0%
Budget grants	0	0%	0	0%	0	0%	41	1%
Total Expenditure	4,000	34%	2,745	27%	2,107	25%	921	16%
Current expenditure	3,200	27%	2,140	21%	1,603	19%	804	14%
Capital expenditure	800	7%	606	6%	415	5%	45	1%
Budget Balance	0	0%	276	3%	232	3%	54	1%
Nominal GDP	11,914		10,007		8,290		5,899	

Sources: The 2012 Nationcal Budget, Budget Strategy Paper 2012

Central Government Revenues have increased from 974 mil. USD in 2009, to 3.0 bn. USD in 2011 and representing 30% of the 2011 estimated nominal GDP. In terms of the ratio between the GDP and the government revenue, this 30% indicates that the government is not large-sized. The revenue projection for 2012 is about 4 bn. USD, which is more than 30% increase from that of 2011. Since the actual revenue has been usually lower than the projection in the past years, the 3 bn. USD could be a modest guess for the 2012 actual revenue. Apart from the economic growth, the main contributor of the budget increase is revenue from diamond. The mineral revenue that the government will receive from the mining industry is anticipated to be 600 mil. USD in 2012. This diamond revenue is an important revenue source especially when budgeted grants have been minimal due to the lack of full engagement of the international development partners.

Table 3.4.2 provides a summary of the government revenues in 2012. Of the total revenue collections of 3,257 mil. USD, the value added tax (VAT) was the largest contributor, accounting for 33% of the total. Other major contributors were personal income tax levied through the “pay-as-you-earn” (PAYE) system (21%), corporate tax (14%), excise duty (12%) and customs duty (11%).

Table 3.4.2 Composition of Government Revenues

(USD million, % of total)

Revenue item		
Value added tax (VAT)	1,083	33%
Personal income tax (PAYE)	686	21%
Corporate income tax	443	14%
Excise duty	394	12%
Custom duty	354	11%
Mining royalities	137	4%
Carbon tax	37	1%
Other taxes	123	4%
Total	3,257	100%

Source: ZIMRA

The composition of the government expenditure by ministerial allocation is shown in Table 3.4.3. The Ministry of Education, Sport, Arts and Culture receives the highest budget allocation, accounting for 18% of the total expenditure in 2012. Ministries relatively pertinent to investments for water supply, sewerage and solid waste management are (i) environment and natural resources management, (ii) local government, urban and rural development, (iii) health and child welfare, (iv) national housing and social amenities, (v) water resources development and management, and (vi) public works. Allocation to those ministries constitutes 15% of the total expenditure budget in 2012.

Table 3.4.3 Composition of Government Expenditure by Ministry

(USD million)

Ministry	2012 Budget		2011 Estimate	
Education, Sport, Arts and Culture	707	18%	469	17%
Constitutional and Statutory Appropriations	352	9%	278	10%
Health and Child Welfare	346	9%	256	9%
Defence	318	8%	198	7%
Home Affairs	308	8%	200	7%
Higher and Tertiary Education	296	7%	159	6%
Finance	285	7%	168	6%
Agriculture, Mechanisation and Irrigation Development	227	6%	124	5%
Office of the President and Cabinet	172	4%	121	4%
Public Service	126	3%	76	3%
Justice and Legal Affairs	111	3%	83	3%
Transport and Infrastructural Development	109	3%	74	3%
Local Government, Urban and Rural Development	90	2%	100	4%
Foreign Affairs	74	2%	77	3%
Water Resources Development and Management	71	2%	37	1%
Public Works	51	1%	37	1%
Energy and Power Development	50	1%	67	2%
Youth Development, Indigenisation and Empowerment	48	1%	37	1%
Labour and Social Services	46	1%	36	1%
National Housing and Social Amenities	34	1%	17	1%
Judicial Services Commission	23	1%	16	1%
Office of the Prime Minister	19	0%	14	1%
Parliament of Zimbabwe	18	0%	16	1%
Lands and Rural Resettlement	14	0%	8	0%
Media, Information and Publicity	11	0%	6	0%
Environment and Natural Resources Management	11	0%	6	0%
Women's Affairs, Gender and Community Development	10	0%	7	0%
Constitutional and Parliamentary Affairs	10	0%	18	1%
Science and Technology Development	9	0%	5	0%
Information Communication Technology	9	0%	8	0%
Industry and Commerce	9	0%	4	0%
Small and Medium Enterprises and Co-operative Development	9	0%	6	0%
Mines and Mining Development	7	0%	5	0%
Tourism and Hospitality Industry	6	0%	4	0%
Audit	5	0%	4	0%
Economic Planning and Investment Promotion	3	0%	2	0%
Regional Integration and International Co-operation	2	0%	2	0%
State Enterprises and Parastatals	2	0%	1	0%
Total expenditures	4,000	100%	2,746	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance

The composition of the government expenditure by purpose is shown in Table 3.4.4. As interannual and year-round data are not available, the revised budget of 2011 is used for the composition analysis. Fiscal space remains severely constrained under the cash budgeting principle. As a result, 52% of the expenditure was allocated for the employment costs. International best practices require that employment costs are contained at 30% of the total budget or 10% of GDP.

Table 3.4.4 Composition of Government Expenditure by Purpose

(USD million, % of total)

Expenditure item	2011 budget	
Recurrent Expenditure	2,140	78%
Employment cost	1,441	52%
Civil service	920	34%
Pension	237	9%
Medical aid	35	1%
Recurrent operation	659	24%
Health	73	3%
Education	59	2%
Social protection	29	1%
Agriculture	23	1%
Maintenance of infrastructure	9	0%
Defence & security	153	6%
Foreign travel	47	2%
Foreign missions	31	1%
Capital expenditure	606	22%
Total	2,746	100%

Source: National Budget Statement 2012

The same type of expenditure data of 2012 is not available at the time of this report. However the actual expenditure disbursement of 2012 totalled 3.6 billion USD, of which employment cost was 1.7 billion USD. Other recurrent costs and capital expenditure were 1.5 billion USD and 0.3 billion USD respectively.

Main components of the capital expenditure or the hard infrastructure budgets are summarized in Table 3.4.5.

Table 3.4.5 Main Components of Government Capital Budget

(USD million, % of total)

Item	2012		2011		2010		2010-2012 total	
Energy	16	3%	35	13%	15	7%	66	7%
Water and Sanitation	86	18%	47	18%	40	19%	173	18%
Transport	50	10%	45	17%	39	18%	134	14%
Information and communication technologies	32	7%	1	0%	15	7%	48	5%
Health	47	10%	30	11%	17	8%	94	10%
Education	25	5%	29	11%	52	25%	106	11%
Agriculture	132	27%	6	2%	2	1%	140	15%
Housing	40	8%	69	26%	32	15%	141	15%
Others	55	11%		0%		0%	55	6%
Total	483	100%	260	100%	213	100%	956	100%

Sources: 2013 National Budget Statement, State of the Economy Report for December 2012 and January 2013

Key destinations of the capital budget during the 2010-2012 period were water & sanitation (173 mil. USD or 18% of the total capital expenditure), housing (141 mil. USD or 15%), agriculture (140 mil. USD or 15%) and transport (134 mil. USD or 14%).

The government uses the Public Sector Investment Programme (PSIP) as a main instrument for implementing the provision of economic and social infrastructure in the public sector. Sector ministries examine and select projects which have been brought up by agencies and departments under their jurisdiction. The selected projects are submitted to the Ministry of Finance (MF). MF has primary responsibility for the national resource allocation process thorough the PSIP. When local authorities such as the City of Harare and the Chitungwiza Municipality need financing from the PSIP, the petitions have to go through its line ministry, which is the Ministry of Local Government, Urban and Rural Development (MLGURD). The lending terms of the PSIP fund are currently 5% interest rate per annum and 2 year repayment period.

A total of 302 mil. USD was expended as PSIP in 2012. The breakdown of PSIP in 2012 by development category is not available at the time of this report. As a recent data, Table 3.4.6 shows the list of water and sanitation projects financed under the PSIP in 2011. A total of 21.1 mil. USD funds were budgeted for 43 water and sanitation projects. Even the largest project in terms of the PSIP budget size amounted to 4 mil. USD. Chitungwiza was allocated USD 650,000 for upgrading of sewer lines, which had not been repaid at all in 2011 and 2012.

Table 3.4.6 Water and Sanitation Projects Financed by PSIP

(USD)

Local Authority/ Water supply scheme	Budget for 2011	Utilised during Jan-Sep 2011
Urban Local Authorities		
Bulawayo city-Mtshabezi Pipeline project	4,000,000	10,044,161
Masvingo City	300,000	0
Chitungwiza Municipality	650,000	350,000
Marondera Municipality-Wenimbi project	1,340,000	300,155
Chegutu Municipality	550,000	545,227
Bindura Municipality	1,100,000	880,000
Chinhoyi Municipality	1,500,000	0
Gwanda municipality	720,000	240,000
Chiredzi town	150,000	150,000
Rusape Town	600,000	197,426
Ruwa Town	2,000,000	1,600,000
Chipinge Town	580,000	55,000
Gokwe Town	375,000	72,763
Redcliff Town	550,000	173,000
Beitbridge Town-Beitbridge water project	1,200,000	0
Rural District Councils		
Darwendale	100,000	59,782
Birchenough bridge	50,000	31,840
Glendale	50,000	41,235
Chivhu	50,000	49,549
Plumtree	120,000	55,683
Chivake-Ngundu	90,000	21,760
Nkayi Water supply	50,000	13,000
Lupane	1,000,000	94,064
Mataga	200,000	55,797
Connemara	200,000	199,722
Shamva	100,000	53,144
Guruve	100,000	14,122
Sadza	200,000	40,692
Mushandike	100,000	0
Inyathi	30,000	3,102
Kenilworth	30,000	0
Binga Rural	200,000	0
Karoi	100,000	4,990
Gutu	150,000	0
Marange	50,000	0
Gokwe	185,000	0
Checheche	150,000	0
Murewa RDC	450,000	225,186
Mutasa RDC	200,000	32,000
Mutoko RDC	560,000	548,000
Runde RDC	280,000	0
Chivi RDC	450,000	236,000
Tongogara RDC	245,000	149,000
Total	21,105,000	16,536,400

Source: The 2012 National Budget by Ministry of Finance

3.4.2 Development Assistance

Zimbabwe has been under economic sanctions from Western countries since the early 2000s because of political turmoil. Also international financial institutions withdrew the funding to Zimbabwe due to the non-payment of its debt obligations. But after the cholera outbreak in 2008, the international community made a concerted effort to meet the immediate humanitarian needs. Most of funds that Zimbabwe currently receives are therefore limited to use for humanitarian assistance.

For the 2013 budget, the GOZ projected inflows of the official development assistance (ODA) at 333 mil. USD, which may increase as more donors finalize their next year budgetary cycles. However it may also decrease if some of the ODA is channeled outside the GOZ budget, through NGOs and other private sector players. On the actual disbursement basis, the ODA during the January – September 2012 totaled 651.1 mil. USD of which the bi-lateral assistance was 438.6 mil. USD and the multi-lateral assistance was 212.5 mil. USD. Table 3.4.7 provides a summary of the bi-lateral assistance from 2009 to 2012, which shows a tendency of gradual increase.

Table 3.4.7 Bilateral Development Assistance to Zimbabwe

(USD million, % of total)

Development Partner	Disbursed Jan-Sep 2012		Pledged for 2012		Disbursed in 2011		Disbursed in 2010		Disbursed in 2009	
USA	115.5	26%	131.7	23%	86.8	19%	-		-	
European Union	15.3	3%	74.9	13%	85.9	18%	141.3	33%	137.2	33%
United Kingdom	137.9	31%	168.5	30%	68.7	15%	100.0	23%	102.5	25%
Australia	36.1	8%	48.0	8%	54.2	12%	41.0	9%	40.8	10%
Germany	18.5	4%	18.7	3%	34.9	8%	18.1	4%	4.6	1%
Sweden	27.7	6%	34.5	6%	32.9	7%	30.2	7%	25.9	6%
Netherlands	15.3	3%	17.8	3%	22.9	5%	20.2	5%	28.6	7%
Norway	15.0	3%	23.4	4%	20.2	4%	29.4	7%	26.0	6%
Denmark	12.7	3%	25.8	5%	19.8	4%	-		-	
Switzerland	5.5	1%	9.1	2%	11.7	3%	1.6	0%	4.4	1%
Canada	-		4.5	1%	11.3	2%	6.2	1%	27.8	7%
Ireland	0.9	0%	4.0	1%	8.2	2%	4.3	1%	-	
Japan	0.2	0%	-		6.0	1%	30.7	7%	10.7	3%
Spain	-		-		2.3	0%	-		-	
France	-		0.4	0%	1.6	0%	1.3	0%	2.9	1%
Italy	-		-		1.1	0%	-		-	
Czech Republic	-		-		0.1	0%	-		-	
China	37.7	9%	-		-		-		-	
Finland	-		5.4	1%	-		9.1	2%	0.2	0%
Total	438.6	100%	566.5	100%	465.2	100%	433.4	100%	411.6	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance.

The pledged amount for 2012 was 566.5 mil. USD and the disbursed amount during the Jan – Sep 2012 period was 438.6 mil. USD. Major contributors in terms of the disbursement were the United

Kingdom (137.9 mil. USD), the United States (115.5 mil. USD), China (37.7 mil. USD), Australia (36.1 mil. USD), and Sweden (27.7 mil. USD). Supported areas by the bilateral development assistance are summarized in Table 3.4.8. The health area was the largest sector, accounting for 26% (114.4 mil. USD) of the disbursement.

Table 3.4.8 Supported Areas by Bilateral Development Assistance

(USD million, % of total)

Development Area	Disbursement Jan-Sep 2012	
Health	114.4	26%
Food security	56.9	13%
Governance	53.8	12%
Multi-donor trust funds	39.5	9%
Education	38.9	9%
Economic sectors	37.4	9%
Social protection	30.8	7%
Water & sanitation	26.9	6%
Humanitarian interventions	20.3	5%
Others	19.7	4%
Total	438.6	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance

The multilateral ODA for 2012 is shown in Table 3.4.9. The actual disbursement during the Jan – Sep 2012 period was 212.5 mil. USD. These were mainly contributions by the Global Fund, the World Bank and various UN Agencies, targeting health, education, social protection, and food security.

Table 3.4.9 Multilateral Development Assistance to Zimbabwe

(USD million, % of total)

Development Partner	Disbursed Jan-Sep 2012		Pledged for 2012	
Global Fund	191.1	90%	0.0	0%
World Bank	7.3	3%	0.0	0%
WHO	4.3	2%	8.7	40%
UNDP	3.6	2%	3.6	17%
UNFPA	2.7	1%	2.9	13%
UNICEF	2.3	1%	4.4	20%
UNESCO	0.6	0%	0.9	4%
UN Women	0.6	0%	0.7	3%
ILO	0.3	0%	0.4	2%
FAO	0.2	0%	0.1	1%
IFAD	0.1	0%	-	
AfDB	0.0	0%	-	
Total	212.5	100%	21.7	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance.

Both bi-lateral and multi-lateral assistance directed to the GOZ are disbursed through trust funds, which include (i) the Programmatic Multi-Donor Trust Fund (Zim-Fund), (ii) the Analytical Multi-Donor Trust Fund, (iii) Results Based Financing Trust Fund, (iv) the Health Transition Fund, (v) the Education Transition Funds and (vi) the Child Protection Fund. These trust funds are managed by multi-lateral development banks such as the African Development Bank (AfDB) and the World Bank. These banks have not been funding the GOZ due to the arrears accumulation. However through administration of these trust funds, only humanitarian assistance has been made available.

(1) Zim-Fund projects

The Zim-Fund is managed by the African Development Bank (AfDB). The purpose of the Zim-Fund is to contribute to early recovery and development efforts in Zimbabwe by mobilizing donor resources, initially focusing on infrastructure investments in water and sanitation and energy. Donors' cumulative commitment to the Zim-Fund from 2010 to the end of September 2012 was an equivalent of 124.5 mil. USD (Table 3.4.10). Out of this amount, 101.5 mil. USD was transferred into the fund.

Table 3.4.10 Zim-Fund Contributions by Donors

Contributing Donor	Amount pledged (original currency)	Amount pledged (USD million approx)		Amount disbursed (USD million approx)	
Australia	AU$20 million	19.9	16%	19.9	20%
Denmark	DK 75 million	13.1	11%	13.1	13%
Germany	Euro 20 million	26.7	21%	13.8	14%
Norway	NOK 82 million	14.2	11%	7.1	7%
Sweden	SEK 90 million	13.1	11%	10.1	10%
Switzerland	CHF 4.9 million	6.1	5%	6.1	6%
United Kingdom	GBP 20 million	31.4	25%	31.4	31%
	Total	124.5	100%	101.5	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance.

Tables 3.4.11 and 3.4.12 provide summaries of project implementation for the energy sector and the water & sanitation and energy sector under the Zim-Fund at the end of March 2012.

Table 3.4.11 Implementation of Power Projects under Zim-Fund

(USD million, % of total)

Rehabilitaion of Ash Dam at Hwange Power Station	14.9	42%
Sub transmission Works	5.0	14%
Distribution Reinforcement	10.0	29%
Consultancy for Environmental Audit	1.2	3%
Project Management and Eng. Services and Project Audit	1.6	4%
Environmental Monitoring and Capacity Building	2.4	7%
Total	35.0	100%

Source: Compiled by JICA Project Team based on data of Ministry of Finance

Table 3.4.12 Implementation of Water and Sanitation Projects under Zim-Fund

(USD 000)

Harare			9,525
	Water (Rehabilitation of chemical dosing plant)		4,925
		Distribution rehab and metering	2,000
		MJ - Filters pneuatics	2,100
		MJ - TP - backwash recovery plant, detailed assessment	50
		PE - TP water filtration	650
		Utility vechicles/tractors	125
	Sewerage		4,600
		Repair of intake works	300
		Rehab of unit 3	2,500
		Desludging and repair digesters and ponds	1,000
		Final effluent pumps	500
		O&M equipment	300
Chegutu			1,950
	Water		820
	Sewerage		1,130

Chitungwiza			1,430
	Sewerage		1,430
		Zengeza WWTW	350
		Zengeza effluent pump station	950
		O&M equipment	100
		Utility vechicle	30
Masvingo			2,792
	Water		1,460
	Sewerage		1,332
Mutare			5,560
	Water		3,230
	Sewerage		2,330
Kwekwe			3,600
	Water		1,520
	Sewerage		2,080
Sanitation & hygiene education			300
Capacity building			1,561
Project management			2,933
Grand Total			29,651

Source: Compiled by JICA Project Team based on info of AfDB

(2) Analytical multi-donor trust fund

The Analytical Multi Donor Trust Fund (A-MDTF) is supported by 13 donors[1] and administered through WB. The objective of the A-MDTF is to contribute to analytical work on the key development challenges facing Zimbabwe within the context and objectives of the WB's Interim Strategy Note and to develop suitable instruments such as informative notes and reports that can enable the Government and donors to respond quickly to changes in conditions for re-engagement. Total contributions to the A-MDTF amounted to 19.7 mil. USD during the period June 2008 to September 2012. Of this amount, 17.6 mil. USD was utilized to support the following consultancies:

- Payroll and Skills Audit;
- Upgrading of the Public Financial Management System;
- Country Integrated Fiduciary Assessment;
- FinScope Consumer Survey[2];
- Infrastructure;
- Safety Net Programme;
- Budget Process; and
- Public Investment Management, among others

1 The 13 donors include AusAID, CIDA, DANIDA, DFID, DGIS, EU, FINNIDA, GIZ, NORAD, SIDA, USAID, SDC and WB

2 FinScope Consumer Survey is designed to clarify the penetration level of various financial services among the population. This survey is an initiative of FinMark Trust and funded by DFID.

Since September 2012, new consultancy services have been provided under the A-MDTF. Among them there are two technical assistance (TA) projects which are related to this Master Plan study. The one is the assistance to develop the "Greater Harare Water and Sanitation Strategic Plan". As a backdrop in preparing this plan, there is a growing concern among GOZ and relevant local authorities that the water provision to the Greater Harare should be best viewed as a single system. It is also perceived that the situation in satellite towns is worse compared to the City of Harare and that development of independent supplies by satellite towns is unlikely to result in cost-effective use of scarce resources. In response to this concern, this TA is expected to undertake research and analytical work to formulate the strategic plan. The Greater Harare Water and Sanitation Strategic Plan will include an organizational restructuring plan which may propose an autonomous water supply and sewerage authority to cover Harare, Chitungwiza, Norton, Ruwa and Epworth. The Master Plans of water supply and sewerage of Chitungwiza will be examined and included as one of existing investment plans within the Greater Harare. The Greater Harare Water and Sanitation Strategic Plan is expected to be completed within 2013.

The other relevant TA is to undertake research and analytical work by which the Government's development of a Water Sector Investment Framework (WSIF) will be prepared. The WSIF will cover investment needs in the short, medium and long term to restore the water sector in Zimbabwe including water supply and sanitation, water resources development (including irrigation) and management functions. The investment framework will enable prioritisation of funding allocation in the national budget and it will provide a resource for funders – both in the donor sector and private – to assess how they can support the sector.

(3) Results based financing trust fund

The Results Based Financing Trust Fund is managed by the World Bank. By this fund, a 15 mil. USD health initiative project has been formulated which aims at increasing key maternal and neo-natal health interventions in 18 rural districts.

(4) Health transition fund

The Health Transition Fund (HTF) is managed by the World Bank. With a planned budget of 435 mil. USD over 5 years (2011-2015), has particular focus on women and children under the age of 5. The targets of the HTF are to:

- Reduce maternal mortality by three quarters;
- Reduce under 5 mortality by two thirds, towards achievement of MDGs 4 & 5;
- Eliminate user fees for children under 5 years of age;
- Eliminate user fees for pregnant and lactating women by 2015;
- Halve the prevalence of malnutrition in children under 5 years of age, in line with MDG 1;
- Halt and reverse trends in HIV and AIDS; and

- Halt and reverse trends in malaria and other diseases, in fulfillment of MDG 6 by 2015.

(5) Education transition fund

The Education Transition Fund (ETF) is managed by the World Bank. The ETF was created in response to the challenges faced by the education sector in 2009. The first phase of the ETF, funded to the tune of 51 mil. USD, focused on the revitalization of the education sector, through the distribution of essential primary and secondary school stationery and core textbooks. Currently, the ETF is in its second phase and has a total budget of 80 mil. USD, principally focusing on the continued revitalization of the education sector.

(6) Child protection fund

The Child Protection Fund (CPF) is managed by UNICEF. The objective of the CPF is to reduce the number of vulnerable and marginalized children through the provision of quality social and child protection assistance in promotion of children's rights. The CPF has an estimated budget of 72.8 mil. USD. Development partners have pledged 48.7 mil. USD towards the fund, out of which 33.3 mil. USD has been disbursed.

(7) Other funds administered by AfDB

In addition to Zim-Fund, there are three more multi-donor trust funds managed by the AfDB, the Fragile States Facility (FSF), the Special Relief Fund (SRF) and the African Water Facility (AWF). The AWF is an initiative led by the African Ministers' Council on Water (AMCOW) to mobilize resources to finance water resources development activities in Africa. The AfDB hosts the AWF on the request of AMCOW. The Chitungwiza Water Supply and Sanitation Rehabilitation Project (Euro 2 million) is an ongoing project supported by the AWF. The project is aimed at (i) stabilizing the deterioration of the water supply and sanitation services facilities in Chitungwiza and (ii) enhancing the institutional capacity.

(8) Noted assistance for water supply and sanitation sector

Other noted development assistance that the water supply and sanitation sector received in recent years includes the following:

- The Water Sanitation and Hygiene (WASH) Cluster was co-led by UNICEF and OXFAM. The members of the cluster include UNDP, WFP, WHO, Governmental organizations, and international and local NGOs. The WASH partners have rehabilitated water points, distributing non-food items, and providing safe water to communities, including drilling of 200 boreholes in urban areas.

- The Emergency Rehabilitation and Risk Reduction program is coordinated by UNICEF and started in 2009. Over four million people in 20 urban councils have been benefitted from the provision of water treatment chemicals supplied to local authorities and the ZINWA catchments. Also urban councils have been assisted to rehabilitate water and sewage systems in major towns and cities as a measure to minimize the recurrence and extent of cholera and other water borne diseases. 167 new boreholes were drilled in urban centers to provide alternative water sources to communities and 56 high-yielding boreholes were rehabilitated at the Nyamandlovu aquifer near Bulawayo. In Chitungwiza, hand pumped wells were drilled benefitting two clinics, nine schools and seven communities.

- The German Government through GIZ provided funding for the rapid review assessment of eight of the largest urban areas in the country, including Harare, and provided 6 mil. USD to finance the emergency rehabilitation of the WSS systems in urban areas of Gweru, Kadoma, and Kariba.
- South Africa Government financed the emergency rehabilitation works for the water and sanitation infrastructure in Harare.
- The U.S. Agency for International Development (USAID) allocated over 7.3 mil. USD in FY 2009 for humanitarian assistance in response to the cholera outbreak, of which 6.1 mil. USD was provided for WASH programs. These programs targeted the most vulnerable individuals in areas with high reported cholera rates and poorly maintained water and sanitation infrastructure. USAID also contributed USD 750,000 to WHO for improved data collection and information distribution through the cholera command-and-control center.
- Recently China has emerged a distinct development partner for Zimbabwe. In April 2012 the government of Zimbabwe signed with the Chinese government several economic and technological cooperation agreements worth RMB yuan 1,141 million (180 mil. USD), including RMB yuan 1,025 million (161.7 mil. USD) loan for upgrading of Victoria Falls Airport, RMB yuan 80 million (12.6 mil. USD) grant on economic and technical cooperation, RMB yuan 31.5 million (5 mil. USD) for equipment provision for the Zimbabwe Broadcasting Corporation and RMB yuan 4.5 million (0.7 mil. USD) for neonatal equipment.
- China EXIM bank has extended a USD 144 million concessional loan to the Harare City Council. This fund will be used to improve the water supply and sanitation of Harare.

3.4.3 Financial Status of Harare Province

Zimbabwe's provincial tier of government is headed by a Provincial Governor (Resident Minister) who is a presidential appointee. In Harare Province, under the Harare Provincial Governor, there are Provincial Administrator and District Administrators as senior representatives from the central government (Ministry of Local Government, Urban and Rural Development). Furthermore administrative and assisting staffs are working under the provincial and district administrators. Functions of provincial governments include coordination of policy formulation, monitoring and evaluation of local government performance and development projects by NGOs.

Because of the functional characteristic as a local administrative organ of the central government, provincial governments have no direct involvement in operational side of water supply, sewerage and solid waste management, which are mandated to local authorities. Likewise there are neither revenues nor expenditures which are channelled through provincial governments in terms of those public services.

3.4.4 Financial Status of City of Harare

(1) Financial data analysis

Available information for JICA Project Team to analyse the financial status of City of Harare was limited to budgets of 2011 and 2012. The budget data are summarized in Table 3.4.13. The cash budgeting principle is employed also at City of Harare. Hence the expenditure balances with the revenue in both the recurrent and the capital budgets. The fiscal size of City of Harare in terms of the recurrent expenditure was estimated at 259 mil. USD for the 2011 fiscal year and 270 mil. USD for 2012. Actual execution of the 2011 budget is expected to be about 70% of the estimates, due to possible shortage of revenues and failure in obtaining capital funds from expected financial sources. The ratio of national budget (4 bn. USD, 2012 projection) and Harare budget (0.4 bn. USD, 2012 estimate) is 10:1.

Table 3.4.13 Budgets of City of Harare

(USD million, % of total)

Item	2012 estimate		2011 estimate	
Revenue				
Recurrent revenue *1	272	65%	260	65%
Capital funds to be provided from				
Loans	117	28%	99	25%
Other sources	19	4%	28	7%
Revenue contributions	11	3%	10	3%
Total	418	100%	398	100%
Expenditure				
Revenue appropriations and transfers	2	0%	2	0%
Recurrent expenditure *2	270	65%	259	65%
Capital expenditure	146	35%	138	35%
Total	418	100%	398	100%

Source: Capital Estimates 2011 and 2012, City of Harare

*1 For convenience sake, "recurrent revenue" is employed here as a synonym of "revenue income", accounting term generally used in Zimbabwe.

*2 For convenience sake, "recurrent expenditure" is employed here as a synonym of "revenue expenditure", accounting term generally used in Zimbabwe.

The recurrent revenue of City of Harare in 2011 and 2012 are broken down and summarized in Table 3.4.14. The largest revenue source is "Rates", which include property tax and various service charges. Rates constituted 35% of the recurrent revenue in the 2012 estimate. The second largest source was water charges, accounting for as much as 33% of the total revenue. Sewerage charges and waste management fees constituted between 10% and 8% respectively.

Table 3.4.14 Composition of Recurrent Revenue of City of Harare

Revenue source	2012 estimate	2011 actual	2011 estimate
Rates	35%	38%	25%
Water charges	33%	33%	39%
Sewerage charges	10%	7%	12%
Waste management fees	8%	8%	9%
Other fees and rates	14%	14%	15%
Total	100% USD 272 million	100% USD 250 million	100% USD 260 million

Source: City of Harare, Capital and Revenue Budget 2012

The recurrent expenditures of City of Harare in 2011 and 2012 are summarized in Table 3.4.15. The main expenditure drivers in the 2012 estimate were salaries (40%), general expenses (32%) and repairs and maintenance (12%). The weight of salary is such that there is a constant criticism that Harare City Council spends most of the revenues on salaries and wages at the expense of proper service delivery.

Table 3.4.15 Composition of Recurrent Expenditure at City of Harare

Expenditure Item	2012 estimate	2011 actual	2011 estimate
Salaries & Allowances	40%	44%	38%
Admin charges	9%	5%	4%
General expenses	32%	37%	38%
Repairs & maintenance	12%	11%	13%
Loan expenses	3%	3%	5%
Revenue contribution to capital outlay	3%	1%	1%
Total	100% USD 270 million	100% USD 246 million	100% USD 259 million

Source: City of Harare, Capital and Revenue Budget 2012

Table 3.4.16 shows estimated fund sources for the capital expenditure of 2012. Internally generated fund from revenues account for 7%. Other funding sources are loans. The central government has been providing direct funding to local authorities over the years, but a lack of funds and failure to repay previous loans resulted in a drastic decrease in new loans from the central government. Such credit crunch from the government forced local authorities to seek other fund sources such as international development partners, private banks and PPP. Recent examples include a 150 mil. USD loan facility that the Chinese government has provided to the Harare City Council. This fund is expected to be used to improve its water and sewer reticulation systems.

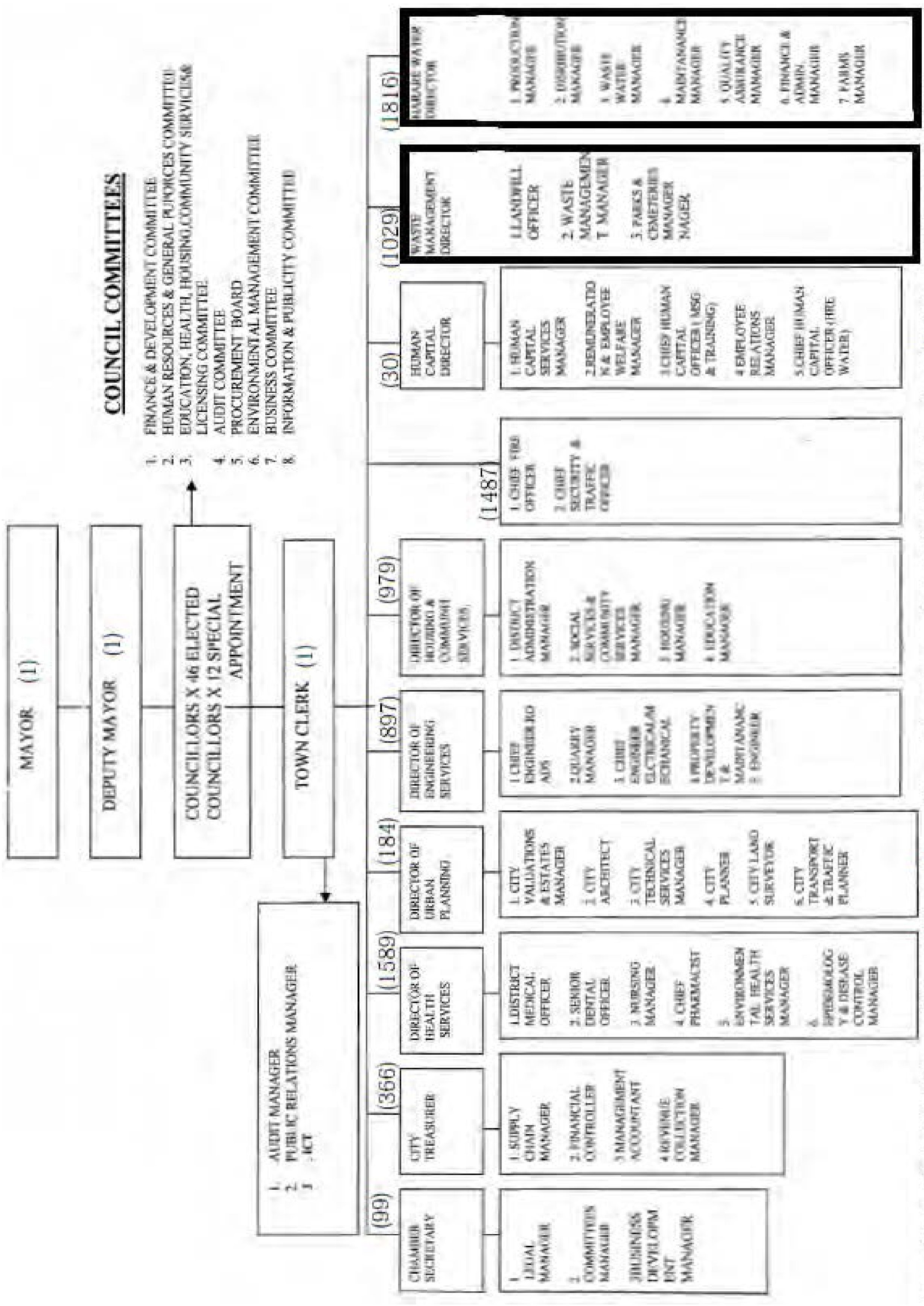
Table 3.4.16 Source of Capital Expenditure at City of Harare (2012 estimate)

Fund Source	% of total
Revenue	7%
Loan	86%
Consolidated Loan Funds	2%
Zimbabwe National Road Administratior	1%
Public Sector Investment Programme	4%

Source: Compiled by JICA Project Team based on data of the City of Harare

(2) Organization

Figure 3.4.1 shows the organization of City of Harare. Water supply and sewerage are operated by the Department of Water and Sanitation which is also called as "Harare Water". Solid waste management is operated under Department of Amenities. The total number of staffs who are actually deployed at City of Harare is about 9,700 in 2012.



Source: Harare City Capital & Revenue Budget, HR Dept of Harare City   Figures in parenthesis indicate the number of actually deployed staffs, which total 9684.

Figure 3.4.1 Organization Chart of City of Harare

3.4.5 Financial Status of Harare Water

The budget, organization and service tariffs of Harare Water, or Department of Water and Sanitation of City of Harare, are explained in subsequent paragraphs.

(1) Financial data analysis

The budgets of Harare Water are summarized in Table 3.4.17. As Harare Water does not prepare the financial statements such as balance sheet and income statement, an attempt was made based on the budget data.

Table 3.4.17 Budgets of Harare Water

(USD million, % of total)

	2012 Planned		2011 Approx. actual		2011 Planned		2010 Approx. actual		2009 Approx. actual	
Recurrent Budget *										
Revenue	118.1	100%	100.3	100%	133.4	100%	90.8	100%	65.6	100%
Water Sales	90.5	77%	81.8	82%	103.1	77%	72.3	80%	41.0	63%
Sewerage Sales	27.6	23%	18.5	18%	30.3	23%	18.5	20%	24.5	37%
Expenditure	116.1	100%	103.6	100%	124.6	100%	78.9	100%	68.0	100%
Salaries & Allowances	30.9	27%	21.4	21%	24.6	20%	21.5	27%	12.7	19%
Administration Charges	2.7	2%	2.2	2%	2.6	2%	2.0	2%	0.6	1%
General Expenses	60.0	52%	63.8	62%	78.3	63%	47.9	61%	48.5	71%
Chemicals	22.3	19%	26.7	26%	26.1	21%	23.6	30%	23.6	35%
Electricity	16.1	14%	15.6	15%	23.4	19%	13.8	17%	13.8	20%
Insurance	2.9	2%	3.0	3%	3.6	3%	3.4	4%	3.4	5%
Other	18.8	16%	18.6	18%	25.2	20%	7.1	9%	7.7	11%
Repairs and Maintenance	13.0	11%	14.1	14%	18.1	15%	6.3	8%	4.9	7%
Loan Expenses	2.0	2%	1.0	1%	1.0	1%	0.2	0%	1.2	2%
Capital Outlay	7.5	6%	1.0	1%	0.0	0%	1.0	1%	0.0	0%
Surplus/(Deficit)	1.9		-3.3		8.8		11.8		-2.4	
Capital Budget										
Revenue	98.7	100%			69.9	100%	89.0	100%		
Loans	92.2	93%			62.5	89%	85.2	96%		
Revenue Contribution	6.5	7%			7.4	11%	3.8	4%		
Expenditure	98.7				69.9		89.0			

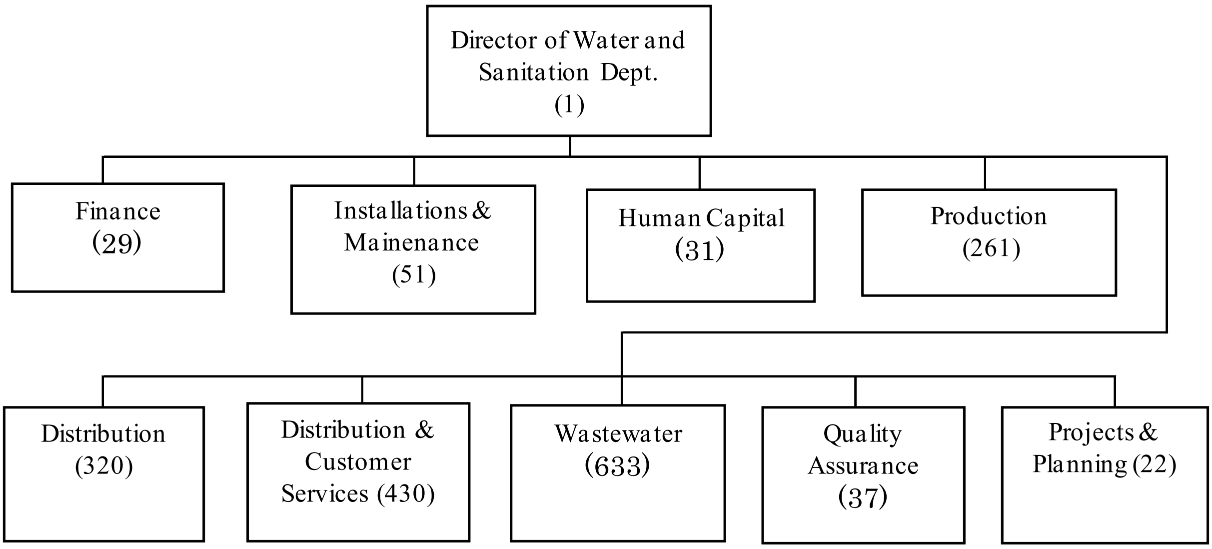
Source: Compiled by JICA Project Team based on data fo Harare Water

* For convenience sake, "recurrent budget" is employed here as a synonym of "revenue budget", accounting term generally used in Zimbabwe.

Due to the cash principle which underlies the budgeting process, Harare Water's revenue and expenditure mostly balance out. Out of the USD 118 revenue budgeted for 2012, water sales accounts for 77%. The remaining 23% is expected as sewerage sales. Important cost drivers are salaries, chemicals and electricity, each constituting 27%, 19% and 14% in the 2012 budget.

(2) Organization

The water supply in Harare was once taken over by Zimbabwe National Water Authority (ZINWA) in 2005, but due to declining service delivery under ZINWA, Harare City Council repossessed the mandate in 2009. Figure 3.4.2 is the current organization chart of Harare Water (Water and Sanitation Department of City of Harare). A total of 1,800 staffs are deployed under nine sections. The sewerage operation is nearly condensed in one section.



*Figures in parenthesis indicate the number of actual staffs, which total 1816.

Figure 3.4.2 Organization Chart of Harare Water

3.4.6 Financial Status of Department of Amenities at City of Harare

Solid waste management in City of Harare is operated by Department of Amenities under Waste Management Director (Figure 3.4.1). The budget, organization and service tariffs are explained in subsequent paragraphs.

(1) Financial data analysis

Relatively detailed financial data was made available at the Department of Amenities. Table 3.4.18 is budgets of the department activities. A 99% of the income comes from “Owners Charges Refuse” which comprises refuse removal charges monthly levied on residential, commercial and industrial properties. The largest expenditure item is personnel cost, accounting for 50% of the total expenditure in the 2012 budget. If capital expenses (interest, repayment and revenue contribution to capital outlay) are excluded, the weight of personnel cost will increase to as much as 63% of the total recurrent expenditures.

Table 3.4.18 Budgets of Solid Waste Management at City of Harare

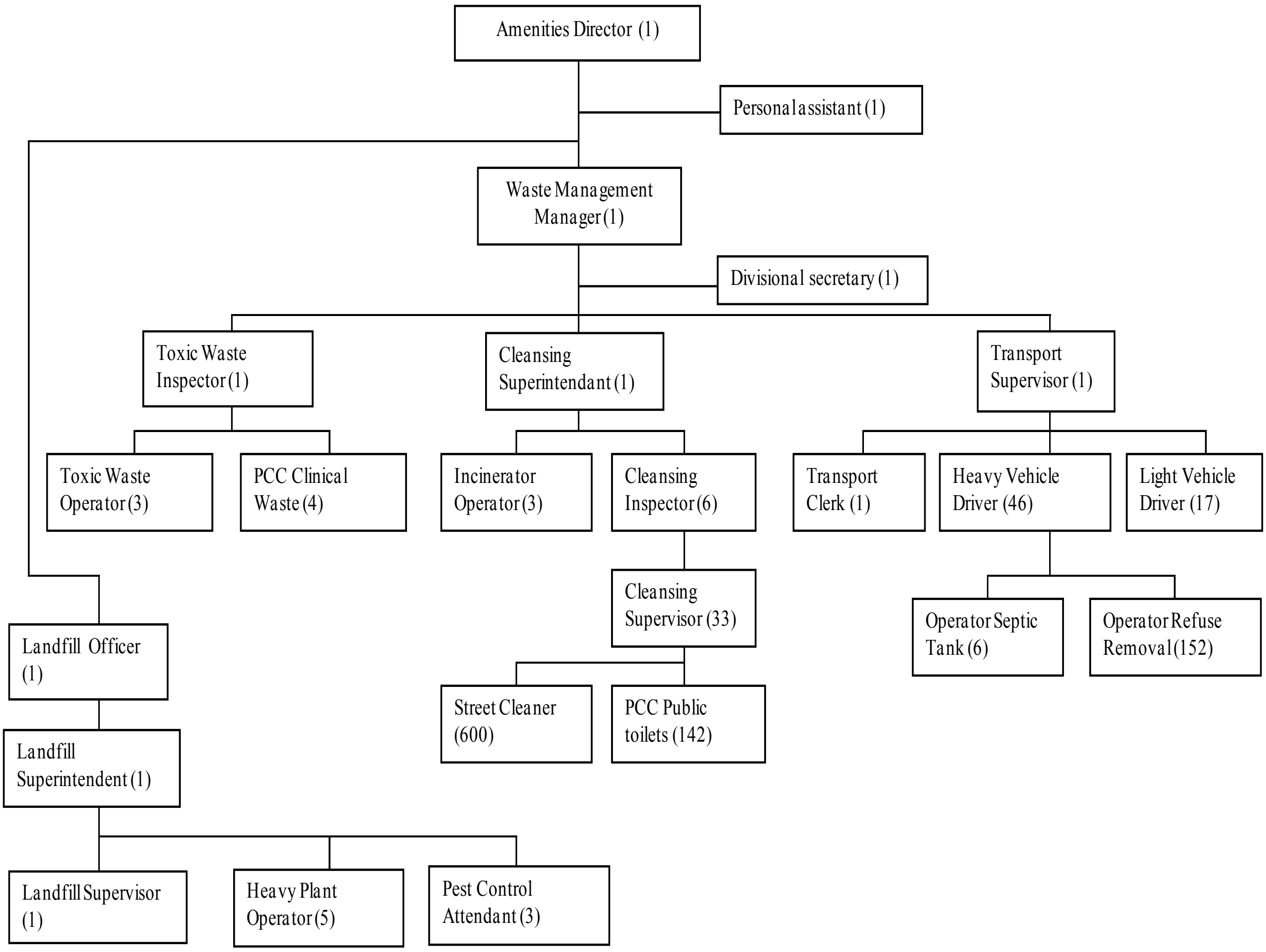
(USD, % of total)

	2012 Plan		2011 Actual		2011 Plan	
Revenue	22,504,000	100%	20,132,100	100%	24,811,800	100%
Owners Charges Refuse	22,182,000	99%	19,830,800	99%	24,504,800	99%
Septic tanks	60,000	0%	51,900	0%	45,000	0%
Liquid waste	80,000	0%	78,800	0%	80,000	0%
Solid waste	120,000	1%	111,300	1%	120,000	0%
Pay toilets	62,000	0%	59,300	0%	62,000	0%
Expenditure	21,270,800	100%	20,100,700	100%	24,223,200	100%
Personnel Cost	10,702,200	50%	9,432,000	47%	9,812,500	41%
Salaries	4,259,100	20%	4,011,800	20%	4,057,300	17%
Overtime salaries	894,100	4%	733,800	4%	700,000	3%
Annual Bonus	354,900	2%	334,400	2%	338,100	1%
Pension/Provident Fund	5,194,100	24%	4,352,000	22%	4,717,100	19%
Admin Charges	912,300	4%	612,200	3%	896,400	4%
Central Department	811,300	4%	552,200	3%	799,600	3%
Other Departments	101,000	0%	60,000	0%	96,800	0%
General Expenses	4,188,900	20%	2,610,000	13%	3,990,800	16%
Commission &Exchange	8,500	0%	4,400	0%	8,500	0%
Conferences Institute etc	9,000	0%	4,900	0%	8,600	0%
Councillors Allowances	75,000	0%	66,900	0%	115,200	0%
Fire Brigade	22,300	0%	10,000	0%	22,100	0%
Refuse removal	1,500	0%	1,200	0%	1,500	0%
Sewerage Treatment Disposal	6,400	0%	2,500	0%	5,100	0%
Chemicals	90,000	0%	54,000	0%	135,200	1%
Drugs and dressings	5,000	0%	3,000	0%	5,000	0%
Entertainment	8,000	0%	4,400	0%	7,300	0%
Food	1,300	0%	700	0%	1,200	0%
Sundry materials	175,000	1%	86,700	0%	175,900	1%
Advertising	37,500	0%	17,900	0%	35,700	0%
Books,printing & stationery	105,000	0%	38,200	0%	105,200	0%
Postage & stamps	3,600	0%	2,100	0%	3,500	0%
Bad Debts	2,700	0%	1,400	0%	2,400	0%
Sundry office Equipment	21,800	0%	10,100	0%	19,800	0%
Teas	102,000	0%	53,800	0%	98,800	0%
Telephone	85,000	0%	47,700	0%	82,900	0%
Audit* legal &Professional fees	74,700	0%	10,600	0%	73,300	0%
Insurance	129,500	1%	85,100	0%	129,500	1%
petrol,Diesal& oil	1,660,200	8%	1,025,100	5%	1,453,900	6%
Allowance	38,300	0%	20,400	0%	34,900	0%
Uniforms&protective clothing	220,500	1%	122,300	1%	208,700	1%
protective measures	109,400	1%	60,000	0%	108,500	0%
Electricity	93,700	0%	55,600	0%	92,600	0%
Tests and investigations	6,700	0%	3,600	0%	6,000	0%
Medical attention	12,900	0%	7,200	0%	12,000	0%
Water	66,200	0%	36,200	0%	60,400	0%
Rates and Charges	165,500	1%	149,700	1%	165,500	1%
containers ex suppliers	600,000	3%	493,000	2%	500,000	2%
Licenses	9,100	0%	4,400	0%	8,700	0%
Loose tools	100,000	0%	55,100	0%	100,000	0%
Hire charges	43,200	0%	18,900	0%	100,800	0%
Travelling	37,500	0%	20,900	0%	39,500	0%
Rents	34,200	0%	19,200	0%	32,700	0%
Staff Training	20,300	0%	10,600	0%	18,700	0%
Service/Supp Charges	200	0%	100	0%	200	0%
Appointment Expenses	7,200	0%	2,100	0%	11,000	0%
Repairs & Maintanance	1,246,800	6%	792,100	4%	1,126,100	5%
Building	93,000	0%	55,600	0%	90,800	0%
Furniture and Equipment	40,000	0%	22,400	0%	37,400	0%
Land Improvements	92,900	0%	54,200	0%	90,400	0%
Plant nad machinery	122,900	1%	71,300	0%	116,300	0%
Vehicles	898,000	4%	588,600	3%	791,200	3%
Capital Expenses	4,170,100	20%	6,640,200	33%	7,897,400	33%
Interest	102,800	0%	707,500	4%	931,700	4%
Repayments	4,067,300	19%	5,932,700	30%	6,965,700	29%
Revenue contribution to capital outlay	50,500	0%	14,200	0%	500,000	2%
Surplus/Deficit	1,233,200	5%	31,400	0%	588,600	2%

Source: City of Harare Capital & Revenue Budget 2012

(2) Organization

Figure 3.4.3 shows the organization chart of Department of Amenities of City of Harare. A total of 1,029 staffs are employed, of which 600 as street cleaner. This indicates the labor-intensive operation, explaining the high weight of personnel cost. It is noted that the landfill officer directly reports to the Director, which is meant to mitigate the wide responsibilities charged to the Waste Management Manager.



*Figures in parenthesis indicate the number of deployed staffs. It totals 1029.

Figure 3.4.3 Organization Chart of Department of Amenities of City of Harare

3.4.7 Financial Status of Chitungwiza Municipality

(1) Financial data analysis

The accounting system of the Chitungwiza Municipal Council employs the double entry principle and the accrual basis. The accounting system is in accordance with requirements stipulated in the Urban Councils Act, Chapter 29:15. However the accounting ledgers of the Council are manually maintained and many numerical errors are found in the financial data.

In fact there were attempts in the past to introduce a computer accounting software at the Council. The first one was in 1990s when World Bank implemented a PFM program in Zimbabwe. An accounting software called PROMUN was installed. But due to the lack of continuous staff training and follow-up maintenance, problems of license and source code, it ceased to be used by early 2000s. Only its bill issuance function was left functional which has been used to date in order to print out bills. In 2011 the Council stated a trial use of Pastel, another well-known accounting software package. The implementation of Pastel-based accounting had been halted during 2012 but resumed in 2013.

The independent auditor report on the financial statements for the period ended 31 December 2011 was made available in July 2013. In this report the auditor expressed a notably adverse opinion on the quality of the financial statements, indicating that the validity and accuracy of accounting data could not be confirmed in many areas such as the following:

(a) Integrity of accounting information system ---------- Ledger accounts maintained manually were not balanced off at year end. The ledger balances continuously change due to journal entries and most balances differed from balances in the financial statements.

(b) Cash and cash equivalents ---------- There were significant number of unreconciled items in the name of unknown transfers/withdrawals on the bank reconciliation statements, and most of these bank transactions were not updated to the cash book. The unknown transfers/withdrawals were USD 966,636.

(c) Non-current assets register ---------- The Council did not maintain an updated non-current assets register for its long term capital outlay.

(d) Accounts payables ---------- The Council did not maintain a detailed subsidiary ledger for its accounts payables and control accounts.

(e) Accounts receivables ---------- The Council did not maintain ledger accounts for stands sales beneficiaries for the purpose of accounting for accruals and receipts.

(f) Special funds ---------- The Council did not maintain separate ledger accounts for its special funds.

(g) Temporary advances ---------- Advance from Special Funds (USD 388,470) on the capital fund section had no corresponding debt entry on the special fund section and was not supported by ledger balances.

The accounting system of the Council does not fully comply with the International Public Sector

Accounting Standards (IPSAS), which is formulated for the public sector accounting on the basis of the International Financial Reporting Standards (IFRS). In fact neither central nor local governments of Zimbabwe have adopted the IPSAS. At the central government level, the GOZ is aiming to adopt and implement the new system of public finance reporting in compliance with the cash basis IPSAS. Although this movement is considered to take still many more years to trickle down to local authorities, the poor accounting practices explained above and the accounting system of Chitungwiza imminently need rectification. Pastel, the earlier mentioned accounting software which is currently during the implementation, is expected to solve this problem.

In analyzing the financial status of the Chitungwiza Municipal Council, the JICA Project Team used two types of financial information which are (i) budget data and (ii) financial statements. The Council prepares the budgets to comply with the legally required budgeting procedure. After the end of every fiscal year, the financial statements are prepared by the Council and audited by an external auditor. The presentation and format differ between the budget data and the financial statements. Numbers shown in the two types of data do not necessarily coincide due to difference in preparation method and timing. The budget data are made on the cash basis in general. Planned and revised budgets are available but the amounts of budgets actually executed budgets are usually unavailable. Financial statements are prepared on the accrual basis and they contain actual numbers in principle. Furthermore erroneous numbers are often shown in both data. Considering these, JICA Project Team judged it better to use both budget data (cash basis) and financial statement data (accrual basis) in order to analyze the financial status of the Council in a complementary and multifaceted manner.

The recurrent budgets of the Council since 2007 are summarized in Table 3.4.19. In 2009 the Council resumed water supply and sewerage services. ZINWA had been running the operations from 2005 to 2009. Therefore the annual budgets of 2007 and 2008 did not include revenues and expenditures related to water supply and sewerage. It is noted that the budgets are denominated in US dollars since 2009. This is because the dollarization of the Zimbabwean economy started in 2009 and put an end to the notorious hyper-inflation. Changes in the exchange rates of Zimbabwe dollar against the US dollar and Japanese yen during the hyper-inflation era are summarized in Table 3.4.20, by highlighting the year beginning rates.

Table 3.4.19 Recurrent Budgets of Chitungwiza

	Recurrent revenue *1	Recurrent expenditure*2	Surplus / (Deficit)
2007 estimated (ZIM$ billion) *3	35.6	126.8	(91.1)
2008 estimated (ZIM$ billion) *3	460,462.3	2,546.1	457,916.2
2009 estimated (USD million)	18.1	14.7	3.4
2010 estimated (USD million)	21.7	18.8	2.9
2011 planned (USD million)	63.5	44.2	19.2
2011 estimated (USD million)	20.0	17.8	2.3
2012 planned (USD million)	77.7	77.6	0.2
2012 estimated (USD million)	18.9	18.2	0.7
2013 planned (USD million)	35.3	35.5	(0.2)

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

*1 For convenience sake, "recurrent revenue" is employed here as a synonym of "revenue income", accounting term generally used in Zimbabwe.

*2 For convenience sake, "recurrent expenditure" is employed here as a synonym of "revenue expenditure", accounting term generally used in Zimbabwe.

*3 Due to steep depreciation of Zimbabwe dollar during the hyper-inflation period, there was no single exchange rate that could appropriately convert a Zimbabwe dollar amount cummulative of one year, into a US dollar equivalent.

Table 3.4.20 Changes in Foreign Exchange Rates from 2007 to 2009

	ZIM$ per USD	ZIM$ per JPY
2 January 2007	250	2.11
2 January 2008	30,000	269.07
2 January 2009	5,601,509	61,473.98
2 February 2009 *	12,336,416,667	137,706,275.24

Source: Compiled by JICA Project Team based on data of Reserve Bank of Zimbabwe

* After this date, the Zimbabwe dollar stopped circulating, replaced by the US dollar and the South African rand.

It should be also noted that in 2011 and 2012 the estimated budgets were far less than the planned budgets. The Council had been optimistic in budgeting. Besides, failure in securing funds and from expected financial sources caused this big gap between budgeting and actual execution.

The Council's operation results of years 2009, 2010 and 2011 are better summarized in the income statements (Table 3.4.21). Four main revenue sources are (i) water charges and connection fees, (ii) rents and service charges and rates, (iii) refuse and sewerage charges and (iv) health, education and welfare fees. Each of these revenue sources constitutes about 20 to 30% of the total revenue and altogether accounts for more than 95%.

Table 3.4.21 Income Statements of Chitungwiza

(USD thousand, % of total)

	2011		2010		2009	
Revenue						
Rates and Fees						
Rents and service charges and rates	6,151	26%	6,941	31%	4,611	25%
Refuse and sewerage charges	5,081	22%	4,911	22%	4,789	26%
Health, Education and Welfare fees	4,490	19%	3,521	16%	1,853	10%
Water charges and connection fees	5,959	26%	5,592	25%	6,352	35%
Maintenance charges	2	0%	6	0%	1	0%
Licensing						
Vehicles	0	0%	80	0%	173	1%
Business & miscellaneous fees	390	2%	303	1%	159	1%
Administration						
Interest	39	0%	1	0%	0	0%
Miscellaneous recoveries	561	2%	99	0%	37	0%
Grants	0	0%	230	1%	123	1%
Total revenues	23,210	100%	22,138	100%	18,098	100%
Expenditure						
Water and sewerage	5,951	23%	5,626	28%	4,664	32%
Housing	1,593	6%	1,333	7%	1,704	12%
Rates	12,436	47%	9,228	46%	6,439	44%
Health	4,971	19%	1,990	10%	1,349	9%
Education	7	0%	16	0%	15	0%
Welfare	404	2%	641	3%	506	3%
Total expenditures	26,401	100%	19,863	100%	14,678	100%
Surplus (deficit) for the year	-3,191	-14%	2,274	10%	3,420	19%
Surplus (deficit) brought forward	5,013		2,761		0	
Revenue Contribution to Capital Outlay	20		22		0	
Resultant surplus (deficit) transferred to summary of operations and balance sheet	1,802		5,013		3,420	

Source: Reconstituted by JICA Project Team based on auditied financial statements

The expenditures are shown by account groups (cost centers). The rates account expended 47% of the expenditure in 2011. Refuse collection and solid waste management activities are included in the rates account. The water account and the sewerage account are combined for the financial reporting purpose. The expenditure at the water and sewerage account constituted 23% of the total.

The profitability was high in 2009 and 2010 but plummeted in 2011. The surplus was 3.4 mil. USD in 2009 and 2.3 mil. USD in 2010, accounting for 19% and 10% of the revenues in the respective years. But the year 2011 recorded a deficit of 3.2 mil. USD, representing 14% of the revenues. Apparent reasons of this profit deterioration are revenue decrease and expenditure increase. The 2011 revenues showed a slight increase of 5% from 2010 partly due to a sales promotion program effectuated during the year. Under the program, customers in arrears could settle their unpaid bills with a 50% reduction.

The 2011 expenditure increased by as much as 33% from the previous year. This increase was in part due to planless raising of personnel costs.

The breakdown and composition of the expenditures by function are summarized in Table 3.4.22.

Table 3.4.22 Composition of Chitungwiza Expenditure by Function

(USD, % of total)

	2011		2010		2009	
Salaries and wages	18,077,701	71%	11,555,470	61%	10,071,840	69%
Water - bulk	3,453,580	14%	4,354,948	23%	3,663,363	25%
Bank interest	933,837	4%	460,002	2%	0	0%
Repairs and maintenance	461,003	2%	227,831	1%	62,283	0%
Fuel and oil	429,482	2%	336,626	2%	174,793	1%
Computer costs	400,773	2%	128,955	1%	3,420	0%
Legal and professioal fees	242,257	1%	331,181	2%	15,214	0%
Conference and official visit	192,940	1%	68,976	0%	13,319	0%
Bank charges	184,071	1%	293,645	2%	74,892	1%
General expenses	164,038	1%	189,091	1%	100,352	1%
Protective clothing and uniforms	140,596	1%	99,047	1%	54,582	0%
Electricity	124,739	0%	184,164	1%	55,338	0%
Interest and loan redemption	96,155	0%	5,364	0%	0	0%
Insurance	75,666	0%	30,850	0%	7,435	0%
Loose tools and minor equipment	73,820	0%	28,429	0%	27,247	0%
Printing and stationery	51,837	0%	55,467	0%	14,771	0%
Audit fees	45,650	0%	63,748	0%	17,594	0%
Advertising	37,991	0%	109,011	1%	616	0%
Rent	28,858	0%	7,566	0%	825	0%
Security measures	28,732	0%	17,523	0%	7,183	0%
Postage and telephones	25,450	0%	114,399	1%	23,247	0%
Travelling and subsistence	20,093	0%	15,545	0%	918	0%
Dust bins	19,200	0%	37,985	0%	24,000	0%
Chemicals and cleaning	15,275	0%	46,044	0%	2,337	0%
Hire charges	15,043	0%	2,578	0%	161	0%
Councillors allowances	10,770	0%	9,432	0%	0	0%
Licensing	6,833	0%	16,109	0%	18,283	0%
Donations	2,880	0%	520	0%	0	0%
Consumable stores	361	0%	196	0%	232	0%
Sewerage costs and water	185	0%	0	0%	0	0%
Administration charges	0	0%	320	0%	219,903	1%
Entertainment	0	0%	0	0%	1,887	0%
Fire services	0	0%	2,231	0%	1,002	0%
Street name plates and traffic signs	0	0%	17,631	0%	0	0%
Trtaining levy	0	0%	410	0%	0	0%
Books and periodicals	-3,268	0%	6,897	0%	5,597	0%
Total expenditures	25,356,548	100%	18,818,191	100%	14,662,634	100%

Source: Reconstituted by JICA Project Team based on audited financial statements of Chitungwiza Municipality

Two main expenditure drivers are salaries and bulk water cost. The salary cost accounted for as much as 71% of the total expenditure of 2011. The bulk water cost represented 14%. The Chitungwiza Municipality is under the same criticism as City of Harare, because of its high personnel cost. The weight of personnel cost is expected to be lowered in 2012 as salaries of some higher level staffs have been reduced. It should be noted that the expenditure composition shown in Table 3.4.22 is prepared on the accrual basis, meaning that cash basis expenditure might be different from what is shown in Table 3.4.22. The municipality does not usually prepare the cash basis expenditure composition data. There exists only a data of financial year 2011, a simple cash flow schedule featuring the salary expenditure (Table 3.4.23). The salary expenditure accounted for 74% of the cash outflow of this year. The cash outflow exceeded the cash inflow by 3.257 USD million. When compared with the cash inflow, the salary expenditure accounted for as much as 86% of the cash inflow.

Table 3.4.23 Cashflow and Salary Expenditure of Chitungwiza in 2011

(Unit: USD thousand)

	Cash Inflow	Cash Outflow	of which salaries	Surplus/ Deficit	Salaries as % of inflow	Salaries as % of outflow
January	1,294	1,230	877	64	68%	71%
February	1,458	1,471	946	-13	65%	64%
March	1,414	1,535	990	-122	70%	65%
April	1,391	1,453	995	-62	72%	68%
May	1,436	1,472	917	-35	64%	62%
June	1,570	1,722	969	-152	62%	56%
July	1,769	2,117	1,530	-347	87%	72%
August	1,708	2,166	1,685	-459	99%	78%
September	1,968	2,568	2,151	-600	109%	84%
October	1,891	2,628	2,235	-737	118%	85%
November	2,554	2,695	2,192	-141	86%	81%
December	1,086	1,740	1,389	-654	128%	80%
Total	19,540	22,797	16,878	-3,257	86%	74%

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

Table 3.4.24 shows the capital budgets of the municipality since 2009. The budget execution was poor in 2011, being merely 1% of the budget. This was mainly due to shortage of revenues and failure in obtaining anticipated PSIP funds.

Table 3.4.24 Capital Budget of Chitungwiza Municipality

(USD thousand, % of total)

	2012 Plan		2011 Estimate		2011 Plan		2010 Actual		2009 Actual	
Expenditure										
Infrastructure Servicing	30,000	28%	0	0%	42,000	42%	0	0%	0	0%
Sewerage upgrading	6,000	6%	255	23%	4,000	4%	0	0%	0	0%
Sewerage works upgrading	12,000	11%	0	0%	12,000	12%	0	0%	0	0%
Water upgrading	5,000	5%	7	1%	2,500	3%	0	0%	0	0%
Plant and equipment	8,000	7%	2	0%	7,000	7%	0	0%	0	0%
Civic centre	7,000	7%	0	0%	7,000	7%	0	0%	0	0%
Stadium	4,000	4%	0	0%	0	0%	0	0%	0	0%
Industrial area servicing	2,500	2%	0	0%	2,500	3%	0	0%	0	0%
Construction of fire station and drill tower	1,500	1%	0	0%	1,500	2%	0	0%	0	0%
Clinic refurbishment	2,000	2%	0	0%	2,000	2%	0	0%	0	0%
School refurbishment	1,000	1%	0	0%	2,200	2%	0	0%	0	0%
Roads Rehabilitation	10,000	9%	0	0%	4,500	5%	0	0%	0	0%
Rehabilitation of streets and tower lights	5,000	5%	0	0%	1,100	1%	0	0%	0	0%
Residential stands - Masanga Industrial Area water sewer and roads	2,500	2%	0	0%	2,500	3%	0	0%	0	0%
Cemetery-C/House, Toilet and Offices	1,000	1%	0	0%	0	0%	0	0%	0	0%
6 H/D Staff Houses	1,000	1%	0	0%	0	0%	0	0%	0	0%
Zengeze 5 P/Toilets	1,000	1%	0	0%	1,000	1%	0	0%	0	0%
Residential stands - St Marys Phase 4 & 5 water sewer and roads	1,000	1%	0	0%	1,000	1%	0	0%	0	0%
Bridge	7,000	7%	0	0%	7,000	7%	0	0%	0	0%
Land Improvement	0	0%	150	14%	0	0%	353	48%	37	55%
Buildings Other	0	0%	14	1%	0	0%	12	2%	0	0%
Furniture & equipment	0	0%	128	12%	0	0%	117	16%	31	45%
Light motor Vehicles	0	0%	527	49%	0	0%	251	34%	0	0%
Health Equipment	0	0%	2	0%	0	0%	0	0%	0	0%
Total expenditure	107,500	100%	1,085	100%	99,800	100%	733	100%	68	100%
Financing										
Public Sector Investment Programme	104,500	97%	650	44%	96,800	97%	0	0%	0	0%
Internal Loans	0	0%	673	46%	0	0%	380	52%	31	45%
Endowment Fund	0	0%	150	10%	0	0%	353	48%	37	55%
Grants	3,000	3%	0	0%	3,000	3%	0	0%	0	0%
Total financing	107,500	100%	1,473	100%	99,800	100%	733	100%	68	100%
Unexpended funds	0		388		0		0		0	

Source: Reconstituted by JICA Project Team based on budget data of Chitungwiza Municipality

The balance sheets of the municipality at the end of years 2009, 2010 and 2011 are presented in Table 3.4.25.

Table 3.4.25 Balance Sheets of Chitungwiza

(USD thousand, % of total)

	2011		2010		2009	
Assets						
Capital assets						
Capital outlay	28,329	43%	27,223	49%	23,165	62%
Special fund assets						
Cash and cash equivalents-Estates	544	1%	201	0%	67	0%
Internal loans	51	0%	410	1%	31	0%
Accounts receivables	2,967	4%	0	0%	0	0%
Temporary advance to revenue	968	1%	1,608	3%	109	0%
Revenue assets						
Inventory	221	0%	156	0%	8	0%
Accounts receivables	30,179	46%	24,042	43%	13,212	36%
Liquor current (inter acc. transfers)	1,458	2%	999	2%	476	1%
Xmas cheer fund	0	0%	-17	0%	-1	0%
Canteen current account	0	0%	-8	0%	-5	0%
Suspense	0	0%	4	0%	0	0%
Liquor current inter acc. receivables	308	0%	0	0%	0	0%
Investments	487	1%	0	0%	0	0%
Cash & cash equivalents	517	1%	1,324	2%	50	0%
Total assets	66,029	100%	55,942	100%	37,111	100%
Equity and liabilities						
Capital Finance						
Loans	1,684	3%	410	1%	31	0%
Accumulated reserves	27,033	41%	26,813	48%	23,135	63%
Temporary advance from special funds	-388	-1%	0	0%	0	0%
Special funds	4,530	7%	2,219	4%	207	1%
Accumulated surplus	1,802	3%	5,013	9%	3,420	9%
Revenue liabilities						
Accounts payables	23,557	36%	18,879	34%	10,210	28%
Bank overdraft	5,080	8%	0	0%	0	0%
Suspense	1	0%	0	0%	0	0%
Temporary advance to special funds	968	1%	1,607	3%	0	0%
Liquor inter acc. payables	1,763	3%	1,001	2%	0	0%
Total equity and liabilities	66,029	100%	55,942	100%	37,002	100%

Source: Reconstituted by JICA Project Team based on financial statements of Chitungwiza Municipality

The bank overdraft emerged the first time in the 2011 balance sheet as one of revenue liabilities and amounted to 5 mil. USD. The same amount is also shown in the cash flow statement of 2011 as net movement in cash and cash equivalents (Table 3.4.26). This cash decrease was mostly a result of increase of uncollectible bills which is observable in the balance sheet as increase of accounts receivable. The accounts receivable increased from 24 mil. USD in 2010 to 30 mil. USD in 2011. In order to encourage payment from the debtors, the municipality introduced a sales promotion program in 2011. Under the program, debtors were discharged from a half of the debts if they paid the remaining half.

Table 3.4.26 Cash Flow Statements of Chitungwiza

(USD thousand, % of net movement in cash)

	2011		2010		2009	
Cash Inflow/Outflow from Operating Activties	-5,150	102%	1,455	103%	50	43%
Operating Activties						
Surplus/Deficit for the year before interest	-3,191	63%	2,252	160%	3,420	2925%
Adjust for non cash items	207	-4%	179	13%	0	0%
Changes in Working Capital						
Accounts Payables	4,678	-93%	8,295	588%	10,210	8733%
Inter-A/c payables	762	-15%	702	50%	115	99%
Inventory	-65	1%	-74	-5%	-8	-6%
Advance to special funds	-639	13%	1,498	106%	0	0%
Suspense	3	0%	-4	0%	0	0%
Accounts Receivables	-6,137	121%	-10,712	-759%	-13,212	-11300%
Inter-A/c Receivables	-766	15%	-681	-48%	-476	-407%
Cash Inflow/Outflow from Investing Activties	-3,791	75%	-1,831	-130%	-146	-125%
Non current assets acquisitions	-1,106	22%	-755	-54%	-68	-58%
Investment	0	0%	0	0%	0	0%
Proceeds from assets disposal	0	0%	44	3%	0	0%
Internal loans	-358	7%	379	27%	31	26%
Special Funds receivables	-2,967	59%	0	0%	0	0%
Advances to revenue	640	-13%	-1,499	-106%	-109	-93%
Cash Inflow/Outflow from Financing Activties	3,883	-77%	1,787	127%	213	182%
Endowments	3,883	-77%	1,787	127%	213	182%
Net Movement in Cash & Cash Equivalents	-5,057	100%	1,411	100%	117	100%
Cash balance at the year beginning	1,525	-30%	115	8%	0	0%
Cash balance at the year end	-3,532	70%	1,525	108%	117	100%
Represented by						
Overdraft	-5,080		0		0	
Investment	487		0		0	
Estates	544		201		67	
Other	517		1,324		50	

Source: Reconstituted by JICA Project Team based on audited financial statements

The sales promotion program succeeded in slowing down the increase rate of accounts receivable but did not succeed in reducing the total accounts receivable at the year-end. After the sales promotion program ended, the accounts receivables started soaring again, reaching 38 mil. USD at the end of July 2012. Major debtors as of July 2012 are shown in Table 3.4.27.

Table 3.4.27 Major Debtors of Chitungwiza

(as of 31 July 2012)

Debtor	Amount (USD thousand)	
Davison Chemical Company	168	0.4%
Zano-Remba HSE Cooperative	161	0.4%
MODZONE Enterprises	136	0.4%
Gukwe Armstrong	128	0.3%
Zimbabwe Cricket Union	124	0.3%
Others	37,663	98.1%
Total	38,379	100.0%

Source: Chitungwiza Municipality

The municipality also tried to solve the cash shortage by delaying or avoiding payment to creditors. As a result the accounts payable increased from 18.9 mil. USD in 2010 to 23.6 mil. USD in 2011. Major creditors as of June 2012 are shown in Table 3.4.28.

Table 3.4.28 Major Creditors of Chitungwiza

(as of 30 June 2012)

Creditor	Amount (USD thousand)	
City of Harare	11,213	55%
ZIMRA	2,934	14%
Unified Pensions Fund	2,805	14%
Local Authorities Pension Funds	1,630	8%
NSSA	648	3%
Others	1,051	5%
Total	20,281	100%

Source: Chitungwiza Municipality

The biggest creditor is the City of Harare, who is providing bulk water to the Chitungwiza Municipality. The outstanding accounts payables to Harare amounted to 11.2 mil. USD at the end of June 2012. Table 3.4.29 shows bulk water bills from Harare and payments since 2009.

Table 3.4.29 Bulk Water Payment by Chitungwiza

Period	Billing by Harare (USD)	Payment by Chitungwiza (USD)	Payout ratio
2009 (June – Dec)	1,991,654	286,000	14%
2010 (Jan – Dec)	3,414,264	900,000	26%
2011 (Jan – Dec)	3,414,264	910,000	27%
2012 (Jan – Dec)	3,414,264	0	0%
2013 (Jan – June)	1,841,178	311,500	17%
Total	14,075,624	2,407,500	17%

Source: Chitungwiza Municipality

The monthly billing amount has been the same as the bulk water meter is not functional. Therefore the same water volume (824,535 m^3) has been used in billing as an estimated monthly consumption on the basis of water volume in the past when the meter was still functional. The payout ratio by the municipality hovers around as little as 20%. No payment was made between December 2011 and December 2012. In January 2013 the Harare City Council sued the Chitungwiza Municipality for the non-payment of water bills. In response to this, monthly payment by the municipality was resumed in January 2013. The municipality promised to pay monthly at least 10,000 USD.

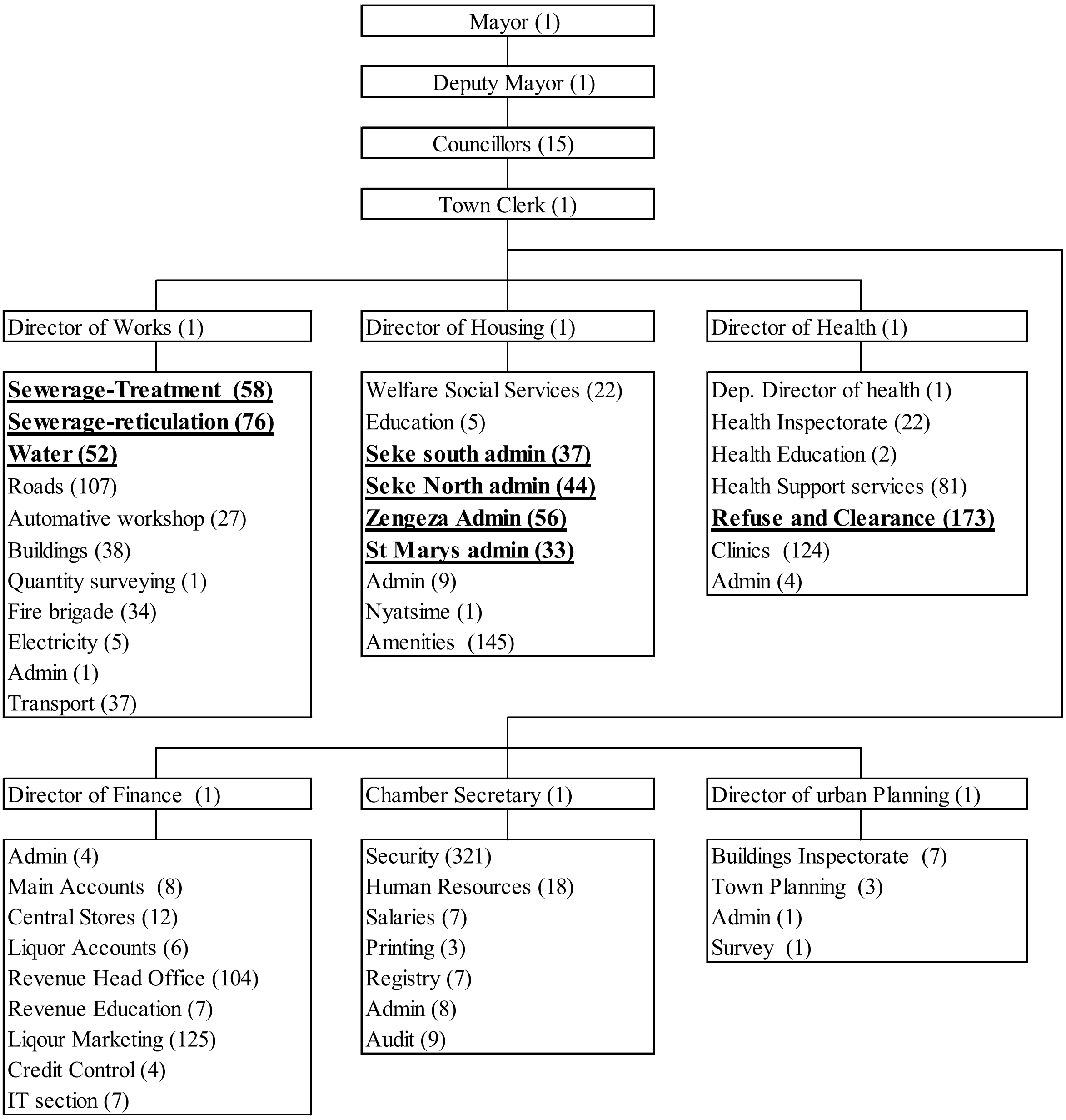
The second biggest creditor is the Zimbabwe Revenue Authority (ZIMRA), to which the Chitungwiza Municipality owes 2.9 mil. USD. These accounts payables include taxes withheld by the municipality but unforwarded to the ZIMRA such as pay-as-you-earn tax (PAYE) and value added tax (VAT). Other big creditors are pension funds to which the municipality has not been paying legal pension premiums for the staffs.

Although the outstanding amount is not as big as the above items, unpaid fines charged by the Environmental Management Agency (EMA) amounted to USD 28,411. During the period of May 2009 to June 2012, the EMA levied fines on the Chitungwiza Municipality as many as 17 times for discharging raw sewage into the environment. The total amount of the 17 fines reached USD 53,559. The EMA determines the amount of fine according to the level of contamination. There are 15 levels whose corresponding fine rises from USD 5 to 5,000.

Capital assets are called “capital outlay” and amounted to 24.7 mil. USD at the end of 2011. Most of the assets included in this 24.7 mil. USD were valuated in 2009 after the hyperinflation era ended. The asset register currently maintained at the finance section of the Chitungwiza Municipality does not account for details of the assets. Although operation sections keep a list of equipment used at the working places, the asset information are not supported by accounting evidences.

(2) Organization

Figure 3.4.4 shows the organization chart of the municipality. About 1,900 staffs are employed. The water supply and the sewerage operations are under the ambit of Director of Works. While the water supply organization is set within one section, the sewerage operation is divided into two sections, which are “sewerage-treatment” and “sewerage-reticulation”. The solid waste management is controlled under the Director of Health, named as “Refuse and Clearance”.



- Figures in parenthesis indicate the number of actually deployed staffs, which total 1886. About 15% are female.
- Sections shown in bold letters with underline are strongly involved in water supply, sewerage and waste management operations.

Figure 3.4.4 Organization Chart of Chitungwiza Municipality

(3) Employment cost

As shown in the income statements and the budgets, salaries and wages is the biggest cost driver, accounting for about 70% of the total expenditures. Because of such a considerable weight in finance of the municipality, the employment cost was scrutinized.

Table 3.4.30 shows the base salary structure at the municipality. There are 16 salary grades and each grade has one to three notches. The lowest salary level is Notch 1 of Grade 1 and earns USD 200 per month. Most of staff belong to this level are positioned as "General Hand". The highest salary levels are Grades 14, 15 and 16 and earn well over USD 2,000 per month. The positions there are Director or

Town Clerk.

Table 3.4.30 Base Salary Structure at Chitungwiza Municipality

Grade	Notch	Base salary (USD/mth)	Position/Title
1	1	200	Genaral hands
1	2	212	
1	3	224	
2	1	238	
2	2	252	
2	3	266	
3	1	284	
3	2	301	
3	3	317	
4	1	338	Machine operator, assistant drain layer,
4	2	356	sewer rod man, slumber, pond operator,
4	3	380	semi skilled fitter,
5	1	401	Pump operator, drain layer
5	2	426	
5	3	450	
6	1	478	Genaral clerk
6	2	506	
6	3	538	
7	1	576	costing clerk, assistant foreman,
7	2	608	private secretary
7	3	645	
8	1	690	draughts person
8	2	732	
8	3	776	
9	1	832	Foreman, Quantity surveying technician,
9	2	881	fitter, works attendent,
9	3	934	trade waste inspector
10	1	1,000	enviroment health officer
10	2	1,058	
10	3	1,123	
11	1	1,200	water superitendent
11	2	1,272	
11	3	1,349	
12	1	1,442	works superintendent
12	2	1,531	
12	3	1,622	
13		1,710	Principal engineer water and sewer
14		2,282	Special management grade
15			Director
16			Town Clerk

Source: Chitungwiza Municipality

At Zimbabwean public organizations, a term “employment cost” is often used to refer to personnel cost. The employment cost comprises base salary, allowance, bonus, pension contribution, development levy, medical contribution and workman compensation. The salary, the allowance and the bonus are what employees receive but the other items are what employers pay to the government authorities. The employment cost of the Chitungwiza Municipality is shown in Table 3.4.31.

Table 3.4.31 Employment Cost at Chitungwiza

Position	Number of staffs	Job grade	Basic salary (USD/yr)	Allowance (USD/yr)	Bonus (USD/yr)	Pension contribution (USD/yr)	Development levy (USD/yr)	Medical contribution (USD/yr)	Workman compensation (USD/yr)	Employment cost (USD/yr)	Personnel-related expenses within general expenses (USD/yr)	(% of salary & allow.)	Office Vehicle *2 (USD/yr)	Total Personnel-related cost (USD/yr)
Upper echelon *1	7	15-16	191,723	65,940	15,974	33,166	287	672	1,785	309,547	25,766		40,768	376,081
Dept. of Works	453	1-13	3,133,274	873,300	349,585	691,147	6,253	76,992	38,227	5,168,778	400,657	10%		5,569,435
Dept. of Housing	352	1-13	1,864,000	493,486	158,985	298,501	2,782	33,696	17,143	2,868,593	235,749	10%		3,104,342
Dept. of Health	407	1-13	2,079,760	326,506	172,802	358,588	3,140	22,272	19,252	2,982,320	240,627	10%		3,222,947
Dept. of Finance	283	1-13	1,989,019	422,270	165,755	344,128	3,029	27,168	18,456	2,969,825	241,129	10%		3,210,954
Chamber of Secretary	373	1-13	2,327,734	548,320	194,010	402,049	3,550	35,808	21,547	3,533,018	287,605	10%		3,820,623
Dept. of Urban Planning	12	1-13	180,798	25,980	18,702	38,828	341	2,208	2,085	268,942	20,678	10%		289,620
Total	1,887		11,766,308	2,755,802	1,075,813	2,166,407	19,382	198,816	118,495	18,101,023	1,452,211		40,768	19,594,002

Source: Chitungwiza Muicipality
*1 Upper echelon includes town clerk, directors and chamber secretary.
*2: Grade 14, 15,16 staffs are issued a vehicle. Grade 16 (Town Clerk) is issued a driver. Instad the transport allowance is not paid. The fuel use limit is 80 liter/week. Assuming that the fuel price is US$1.40/liter, the vehicle benefit is calculated at US$5824/year (=1.4x80x52).

In addition to the employment cost, there are some expense items that are closely related to the number of staffs employed such as uniform expense and office beverage. They are shown under general expenses. From the past data, these personnel related general expenses can be considered about 10% of the total of basic salaries and allowances. These personnel related general expenses are also shown in Table 3.4.31. If all these costs were taken into account, the personnel cost of Chitungwiza could have been 20 mil. USD in 2011, which constituted as much as 80% of the total expenditures of the year.

3.4.8 Financial Status of Water Supply Operation at Chitungwiza

(1) Financial data analysis

Income statement of water supply account of the Chitungwiza Municipality is shown in Table 3.4.32.

Table 3.4.32 Income Statement of Water Supply Account at Chitungwiza Municipality

(USD, % of total)

	2011		2010		2009	
Revenue						
Water sales	5,910,573	99%	5,527,260	97%	6,330,667	100%
Water connnection charge	33,330	1%	46,613	1%	5,681	0%
Miscellaneous recoveries	2,458	0%	130,432	2%	836	0%
Total revenues	5,946,361	100%	5,704,305	100%	6,337,184	100%
Expenditure						
Water Bulk Purchases	3,453,580	78%	4,354,948	93%	3,663,363	94%
Salaries and wages	652,912	15%	288,223	6%	206,581	5%
Bank interest	233,879	5%	0	0%	0	0%
Bank Charges	55,504	1%	10,503	0%	3,294	0%
Fuel & oil	6,957	0%	6,834	0%	4,565	0%
Loose tools	5,970	0%	-160	0%	920	0%
Protective Clothing	5,155	0%	2,614	0%	0	0%
Audit fees	2,128	0%	1,691	0%	559	0%
Repairs & maintance	1,941	0%	1,937	0%	1,424	0%
Electricity Charges	0	0%	844	0%	10,930	0%
Serminars	0	0%	700	0%	0	0%
Staff welfare	0	0%	650	0%	250	0%
Professional fees	0	0%	450	0%	0	0%
Conferences & official visits	0	0%	144	0%	0	0%
Printing & Stationery	0	0%	11	0%	0	0%
Admin-charges	0	0%	0	0%	6,052	0%
Security Mesures	0	0%	0	0%	149	0%
Teas & refreshments	0	0%	0	0%	49	0%
Total expenditures	4,418,026	100%	4,669,389	100%	3,898,136	100%
Surplus for the year	1,528,335	26%	1,034,916	18%	2,439,048	38%
Surplus brought forward	3,473,964		2,439,048		0	
Resultant surplus transferred to balance sheet	5,002,299		3,473,964		2,439,048	

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

The water supply operation is apparently profitable. However it should be noted that the surplus may have resulted from constrained expenditures. The largest expense item in the water supply operation is bulk water purchase, accounting for 78% of the total expenditures in 2011 and 93% in 2010. Salaries and wages is the second largest item, constituting 15% of the total in 2011 and 6% in 2010. A huge salary boost in 2011 was due to an overall pay raise effected during the year. The weights of these two main expenditure items in the total expenditure fluctuated considerably from 2010 to 2011. Only marginal sums were expended as other expenditure items including "Repairs & maintenance". It is suspected that the annual expenditures of water supply operation were determined by accidental cash availability and arbitrary cost allocation with other activities. It is therefore unworkable to deduce from the past figures, an appropriate level of expenditure to sustain a satisfactory water supply operation at Chitungwiza. Further analysis is required based on more reliable data which will be made available in 2013.

Also the surplus in income statements does not necessarily mean cash surplus as the Chitungwiza Municipality uses the accrual basis accounting system. Actual cash movement is not certain as the municipality has been failing to prepare cash flow statement for the water supply account. In fact the Chitungwiza Municipality is chronically cash-strapped. Balance sheets of water supply account (Table 3.4.33) indicate that both accounts receivables and accounts payables increased significantly in 2011. This suggests that the water operation could not collect sufficient water rates and could not make timely payments either.

Table 3.4.33 Balance Sheet of Water Supply Account at Chitungwiza Municipality

(USD, % of total)

	2011		2010		2009	
Assets						
Fixed assets						
Capital outlay	2,795,239	20%	2,788,339	24%	2,791,939	34%
Current assets						
Receivables	11,883,347	83%	8,627,598	75%	5,360,094	65%
Liquor current account	-3,528	0%	-13,528	0%	0	0%
Staff canteen current account	1,539	0%	1,539	0%	1,539	0%
Cash resources	-433,012	-3%	128,724	1%	40,042	0%
Total assets	14,243,585	100%	11,532,672	100%	8,193,614	100%
Equity and liabilities						
Special funds	3,600	0%	3,600	0%	0	0%
Surplus	9,538,477	67%	5,769,427	50%	2,451,383	30%
Capital Finance						
Loans	6,900	0%	0	0%	0	0%
Accumulated reserves	3,176,809	22%	2,788,339	24%	2,791,939	34%
Current liabilities						
Payables	9,751,544	68%	7,791,119	68%	3,329,432	41%
Inter funds	-8,233,745	-58%	-4,819,813	-42%	-379,139	-5%
Total equity and liabilities	14,243,585	100%	11,532,672	100%	8,193,615	100%

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

The revenues during the 2009-2011 period fluctuated. The 2010 revenues decreased by 10% compared with the 2009 revenues. The 2011 revenues increased by 4% from the previous year.

The indicator “collection efficiency” can be computed from financial data of the municipality. The collection efficiency is defined as “cash collection during a certain period ÷ accrued revenue during the same period × 100”. The cash collection in the water supply account during 2011 was USD 3,880,409. Therefore the collection efficiency of the water supply operation in 2011 was computed at 65% (= 3,880,409 ÷ 5,946,361).

Table 3.4.34 shows capital budgets of water supply operation in Chitungwiza. The figures are planned values, not actual ones. The primary activity in the water supply operation is to distribute the bulk water provided by the City of Harare, to consumers in Chitungwiza. Therefore the largest part of the capital expenditure was directed to rehabilitation of water network, which accounted for more than 50% of the total capital expenditure budget of both 2011 and 2012. The fund was expected to be obtained as either loans from the Ministry of Local Government or own funds, which were considered difficult to be secured in view of tight fiscal situation.

Table 3.4.34 Capital Budget of Water Supply Operation at Chitungwiza

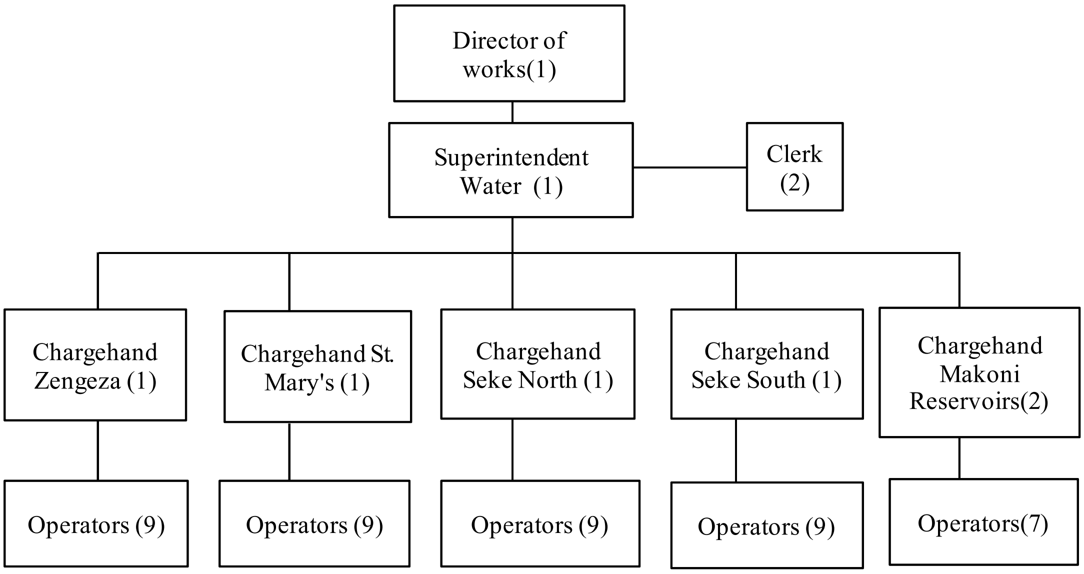
(USD million, % of total)

	2012 Plan		2011 Plan	
Capital expenditure				
Generator and pumps	0.2	3%	0.2	7%
Reservoir	0.5	7%	0.5	19%
Rehabilitation of water network	3.6	53%	1.5	56%
Water upgrading	2.5	37%	0.5	19%
Total expenditure	6.8	100%	2.7	100%
Capital financing				
Min of Local Government	0.0	0%	2.7	100%
Own resources	6.8	100%	0.0	0%
Total financing	6.8	100%	2.7	100%

Source: Chitungwiza Municiapality

(2) Organization

The organization chart of water supply section at Chitungwiza Municipality is shown in Figure 3.4.5. The water section is divided into five units, each of which has about 10 staffs. Currently 53 staffs are deployed for the water supply operation.



- Figures in parenthesis indicate the number of actually deployed staffs, which total 53.

Figure 3.4.5 Organization Chart of Water Supply Section at Chitungwiza Municipality

(3) Employment cost

Table 3.4.35 shows the employment cost and the total personnel related cost at the water supply section. The employment cost comprises base salary, allowance, bonus, pension contribution, development levy, medical contribution and workman compensation. The total personnel related cost is the employment cost plus some general expense items closely related to the number of staffs employed such as uniform and office beverage. It was estimated that the employment cost and the total personnel related cost of 53 staffs in the 2011 budget amounted to 0.46 mil. USD and 0.51 mil. USD respectively.

Table 3.4.35 Employment Cost of Water Supply Operation at Chitungwiza Municipality (Year 2011)

Section	Position	Number of staffs Actual	Number of staffs Budget	Job grade	Basic salary (USD/yr/cap)	Allowance (USD/yr/cap)	Bonus (USD/yr/cap)	Pension contribution (USD/yr/cap)	Development levy (USD/yr/cap)	Medical contribution (USD/yr/cap)	Workman compensation (USD/yr/cap)	Employment cost (USD/yr/cap)	Personnel-related expenses within general expenses (USD/yr/cap)	Personnel-related expenses within general expenses (% of salary & allow.)	Office Vehicle *2 (USD/yr/cap)	Total Personnel-related cost (USD/yr/cap)	Actual cost per position (USD/year)
Manager	Director of Works *1	1	1	15	27,389	9,420	2,282	4,738	41	96	255	44,222	3,681	10%	5,824	53,726	53,726
Staff	WATER FOREMAN	0	1	9	11,201	1,380	933	1,938	17	96	104	15,669	1,258	10%		16,927	0
Staff	ASSISTANT FOREMAN	0	4	8	9,315	1,863	776	1,612	14	96	87	13,763	1,118	10%		14,881	0
Staff	PLUMBER CLASS ll	0	2	7	7,734	1,547	644	1,338	12	96	72	11,442	928	10%		12,371	0
Staff	CHARGE HANDS	6	3	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	62,630
Staff	CLERK	2	1	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	20,877
Staff	SENIOR OPERATORS	23	18	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	207,215
Staff	OPERATORS	20	19	4	4,563	1,380	380	789	7	96	42	7,258	594	10%		7,853	157,052
Staff	GENERAL HANDS	1	1	2	3,198	1,380	267	553	5	96	30	5,529	458	10%		5,986	5,986
	Total	53	50						Total employment cost of actual staff			463,754					507,486

Source: Chitungwiza Municipality
*1: This position manages plural sections.
*2: Grade 14, 15,16 staffs are issued a vehicle. Grade 16 (Town Clerk) is issued a driver. Instad the transport allowance is not paid. The fuel use limit is 80 liter/week. Assuming that the fuel price is US$1.40/liter, the vehicle benefit is calculated at US$5824/year (=1.4x80x52).

3.4.9 Financial Situation of Sewerage Operation at Chitungwiza

(1) Financial data analysis

Income statements and balance sheets of sewerage account of the Chitungwiza Municipality are summarized in Tables 3.4.36 and 3.4.37 respectively.

Table 3.4.36 Income Statement of Sewerage Account of Chitungwiza Municipality

(USD, % of total)

	2011		2010		2009	
Revenue						
Sewer charges	2,234,821	99%	3,163,405	100%	3,039,377	100%
Sewer connection charge	9,005	0%	3,965	0%	2,535	0%
Miscellaneous recoveries	2,411	0%	2,468	0%	254	0%
Total revenues	2,246,237	100%	3,169,838	100%	3,042,166	100%
Expenditure						
Salaries and wages	1,453,443	91%	837,970	88%	675,084	89%
Protective Clothing	37,705	2%	13,138	1%	24,476	3%
Fuel & oil	31,218	2%	34,201	4%	14,833	2%
Professional fees	28,411	2%	0	0%	0	0%
Electricity Charges	12,681	1%	11,303	1%	9,954	1%
Loose tools	8,316	1%	1,417	0%	440	0%
Chemicals and Cleaning	5,999	0%	37,398	4%	0	0%
Repairs & maintenance	5,845	0%	7,041	1%	5,327	1%
Audit fees	5,033	0%	4,943	1%	1,712	0%
Bank Charges	4,709	0%	3,896	0%	5,567	1%
Printing & Stationery	115	0%	284	0%	1,000	0%
Admin-charges	0	0%	0	0%	16,061	2%
Security measures	0	0%	0	0%	209	0%
Total expenditures	1,593,475	100%	951,591	100%	754,663	100%
Surplus for the year	652,762	29%	2,218,247	70%	2,287,503	75%
Surplus brought forward	4,501,152		2,287,503		0	
Resultant surplus transferred to balance sheet	5,153,914		4,505,750		2,287,503	

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

Table 3.4.37 Balance Sheet of Sewerage Account of Chitungwiza Municipality

(USD, % of total)

	2011		2010		2009	
Assets						
Fixed assets						
Capital outlay	6,606,662	55%	6,352,033	59%	6,352,033	71%
Current assets						
Receivables	5,319,839	44%	4,446,863	41%	2,561,323	29%
Liquor current account	-18,063	0%	-5,263	0%	0	0%
Cash resources	78,865	1%	38,492	0%	4,617	0%
Total assets	11,987,303	100%	10,832,125	100%	8,917,973	100%
Equity and liabilities						
Surplus	8,660,480	72%	6,948,160	64%	2,283,127	26%
Capital Finance						
Loans	650,000	5%	0	0%	0	0%
Accumulated reserves	6,345,133	53%	6,352,033	59%	6,352,033	71%
Current liabilities						
Payables	415,720	3%	235,962	2%	111,717	1%
Inter funds	-4,084,030	-34%	-2,704,030	-25%	171,097	2%
Total equity and liabilities	11,987,303	100%	10,832,125	100%	8,917,974	100%

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

The sewerage operation is seemingly profitable, recording large surplus during the 2009-2011 period. The surplus was 2.3 mil. USD in 2009, 2.2 mil. USD in 2010 and 0.7 mil. USD in 2011. These high profits were simply because the municipality did not maintain adequate sewerage facilities while the sewerage tariffs were set and charged on the assumption that adequate service should be provided. A huge salary increase of 2011 was caused by an overall pay raise effected during the year. Currently non-functional sewerage treatment plant and sewers in Chitungwiza obviously require minimal maintenance costs which should leave large profit margins if the sewerage tariff were collected properly.

The collection efficiency which can be computed from the municipality's financial data is defined as "cash collection during a certain period ÷ accrued revenue during the same period × 100". The cash collection apportioned for the sewerage account during 2011 was USD 1,467,649. Hence the collection efficiency of sewerage operation in 2011 was computed at 65% (= 1,467,649 ÷ 2,246,237).

Table 3.4.38 shows capital budgets of sewerage operation at the municipality. The figures are not actual but estimated values. 5.9 mil. USD capital investment was budgeted in 2012. This is considered optimistic to fully execute under the tight fiscal situation.

Table 3.4.38 Capital Budget of Sewerage at Chitungwiza Municipality

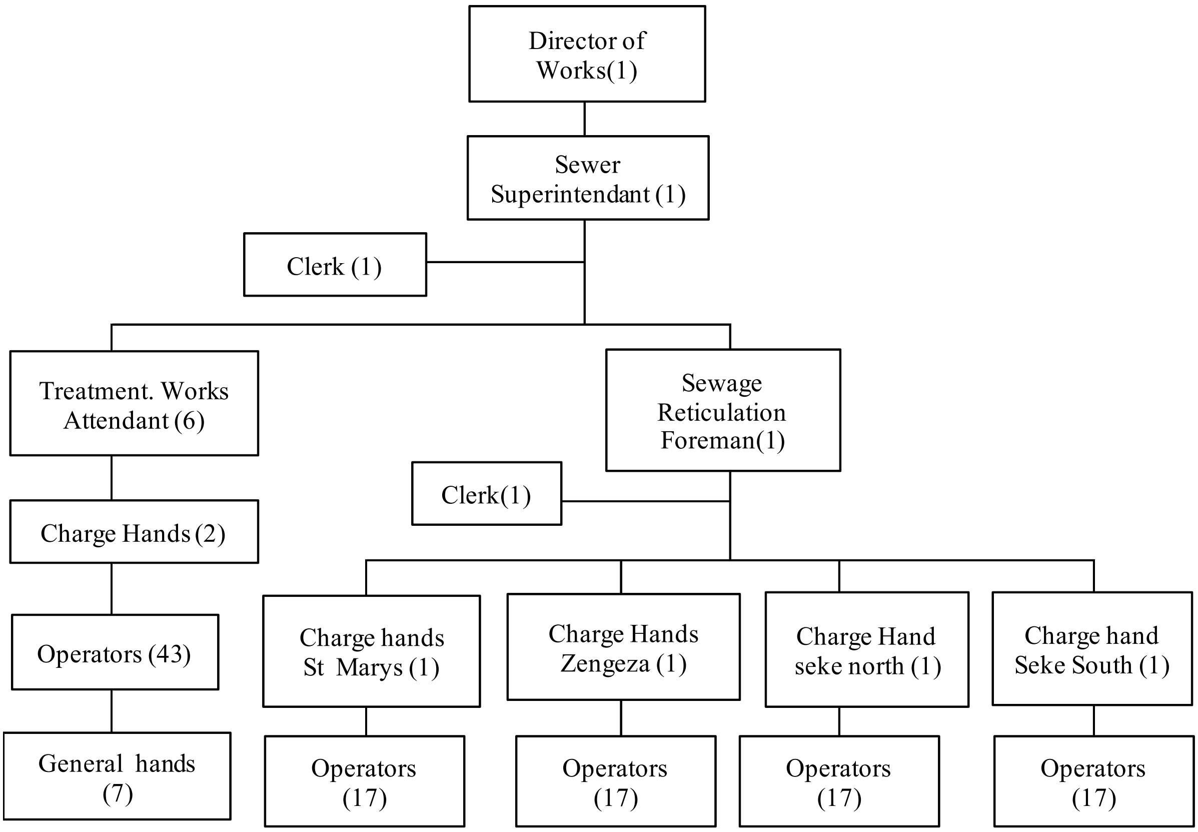
(USD million, % of total)

	2012 Plan		2011 Plan	
Capital expenditure				
Sewer upgrading	2.0	34%	0.3	75%
Sewage works upgrading	3.5	59%	0.0	0%
Hard standing concrete (St Mary's 1&3)	0.3	5%	0.0	0%
Motor vehicles	0.1	2%	0.1	25%
Total expenditure	5.9	100%	0.4	100%
Capital financing				
Loan - Min of Local Government	4.0	100%	0.4	100%
Total financing	4.0	100%	0.4	100%

Source: Chitungwiza Municiapality

(2) Organization

Figure 3.4.6 shows the organization chart of sewerage operation at Chitungwiza Municipality. The sewerage operation is divided into treatment and sewage reticulation. Currently 135 staffs are deployed for the sewerage operation.



- Figures in parenthesis indicate the number of actually deployed staffs, which total 135.

Figure 3.4.6 Organization Chart of Sewerage Section at Chitungwiza Municipality

(3) Employment cost

Table 3.4.39 shows the employment cost and the total personnel related cost at the sewerage section. The employment cost comprises base salary, allowance, bonus, pension contribution, development levy, medical contribution and workman compensation. The total personnel related cost is the employment cost plus some general expense items closely related to the number of staffs employed such as uniform and office beverage. It was estimated that the employment cost and the total personnel related cost of 135 staffs in the 2011 budget amounted to 1.18 mil. USD and 1.28 mil. USD respectively.

Table 3.4.39 Employment Cost of Sewerage Operation at Chitungwiza Municipality (Year 2011)

Section	Position	Number of staffs Actual	Number of staffs Budget	Job grade	Basic salary (USD/yr/cap)	Allowance (USD/yr/cap)	Bonus (USD/yr/cap)	Pension contribution (USD/yr/cap)	Development levy (USD/yr/cap)	Medical contribution (USD/yr/cap)	Workman compensation (USD/yr/cap)	Employment cost (USD/yr/cap)	Personnel-related expenses within general expenses (USD/yr/cap)	Personnel-related expenses within general expenses (% of salary & allow.)	Office Vehicle *2 (USD/yr/cap)	Total Personnel-related cost (USD/yr/cap)	Actual cost per position (USD/year)
*1	Director of Works	1	1	15	27,389	9,420	2,282	4,738	41	96	255	44,221	3,681	10%	5,824	53,726	53,726
Treat.	Works Superintendent	1	1	12	19,458	1,380	1,622	3,366	29	96	229	26,180	2,084	10%		28,264	28,264
Treat.	Works Attendend	6	9	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	102,894
Treat.	Trade Watse Inspector	0	1	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	0
Treat.	Fitter	0	1	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	0
Treat.	Senior LAB Analyst	0	1	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	0
Treat.	Electrician	0	1	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	0
Maint.	Foreman	0	1	9	11,380	1,380	933	1,963	17	96	104	15,873	1,276	10%		17,149	0
Maint.	Ass Foreman	0	4	8	9,315	1,380	776	1,612	14	96	87	13,280	1,070	10%		14,349	0
Maint.	Plumber Class II	0	2	7	7,734	1,380	644	1,338	12	96	72	11,276	911	10%		12,187	0
Treat.	Charge Hands	2	2	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	20,878
Maint.	Charge Hands	9	9	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	93,953
Maint.	Clerk	1	4	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	10,439
Treat.	Clerk	1	2	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	10,439
Treat.	Ass Electrician	0	1	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	0
Treat.	Junior LAB Analyst	0	1	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	0
Treat.	Heavy plant Operator	0	1	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	0
Treat.	Heavy Duty Lorry DR	0	1	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	0
Treat.	Typist	1	1	6	6,455	1,380	538	1,117	10	96	60	9,656	784	10%		10,439	10,439
Treat	Senior Operators	11	23	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	99,099
Treat	Senior Operators(screen)	10	10	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	90,090
Treat	Senior Operators Blor	4	4	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	36,036
Treat	Senior Operator PST	4	4	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	36,036
Treat	Senior Operator FST	0	10	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	0
Maint.	Senior Operators	37	52	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	333,333
Treat.	Operators	14	47	4	4,563	1,380	380	789	7	96	42	7,257	594	10%		7,851	109,916
Treat.	Semi skilled Fitter	0	1	4	4,563	1,380	380	789	7	96	42	7,257	594	10%		7,851	0
Treat.	Sampler	0	1	4	4,563	1,380	380	789	7	96	42	7,257	594	10%		7,851	0
Maint.	Operators	26	26	4	4,563	1,380	380	789	7	96	42	7,257	594	10%		7,851	204,130
Treat.	General Hands	0	1	3	3,811	1,380	381	410	6	96	35	6,119	519	10%		6,638	0
Maint.	General Hands	7	16	2	2,858	1,380	286	307	4	96	27	4,958	424	10%		5,382	37,673
	Total	135	239						Total employment cost of actual staff			1,175,586					1,277,346

Source: Chitungwiza Municipality
*1: This position manages plural sections.
*2: Grade 14, 15,16 staffs are issued a vehicle. Grade 16 (Town Clerk) is issued a driver. Instad the transport allowance is not paid. The fuel use limit is 80 liter/week. Assuming that the fuel price is USD 1.40/liter, the vehicle benefit is calculated at USD 5824/year (=1.4x80x52).

3.4.10 Financial Situation of Solid Waste Management Operation at Chitungwiza Municipality

(1) Financial data analysis

The recurrent budget of refuse removal operation at the Chitungwiza Municipality is summarized in Table 3.4.40. The refuse removal operation can be a cost recoverable operation if there is no significant revenue contribution to capital outlay. When a large amount of capital outlay is required, the recurrent budget easily goes to the red. Such deficit however, can be usually made up by surplus of other accounts. The largest recurrent expense item in the refuse removal operation is personnel cost, accounting for 63% in the 2011 budget. This reflects the fact that a large number of staff is deployed as waste collector. The repairs and maintenance cost and the fuel cost are not as large as the personnel cost. This may indicate that a proper level of maintenance activity is not done due to the fund shortage.

The collection efficiency of solid waste management operation is not computed. This is because the cash collection corresponding to the waste management operation is not segregated from other rate collection under the current accounting system. However, the collection efficiency of solid waste management is estimable as the same rate as that of water supply operation or sewerage, which is 65%, on condition that the total collection is prorated among various services of the municipality.

Table 3.4.40 Recurrent Budget of Refuse Removal at Chitungwiza Municipality

(USD, % of total)

	2012 Plan		2011 Plan	
Revenue				
Refuse Removal Fees	2,419,200	83%	2,419,200	76%
Refuse Removal - Other fees	495,682	17%	751,402	24%
Total revenue	2,914,882	100%	3,170,602	100%
Expenditure				
Personnel Costs	2,478,321	31%	1,669,487	63%
Salaries and wages & Allowances	1,516,384	19%	864,027	33%
Pension Fund Contributions	818,378	10%	730,566	28%
Bonuses	106,521	1%	44,800	2%
Medical Aid Contributions	23,232	0%	24,288	1%
Dev levy and workmen's compensation	13,805	0%	5,806	0%
General Expenses	415,819	5%	407,545	15%
Fuel and Oils	200,000	2%	200,000	8%
Protective Clothes & Uniforms	70,000	1%	70,000	3%
Dust bins	50,000	1%	50,000	2%
Chemicals & Cleaning Material	45,000	1%	45,000	2%
Manpower levy	21,199	0%	12,925	0%
Medical Examinations	10,000	0%	10,000	0%
Conferences & Official Visits	2,000	0%	2,000	0%
Hire Charges	1,700	0%	1,700	0%
Laboratory Tests	1,700	0%	1,700	0%
Loose Tools & Minor Equipment	1,500	0%	1,500	0%
Teas & Refreshments	1,500	0%	1,500	0%
Haulage	1,300	0%	1,300	0%
Training	1,200	0%	1,200	0%
Drugs & Dressings	1,000	0%	1,000	0%
Printing & Stationery	1,000	0%	1,000	0%
Security measures	900	0%	900	0%
Advertisements	800	0%	800	0%
Long service awards	800	0%	800	0%
Legal & Professional Fees	800	0%	800	0%
Administration Charges	700	0%	700	0%
Telephones	700	0%	700	0%
Books & Periodicals	500	0%	500	0%
Insurance	500	0%	500	0%
Workshop Consumable	500	0%	500	0%
Electricity	400	0%	400	0%
Fire Services	120	0%	120	0%
Repairs and Maintenance	225,000	3%	225,000	9%
Plant and Machinery	140,000	2%	140,000	5%
Motor Vehicles	65,000	1%	65,000	2%
Electricity	10,000	0%	10,000	0%
Furniture and Equipment	5,000	0%	5,000	0%
Buildings	5,000	0%	5,000	0%
Capital Charges	150	0%	150	0%
Internal Loans Repayments	150	0%	150	0%
Revenue contribution to capital outlay	5,004,000	62%	336,600	13%
Buildings	2,000	0%	20,000	1%
Plant and Machinery conversions	2,000,000	25%	150,000	6%
Furniture and Equipment	2,000	0%	96,600	4%
Motor Vehicles	3,000,000	37%	70,000	3%
Total expenditure	8,123,289	100%	2,638,781	100%
Surplus/(deficit) for the year	-5,208,407	-179%	531,821	17%
Surplus (deficit) brought forward	263,402	0	340,906	
Resultant surplus (deficit) transferred to capital outlay	-4,945,005		872,727	

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

The capital budgets of refuse removal operation in 2011 and 2012 are summarized in Table 3.4.41. The figures are estimated. Actually executed amounts are not clarified at the time of this reporting. The municipality's own funds are expected as the single source of capital financing.

Table 3.4.41 Capital Budget of Refuse Removal Operation at Chitungwiza Municipality

(USD)

	2012 Plan	2011 Plan
Capital expenditure		
Plant & heavy vehicles	70,000	70,000
Capital financing		
Own resources - Direct	70,000	70,000

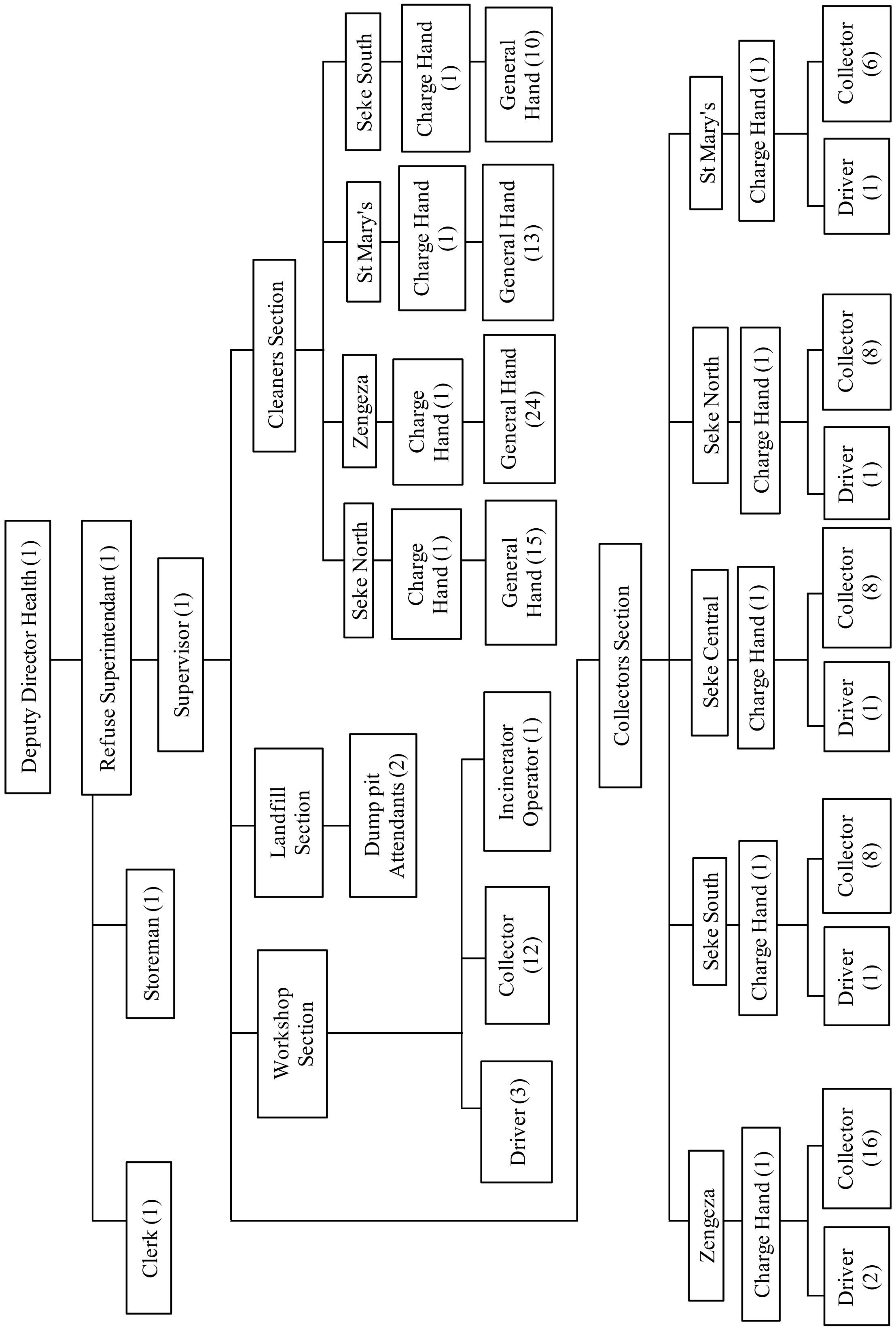
Source: Chitungwiza Municiapality

(2) Organization

Figure 3.4.7 shows the organization chart of refuse removal section at Chitungwiza Municipality. Currently 146 staffs are deployed.

(3) Employment cost

The employment cost and the total personnel related cost at the refuse removal operation are summarized in Table 3.4.42. The employment cost comprises base salary, allowance, bonus, pension contribution, development levy, medical contribution and workman compensation. The total personnel related cost is the employment cost plus some general expense items closely related to the number of staffs employed such as uniform and office beverage. It was estimated that the employment cost and the total personnel related cost of 175 staffs in the 2011 budget amounted to 1.42 mil. USD and 1.54 mil. USD respectively.



*Figures in parenthesis indicate the number of actual staffs, which total 146.

Figure 3.4.7 Organization Chart of Solid Waste Management Section at Chitungwiza Municipality

Table 3.4.42 Employment Cost of Solid Waste Management at Chitungwiza Municipality (Year 2011)

Section	Position	Number of staffs Actual	Number of staffs Budget	Job grade	Basic salary (USD/yr/cap)	Allowance (USD/yr/cap)	Bonus (USD/yr/cap)	Pension contribution (USD/yr/cap)	Development levy (USD/yr/cap)	Medical contribution (USD/yr/cap)	Workman compensation (USD/yr/cap)	Employment cost (USD/yr/cap)	Personnel-related expenses within general expenses (USD/yr/cap)	Personnel-related expenses within general expenses (% of salary & allow.)	Office Vehicle *2 (USD/yr/cap)	Total Personnel-related cost (USD/yr/cap)	Actual cost per position (USD/year)
Manager	Director of Health *1	1	1	15	27,389	9,420	2,282	4,738	41	96	255	44,221	3,681	10%	5,824	53,726	53,726
Manager	Deputy Director Health Services	1	1	13	25,886	10,354	2,157	4,478	39	96	241	43,251	3,624	10%		46,875	46,875
Manager	Deputy Director Waste Management	0	1	13	21,876	7,726	1,823	3,785	33	96	203	35,542	2,960	10%		38,502	0
Manager	Refuse Superintendent	0	1	12	16,196	1,380	1,350	2,802	24	96	151	21,998	1,758	10%		23,756	0
Staff	WASTE INSPECTOR	2	1	9	11,201	1,380	933	1,938	17	96	104	15,669	1,258	10%		16,927	33,855
Staff	ASSISTANT REFUSE FOREMAN	1	4	8	9,315	1,380	776	1,612	14	96	87	13,280	1,070	10%		14,349	14,349
Staff	RECORDS CLERK	0	1	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	0
Staff	HEAVY DUTY LORRY DRIVER	13	13	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	135,699
Staff	TIN SMITH	1	1	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	10,438
Staff	INCINERATOR OPERATOR	1	1	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	9,009
Staff	CHARGEHANDS	7	6	6	6,455	1,380	538	1,117	10	96	60	9,655	783	10%		10,438	73,069
Staff	DUMP PIT ATTENDANTS	2	4	5	5,409	1,380	451	936	8	96	50	8,330	679	10%		9,009	18,019
Staff	WASTE COLLECTORS	146	220	4	4,563	1,380	380	789	7	96	42	7,258	594	10%		7,853	1,146,476
	Total	175	255						Total employment cost of actual staff			1,419,540					1,541,516

Source: Chitungwiza Municipality
*1: This position manages plural sections.
*2: Grade 14, 15,16 staffs are issued a vehicle. Grade 16 (Town Clerk) is issued a driver. Instad the transport allowance is not paid. The fuel use limit is 80 liter/week. Assuming that the fuel price is USD 1.40/liter, the vehicle benefit is calculated at USD 5824/year (=1.4x80x52).

3.4.11 Tariff Analysis

As stipulated in Section 219 of the Urban Councils Act, local authorities can fix or revise tariffs for water supply, sewerage service and solid waste management. The required process for tariff revision is as follows.

1) A resolution for new tariff proposal is passed by a majority of the total membership of the council.
2) A statement setting out the proposed tariffs is advertised in a newspaper and at the office of the council.
3) The number of objections lodged within 30 days of the tariff advertisement is less than thirty persons or less than 50% of the number of users.

However, in terms of Section 314 of the same Act, the Minister of Local Government, Rural and Urban Development, may reverse, suspend, rescind resolutions, decisions, etc. of councils. Therefore local authorities usually ask approval of tariffs together with annual budgets to the MLGURD once a year. In fact both the Chitungwiza Municipal Council and the Harare City Council have not raised water, sewerage and solid waste management tariffs since they were revised in 2009. Even though there are no changes in the tariffs, both councils announce once a year their service tariffs for the next financial year together with the budget estimates.

Tariffs of water, sewerage and solid waste management in Chitungwiza and Harare are summarized in the following tables which are presented subsequently.

Table 3.4.43 Water Tariff of Chitungwiza
Table 3.4.44 Sewerage Tariff of Chitungwiza
Table 3.4.45 Solid Waste Management Tariff of Chitungwiza
Table 3.4.46 Water and Sewerage Tariff of Harare
Table 3.4.47 Waste Management Tariff of Harare (1/2)
Table 3.4.48 Waste Management Tariff of Harare (2/2)

Table 3.4.43 Water Tariff of Chitungwiza

	Year 2013	Year 2009 - 2012	Unit
Minimum water charges			
Residential *	3.90	4.49	USD/connection/month
Schools , Creches and Churches	17.25	17.25	USD/connection/month
Commercial, Industrial, Gov. institutions	34.50	34.50	USD/connection/month
Water volume charge - Residential **	0.38	0.38	USD/cubic meter
Water volume charge - Non Residential	0.75	0.75	USD/cubic meter
Penalty for tampering with water meters	69.00	69.00	USD/case
Water Sales - Mayambara area	0.92	0.92	USD/cubic meter
Water Connection Fees			
15 mm water meter residential	34.50	34.50	USD/connection
15 mm water meter non residential	43.13	43.13	USD/connection
20 mm water meter non residential	51.75	51.75	USD/connection
25 mm water meter non residential	69.00	69.00	USD/connection
40 mm water meter non residential	86.25	86.25	USD/connection
50 mm water meter non residential	103.50	103.50	USD/connection
80 mm water meter non residential	129.38	129.38	USD/connection
100 mm water meter non residential	172.50	172.50	USD/connection
150 mm water meter non residential	215.05	215.05	USD/connection
Re-routing of water meter position			
Residential	86.25	86.25	USD/work
Non residential	172.50	172.50	USD/work
Water meter repairs			
- Changing register	8.63	8.63	USD/work
- Changing Chamber	12.94	12.94	USD/work
- Cleaning Chamber	12.94	12.94	USD/work
- Stop cork repairs	17.25	17.25	USD/work
- Replacement of stop corks	25.88	25.88	USD/work
- Replacement of water meter connectors	12.94	12.94	USD/work
Repair of damaged water pipes			
- 40 mm	43.13	43.13	USD/work, minimum
- 25 mm	25.88	25.88	USD/work, minimum
- 20 mm	21.56	21.56	USD/work, minimum
Replacement of meters			
- 15 mm	103.50	103.50	USD/work
- 20 mm	129.38	129.38	USD/work
- 25 mm	172.50	172.50	USD/work

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality
Note: All the rates are inclusive of 15% VAT, except water charge for residential.
* Minimum water charge for residential has become zero-rated for VAT since 2013.
** Water volume charge for residential has been zero-rated for VAT since 2009.

Table 3.4.44 Sewerage Tariff of Chitungwiza Municipality

	Year 2009 - 2013 tariff *1	Unit
Sewerage charges		
Residential	4.51	USD/property/mth
Schools , Creches and Churches	11.50	USD/property/mth
Public properties (government) - closet	11.50	USD/closet/mth
Public properties (government) - urinal	5.75	USD/closet/mth
Industrial - closet	11.50	USD/closet/mth
Industrial - urinal	8.05	USD/metre/month
Commercial - closet	11.50	USD/closet/mth
Commercial - urinal	5.75	USD/metre/month
Communal toilets (closet) at markets	34.50	USD/closet/month
Commercial toilets	43.13	USD/office/month
Industrial effluent *2		
Sewer connection fees		
Residential	21.56	USD/connection
Public properties	25.88	USD/connection
Commercial	129.38	USD/connection
Industrial	172.50	USD/connection
Clearing of toilet blockage		
Residential	8.63	USD/work
Public properties	12.94	USD/work
Commercial	43.13	USD/work
Industrial	86.25	USD/work
Emptying of septic tanks	258.75	USD/work
Sewer blockage excavation		
Residential	8.45	USD/work
Public properties	12.94	USD/work
Commercial	43.13	USD/work
Industrial	86.25	USD/work

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality
*1: All the rates are inclusive of 15% VAT.
*2: Industrial effluent has not been charged. Effluent formulae for future charging is proposed.

Table 3.4.45 Solid Waste Management Tariff of Chitungwiza Municipality

	Year 2009-2013 tariff	Unit
Refuse collection		
- residential *1	3.36	USD/unit/month
- commercial shops per bin	34.50	USD/bin/month
- schools, hospitals, gov. institutions	17.25	USD/unit/month
- served with skip dish or equivalent	103.50	USD/unit/month
- single drum collection and disposal 5 times per month	57.50	USD/unit/month
- markets (home industries)	20.70	USD/unit/month
- markets (skip)	13.80	USD/skip/collection
Scrap vehicle removal	103.50	USD/load
Removal of rubbles	103.50	USD/load
Dumping of industrial refuse by outsiders		
- less than 3 tonnes	69.00	USD/tonne
- more than 3 tonnes	345.00	USD/tonne
- quantity below 5cubic metres	103.50	USD/tonne
- special waste collection (e.g. glass)	138.00	USD/tonne
Dumping of non industrial refuse by outsiders		
- less than 3 tonnes	103.50	USD/tonne
- more than 3 tonnes	414.00	USD/tonne
- quantity below 5cubic metres	172.50	USD/tonne
Plastic paper recovery	69.00	USD/unit/month
Clinical waste collection including incineration		
- surgery	102.82	USD/unit/month
- hospital	102.82	USD/unit/month
- nursing home	102.82	USD/unit/month
Incineration only (Food)		
- 0.0kg to 50kgs	102.82	USD/incineration
- 50kgs to 100kgs	68.99	USD/incineration
- 100kgs to 200kgs	102.84	USD/incineration
- 200kgs to 400kgs	143.75	USD/incineration
- 400kgs to 1000kgs	172.50	USD/incineration
- above 1000kgs *2	0.20	USD/kg
Incineration only (Non foodstuffs,non medical & non hazardous)		
- 0cubic meters to 2cubic meters	103.50	USD/incineration
- 2cubic meters to 4cubic meters	309.35	USD/incineration
- 4cubic meters to 5cubic meters	447.81	USD/incineration
- above 5cubic meters *3	103.00	USD/cubic meter
Industrial waste disposal		
- Less than 3 tonnes	103.50	USD/tonne
- More than 3 tonnes	103.50	USD/tonne
- Liquid		
- quantity below 5cubic metres	69.00	USD/cubic meter
- quantity above 5cubic metres	103.50	USD/cubic meter
Solid requiring burial only		
- quantity below 7000cubic metres	69.00	USD/cubic meter
- quantity above 7000cubic metres	103.50	USD/cubic meter
Reclamation of waste		
- Bottles, glass etc	27.60	USD/carrying-in
Solid humus (excreta) Collection		
- Less than 1 tonne	13.80	USD/collection
- 1 tonne and less than 2 tonnes	34.50	USD/collection
- 2 tonnes up to 3 tonnes	138.00	USD/collection
- Penalty for illegal dumping	34.50	USD/case
Hire of equipment		
-Front end loader	34.50	USD/hour
-Tipper	20.70	USD/hour
-Tractor	17.25	USD/hour

Source: Compiled by JICA Project Team based on data of Chitungwiza Municipality

*1: All the rates are inclusive of 15% VAT, except residential refuse collection tarif, which is zero rated for VAT.

*2: Prorated according to the unit charge of 400 to 1000kg. For example, 1200kg incineration is charged USD207 (=172.5/1000*1200)

*3: Prorated according to the unit charge of 4 to 5 cubic meters. For example, 6 cubic meter incineration is charged USD537.37 (=447.81/5*6)

Table 3.4.46 Water and Sewerage Tariff of Harare

(Effective in 2012)

1. HIGH DENSITY DOMESTIC CONSUMERS			5. NON-RESIDENTIAL PROPERTIES		
Fixed water charge per month	5.75	USD/connection	Fixed water charge per month	92.00	USD/connection
1-20 cubic meter *1	0.25	USD/cubic meter	1-100 cubic meter	0.92	USD/cubic meter
21-30 cubic meter *1	0.50	USD/cubic meter	>100 cubic meter	1.38	USD/cubic meter
31-50 cubic meter *1	0.75	USD/cubic meter	Sewer charge per fitment	17.25	USD/month
51-100 cubic meter *1	1.00	USD/cubic meter	6. HOTELS AND RESTAURANT		
>100 cubic meter *1	2.00	USD/cubic meter	Fixed water charge per month	92.00	USD/connection
Sewer charge per month	5.75	USD/connection	1-100 cubic meter	0.92	USD/cubic meter
2. LOW DENSITY DOMESTIC CONSUMERS			>100 cubic meter	1.38	USD/cubic meter
Fixed water charge per month	12.65	USD/connection	Sewer charge per fitment	17.25	USD/month
1-20 cubic meter *1	0.40	USD/cubic meter	7. BULK WATER		
21-30 cubic meter *1	0.80	USD/cubic meter	Fixed water charge per month	92.00	USD/connection
31-50 cubic meter *1	1.00	USD/cubic meter	Volumetric charge	0.345	USD/cubic meter
51-100 cubic meter *1	1.50	USD/cubic meter	8. WATER/SEWER CONNECTION CHARGES		
>100 cubic meter *1	2.00	USD/cubic meter	High density domestic		
Sewer charge per month	12.65	USD/connection	Without sewer *2	69.00	USD/connection
3. HIGH DENSITY COMMERCIAL CONSUMERS			With sewer *3	126.50	USD/connection
Fixed water charge per month	92.00	USD/connection	Unserviced *4	184.00	USD/connection
1-100 cubic meter	0.92	USD/cubic meter	Low density domestic		
>100 cubic meter	1.38	USD/cubic meter	Without sewer *2	184.00	USD/connection
Sewer charge per fitment	17.25	USD/month	With sewer *3	247.25	USD/connection
4. LOW DENSITY COMMERCIAL CONSUMERS			Unserviced *4	333.50	USD/connection
Fixed water charge per month	92.00	USD/connection	Commercial		
1-100 cubic meter	0.92	USD/cubic meter	Without sewer *2	212.75	USD/connection
>100 cubic meter	1.38	USD/cubic meter	With sewer *3	569.25	USD/connection
Sewer charge per fitment	17.25	USD/month			

Source: Compiled by JICA Project Team based on data of Harare Water

*1 Volumetric charges to domestic users are zero rated for VAT. All other rates are inclusinve of 15% VAT.

*2 This rate applies when there is no sewer connectible to the area, therefore only water connection is needed.

*3 This rate applies when the area is sewer connectible and if both water and sewer connection are needed.

*4 This rate applies where no sewer nor water connection are available and if borehole and septic tank are needed.

Table 3.4.47 Waste Management Tariff of Harare (1/2)

(Effective in 2012)

Refuse removal charge	
Residential property High Density Areas	
Once per week collection	* 6.50 USD/bin/month
Residential property Low Density Areas	
Once per week collection	* 9.50 USD/bin/month
Commercial Property:	
Once per week collection	17.25 USD/bin/month
Twice per week collection	23.00 USD/bin/month
Thrice per week collection	33.35 USD/bin/month
Four times per week collection	41.40 USD/bin/month
Five times per week collection	49.45 USD/bin/month
Six times per week collection	55.20 USD/bin/month
Seven times per week collection	60.95 USD/bin/month
Industrial Property:	
Once per week collection	17.25 USD/bin/month
Twice per week collection	23.00 USD/bin/month
Thrice per week collection	33.35 USD/bin/month
Four times per week collection	41.40 USD/bin/month
Five times per week collection	49.45 USD/bin/month
Six times per week collection	55.20 USD/bin/month
Seven times per week collection	60.95 USD/bin/month
Medical Property:	17.25 USD/bin/month
Removal of excess domestic waste or garden waste	17.25 USD/bin/month
Charge per 3-tonne load or part load for the bulk removal of excess domestic or garden waste	57.50 USD/load
Septic tanks emptied by Council within the city's boundary	
Residential property per load per septic tank or part thereof	92.00 USD
Commercial and Industrial properties per load or part thereof	115.00 USD
Septic tanks emptied by Council beyond the city's boundary	
-Residential property per load or part thereof plus transport cost as per prevailing AA rates per every kilometer covered	92.00 USD
-Commercial and Industrial properties per load or part thereof plus transport costs as per prevailing AA rates per every kilometer covered	115.00 USD
Liquid Waste	
-Sewage sludge emptied by any other person into Council's main holes per 1000 litres load or part thereof	1.15 USD
Incineration (standard waste receptacle maximum weight 10kgs)	
-For the incineration of all material other than food condemned as being unfit for human consumption, a charge which shall be per standard waste receptacle or part thereof	6.90 USD
-For the incineration of all material other than food condemned as being unfit for human consumption, a charge which shall be per standard waste receptacle collected or part thereof	13.80 USD

Source: Compiled by JICA Project Team based on data of City of Harare

Note: All the rates are inclusinve of 15% VAT except residential tariffs indicated as *, which are zero rated for VAT.

Table 3.4.48 Waste Management Tariff of Harare (2/2)

(Effective in 2012)

Solid waste	
-For the disposal of waste delivered by any person to a waste disposal site other than waste specified elsewhere in this tariff,and excluding ash, clinker, soil and builders rubble or any other waste required by the Council for sanitary landfill purposes at the waste disposal site the following rates apply:	
For the hire of a portable toilet,and removal and disposal of night	11.50 USD
Domestic waste	
Per load or part load for vehicles of not more than 3-ton capacity	5.75 USD
Per load or part load for vehicles of 3-ton to 5-ton capacity	11.50 USD
Per load or part load for vehicles in excess of 5-ton capacity	17.25 USD
Commercial waste	
Per load or part load for vehicles of not more than 3-ton capacity	11.50 USD
Per load or part load for vehicles of 3-ton to 5-ton capacity	17.25 USD
Per load or part load for vehicles in excess of 5-ton capacity	23.00 USD
Industrial waste	
Per load or part load for vehicles of not more than 3-ton capacity	17.25 USD
Per load or part load for vehicles of 3-ton to 5-ton capacity	23.00 USD
Per load or part load for vehicles in excess of 5-ton capacity	28.75 USD
-For the disposal of toxic liquid waste per 100 liters	2.30 USD
-For the disposal of toxic solid waste per ton	23.00 USD
Trenching fees per hour	57.50 USD
-For the hire of a portable toilet,and removal and disposal of night soil for a complete unit per day or part thereof excluding transport	11.50 USD
-For the hire of a portable chemical removal and disposal of night soil for a complete unit per day or part thereof including transport	57.50 USD
-Skips	
Per skip removed	115.00 USD
Skip bin rental fee per day	0.58 USD
Car Shell	
-For the removal of car shell or part thereof	
Pay toilets fees	34.50 USD
Posters Fees	0.58 USD
-Per every 50 posters or part thereof	57.50 USD
Penalties and Fines	
Unauthorised dumping of refuse /illegal dumping on undesignated places:	
Domestic waste from a standard size receptacle/carts	23.00 USD
Dumping of Domestic waste from a motor vehicle	57.50 USD
Dumping of Industrial/Commercial waste	287.50 USD
Illegal discharge of domestic and industrial effluent	287.50 USD
For the removal and disposal, of carcasses of---	
(a) a domestic animal	5.75 USD
(b) any animal other than a domestic animal which is not an equine animal	11.50 USD
(c) an equine animal	28.75 USD
Transport charge for the removal of carcasses per kilometer	1.15 USD

Source: Compiled by JICA Project Team based on data of City of Harare

Note: All the rates are inclusinve of 15% VAT.

(1) Water tariffs of Chitungwiza

The water tariff of Chitungwiza (Table 3.4.43) can be divided into the minimum water charge (fiexed rate) and the water sales charge (volumetric rate). There are three customer categories in the minimum water charges, which are (i) residential, (ii) school, crèche and church and (iii) commercial and industrial. The three fixed charges of each category are respectively USD 3.90, USD 17.25 and USD 34.50. Government customers are considered as commercial and industrial.

The water sales charges are divided into two customer categories which are (i) residential and (ii) non-residential. By unknown reason, this categorization is different from that of the minimum water charges. The two volumetric charges of each category are respectively USD 0.38 per m^3 and USD 0.75 per m^3.

According to the recurrent budget estimate from water supply operation, the largest water revenue comes from the block of water sales for residential, which amounts to 4.1 mil. USD in the 2012 budget and accounts for 34% of the total water revenue. The second largest block in terms of revenue contribution is the minimum water charges for residential, amounting to 2.9 mil. USD and accounting for 25% of the total. The third largest contributor is the replacement fee of 15 mm sized meters, amounting to 2.2 mil. USD and accounting for 18% of the total water revenue. Under the current tariff setting, these three tariff categories have very strong impacts on the revenue estimates.

(2) Sewerage tariff of Chitungwiza

Table 3.4.44 shows the sewerage tariff of Chitungwiza. The sewerage tariff can be divided into three types, which are (i) per property charge, (ii) per closet charge and (iii) per urinal charge. The per property charge applies only to residential users. The per closet charge applies to industrial, commercial school and communal toilets. The per urinal charge applies to government, industrial and commercial users. All these three types of sewerage tariff are per-unit basis, not volumetric basis. Therefore the use of well water is not a factor that is taken into consideration when sewerage bills are computed.

Contributions of each tariff type to the total sewerage revenue are 69% (per property charge), 23% (per closet charge) and 3% (per urinal charge). Two large revenue contributors among the tariff/customer types are (i) per property charge from residential users, accounting for 69% of the total sewerage tariff revenues and (ii) per closet charge from commercial users, accounting for 17% of the total. Tariff setting for these two categories are most influential under the current tariff structure.

(3) Solid waste management tariffs of Chitungwiza

Solid waste management tariffs of Chitungwiza (Table 3.4.45) can be divided into many tariff categories, including (i) refuse collection fee, (ii) scrap and dumping fee, (iii) incineration fee and industrial waste disposal fee. Night soil collection is dealt in the same refuse removal section. Despite the variety of tariff categories, the number of large contributors to the total revenue is limited. The largest revenue comes from the block of refuse collection fees from residential, which accounts for as much as 84% of the total revenue estimate in 2012. The second and the third contributors are by far smaller. They are the refuse collection fee per bin from commercial shops (5%) and clinical waste collection fee from surgery (5%).

(4) Billing and collection system of Chitungwiza

The water meter reading, billing and collection is a monthly process which is performed by the municipality staffs. Billing and collection are not separated by service type but combined under all services (water, sewerage, refuse collection, and other rates).

Staffs deployed at four ward offices (Seke South, Seke North, Zengeza and St. Mary's) under the Director of Housing are in charge of water meter reading and bill delivery. About six staffs at the Administration Office of each ward are supposed to read water meters installed at all dwellings in its area. However, often the water meters are not read, instead the water consumptions are estimated based on the past consumptions.

The results of water meter reading, whether based on real reading or estimate, are entered into the bill issuance computer system at the IT section under the Director of Finance. Other rate data including sewerage charge are also entered in the system to issue the bills per dwelling. The printed bills are delivered to the dwellings by the same staffs of each Administration Office who do meter reading.

Residents can pay the bills at the four ward offices, the main municipality office or three private banks (Kingdom Bank, Metropolitan Bank and FBC). Unpaid bills of 12 months after due date are subject to penalty interest of 17.5% per annum. Water supplies may be disconnected if the bills remain unpaid after due date. However those penalties and disconnections are hardly effectuated as the Chitungwiza municipality is aware that the municipality itself is not providing acceptable services to the residents.

The municipality offers an incentive program rather than imposing penalties. In order to encourage payment from the debtors, the municipality introduced a sales promotion program in 2011. Under this program, debtors were discharged from a half of the debts if they paid the remaining half. This program was not successful in reducing the total accounts receivable at the year-end but succeeded in slowing down the increase rate of accounts receivable. After the sales promotion program ended, the accounts receivables started soaring again. In 2013, despite the possibly limited success, the municipality, desperate for cash to finance recurrent operation costs, resorted again to the same promotion program.

(5) Water and sewerage tariffs of Harare

Water and sewerage tariffs of Harare are shown in Table 3.4.46. Domestic consumers are classified as a resident in either high density area or low density area. The high density area is generally characterized as the low income area where informal settlements often exist. The low density area is characterized as a higher income area. The water tariff structure comprises fixed charge and volumetric charge. In case of domestic, the volumetric charge has five consumption blocks, (i) 1-20 m^3, (ii) 21-30 m^3, (iii) 31-50 m^3, (iv) 51-100 m^3 and (v) over 100 m^3. The unit rate per block increases as the block goes up. The bulk water tariff is composed of the fixed charge (USD 80/connection/month) and the single block volumetric charge (USD 0.3/m^3).

There are two types sewerage tariffs which are (i) per property charge and (ii) per fitment charge. The per property charge applies only to domestic users. The per closet charge applies to non domestic customers such as industrial, commercial and hotels and restaurants.

(6) Waste management tariffs of Harare

Waste management tariffs of Harare are summarized in Tables 3.4.47 and 3.4.48. Harare's tariffs are characteristic of volumetric charge. Rather than per-unit tariffs, per-bin tariffs are employed. Tariffs for residential properties are differentiated between those who live in high density areas and those who live in low density areas. Monthly collection charges for commercial property and industrial property vary depending on collection frequency per week, which ranges from once per week to seven times per week.

(7) Tariff comparison between Chitungwiza and Harare

Domestic tariffs and monthly water bills of water, sewerage and refuse collection in Chitungwiza and Harare are computed and summarized in Table 3.4.49. For the water bill, the monthly consumption is assumed to be 30 m^3 per connection. Harare has the low density area tariff and the high density area tariff, while Chitungwiza has no such distinction. In terms of water bill, residents of Chitungwiza are billed USD 15.89 per month which is slightly higher than those who live in high density areas of Harare, who are charged USD 15.75. But residents in low density areas of Harare are billed nearly a double (USD 28.65).

For both sewerage and refuse collection, Chitungwiza residents are charged much lower bills. The monthly sewerage bill in Chitungwiza is USD 4.51 per connection, while in Harare the bills are USD 5.75 at high density areas and USD 12.65 at low density areas. The refuse collection bill in Chitungwiza is USD 3.36 per residence, while in Harare they are USD 7.48 at high density areas and USD 10.93 at low density areas.

Table 3.4.49 Domestic Tariff Comparison between Chitungwiza and Harare

Service Type	Chitungwiza		Harare	
	Tariff	Monthly bill (inclusive of VAT)	Tariff	Monthly bill (inclusive of VAT)
Water (monthly 30m^3 use)	Fixed charge --USD 4.49 per connection Volumetric charge USD 0.38 per cubic metre	USD 15.89	High density area Fixed charge --USD 5.00 per connection (excl. VAT) Volumetric charge USD 0.25/m^3 for 1-20 m^3 use USD 0.50/m^3 for 21-30 m^3 use Low density area Fixed charge --USD 11.00 per connection (excl. VAT) Volumetric charge USD 0.4/m^3 for 1-20 m^3 use USD 0.8/m^3 for 21-30 m^3 use	USD 15.75 (high density area) USD 28.65 (low density area)
Sewerage	Flat rate –USD 4.51 per connection	USD 4.51	High density area Fixed charge --USD 5.00 per connection (excl. VAT) Low density area Fixed charge --USD 11.00 per connection (excl. VAT)	USD 5.75 (high density area) USD 12.65 (low density area)
Refuse collection	Flat rate –USD 3.36 per dwelling	USD 3.36	High density area Fixed charge --USD 6.50 per residence (excl. VAT) Low density area Fixed charge --USD 9.50 per residence (excl. VAT)	USD 7.48 (high density area) USD 10.93 (low density area)

Source: Compilation by JICA Project Team

(8) Borehole tariff

Water from shallow wells is usually regarded to be used for basic household needs. Water use for such basic needs does not require a permit nor fee payment. Any water use for other than basic needs is regarded as commercial use and requires to be registered at ZINWA. Water from boreholes is regarded as commercial use. The annual abstraction fee is USD 40 per mega litre and to be paid to ZINWA. Some local authorities set their own user charges for borehole users, which are separate charges from the ZINWA tariff. The Chitungwiza Municipality has not yet set the borehole tariff.

(9) Ability to pay for water, sewerage and solid waste management

Household's ability to pay for water, sewerage and solid waste management can be examined by doing two types of comparison. The first one is comparison between the water, sewerage and solid waste management tariff level and the average household income. The second one is comparison between the water, sewerage and solid waste management bill and other utility bills. Other utilities may include electricity, gas and telephone.

There is a generally known rule of thumb to judge whether water and sewerage bill is affordable to households. This is called "5% rule". This rule suggests that a household can spend for water and sewerage, up to about 5% of the income, without hardship. When the solid waste management bill is added to the analysis, the threshold can be the same 5% or modified to 6%.

In fact application of this rule is somewhat arbitrary. For example, the definition of household may be either the "average-income" household or the "poor" household, which can be for example, the lowest quintile of income distribution. Furthermore the ratios of water bill and sewerage bill (and solid waste management bill) vary depending on locations. In many countries, domestic customers are charged a higher water bill than the sewerage bill. The solid waste management bill tends to be lower than the sewerage bill. Considering such situations, the reasonable ceiling of affordability for water supply would be around 3% of the average income. For the sewerage and the solid waste management, that would be about 1.5% and 0.5% respectively. This ratio seems acceptable in Chitungwiza where the water supply has been always prioritized over the sewerage service.

In estimating the household income, three data sources were available (i) the Environmental and Social Considerations Baseline Study conducted by JICA Project Team in August 2012, (ii) the Housing Survey conducted by JICA Project Team in July 2012 and (iii) the poverty line data of September 2012 announced by the Zimbabwe National Statistic Agency (ZIMSTAT).

A result of the Environmental and Social Considerations Baseline Study suggested that the average value of monthly household income at USD 390.16. The average household size of surveyed household was computed at 5.98 persons per household. Hence the average monthly per capita income was computed at USD 65.24 (= 390.16 ÷ 5.98).

The survey also established that it was a common practice for a household to share dwelling with another household. However the survey did not estimate how many households on average share one dwelling unit. On the other hand, the Housing Survey asked a straightforward question as to how many dwellers were living in one dwelling unit. As a result, the average number of dwellers per dwelling unit was estimated at 9.09 persons. Combining this 9.09 with the average monthly per capita income of USD 65.24, the average monthly income per dwelling was computed at USD 593 (= 65.24 × 9.09).

ZIMSTAT publicizes monthly the poverty datum line (PDL). The PDL signifies the cost of a defined basket of goods and requirements enabling the most basic standard of living. The PDL is used as the principal instrument for the GOZ to make policies towards the poor.

There are two types of PDL, the food poverty line (FPL) and the total consumption poverty line (TCPL). The FPL represents the minimum consumption expenditure necessary to ensure that each household member can consume a minimum food basket. An individual whose total consumption expenditure does not exceed the FPL is deemed "very poor". The TCPL is derived by computing the non-food consumption expenditures of poor households whose food consumption expenditures are just equal to the FPL. The TCPL is a total of the non-food consumption amount and the FPL. An individual who consumes less than the TCPL is considered "poor". The FPL per capita in September 2012 was USD 32.92. The TCPL per capita was USD 106.38.

The average size of a dwelling unit was found to be 9.09 persons by the Housing Survey. Applying this 9.09, the average TCPL per dwelling in Chitungwiza was estimated at USD 967 (= 106.38 × 9.09). The average FPL per dwelling was estimated at USD 299 (= 32.92 × 9.09). The average per dwelling income of USD 593 lies between the TCPL (USD 967) and the FPL (USD 299). This means that the majority of dwellings in Chitungwiza are considered as "poor" but not "very poor". This is a plausible corollary also based on societal experience in Chitungwiza.

As the average per dwelling income is USD 593, the 5% of that amount is USD 29.65. Applying the earlier mentioned WSSW distribution ratio, which is 3% for water supply, 1.5% for sewerage and 0.5% for solid waste management, the USD 29.65 can be broken down into three affordable monthly bills, (i) USD 17.79 (= 29.65 × 3 ÷ 5) as the water supply, USD 8.90 (= 29.65 × 1.5 ÷ 5) as the sewerage and USD 2.96 (= 29.65 × 0.5 ÷ 5) as the solid waste management.

Tariffs of typical utility service are summarized in Table 3.4.50. Detailed electricity tariffs are shown in Table 3.4.51. The monthly water bill per average household (USD 15.89) is less than the estimated ceiling of USD 17.79. The sewerage bill (USD 4.51) is also below the estimated ceiling of USD 8.90. But the solid waste management bill (USD 3.36) slightly exceeds the estimated ceilings of USD 2.96. If the water, the sewerage and the solid waste management are combined as WSSW, the total monthly bill will be USD 23.76. This is below the USD 29.65 ceiling, which is 5% of the average estimated per-dwelling income. Therefore the current tariffs for water, sewerage and solid waste management in Chitungwiza are considered to be affordable.

In comparison with the monthly electricity bill (USD 37.30), LP gas cost (USD 30) and firewood (USD 30), the water bill (USD 15.89) is less than a half. The existing sewerage bill (USD 4.51) and the solid waste management bill (USD 3.36) are even lesser. The mobile telephone cost (USD 30) is nearly twice the water bill. It seems that the existing water, sewerage and solid waste management tariffs are reasonable and the municipality has even some leeway to raise them if the services are provided properly.

Table 3.4.50 Comparison of Utility Charges

Service Type	Rate		Monthly Household Bill Estimates
Water (domestic)	Domestic (Subsidized)	Fixed charge ---- USD 4.49/connection Volumetric charge 0.38/m^3	USD 15.89 (assuming monthly usage of 30 m^3)
Sewerage	Domestic	USD 4.51/connection The rate applies to all residential areas	USD 4.51
Solid Waste Collection	Domestic	USD 3.36/property	USD 3.36
Electricity	Industry ,Public institutions and Business services	• Monthly capacity charge per unit of demand USD 6.93/11kV,USD 5.08/33kV • USD 0.12/kWh on peak • USD 0.07/kWh Standard energy charge • USD 0.05/kWh off peak	USD 37.30 (assuming 380 kWh consumption)
	Household	• USD 0.02/ kWh up to 50 kWh/ month • USD 0.11/ kWh from 51 to 300kWh/ month • USD 0.15/kWh over 300kWh	
Gas	LP gas (domestic)	• USD 3.00/ kg	USD 30 (Assuming that an average family Use 10 kg/month.
Firewood		• USD 2.00/bundle/ two days	USD 30
Cellular phone	Fixed charge	• Nil	USD 30 (assuming 2 hour call monthly)
	Volumetric charge	• USD 0.23/air minute for an national call	

Source: Compilation by JICA Project Team

Table 3.4.51 Electricity Tariff in Zimbabwe

Domestic Metered Customers

Conventional Meter	
	E1.1
a) Fixed Monthly Charge	$0.00
b) Energy charge per I(i)1st 50 kWh	$0.02
(ii) 51 to 300 kWh	$0.11
(iii) Balance	$0.15

Prepayment Meter	Standard E1.2.1	Stepped E1.2.2
(I) 1st 50kWh	$0.09	$0.01
(ii) 51 to 300kWh	$0.09	$0.06
(iii) Balance	$0.09	$0.15

Domestic Load Limited E1.3

Amperage	1.0 Amp	2.5 Amp	5.0 Amp	7.5 Amp	10.0 Amp	15.0 Amp	22.5 Amp	30.0 Amp
a) Fixed Monthly Charge								
a) Fixed Amperage Charge	$4.64	$7.08	$11.14	$15.21	$19.28	$27.42	$37.01	$43.39

Public Lighting

	Metered E2.1	Unmetered E2.2
a) Fixed Monthly Charge	$0.00	n/a
b) Energy charge per kWh	$0.11	n/a
c) Monthly charge per watt of installed capacity of luminaire	n/a	$0.03

Mining, Industrial, Commercial & Pumping Works

Low Voltage Supply E3.1, E4.1	
a) Fixed Monthly Charge	$0.00
b) Energy charge per kWh	$0.12

Mining, Industrial, Commercial & Pumping Works Customers - Maximum Demand

	11kV Supply E3.2.11, E4.2.11	33kV Supply E3.2.33, E4.2.33	Secondary Distribution E6.1
a) Fixed Monthly Charge	$0.00	$0.00	$0.00
b) A monthly capacity charge per unit of demand	$6.93	$5.08	$3.25
c) An interruptable demand charge	n/a	n/a	$2.44
d) On-Peak Energy charge per kWh	$0.12	$0.12	$0.12
e) Standard Energy charge per kWh	$0.07	$0.07	$0.07
f) Off-Peak Energy charge per kWh	$0.05	$0.05	$0.05

Agricultural Customers

Low Voltage E5.1	11kV Supply E5.2.11	33kV Supply E5.2.33
$0.00	$0.00	$0.00
n/a	$6.93	$5.08
n/a	n/a	n/a
$0.12	$0.12	$0.12
$0.12	$0.07	$0.07
$0.12	$0.06	$0.05

Institutions (Government, Municipal, Mission Schools, Hospitals and Clinics)

	Low Voltage E4.3	11kV Supply E4.3.11	33kV Supply E4.3.33
a) Fixed Monthly Charge	$0.00	$0.00	$0.00
b) A monthly capacity charge per unit of demand	n/a	$6.93	$5.08
c) An interruptable demand charge	n/a	n/a	n/a
d) On-Peak Energy charge per kWh	$0.12	$0.12	$0.12
e) Standard Energy charge per kWh	$0.12	$0.07	$0.07
f) Off-Peak Energy charge per kWh	$0.12	$0.05	$0.05

Notes

i) The rates are exclusive of the 6 % Rural Electrification Levy and 15% VAT. In terms of Statutory Instrument 273 of 2003, electricity charges for Domestic customers are zero rated for VAT and in terms of Statutory instrument 215 of 2005, fixed charges on Commercial and Domestic electricity are zero rated for VAT.

3.4.12 Performance of Water Supply, Sewerage and Solid Waste Management Operation

(1) Water supply and sewerage

An attempt to compare the operation efficiency of water supply and sewerage between City of Harare and Chitungwiza Municipality was done by comparing their performance data with other water utilities (Table 3.4.52). Useful referential data of water utilities in neighbour countries of Zimbabwe are available in the data base of IBNET. Raw data such as population and water supply volume are still estimates or not definitive. Also some data might include distortion factors such as hidden subsidy receipt and treatment of depreciation. However these data can still suggest to certain extent, performance of the water supply operations.

Table 3.4.52 Comparison of Performance among Water Supply and Sewerage Operators

Indicator	Chitungwiza 2011	Harare 2011	South Africa 2009	Zambia 2011	Mozambique 2007
Water Coverage (%)	99	85	78	76	37
Water priduction (m3/day)	30,000	640,000	N/A	N/A	N/A
Sewerage Coverage (%)	99	80	53	53	N/A
Total Water Consumption (l/person/day)	64	205	242	123	87
Non Revenue Water (%)	25	57	37	46	59
Operational Cost W&WW (USD/m3 water sold)	0.73	1.03	1.41	0.35	0.85
Staff W/1000 W pop served (W/1000 W pop served)	0.2	0.8	0.3	N/A	1.0
Average Revenue W&WW (USD/m3 water sold)	1.00	1.00	1.26	0.44	0.69
Collection Period (Days)	766	N/A	284	N/A	334
Collection Ratio (%)	65	N/A	100	81	85
Operating Cost Coverage (ratio)	1.36	0.97	0.89	1.25	0.82

Sources: IBNET, Chitungwiza Municipality, Harare Water, JICA report, Compilation and estimate by JICA Project Team
W = water supply, WW = wastewater, SWM = solid waste menagement, N/A = not available

The parameters used for comparison are as follows:

- Water coverage ---- Defined as: (population served for water ÷ total population in area of water supply responsibility) × 100
- Water production ---- Volume of water distributed to the network
- Sewerage coverage ---- Defined as: (population served for sewerage ÷ total population in area of water sewerage responsibility) × 100
- Total water consumption ---- Defined as: volume of water sold ÷ population served for water ÷ 365
- Non-revenue water ---- Defined as: (volume of water produced – volume of water sold) ÷ volume of water produced × 100

- Operational cost of water and sewerage --- Defined as: operational expenses of water and sewerage ÷ volume of water sold. The operational expenses usually include depreciation.

- Number of water staff per 1000 water served population ---- Defined as: number of staff in water section / (water served population ÷ 1000). This parameter is used to measure the staff productivity.

- Average revenue from water and sewerage ---- Defined as: revenues billed for water and sewerage ÷ volume of water sold

- Collection period ----This is defined as: year-end accounts receivable ÷ annual revenues billed for water and sewerage × 365.

- Collection ratio ---- Defined as: cash income of water and sewerage ÷ revenues billed for water and sewerage. The nearer to 100%, the better.

- Operating cost coverage ---- Defined as: revenues billed for water and sewerage ÷ operational expenses of water and sewerage. A ratio below one means the operator does not cover the O&M cost.

Both the water coverage and the sewerage coverage are relatively high in Chitungwiza and Harare when compared with other countries. It is noted that the water coverage data are based on self-evaluation of each city thus it tends to be optimistic. Also the high rate of coverage does not mean that the served population receives enough volume of water. Even when the water is supplied only for limited hours or with limited amounts, the population is regarded to be served.

In fact the total water consumption in Chitungwiza is the lowest among the country averages selected here. The total water consumption in Harare is high. This is partly because bulk water supplied to satellite town including Chitungwiza is included here.

The number of water section staff per 1000 water served population shows a clear difference between Chitungwiza and Harare. Chitungwiza's result is as low as 0.2 but that of Harare is 0.8.[3] This can be mainly due to the fact that Chitungwiza purchases bulk water from Harare and simply deliver it to the served population. Such delivery operation by Chitungwiza does not require as many staff as the manufacturing operation by Harare.

The collection period and the collection ratio are very poor at both Chitungwiza and Harare. The

[3] The number of staff engaged in water operation at Chitungwiza is 53 and that of Harare is considered 1,140. The populations of Chitungwiza and Harare are 354,500 and 1,581,900 respectively. The water supply coverage are considered 99% in Chitungwiza and 85% in Harare. Thus the value of this indicator at Chitungwiza is computed at 0.2 [= 53÷(354500×99%÷1000)] and that of Harare is 0.8 [= 1140÷(1581900×85%÷1000)].

collection amount of water tariff in 2011 at Chitungwiza Municipality is only 65% of the billed amount during the same period, which makes the collection period as long as 766 days. The collection ratio data is not available at Harare, but it was reported in 2011 that as low as 30% of the customers paid full amount of the water bills.

The operating cost coverage ratio of Chitungwiza Municipality is 1.36 which is computed based on the 2011 data and well above 1. This means that the operating cost could be fully covered with the operating revenue. Such favourable result is not always secured though. In 2011, the bulk water cost, which is the largest cost driver at Chitungwiza, reduced by 20% from 2010, indicating that City of Harare could not supply enough water to Chitungwiza. This notwithstanding, the water revenue which is the largest revenue source, increased by 6% in absence of tariff increase. This suggests that many of the water billings at Chitungwiza were done based on flat rate computation instead of correct meter reading. Such irregularity could distort proper revenue and cost recognition and make the operating cost recovery rate nicer than the reality. Also it should be noted that actual cash revenue from water supply and sewerage operations does not necessarily cover the cash O&M expenses. Since the accounting policy at Chitungwiza Municipality recognizes revenues and expenses on the accrual basis, cash shortage can occur when the collection ratios is low. Actually Chitungwiza Municipality is chronically devoid of cash, causing delayed or non payment of financial obligations such as staff salary and water bills from City of Harare.

The operating cost coverage ratio of City of Harare is 0.97, meaning that the operating revenue is slightly short to cover the operating expenses. The revenue and cost breakdown at Harare are more stable compared over the past years and consistent in comparison with that of Chitungwiza. Therefore the result of Harare can be considered as more reliable than that of Chitungwiza.

To sum up, focusing on comparison between Chitungwiza and Harare, the following can be said as a preliminary analysis result.

- Neither of the operators secures safe margin (revenue minus expenditure). Both operators run the water supply and sewerage unsteadily.

- Chitungwiza is a water “deliverer”, meaning that they purchase treated water from Harare and distribute it. While Harare is a water “manufacturer”- cum – “deliverer”, meaning that they treat raw water and distribute the treated water. The business is generally more complex at Harare because of the double role.

- The rough cost composition of water and sewerage operation at Chitungwiza is bulk water (67%), salary (28%) and others (5%). While that of Harare is chemicals (28%), salary (24%), electricity

(16%) and others (32%). The cost control and the tariff setting should be easier at Chitungwiza as main cost drivers are only two.

(2) Solid waste management

The performance comparison of solid waste management between Chitungwiza and Harare was attempted using limited amount of financial data. Further technical data are necessary to complete the analysis. The results are summarized in Table 3.4.53.

Table 3.4.53 Performance Comparison of Waste Management between Chitungwiza and Harare

Indicator	Chitungwiza 2011 Approx. actual	Chitungwiza 2011 Budget	Harare 2011 Approx. actual
Operational Cost (USD/served population)	1.31	7.44	12.71
Staff per 1000 population	0.49	0.49	0.11
Operating Cost Coverage (ratio)	1.57	1.20	1.00

Sources: Chitungwiza Municipality, City of Harare, Compilation and estimate by JICA Project Team

The parameters used for comparison are as follows:

- Operational cost of waste management ---- Defined as: operational expenses of waste management ÷ population in served area

- Number of staff per 1000 served population ---- Defined as: number of staff in water management section / (Served population ÷ 1000). This parameter is used to measure the staff productivity.

- Operating cost coverage ---- Defined as: revenues billed for waste management ÷ operational expenses of waste management. A ratio below one means the operator does not cover the O&M cost.

There is a big difference between the operational cost result between the budget estimate and the approximate actual of the year 2011 operation of Chitungwiza. This is primarily due to shortage of expected revenues which obliged them to curtail expenditure. It can be roughly said that the solid waste management operation costs lesser in Chitungwiza than in Harare.

3.4.13 Measures to Remedy the Financial Difficulties of the Chitungwiza Municipality

As analyzed in previous sections, the Chitungwiza Municipality is experiencing dire financial difficulties, which are the revenue shortfall and the resultant incapability of proper fiscal spending. At first sight of the financial statements, this financial problem is not conspicuous as the revenue almost balances with the expenditure, showing no significant deficit or surplus. This is because the municipality employs the cash budgeting principle where total spending is simply contained within available cash revenue. In fact the municipality faces a severe shortfall in both revenues. Thus the municipality is forced to slash both the recurrent and capital expenditure and degrade the service provision to an unbearable level to the residents. So, unsatisfied residents are not willing to pay tax and rates to the municipality, which creates a vicious circle of degrading services and falling revenues. To remedy the situation, the following measures are suggested.

(1) Revenue increase by tariff reforms

Realizations of the M/P projects easily lead to improvement of the revenue collection efficiency as the residents should become more willing to pay for the better services, which in turn leads to revenue increase unless the user population decreases. On the other hand the tariff structure and level requires a careful consideration when they are changed. The tariff analysis shows that there is a certain leeway to raise the current tariffs of water, sewerage and refuse collection when compared with the affordability ceilings. It may be unrealistic and unacceptable to raise the tariffs before the services have been improved. A large tariff increase in one go will encounter strong objections of the service users. Thus, gradual tariff reforms may be needed which will move toward the O&M cost recovery through tariff revenues as modest target. Also if the tariffs increase and near to the affordability level, a pro-poor factor could be incorporated into the tariff structure. For example, a lifeline block could be built in the water tariff structure.

(2) Cost reduction by organization restructuring

Two main expenditure drivers of the municipality are salaries and bulk water cost, accounting respectively for 71% and 14% of the total cost (accrual basis) of the financial year 2011. Obviously staff cut impacts most strongly on the cost reduction. The municipality already has an idea of halving the number of staff but its realization is opaque due to the political situation.

(3) Separation of accounts and ring-fencing of revenues

Under the current accounting system of the municipality, the water supply operation and the sewerage are dealt with by each separate account. The waste management operation is included in the rates account where other rates and taxes are also dealt with. Traditionally the revenues from water supply operation have been used to finance other municipal services outside of the water account. The same can be said to a lesser degree, about the sewerage account.

If the municipality embarks on sizable projects in water supply, sewerage and solid waste management, the municipality should use separate accounts according to the operation type and ring-fence the revenues. Ring-fencing of revenues means that funds of an operation are strictly controlled. Profits generated by the operation will be kept only for the same business line. By ring-fencing, the operator will be incentivized as the profit can be ploughed back into the operation or awarded in some way among concerned parties. Ring-fencing requires technically, setting a separate bank account and rule setting for the money withdrawal process where an approval of the board or a higher organ should be stipulated.

It goes without saying that the organizational structure should be separable according to the activities. The water supply and the sewerage are already run under separate accounts, thus the ring-fencing can follow relatively easily. For the solid waste management activities, to create a separate "waste management" account will be the first step. This requires modification of budgeting and accounting systems. The ring-fencing should be pursued after the account separation has been done.

(4) Diversification of funding sources

Sources of funds which are generally considered applicable to finance capital expenditure of WSSW projects include (i) national budgets, (ii) local government (municipality) funds, (iii) funds from financial institutions, (iii) donor support and (iv) private funds. What are currently used by the Chitungwiza Municipality are national budgets (in a form of PSIP) and donor support (in a form of MDTF such as Zim-fund). To realize the M/P projects, these sources should be pursued even more enthusiastically so that additional funds may come from these sources.

Other sources have not been made available to the municipality due to obvious reasons such as the municipality's own financial difficulty and a lack of creditworthiness of both the GOZ and the municipality. Considering the tight financial situations of the GOZ, it is not realistic to expect that the municipality can receive a sufficient amount of funds from the GOZ under PSIP. However there is the Infrastructure Development Bank of Zimbabwe (IDBZ), a governmental bank whose mandate includes provision of funds for infrastructure projects to local authorities[4]. The possibility of using the IDBZ should be pursued.

Another possibility is to seek long term loans from banks with which the municipality already has banking relationship. The municipality currently uses over draft facility from a few private banks for short-term financing. These banks also handle cash transaction of the municipality such as tariff collection and invoice payment. Additional credit line from those banks should be sought.

(5) Private sector participation

Public-private partnership (PPP) refers to arrangements between the public and private sectors by which the private sector provides part of the services that originally fall under the responsibilities of the public sector. In the basic PPP model the public sector contracts with the private sector for service

[4] According to IDBZ Annual Report 2011, USD 6.47 million loan was extended to Bulawayo City Council to finance a rehabilitation project of sewer and water treatment works. USD 2.9 million loan was extended to Marondera Municipality to finance a project of sewerage and water supply.

delivery. After competitive selection among proposals, a private company is selected or created to deliver these services, which often involves building new infrastructure. The company has to build, operate, maintain, and finance the asset and provide the service over a certain period of time in exchange for regular payments from the public sector. At the end of the contract period, operation of the asset is transferred to the public sector. The ownership of the asset may also revert to the public sector, depending on the contract.

It is assumed in the M/P projects that the operations of water supply, sewerage and solid waste management will be operated by the municipality as it is the standard way those services are currently run. However, by the private sector participation into part or all of the operations, the operation efficiency can be improved and the operating costs can be lowered in comparison with the standard municipality operation system. It is also expected that PPP can contribute to cost saving in the capital expenditure. It should be noted however, that the municipality organization needs to be changed according to the PPP model adopted. Staff reduction and transfer are often entailed. Under PPP arrangements such as outsourcing and concession, the private sector can be invited to practically all activities of the WSSW operations, either separately or combined. Those activities include:

- Water distribution O&M
- Borehole O&M
- House connection
- STP O&M
- Sewer and PS O&M
- Refuse collection and disposal
- Dumping site O&M
- Composting and sales
- Material recovery and sales
- Meter reading
- Billing
- Tariff collection
- Accounting
- IT support

(6) Improvement of accounting system and introduction of MIS system

In 2013 the municipality started to use new accounting software package which at the time of this report, has not been fully operational. The accounting ledgers are still manually maintained in parallel with the new system and numerical errors are still found in the financial data. The new system should be put into full utilization as early as possible so that reliable accounting data will be made available on real time.

Currently the municipality prepares management reports which deal with performance of each division on the monthly, quarterly, annual or ad-hoc basis. However the information cannot be used inter-sectionally or integrally. There is no management information system (MIS) that involves all aspects of gathering, storing, tracking, retrieving and using information about technical, financial and organizational performances. Such MIS should be introduced to monitor and manage the operations under the M/P projects efficiently and effectively. The new accounting software has a function of producing financial reports which can be part of an MIS but technical information related to the M/P project operations have to be obtained and integrated into such an MIS.

(7) Careful use of promotion program

The municipality implemented “promotion program” in 2011 and 2013. Under the program, service users in arrears can settle their unpaid bills with a 50% reduction. In other words, debtors are discharged from debts if they pay a half. The aim of this program is to temporarily increase cash inflow when the municipality faces severe cash shortage and the result seems successful in the short run. However, such promotion cannot continue in the long run as it requires huge amount of writing-off of accounts receivable that undermines the municipality’s revenue base. Also this promotion is not fair to those who have been paying charges loyally. Thus the use of promotion has to be limited. When it is used, the timing has to be carefully selected.

CHAPTER 4 CURRENT STATUS OF WATER SUPPLY, SEWAGE AND SOLID WASTE MANAGEMENT

4.1 Water Supply

4.1.1 Water Supply System of Great Harare Water Distribution

(1) Project area

For the purpose of this study, the project area (Harare Province) is subdivided into four administrative districts: (a) Harare Urban, (b) Harare Rural, (c) Chitungwiza and (d) Epworth. It should be noted that contrary to the administrative division of Harare Province, the project area has been sub-divided according to the various modes of supplying water to its consumers which are adopted at present and will continue to be adopted in the future, as shown in Figure 4.1.1:

❒ Areas for which public potable pipe borne water supply has to be provided:
Major part of the City of Harare, (Zone-1 in Figure 4.1.1) including New Development Zones is considered in this category.

❒ Areas located outside the boundaries of the City of Harare which receive bulk water supply from the City of Harare (Zone-2 in Figure 4.1.1):
The following ward, district and township are included in this category:

- Epworth,
- Chitungwiza, and
- Other Townships

❒ Areas which are supplied by the Department of Water Resource and Development through bulk supply originating from City of Harare (COH) (Zone-3 in Figure 4.1.1):
The following areas are included in this category:

Areas located within the boundaries of COH	Areas located outside the boundaries of COH
♦ Chikurubi Complex	♦ Domboshawa
♦ Cranborne Barracks	♦ Ruwa
	♦ Norton

Note: Domboshawa and Inkomo Barracks are included in Harare Rural

The city planning map for City of Harare in 2012 is shown in Figure 4.1.2. The areas and populations of all the parts that form the entire project area according to Year 1992, 2002 and 2012 Censuses are summarized in Table 4.1.1 with the growth rate, while 2012 Census data was preliminary one so far.

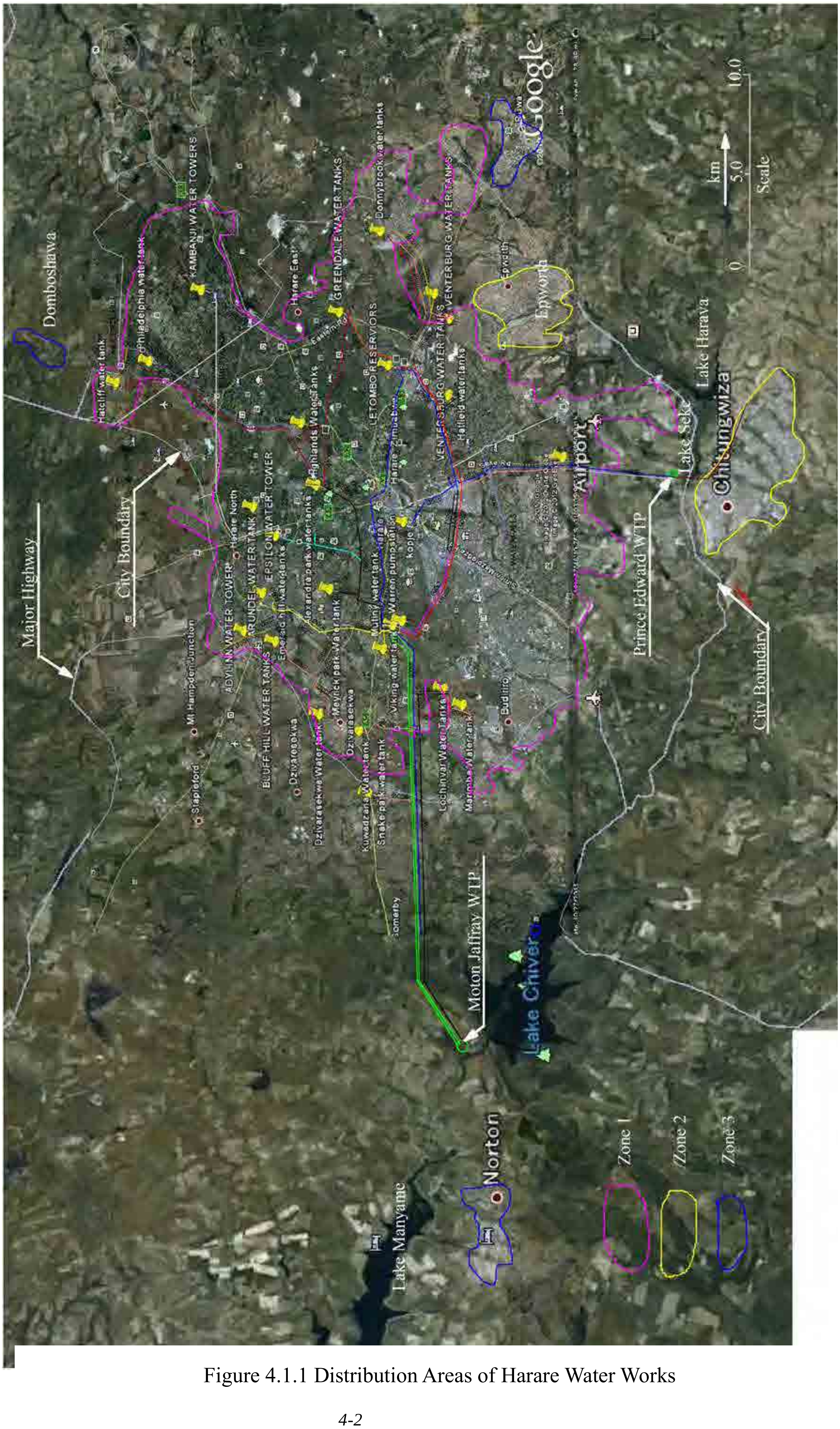


Figure 4.1.1 Distribution Areas of Harare Water Works

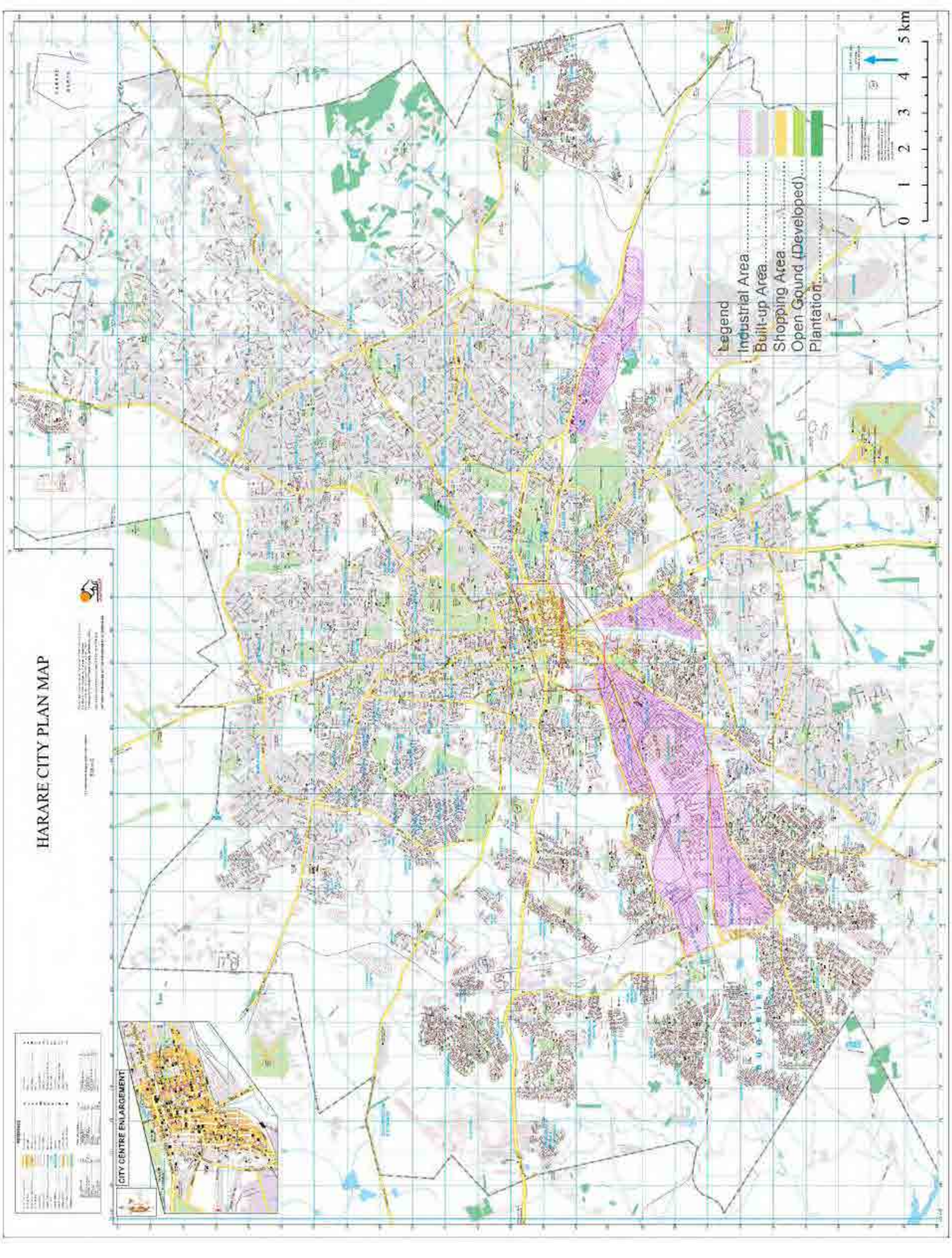


Figure 4.1.2 City Plan Map of City of Harare

Table 4.1.1 Population of Target Area

Division	Name	Area (km^2)	Population			Increase Ratio (%)	
			1992	2002	2012	1992-2002	2002-2012
Harare Province	Urban District	579	1,126,473	1,435,784	1,468,767	2.46	0.23
	Rural Dis.	225	21,600	23,023	113,120	0.64	17.26
	Chitungwiza Dis.	42	274,912	323,260	354,472	1.63	0.93
	Epworth Dis	26	62,630	114,067	161,840	6.18	3.56
	Sub-total	872	1,485,615	1,896,134	2,098,199	2.47	1.02
Surrounding Area	Ruwa	8	1,500	23,681	56,333	31.77	9.05
	Norton	20	24,500	27,332	58,421	1.1	7.89
	Sub-total	28	26,000	51,013	114,754	6.97	8.44
Total		900	**1,511,615**	**1,947,147**	**2,212,953**	**2.56**	**1.29**

(2) Water supply area

The water supply network for Harare Water Works is shown in Figure 4.1.3 and the locations of relevant facilities are shown in Figure 4.1.1. The waterworks system gets its raw water from Lake Chivero, Seke, Harava and Manyame dams. The raw water is treated at the City's two major water treatment plants (WTPs), Morton Jaffray (MJ) (in Norton) and Prince Edward (PE) WTP (along Seke Road). Once the water is satisfied fit for human consumption, it is stored in reservoirs from where it is pumped to different parts of the City and its satellite towns.

Generally, water is pumped from MJ-WTP to Lochinvar Reservoirs and Warren Control pump station (P/S). Lochinvar Reservoir supplies water to the western suburbs such as Mufakose, Kuwadzana, Glen View, Glen Norah, Highfield, Kambuzuma, Budiriro and Norton. From Warren Control pump station (P/S) water is transmitted to Letombo and Alexandra Park Reservoirs where it is distributed to the rest of the City, Chitungwiza, Ruwa and Epworth. Addylin and Dzivaresekwa reservoirs also get water from Warren Control P/S, while Chitungwiza also gets water from Letombo, especially when there are problems at PE-WTP.

- Abstracted raw water from Seke and Harava Dam Lakes is treated at PE-WTP and that from Manyame and Chivero Dam Lakes is treated at MJ-WTPs respectively
- Treated water is distributed to various parts of Harare Metropolitan Province by transmission, storage and distribution systems
- Ensuring that water production procedures are consistently adhered to and that the distribution system is in a good state to receive the high quality water from the WTPs

(3) Water resource

Drinking water supply in the City of Harare depends on surface water and, to a negligible extent, on groundwater sources. The locations of dams for water resource are shown in Figure 4.1.1.

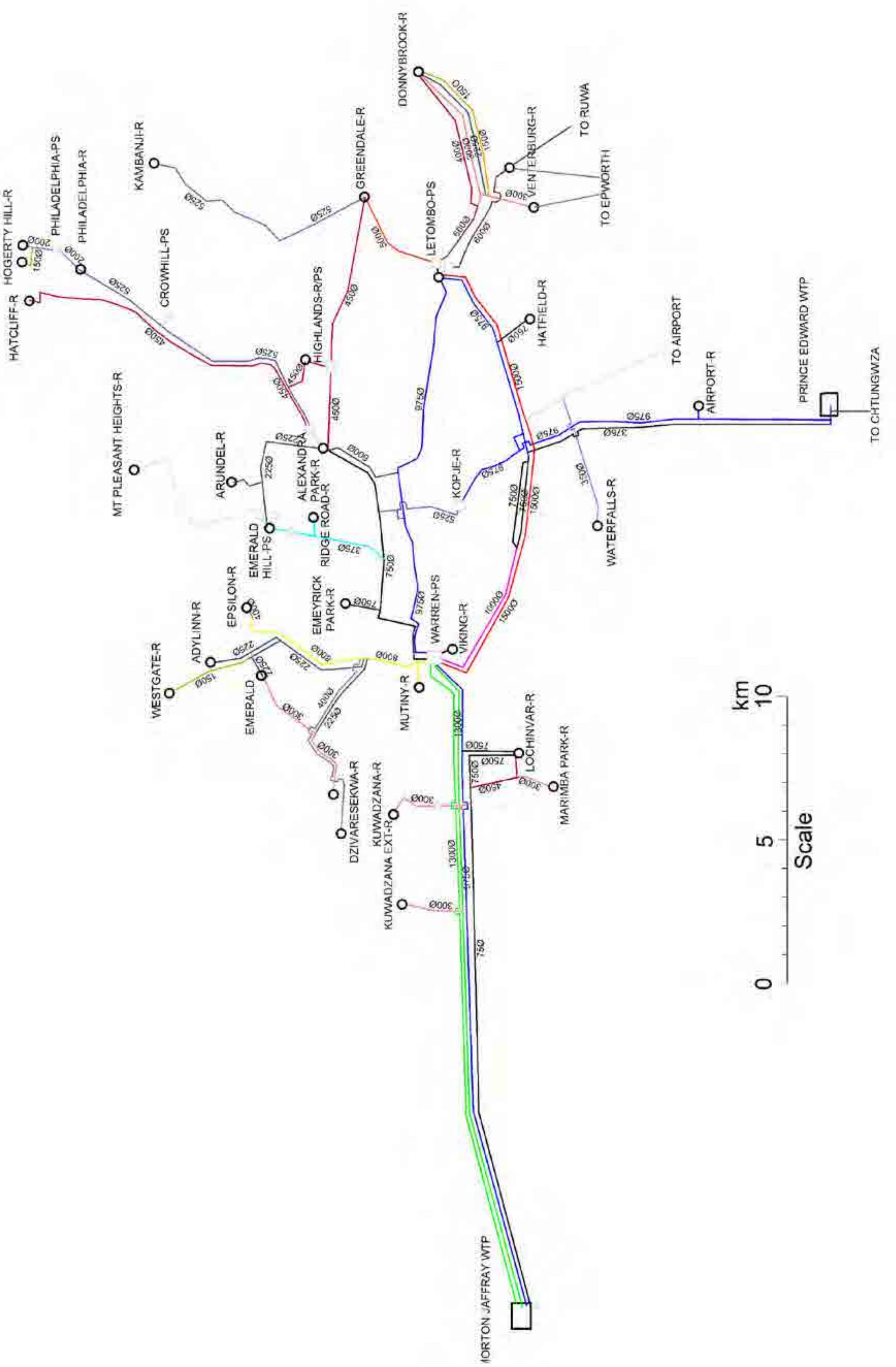


Figure 4.1.3 Water Supply Network of Harare Water Works Source: Harare Water Works

1) Surface water

The Harare Water Supply System currently draws raw water from four man-made impoundments – Lake Chivero, Harava, Seke and Manyame Dams. All these impoundments are located on the Manyame River System. Some of their main characteristics are presented below:

Table 4.1.2 List of Dam for Harare Water Works

Name of Dam	Year Built	Catchment Area (km^2)	Effective Storage Capacity (×1000 m^3)
Harava	1973	777	9,250
Seke	1929	793	3,380
Chivero	1952	2,217	247,181
Manyame	1976	3,792	480,236

Source: Harare Water Supply Study Stage II

According to the Operation and Maintenance Manual for Darwendale (Manyame) Dam prepared by the Ministry of Energy and Water Resources in November 1979, the total 4% yield from Chivero-Manyame catchment is 204.6 mil.m^3/year (560,000 m^3/day), of which 34.0 mil.m^3/year (93,000 m^3/day) is committed to downstream towns and agricultural uses. Therefore, the 4% yield available for Harare water supply is 170.6 mil.m^3/year (467,000 m^3/day).

SAPROF study team of **“Harare Water Supply Project”** (*1993 -1996)* recommended that the design yield available for the purpose of water supply should be 537,050 m^3/day, a value 15% more than the 4% yield, in view of the following factors:

(a) Manyame water supply system can be characterised as a system with a large storage capacity (740 million m^3), which is equivalent to four year's water volume. In case of extraordinary droughts, measures to save water can easily be taken with a sufficient lead time to observe the water volume stored in the dams.
(b) It is important to operate the existing water supply facilities such as water treatment plants, pump stations, transmission mains, distribution networks and so on at their full capacities in normal years to meet increasing water demand of the City of Harare and its adjoining areas.
(c) In case of the Kunzwi project, the 4% yield of the Kunzwi dam is 180,500 m^3/day while the average raw water requirement for the new treatment plant is 209,200 m^3/day, which is 15.9% more than the 4% yield.

Based on the study carried out by the SAPROF Team, the supplementary recycled water from the existing two sewage treatment plants (STPs), Crowborough and Firle, was calculated as a water resource. Indeed, effluent water from these STPs has been discharged into the basin of Lake Chivero even though advanced treatment plants, in which the influent water is treated to water quality levels acceptable as recycling water, have not operated from around year of 2005 to date. These STPs also employ the trickling filter method and treated water from these plants is used for irrigation of pastures of the COH lands. However, most of these trickling filters and pumps that transmit treated water to pastures of the COH lands are not functioning. Thus, almost all waste water flowing in STP is being discharged to the Basin after simple screening and grit removal, and it has caused heavy pollution to water resources, especially Chivero Lake. The design capacity and planned amount of recycling water were calculated by the SAPROF Team as shown in Table 4.1.3.

Table 4.1.3 Planned Recycled Water from STP

Sewage Plant	Plant Capacity (m^3/day)	Recycled Water (m^3/day)	Year of Commissioning
Existing Recycled Water			
Crowborough III	18,000	14,400	-
Firle III	18,000	14,400	-
Firle IV	18,000	14,400	-
Subtotal	54,000	43,200	-
Future Planed Recycled Water			
Firle V	72,000	57,600	1998
Crowborough IV	54,000	43,200	2002
Firle III Expansion	24,000	19,200	2004
Subtotal	150,000	120,000	
Total	**204,000**	**163,200**	

2) Groundwater

According to the "Harare Water Supply Study Stage II", Harare City and its surrounding areas have scarce groundwater development potential, and very limited quantity of groundwater is taken through wells and boreholes for private purposes such as garden irrigation. Groundwater resources cannot be considered as a supplemental water source for the Harare water supply system and therefore this source of water has been discarded from possible water sources for Harare water supply.

However, in the case of Chitungwiza Municipality, it is said that the groundwater potential is better than City of Harare (from Zimbabwe University professor, I. NHAPI), and the current use of ground water from shallow wells and boreholes is considerable. Although the groundwater resource of Harare Metropolitan Area will be limited in the near future, that in Chitungwiza should be pursued.

(4) Water treatment plants

The existing water supply system serving the City of Harare and surrounding areas is comprised of: (i) two water treatment plants, i.e. MJ-WTP and PE-WTP, (ii) 16 clear water PSs, (iii) 25 clear water reservoir sites, (iv) approximately 2,547 km of transmission and distribution network with diameters ranging from ND 50 mm to ND 1500 mm, and (v) about 146,483 consumer connections.

1) Price Edward WTP (PE-WTP)

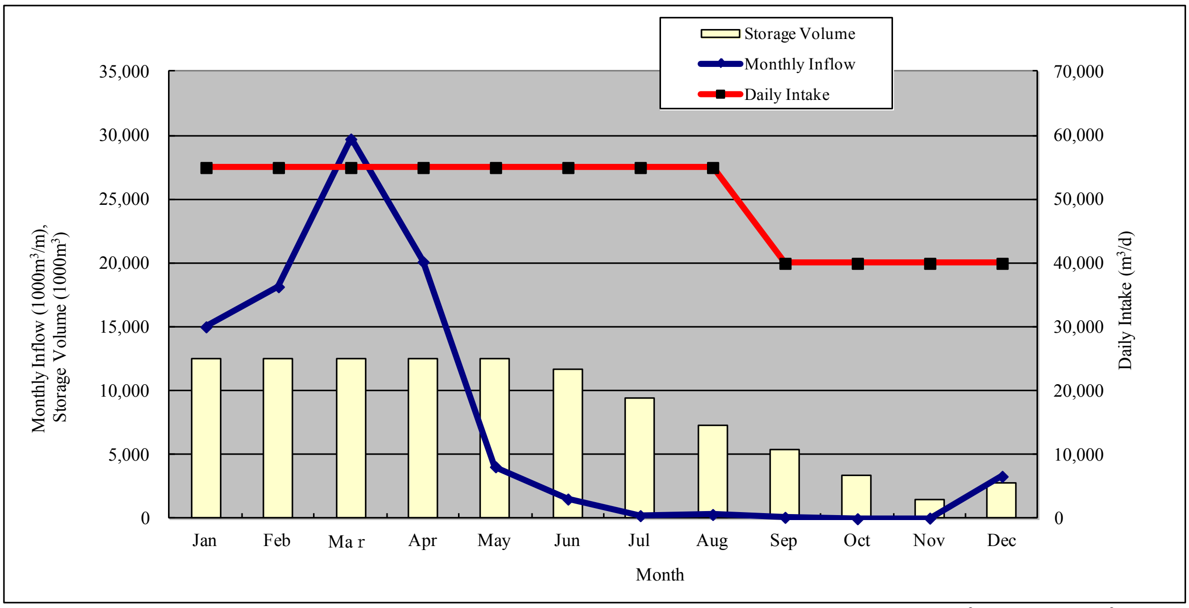
i) Water source and intake

Intake water of PE-WTP is taken from Seke and Harava Dams with the volume of 12.5 million m^3 as the exclusive reservoir of PE-WTP. The amount of treated water at PE-WTP is 55,000 m^3/d in ordinary seasons and 40,000 m^3/d in the dry season respectively, and the intake amount is around 60,000 m^3/d in ordinary seasons and 45,000 m^3/d in the dry season (from September to December). The other water reduction (withdrawal) amount from the lakes consists of evaporation from water surface of the lake and penetration/leakage from the bottom and dam structure.

The water balance between inflow to Seke/Harava Dam and reduction amount from the dams are calculated in Table 4.1.4 and the balance is shown in Figure 4.1.4. Inflow amount is the average flow data at the Seke Dam observation point from 1999 to 2009.

Table 4.1.4 Balance between Inflow and Reduction Amount

Division	Item/month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
WTP	Daily Intake(1000m^3/d)	60	60	60	60	60	60	60	60	45	45	45	45
	Daily Distribution(1000m^3/d)	55	55	55	55	55	55	55	55	40	40	40	40
DAM	Daily Flow(1000m^3/d)	485	649	959	670	131	51	8	11	4	0	2	107
	Monthly Inflow(1000m^3/d)	15,026	18,168	29,730	20,114	4,071	1,542	244	335	111	3	49	3,321
	Daily reduction(1000m^3/d)	80	80	80	80	80	80	80	80	65	65	65	65
	Monthly Balance(1000m^3/M)	12,546	15,928	27,250	17,714	1,591	-858	-2,236	-2,145	-1,839	-2,012	-1,901	1,264
	Storage Volume(1000m^3)	12,500	12,500	12,500	12,500	12,500	11,642	9,406	7,261	5,422	3,410	1,509	2,773



Evaporation = 216 ha (Average surface area of lakes) × 5 mm/d (daily evaporation) = 10,800 m^3/d---10,000 m^3/d
Penetration/leakage = assumed to be 10,000 m^3/d

Figure 4.1.4 Balance between Inflow and Reduction Amount

As shown in Table 4.1.4 and Figure 4.1.4, the dam/lake becomes empty in December even though the inflow amount is the average value of 10 years. The design capacity (production amount) of PE-WTP is 90,000 m^3/d, but actual production amount is 55,000 m^3/d in ordinary seasons and 40,000 m^3/d in dry season due to the insufficient storage volume of the dam. Furthermore, the production amount must be reduced in the case of draught years.

ii) System of the WTP

The specifications of PE-WTP are shown in Table 4.1.5 and the layout and flow sheets are shown in Figure 4.1.5(1) and Figure 4.1.5(2) respectively. Since the WTP was constructed in 1950 and renovated in 1973, the facilities have deteriorated due to long time of lack of proper rehabilitation. Raw water is taken from Seke Dam by two intake pipes, which is are installed at different depths, and pumped up to a mixing tank.

Table 4.1.5 Specifications of PE-WTP

Item		Prince Edward
Capacity (m^3/d)		90,000
Water Source		Seke dam（Connecting with Harava dam）
Process	Sedimentation	Upper flow sludge blanket type
	Filtration	Akazu Filter（Constant water level control by siphon）, Washing by air and water
	Sludge Treatment	After sedimentation, discharge to sludge lagoon
Treatment Facilities	Sedimentation Basin	Rectangular Tank 7
	Rapid Sand Filters	16 Filters
	Clear Water Tank	1 tank (under the filters)
	Sludge Treatment	Two series of sludge tanks, sludge transmission pumps and sludge lagoon
	Transmission facilities	A transmission P/S to southern east area of Harare and Chitungwiza Municipality from the clear water tank
Using Chemical		Powder activated carbon, Aluminum Sulphate, Soda ash, Chlorine (by one ton cylinder), Coagulation aid
Treated Quality		Based on WHO Standard

In the mixing tank, aluminum sulphate is injected as a coagulant, but since raw water pH is usually high due to the eutrophication in the dam, lime is not injected. When the flocculation is improper, sodium silicate is injected as an accelerator for flocculation. In addition, activated carbon powder is thrown in the mixing tank by hand in order to remove colour and smell. Aluminum sulphate is transported by tanker trucks as quite dense liquid and mixed in concrete tanks. The liquid aluminum sulphate is diluted in concrete tanks with a mixer and injected by a chemical injection pump. If sodium silicate is necessary, it is dissolved in a concrete tank with a mixer and injected by a chemical injection pump.

After the mixing, water with a coagulant injection is flowed into 14 sedimentation basins through a flocculation basin, of which the design retention time is around 2 minutes. The time is too short, but the flocculation is mainly progressed at the bottom of the sedimentation basin. The bottom of the sedimentation basin is formed in a reverse pyramid shape with a depth of 9 m. Water with coagulant injection flows near the bottom and water raises upward catalysing flocculation. Then the floc forms a floating floc blanket zone, which filtrate particles floating in water, making treated water so transparent.

Generated sludge in sedimentation tanks is withdrawn from the bottom of the cone by opening manual valves and discharged to sludge discharge tanks. Treated water is collected by several troughs installed at the top of the tanks and flows to rapid sand filters.

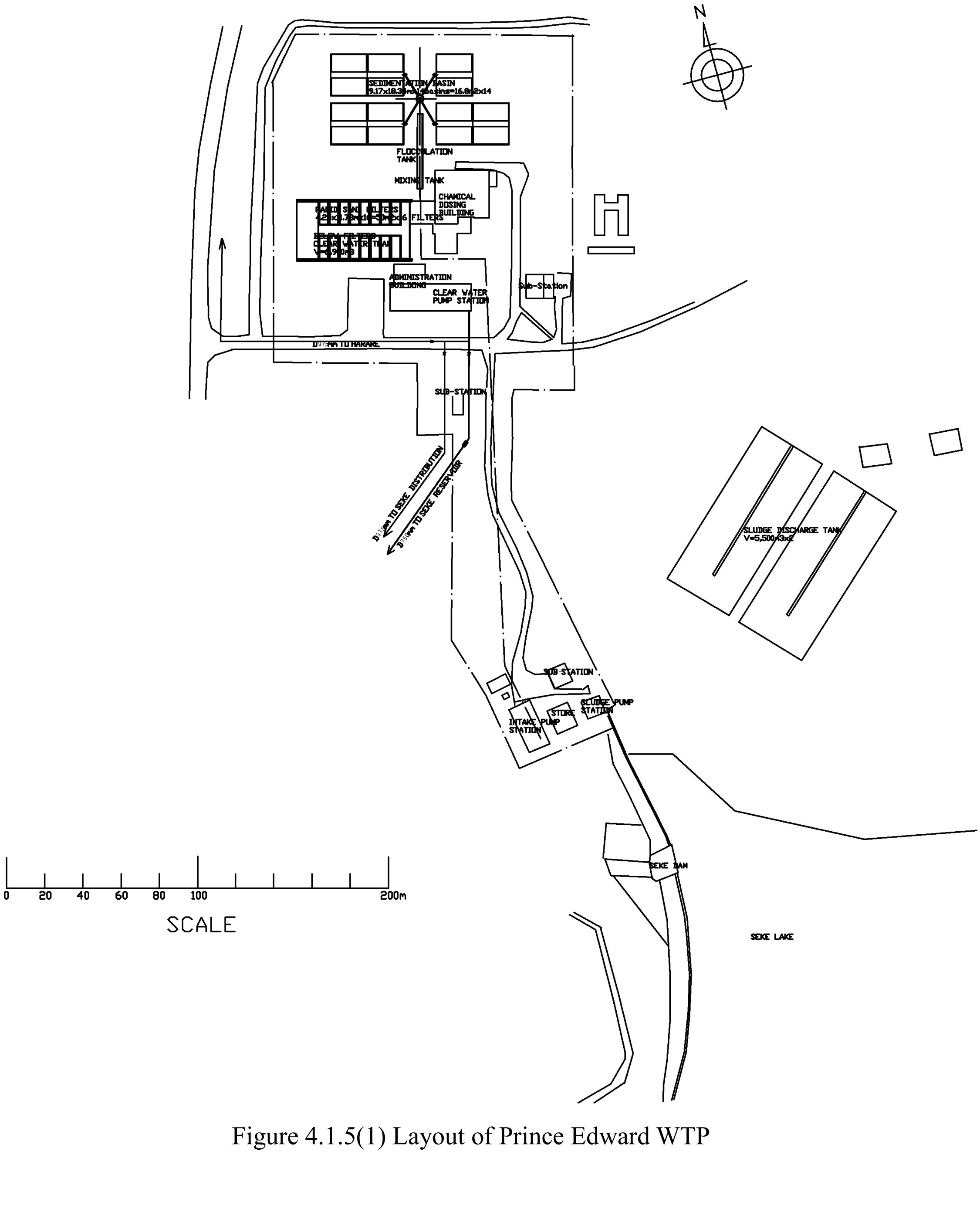


Figure 4.1.5(1) Layout of Prince Edward WTP

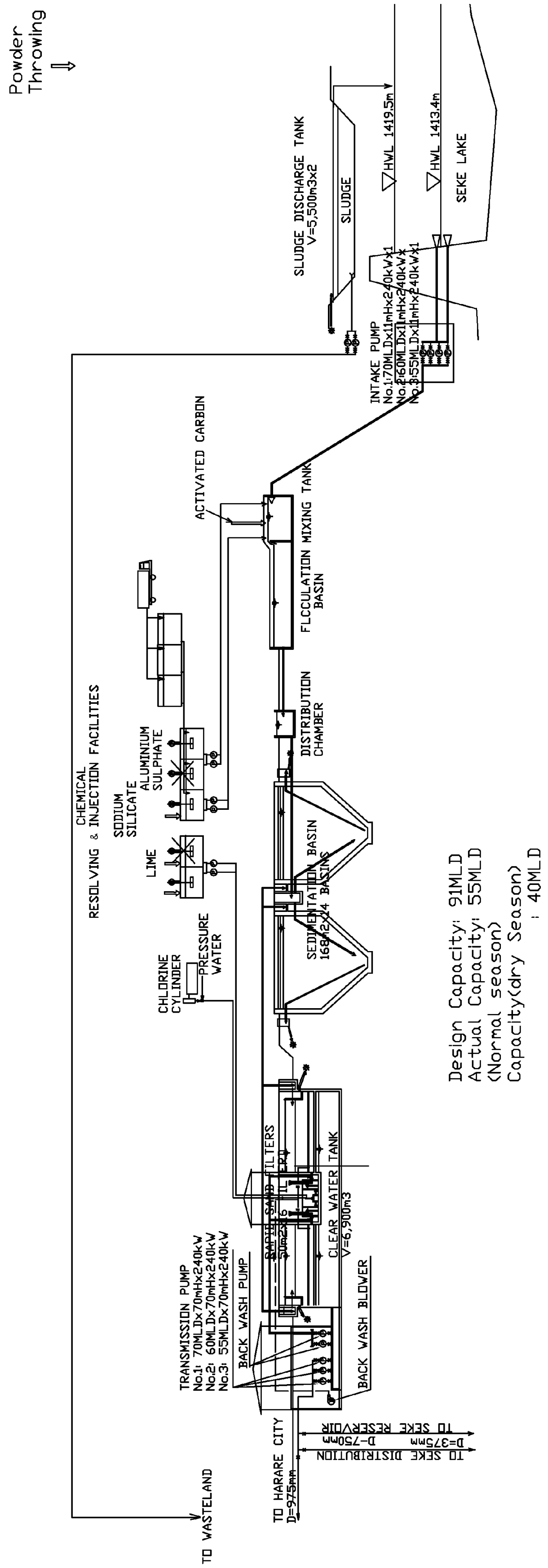


Figure 4.1.5(2) Flow Sheet of Prince Edward WTP

Around 50 m^3 of 16 rapid sand filters are installed on the clear water tank with a capacity of 6,900 m^3. The filter layer consists of a sand layer with a thickness of around 0.7 m, and four layers of supporting gravel. A filtration bed, on which many nozzles for collecting water and flashing backwash water/air are attached, is installed under these layers. The water depth on the sand filter surface is controlled by a siphon, of which the vacuum strength is regulated by a float so that water level in filters is constant. When the resistance of a filter reaches 1.5 m, washing of filter layer by pumped water and pressurized air must be carried out. For the washing, many valves, backwash pumps and blowers need to be operated.

Filtrated water flows in a clear water tank installed under the filters through a chlorine and lime-dosing channel. Chlorine is conveyed by a one ton cylinder. At the cylinder, evaporation equipment with gas flow meter is attached and evaporated chlorine gas is dissolved in chlorine water, which is injected in filtrated water. Powder lime is dissolved in the water by a mixing concrete tank and the dissolved lime is also injected in filtrated water for pH adjustment.

As shown in Figures 4.1.5(1) and 4.1.5(2), treated water from PE-WTP is transmitted to the City of Harare and Chitungwiza Municipality. In the original design, major distribution of water to Chitungwiza Municipality is provided mainly through Seke reservoir by diameter 750 mm of pipe. This pipe diameter is reduced to 600 mm transmission pipes and partly to be directly provided to Seke area by 375 mm pipes. Currently, 600 mm pipes are only used to transmit water to Chitungwiza Municipality and the use of 375 mm pipes have been stopped.

iii) Operation status

Although the design capacity of the WTP is 90,000 m^3/d, the actual daily treatment amount has been around 55,000 m^3/d during the ordinary season and 40,000 m^3/d in four months of late dry season (from September to December) as aforementioned. The major cause of such small water production figures is the small capacity of dam lakes, but facilities of WTP have deteriorated and were malfunctioning.

In 2009, the EU and Red Cross assisted with the refurbishment of essential facilities; intake pumps, chemical dosing facilities, rapid sand filters and a distribution pumps (The total costs was around 4 mil.USD). The refurbishment was not complementary: facilities such as auto-valves, standby mixers, flow meters and old fashioned indicators which have deteriorated and outdated but are able to be operated.

In the operation of treatment processes, the stabilization of the blanket zone of the sedimentation basin is important and it seems stable because of the relatively low flow rate. The surfaces of sand layers of rapid sand filters are uneven due to manual operation of the washing process, and it is a dangerous feature of purification of treated water. Recent average raw and treated water quality as shown in Table

4.1.6 indicates that the raw water quality is relatively contaminated, but it is better than that of MJ-WTP. Chemical consumption and approximate injection rate are shown in Table 4.1.7. In order to mainly remove colour and smell, activated carbon is injected and consumption of aluminum composition as coagulant was very large.

Table 4.1.6 Raw and Treated Water Quality of PE-WTP

Analysis Items/Year Average	2010 Jan - Dec		2011 Jan - Dec		2012 Jan - May	
	Raw	Treated	Raw	Treated	Raw	Treated
pH	7.2	7.0	7.2	6.9	7.3	6.8
Total Solids (mg/l)	38.0	29.0	---	---	---	---
Dissolved solids (mg/l)	18.1	9.0	---	---	---	---
Suspended solids (mg/l)	7.0	1.3	13.2	2.4	24.0	0.7
Turbidity (NTU)	3.1	0.7	0.5	6.9	6.9	0.5
Color (Hazen Units)	50	5	<5	35	35	5
Alkalinity 'P' (mg/l $CaCO_3$)	Nil	Nil	Nil	Nil	Nil	Nil
Alkalinity 'M' (mg/l $CaCO_3$)	58	67	72	69	50	42
Total hardness (mg/l $CaCO_3$)	62	80	83	72	49	53
Permanent Hardness (mg/l $CaCO_3$)	12.0	18.0	13.0	8.0	Nil	16.0
Temporary Hardness (mg/l $CaCO_3$)	54.0	56.0	63.0	58.0	387.0	47.0
Dissolved Oxygen	3.2	1.2	6.7	7.6	4.3	7.2
B.O.D (5day)	1.3	0.3	2.3	0.8	0.9	6.2
4 Hour Value	3.8	1.10	6.0	0.9	6.2	1.0
Free NH_3 (N)	TR	Nil	Nil	Nil	0.4	Nil
Nitrous (N)	Nil	Nil	TR	Nil	TR	Nil
Nitric (P)	Nil	Nil	Nil	Nil	Nil	Nil
Iron (mg/l Fe)	0.01	Nil	0.02	0.01	0.13	Nil
Manganese (mg/l Mn)	0.31	Nil	Nil	Nil	Nil	Nil
Copper (Cu)	Nil	Nil	Nil	Nil	Nil	Nil
Aluminium (mg/l AL)	0.01	Nil	Nil	Nil	Nil	Nil
Calcium (mg/l Ca)	22.0	46.0	36.0	38.0	36.0	38.0
Magnesium($CaCO_3$)	12.0	38.0	44.0	43.0	19.0	16.0
Chlorides (mg/l Cl^-)	58.0	75	37.0	53.0	31.0	31.0
Fluorides (mg/l F^-)	Nil	Nil	Nil	Nil	0.05	Nil
Phosphate (PO_4^{3-})	0.13	0.04	0.18	0.03	0.02	0.04
Silicate	4.80	3.60	4.60	3.20	0.27	0.39
Conductivity (mS/m)	170.0	24.0	175.0	200.0	160.0	180.0
Temperature 0℃	19.3	21.3	23.4	22.8	19.7	20.1
Plate Count	---	52	---	61	---	48
Total Coliforms	104	Nil	98	Nil	102	Nil
E. Coli	+	Nil	+	Nil	+	Nil

Source: Harare Water Works

Table 4.1.7 Chemical Consumption at PE-WTP

Chemical/duration	Consumption (ton)		Injection Rate (mg/l)
	Monthly	Daily	
Activated Carbon	36.0	1.20	21.8
Granular Alum	115.0	3.83	69.6
Liquid Aluminum Sulphate	220.0	7.33	133.3
Chlorine GAS	4.0	0.13	2.4
Powder Lime	20.0	0.67	12.2
Hypochlorite	4.0	0.13	2.4

Injection rate was calculated by 55,000 m^3/d of production amount
Source: Harare Water Works

2) Morton Jaffray WTP (MJ-WTP)

i) System of facilities

The water source of this WTP is Chivero (V=247 mil.m^3) and Lake Manyame (V=480 mil.m^3), some 60% of raw water is taken from Lake Chivero and 40% is from Lake Manyame. The specifications of MJ-WTP are shown in Table 4.1.8 and the layout and flow chart are shown in Figure 4.1.6 and Figure 4.1.7, respectively. This plant is divided into three sections; No.1, No.2 and No.3 plants with design capacities of 160,000, 220,000 and 220,000 m^3/day respectively, giving a total of 600,000 m^3/day.

Table 4.1.8 Specifications of MJ-WTP

Item		Morton Jaffray
Capacity (m^3/d)		No.1：160,000（half of them are operating）, No.2：220,000, No.3：220,000, Total：600,000
Water Source		Lake Chivero:60%
		Lake Manyame:40%
Process	Sedimentation	No.1：Upper flow sludge blanket type
		No.2,3： Ditto +Vacuum Pulsation
	Filtration	Akazu Filter（Constant water level control by siphon）, Washing by air and water
	Sludge Treatment	Direct discharge
Treatment Facilities	Sedimentation Basin	No.1：Rectangular tank 6, Circular tank 2
		No.2,3： Rectangular tank 12 each
	Rapid Sand Filters	No.1：12 +14 Filters
		No.2,3：1 8Filters each
	Clear Water Tank	No.1：2 (Under the filters)
		No.2,3: 1 each pond (Under the filters)
	Sludge Treatment	Filtration type treatment plant was broken and left. Sludge and wastewater are discharged to Lake Manyame directly
	Transmission Facilities	Three transmission P/S to mainly Warren P/S(level difference is around 150m) from clear water tanks
Using Chemical		Powder activated carbon, Aluminum Sulphate, Soda ash, Chlorine (by one ton cylinder), Coagulation aid
Treated Quality		Based on WHO Standard

Source: Harare Water

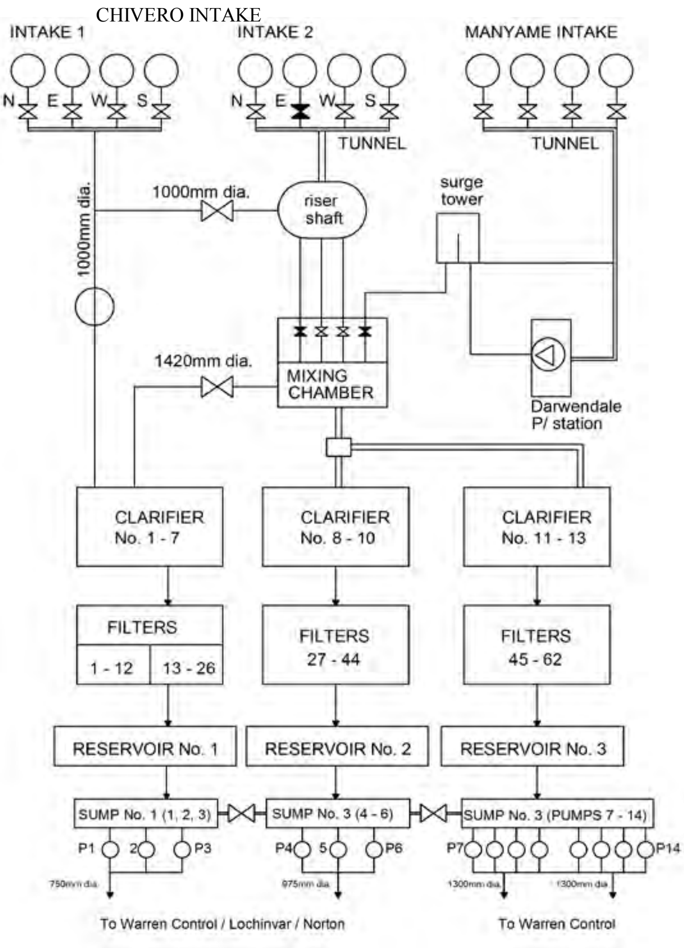
The actual capacity of No.1 Plant is half the design capacity and, therefore, the actual total capacity is calculated to be 520,000(=80,000+220,000×2) m^3/day. However actual treatment water amount was said to be 595,000 m^3/day, according to the explanation of an engineer working at the WTP. The raw water from Lake Chivero flows in by gravity and that from Lake Manyame is pumped up by the P/S, located 40 m below ground level, to a receiving well. The type of sedimentation basins of Plant No. 1 is same with these in PE-WTP and two radiated flow circular basins. These of Plant 2 and 3 are said “pulsator”, of which coagulant (aluminum sulphate) dosed water flows in through the porous pipes installed at the bottom of sedimentation basins.

Figure 4.1.6 Layout of Morton Jaffray WTP

Before sedimentation aluminium sulphate is injected as coagulant, coagulant injected water then flows in flocculation channels and pre-flocculation is carried out. The mechanism of a pulsator is shown in Figure 4.1.8. After the sedimentation process, water flows into rapid sand filters, which is also termed the “Akazu Filter”. The height of the filter is relatively small because the water level is controlled to be static. Since there is no inlet valve for the filters, the water flowing into the filters continues even when filters are washing and it is one cause of wastage of water. Filters need to be washed off the sand layer once a day, and for the washing, the operation of valves and washing pump is required.

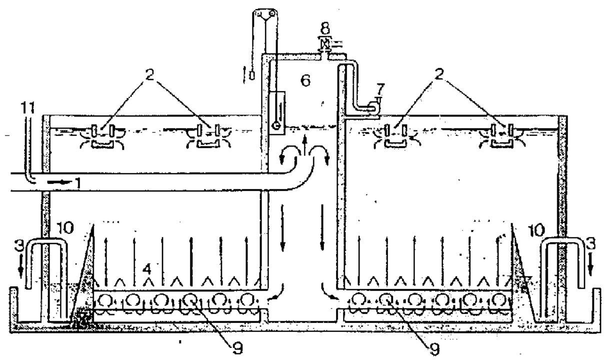
Since the washing operation is a relatively complicated procedure, it is usually carried out by an automatic control system, but the automatic system broke down and the operators need to switch on/off the control of each valve and pump at the control panels installed at each filter observing the condition of the washing process. Miss-operation can be caused easily by such manual operation.

After filtration, chlorine, which is delivered to the WTP by one ton gas cylinders, is dissolved into water by a vacuum made by jet flow and chlorine melted water is injected in filtered water for disinfection. Dissolved lime is also injected in filtered water for pH neutralization, and powder lime is delivered by tanks and stored in silos. After injection of chlorine and lime, water flows into the clear water reservoir located at the basement of the rapid filter.



Source: Harare Water Works

Figure 4.1.7 Flow Chart of WTP



1. Raw water inlet
2. Clarified water Trough
3. Sludge drainage
6. Vacuum chamber
7. Vacuum pump
8. Automatic breaker valve
9. Porous inflow pipes
10. Sludge concentrators
11. Coagulant injection

Figure 4.1.8 Mechanism of a Pulsator

There is a laboratory with analysis equipment such as turbidity meter, chlorine meter, UV meter, table balance, furnace and photo-spectrometer (out of order), and the jar-test is carried out every day to decide chemical injection ratio. The chlorine room seems very dangerous because many gas cylinders are lying around without any safety equipment.

There are two transmission pumping stations with various capacities of pumps installed in these buildings. Because the level difference between this WTP (EL. 1,350 m) and reservoirs and P/S with the City of Harare (EL. 1,420-1,460 m) is large, the lift heads of transmission pumps are also very large. Two pumps are connected in series to attain such high head of 120-150 m.

ii) Operation status

In upper Manyame Basin, almost all pollution loads of Harare Metropolitan Area flow in without any treatment, thus Lake Chivero has always been on the receiving end, resulting to its being heavily polluted. In the case of Lake Manyame, water flows from Chivero Dam and some rivers, such as Gwebi and Muzururu Rivers, which flow in through the countryside. Since the overflow water from Chivero Dam is limited during only rainy season and the quality of river water directly flowing in is not polluted, the quality of Lake Manyame is much better than that of Lake Chivero.

Table 4.1.9 Production amount of MJ-WTP (1000 m^3/d)

Production /Month	2009		2010		2011	
	Monthly	Daily	Monthly	Daily	Monthly	Daily
Jan	13,459	434	18,011	581	18,182	587
Feb	10,968	392	15,526	555	15,513	554
Mar	11,913	384	17,173	554	18,576	599
Apr	11,452	369	15,923	514	17,792	574
May	11,228	362	18,151	586	17,985	580
Jun	14,667	489	15,147	505	17,981	599
Jul	11,891	384	16,822	543	18,804	607
Aug	15,930	514	18,207	587	17,794	574
Sep	17,887	596	17,535	585	17,683	589
Oct	16,944	547	17,816	575	17,559	566
Nov	15,976	533	17,248	575	17,573	586
Dec	16,362	528	17,581	567	18,029	582
Total	168,677	462	205,140	562	213,471	585

Source: Harare Water Works

Gravity inflow water from Lake Chivero and pumped up inflow water from Lake Manyame flow into the receiving well, where violent air bubbling takes place due to supersaturated air which is mixed with raw water. Thick sulphuric acid is injected into the receiving tank for neutralization, because the pH of mixed inflow water averages 7.9, while that from Lake Chivero and Lake

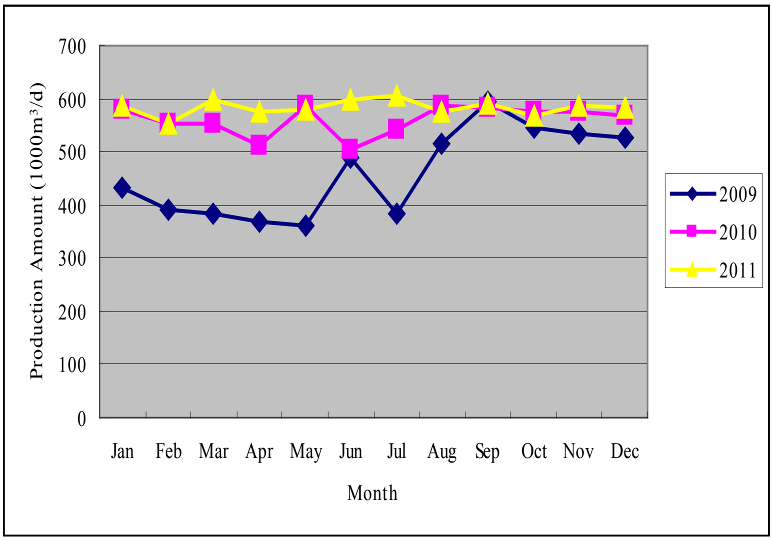


Figure 4.1.9 Fluctuation of Production amount of MJ-WTP

Manyame ranges from 8.5-9.0 and 7.0-8.0, respectively. The production amounts of the past three years, from 2009 – 2011, are shown in Table 4.1.9 and the each year's fluctuation is shown in Figure 4.1.9. As shown in the table and figure, the current production amount has reached 600 thousands m^3/d and the amount has been gradually increasing.

The neutralized water flows into flocculation tanks at No.1, No. 2 and No.3 Plants, and then flows into a sedimentation basin after injection of a coagulant. In the sedimentation tank, sludge blanket zone is formulated, but the zone seems unstable and flock overflows at some places. Two of the circular sedimentation tanks at No.1 Plant were not working and only the rectangular tanks were working. The rapid sand filters at No.1 Plant were also not working due to their deterioration and so the maximum capacity of No.1 Plant is half to the design capacity. Plants No.2 and No.3 are said to be working normally, but almost all measurement facilities have broken down and machines such as pumps, auto-valves and mixers and electrical facilities have already deteriorated. In addition, as mentioned previously, the chlorine injection facilities including one ton cylinders are functioning without any safety facility, which is a very dangerous procedure. In 2009, a survey for the improvement of WTP was carried out by UNICEF, and financing of the water treatment chemical was also partly provided by UNICEF (500 thousands USD/year). Since 2012, the chlorine injection facilities are being refurbished. Chemical consumption of MJ-WTP is shown in Table 4.1.10 showing large injection rate of coagulant and acid.

Table 4.1.10 Chemical Injection Rate at MJ-WTP

Chemical/duration	Consumption (ton)		Injection Rate (mg/l)
	Monthly	Daily	
Activated Carbon	270.0	9.00	15.4
Granular Alum	2,025.0	67.50	115.4
Liquid Aluminum Sulfate	3,900.0	130.00	222.2
Chlorine Gas	45.0	1.50	2.6
Powder Lime	162.0	5.40	9.2
Sodium Silicate	35.0	1.17	2.0
Sulphuric Acid	4.7	0.16	0.3
Base Sulphuric Acid	450.0	15.00	25.6
Hypochlorite	30.0	1.00	1.7

Source; Harare Water Works

Recent average raw and treated water quality is shown Table 4.1.11 and indicates that raw water quality, especially colour and free NH_3, is quite high. These items should be removed as much as possible, if not completely.

Sludge treatment facilities were constructed by an Israeli Company to recover separated water. The aggregates of filter tanks have a diameter of 2-3 m, but it is reported that they have not been working for a long time. Therefore, sludge from the sedimentation basin and washed water is directly discharged into Lake Manyame.

On the condition of operations, a carrying over of flock in the sedimentation basin sometimes takes place, and water washed off the sand filter is not cleaned at the final stage of washing even though the filtered water seems pure.

From the view of safety of water distribution to Harare Metropolitan Area, this WTP must be rehabilitated thoroughly due to its progressive deterioration.

Table 4.1.11 Recent Raw and Treated Water Quality Records of MJ-WTP

Analysis Item/Year Average	2010(Jan-Dec)		2011(Jan-Dec)		2012(Jan-May)	
	Raw	Treated	Raw	Treated	Raw	Treated
pH	7.7	7.0	7.7	6.9	7.7	6.8
Total Solids (mg/l)	44.3	185.0	ND	ND	ND	ND
Dissolved solids (mg/l)	43.1	15.2	ND	ND	ND	ND
Suspended solids (mg/l)	42.0	9.0	30.0	9.8	28.0	0.8
Turbidity (NTU)	6.3	0.9	8.2	1.05	19.7	0.7
Color (Hazen Units)	60	5	70	5	>70	5
Alkalinity 'P' (mg/l $CaCO_3$)	Nil	Nil	Nil	Nil	Nil	Nil
Alkalinity 'M' (mg/l $CaCO_3$)	172.0	124.0	150.0	93.0	155.0	82.0
Total hardness (mg/l $CaCO_3$)	130.0	148.0	170.0	168.0	138.0	120.0
Permanent Hardness (mg/l $CaCO_3$)	19.0	33.0	19.0	68.0	Nil	49.0
Temporary Hardness (mg/l $CaCO_3$)	158.0	115.0	130.0	93.0	140.0	84.0
Dissolved Oxygen	3.8	0.6	2.7	6.5	1.3	3.2
B.O.D (5day)	2.4	0.3	3.4	1.0	0.9	1.2
4 Hour Value	4.6	1.2	4.3	1.3	6.2	1.8
Free NH_3 (N)	3.9	0.7	4.2	0.3	6.1	0.9
TKN/Albuminoid Nitrogen	ND	ND	ND	ND	ND	ND
Nitrous (N)	0.20	Nil	0.80	Nil	0.02	TR
Nitric (P)	Nil	Nil	TR	Nil	TR	Nil
Iron (mg/l Fe)	0.10	Nil	0.01	0.02	0.01	0.18
Manganese (mg/l Mn)	4.40	0.02	0.20	Nil	0.88	1.21
Copper (Cu)	Nil	Nil	Nil	Nil	Nil	Nil
Aluminium (mg/l AL)	0.02	0.03	Nil	Nil	Nil	Nil
Calcium (mg/l Ca)	69.0	78.0	71.0	68.0	72.0	66.0
Magnesium($CaCO_3$)	58.0	68.0	82.0	74.0	76.0	54.0
Chlorides (mg/l Cl^-)	84.0	97.0	67.0	73.0	83.0	53.0
Fluorides (mg/l F^-)	Nil	0.01	0.07	0.03	0.20	0.02
Phosphate (PO_4^{3-})	1.09	0.04	1.22	0.01	0.04	0.12
Silicate	6.30	1.80	6.18	4.36	0.72	0.17
Conductivity (mS/m)	420	600	450	480	500	510
Temperature 0℃	21.2	20.9	23.0	21.7	23.6	22.6
Detergent (Manoxol OT)	ND	ND	ND	ND	ND	ND
Sodium (Na-)	ND	ND	ND	ND	ND	ND
Potassium (K)	ND	ND	ND	ND	ND	ND
Plate Count	ND	160	ND	79	ND	92
Total Coliforms	700	Nil	720	Nil	680	Nil
E. Coli	+	Nil	+	Nil	+	Nil

Source: Harare Water Works

(6) Transmission and main distribution network for Great Harare Area

1) Great Harare pipeline network

The pipeline network of Harare Water Works is shown in Figure 4.1.3. The purified water from Morton Jaffray WTP is pumped through four transmission mains to the Warren Control Pump Station and the Lochinvar Reservoir. Two of these transmission mains of ND 1,300 mm have a total length of 27.2 km each, whereas the lengths of the remaining ND 975 mm and 750 mm transmission mains are 24.9 km and 21.4 km, respectively. Treated water from Prince Edward WTW is supplied to Kopje Reservoir by a ND 525/375 mm transmission main with a total length of 33.0 km, and a ND 975 mm transmission pipeline with a length of 11.9 km, and is pumped directly in the network.

In addition to the above, there are four principal distribution pipes conveying water from Warren Control Pump Station to 22 of the 25 distribution reservoirs within the city. The total length of these four main distribution pipes, of diameters ND 400 mm to ND 1,000 mm, is about 62.20 km. These existing transmission and main distribution pipes were constructed between the years 1938 and 1989 and are, therefore, between 23 and 74 years old. Pipe materials are generally bitumen-lined steel. Only the pipelines constructed before the year 1980 are equipped with a cathodic protection and surge relief structure. It has been reported that the majority of the valves, fittings and other appurtenances installed in the various structures along the transmission mains, e.g. inspection chambers, air release and blow off manholes and so on, are inoperative and need maintenance.

It is therefore considered imperative that the existing transmission and main distribution pipelines be physically examined, and that rehabilitation or replacement be initiated, should the suspected poor condition be confirmed.

The network model simulations carried out within the frame of the "Harare Water Supply Study Stage II" on the existing system indicated that the main distribution system of the city is fairly well dimensioned and has spare capacities. Pipes are located at Dzivarasekwa, Hogerty Hill and Eastern Road (supply to Chikurubi Complex), and the inlet pipe (Highfield Main) into Letombo Reservoir (incomplete sentence). The gravity main from Lochinavar to Marimba Park Reservoir seem to be overloaded.

Presently, and in the future, water supplies are / will be made to areas located outside the boundaries of the City of Harare through bulk supply pipes.

2) Distribution reservoirs

The present water supply system of the City of Harare includes 25 distribution reservoirs, located throughout the system, with volumes ranging from 1,140 m^3 to 70,770 m^3 of Greendale Reservoir. Their total storage capacity is about 783,060 m^3, equivalent to about two-day consumption of the system. However, the capacity has not been utilized effectively, because the actual maximum volume of reserved water of reservoir has been very small, averaging less than 40% due to insufficient water production. Currently, almost all level recorders in the reservoirs have been out of operation and these need replacement to set to correct levels. The elementary system is not functioning due to old equipment.

3) Distribution pump station

In addition to the transmission pump stations (PSs) at Morton Jaffray with capacity of 552,000 m^3/d and Prince Edward WTPs, a total of 16 distribution PSs has been operated in various parts of the system. The capacities of the pump stations range from 325 m^3/day to 496,000 m^3/day of Warren Control P/S. Nine PSs are feeding directly into the distribution system and/or to connected distribution reservoirs. The remaining PSs engage as lift stations to feed elevated tanks to supply high level areas.

The majority of the existing 16 distribution PSs need overhaul/replacement/repair of their electrical/ mechanical equipment, and the provision of control and safety devices on the pumps. Also, spare parts that are essential to maintain functional continuity of the water pump systems are missing.

4) Branch distribution network

There is a total of approximately 2,420 km of distribution pipes with diameters ranging from 50 mm to 600 mm. At present, about 90% of the distribution pipes are asbestos cement pipes. The remaining pipes are steel.

The distribution system of Harare is supplied by pumping and gravity mode. The city can be classified in three area categories in terms of supply mode, i.e. areas supplied from reservoirs by gravity, areas supplied off pumping mains by pumping, and areas using both gravity and pumping mode. At present, about 46% of the water demand is supplied by pumping and 54% by gravity from the reservoirs.

5) Diagnosis of the distribution network

Due to financial and other constraints, there has been little rehabilitation, repair and upgrading of the distribution system in the recent past. As a result, the condition of the network has gradually deteriorated over the years.

In the Harare Water Supply Study Stage II, the unaccounted-for-water ratio in the year 1995 (or the difference between water production and billed water consumption) was estimated to be about 37% (However currently the difference was said to reach over 50%). This composed of several factors, potentially including:

(a) Understatement of water consumption due to under-registering, broken or disconnected consumer meters,

(b) Improper meter reading, including non-reading of "lost" meters, and inability to find or obtain access to meters,

(c) Water leaks in the network. A number of pipe bursts are reported to run at an average of 300 per month, and

(d) Unmetered consumption such as fire fighting, hydrant and main flushing, and illegal connections.

Reasons for the bursts were attributed to the high pressure and damage caused by contractors, roots, incorrect installation (AC Pipes) (e.g. poor bedding and backfilling), or corroded and old pipes (steel).

The following rehabilitation, replacement and upgrading programmes which are aimed at reducing water leaks in the overall system are proposed in the Harare Water Supply Stage II:

- ❒ Replacement/ upgrading of all distribution pipes laid before the year 1940, and
- ❒ Rehabilitation only of the remaining network, including replacement and repair of bulk meters and pressure reducing valves.

It is suggested that this water supply rehabilitation programme should, however, be accompanied by an overall systematic programme to reduce unaccounted-for-water of the system.

6) Consumer connections

The estimated number of existing connections in the year 2012 was 192 thousand for domestic consumers and 8.8 thousands of commercial and industrial consumers (from Urgent infrastructure rehabilitation-India Eximbank). It is probable that a fair proportion of these service connections are in poor condition, and that rehabilitation/replacement of these service connections has to be anticipated.

4.1.2 Water Supply System in Chitungwiza Municipality

(1) Composition of the system

Because Chitungwiza Municipality does not have any water resource and water treatment plant (WTP) and the distribution water is supplied from City of Harare, the water supply system is not independent. The distribution network for the City of Harare is presented in Figure 4.1.10 which shows that water is transmitted to Chitungwiza Municipality from Prince Edward WTP (PE-WTP) or the distribution network of Harare Water Works.

When PE-WTP is operated normally, the produced water is distributed to both the City and Chitungwiza Municipality by the transmission pumps installed in PE-WTP. When the operation of

PE-WTP is stopped, water is distributed from the city network to Chitungwiza Municipality by gravity, of which water comes from Letombo, Hatfield, Kopje and Ventersburg Reservoir.

Accordingly, the distribution water for Chitungwiza Municipality is directly transmitted from PE-WTP but is sometimes transmitted from the distribution water network of Harare City, which water is produced in MJ-WTP, when PE-WTP is stopped.

The layout of water supply system of Chitungwiza Municipality is shown in Figure 4.1.11 and a profile of reservoirs is shown in Figure 4.1.12. As shown, the water layout of water distribution system in Figure 4.1.12, diameter 525 mm and 225 mm of the distribution pipes are branched off from 600 mm main transmission pipe. Many pipes for distribution to consumers are branched off by 525 mm, and 225 mm dia. pipes and distribute to semi-urban and high elevation areas. The 600 mm of transmission pipe coming from PE-WTP is reduced to the diameter of 450 mm, and finally connected to ground reservoirs in Seke Reservoir Site.

As shown Figure 4.1.12, areas marked pink can be served water in daytime and other areas can be served by restricting supply to the areas highlighted pink. In the daytime, water coming from the city of Harare cannot reach valve ⑤, valve ⑥ and the ground reservoir. There are also three areas in Unit A, Unit M and Unit O where water never reaches Unit A, although it sometimes reaches Units M and O under certain conditions. In order to provide water to the whole area, the water supply section of Chitungwiza Municipality operates valves, ①, ③, ⑤, and ⑥ as shown in Figure 4.1.12. The operation schedule is shown in Figure 4.2.13, and in the table, coloured columns show valve stopping schedule from 5 PM to 5 AM.

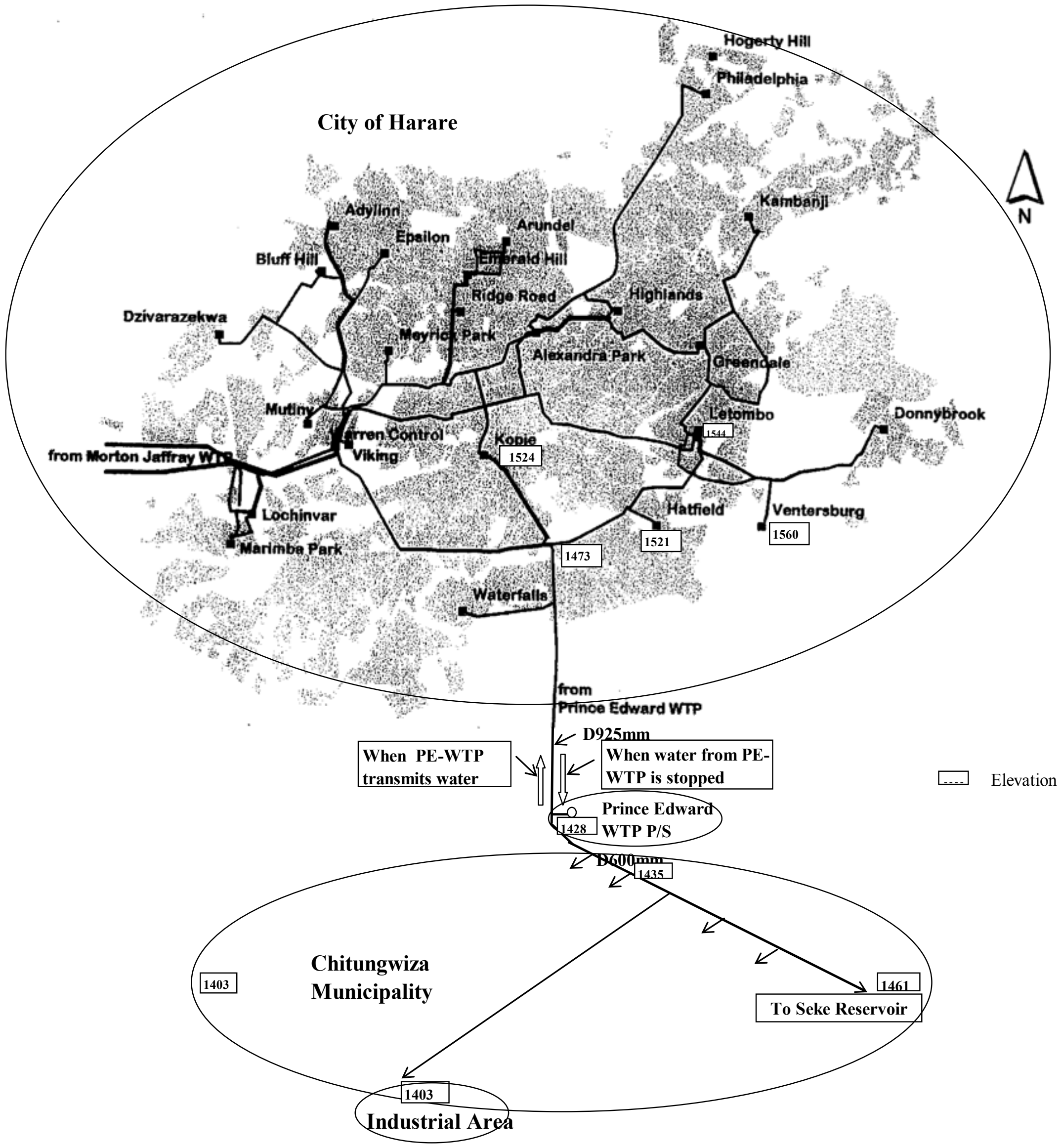


Figure 4.1.10 Distribution Network of City of Harare

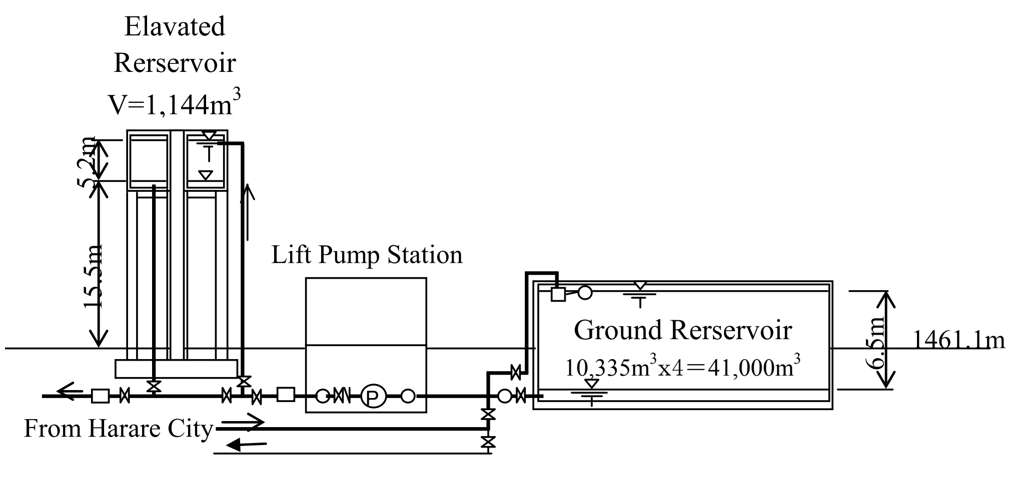


Figure 4.1.11 Profile of Seke Reservoirs

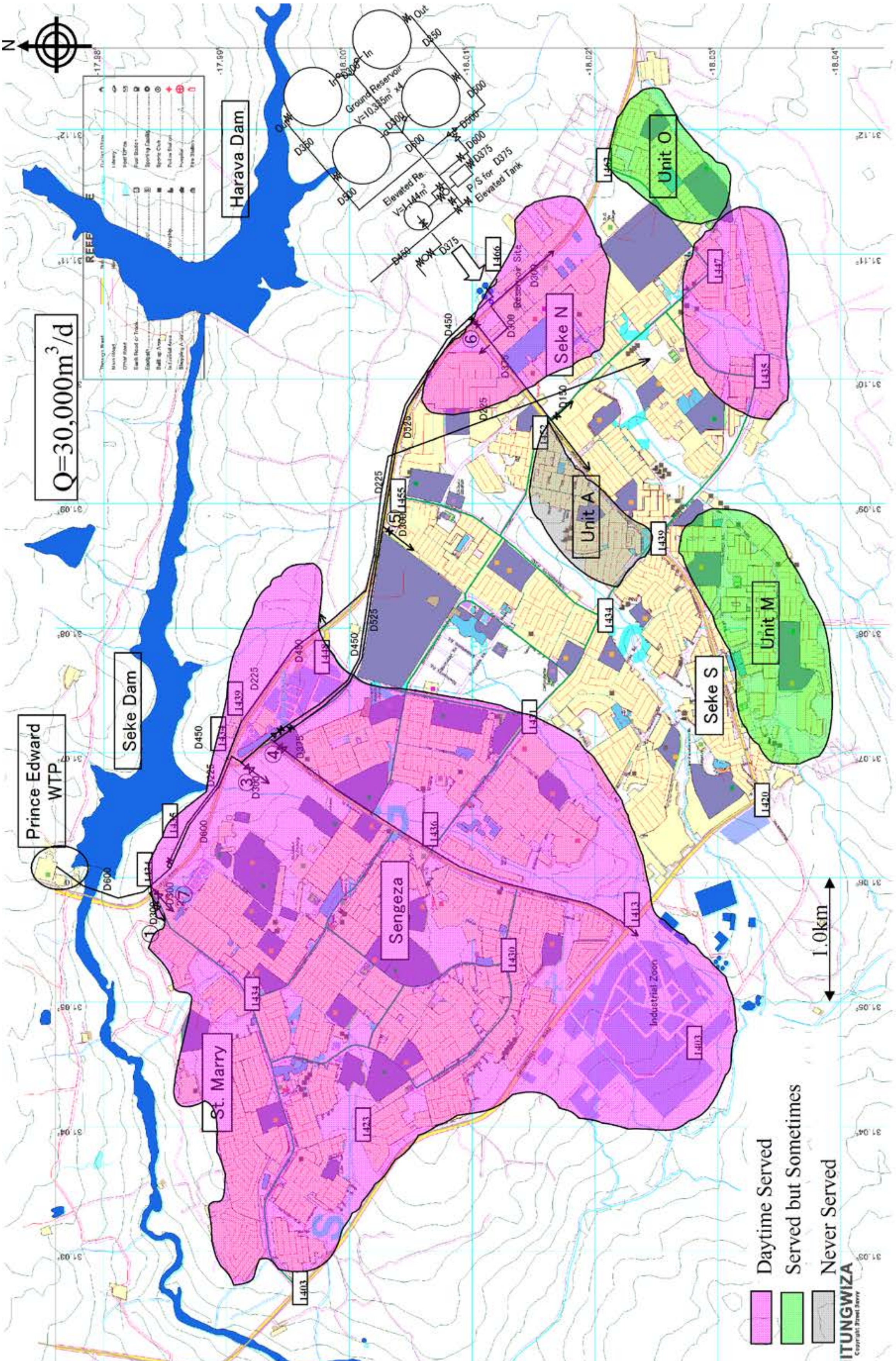


Figure 4.1.12 Water Distribution in Chitungwiza Municipality

Mark	Name	Dia.(mm)	Mon	Tue	Wed	Thu	Fri	Sat	Sun
①	Manayme Park	300							
②	St.Marry Old	300							
③	Zengeza	300							
④	Industrial Zoon	375							
⑤	Unit H	300							
⑥	Mharapara	375							
⑦	Guzha/Mayambara	225							

Valve Close

Figure 4.1.13 Valve Operation Schedule in Chitungwiza Municipality

The concept of the system is different in that ground reservoirs with a total storage volume of over 40,000 m^3 are just used as pump pits for lift pumps with a capacity of only 25 m^3/min. Thus, the Seke Reservoir Site is only used to utilize the elevated reservoir, and the reservoir distributes water only to surrounding areas.

(2) Evaluation of the water supply system

1) System

Figure 4.1.14 shows the model of the current system in the municipality and Figure 4.1.15 shows the network of distribution main pipes. Based on the elevation relationship of the system as shown in Figure 4.1.14, the original design concept is assumed to be: all water distributed from City of Harare is once received in the ground reservoirs in Seke Reservoir Site and most of the water is distributed to the majority of the areas, and some water is lifted to elevated reservoirs by P/S and distributed to surrounding high elevation areas. However, even though transmission pipes with diameters from 600 mm to 450 mm to the reservoirs are installed, there is no distribution pipe derived from the ground reservoirs; making it quite different from the assumed concept.

Thus currently water distribution to residential areas, shown in Figure 4.1.12 and Figure 4.1.15, is carried out through the distribution main with 600 mm and 525 mm diameter pipes. The transmission pipes with diameter 450 mm branched from 600 mm of distribution pipes are connected to reservoirs, however, water cannot reach the reservoirs due to decreased pressure when water is being distributed to the municipality by distribution pipes branched from above mentioned distribution mains. Accordingly, in order to fill in the ground reservoirs, the majority of distribution pipes branched from the distribution main must be shut down, and this operation is carried out Mondays and Fridays from 5 PM to 5 AM as shown in Table 4.2.5.

As mentioned in Appendix 1, water flow rate from PE-WTP was measured by a portable ultra-sonic flow meter. Conditions relevant to distribution flow rate are listed below:

a) The usual distribution flow rate to the municipality is about 30,000 m^3/d, and when all branch valves are opened, the areas marked pink are only served to areas marked pink as shown in Figure 4.1.12.

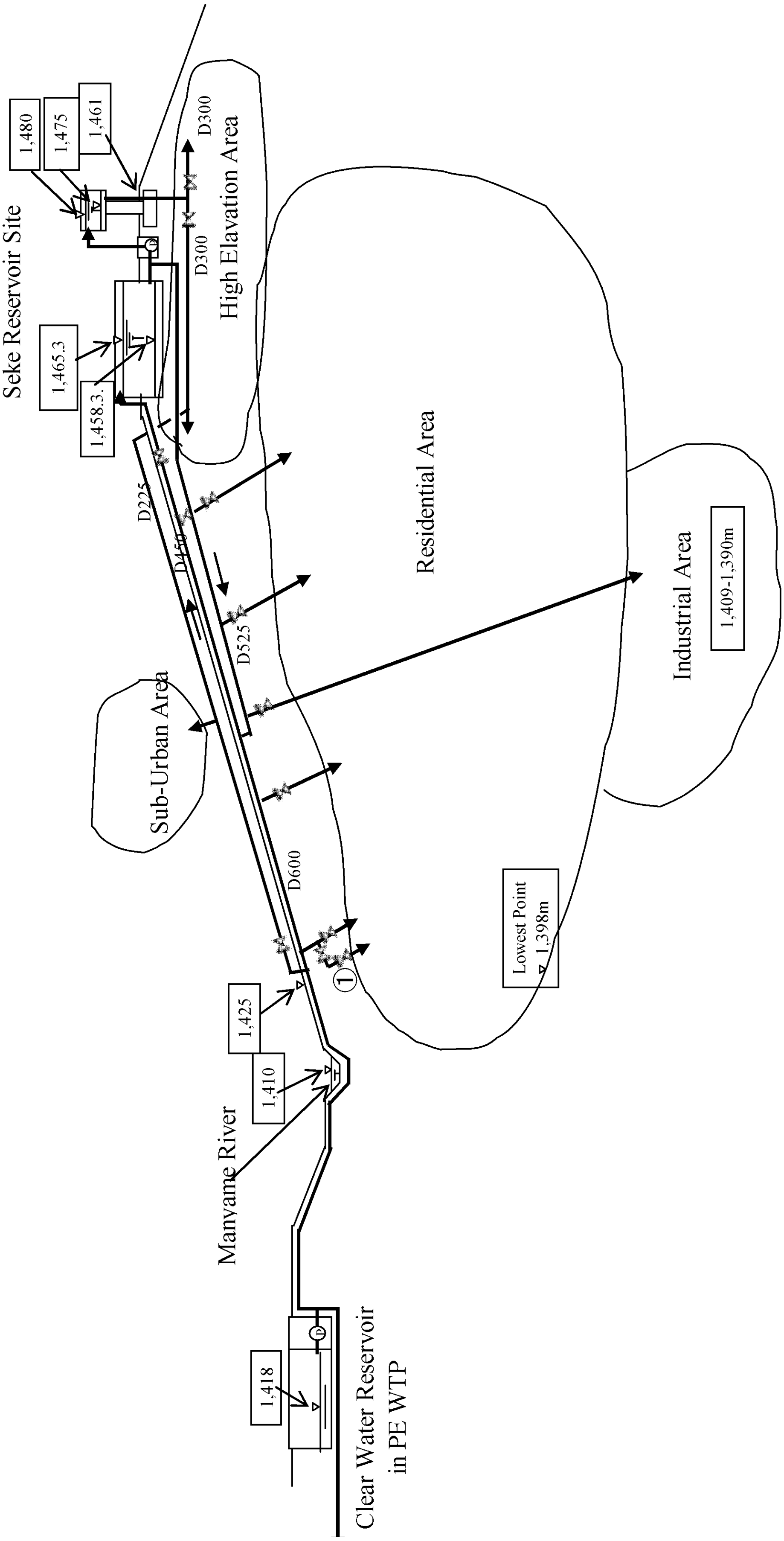


Figure 4.1.14 Current Water Supply System in Chitungwiza

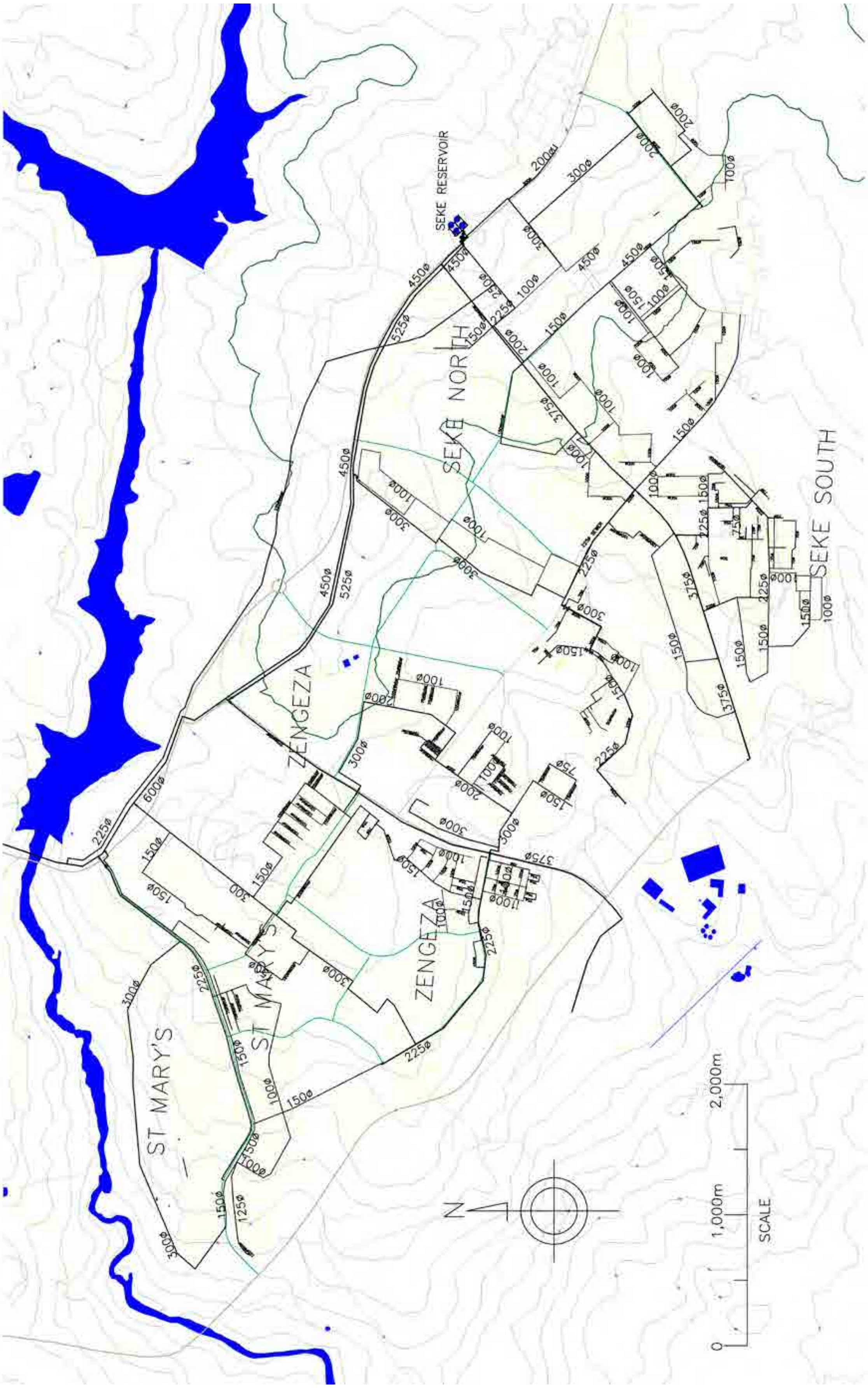


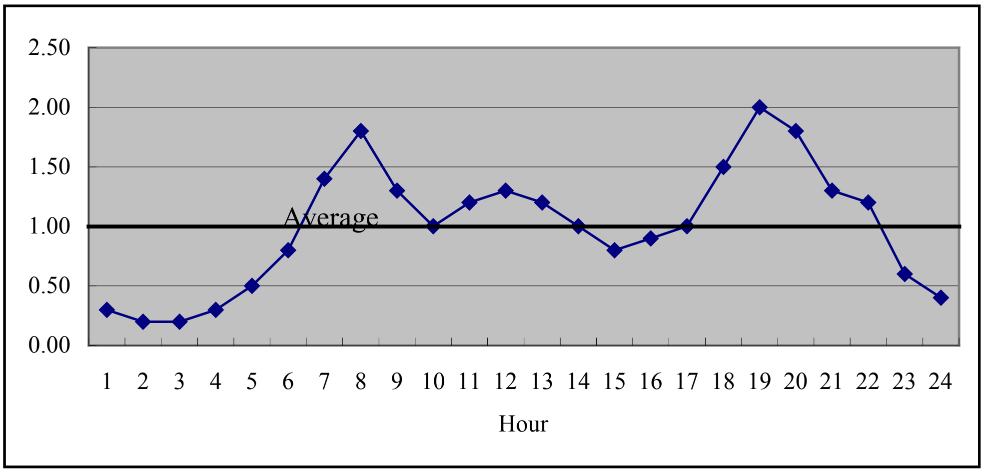
Figure 4.1.15 Distribution Pipe Network in Chitungwiza

When the flow rate is increased to 36,000 m^3/day, water can be served in almost all areas including Unit A, in which water had never been served, except for the high elevation area where water is distributed from the elevated reservoir. However, in order to supply to the ground reservoir, the majority of valves except for ① and ④ were needed to be closed, and the flow rate was decreased to 35,000 m^3/d in this case.

b) When the operations of the Prince Edward WTP was stopped by a power failure or other causes, the flow rate to the municipality was down to 24,500 m^3/d

The above results mean that water can be served to almost all areas in the municipality except for the high elevation areas when water flow is increased to 36,000 m^3/d. To serve the high elevation areas, a valve operation is simply required to supply to the ground reservoirs at midnight. Fortunately, the volume of the reservoirs is very large, and this procedure is considered easy.

However, the biggest problem of this system is: a) the distributing flow rate to the municipality is basically flat because produced water of PE-WTP is directly transmitted by pumps, but the demand of municipality shall be fluctuated as shown in Figure 4.1.16. In order to meet the demand, the reservoir is constructed and the volume is usually stipulated to have 12 hours of retention time. But the reservoirs are not utilized for regulation of distribution flow rate due to lack of essential facilities such as transmission main and so the distribution of the municipality does not meet the water demand fluctuation.



Source: JICA Project Team *This Pattern does not show a specific example

Figure 4.1.16 Example of Domestic Water Demand Pattern

4.1.3 Population of Distribution Area

(1) Current population of Harare Metropolitan Area

The current population of Harare Metropolitan Area is shown in Table 4.1.12 derived from census results. The characteristics of these residential areas are; i) Categorized as low, medium, high and very high density, ii) Average population density is at 6 for low, 19 for medium, 131 for high and 257 for very high density estimated in 1995, respectively, as shown in Table 4.1.13.

However, a report made by Harare Water Works in 2012 (Urgent Infrastructure rehabilitation - India Eximbank) mentioned that the total population of Harare water supply area is 4.5 million and only that for Harare Urban and rural is 2.5 million, which was largely excessive compared to the preliminary census results in 2012. The detailed estimation process of Harare Area is shown Appendix 4.1.

Table 4.1.12 Estimated Results of Harare Metropolitan Area

Division	Name	Area (km^2)	Population		Increase Ratio (%/y)
			2002	2012*	
Harare Province	Urban District	579	1,435,784	1,468,800	0.23
	Rural Dis.	225	23,023	113,100	17.25
	Chitungwiza Dis.	42	323,260	354,500	0.93
	Epworth Dis	26	114,067	161,800	3.56
	Sub-total	872	1,896,134	2,098,200	1.02
Surrounding Area	Ruwa	8	23,681	56,300	9.05
	Norton	20	27,332	58,400	7.89
	Sub-total	28	51,013	114,700	8.44
Total		900	1,947,147	2,212,900	1.29

Source: JICA Project Team, * Values of preliminary census were modified

Table 4.1.13 Population Density by Each Categorized Area in 1995

Item / Category	Area (km^2)	Ratio of Area (%)	Population	Ratio of population (%)	Average density (Pop/ha)
Low	68.7	25.7	44,264	3.65	6.4
Medium	146.1	54.7	273,569	22.58	18.7
High	35.6	13.3	466,200	38.48	131.1
Very High	16.6	6.2	427,489	35.29	256.6
Total (Ave.)	267.0	100.0	1,211,522	100.00	45.4

Source: JICA Project Team, Each categorized area is residential within Harare urban district

(2) Estimation of population of Chitungwiza Municipality

The number of housing units and the population of Chitungwiza Municipality are summarized in Table 4.1.14 and were estimated as shown below:

i) The registered number of housing units (a) was obtained from recorded data of the municipality, and the number of housing units from the number of water meters (c) was also obtained from recorded data for the water charges, and both numbers are similar. The counted number of housing units (b) was actually counted from Google Map, while the counting was considered the more reliable because almost all housing units in Chitungwiza are one story and these can be distinguished clearly.

ii) The population data of over one million people (d) derived from municipality was judged to be unreliable, and justification was considered necessary.

iii) The estimated population (e) based on the number of primary school pupils was around 427 thousand.

iv) The estimated population (f), of which the counted number of housing units on Google Map multiplied by the average dweller number by an actual survey, was around 337,000.

v) The estimated population (g), of which the number of housing units derived from the number of water meters multiplied by the average dweller number by an actual survey, was around 481,000.

Table 4.1.14 Comparison of registered Value and estimated Results

Area/Item	Number of Housing			Population			
	(a) Registered	(b) Counted	(c) From Meter	(d) Registered	(e) From Pupils	(f) Counted	(g) From Meter
St. Mary's	9,839	5,899	8,379	63,642	89,600	66,900	95,100
Zengeza	14,893	11,924	15,031	771,218	135,600	92,400	116,800
Seke South	12,665	11,145	13,296	55,257	80,200	96,900	115,800
Seke North	15,538	8,126	15,357	180,000	122,100	80,800	153,000
Total	52,935	37,094	52,063	1,070,117	427,500	337,000	480,700

After the above survey, the Team obtained a pre-census date, for which the census office of National Statistic Authority has started a pre-survey for population census. It shows that the population and number of families are 326,793 and 79,171, respectively. The population was quite similar to our assumption (f), even though the number of families has a relatively large difference.

The JICA Project Team once decided to use the population of **330,000** based on the survey. However January 2013, the preliminary data of 2012 Census carried out August 2012 was published by internet, by which population was disclosed in public as 354,472. Therefore, the population of **354,500** was determined as the current population of Chitungwiza Municipality. The detailed estimation process is shown in Appendix 4.2.

4.1.4 Water Consumption of Target Area

(1) Current water consumption in Harare Metropolitan Area

1) Actual production amount of WTPs

The water consumption of Harare Metropolitan Area is assumed from the production amount of WTPs, because the distribution water data is not reliable due to the malfunctioning of almost all water flow meters in this area.

Current actual production amount of Morton Jaffray WTP totals 585,000 m^3/d derived from Table 4.1.9. The actual production capacity of Prince Edward WTP is 55,000 m^3/d in normal season and 40,000 m^3/d in dry season. Thus total production amount is 640,000 to 625,000 m^3/d.

In the SAPROF Study, the NRW (Non Revenue Water) was assumed to be 30%, and Harare Water Works assumed to be 57% (Shown in Urgent Infrastructure Rehabilitation-India Exim Bank in April 2012). This 57% is used for the assumption for NRW. Then the distribution amount to the distributed area is calculated below:

$$(640,000 - 625,000) \times (1-0.57) = 275,200 – 268,750 \text{ m}^3/\text{d}$$

2) Water demand

In the SAPROF Study, water consumption in the entire project area in 1995 was estimated as shown in Table 4.1.15 by each category of consumption. Since there is no reliable data*, current demand is estimated from the consumption shown in Table 4.1.16 under the conditions below:

1) Industrial and commercial demand is estimated to be the same with the value in 1996 due to the continuous severe recession,
2) Domestic demand and bulk water demand are estimated to be proportional to the population, except for Chitungwiza
3) The increased ratio of Harare Urban is adopted on the assumption of water demand in Harare Rural, Sublime Township, Chikurubi Complex, Cranbome Barracks, Domboshawa and Inkomo Barracks, and
4) For the water demand of Chitungwiza, measurement results are adopted.

Table 4.1.15 Estimated Water Consumption by SAPROF Team

Division	Purpose	Consumption (m^3/day)
Direct Distribution	Domestic	144,075
	Industrial	89,717
	Commercial	18,516
	Institutional	13,218
	Sub-total	265,526
Bulk water Distribution	Epworth	5,000
	Chitungwiza	30,000
	Sublime Township	54
	Chikurubi Complex	4,750
	Cranbome Barracks	750
	Ruwa	1,363
	Domboshawa	406
	Norton	3,470
	Inkomo Barrachs	2,506
	Sub-total	45,963
Total		311,489

The results, shown in Table 4.1.16, indicate that the estimated current water demand is at 374,000 m^3/d, without NRW amount, calculated from production capacity of WTPs.

* The team acquired the consumption data of Harare for August 2011, but the water consumption was 138,000 m^3/d of domestic purpose, 62,700 m^3/d for others and 33,500 m^3/d for bulk water, which is much smaller than that in 1995, even though the connection was increased. Since these data was not reliable, and the data of SAPROF team was used.

However, since the consumption is an average value, the distribution amount exceeds the daily maximum consumption.

Daily factor of maximum/average is usually 1.15 -1.2 and then maximum consumption is usually 1.15 -1.2 and then maximum consumption is: 374,012 m^3/d ×(1.15-1.2) = 430,000-449,000 m^3/d of demand → 275,200–268,750 m^3/d of actual distribution considering 57% of leakage. Therefore, actual distribution amount is seriously short compared to the demand, meaning that the water supply amount in the areas supplied by Harare Water Works does not meet the present demand.

Table 4.1.16 Estimation of Current Water Consumption

Division	Name	Area (km^2)	Population				Consumption (m^3/d)	
			1992	1995	2002	2012	1995	2012
Harare Province	Urban District	579	1,126,473	1,211,522	1,435,784	1,468,800	152,541	195,620
	Rural Dis.	225	21,600	22,017	23,023	113,100		
	Chitungwiza Dis.	42	274,912	288,603	323,260	354,500	27,664	30,000
	Epworth Dis	26	62,630	74,971	114,067	161,800	5,000	10,791
	Sub-total	872	1,485,615	1,597,114	1,896,134	2,098,200	185,205	236,410
Surrounding Area	Ruwa	8	1,500	3,432	23,681	56,300	1,363	7,601*
	Norton	20	24,500	25,317	27,332	58,400	3,470	8,004
	Sub-total	28	26,000	28,750	51,013	114,700	4,833	30,362
Total		900	1,511,615	1,625,864	1,947,147	2,212,900	190,038	252,561
Consumption (m^3/d)	Industrial						18,516	18,516
	Commercial						89,717	89,717
	Institutional						13,218	13,218
Total							311,489	374,012

*Because the per capita consumption of Ruwa was too large in 1995, the value was modified from 397 to 135lpcd in 2012
Source: JICA Project Team

3) Per capita demand

In the SAPROF Report, per capita demand of each category in 1995 is as shown in Table 4.2.17, while the per capita demand derived from Table 4.1.16 was 124 {152,541×1000/ (1,211,522+22,017)}l/c/d.

Table 4.1.17 Per Capita Consumption in Harare Area

Housing Type	House Connections (l/c/d)	Yard Taps (l/c/d)
Very High Density	80.0	60.0
High Density	90.0	70.0
Medium Density	150.0	70.0
Low Density	380.0	-
Average	110.0	-

Source: JICA Project Team

(2) Current water consumption in Chitungwiza municipality

1) General condition

The average daily water distribution amount in Chitungwiza Municipality is 30,000 m^3/day, which value was taken from the flow measurement by the JICA Project Team in May 2012 as shown in Appendix 5.1; however as mentioned previously, the areas distributed at all times are very limited as presented in Chapter 4.1.2. Therefore, the actual consumption of Chitungwiza municipality cannot be determined by the distribution amount.

In the municipality, handwritten water bill records for various entities distributing water and computed bill records of residential housing are kept at each area's administration office. The average records from January 2012 to June in 2012 for various entities are summarized in Table 4.1.18, and the monthly fluctuations of domestic uses are shown in Table 4.1.19. In Table 4.1.18, the consumption of churches, schools, and institutions in St. Mary's and Zengeza is included in commercial consumption, and the number of each entity is the total of each area. As shown in these tables, the consumption in Zengeza is very large since relatively big industries and a hospital with the highest consumption are located in this area. The largest monthly consumption in January is 1.26 times the average value.

Table 4.1.18 Water Consumption of Various Entities

Category/Area	Consumption(m^3/d)					Number of each entity
	St. Mary	Zengeza	Seke S	Seke N	Total	
Church	---	---	13	7	20	131
School	---	---	97	4	101	77
Institution	---	---	2	1	3	38
Commercial	139	581	109	103	933	1,066
Industrial	---	1,129	---	---	1,129	15
Total	139	1,710	222	115	2,186	1,327
Period	Jan.-Jun.	Jan.-Jun.	Jan.-Jun.	Jan.-May	---	---

Source: JICA Project Team

Table 4.1.19 Fluctuations of Monthly Consumption of Various Entities (m^3/d)

Area/Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Average
St. Mary	167	155	135	124	124	133	139
Zengeza	2,226	1,903	1,285	1,707	1,512	1,720	1,710
Seke S	250	269	207	155	214	247	222
Seke N	111	87	101	97	108	---	115
Total	2,753	2,415	1,728	2,082	1,958	---	2,186
Ratio to Ave.	1.26	1.10	0.79	0.95	0.90	---	1.00

Source: JICA Project Team

Consumption of residential houses in 2012 is shown in Table 4.1.20 but the total consumption of some months exceeds 30,000 m^3/d. Because the distribution amount in this period is less than 30,000 m^3/d where at times the distribution is stopped, the figure must be less than 28,000 m^3/day (= 30,000-2,000), even if there is no water leakage.

Table 4.1.20 Consumption of Residential Housings

Area/Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Average	Number
St. Mary	9,495	13,994	10,844	10,086	6,900	6,991	9,660	8,379
Zengeza	8,981	10,584	8,070	14,049	8,870	10,143	10,086	15,031
Seke S	6,266	6,932	6,231	6,450	6,280	6,566	6,446	12,946
Seke N	1,018	1,017	1,014	1,000	1,017	1,018	1,009	15,357
Total	25,760	32,527	26,159	31,585	23,067	24,718	27,201	51,713

Source: JICA Project Team

A domestic consumption survey in Manyame Park was carried out and the procedures are shown below:

1) To acquire water bill records of 100 housing units in the target area
2) To make an oral survey so as to acquire the composition of dwellers, such as total number, family number, and composition of adults, children and infants from the above housing units.

The results are shown in table 4.1.21.

Table 4.1.21 Water Consumption in Manyame Park

Item	Sample Number	Total Consumption (m^3/d)	Dweller				Family Number
			Total	Adult	Child	Infant	
Total	59	2,049.0	812.0	498.0	225.0	89.0	211.0
Average	-	34.7	13.8	8.4	3.8	1.5	3.6
Per capita consumption (L/cap/d)							84.1

Source: JICA Project Team

In the above survey, it was found out that meter reading was not actually carried out and the bill record was only an assumption based on past records. The majority of monthly bills were 35 m^3/month. However, since this was based on past records, the above results can be referenced. The actual meter readings from the survey are higher than those recorded on the bill, therefore actual water consumption is assumed to be larger. In addition, since the residents of Manyame Park Area are of a relatively low income, the average value is assumed to be lower than that of the whole municipality area.

Accordingly, per capita consumption in normal condition is assumed to be at 100 Lpcd, and total consumption in the municipality is presented in Table 4.1.22. In the calculation, the rate of each area per capita demand is assumed to be proportional to the water consumption record shown in Table 4.1.20, because the record presents each area's water served condition. The resident consumption calculation was modified by setting it up to be proportional to 100 Lpcd of St. Mary's consumption. As shown in the table, the average modified consumption is around 56 Lpcd, and the assumed actual resident consumption is around 19,800 m^3/d.

Table 4.1.22 Assumption of Actual Consumption of Municipality

Area/Month	Resident Con. ($1000m^3$/m)	Population	Con.(Lcpd)	Modified Con.(Lcpd)	Assumed Actual Con.($1000m^3$/d)
St. Mary	9,660	70,400	137.2	100	7,040
Zengeza	10,086	97,200	103.8	75.6	7,350
Seke S	6,446	101,900	63.3	46.1	4,697
Seke N	1,009	85,000	11.9	8.6	735
Total	27,201	354,500			**19,823**
Average			76.7	55.9	

Source: JICA Project Team

As a result of the above assumption, the water balance in the municipality is formulated below:

Distribution: 30,000 m^3/day

Water consumption of various entities: 2,200 m^3/d

Water consumption of residents: 19,800 m^3/d

Amount of unknown water including leakage:

30,000 - 2,200 - 19,800 = 8,000 m^3/d

The ratio of unknown water: 8,000/30,000×100= 26.7%

3) The results of survey for wells

Deep wells (boreholes) are managed by the municipality and the list is shown in Table 4.1.23 with their locations in Figure 4.1.17. The gray-marked columns show wells with electrical submerged pumps. The yield capacity of deep wells are said to be over 200 m^3/day, and the actual withdrawal capacity is limited to (50 L/min × 1,440 min/day = 72 m^3/d). The total yield amount of deep wells is assumed below:

(30 L/min × 49+ 50 L/min×4+100 L/min) × 8 hr × 60 min = 850 m^3/d

For resident purposes the yield amount except for Number 47-51 of hospital is 718 m^3/d. Shallow wells were also surveyed to obtain their number and locations as shown in Figure 4.1.17 and Table 4.1.24. As shown in the figure, the distribution is not even, and the density is high in the areas where water service is poor.

Table 4.1.23 List of Deep Wells in the Municipality

No.	Water Level (GL-m)	Pump Capacity		Donor	No.	Water Level (GL-m)	Pump Capacity		Donor
		L/stroke	L/min				L/stroke	L/min	
1	3.6	0.8	24.9	C.D Funding	27	6.4	1.1	33.3	UNICEF
2	3.0	1.2	35.1	C.D Funding	28	32.0	0.7	19.8	C.D Funding
3		1.1	33.3	UNICEF	29	32.0	-	-	C.D Funding
4	5.2	1.2	35.1		30	-	-	-	C.D Funding
5	3.8	1.1	31.5		31	10.2	1.1	33.3	UNICEF
6	3.0	1.7	49.8	UNICEF	32	10.8	1.0	30.0	UNICEF
7	3.0	0.7	22.2	C.D Funding	33	5.1	1.2	35.1	C.D Funding
8	4.2	0.9	27.0	C.D Funding	34	4.8	0.8	24.9	UNICEF
9	12.3	1.0	30.0	C.D Funding	35	-	-	-	C.D Funding
10	10.7	0.8	22.8	UNICEF	36	5.6	0.9	27.0	C.D Funding
11	4.1	1.3	39.9	UNICEF	37	30.0	0.9	25.8	UNICEF
12	3.2	1.2	35.1	UNICEF	38	6.9	1.1	31.5	UNICEF
13	7.3	1.0	28.5	UNICEF	39	-	-	-	C.D Funding
14		0.2	4.8	C.D Funding	40	1.1	-	-	C.D Funding
15		1.2	35.1	C.D Funding	41	-	-	-	C.D Funding
16		0.1	3.0	UNICEF	42	-	-	-	C.D Funding
17	10.8	0.8	24.0	C.D Funding	43	-	-	-	C.D Funding
18	8.7	0.8	24.0	UNICEF	44	3.8	-	-	
19	9.6	1.0	30.0	UNICEF	45	-	-	-	C.D Funding
20	5.2	0.9	27.0	C.D Funding	46	27.3	1.1	33.0	UNICEF
21	10.0	1.2	35.1	UNICEF	47	15.0	-	50.0	USAID
22	2.5	1.5	45.9	UNICEF	48	20.0	-	50.0	USAID
23	4.0	1.4	42.6	UNICEF	49	25.0	-	50.0	USAID
24	6.0	0.6	19.2	C.D Funding	50	20.0	-	50.0	USAID
25	40.0	0.8	22.8	UNICEF	51	20.0	-	25.0x3	UNICEF
26	7.5	1.1	33.3	UNICEF	52	25.0	-	100.0	EU

Source: JICA Project Team

These wells' actual yield amount was surveyed through hearings and inspection at three places as shown in Figure 4.1.17, and the results are shown in Table 4.1.24. According to the results, the wells' daily yield amounted to approximately 750 L/d (30 times withdrawals of a 25 litter bucket) in the case of water being un-served in a day. Then if the yield amount of one well is assumed to be 0.6 m^3/day, the total yield amount of shallow wells is 2,250 (0.75×3,000 = 2,250) m^3/day. The yield amount of shallow wells is applied to people/wells in the table, and as a result of that, per capita amount is around 10 Lpcd in Seke North and Seke South, where the majority of wells are located. The yield capacities and quality for some wells in the municipality are shown Appendix 5.3.

It means that the total water service in Seke North and Seke South is apparently very poor. Accordingly the actual residential consumption is assumed to be 19,800+710+2,250 = 22,760 m^3/d.

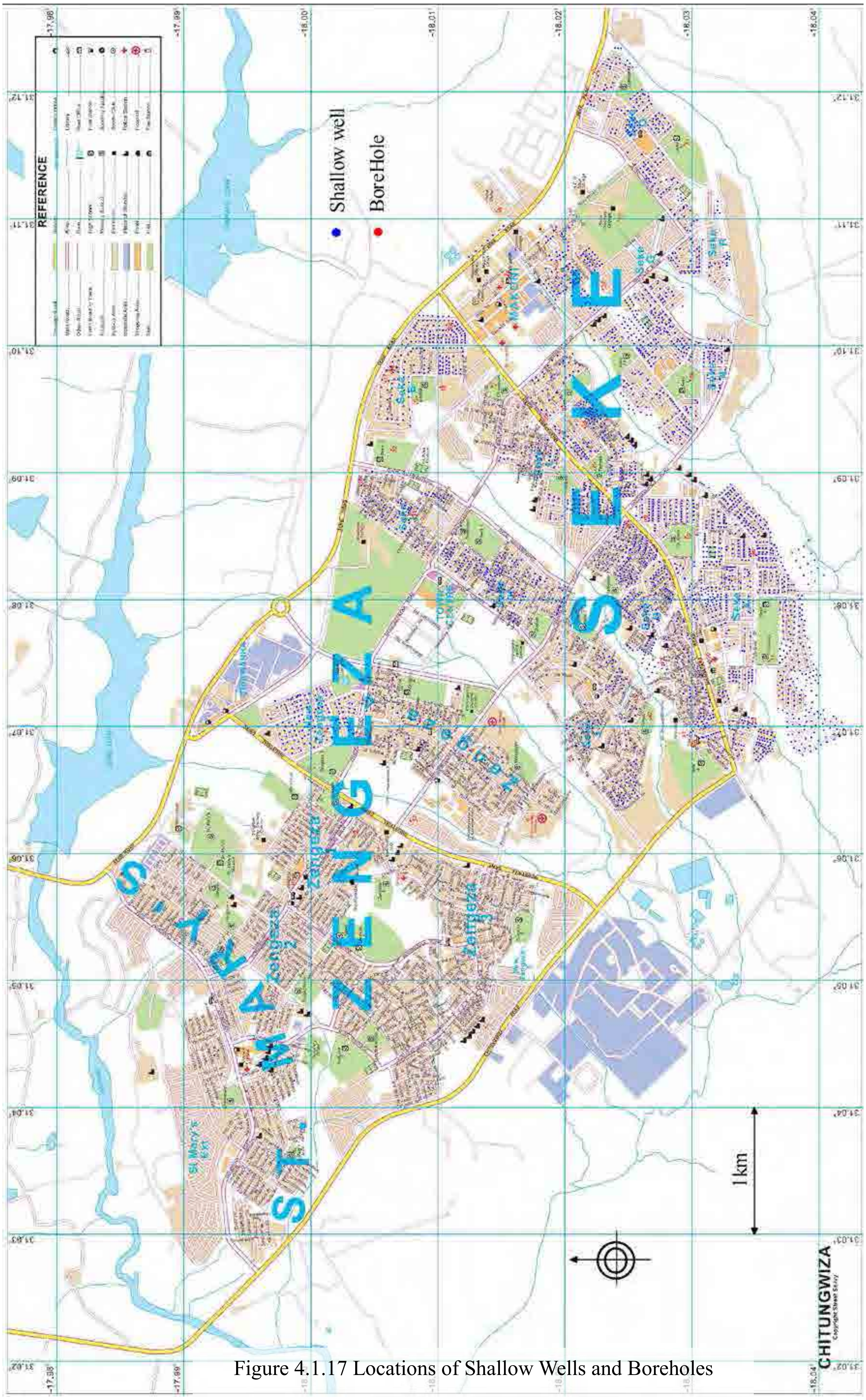


Figure 4.1.17 Locations of Shallow Wells and Boreholes

Table 4.1.24 Number of Shallow Well and the Analysis

Area-Ward/Items		Number of Housings	Population	Number of Shallow Wells	House/ wells	People/ wells	Per capita con.(Lpcd)
St. Mary	Old St. Mary			7			
	Manyame P			2			
	Sub-total	5,899	70,400	9	655.4	7,278	0.1
Zengeza1,2,3, 5	Zengeza1			1			
	Zengeza2			8			
	Zengeza3			20			
	Zengeza5			17			
	Sub-total	9,221	76,900	46	200.5	1,557	0.4
Zengeza 4		2,703	20,400	154	17.6	123	4.9
Zengeza All		11,924	97,200	200	59.6	453	1.3
Seke South	UnitD			175			
	UnitE			25			
	UnitJ			61			
	UnitK			421			
	UnitM			327			
	UnitL			457			
	Zanoreba						
	Sub-total	11,145	101,900	1,466	7.6	65	9.3
Seke North	Unit A			188			
	Unit B			120			
	Unit C			150			
	Unit F			120			
	Unit G			106			
	Unit H			68			
	Unit N			300			
	Unit O			190			
	Unit P			90			
	Riverside			---			
	Sub-total	8,126	85,000	1,332	6.1	59	10.1
Total		37,094	354,500	3,007	12.3	110	5.5

Source: JICA Project Team

Table 4.1.25 Survey for Actual Well Yield Amount

Unit	Number	Diameter (m)	Water Level (m)	Consumption of Each Well (L/d)	
				Water Serving	Water Un-serving
Zengeza 4	6	0.6-1.1	2.5-8	0-250	500
Unit A	8	0.5-1.2	3-8	0-60	600
Unit H	8	0.7-1.4	7-11	0-200	500

Source: JICA Project Team

If well water is filly used, per capita consumption is shown below;

Per capita consumption is; 22,760 /354,500 = 64.2 Lpcd

4.2 Sanitation/Sewerage

4.2.1 Service Coverage and Sewerage System

(1) Service coverage

Within the Chitungwiza municipal area of 1,519.5 ha, three townships (St. Mary's, Zengeza and Seke) and the Tilcor industrial area are almost fully served by the public sewerage system. There are, however, three schools in the area which use septic tanks. One school has a seepage type septic tank. This type of septic tank is installed on a hole dug in the ground. When it becomes full, the hole is not emptied but simply filled up. The tank cover is transferred from the old hole to a new hole. The work of filling-up the old hole, digging a new hole and setting the tank cover is done by school janitors, therefore no out-of-pocket cost is incurred. Two other schools ask a private contractor or the Harare City Council to empty the septic tank when it becomes full at intervals of 5 to 8 years. The emptying cost is about USD 800 by the council and USD 1,300 by the private contractor. The Chitungwiza Municipality does not offer the service. Collected sullage is disposed at the sewage treatment plant.

Source: JICA Project Team

Figure 4.2.1Chitungwiza Municipality and Sewerage System

However, there are areas which are not connected to Zengeza STP due to blockage or malfunction of the sewerage system. In St. Mary's,, population of some 54,000 are not connected due to breakdown of three pump stations in the area. Also, around 21,300 in Seke north are not connected because of blockages in the trunk sewers; while about 35,900 in Seke-south are not connected due to the breakdown of a pipe bridge discharging the sewage into a channel. Finally, about 7,100 in a part of the Zengeza near the industrial area are not connected, again due to sewer breakdown.

From the result of the investigation, about 410 ha and about 120,000 of the areas' population are not connected to the ZSTP as shown in Table 4.2.1. , population of 211,744 is considered to be connected.

Table 4.2.1 Connected area and no-connection area to the STP

Connected Condition	Name of the Area	Population	Area (ha)
No-connection Area to STP	St. Mary	54,000	216.5
	Seke North	21,294	78.9
	Seke South	35,887	101.9
	Zengeza	7,074	12.5
Connected Area	Seke, Zengeza	236,245	1,109.7
		354,500	1,519.5

Source: JICA Project Team

Since the ZSTP is not working, full flow of sewage has been flowing out to both of Nyatsime River and Manyame River. After the completion of the AWF project for sewers and three pump stations, most of the sewage from the municipality will flow into the ZSTP. In this connection, earlier rehabilitation of ZSTP with the commencement of treatment is required. Rehabilitation of ZSTP will be conducted for pre-treatment (screening and grit chamber), three anaerobic ponds, five units of trickling filters and pump stations for irrigation under the AWF project.

(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 employed is the separate system and makes full use of gravity, except for some areas in St. Mary's and the Tilcor industrial area. Clogging of the sewers has been a serious problem in the system. The removal of deposited sand and silt in the sewers is done by using a jet-cleaning vehicle, however, this has not been done since the equipment broke down in 2001. Sand in the sewers and screenings accumulated at the pump stations has to be manually removed.

The major trunk sewers are branched to three lines and an independent alignment to the Zengeza STP without joining any other lines on its route as follows:

- Alignment 1 of domestic, institutional and commercial sewage generated in St. Mary's and Zengeza. As stated (1), St. Mary area is not connected to the ZSTP due to malfunction of the pump stations.
- Alignment 2 of domestic and institutional sewage from Seke. There are some blockages along the Alignment 2 causing partial direct discharge of the raw sewage to the river.

- Alignment 3 of industrial wastewater from the Tilcor industrial area. Tilcor pump station has broken down and pipe bridge from the industrial area is also damaged.

There are four pump stations in St. Mary's (No. 1, 2 and No. 3) and in the Tilcor industrial area due to topographical configuration.

Figure 4.2.2 shows the existing sewerage system. Table 4.2.2 shows the list of major trunk sewers and Table 4.2.3 indicates the list of pump stations.

Table 4.2.2 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

Source: JICA Project Team

Table 4.2.3 List of Pump Stations

Collection Area	Inflow (m^3/min)	Pump Type	Ancillary Equipment	Motor
Pump Station 1	10.60	150A, Centrifugal	Screen	30 kw ×3
Pump Station 2	1.92	80A, Submersible	Screen	5.5 kw ×2
Pump Station 3	1.92	Centrifugal	Screen	30 kw ×3
Tilcor Pump Station	2.95	150A, Centrifugal	Screen	22 kw ×3

Source: JICA Project Team

Figures 4.2.3 to 4.2.5 show the enlarged image of the St. Mary, Zengeza and Seke areas with the town blocks. Figure 4.2.6 shows a profile of the trunk sewers from manhole no. 1 to manhole no. 8. For all the alignments refer to the APPENDIX.

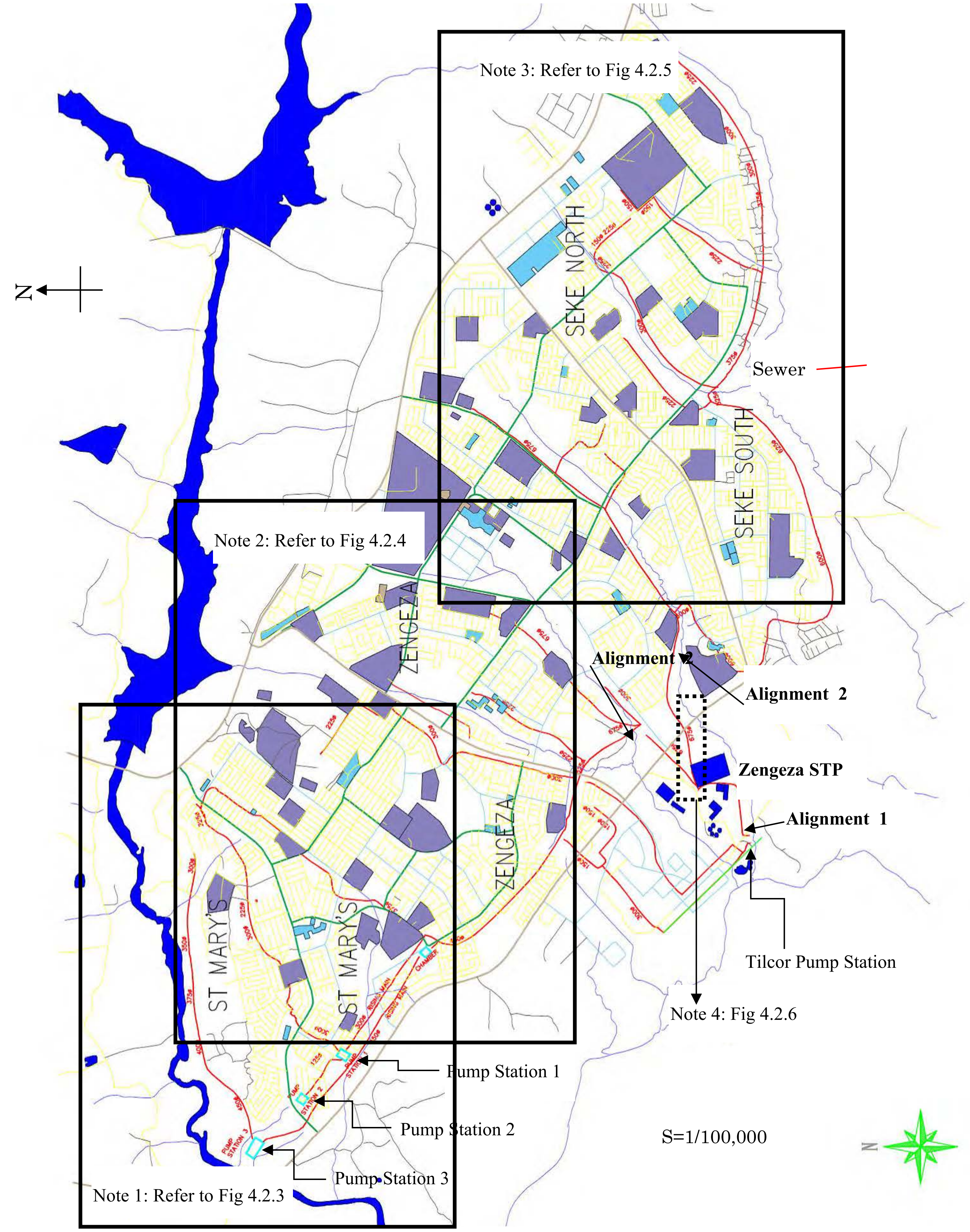


Figure 4.2.2 Trunk Sewer Alignment Source: JICA Project Team

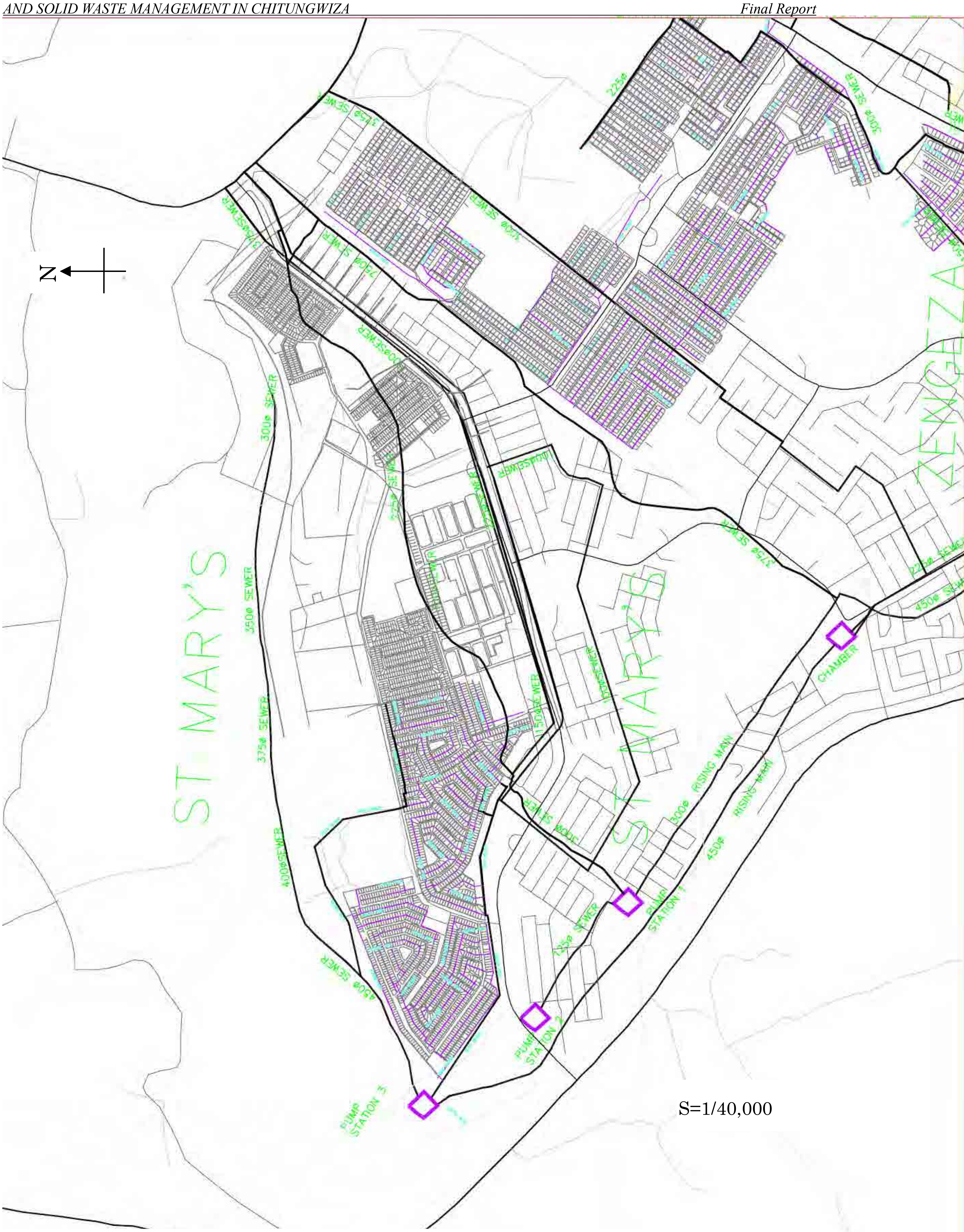


Figure 4.2.3 Sewer Alignment in St. Mary Area Source: JICA Project Team

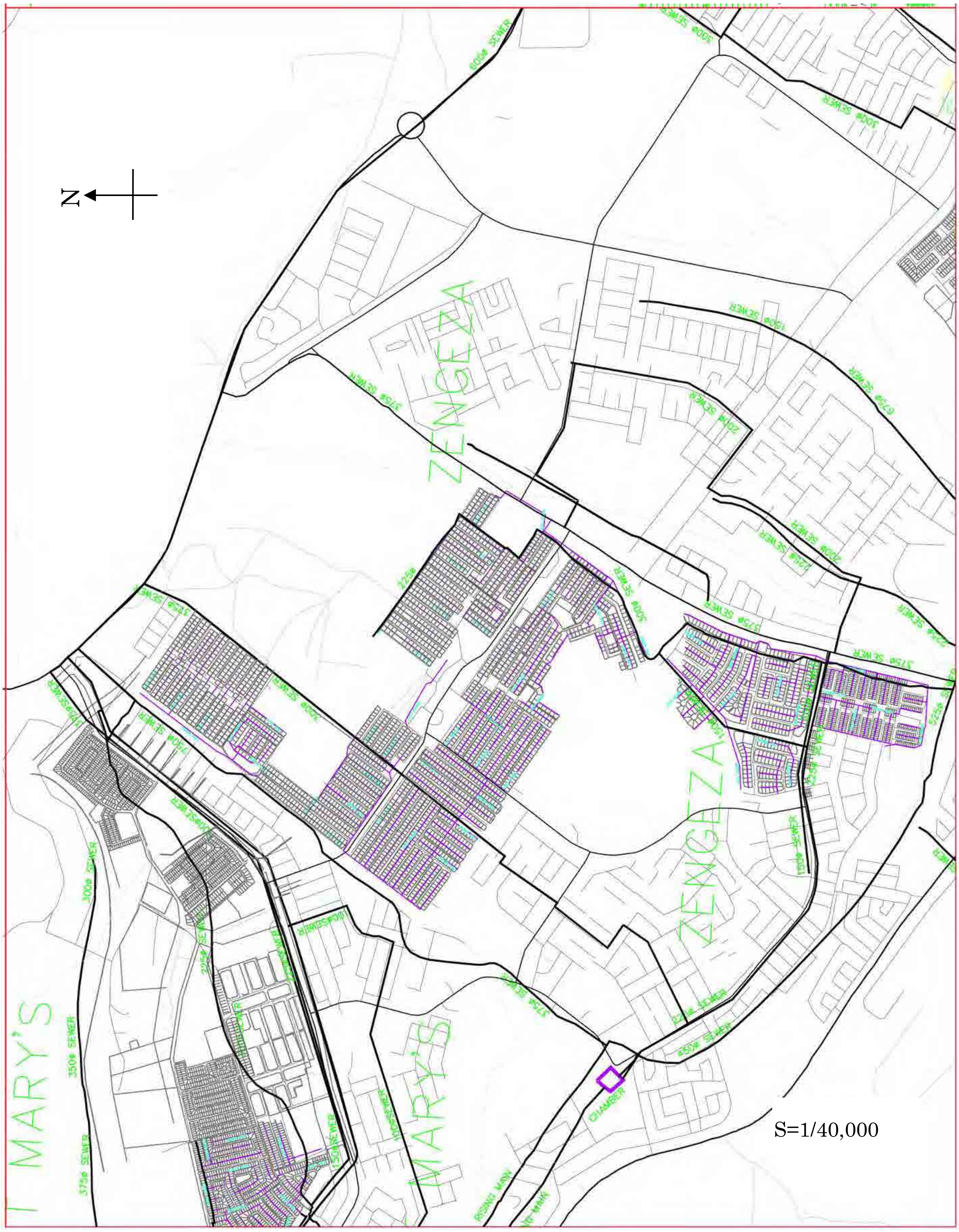


Figure 4.2.4 Sewer Alignment in Zengeza Area Source: JICA Project Team

Figure 4.2.5 Sewer Alignment in Seke Area Source: JICA Project Team

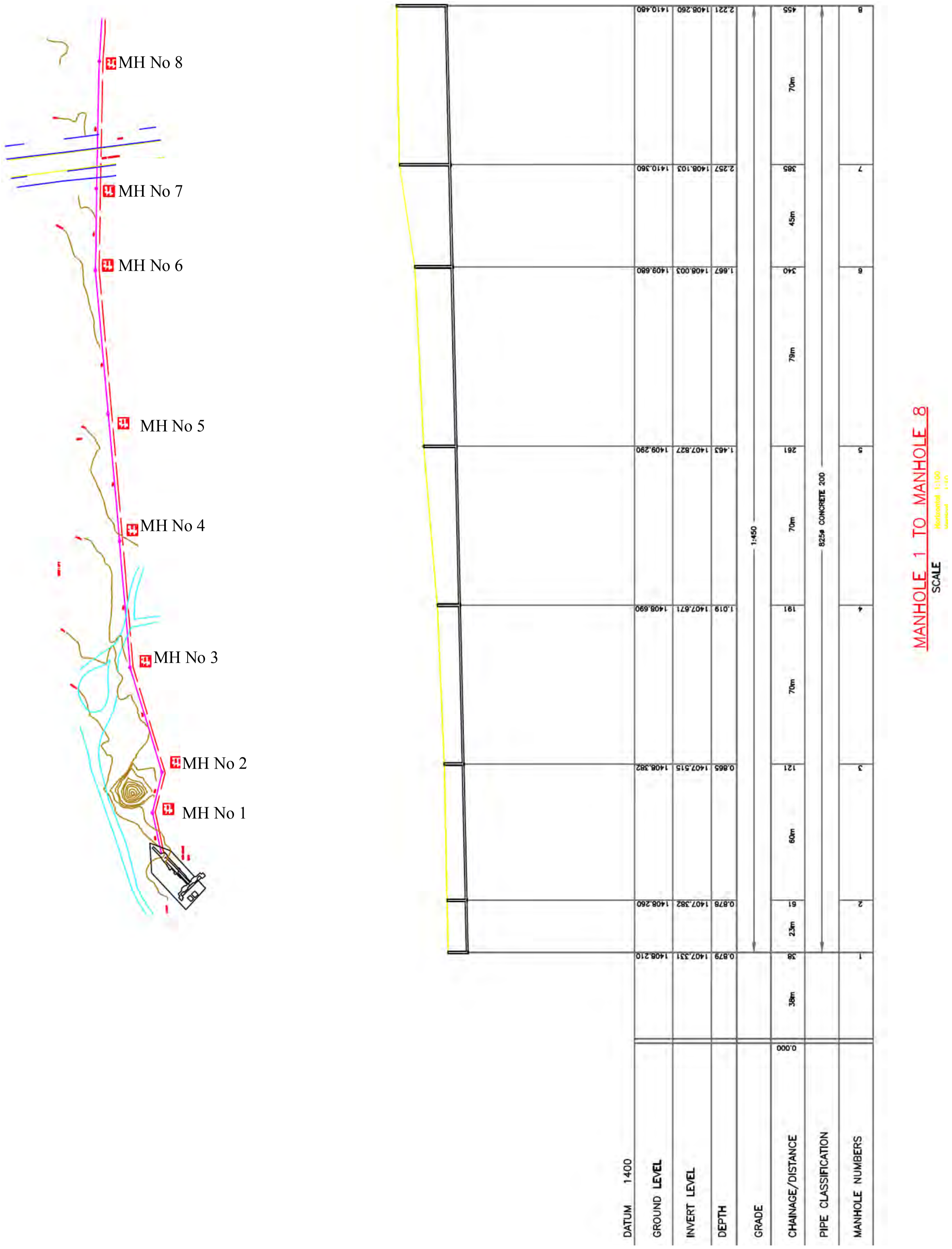


Figure 4.2.6 Trunk Sewer Profile Source: JICA Project Team

2) Evaluation of the existing sewer reticulation

The three lines of major trunk sewers (St. Mary's and Zengeza, Seke and Tilcor) and four pump stations (St. Mary's No. 1, 2, 3 and Tilcor) were evaluated from the viewpoint of pipe flow and pump capacities.

In the study of the major trunk sewers, evaluation was made based on the current status of the networks using the pipe diameter, gradient, and their flow capacities. In evaluating the flow capacity of the existing sewers, the sewage flow (PWWF) was estimated as 1.5 times that of ADWF, considering both the fluctuation of the water supply and the limited inflow of storm water into the sewer under the adopted separate system.

a) Sewage flow by major trunk sewer line

The sewage flow in 1995 was estimated as included in the JICA Study report. The result of the flow 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

In the ILBM report 2010, sewage flow to Zengeza STP was studied:

Considering that the average inflow at ZSTP was 19 408 m^3/day and the sewage pumps produced 8,160 m^3/day, the total discharge of sewage discharge from Chitungwiza was 27,568 m^3/day.

- Average Inflow to ZSTP : 19,408 m^3/day
- Direct Discharge from Pump Stations : 8,160 m^3/day

Total : 27,568 m^3/day

There are large discrepancies between the two studies making further detailed study necessary in this project.

Since domestic and institutional/commercial sewage is collected by two alignments from St. Mary's/ Zengeza and Seke, then, the sewage flow of line was calculated proportional to the rate of distribution of each residential area. Table 4.2.4 shows the area-wise ratio of the domestic sewage flow rate.

Table 4.2.4 Domestic and Institutional/commercial Sewage Flow by Line

Line Name	Residential Area * (km^2)	Percentage (%)
St.Mary's and Zengeza	9.87	43
Seke	12.95	57
Total	22.82	100

Note: * measured by the Project Team

The industrial wastewater from the Tilcor area is discharged to the river instead of draining it into major trunk sewer of Tilcor due to break down of the trunk sewers and manholes. The sewage flow by major trunk sewer and type of sewage is summarized as shown in Table 4.2.5 and total flow rate obtained in the former JICA report was used in this table.

Table 4.2.5 Sewage Flow by Alignment 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

Source: JICA Project Team

The generated sewage flow by line was calculated based on the unit flow rate per area (km^2) as shown below:

St.Mary's & Zengeza Line: 21,450 / (9.87 × 86,400) = 0.0252 ($m^3/sec/km^2$)

Seke Line : 28,433 / (12.95 × 86,400) = 0.0254 ($m^3/sec/km^2$)

The current condition of trunk sewers is shown in Table 4.2.6. Capacity and leeway of the sewers were evaluated from assumed sewage flow and sewer flow capacity.

Table 4.2.6 Current Condition of Existing Sewers

Sewer/Pump No.	Downstream Sewer No.	Area (km^2)	Accumulated Area (km^2)	Unit Sewage Quantity ($m^3/sec/km^2$)	Sewage Quantity (m^3/sec)	Sewer Length (m)	Sewer Flow Capacity: Diameter (mm)	Gradient (1/1,000)	Velocity (m/sec)	Flow (m^3/sec)	Evaluation
P-1	1-1	1.52	1.52		0.038	N/A	N/A	N/A	N/A	N/A	
P-2	1-1	0.33	0.33		0.008	N/A	N/A	N/A	N/A	N/A	
1-1	1-2	0.00	1.85		0.047	1,240 *1	300	Force Main	1.50 *2	0.106	Affordable
1-2	1-3	3.32	5.17		0.130	1,790	450	4.4 *3	1.19	0.189	Affordable
				0.0252			525	4.4 *3	1.32	0.285	Affordable
1-3	1-4	2.05	7.22		0.182	1,230 *1	525	4.2 *3	1.29	0.279	Affordable
							675	4.2 *3	1.52	0.545	Affordable
1-4	1-5	1.09	8.31		0.209	340 *1	675	3.2 *3	1.33	0.476	Affordable
1-5	STW	1.56	9.87		0.249	920 *1	675	5.1 *3	1.68	0.600	Affordable
											(Seke)
Sewer No.	Downstream Sewer No.	Area (km^2)	Accumulated Area (km^2)	Unit Sewage Quantity ($m^3/sec/km^2$)	Sewage Quantity (m^3/sec)	Sewer Length (m)	Sewer Flow Capacity: Diameter (mm)	Gradient (1/1,000)	Velocity (m/sec)	Flow (m^3/sec)	Evaluation
2-1	2-2	1.38	1.38		0.035	800 *1	300	10.0 *3	1.37	0.097	Affordable
						720	375	4.0 - 5.0 *3	1.00 - 1.12	0.111 - 0.124	Affordable
2-2	2-3	1.86	3.24	0.0254	0.082	1,240	375	4.4 - 5.7 *3	1.05 - 1.20	0.116 - 0.132	Affordable
2-3	2-4	5.17	8.41		0.214	1,300	525	2.9 - 3.3 *3	1.07 - 1.14	0.232 - 0.247	Affordable
						2,420	600	2.2 *3	1.02	0.288	Affordable
2-4	STW	4.54	12.95		0.329	1,420	675	2.1 *3	1.08	0.385	Affordable
											(Tilcor)
Sewer No.	Downstream Sewer No.	Area (km^2)	Accumulated Area (km^2)	Unit Sewage Quantity ($m^3/sec/km^2$)	Sewage Quantity (m^3/sec)	Sewer Length (m)	Sewer Flow Capacity: Diameter (mm)	Gradient (1/1,000)	Velocity (m/sec)	Flow (m^3/sec)	Evaluation
3-1	STW	Tilcor Industrial Area			0.019	1,040 *1	300	Force Main	1.2 *2	0.085	Affordable

Note : *1 ; Measured Length
*2; Assumption
*3; Assumption based on the Ground Gradient
N/A : Not Applicable

P-1 : St.Mary's No.1 Pump Station
P-2 : St.Mary's No.2 Pump Station
3-1 : Tilcor Pump Station

Source: JICA Project Team

From the computed results, trunk sewers are considered to have adequate capacity for the flow. However, sewer clogging and sewage spilling out from the manholes have been frequently occurring. They are considered to be the result of the inflow of sand from the outside. The three major trunk sewers are thought to have sufficient capacities against current sewage flow. However, the sewer reticulation (including the trunk sewers) system is not properly maintained as shown from the frequently reported spilling-out from manholes.
The sewage flow study was studied at the STP site to confirm the current flow rate, and the unit per capita flow rate. It clarified the unit flow rate of sewage and fluctuation of sewage flow. It also provided some information on water leakage from water supply. The result is described in the Chapter 6 Pollution Analysis.

b) Sewer Clogging Problem
As a result of the evaluation of existing sewers, the sewer reticulations have some leeway for the expected flow and rated pump discharge capacities. A major problem has been the sand deposit in the sewer lines due to high sand concentration in the sewage. Photos of clogged sewers in Chitungwiza are shown in Picture 4.2.1. In both the two photos, it is obvious that sand deposit occupies the half section of the pipe in the sewers.

Photo 4.2.1 Sand Deposit in the Sewers in Chitungwiza
Source: AWF Project Chitungwiza

This unit generation of the sand in the sewers and their origins have been studied in the Pilot Project in this Project and the situation is understood to be serious necessitating drastic countermeasures.

c) Vandalism

Vandalism against the sewerage system is another issue. Theft of the manhole covers, disposal of the solid waste to the sewer lines have been recorded a lot in Chitungwiza Municipality.

In actuality, the following problems were identified by the Municipality Report of the "Second Urban Development Project, Reference No. 3070, Project Proposals for the Sewage Augmentation Scheme, February 1996", and were also confirmed through the field survey.

- Foreign matter discharged into the sewers, causing blockages: The foreign matter included rags; large quantities of paper; maze cobs; and sand or silt, all of which may have been used for cleaning pans and pots
- Spilled flows from manholes: Overflows from manholes at peak flow exceeding the sewer and pump capacities
- Damaged sewers by irresponsible maintenance work and vandalism; vehicle-damaged manholes, etc.
- Poor sewer gradients coupled with low flows, resulting in low velocities, the settlement of solids and ultimately to blockages
- Broken, decrepit pump equipment and insufficient capacity, causing overflows.
- No preventative maintenance system for the above problems due to lack of finance and manpower

30 problem spots identified by Engineering Dept. are shown in the Table 4.2.7 and Figure 4.2.7

Table 4.2.7 30 Problem Spots Identified by Engineering Department

Reference No.	Township/Area	Zone/Unit	Road or Area Name/Description	Sewer Dia. (mm)	Length Affected (m)
1	St. Mary's	-	Ndomene Road	150	200
2	St. Mary's	-	Bango Road	150	400
3	St. Mary's	-	Mhangura aroad	150	300
4	St. Mary's	-	Town Center	150	400
5	St. Mary's	-	Chitungwiza Road	150	500
6	St. Mary's	-	N of Chaminuka	225	800
7	Zengeza	5	Rufaro Road	150	250
8	Zengeza	1		300	450
9	Zengeza	1	Adj Mission P/S	225	150
10	Zengeza	4		150	150
11	Zengeza	5		150	50
12	Zengeza	5	Gadza Road	150	60
13	Zengeza	5	Mbizi Close	150	100
14	Seke	J	Trunk Sewer	675	180
15	Seke	C-D	Trunk Sewer	675	100
16	Seke	D		150	180
17	Seke	D	By Sec. School	150	400
18	Seke	B	Sewer to unit H	150	200

Reference No.	Township/Area	Zone/Unit	Road or Area Name/Description	Sewer Dia. (mm)	Length Affected (m)
19	Seke	C		150	50
20	Seke	C		150	70
21	Seke	O	Adj. Prim School	150	80
22	Seke	E		150	200
23	Seke	H		150	200
24	Seke	H		225	400
25	Seke	G	Connector to 'N'	150	800
26	Seke	M		150	60
27	Seke	M		150	70
28	Seke	L		150	180
29	Seke	L	Marapara Road	225	200
30	Seke	-	To STP	225/150	200

Remarks: There are a lot of alignments under the existing households interfering maintenance work for the sewer reticulation.

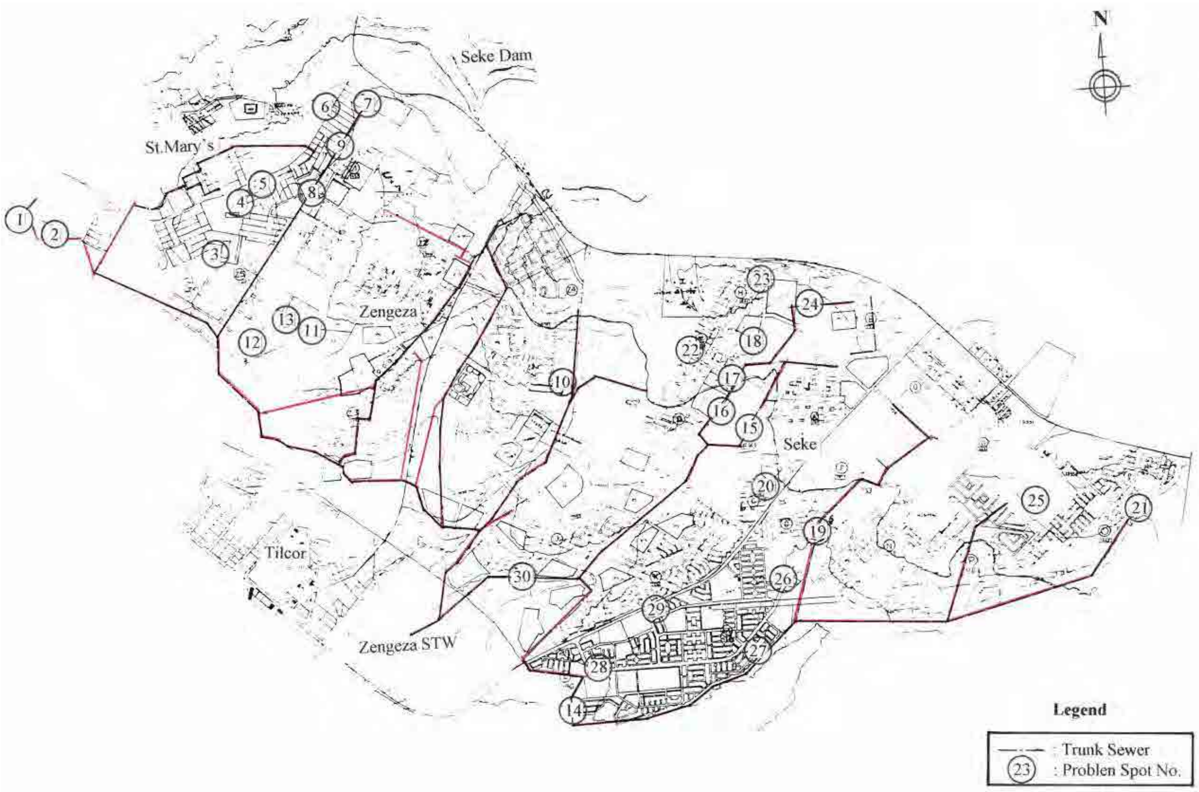


Figure 4.2.7 Problem Spots Identified by Engineering Department

Source: Chitungwiza Engineering Dept

d) Evaluation of pump capacity

The pump capacities of St. Mary's No. 1, 2, 3 and Tilcor were evaluated based on the specifications of their pump equipment as below.

- St. Mary's No. 1 PS

Sewage inflow : $Q = 1.5\times 0.0252 = 0.038\ m^3/sec = 2.28\ m^3/min$

Existing pump capacity: q = 0.0883 m^3/sec ×3(1 standby) units
= 10.60 m^3/min

- St. Mary's No. 2 PS

Sewage inflow : Q = 0.33 × 0.0252 = 0.008 m^3/sec = 0.48 m^3/min
Existing pump capacity: q = 0.032 m^3/sec× 2(1 standby) units = 1.92 m^3/min

- St. Mary's No. 3 PS

Sewage inflow : Q = 0.33 × 0.0252 = 0.008 m^3/sec = 0.48 m^3/min
Existing pump capacity: q = 0.032 m^3/sec × 2(1 standby) units = 1.92 m^3/min

- Tilcor PS

Sewage inflow : Q = 0.019 m^3/sec = 1.14 m^3/min
Existing pump capacity: q = 177 m^3/hr × 3(1 standby) units
= 2.95 m^3/min

According to the result, the pump capacities at the four pump stations have allowances to the expected inflow. However, the overflow of raw sewage from the pump pits at these pump stations has been occurring frequently. The reason for this can probably be attributed to the breakdown of the pump equipment and to inadequate maintenance.

As shown in the evaluation of the existing sewer reticulation, major problems can be summarized as follows:

1) Breakdown or damage of sewer reticulation
2) Clogging or blockage by sand
3) Constructed household interfering the maintenance work
4) Breakdown of pump stations

(3) Sewage treatment works

1) Outline of sewage treatment and disposal

The Zengeza Sewage Works is situated north of Nyatsime River between two tributaries draining the Seke section of the Residential Area. The existing and proposed new Industrial Area lies to the southwest and is unable to gravitate to the Zengeza Works. The present capacity of the Works was designed for 40,400 m3/day within the present fenced area. However, all the works are not functioning due to breakdown of the facilities.

The Zengeza Sewage Treatment Plant was designed by the City of Harare for an ultimate flow of 27,270 m^3/day. This Works was commissioned late in 1978 and consisted of two sets of anaerobic ponds and two biological filters. In December 1980, biological filter number 3 was commissioned and in June

1981, the third set of anaerobic ponds were in operation with the fourth biological filter being commissioned in September 1986, and the fifth biological filter commissioned in 1987.

Allowance has been made in the design for the inclusion of Humus Tanks; but this has not been found necessary, provided that the anaerobic ponds were not overloaded. The effluent from the biological filters gravitates to the existing pumpstation containing four pumps. Pumps numbers 1 & 2 pump to Imbgwa Farm, while pumps numbers 3 & 4 rccirculate the effluent to the three pond sets via spray jets. The old pumps which were installed initially kept breaking down and were later replaced with new pumps, but only to create another set of problems.

This pump station has now been closed down. Under a future phase, the existing pumps and electrical control gear will be replaced and the total output of the old and new effluent pump station is expected to provide 55 Ml/d.

The following is an outline of treatment capacity and processes with their functions, and major equipment and facilities for each treatment process:

The treatment capacity of the old system with trickling filters is 21,750 m^3/day. The present sewage inflow rate is 27,000 to 35,000 m^3/day as assumed in the former section, and the BOD concentration 600 mg/l (estimated figure: 577 mg/l), the SS concentration 650 mg/l (estimated figure: 648 mg/l).
The treatment processes employed at the STP include anaerobic ponds for the primary treatment and trickling filters for the secondary treatment, and Biological Nutrient Removal (BNR) facility for advanced treatment as shown below:

Old : Influent → Screen & grit chamber → Anaerobic ponds → Trickling filters → Farmland
Latest : Influent → Screen & grit chamber → BNR Facility → Maturation Pond → River

There is no final sedimentation tank and the treated effluent is sent to farmland for the old system. The regulation to discharge effluent into the river is strict, not allowing for the secondary treated effluent. The effluent is therefore sent to the farmland for further treatment and re-use/disposal under the old system.

For the BNR system, effluent from the system was good enough for discharge directly to the river. As shown in the APPENDIX, effluent had been discharged to the river. However, after the economic crisis after 2002, due to frequent blackouts and lack of budget for the maintenance work for the STP, operation of the STP was stopped in 2004. Since then, the BNR system has not been working.

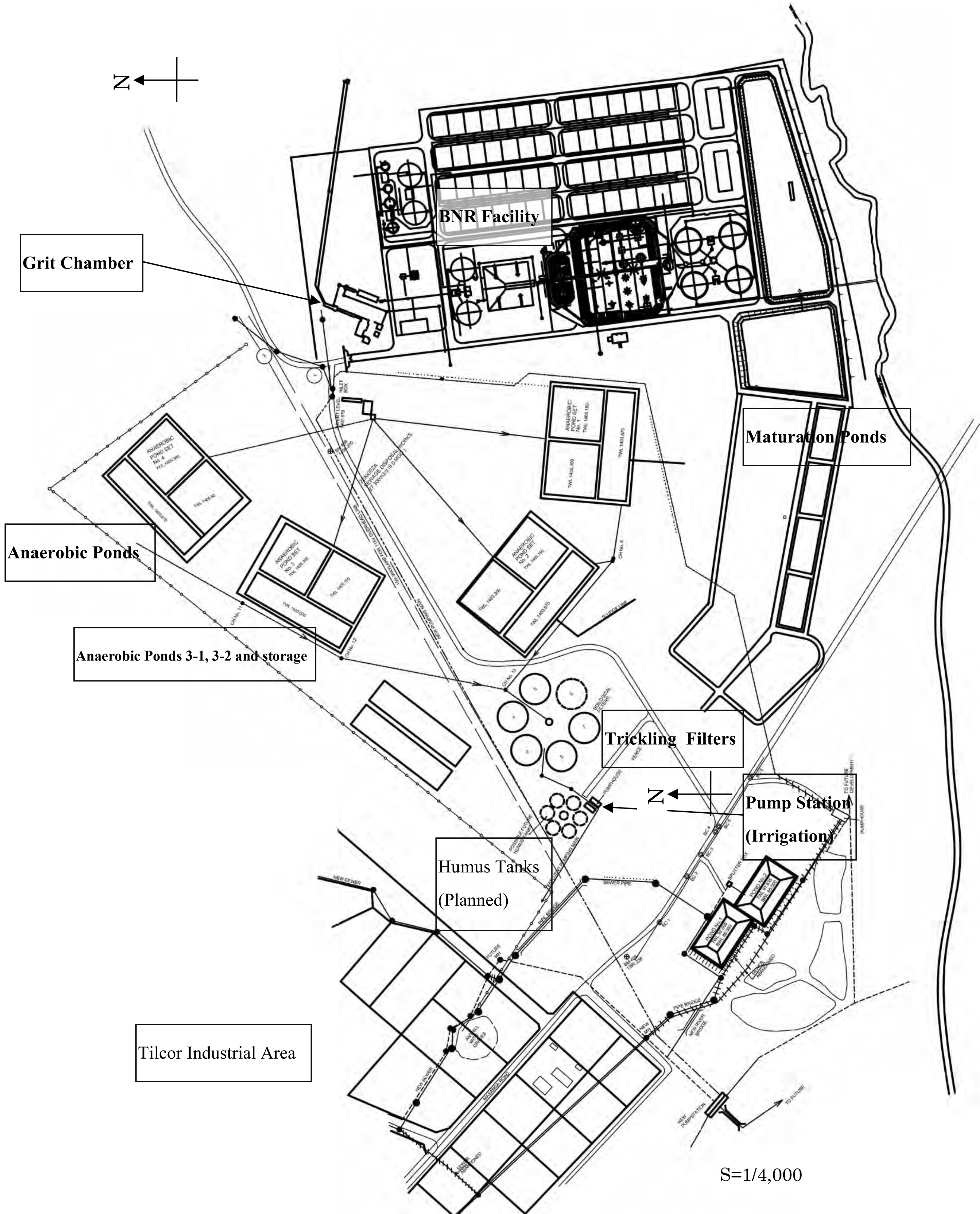


Figure 4.2.8 Plant Layout of the Zengeza STP Source: JICA Project Team

The following are detailed descriptions of each facility.

(a) Screen and grit chamber

Each of the two units of channel and screen (coarse and fine screen) is installed with rectangular flumes at the end of the channel. Then, two units of grit chamber are arranged lateral to the channel, from which grit is intermittently removed by airlift.

(b) Anaerobic pond

Sewage flows to the pond units by gravity through pipes from the distribution box installed after the grit chamber. Each unit consists of three ponds through which the sewage flows in series. The anaerobic ponds are employed to treat highly concentrated sewage.

(c) Trickling filter

The treated sewage from an anaerobic pond flows by gravity to the distribution tower of trickling filters, from which it is distributed to each trickling filter. The trickling filter process utilises aerobic bacteria. Generally, the process can withstand against load fluctuations making the treatment stable even for the high pollution loads, albeit at a decreased treatment efficiency. Furthermore, maintenance is easy and energy costs are comparatively low. Treated sewage from the trickling filter flows into the pump pit, to which it is then sent to the farmland.

The sludge treatment process is as follows:

Anaerobic pond → Sludge drying bed → Land application/land disposal

There were three sludge drying beds installed according to the locations of the anaerobic ponds.

Table 4.2.8 Outline of the Old Facility

Facilities	Specification	Nos.
Grit Chamber	Plug flow, gravity type $0.9m^{W} \times 15m^{L} \times 0.5m^{H}$ <Equipment> Gate: Manual, $0.6\ m^{W} \times 0.8\ m^{H}$ 2units Fine Screen: Manual type, Screen gap 14 mm $0.6\ m^{W} \times 1.4\ m^{H}$ 2units	2
Anaerobic Ponds	Earth Structure Width 140.0 m Length 110.0 m Side Depth 3.0 m	4
Trickling Filter	RC Structure Diameter 37.0 m Depth 5.0 m <Equipment> Sprinkler: Hydraulic Operation: Dia. 36 m with 4armas 4units	5

Facilities	Specification	Nos.
Pump Stations	RC Structure Width 12.0 m Length 15.0 m	2
Electrical Building	Inlet works & Step down transforming Lot area 7.6 m x 17.2 m = 130.7 m^2 <Equipment> Cubicle High Voltage, 11 KV Transformer 1000kVA 11/0.4 kV Switchboard 1000kVA 11/0.4 kV	1

Source: Jica Project Team

Table 4.2.9 Outline of the BNR Facility

Facilities	Specification	Nos.
Grit Chamber	Plug flow, gravity type 1.4 m^W×6.3 m^L×0.5 m^H <Equipment> Gate: Electrical operation type, 0.6 m^W×0.8 m^H 1unit Course Screen: Manual type, Screen gap 40 mm 1.8 m^W×1.4 m^H 1unit Fine Screen: Manual type, Screen gap 14 mm 0.6 m^W×1.4 m^H 2units	2
Primary Sedimentation Tank	Circular type with scraper Diameter 21.0m Side Depth 3.2m <Equipment> Sludge Scraper: Circumference drive, 21.0 m^D×1.5 kW 2units Sludge Pump: Diaphragm type φ100×0.083 m^3/min.×6 m×22 kW 2units	2
Equalization Tank	Orifice effluent type with mixer Width 40.0m Length 40.0m Side Depth 2.9m <Equipment> Mixer: Speed control type, 11 kW 4units Gate: Motorised, 0.25 m^W×0.25 m^H 1unit	1
BNR Reactor	Anaerobic Tank Capacity 1,580 m^3 I.D./O.D. 4.7/18.1 m Side Depth 6.4 m Anoxic Tank Capacity 11,000 m^3 I.D./O.D. 18.9/50.1 m Depth 6.4 m Aerobic Tank Capacity 13,400 m^3 I.D./O.D. 50.9/84.9 m Depth 4.45 m <Equipment> Mixer: Anaerobic Tank : Speed control type, 3 kW 4units Anoxic Tank : Speed control type, 15 kW 4units Aerator: Aerobic Tank : 110 kW 4units 90 kW 3units 75 kW 3units 55 kW 2units Circulation Pump: φ700×27.9 m^3/min.×0.7 m×15 kW 3units	1

Facilities	Specification	Nos.
Final Sedimentation Tank	Circular type with scraper Diameter 23.0 m Side Depth 3.5 m <Equipment> Sludge Scraper Circumference drive, 23.0 m^D×1.5 kW 4units Return Activated Sludge Pump Screw type φ1350×21.0 m^3/min.×7.5 m×45 kW 2units Waste Activated Sludge Pump Nonclogging type φ80×0.67 m^3/min.×15 m×7.5 kW 2units	4
Maturation Pond	Multi-cell type Total volume 60,000 m^3 Water depth 1.5 m	4
Outlet Channel & Bypass Pipe	Outlet Channel : 1.0 m^W×15 m^L (Cascade Type) Bypass Pipe : Dia.600 mm×450 m^L (RC Pipe)	1 1
Sludge Thickening Tank A (For primary settled sludge)	Circular type with scraper Diameter 6.0 m Depth 4.0 m <Equipment> Sludge Scraper: Center drive type, 6.0 m^D×0.4 kW 2units Sludge Pump: φ80×0.097 m^3/min.×4kgf×7.5 kW 3units	2
Sludge Thickening Tank B (For final settled sludge)	Circular type with scraper Diameter 8.0 m Depth 4.0 m <Equipment> Sludge Scraper: Center drive type, 8.0 m^D×0.4 kW 2units Sludge Pump: φ80×0.11 m^3/min.×8 kgf×11 kW 3units	2
Sludge Digestion Tank (For primary settled sludge)	Type: No-heating with re-circulation Diameter 20.0 m Side depth 10.0 m Circulation Pump: φ150×3.0 m^3/min.×21 m×22 kW 2units Sludge Pump: φ65×0.063 m^3/min.×8 kgf×11 kW 3units	2
Sludge Drying Bed	Width 15.0 m Length 20.0 m Sludge height 20 cm	56
Sludge Storage Yard	Yard with roof Width 12.0 m Length 36.0 m Sludge height 2.0 m	2
Electrical Building	Inlet works & Step down transforming Lot area 7.6 m × 17.2 m = 130.7 m^2 <Equipment> Cubicle High Voltage, 11 KV Transformer 1000 kVA 11/0.4 kV Switchboard 1000 kVA 11/0.4 kV	1
Water Examination and Supervisory Building	Laboratory, Staff office & Supervisory room, Labors room, Storage room Proposed area 12.0 m × 24.0 m = 288.0 m^2 <Equipment> Monitoring Panel Meter Panel Flow, pH, DO, MLSS	1

Source: JICA Project Team

Some improvement/augmentation projects for the existing STP have been planned in 2012 by AWF project under the AfDB. The project consists of rehabilitation of existing grit chambers, anaerobic ponds, trickling filters and pumping stations to send the effluent to the farmland for irrigation.

The rehabilitation project does not include the BNR facility but only deals with old system. Therefore, capacity after the rehabilitation will be limited to the capacity of the old trickling filters. The capacity for the rehabilitation is 21,750 m^3/day against the current flow rate of 23,000 m^3/day. Since the effluent water quality will not satisfy the water quality for discharge to the Nyatsime River, effluent is planned to be sent to the Imbwa Farm for irrigation.

b) Facilities for effluent pumping and final disposal

The secondary treated effluent will be sent to the Imbgwa farm through a 7 km force main. The pump station is located after the trickling filters in the STP.

The pond performs the functions for storage, final disposal (evaporation), and polishing of the treated effluent prior to irrigation use (the effluent regulations for irrigation reuse; max. BOD 60 mg/l).

The effluent pump facilities had a total capacity of 35,000 m^3/day, and since its completion at the end of 1995, the total flow of treated effluent has been sent to the farmlands consisting of Imbwa Farm, Boronia Farm and Ellerton Farm. The total area of the farmlands is about 4,500 ha. The owners of the farms are expecting the effluent for growing pasture.

c) Pre-treatment facilities for the Tilcor industrial area

The industrial area is located next to the STP. The treatment works consists of storage ponds and anaerobic ponds intended to serve as pre-treatment facilities for the industrial wastewater discharged from the factories. The pollution load from the whole industrial area is organic pollution, and accounts for about 5% of the treatment works' total flow.

The anaerobic ponds were constructed to treat high organic substances (BOD 6,000 mg/l) discharged from the Chibuku Breweries, Ltd., by reducing the BOD to about 1,000 mg/l. Wastewater discharged from factories is collected to flow into the pump pit of the Tilcor Pump Station. Wastewater collected in the Tilcor area is sent from the pump station to the STP. There are three pipe bridges between industrial area and Tilcor pre-treatment facilities; however, all the pipe bridges are broken thus sewage is discharged to the Nyatsime River.

The number of ponds and size of each facility are shown in Table 4.2.10.

Table 4.2.10 List of Pre-treatment Facilities for Tilcor Industrial Area

Facilities	Details
Influent pipe	a) Chibuku Brewer Line 300^{mm} dia b) Another Line 300^{mm} dia

Facilities	Details		
Anaerobic pond	No. 1	pond,	72 m × 41 m × 4.0 m (effective depth) A = 2,952 m^2, V = 5,730 m^3
	No. 2	pond,	72 m × 40 m × 3.65 m (effective depth) A = 2,880 m^2, V = 5,329 m^3
	No. 3	pond,	It was not built. The land area for No.3 pond is prepared.
Pump station	a)	Pump	
		Type	Horizontal centrifugal pump
		Capacity	177 m^3/hr/pump
		Number	2 units
		Motor	37 kW
	b)	Screen	
		Manual	bar screen 0.5 m (width)
	c)	Pump pit	7.3 m × 2.3 m × 1.7 m (depth)
	d)	Building	28 m^2 (7.3 m × 3.8 m)
Pumping main	Asbestos cement pipe 300^{mm} dia		

Source: JICA Project Team

2) Present condition of each facility

The problem areas on each facility were identified in terms of the hydraulic, structural, operational and maintenance conditions.

a) Existing sewage treatment works

The major problems of the facilities are summarized below:

- Flow Meters

There are two flow meters located next to the Parshall flume in ZSTP to measure the water level, but both are broken, and the flow rate cannot be measured.

- Accumulation of sludge in the anaerobic ponds

Accumulated sludge is not being removed from the anaerobic ponds resulting in the reduction of the ponds' detention time. Apparently, treatment efficiency is very low needing urgent rehabilitation. Screens for the influent are decrepit and need replacement.

- Trickling filters

Ponding in the filters was occurring, in various degrees, in all five of the trickling filter tanks when they were working. The filter media employed in this facility is a fairly fine 30-60 mm. When the filter is overloaded, matter accumulates, clogging the filter and causing ponding to occur. The root cause of this problem is that influent flow rates were much higher than the treatment capacity and high concentration of sand in the sewage. Equipment such as sprinklers, rotating arms, supporting rods and stays are all broken down needing replacement. Structure of the trickling filters is decrepit showing exposures of corroded Re-bars on the surface of RC. Expansion joints of the side walls of the trickling filters are also damaged.

- Breakdown of Yard Pipe and Distribution Tank

Sewage flooding at the yard occurs due to the breakdown of the yard pipe. The distribution tank is also broken. Manholes and pits for the yard pipelines need replacement. Screens of the distribution tank must be rehabilitated.

- Administration building

It was constructed under JICA project and commissioned in 2000. It is judged sound in structure however, rehabilitation is needed for the building services.

- BNR Facilities

They were constructed under JICA project and commissioned in 2000. They consist of primary sedimentation tanks, flow equalization tank, biological reactors and final sedimentation tanks with the equipment. From observation, the structure is judged to be sound. However, replacement of all the mechanical/electrical equipment and rehabilitation is needed, if the original function of BNR is required.

- Sludge Thickening Tank

It was constructed under JICA project and commissioned in 2000. The structure is judged to be sound; however, rehabilitation is needed for the equipment.

- Sludge Digestion Tank

It was constructed under JICA project and commissioned in 2000. The structure is judged to be sound; however, rehabilitation is needed for the equipment pipe works. Clean-up of the contents inside the tank must be made at the beginning, which will need careful work for the safety around the tanks.

- Sludge Drying Bed

It was constructed under JICA project and commissioned in 2000. The structure is judged to be sound; however, rehabilitation is needed for it to be usable.

- Fence around the Old Trickling Filters

Lack of fences is a problem for providing the electricity by ZESA for security reason.

c) Pre-treatment facilities for the Tilcor industrial area

- Sludge accumulation in the anaerobic ponds and jet nozzle problem

Sludge has accumulated in both the anaerobic ponds, in addition to the jet for breaking scum which is broken.

- Sludge and scattered refuse in the storage pond No. 3

Storage pond No. 3 functions as an equalizing pond for the pump facility, and it is littered with refuse and sludge.

3) Evaluation of the each facility's capacity (Present / On-going)

a) Existing sewage treatment works

The current influent flow rate to the STP is about 10,000 to 13,000 m^3/day, with a BOD concentration of 600 mg/l (577 mg/l), and the SS concentration of 650 mg/l (648 mg/l). An examination of the treatment capacity of the existing STP is shown below, the number and capacity of anaerobic ponds and trickling filters, which determine the STP's treatment capacity, are as follows:

- three units of anaerobic ponds with a storage capacity of 108,900 m^3
- five trickling filters with a filter media of 21,750 m^3 and 5,875 m^2 surface

- Treatment capacity of the anaerobic ponds

Assuming a detention time of five days, as recommended by the "Sanitation Manual, Design Procedures", the treatment capacity per day is calculated as shown below:

108,900 m^3/5 days = 21,780 m^3/day.

- Treatment capacity of the trickling filters

According to the "Sanitation Manual, Design Procedures 5" (1990), solid loading rates are 0.2 kg/m^3/day (with recirculation). Subsequent facilities are expected to provide more treatment, (with a polishing pond on the irrigation land that can be expected to provide a BOD polishing), so it is possible to load the trickling filters more than usual with little loss in treatment efficiency. Accordingly, solid loading rates may be calculated with a 20% margin, to yield 0.24 (=0.2 $\times$ 1.2) kg/m^3/day. Compared to the solid load rates given in "Wastewater Engineering: Treatment, Disposal and Reuse, Third Edition," Metcalf and Eddy, Inc, p. 615, which are as follows:

- Low rate : 0.08 - 0.40 kg/m^3/day
- Intermediate rate : 0.24 - 0.48 kg/m^3/day,

The load rate of the existing trickling filter is at the average low rate, and at the low end of the intermediate range. If the BOD concentration of the influent sewage is taken to be 600 mg/l, this is assumed to be reduced to 240 mg/l by the time the sewage enters the trickling filter (with a five-day detention period in the anaerobic ponds, which is assumed to remove about 60% of the BOD). Accordingly, the treatment capacity is calculated as follows:

21,750 m^3 $\times$ 0.24 kg/m^3/day/(240 mg/l $\times$ 1000) = 5,220 kg/day

To check the surface load for this case, the calculation is as follows, assuming a recirculation ratio of 1.0: 21,750 m^3/day $\times$ (1+1.0)/5,875 m^2 = 7.4 m^3/m^2/day.

Compared to the surface load rates given in "Wastewater Engineering: Treatment, Disposal and Reuse, Third Edition," Metcalf and Eddy, Inc, p. 615, which are as follows:

- Low rate : 1.17 - 3.52 m^3/m^2/day
- Intermediate rate : 3.52 - 9.39 m^3/m^2/day,

The surface load rate for the existing trickling filter equals to the middle of the intermediate range. According to the same figure, a 60% BOD removal ratio can be expected. (7.4 m^3/m^2/day is equivalent to 2.0 m^3/m^3/day when filter depth is 3.7 m.) For this load rate, the treated water quality at the outlet of the trickling filter is calculated as follows: 240 mg/l $\times$(1 - 0.60) = 96 mg/l.

This treated water is then sent to irrigation land, so the treatment capacity of the ponds at the irrigation land should also be studied in the next paragraph. The treatment capacity of the anaerobic ponds is 21,780 m^3/day and that of the trickling filter is 21,750 m^3/day, so the existing treatment capacity is taken as the smaller of the two, or 21,750 m^3/day. The current quality of the treated water is 141 mg/l. (yearly average, according to the measurement data of the STP)

b) Facilities for irrigation use and final disposal of the sewage

The effluent had been provided to the farms at no charge when the system was working before. It was utilized for pastures, not for crops, according to the regulation in Zimbabwe. Chitungwiza municipality is planning to charge to the farms after resuming water provision from the ZSTP. Tariff is not yet decided and will be determined by the Board.

Currently, there are seven existing ponds (about 14,000 m^3/pond, total flow 98,000 m^3). The purpose of these ponds is storage, but some treatment effects can be expected during the period the treated water is stored. If the water is treated to meet the standard of the Effluent Regulations for Irrigation Reuse, which is BOD 60 mg/l, there is no need of a detention period for polishing, but if the quality is higher than that, a polishing period commensurate to the water quality and flow is required. Two sets of figures are used to calculate the polishing period. Firstly, the result of the calculations above is used to determine the detention time where 21,750 m^3/day of treated water has been treated to 96 mg/l. Secondly, figures from the current situation, namely, 36,000 m^3/day treated to 141 mg/l, is used.

In the first case, (1 – 60 mg/l/ 96 mg/l) × 100 = 40% is the necessary removal rate. According to the evaluation criteria of treatment capacity, that is based on “Wastewater Engineering: Treatment, Disposal and Reuse, Third Edition,” Metcalf and Eddy, Inc, p. 644-648, the detention time is three days. The flow is thus 21,750 ×3 = 65,250 m^3. If the new pond is available, the treatment objectives can be realized.

In the second case, (1 - 60/141) × 100 = 60% is the necessary removal rate. Based on the evaluation criteria of treatment capacity, the detention time is seven days. The required flow is 36,000 × 7 = 252,000 m^3. Unless the five existing ponds are available, the treatment objectives cannot be attained.
If the operation of the existing STP’s anaerobic ponds and trickling filters is rehabilitated to bear no more than an appropriate load, the irrigation facilities can also be efficiently utilized, with the new pond used as a maturation pond and the five existing ponds used as storage ponds.

c) Pre-treatment facilities for the Tilcor industrial area

Industrial wastewater flow was surveyed and the result is shown in the Table 4.2.11. Flow of about 2,300 m^3/day was confirmed.

Table 4.2.11 Industrial Wastewater generated in Chitungwiza Municipality

	Company Name	Type of Industry	Number of Employees	Wastewater Flow	Unit Wastewater Flow
			nos.	m^3/day	m^3/capita/day
1	Chibuku Brew	Processed Foodstuffs	250	75.0	0.3
2	Olivine Ind.	Ditto	1,500	759.1	0.506
3	D.M.B.	Ditto	600	900.0	1.5
4	National Foods	Ditto	516	256.5	0.497
5	Aroma Bakeries LTD	Ditto	145	18.7	0.129
6	Dailiboard	Ditto	70	22.0	0.314
7	Food & Industrial	Ditto	168	22.0	0.131
8	NBC	Ditto	103	3.3	0.032
9	Zim Freeze	Ditto	200	64.8	0.324
	Sub Total		**3,552**	**2,121**	**0.373**
10	Caps	Chemicals	400	65	0.163
11	Windmill (Pvt) Ltd.	Ditto	450	12	0.027
	Sub Total		**850**	**77**	**0.095**
12	Pyramid Products	Plastics	34	6	0.176
	Sub Total		**34**	**6**	**0.176**
13	Zupco	Transportation	3,226	70	0.022
14	GDC Hauliers	Ditto	400	33	0.083
	Sub Total		**3,626**	**103**	**0.026**
	Total		**8,028**	**2,302**	

Source: JICA Project Team

The capacities of the two anaerobic ponds are as follows:

Anaerobic pond No.1 = 5,700 m^3

Anaerobic pond No.2 = 5,300 m^3

The total anaerobic pond capacity is 11,000 m^3. The wastewater from the industries was estimated to be about 2,300 m^3/day based on the field survey. For this flow rate, there is a 4.8 days detention time in the anaerobic ponds. The BOD concentration of the wastewater is about 6,000 mg/l, requiring a detention time of five days to achieve 70% removal, according to the evaluation criteria of treatment capacity. Taking both the high concentration and the long detention time into account, a removal rate of 70% can be expected. Therefore, the BOD concentration is 6,000 mg/l × (1 - 0.7) = 1,800 mg/l.

4.2.2 Re-use of Treated Effluent and Sludge

(1) Re-use of treated effluent

1) Present Condition of Reuse of Treated Effluent

Most treated sewage is used for irrigation, but this is more a part of the sewage treatment process than a form of reuse. The reason for this is the very strict 1977 Water (Effluent and Wastewater Standards) Regulations (GN687/77), the content of which is shown in Table 4.2.28.
At the time when the 1977 Water Regulations were instituted, the treatment technology was not developed enough to meet the requirements for water quality, so the only option was to conduct irrigation following secondary treatment. This method is similar to the Overland Flow Land Treatment System, one of the natural systems that were developed in the United States as systematized treatment technology. It is known as a very effective method for the removal of organic matter and nutrients.

Table 4.2.12 Effluent Regulation to Discharge into River

Parameter	Limit		
pH		6.9	
Temperature	<	35	deg C
Diss Oxygen	≥	60	% sat
CODcr	≤	60	mg/l
SS	≤	25	mg/l
TDS	≤	500	mg/l
Ammonia (free)	≤	0.21	mg/l

Also limits heavy metals, oils, pesticides and other toxic chemicals
Source: Water (Effluent & Wastewater Standards) Regulations: (GN 687/77)
Source: EMA

The standards set forth that COD and T-N are to be less than 60 mg/l and 10 mg/l, respectively. It is hardly possible to attain such stringent regulation by the conventional sewage treatment processes and, as an economic way of disposing the treated effluent, the reuse for irrigation supply has been widely employed. After the BNR treatment process was developed, it had become possible to clear the standards of the effluent regulations. Using BNR system for the sewage treatment is very essential for the improvement of the water cycle in the closed environment system like Upper Manyame Catchment area, when it is properly used and maintained since it effectively removes nutrient matter as well as organic matter. Consequently, discharging treated effluent directly into rivers became possible. Although it was thought that this practice would continue and solve the issue of water quality and environment in the future, economic crisis made it impossible.

Firle STP, Crowborough STP and Zengeza STP have been partly employing the BNR system. In 2012, BNR in Zengeza STP broke down with no prospect for future resumption. Necessity of adequate budget for construction/O&M and high-grade technical support are the serious issues for the process. For Firle STP and Crowborough, rehabilitation of the system is on-going under AfDB fund. Harare Water has sufficient experience, budget and human resources for the rehabilitation. However, Chitungwiza municipality is short of those requisites. Since the BNR process needs delicate technique for correct operation and expenditure for the maintenance and repair, it will be more problematic to conduct mere rehabilitation of BNR. Besides, it will be long way for the Chitungwiza Municipality to regain the financial strength and attain the capacity development of its personnel. In this context, Chitungwiza Municipality should focus on using irrigation method other than rehabilitation of BNR, since the conventional process will be able to economically satisfy the water quality.

The use of treated effluent for irrigation is controlled by the Public Health (Effluent) Regulations (GN637/72). The items covered by the regulations are BOD, DO, and E.Coli, and the requirements are relatively easy to meet. The contents of these regulations are shown in Table 4.2.13. Surface irrigation of non-edible crops, pastures and orchards/plantations should be applied for the sewage effluent in view of safety factor.

Table 4.2.13 Effluent Regulation for Irrigation Reuse

Public Health (Effluent) Regulations GN637/72	
Conventional Works Effluent	Pond System Effluent
(A) Surface irrigation of non-edible crops, pastures & orchards/plantations.	
BOD ≤ 70 mg/l	DO ≥ 1 mg/l at all times
(B) Spray irrigation of ditto	
BOD ≤ 30 mg/l	BOD ≤ 30 mg/l
(C) Surface or spray irrigation of the above plus pastures for dairy cattle, and cut flowers.	
BOD ≤ 10 mg/l E. Coli ≤ 10/100ml	DO ≥ 1 mg/l at all times E. Coli ≤ 10/100ml
(D) Public Amenities, Playing fields, etc.	
Same as (C) above, plus chlorination	

Source: EMA

The present method of the sewage treatment is described in more detail as follows :

1) Harare

In Harare, the flow of treated effluent is approximately 160,000 m^3/day during the dry season under the present facilities, of which only 40,000 m^3/day or 25% of the total is discharged into the rivers after treatment. The remaining 120,000 m^3/day is transmitted to the pasture lands for irrigation purpose. Harare holds pasture lands extending over approximately 670 ha, where livestock graze.

2) Chitungwiza

The treated effluent is reused in the same method as Harare's. Irrigation for the pasture lands in Imbwa Farm was provided till 2001 for an area of 1,500 ha. The farm is located outside the boundary of the Upper Manyame Catchment Area. The system is still technically usable and the owner of the farm is willing to use the sewage effluent. Irrigation for the farm should be resumed after rehabilitation of the sewerage system in the municipality.

3) Norton town

The sewage was generated not only from the STP but also from the pulp industry. After treatment, this was conveyed to the pasture lands and afforestation areas by the transmission facilities installed by the said industry. The pulp industry business has since closed down and the sewage treatment plant/ the transmission system broke down since 2012. In light of conserving water quality in the Lake Manyame, the facilities must be rehabilitated

4) Ruwa local board

The existing sewage treatment works were constructed in 1993 in the vicinity of pasture lands and its treated effluent is reused using the same method as Harare's.

(2) Treated Effluent quality

It is deemed rational and efficient to reuse the treated effluent containing organic matters and nutrients for the purpose irrigating the pasture lands. The qualitative standard of irrigation water is as shown in Table 4.2.29, whereas the actual quality of the treated effluent is also presented in Table 4.2.30.

1) City of Harare

According to the monitoring records, the BOD of the treated effluent from TF process is very high, being in the range of 150 to 200 mg/l, which is almost the same as that of raw sewage in developed countries. The Public Health (Effluent) Regulation stipulates that the BOD concentration from conventional STPs shall be less than 70 mg/l.

A simple attempt was made to determine whether or not the existing pasture lands, with the area of 670 ha, were sufficient to remove the nutrients of the treated effluent. The required area for the removal of the nutrients was calculated in accordance with Overland Flow Land Treatment System, and the result was compared to the actual area of the pasture lands.

a. Design values for Overland Flow Land Treatment System

Minimum pre-treatment	:	Screening
Annual hydraulic loading rate	:	7.32 - 56.7 m/year
Area required for removal of nutrients	:	0.64 - 4.81 ha/1,000 m^3/day

b. Comparison with the actual area

The required area is calculated as presented below:

	Flow Rate (m^3/day)	Calculated Area (ha)	Actual Area Available (ha)
Crowborough	44,000-64,000	106 - 154	150
Firle	55,000-71,000	132 - 170	400
Entire Harare	107,000-143,000	257 - 343	670

Source: Harare Water Works

It is verified that the existing pasture lands are adequate enough to remove the nutrients of the treated effluent under the present condition.

2) Chitungwiza

The treated effluent contained relatively high BOD levels, being about 180 mg/l when irrigation was conducted. It was, however, further polished by seven existing stabilization ponds in the Imbwa Farm so that the BOD concentration was somewhat decreased.

3) Norton town

Due to overloading, the treated effluent was very poor in quality and is also highly polluted by sewage from the pulp industry that flowed into a storage pond in the STP, affecting the residents in the surrounding areas due to generation of offensive odours. At present, the company closed the business. Also, all the units of trickling filters are broken.

(3) Technical evaluation for reuse of treated effluent

It is a common issue in the Study Area that the treated effluent directly runs into the rivers at the end of the irrigation areas during rainy periods, resulting in the pollution of the receiving water body. Another major problem is that during dry season, there is a deficiency of river maintenance flow, which is accelerated by the fact that a portion of the treated effluent is diverted into a different river basin and that a major portion of the STPs effluent is used for the irrigation of the pasture lands.

1) Harare

In order to cope with the above issues, Harare was strengthening the sewage treatment process by means of BNR, although it was deemed to be technically feasible to remove nutrients by means of reuse of the treated effluent for irrigation of the pasture lands as long as the land area required is ensured. The city administration, however, has been of the opinion that the conventional process be used for the irrigation of the pasture lands, since BNR would cause the city administration large amount of annual operation costs, especially in electricity charges.

2) Chitungwiza

In order to upgrade the treated effluent quality, Chitungwiza has been requesting for fund from donors for reconstruction of TF and BNR. Rehabilitation of TF will be commenced by AfDB in 2012. The treated effluent from TF will continuously be used as irrigation supply into the future. However, in order to avoid the risk of an epidemic and/or water-borne diseases and to meet the effluent regulations, Chitungwiza would be required to expand the capacity of the TF process or improve the treatment capability.

3) Norton town

As of 2012, all the facilities in the STP are already broken down. Effluent use for the irrigation will be most practical in terms of conserving the water source of the Greater Harare Area. Rehabilitation of the existing facilities will be required to meet the objective.

4) Ruwa local board

It is advisable to construct a temporary storage pond in order to retain the raw sewage or treated effluent during the rainy season so that the direct run-off of the treated effluent into the river could be minimized.

4.2.3 Reuse of sludge

(1) Present Condition of Reuse of Sludge

The present conditions of reuse of sludge and disposal method of the respective areas are shown below:

1) Harare

The existing STP can be classified into two groups as follows:

a. Group A: Crowborough and Firle STPs

The sludge generated from the primary and secondary treatment processes is continuously treated by the sludge digestion tank. The digested sludge is injected into the transmission main of the treated effluent feeding the irrigation area. The quantity of the sludge was 1,230 m^3/day on average in February 1996, corresponding to about 2% of the incoming sewage volume.

b. Group B: Marlborough, Donnybrook and Hatcliff STPs

These STPs have less treatment capacity than Group A but are provided with anaerobic ponds. Sludge normally accumulates in anaerobic ponds, which are periodically emptied and dried at intervals of several years for the removal of the sludge. The sludge removed from the anaerobic ponds is disposed of by means of reuse for land over agricultural lands and national parks.

2) Chitungwiza

The sludge treatment and disposal at the Zengeza STP are the same as those of the Group B in Harare However, this STP is provided with sludge drying beds for dewatering. The dewatered sludge is wholly . collected and transported by farmers for reuse in the land over their cultivation areas.

3) Norton

The sludge was generated in the trickling filter process and treated using drying beds. About half of the dried sludge is consumed by means of reuse for land, while the remaining volume is stockpiled in an open space next to the sewage works when the STP was working.

4) Ruwa

Sludge treatment and disposal have not yet taken place to date in the existing sewage works.

(2) Technical Evaluation for Reuse of Sludge

Land acquisition is the most important for disposal of the sludge, which particularly in the Study area is considered to be appropriate and rational. Every STP is closely located to wide pasture lands, which are isolated from the densely populated areas. Such geographic location is of great advantage not only in transporting the treated sludge from the STP to the pasture lands but also to the environment.

1) City of Harare

The optimum method is considered to be rational and sound, especially from the following points of view:

- Both the sewage and sludge are properly treated separately, and used as fertilizer for the agricultural lands.
- Both the treated effluent and digested sludge are transported to the pasture lands together through the transmission pipe. This is a very economical way of sludge disposal and does not require the process of dewatering.

This technology is highly sound and appropriate to the local conditions such as climate, land availability and use, environment of the surrounding areas, and to the local agronomy.

2) Chitungwiza and Norton

The sludge treatment method would also be continued into the future unless there are substantial changes in circumstances in the vicinity of the sewage treatment plants.

3) Ruwa

The administration authority has no particular approach to sludge digestion and disposal. It is considered that the same method as Group B of Harare could be adopted here.

4.3 Solid Waste Management

4.3.1 Current State on Solid Waste Management in Chitungwiza Municipality

(1) Organization of solid waste management service

Solid waste management in Chitungwiza is performed by a solid waste management section under the Health Department headed by a deputy director, and assisted by a refuse superintendent, waste inspector, assistant refuse foreman, drivers, waste collectors and dumpsite attendants.

(2) Collection and transport system

1) Collection method

The collection system in Chitungwiza municipality is divided into two systems as shown in Table 4.3.1. These are: 1) house-to house collection method which the municipality's tipper trucks collect the household waste packed with a bag on a road side, and 2) skip-bin method which the municipality's skip loader collect skip bins at shopping areas or markets. The collected wastes are transported to a final disposal site (open dumping), which is located at about five km from the city center. The municipality's tipper trucks for the house-to-house collection operate with a collection frequency of once a week and make four trips to the final disposal site. The skip loader, on the other hand, operates daily and makes eight trips to the final landfill site.

The illegal dumping or littering which seems to have been caused by the insufficient fleet capacity of collection vehicles, however, is prevalent in the municipality. There are some areas where the municipality collection service cannot access due to the bad road condition or the direct overflow of sewage.

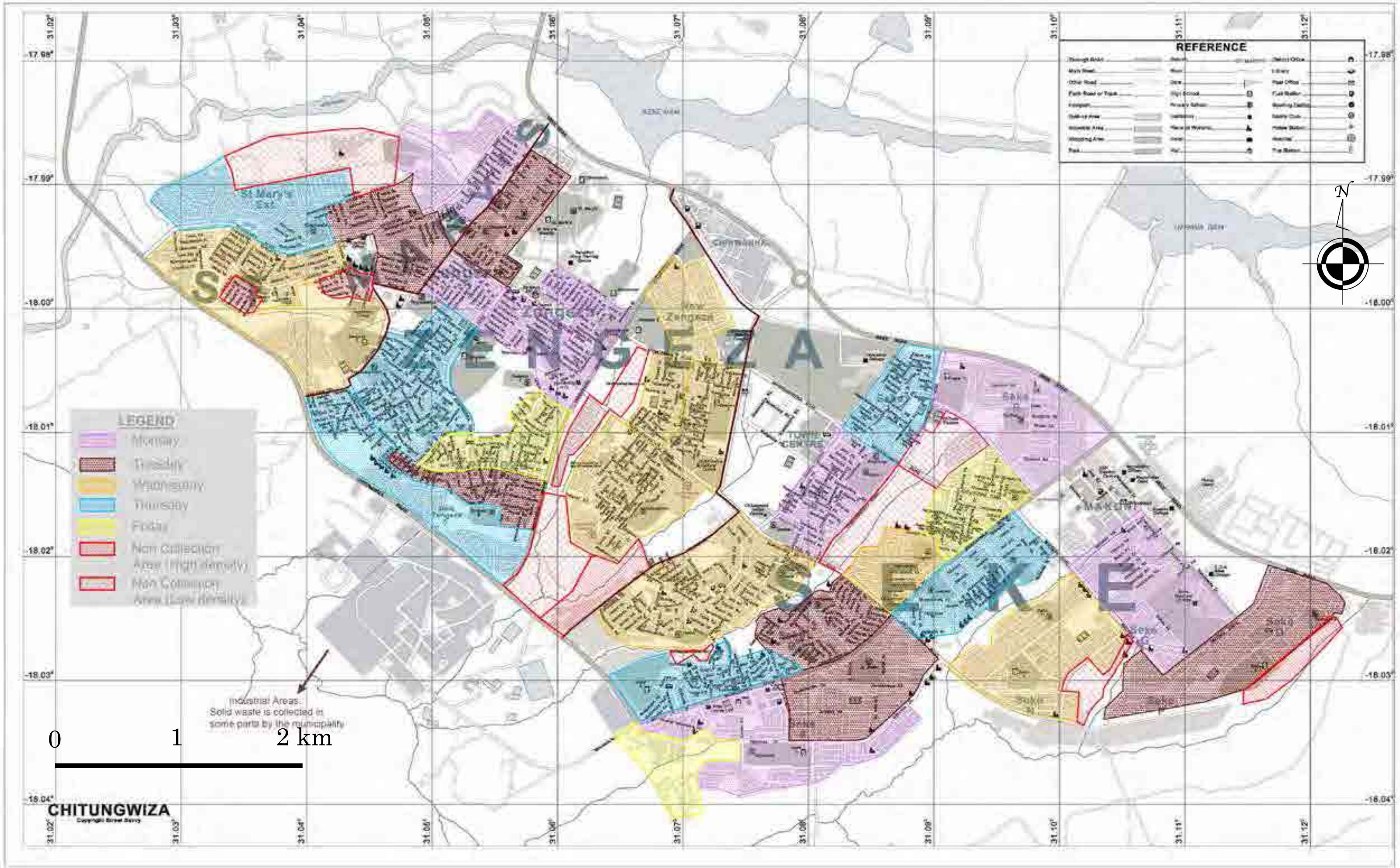
Table 4.3.1 Collection System of Solid Waste in Chitungwiza Municipality

Area	Method	Frequency	Type of Vehicles	Loading Capacity	Average Trip Number per Day
Residential Area	House-to-house collection of waste bags (20 kg size) discharged by residents	Once per week	• Tipper truck • Side loading tipper truck • Dump truck • Skip loader	• 15 m^3 : 2 units • 10 m^3 : 1 unit • 6 m^3 : 3 units • 5 m^3 (Volume of container) : 1 unit	4
Commercial /Markets / Factories / Institutional	Collection of skip bin (container)	Each day	Skip loader	• 5 m^3 (Volume of container) : 2 units	8
Hospital / Clinics	Collection by municipality and transported to an incinerator	Once per week	• Side loading tipper truck	• 10 m^3	1

Source: Chitungwiza municipality

2) Collection service area

The municipality's collection service area is shown in Figure 4.3.1. There are some non-collection service areas in each district of Saint Mary's, Zengeza and Seke. The main cause of non-collection is inaccessibility of collection vehicles of the areas due to bad road conditions or existence of discharge of sewage on the road leading to the areas.



Source: Chitungwiza Municipality

Figure 4.3.1 Collection Service Area

Figure 4.3.1 Collection Service Area

3) Collection schedule

The municipality's collection service is conducted for every week day from Monday to Friday. The detail of the collection schedule is shown in Table 4.3.2.

Table 4.3.2 Collection Schedule

Area	ST. Mary's	Zengeza		Seke		
Team	St Mary's	Zengeza A	Zengeza B	Seke North	Seke Central	Seke South
Monday	C.A.	Zengeza 1-1	Zengeza 2	Unit B & G	Unit D	Unit L
Tuesday	Mangoromera	Zengeza 1-2	Zengeza 3-1	Unit O	Unit K south	Unit M
Wednesday	Chigouanika	Zengeza 4north	Zengeza 4 south	Unit C	Unit N	Unit J
Thursday	Manyame Park	Zengeza 3ex & 5 ex	Zengeza 5	Unit F / P	Unit H / E	Unit K north
Friday	(Commercial & Industrial)	Zengeza 3-2	(Industrial)	Unit A	(Market & Commercial)	Chigumba

Source: Chitungwiza Municipality

(3) Final disposal

1) Existing open dumpsite

The existing final disposal site in Chitungwiza city is located at three to five km from the city centre. The landfill, which has been operating since 1985, is an open dumping without truck scale, administration office, fence, rainwater drain ditch, leachate treatment facility and impermeable liner for leachate.

Table 4.3.3 shows the summary on existing situation on surrounding environment of the landfill area.

Table 4.3.3 Evaluation on Existing Final Disposal Facility

Item	Evaluation
Location	3 to 5 km from city center.
Surrounding Land Use	Graveyard, Quarry Site
Access Road	No pavement with the width 3 to 7 m
Area	Approx. 30 ha
Surrounding Water Area	Nyatsime River

Source: JICA Project Team

Soil covering has not been implemented for the past 10 years because the heavy machine for soil covering cannot be used as it was broken down. At some parts of the dumping site, maize is planted. Some waste pickers collect recyclable materials inside the dumping site. Chitungwiza municipality has received an order from EMA to improve the existing dumping site. However, the order has no deadline, but it includes a recommendation for the development of a new final landfill.

Figure 4.3.2 shows the general map of the existing dumping site

Source: JICA Project Team

Figure 4.3.2 General Map of Existing Final Disposal Facility

2) Municipality's future plan on new final landfill site

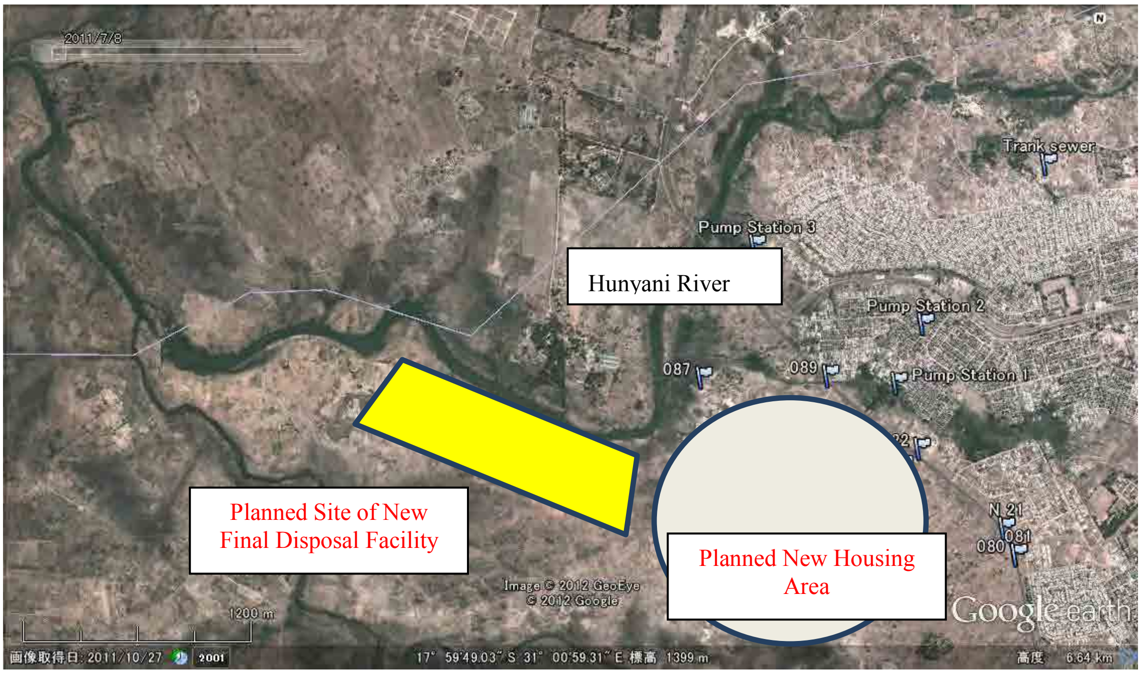
The Chitungwiza city has a future land use plan which covers a new final disposal site as shown in Figure 4.3.3.

The general information on the site is shown as below;

- Area size: 38.1 ha (officially announced by the municipality)
- Distance from city center: 4.5 km
- Land ownership: Government Land
- Surrounding land use: River (Hunyani River), housing lots (planned), schools (planned)

The municipality did not estimate the cost for developing a new landfill site and rehabilitating the existing open dump site. The new housing area is still under planning and the details of the development (development area, population and developer, etc.) have not yet been decided.

However, the site is adjacent to a future housing lots / schools and is not recommend as final landfill site because of its close distance to the housing area.



Source: JICA Project Team

Figure 4.3.3 General Map of Planned New Final Disposal Site

(4) Recycling / Intermediate treatment

Recycling business is currently done by one private group in Chitungwiza. They recycle plastics and glass, not with paper or carton. The group buys the recyclable plastics for 10- 20 cents per kg from the residents. The group also buys the recyclable bottles for 20 to 30 cents each from the residents as shown in Table 4.3.4. The group sells these recyclable materials to manufacturers in Harare.

Table 4.3.4 Recyclable Bottle Price in Chitungwiza

Recyclable Materials	Buying Price
Returnable Bottle	30 cent/bottle
Big Bottle (Beer)	30 cent/bottle
Small Bottle (Sprite, Coke etc…)	20 cent/bottle

Source: JICA Project Team

The group collects the recyclable materials from the existing dumping sites and the residents as shown in Table 4.3.5. The group has a shredder and a washing unity to produce plastic pellets and chips as shown in Photos 4.3.1 to 4.3.7. The list of selling prices of the recycled plastic is shown in Table 4.3.6.

Table 4.3.5 Collection Sources of Recyclable Materials

Collection From	Unit	Quantity	Description
Dump Site	Ton/ week	3	The company hired persons to collect from dump site.
Community / Residents	Ton/ week	1	Residents bring / sell plastic materials at a cost of US 20 cent per Kg
Commercial / Shops	Kg/ week	300 - 400	The company asks to keep plastic materials from some shops and they collect by themselves.

Source: JICA Project Team

Table 4.3.6 Selling Price of Recycled Plastics

Product	Unit	Quantity	Price
Pellets	Ton/ week	2	USD 1 - 1.2 per kg.
Chips	Ton/ week	4	US 60 cent – 70 cent per kg.

Source: JICA Project Team

Source: JICA Project Team

Photo 4.3.1 Pellets

Photo 4.3.2 Chips (White and blue)

Source: JICA Project Team

Photo 4.3.3 Collected and Stored Materials

Photo 4.3.4 Separated Materials

Source: JICA Project Team

Photo 4.3.5 Shredding

Photo 4.3.6 Washing

Photo 4.3.7 Drying

4.3.2 Current State on Solid Waste Management in Harare City

The solid waste management in Harare city is conducted by waste management and final disposal sections which belong to the Amenity Department.

(1) Implementation structure on solid waste management

The solid waste management in Harare city is under the Amenity Director, a toxic waste inspector, cleansing superintendent and transport supervision. The landfill operation is directly managed by the Amenity Director. The road cleaning is operated by a cleansing superintendent, together with street cleaners; while the collection/ transport service is operated under the transport supervisor. A total of 1,030 staff members are involved in the operation of solid waste management.

(2) Solid waste management system

1) Collection and transport system

The collection and transport system in Harare city is to that of Chitungwiza city as shown in Table 4.3.7. For the residential area, a house-to-house collection system is done while the container collection system is used for the commercial and industrial areas. However, compactor trucks are used to service residential areas.

Table 4.3.7 Collection and Transport System in Harare City

Area	Method	Frequency	Type of Vehicle	Maximum Loading Capacity	Trip Number to Final Disposal per Day
Residential Area	House to house collection by using waste bags	Once a week	• Compactor truck	• 10 m^3	• 4
Commercial / market / factories / institutional	Container (skip bin) system collected by the municipality partially collected by private sectors.	Each day	• Skip loader (municipality) • Dump truck (private collector)	• 5 m^3 (Container)	• 4 to 8 (municipality) • 4 (private sector)
Road sweeper	Collection into 70 liter container by road sweepers and transported by municipality skip tractor	Each day	• Manual cart • Skip loader	• 70 litter (container) • 5 m^3 (Container)	• 4 to 8 (municipality)
Park / Street trees	Collected and transported by trailer and tractor of municipality	Each day	• Tractor • Trailer	3 t	• 4
Hospital / clinic	Collected by municipality vehicles at hospitals and clinics and transported to an incinerator. Partially collected by private collectors	Once a week	• Vehicle fabricated specially for hospital use	-	• 1

Source: Harare Municipality

2) Intermediate treatment and final disposal system

The municipality does not own any intermediate facilities such as transfer station, composting and material recovery system (MRF). However, the municipality currently has a plan for reduction of waste generation, such as composting, which is partially carried out at the community level.

The final disposal site is located at around 10 to 15 km north from the city centre and this has been operating since 1984. However, the facility is just an open dumping area which has no fence, lining, truck scale, and rainwater drain and leachate treatment facilities. According to the municipality officer, soil covering and compaction are practiced at the site by the use of a bulldozer. However, exposed piled waste was observed possibly due to the insufficient soil covering at the landfill.

There are waste pickers at the landfill site. The waste pickers are allowed to carry out their activities of sorting and recovering recyclable materials such plastic, metals, used tires, glasses and cardboard papers by paying USD 10 to the municipality officer. The municipality wants to close the landfill, but new sites have not yet been identified.

Harare city also has a final disposal facility of hazardous waste which is located about 5km west from the city centre. The facility was previously used as a final disposal site, but the site was closed in 1999 due to complaints from the surrounding residents of the presence of hazardous waste such as the liquid after washing cars, used cooking oil, asbestos, pesticide and chemicals. The facility is not designed using safety measures such as a concrete wall for the prevention of leakage, thus the municipality received an improvement order from EMA

Source: JICA Project Team

Photo 4.3.8 Existing Open Dumpsite

Photo 4.3.9 Hazardous Waste Treatment Facility

4.3.3 Waste Amount and Composition Survey

As in many cities in the world, solid waste management in Zimbabwe is facing several problems that can directly affect the environment and the health of the population. Amongst these problems are the inefficient Solid Waste Management (SWM) services extended due to lack of accurate data on the waste amount and composition by type.

(1) Survey area

Residential area (household) and establishments were surveyed and waste samples were taken from the same waste generation sources. Three types of residential areas were selected for WACS after discussions held with the municipality and after taking into account the land use. The areas were then classified by housing type, as shown below:

High income area: Upper income area is also known as low density residential area. The low density residential areas were planned for housing that includes wide lot area. Household businesses, community organizations, and some types of commercial and agricultural use are allowed to be built in the land zone.

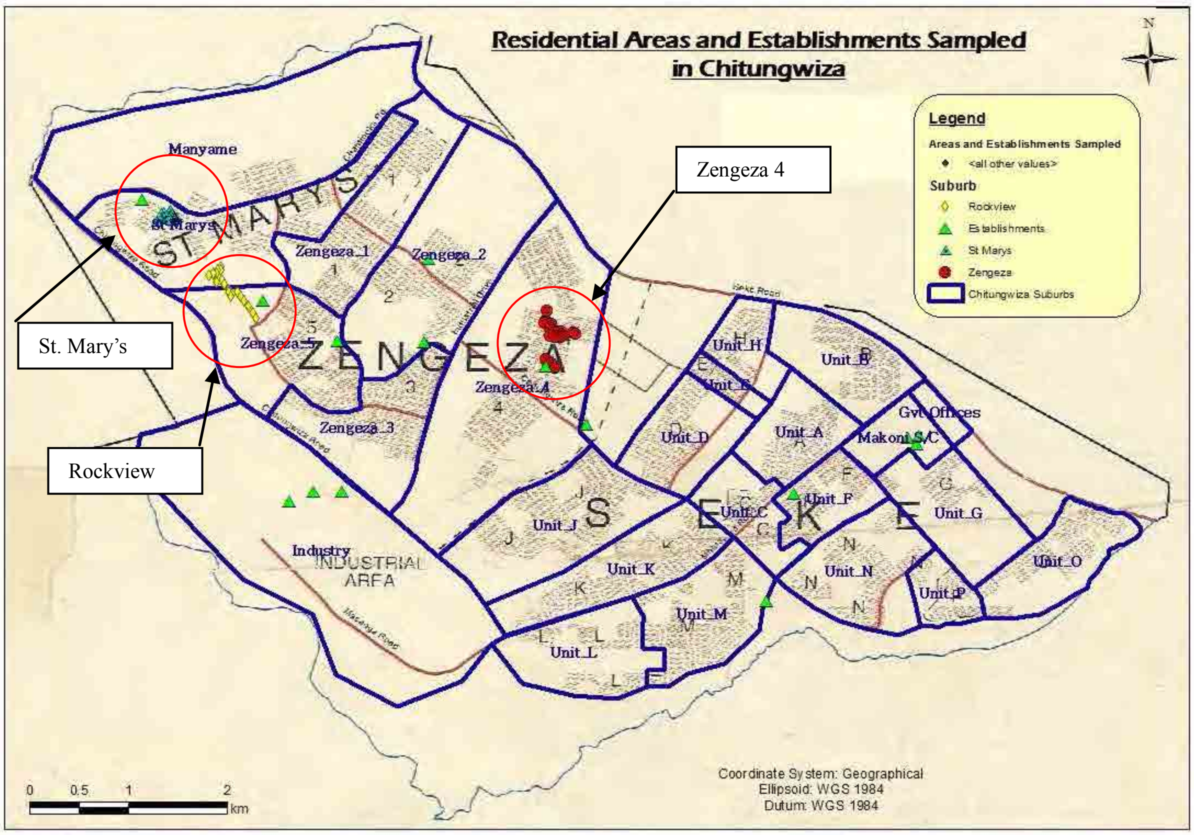
Middle income area: Middle income area is also known as middle density residential area. It is classified as intermediate between low density and high density suburbs.

Low income area: Low income area is known as high density area. Most people living in these areas have very low incomes, and many are not employed. Majority of the communities in high density suburbs live below the poverty datum line. The following districts in Table 4.3.8 were selected.

Table 4.3.8 Sampling Areas in Residential Areas

Area for Sampling	District
High income area	Rockview
Low income area	St Mary's
Middle income area	Zengeza 4

Source: JICA Project Team



Source: JICA Project Team

Figure. 4.3.4 Distribution Map of Sampling Points for Residential Areas

As for the establishments, there are five typical types of establishments, namely, school, corner shops (kiosk), supermarket, factories, markets were selected, all of which generate large amount of solid waste.

(2) Sample number

1) Waste amount survey

The number of samples per day of the waste amount survey is shown in Table 4.3.9.

Table 4.3.9 Sampling Area and Number for Waste Amount Survey

Sampling Area	Number of Samples per Day
1. Residential area (Household)	
a. Upper income area	20
b. Middle income area	20
c. Low income area	20
Sub Total	60
2. Establishments	
a. Schools	3
b. Supermarkets	3
c. Factories	3
d. Markets	3
e. Corner shops	3
Sub Total	15

Source: JICA Project Team

Residential area

Sixty samples per day were taken continuously during the survey period of eight days. The sample for the 1st day was just for reference and those of the remaining 7 days were used for the actual analysis for the per capita waste amount in the residential areas.

Therefore, the total sample number was calculated as shown below;

60 samples/day × 8 days = 480 samples ------------ 1)

Establishment

Three samples per day were taken continuously during survey period of five days.

Therefore, the total sample number was calculated as shown below;

3 samples/day x 5 establishments × 5 days = 75 samples ----------- 2)

Total Sample Number

From 1) and 2), the total number for the waste amount survey is shown below.

480 samples + 75samples = 555 samples

2) Waste composition survey

The number of samples per day of the waste composition survey is shown in Table 4.3.10.

Residential area

Three samples per day were taken continuously during the survey period of eight days. The sample for the 1st day was just for reference and those for the remaining seven days were used for the actual analysis for the per capita waste amount in the residential areas.

Therefore, the total sample number was calculated as shown below;

3 samples/day × 8 days = 24 samples

Establishment

One sample per day for each establishment was taken continuously during survey period of five days for each establishment.

Therefore, the total sample number was calculated as shown below;

1 samples/day × 5 days × 5 establishments = 25 samples

Total Sample Number

From 1) and 2), the total number for the waste amount survey is shown as below.

24 samples + 25 samples = 49 samples

Table 4.3.10 Sampling Area and Number of Waste Composition Survey

Sampling Area	Number of Samples per Day	Period (days)	Total Sample Number
1. Residential area (Household)			
a. Upper income area	1	8	8
b. Middle income area	1	8	8
c. Low income area	1	8	8
Sub Total			24
2. Establishments			
a. Schools	1	5	5
b. Supermarkets	1	5	5
c. Factories	1	5	5
d. Markets	1	5	5
e. Corner shops	1	5	5
Sub Total			25
Total			49

Source: JICA Project Team

3) Actual sample number

The survey intended to sample 555 samples, but 528 samples were collected. However, not all samples were available since some households or establishments forgot and disposed of the waste either by burning or throwing it outside their yard. Table 4.3.11 shows the comparison between the planned and actual sample number.

Table 4.3.11 Planned and Actual Sample Number

Area	Sample Number (Planned)			Sample Number (Actual)
	Sample Number per Day	Sampling Days	Total	Total
1. Residential Area				
High Income	20	8	160	144
Medium Income	20	8	160	156
Low Income	20	8	160	155
Sub Total			480	455
2. Establishment				
Schools	3	5	15	15
Corner Shops (Kiosk)	3	5	15	14
Supermarkets	3	5	15	14
Factories	3	5	15	15
Market	3	5	15	15
Sub Total			75	73
Total			555	528

Source: JICA Project Team

(3) Survey method

1) Interview survey

Before the conduct of the survey, the local subcontractor explained the purpose and method of the survey to the people of each sampling site to obtain their cooperation. At the time, the sample houses and/or establishments were interviewed to obtain necessary data to estimate the unit waste generation rate. Interview items are shown in Table 4.3.12.

Table 4.3.12 Interview Items at Each Waste Sampling Site

Sampling area	Interview Items
1. Residential area	Number of families and inhabitants (including employee), type of house, floor area of house, approximate monthly expenditure
a. Upper income area	
b. Middle income area	
c. Lower income area	
2. Establishments	Number of employees, number of pupils and students, floor area for the business activity, approximate numbers of customers or users or guests per month. Type of activity (to be classified into restaurant, hotel/guest house, fruits shop, cloth shop, electric appliance shop and other shops)

Source: JICA Project Team
Note (1): Surveyor shall mark and record the sample ID, house/building type and address. The location of sampling sites shall be indicated on a map.
Note (2): Concerning commercial establishment and market, type of activity shall be classified as restaurant, hotel/guest house, food shop, cloth shop, electric shop and other shop.

2) Measuring of weight at waste amount survey

Waste bags (sacks) were previously provided to each sampling target to enable measurement of the weight of each sample. The survey companies collected the waste bags and measured the weight of each sample.

3) Waste composition

Survey Item

The waste composition survey consists of measuring the wet base weight of each component, volume of composite sample, bulk density of composite sample (in calculation), water (moisture) content of composite sample.

Waste Composition

The waste composition (weight percent) measured the weight of each waste component as shown in Table 4.3.13.

Table 4.3.13 Components of Waste Composition Survey

1. Organic Waste			Weight (g)
	Food Waste		
	Paper	Recyclable Paper	
		Recyclable Cardboard	
		Mixed Paper	
		Diapers	
		Subtotal-Paper	
	Plastics	Plastic Sheet	
		Recyclable Plastics	
		PET Bottles	
		Other Plastics	
		Subtotal-Plastics	
	Rubber & Leather		
	Textiles		

1. Organic Waste			Weight (g)
	Yard Waste		
	Lumber & Logs		
	Other Org. Waste		
	Organic Waste - Subtotal		
2. In-organic Waste			
	Glass	Returnable Bottles	
		Other Live Bottles	
		Glass bins	
		Broken Glass	
		Glass-Subtotal	
	Metals	Tin Cans (steel cans)	
		Aluminum cans	
		Cupper	
		Other Metals	
		Metal-subtotal	
	Dirt, Ash, Stone, Sand		
	Inorganic Waste - Subtotal		
3. Unclassified residual waste			
4. Domestic Hazardous Waste			
	Batteries - Dry Cells		
	Other Domestic Hazardous Waste		
		Domestic Hazardous Waste-Subtotal	
Total Weight (g)			
Total Weight (kg)			

Source: JICA Project Team

Bulk Density of Waste

Bulk density of the solid waste was measured as a part of the waste composition survey using the same sample with the waste composition survey. After completion of the waste composition survey, all the sorted waste components were mixed and put into a container. The container was shaken and/or tapped lightly for several times to fill up the loose part of the filled solid waste. The bulk density of the waste computed in kg per litre.

Moisture (Water) Content Analysis

After measuring the bulk density, about 2 kg of well-mixed waste was taken from the container and wet-base weight for the wet or raw waste sample was measured for moisture content analysis at a laboratory. The sample waste was dried using an oven with the temperature at 105ºC +/- 5ºC for a day or so until the dry weight became stable. The moisture content was computed as a percentage of the weight of wet waste and dry waste.

4) Data analysis

Result of the waste composition survey shall be put in order and analysed but not limited to the following items.

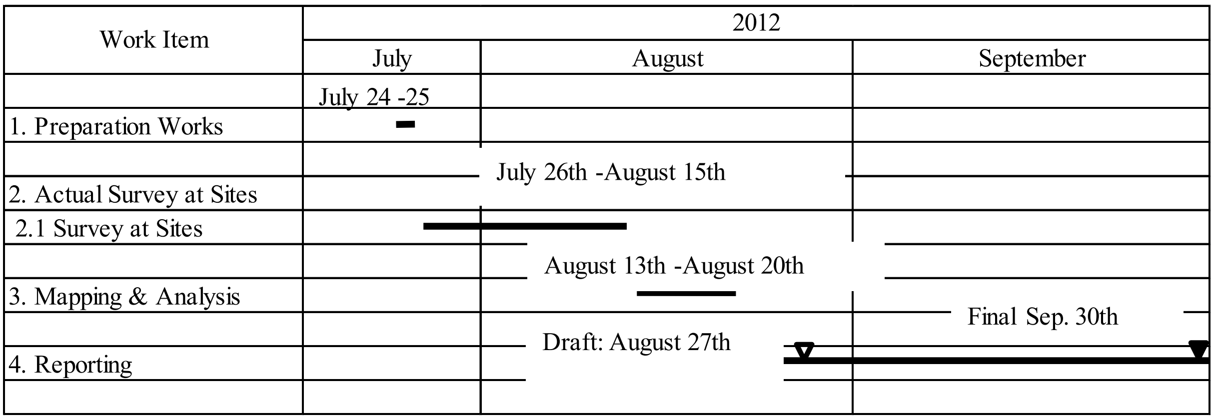
- The range and average waste composition of each income group
- The range and average bulk density of each income group
- The range and average water (moisture) content of each income group
- The range and average waste composition, bulk density and moisture content of the

Municipality

(4) Survey results

1) Actual progress

The actual progress of the WACS (including illegal dumping survey) is shown in Figure 4.3.5.



Source: JICA Project Team

Figure 4.3.5 Actual Work Progress on Waste Amount and Composition Survey

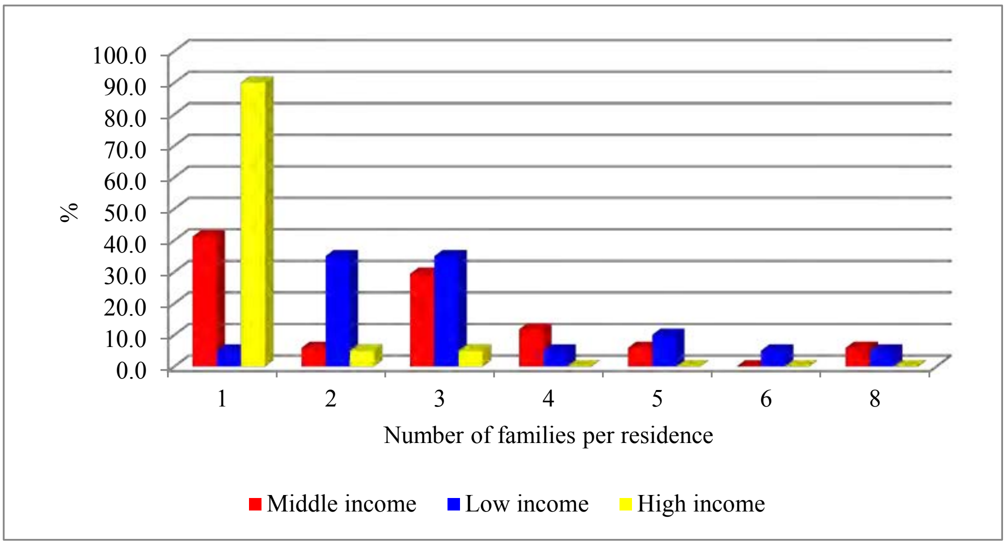
2) Population of sampled residential areas

The total population was obtained from the household questionnaire analysis (based on responses of interviewees) where 60 households were sampled. Most households in the high income area are occupied by single families (90%) as shown in Figure 4.3.6. However in the middle and low income areas, residences are mostly occupied by 2 to 3 families, 35% each respectively as identified by the survey. The average occupants for high, middle and low income areas were 7, 10 and 10 respectively.

Table 4.3.14 Population of Sampled Residential Areas

Residential Areas	Number of Households	Number of Families	Total Population Surveyed	Average Population per Household	Average Number of Families per Household	Average Population per Family
High Income	20	23	131	7	1.2	5.7
Middle Income	20	45	203	10	2.3	4.5
Low income	20	64	204	10	3.2	3.2
Total	60	132	538	9	2.2	4.1

Source: JICA Project Team



Source: JICA Project Team

Figure 4.3.6 Number of Families per Household

3) Waste generation amount

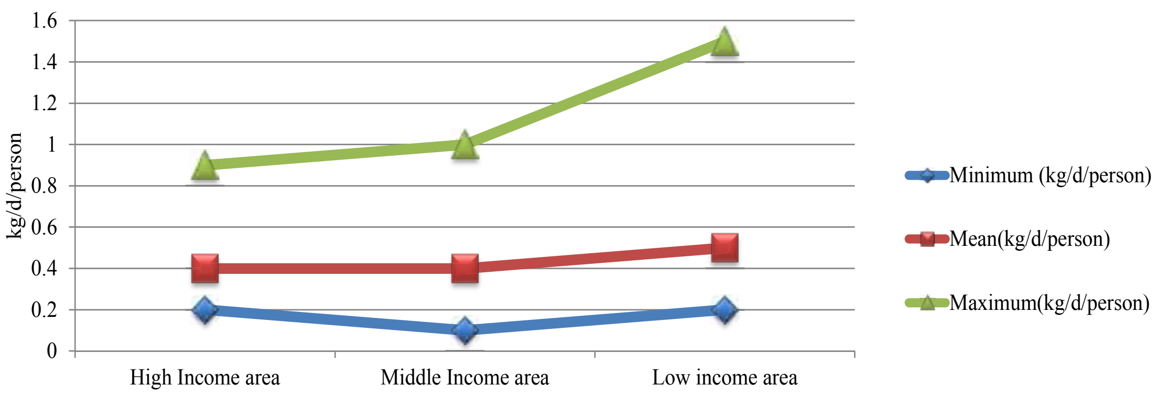
Daily Per Capita Waste Generation or Waste generation Amount per Establishment

The amount of per capita waste generation for residential area is shown in Table 4.3.15 and Figure 4.3.7. About 0.43 kg/person/day is the average per capita waste amount generated from residential areas; while establishments generate a total average of 2,283.4 kg/establishment of waste daily.

Table 4.3.15 Per Capita Waste Generation Amount for Residential Area

Residential Area	Minimum (kg/day/person)	Mean (kg/day/person)	Maximum (kg/day/person)
High Income	0.17	0.41	0.86
Middle Income	0.13	0.38	0.96
Low Income	0.21	0.49	1.54
Total	0.17	0.43	1.12

Source: JICA Project Team



Source: JICA Project Team

Figure 4.3.7 Per Capita Waste Generation Amount for Residential Area

Table 4.3.16 Waste Generation Amount per Establishment per Day

Sector	Generation Amount per day (kg/establishment/day)
School	18.95
Kiosks (Corner Shops)	0.73
Supermarkets	10.72
Factories	101.19
Markets	2,151.85
Total	2,283.44

Source: JICA Project Team

Daily Generation Amount of Waste

The current amount of waste generated on a daily basis in Chitungwiza municipality is estimated at 187.5 t/day as shown in Table 4.3.17. Most of the waste is generated from residential areas. Table 4.3.17 shows the details of the population by income level and the numbers of establishments which were used to estimate the current daily waste generation amount. The population by income level and the number of establishments as shown in Table 4.3.17 which was obtained from JICA Project team and Chitungwiza municipality was utilized for the estimate of the waste amount as shown in Table 4.3.17.

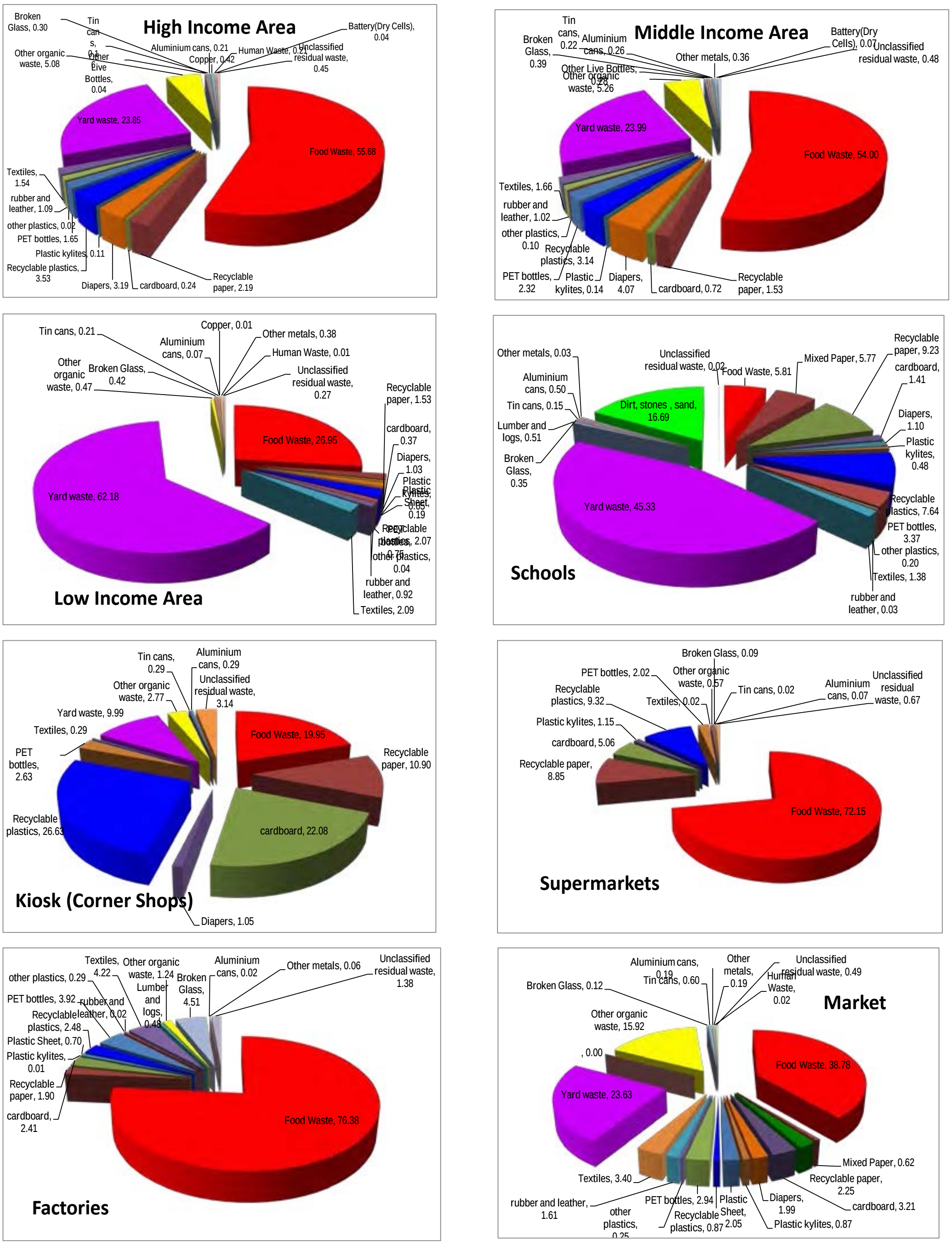
Table 4.3.17 Waste Generation Amount in Chitungwiza Municipality

Generation Source		Unit Generation Rate (kg/Person/day) (kg/establishment/day)	Population/ Quantity (Person/ Unit)	Generation Amount (t/day)
Residential Area	High Income Area	0.41	7,090	2.91
	Middle Income Area	0.38	104,223	39.60
	Low Income Area	0.49	243,187	119.16
	Sub Total		354,500	161.67
Establishment	Schools	18.95	67	1.30
	Corner shops	0.73	309	0.20
	Supermarket	10.72	400	4.30
	Factories	101.20	70	7.08
	Markets	2,151.90	6	12.90
	Sub Total		852	25.80
Total				187.47

Source: JICA Project Team

4) Waste composition

The results for the waste composition for residential areas and establishments are illustrated in Fig 4.3.8. Based on the values shown, food waste and yard waste make up most of the waste produced by the residential communities. The results show that high and middle income areas produced higher food waste compared to low income areas. On the other hand, the low income areas generated more yard waste compared to other income areas. Each establishment has individually different waste composition from one another.



Source: JICA Project Team

Figure 4.3.8 Waste Composition by Generation Sources

5) Bulk Density

The results of the bulk density for residential area and the establishments are shown in Table 4.3.18 and Table 4.3.19, respectively. The average figures of bulk density range from 139.3 to 187.7 kg/m^3 for the residential areas, and those for the establishments range from 49.3 to 168.1 kg/m^3.

Table 4.3.18 Results of Bulk Density for Residential Area

Area	Average (kg/m^3)
High Income Area	139.3
Middle Income Area	187.7
Low Income Area	181.6

Source: JICA Project Team

Table 4.3.19 Results of Bulk Density for Establishments

	Average (kg/m^3)
Schools	49.3
Kiosks (Corner Shops)	-
Supermarkets	80.4
Factories	168.1
Markets	73.4

Source: JICA Project Team
Notes: The waste sample could not fill the container to measure the bulk density.

6) Moisture content

The results of the moisture content for residential area and the establishments are shown in Table 4.3.20 and Table 4.3.21, respectively. The average figures of bulk density range from 31.5 to 38.9% for the residential areas, and those for the establishment range from 15.2 to 50.4%.

Table 4.3.20 Results of Moisture Content for Residential Area

Area	Average (%)
High Income Area	31.5
Middle Income Area	38.9
Low Income Area	35.5

Source: JICA Project Team

Table 4.3.21 Results of Moisture Content for Establishments

	Average (%)
Schools	16.7
Kiosks	15.2
Supermarkets	37.1
Factories	23.1
Markets	50.4

Source: JICA Project Team

4.3.4 Illegal Dumping Survey

Illegal dumping is identified in every place in Chitungwiza city. The survey on the distribution and piled amount of dumped waste is important for formulating of future clean-up plan. In this survey, the location and estimated amount of illegally dumped waste were examined.

(1) Survey area

The survey area was covered in all areas of Chitungwiza city.

(2) Survey method

The middle and large scale illegal waste dumping areas were surveyed. Prior to the survey work, the local survey company collected basic information on distribution of illegal dumping sites from the Chitungwiza Municipality. The target areas were majored by the length, width and height and the piled waste amount was measured by using a tape measure and by visual inspection. The locations of dumping site were identified and saved by using a GPS and plotted on maps. Photographs were taken at least four shots per site to show the feature of the dumping area. In addition, general information of the dump site was collected by interviewing with the neighbouring residents on the following points:

- Surrounding condition of the site in relation to illegal dumping
- Year when illegal dumping started
- Who actually dumps waste
- Municipality's plan on clean-up

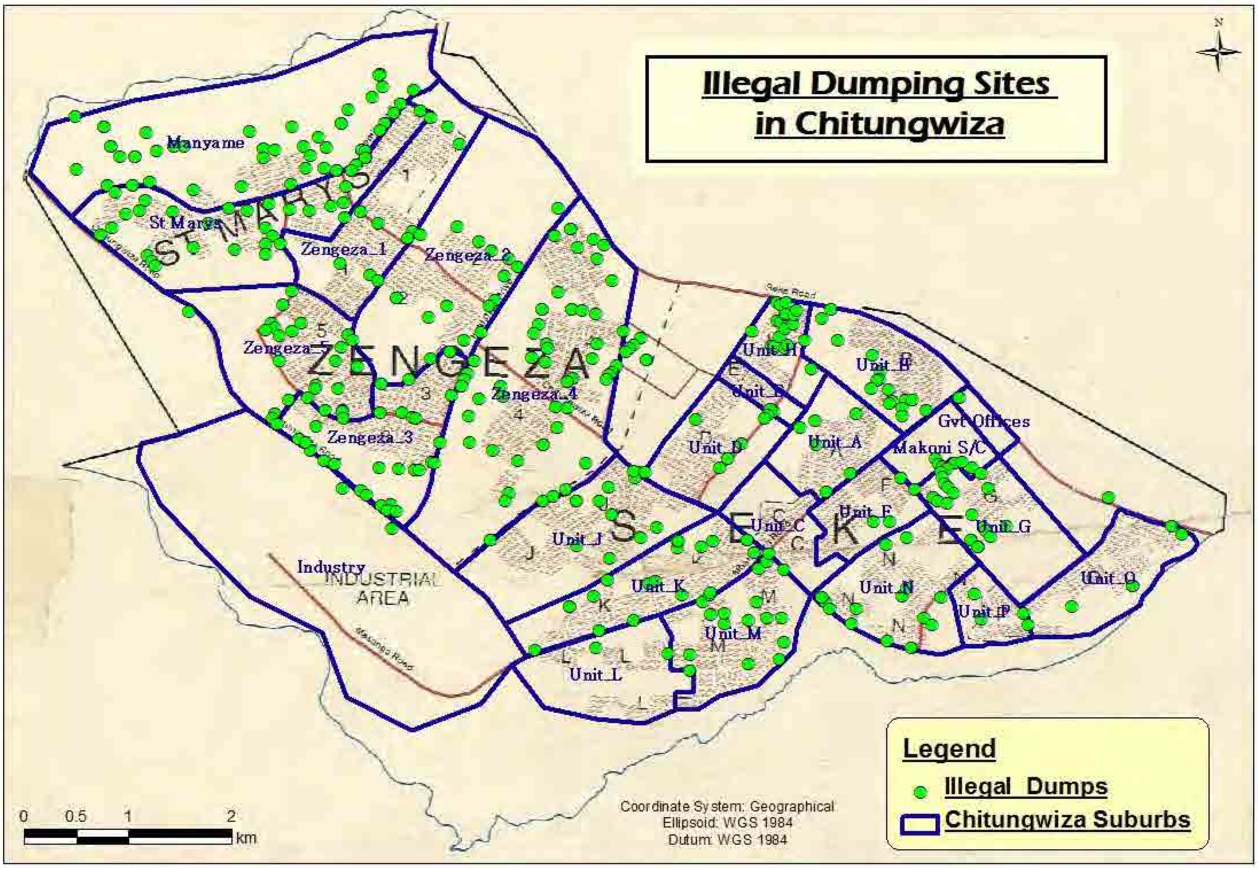
(3) Actual progress

The actual survey was carried out based on the schedule shown in Figure 4.3.5.

(4) Survey results

The completed survey resulted in the identification of 390 illegal dumpsites throughout the municipality. The majority of the sites are in Zengeza district, followed by Seke South. The sites were visible to the public. A great majority of the sites documented in this report were located in close proximity to streams. Figure 4.3.9 shows the illegal dumping sites in Chitungwiza city.

Table 4.3.23 shows the total area and volume of illegal dumpsites in Chitungwiza municipality by residential area, while and Figure 4.3.10 shows the graphical distribution of the area covered by illegal dumpsites by each district in the same municipality. The illegal dumping sites cover an estimated area of 100,000 m^2 and have a volume of 60,000 m^3.



Source: JICA Project Team

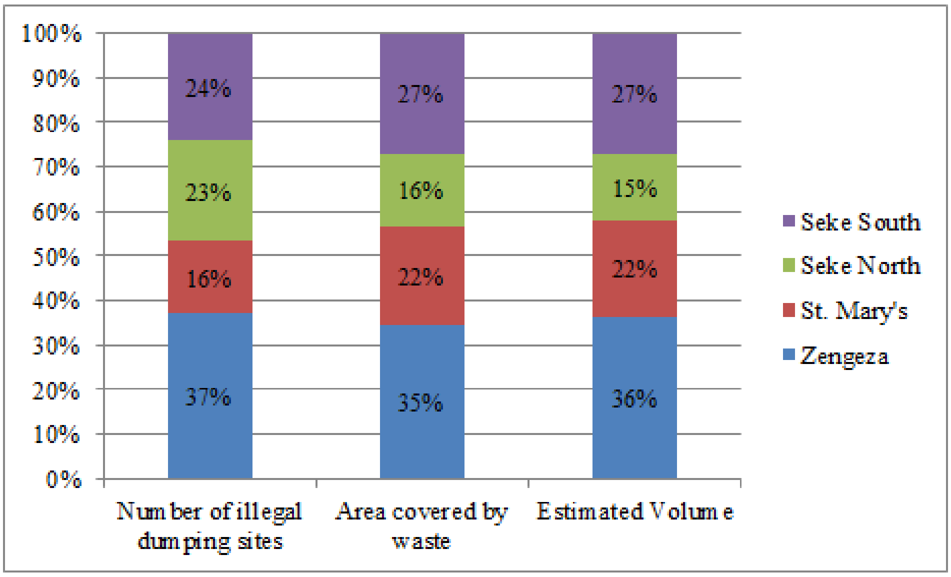
Figure 4.3.9 Location Map of Illegal Dumping Sites

Table 4.3.22 Total Estimated Area and Volume of Illegal Dumps in Chitungwiza

District	Residential Area	Number of illegal dumping sites	Area covered by Waste (m^2)	Estimated Volume of Waste (m^3)
Zengeza	Zengeza 1	19	4,837	2,952
	Zengeza2	13	3,570	1,893
	Zengeza 3	22	4,625	3,398
	Zengeza 3 Ext	22	2,316	1,291
	Zengeza 4	46	11,088	7,643
	Zengeza 5	15	2,635	1,482
	Zengeza 5 Ext	8	4,448	3,158
	Rockview	0	0	0
	Sub Total	**145**	**33,519**	**21,817**
St Mary's	St Mary's	28	13,130	8,763
	Manyame	35	8,489	4,271
	Sub Total	**63**	**21,619**	**13,034**
Seke North	Unit A	7	568	406
	Unit B	24	5,240	3,343
	Unit C	4	428	289
	Unit F	4	406	159
	Unit G	23	6,272	3,197
	Unit N	12	1,490	971
	Unit O	6	663	302
	Unit P	6	535	304
	Riverside	2	195	92
	Sub Total	**88**	**15,797**	**9,063**

District	Residential Area	Number of illegal dumping sites	Area covered by Waste (m^2)	Estimated Volume of Waste (m^3)
Seke South	Unit D	21	11,169	7,576
	Unit E	4	244	115
	Unit H	16	8,008	4,845
	Unit J	14	1,883	992
	Unit K	14	1,713	1,004
	Unit L	7	834	422
	Unit M	18	2,252	1,258
	Sub Total	**94**	**26,103**	**16,212**
Total		**390**	**97,038**	**60,126**

Source: JICA Project Team



Source: JICA Project Team

Figure 4.3.10 Distribution of Illegal Dumping Sites by District

4.4 Socio-Economic Profile of Chitungwiza Municipality

4.4.1 Chitungwiza Environmental and Social Considerations Baseline Study

(1) Methodology

The Environmental and Social Considerations Baseline Study was to sum up the present situation of Chitungwiza in the field of environmental sanitation, which comprises water supply, wastewater management and solid waste management including health and hygiene practices. The goal was to have enough qualitative and quantitative data to be able to develop environmentally sound projects that are adapted to the local situation and correspond to the need of the various stakeholders.

The survey was limited to Chitungwiza municipality, the direct influence area of the Study. It must be noted that the Study covered the City of Harare and its contiguous areas within the upper Manyame basin (refer to Section 1.3.). In order to collect the information required for the Study, three main tools were used: a) direct observations; b) structured interviews; and c) key informants interviews (KII) and focus group discussion (FGD).

- Direct observations

  This is to become familiar with the local settings and the level of vulnerability of households to access these basic services. A number of visits and observations were undertaken. Main focus was given to observations of environmental infrastructures such as water supply, sewage treatment facilities, toilets, and drainage.

- Structured interviews

  This tool was chosen because it ensures that the interview stays focused on the specific issue, and also makes certain that the interview is conversational enough to allow participants to introduce and discuss issues which they think are relevant. The interview guide, in the form of a questionnaire was designed by the Project Team and was pre-tested prior to implementation of the survey. Two questionnaires were developed: one for household interviews; and one for establishments. General topics were identified and more specific issues within each topic were defined. The main topics defined are:

  <u>Household survey</u>

  - Household profile. Size, educational attainment, occupation and place of work of household members, no. of families in the household, estimated monthly household income, expenditures and savings, consumption rate of water, service charge and the amount willing to pay for the service.
  - Household amenities and hygiene practices. Sources of potable water, toilet, sewerage and drainage facilities and their condition, adequacy and accessibility and expectations for improvement of these facilities, basic hygiene practices.

- Awareness/recognition of the household about health implications. Level of awareness of the health effects of unsafe drinking water and unsanitary conditions, and average medical expense for the last sickness experienced (only for water-related diseases).
- Awareness/recognition of the residents about water pollution. Level of awareness of water pollution of the rivers and lakes of the Municipality.
- Experiences and willingness to participate in municipal affairs related to health and environmental concerns: the experiences of past/present participation in municipal affairs related to health and environment concerns, expectation to water quality improvement, willingness to participate in municipal affairs, and opinion on the best way to address water pollution concerns in the area.

Establishment Survey

- Establishment Profile: type, size (no. of employees), volume of production, establishment lot and floor area, outline of facility: manufacturing (production) facility, operation and maintenance facilities.
- Establishment amenities and hygiene practices: sources of potable water, toilet, sewerage and drainage facilities and their condition, adequacy and accessibility and expectations for improvement of these facilities.
- Awareness/recognition of the establishment about health implications: Level of awareness of the health effects of unsafe drinking water and unsanitary conditions.
- Awareness/recognition of the establishment about water pollution: Level of awareness of water pollution of the rivers and lakes of the Municipality, its causes and necessity to install water pollution control devices/mitigation measures.
- Experiences and willingness to participate in municipal affairs related to health and environmental concerns: the experiences of past/present participation in municipal affairs related to health and environment concerns, expectation to water quality improvement, willingness to participate in municipal activities, and opinion on the best way to address water pollution concerns in the area.

A total of 100 households and 21 establishments were surveyed. In selecting sample households and establishments, the survey employed random sampling procedure. For household survey, distribution for each district was proportional to the population of the area. The data was captured into Statistical Package for Social Sciences (SPSS) software. The household profiles, knowledge and awareness levels, as well as behaviour and practices were drawn from the database using cross tabulations and frequencies. Chitungwiza is divided into 4 administrative districts, namely: St Mary’s, Zengeza, Seke North and Seke South. For this survey, these districts were further demarcated into three economic levels: low, medium, and high income zones based on the value of land (Bvoro, personal communication). The analysis of the data was based on the three economic levels. For the establishments' survey, Microsoft Excel was used for data analysis.

- Key informants interviews (KII) and Focus group discussion (FGD)

For these undertakings, the following were interviewed: the officers and staff of the Department of Health, Department of Urban Planning Service, and Department of Engineering, all of Chitungwiza Municipality. Interviews were also conducted with the officers of the Environment Management Agency (central), the Provincial Office, and the District Office of EMA. Discussion on the levels of pollution and the extent of the government's implementation of the laws and regulations were made. An FGD involves small group of key persons discussing a topic or an issue which is defined at the outset by the study team. The FGD was also used to validate the results of the structured interviews. This was undertaken to a group of women who were queuing to fetch water from a borehole at Unit E/H shops. In this occasion, the household members were able to have an opportunity to talk about issues of interest for them including water supply, sanitation and hygiene issues.

The following information was in large parts gathered during the structured interviews with supplements from the field notes of direct observations, the KIIs and secondary data mostly from the Department of Health of Chitungwiza.

(2) Geographic Location and Administrative Organisation

Chitungwiza Municipality is located about 30 km south of the capital city, Harare. It was established in 1978 as a dormitory town of Harare. The majority of the people who lived in the town had been displaced by the civil war that the country was experiencing during that time. Chitungwiza gained full municipal status in 1981 and it is the third-largest and the fastest-growing urban centre in Zimbabwe.

According to the 2002 Census, the town had a population of 321,782. While the 2012 Census clarified that the current population is 354,500. Most of the people work in Harare, as there are very few opportunities and industries in Chitungwiza. Also, the problem of availability of affordable accommodation in Harare results in some of the workforce residing in Chitungwiza. The area is divided into 4 administrative districts, namely: St Mary's, Zengeza, Seke North and Seke South. Table 4.4.1 shows the administrative districts and their corresponding population.

Table 4.4.1 Population Composition of Chitungwiza Municipality*

District	Number of People
Seke South	67,355
Seke North	102,805
Zengeza	113,940
St. Marys	70,400
Total	354,500

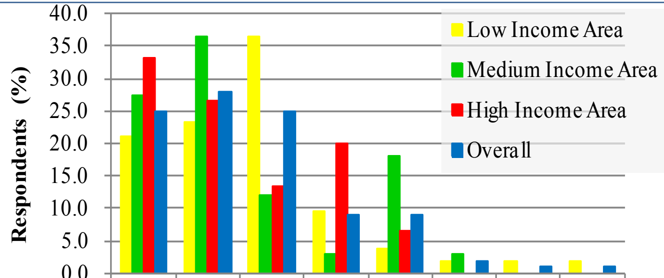
*Based on estimates by Census 2012 and the JICA Project Team

4.4.2 Household Socio-economic and Perception Survey

(1) Household demographic profile

1) Household characteristics of sampled households

The total population of the 100 surveyed households was 598 giving an average household size of 5.98 persons or 6 persons per household, while the median value was taken at 5.00 persons per household. The survey established that it was a common practise for the household to share dwelling with another household (Figure 4.4.1). On the average, most dwellings were shared by 3 households (families), while the median value was at 2.00 households. In low income areas, most dwelling units were shared by 3 households, 2 households in medium income areas, while the high income areas had mostly one household per dwelling unit.



	1	2	3	4	5	6	7	11
Low Income Area	21.2	23.4	36.5	9.6	3.8	1.9	1.9	1.9
Medium Income Area	27.3	36.4	12.1	3.0	18.2	3.0	0.0	0.0
High Income Area	33.3	26.7	13.3	20.0	6.7	0.0	0.0	0.0
Overall	25.0	28.0	25.0	9.0	9.0	2.0	1.0	1.0

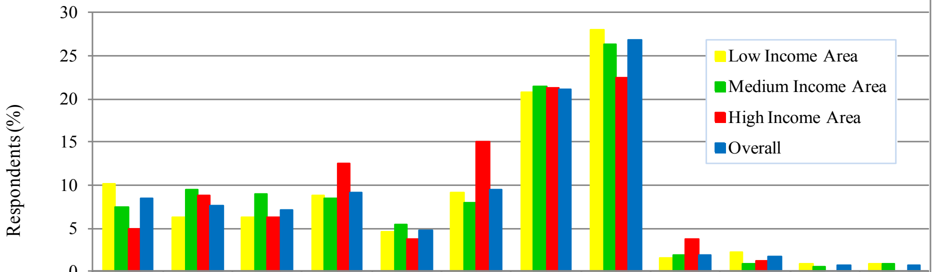
Number of Households (Families)

Source: JICA Project Team

Figure 4.4.1 Number of Households (families) in one dwelling Unit

2) Age and sex distribution of sampled households

In terms of age and sex distributions of household member, the largest proportion of the population were in the 18 to 50 years age group, i.e., the productive age group, followed by the school-age group, then under fives, and lastly the elderly (Figure 4.4.2). The elderly population (greater than 50 years old) was very small indicating mortality at an early age. This figure matches up with the low life expectancy in Zimbabwe of 43.3 years old (Government of Zimbabwe, 2010).



	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	0-5 years		6-12 years		13-17 years		18-50 years		51-65 years		>65 years	
Low Income Area	10.1	6.3	6.3	8.8	4.7	9.1	20.8	28.1	1.6	2.2	0.9	0.9
Medium Income Area	7.5	9.5	9	8.5	5.5	8	21.4	26.4	2	1	0.5	1
High Income Area	5	8.8	6.3	12.5	3.8	15	21.3	22.5	3.8	1.3	0	0
Overall	8.5	7.7	7.2	9.2	4.8	9.5	21.1	26.8	2	1.7	0.7	0.8

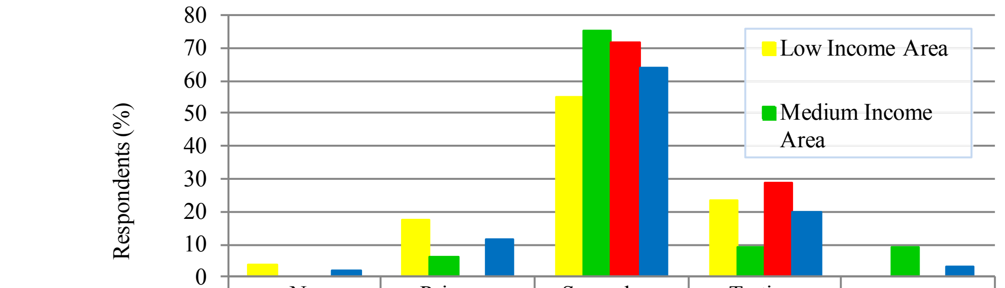
Source: JICA Project Team

Figure 4.4.2 Age and Sex Distribution of Sampled Households

(2) Household heads demographic profile

1) Educational attainment

The level of education of household heads was generally low. Most of the household heads had only attained secondary education (Figure 4.4.3). A large number of household heads in the high income area had tertiary education.



	No schooling	Primary School	Secondary School	Tertiary School	Other
Low Income Area	3.9	17.6	54.9	23.5	0
Medium Income Area	0	6.3	75	9.4	9.4
High Income Area	0	0	71.4	28.6	0
Overall	2.1	11.3	63.9	19.6	3.1

Source: JICA Project Team

Figure 4.4.3 Educational Status of Household Heads in Sampled Households

2) Employment variation of household heads

51% of the household respondents were formally employed. The rest either had informal employment, pensioners, or had no employment at all. The household heads were employed from different locations with about half employed within Chitungwiza (Table 4.4.2). This holds true in almost all income groups. Harare also offers employment to Chitungwiza residents as they commute to and from the city every day. It should be noted that about 9% of the household heads were working overseas.

Table 4.4.2 Place of Work of Household Heads

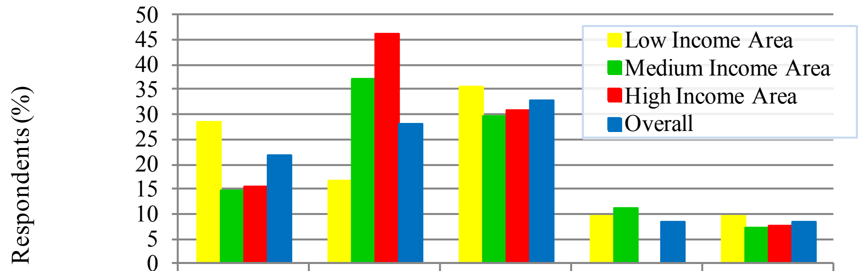
Place of Work	Low income area		Medium income area		High income area		Overall	
	Number	%	Number	%	Number	%	Number	%
Chitungwiza	24	29.6	10	12.3	7	8.6	41	50.6
Harare	14	17.3	11	13.6	5	6.2	30	37.0
Other towns and	1	1.2	2	2.5	0	0.0	3	3.7
Outside the country	4	4.9	2	2.5	1	1.2	7	8.6
Total	43	53.0	25	30.9	13	16.0	81	100.0

Source: JICA Project Team

3) Household head income and expenditure

33% of the household heads stated that their monthly income was in the range of USD 250 – UDSD 500 (Figure 4.4.4) with an average monthly income of USD 390.16. Median monthly income was taken at USD 200.00 per household head. Average monthly expenditure was at USD 334.51 and median value at USD 299.00. The expenditures covered basic needs such as food, rentals, bills (electricity and water) and school fees. Only 33% of the household heads indicated that they saved some amount of cash, the remaining 67% indicated that the income was not sufficient and therefore they had nothing to save. It should however be noted, that some respondents were not willing to divulge information on how much savings they were making.

46% of the household heads informed that other household members were also employed with most of the respondents coming from the low income area. Employment for other members of households varied with a mixture of both the formally employed and informally employed. But only half of the household heads reported that income of the other members of the household contributed to the total expenditures of the household, and about 29% indicated that it partly contributed. The rest do not contribute at all. No amount was disclosed on how much was contributed to the expenditures of the household.



	>$100	<$100-$250	<$250-$500	<$500-$1000	above $1000
Low Income Area	28.6	16.7	35.7	9.5	9.5
Medium Income Area	14.8	37	29.6	11.1	7.4
High Income Area	15.4	46.2	30.8	0	7.7
Overall	22	28	32.9	8.5	8.5

Source: JICA Project Team

Figure 4.4.4 Estimated Monthely Income for Household Heads

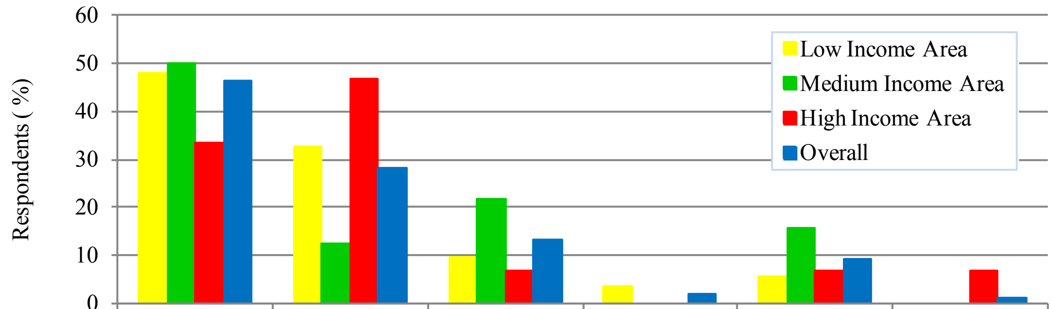
(3) Household Amenities (with focus on water supply and sanitation)

1) Water supply

The main water supply for Chitungwiza comes from Harare City (Morton Jeffry and Prince Edward Water Works). However, due to the current economic challenges faced by Harare City, water is in short supply for the Harare community hence; shortages are also felt by the residents of Chitungwiza.

a) Main source of drinking water

Drinking water from the tap is available to 75% the households in Chitungwiza. The high income area households drink water from the tap although the water is just piped into the yard due to some houses that are still under construction. Other sources are boreholes, shallow wells and a spring found in Rockview (Figure 4.4.5).



	piped water into dwelling	Piped water into yard/plot	Borehole	shallow well unprotected	shallow well protected	Unprotected spring
Low Income Area	48.1	32.7	9.6	3.8	5.8	0
Medium Income Area	50	12.5	21.9	0	15.6	0
High Income Area	33.3	46.7	6.7	0	6.7	6.7
Overall	46.5	28.3	13.1	2	9.1	1

Source: JICA Project Team

Figure 4.4.5 Main Water Source for Drinking of Households

b) Water treatment method used

Over-all, 63% of the households treat their water before drinking. The high income households had a different case as about 60% of the households do not treat their water. In most cases, those who treated the water did so to ensure they are drinking safe water. Those who were not treating their water had a variety of reasons; 1) trusted their sources, 2) lack of time to treat their water, and 3) lack of resources for treating the water. The most common method employed was by adding bleach/chlorine with 62% of the households using this method. Adding chlorine was through the use of water treatment tablets (aquatabs) and water-guard (a local product). Table 4.4.3 shows the water treatment methods employed by the households.

Table 4.4.3 Household Water Treatment Methods Used

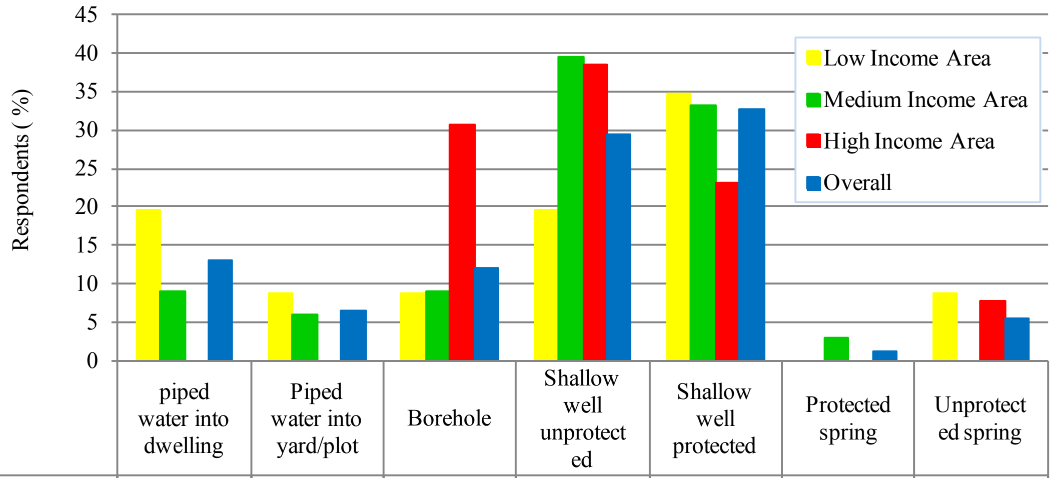
Method	Low income area (%)	Medium income area (%)	High income area (%)	Over-all (%)
Boil	34.2	40.9	20.0	35.4
Add bleach/chlorine	60.5	59.1	80.0	61.5
Boil/add bleach	2.6	0.0	0.0	1.5
Let it stand and settle	2.6	0.0	0.0	1.5
Total	100.0	100.0	100.0	100.0

Source: JICA Project Team

c) Alternative water sources

A high 76% of the interviewed households acknowledged that their main source of water was unavailable at certain times. When water is not available, protected and unprotected shallow wells were the main alternative water source for drinking purposes at 32.6% and 29.4%, respectively.

Another alternative source was the boreholes, especially for the high-income area at 12% (Figure 4.4.6).



	piped water into dwelling	Piped water into yard/plot	Borehole	Shallow well unprotected	Shallow well protected	Protected spring	Unprotected spring
Low Income Area	19.6	8.7	8.7	19.6	34.7	0	8.7
Medium Income Area	9.1	6.1	9.1	39.4	33.3	3	0
High Income Area	0	0	30.8	38.5	23.1	0	7.7
Overall	13	6.5	12	29.4	32.6	1.1	5.4

Source: JICA Project Team

Figure 4.4.6 Alternative Water Sources for Drinking Water

d) Water consumption

Using the average household size of 5.98, the average household daily consumption of water ranged from 100 – 200 L at 40.4% (Table 4.4.4). The average per capita daily consumption was taken at a range of 16.7 to 33.4 L. The lower range of 16.7 L/c/d does not meet the WHO standards for point sources (such as boreholes) that recommended a minimum of 20 L/c/day. Most residents in Chitungwiza municipality now rely on boreholes or shallow wells (point sources) as the alternative water source when tap water is not available.

Combined, the ranges with lower consumption (>50 – 100 L/day/household at 39% and less than 50L/day/household at 16%) totalled to 55.6%. This means that more than half of the population has a capita daily consumption of less than 16.7 L/c/day. The deficit is too large to be ignored. Hygiene practices are determined by adequate quantity of water; several studies established that most endemic diarrhoea is not water-borne, but transmitted from person to person by poor hygiene practices (WHO). Studies also showed that an increase in the quantity of water has a greater health impact than improved water quality because it makes it possible for people to adopt safe hygiene behaviours. The studies asserted that sanitation and hygiene promotion must accompany the infrastructure investments that supply adequate water to realize their full potential as a public health intervention.

Table 4.4.4 Amount of Water Used by Households per Day

Consumption	Low income area (%)	Medium income area (%)	High income area (%)	Over-all
>200-400L/day	7.8	0.0	0.0	4.0
>100-200L/day	33.3	48.5	46.7	40.4
>50L-100L/day	43.1	33.3	40.0	39.4
less than 50L/day	15.7	18.2	13.3	16.2
Total	100.0	100.0	100.0	100.0

Source: JICA Project Team

e) Water charges and perceptions

Overall, 98% of the interviewed households had water meters on their premises and 91% of the meters were functional. 93% of the households confirmed that the municipality takes water meter readings, while 88% confirmed that these visits were monthly. The households who indicated that the visits were rare and said they were being billed by just using estimates (Table 4.4.5).

Table 4.4.5 Frequency of Meter Readings

Frequency	Low income area		Medium income area		High income area		Over-all	
	Number	%	Number	%	Number	%	Number	%
Monthly	41	46.6	25	28.4	11	12.5	77	87.5
Rarely	8	9.1	1	1.1	2	2.3	11	12.5
Total	49	55.7	26	29.5	13	14.8	88	100.0

Source: JICA Project Team

Although a greater part of the sampled households (85%) had recent bill statements with most bills from the months of May to August 2012, only 34% were in agreement. 66% of the respondents disagreed with their bills and argued that their taps were dry most of the times and yet the bills were very high. From the bill statements, 56% of the households consumed an average of 20-40 KL/month (Table 4.4.6) while a smaller proportion of 2.3% consumed less than 10 KL/month.

Table 4.4.6 Consumption Rate of Households Based on Recent Billing

Consumption rate	Frequency of Households	% of Households
>40KL/month	4	9.3
>20-40KL/month	24	55.8
>10-20KL/month	14	32.6
<10KL/month	1	2.3
Total	43	100.0

Source: JICA Project Team

Notwithstanding the income group, the 97 sampled households indicated that they were willing to pay for the water they consumed. The average amount the households were willing to pay per month for the water services was USD 17.09, while the median value was taken at USD 15.00.

Majority of the households indicated that they were prepared to pay less than 10 USD/month for water services (41%) as shown in Table 4.4.7.

Table 4.4.7 Amount Willing to Pay for Water Services per Month

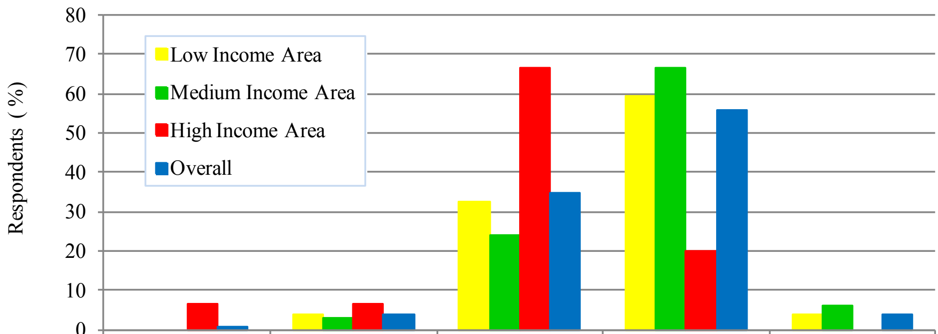
Amount	Frequency	% of Households
> 50 USD	1	1.0
>40-50 USD	2	2.1
>20-40 USD	22	22.7
>10-20 USD	32	33.0
<10 USD	40	41.2
Total	97	100.0

Source: JICA Project Team

2) Sanitation and sewerage

a) Place of defecation

56% of the sampled households use the flush toilet using the bucket system as water is not always available (Figure 4.4.7).



	Pit latrine	BVIP latrine	Flush toilet	Flush toilet using bucket system	Normal fluxh or bucket system
Low Income Area	0	3.8	32.7	59.6	3.8
Medium Income Area	0	3	24.2	66.7	6.1
High Income Area	6.7	6.7	66.7	20	0
Overall	1	4	35	56	4

Source: JICA Project Team

Figure 4.4.7 Place of Defecation

b) Ownership of latrine

Almost all households surveyed owned latrines (99%) except for one household in the low income area who relied on the neighbour's facility (Table 4.4.8). The household head explained that it has yet to be constructed. In terms of ownership of latrines, none of the respondents indicated that they defecated in their houses and placed their faeces in the bins at their premises for collection by the municipality; however, the result of the *Waste Amount and Composition Survey* carried out earlier for the Project, showed that faeces were part of the waste composition especially in Rockview residential area.

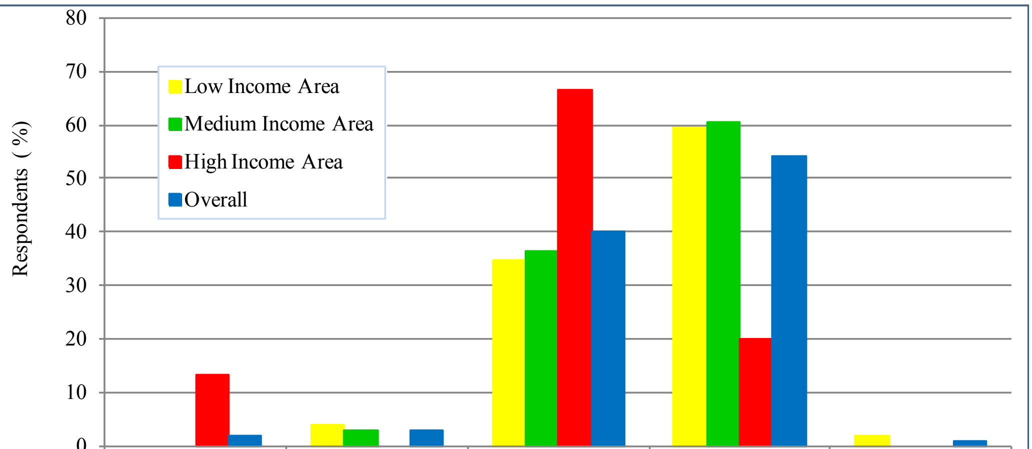
Table 4.4.8 Ownership of a Latrine per Household

Ownership	Low income area		Medium income area		High income area		Overall	
	Frequency of HH	% of HH	Frequency of HH	% of HH	Frequency of HH	% of HH	Frequency of HH	% of HH
Yes	51	98.1	33	100	15	100	99	99
No	1	1.9	0	0	0	0	1	1
Total	52	100.0	33	100	15	100	100	100

Source: JICA Project Team

c) Type of latrine owned

Majority of the households (94%,) across all the income areas owned flush toilets and depending on the availability of tap water, they flushed or used the bucket system (Figure 4.4.8). A number of households in the high-income areas owned pit latrines (13.3%). This can be explained by the fact that the areas were still under construction and therefore proper sanitation structures were not yet in placed.



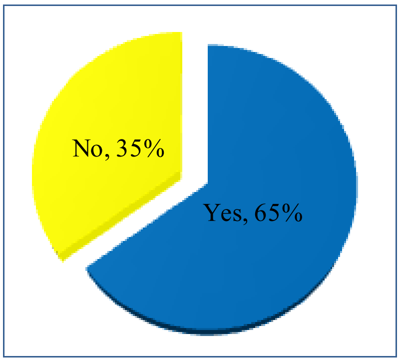
	Pit latrine	BVIP latrine	Flush toilet	Flush toilet using bucket system	Normal fluxh or bucket system
Low Income Area	0	3.8	34.6	59.6	1.9
Medium Income Area	0	3	36.4	60.6	0
High Income Area	13.3	0	66.7	20	0
Overall	2	3	40	54	1

Source: JICA Project team

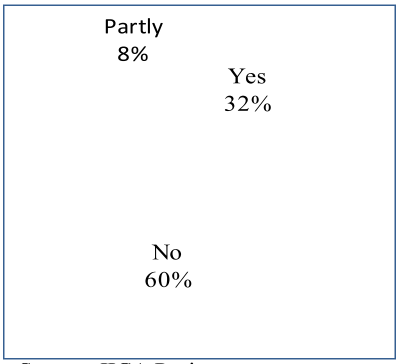
Figure 4.4.8 Type of Latrine Owned

d) Sewage and drainage facilities

65% of the households specified that sewer flows from burst sewer pipes passed through/ in front of/ near their premises. The low income area had most of its sewer pipes burst and flows occurred very often in the area. This could be explained by the fact that majority of the low-income areas have dwellings that were occupied by more than 2 families that puts pressure on the facilities. In cases of sewage burst, the authorities took time in fixing the problem according to 78% of the household respondents. 60% further stated that they were not satisfied with the service (Figure 4.4.10). The main reason for the dissatisfaction was the council workers usually asked them to pay a range of USD 1-3 per household so that the problem will be fixed.



Source: JICA Project team
Figure 4.4.9 Frequency of Sewage Burst Flowing House Premises



Source: JICA Project team
Figure 4.4.10 Satisfaction of Service

In order to improve the issue of blockages of sewer pipes, Table 4.4.9 shows the responses of the respondents. Notable among them were the use of correct toilet paper and not using sand for washing dishes and pots. Also, the early reporting of cases would help in the immediate response/actions of the authorities.

Table 4.4.9 Suggested Ways the Community Can Help Improve the Situation

Suggestions	Frequency	Ratio (%)
Avoid blockages in toilets by using the correct toilet paper, not using sand to wash dishes and pots	26	37.7
Report cases of burst pipes early	16	23.2
Work with plumbers to get the bursts fixed-community contribution	10	14.5
It is the authorities responsibility	8	11.6
Pay for services to council promptly	7	10.1
Call for meeting to discuss issues	2	2.9
Total	69	100.0

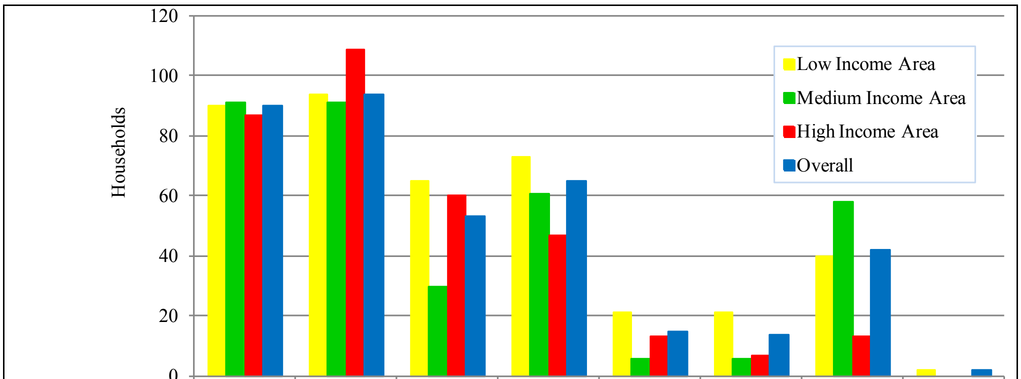
Source: JICA Project Team

(4) Hygiene practices

A recent review of available studies suggests that hand washing with soap could reduce diarrhoea incidence by 47% and save at least one million lives per year (World Bank). Several studies showed that, improved hygiene (hand washing) and sanitation (latrines) have more impact than drinking water quality on health outcomes as these practices can reduce diarrhoea, parasitic infections, morbidity and mortality, and increase child growth.

1) Hand washing

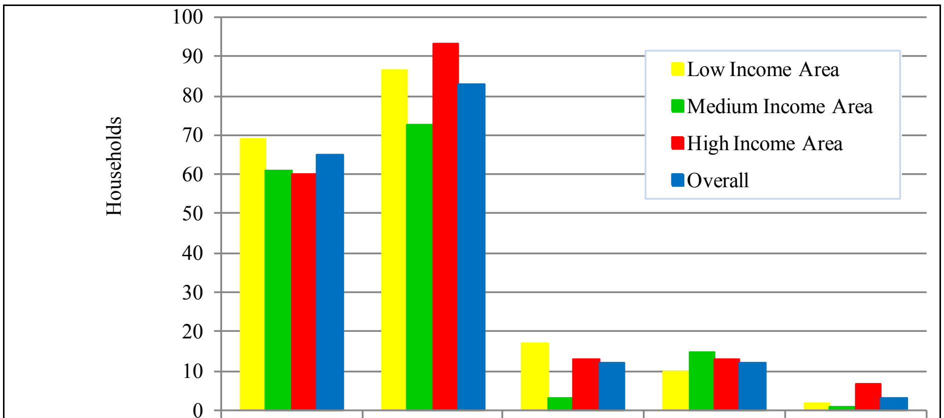
The knowledge of the surveyed households on when hands were usually washed is shown in Figure 4.4.11. While 94% of the households washed their hands after using the toilet, 90% also acknowledged washing of hands before eating. The reasons why households washed their hands are shown in Figure 4.4.12. Most households linked the washing of hands to good health to avoid diseases (83%). However, a notable percentage washed their hands because they simply wanted clean hands (65%). This was directly linked to when they usually washed their hands i.e. before eating.



	Before eating	After using the toilets	Before preparing food	After eating	After handling child's faeces	Before breast feeding	After carrying some work	Other
Low Income Area	90	94	65	73.1	21	21	40	2
Medium Income Area	91	91	30	61	6	6	58	0
High Income Area	87	109	60	47	13	7	13	0
Overall	90	94	53	65	15	14	42	2

Source: JICA Project Team

Figure 4.4.11 Occurrence of Washing of Hand



	To clean hands	To avoid diseas	To remove smell	Common practise	Other
Low Income Area	69	86.5	17	10	2
Medium Income Area	61	72.7	3	15	1
High Income Area	60	93	13	13	7
Overall	65	83	12	12	3

Source: JICA Project Team

Figure 4.4.12 Reasons for Washing of Hands

(5) Awareness of households about health implications

1) Knowledge of water borne diseases

The most prevalent diseases mentioned by the community were typhoid and cholera at 61%, and 58%, respectively (Table 4.4.10). It is worthwhile to note that about 8% do not have any idea at all. One would have expected more people to be aware as the municipality has been experiencing water-borne disease outbreaks during the past five years coupled with IEC activities conducted by the municipality's Department of Health, Ministry of Health and Child Welfare and non-governmental organisations (NGOs). The households had mentioned the causes of the diseases: 1) drinking unclean water; 2) poor hygiene; 3) flowing sewage; and 4) clean water shortages for diseases like dysentery, diarrhea, cholera and typhoid. Those households that had knowledge of malaria mentioned that stagnant water and mosquitos were the causative agents.

Table 4.4.10 Prevalent Water borne Diseases in the Community

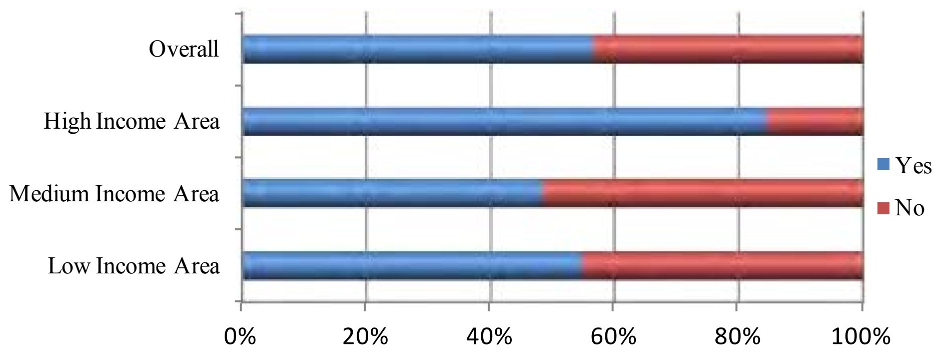
Diseases	Low income area		Medium income area		High income area		Overall	
	Frequency of HH	% of HH	Frequency of HH	% of HH	Frequency of HH	% of HH	Frequency of HH	% of HH
dysentery	9	17.6	4	13.8	2	13.3	15	15.8
diarrhoeal	13	25.5	11	37.9	5	33.3	29	30.5
malaria	1	2.0	2	6.9	2	13.3	5	5.3
bilharzias	4	7.8	0	0	1	6.7	5	5.3
cholera	29	56.9	13	44.8	13	86.7	55	**57.9**
Typhoid	33	64.7	13	44.8	12	80.0	58	**61.1**

Source: JICA Project Team

To prevent themselves from contracting these diseases, the households mentioned that there was a necessity to drink clean safe water as well as treating water by means of boiling or by chlorination (water tablets and water guard). Practising good hygiene would assist in preventing one from contracting the water borne diseases.

2) Health and hygiene education (HHE)

Although changing hygiene behaviour is complex, it has been found out that hygiene promotion is most successful when it targets a few behaviours with the most potential for impact such as hand washing (BRAC, 2008). Figure 4.4.13 indicates that more than half of the respondents (57%) did not receive any form of health and hygiene education in their communities. The highest number of such a response came from the high income area where 85% of the sampled households did not receive any hygiene education.



	Low Income Area	Medium Income Area	High Income Area	Overall
Yes	54.9	48.5	84.6	56.7
No	45.1	51.5	15.4	43.3

Source: JICA Project Team

Figure 4.4.13 Availability of Health and Hygiene Education

The survey established that most households that received Health and Hygiene Education (HHE) was from home visits by staff of the Ministry of Health and Child Welfare (MHCW) for a week as shown in Table 4.4.11. The content covered: 1) disease prevention of waterborne disease like typhoid and cholera; 2) water treatment and its importance; 3) washing of hands and other good hygiene practises; and 4) household solid waste management, i.e. burying or burning.

Table 4.4.11 Hygiene Education Received by Sampled Households

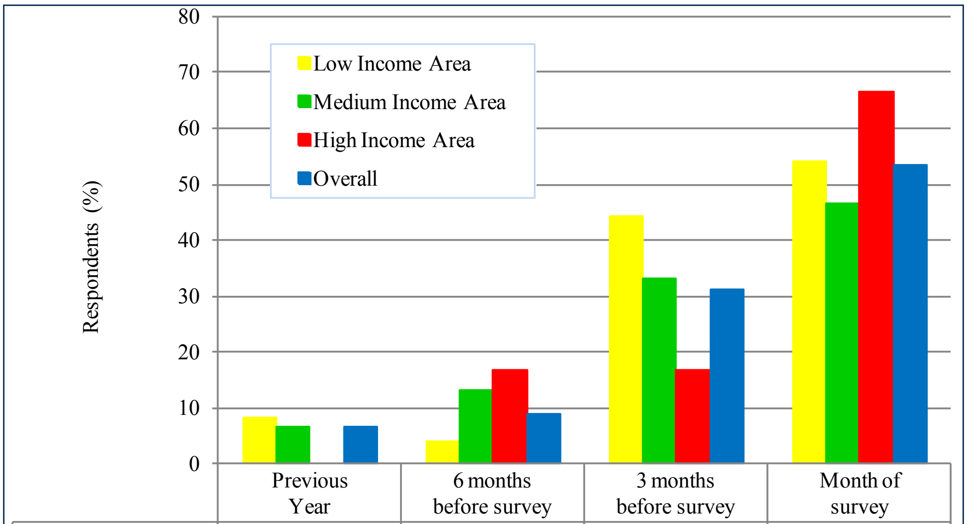
Method	Conducted by:	Duration	% of Respondent Households that Availed
PHHE	NGO	less than a week	14.6
Health Promotion Session	MOHCW	one week	17.1
Home visits	Community Health promoters	more than a week	56.1
Others (schools)	Teachers	one day	12.2

Source: JICA Project Team

3) Medical expenses for last sickness experienced

Most of the members of the sampled households do not have access to medical aid plan (74.2%). A significant number of households paid cash in case a family member became sick. A few of the cases accessed the clinics for free due to age, while others who have relatives who worked in clinics and hospital, have medication brought home for them.

A noticable percentage of households (45%) reported to have one of their family member contracting a water borne disease (refer to Table 4.4.10 for the prevalent water-borne diseases in the community). Most of the disease incidences were faced during the month of August 2012 (month of survey) at 53.3% (Figure 4.4.14), the month Chitungwiza was declared to have a typhoid outbreak.

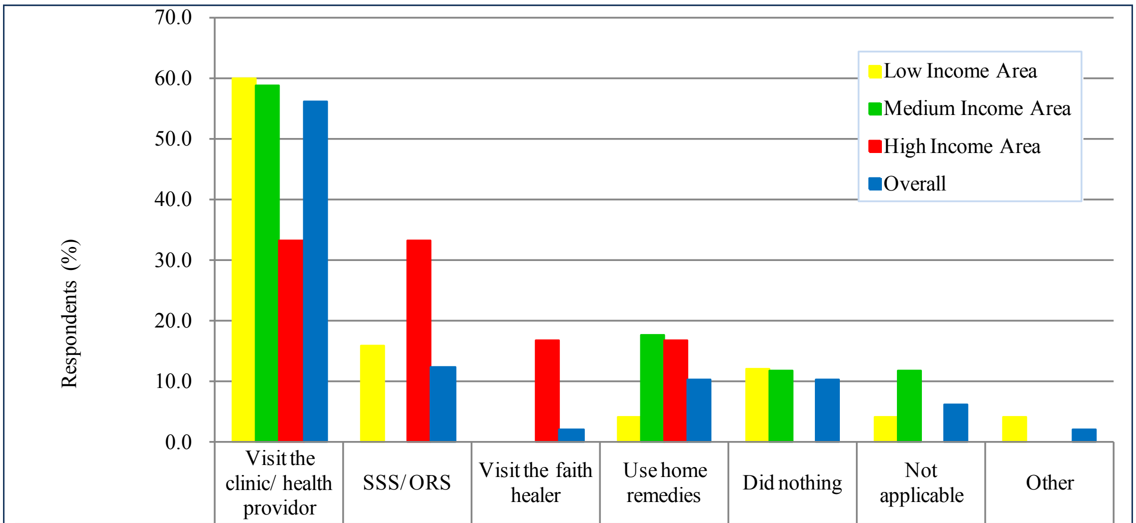


	Previous Year	6 months before survey	3 months before survey	Month of survey
Low Income Area	8.3	4.2	44.4	54.2
Medium Income Area	6.7	13.3	33.3	46.7
High Income Area	0	16.7	16.7	66.7
Overall	6.7	8.9	31.1	53.3

Source: JICA Project Team

Figure 4.4.14 Period of Incidences Typhoid outbreak.

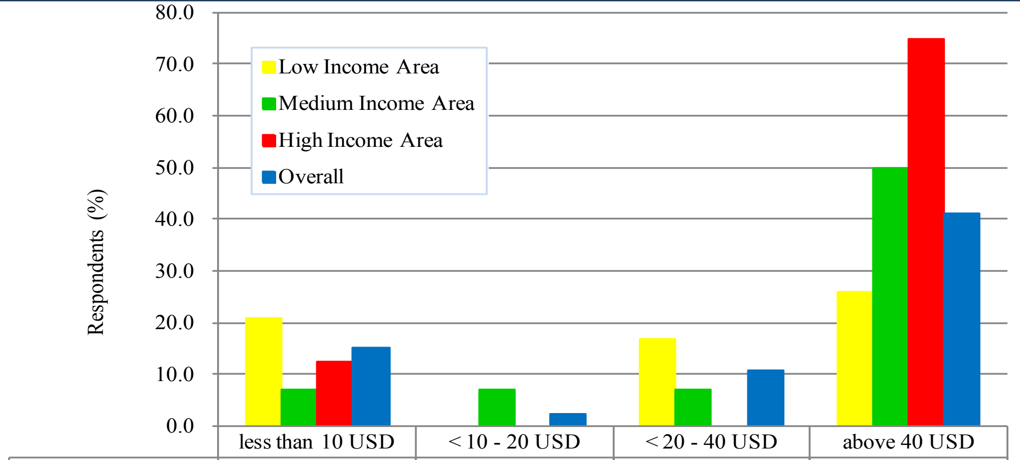
56% of the households overcame the problem by visiting the clinic. Other remedies included: self-medication at home by the use of SSS/ORS and visit to faith healer (Figure 4.4.15). On the average, the households spent USD 20.70 on the last sickness, while the median value was USD 11.50 (Figure 4.4.16). As shown in the figure, households spent less than USD 10.00 (30%) for sickness.



	Visit the clinic/ health providor	SSS/ORS	Visit the faith healer	Use home remedies	Did nothing	Not applicable	Other
Low Income Area	60.0	16.0	0.0	4.0	12.0	4.0	4.0
Medium Income Area	58.8	0.0	0.0	17.6	11.8	11.8	0.0
High Income Area	33.3	33.3	16.7	16.7	0.0	0.0	0.0
Overall	56.3	12.5	2.1	10.4	10.4	6.3	2.1

Source: JICA Project Team

Figure 4.4.15 Ways in Overcoming the Problem



	less than 10 USD	< 10 - 20 USD	< 20 - 40 USD	above 40 USD
Low Income Area	20.8	0.0	16.7	26.0
Medium Income Area	7.1	7.1	7.1	50.0
High Income Area	12.5	0.0	0.0	75.0
Overall	15.2	2.2	10.9	41.3

Source: JICA Project Team

Figure 4.4.16 Amount Spent on Last sickness

(6) Households awareneness about water pollution

1) Knowledge of municipality's water sources

25% of the households do not have an idea about the sources of water for Chitungwiza Municipality (Table 4.4.12). Those who had idea mentioned Manyame Dam, Manyame River, Lake Chivero, Mottorn Jefry, Prince Edward Dam, Hunyani River and Harare city as water sources.

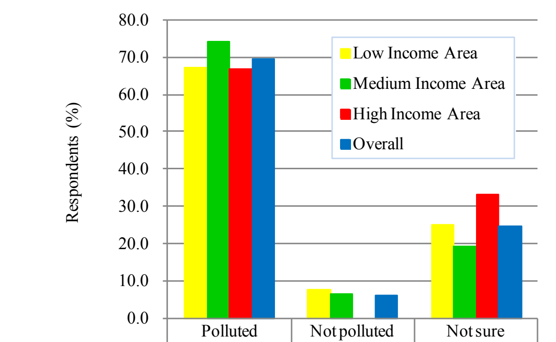
Table 4.4.12 Knowledge of Water Sources for Chitungwiza Municipality

Knowledge	Low Income Area		Medium Income Area		High Income Area		Overall	
	Number	%	Number	%	Number	%	Number	%
No Idea	14	15.2	8	8.7	1	1.1	23	25
Knowledgeable	33	35.9	22	23.9	14	15.2	69	75
Total	47	51.1	30	32.6	15	16.3	92	100

Source: JICA Project Team

2) Perceived state of the water sources

Most of the households perceived that the city's water sources were polluted as shown in Figure 4.4.17 and also majority of the households were not satisfied with the present water quality of the water sources (Table 4.4.13). 96% of the sampled households found the issue of industries installing water pollution control devices a necessity. (Table 4.4.14).



	Polluted	Not polluted	Not sure
Low Income Area	67.3	7.7	25.0
Medium Income Area	74.2	6.5	19.4
High Income Area	66.7	0.0	33.3
Overall	69.4	6.1	24.5

Source: JICA Project Team

Figure 4.4.17 State of the Water Resources

Table 4.4.13 Satisfaction with the Present Water Quality of the Water Sources

Response	Low Income Area		Medium Income Area		High Income Area		Overall	
	Frequency	% HHs	Frequency	% HHs	Frequency	% HHs	Frequency	% HHs
Yes	4	7.8	4	12.9	1	7.1	9	9.4
No	39	76.5	27	87.1	11	78.6	77	80.2
Partly	8	15.7	0	0.0	2	14.3	10	10.4
Total	51	100.0	31	100.0	14	100.0	96	100.0

Table 4.4.14 Necessity of the Industries/Institutions to Install
Water Pollution Control Devices/ Mitigation Measures

Response	Low Income Area		Medium Income Area		High Income Area		Overall	
	Frequency	% HHs	Frequency	% HHs	Frequency	% HHs	Frequency	% HHs
Yes	51	100.0	30	93.8	13	86.7	94	95.9
No	0	0.0	2	6.3	2	13.3	4	4.1
Total	51	100.0	32	100.0	15	100.0	98	100.0

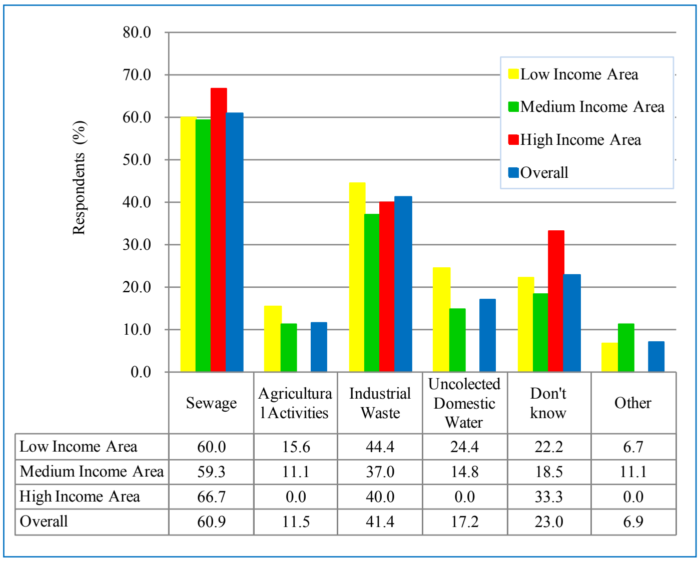
Source: JICA Project Team

3) Causes of pollution of water sources

Sewage and industrial waste were identified by households as the main sources of water pollution at 61% and 41%, respectively (Figure 4.4.18).

To improve the quality of water, residents suggested the following:

- Water should be treated with chemicals
- Buy more waste collection trucks
- Establish separate dumpsite for industries
- Industries should find ways of assisting council
- NGOs must intervene where necessary.

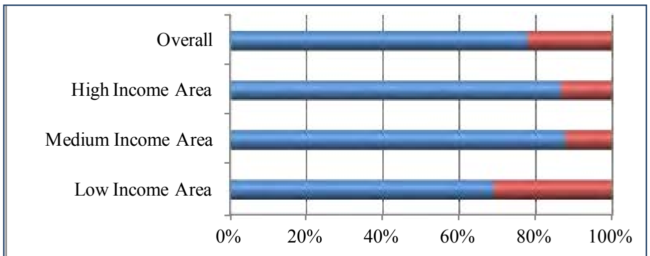


Source: JICA Project Team

Figure 4.4.17 Causes of Water Pollution

(7) Experiences and willingness to participate in municipal affairs related to health and environment

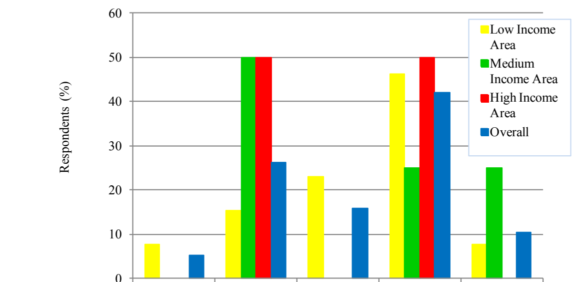
Only 22% of the sampled household indicated to have participated in the municipal health and environment related activities (Figure 4.4.19). Most of the households that participated conducted their activities last year at 42% (Figure 4.4.20). The activities carried out by the communities included: cleaning roads and, drains; clearing illegal dumping sites; burning of solid waste; and cutting grass among others. The households that never participated argued that they were not aware that such activities existed



	Low Income Area	Medium Income Area	High Income Area	Overall
Not participate	69.2	87.9	86.7	78.0
participated in health and environmental activities	30.8	12.1	13.3	22.0

Source: JICA Project Team

Figure 4.4.19 Community Participation in Health and Environment Activities



	This month	Last month	6 month ago	last year	other
Low Income Area	7.7	15.4	23.1	46.2	7.7
Medium Income Area	0	50	0	25	25
High Income Area	0	50	0	50	0
Overall	5.3	26.3	15.8	42.1	10.5

Source: JICA Project Team

Figure 4.4.20 Period of theActivity

(8) Recommendations provided by the household heads on how to mitigate water pollution

The households suggested the following water pollution mitigation measures:

- Avoiding sewer and industrial waste from flowing into sources
- Collecting solid waste regulary
- Attending promptly to burst sewer pipes to reduce flows into sources
- Replacing old pipes
- Upgrading the sewer system

Other ways of community involvement suggested by households included:

- Practising good hygiene
- Avoiding illegal dumping
- Assisting in clearing the current illegal dumpsites
- Paying bills on time
- Construction of boreholes as a source of safe drinking water

4.4.3 Establishment Socio-economic and Perception Survey

(1) Type of establishment, volume of production and number of employees

Out of the 21 establishments surveyed, there were 2 educational institutions, 2 retail shops, 4 restaurants, 1 hotel, 3 medical institutions, 1 funeral parlour and 7 factories. Majority of the factories were into food manufacturing (5) while the remainder (2) manufacture safes and fertilisers (Table 4.4.15).

Table 4.4.15 Nature of Business, Number of Employees, Volume of Production and Floor Area of Establishments

Number	Establishment	Nature of Business	Number of Employees	Volume of Production	Floor Area
1.	Speciss College	Educational institution	64	1,500 students	Not known
2.	Mberi Primary School	Educational institution	Not given	1,500 students	Not known
3.	OK	Retail shop	Not given	Sales/day (not given)	Not known
4.	FCG	Retail shop	Not given	Sales/day (not given)	Not known
5.	Innscor	Restaurant	26	Sales/day (not given)	Not known
6.	Munyoro Foods	Restaurant	35	Sales/day (not given)	Not known
7.	Restaurant (backyard-Unit H)	Restaurant	4	Sales/day (100	Not known
8.	The House of Decor café	Restaurant	4	Sales/day (not given)	Not known
9.	Hotel Mubaiwa	Hotel	22	40 guests when full	Not known
10.	Makoni Medical Centre	Medical institution	24	70 patients/day	Not known
11.	St Michaels Clinic	Medical institution	80	60 patients/day	800 m^2
12.	South Medical Hospital	Medical institution	115	160 patients/day	5,800 m^2
13.	Doves Funeral Parlour	Funeral Parlour	8	5 bodies/month	Not known
14.	Dairiboard Zimbabwe	Factory (beverage)	40	15,000L beverage every 5-6 days	Whole plan 40 000 m^2
15.	Chibuku Breweries	Factory (alcoholic beverage)	109	3.6 million L beer/yr	Not known
16.	Surface Investments	Factory (edible oil)	600	-	262,500 m^2
17.	CHUBB Union	Factory (steel safes)	43	10 safes/month	4,750 m^2
18.	Nico-Orgo	Factory (fertiliser)	50	90 tonnes chemical fertiliser/month, 60 tonnes organic fertiliser/month	6,000 m^2
19.	C Kamason Enterprises	Factory (beverage)	10	5,000 L beverage/day	1,500 m^2
20.	Shcennre Foods	Factory (beverage)	5	600 L of juice/day	80 m^2
21.	Food Incorporated Zimbabwe	Factory (beverage)	27	3 tonnes of soya mince/day	Not known

Most respondents of the establishments in the industrial area were familiar with the number of employees, volume of production and the floor area. Among the major employers were the factories, restaurants and medical institutions with the factories employing a total of 884 people compared to 219 and 303 for medical institutions and restaurants, respectively as shown in Table 4.4.15.

(2) Outline of facility

1) Manufacturing (production) facility

Medical institutions production facilities were generally made up of the observation wing, casualty, pharmacy and laundry. On the other hand, in educational institutions classrooms and offices completed the layout, while retail shops generally had the cooking area for confectioneries, fast foods and grocery areas. Well-laid out production facilities were observed in factories in the industrial area of Chitungwiza, although three of these establishments could not provide the layout of such facilities (Table 4.4.16).

Table 4.4.16 Establishment's Manufacturing, and Operation and Maintenance Facilities

	Establishment	Manufacturing (production) Facility	Operation and Maintenance of Facilities
1.	Speciss College	Classrooms, offices, workshops	Sweeping of school yard and fixing drainage in toilets/septic tank when there is need
2.	Mberi Primary School	Classrooms, offices	Sweeping of school yard and fixing drainage in toilets when there is need
3.	OK	Confectionery, grocery, cooking area (fast foods)	Done on cooking facilities
4.	FCG	Confectionery (cooking area), grocery	Done on cooking facilities
5.	Innscor	Confectionery (bakery), cooking area, eating area (fast foods)	Done on cooking facilities
6.	Munyoro Foods	Fast foods, butchery	Done on cooking facilities
7.	Restaurant (backyard-Unit H)	Cooking area	Sweeping of cooking area
8.	The House of Decor café	Cooking area, eating area	Done on cooking facilities but not often
9.	Hotel Mubaiwa	Bar, guest rooms, cooking area	Routine O&M
10.	Makoni Medical Centre	Casualty section, observation, paediatrics, pharmacy, X-ray	Routine O&M
11.	St Michaels Clinic	Observation, maternity, pharmacy, laundry	Routine O&M
12.	South Medical Hospital	Maternity, casualty, pharmacy, laundry	Routine O&M
13.	Doves Funeral Parlour	Washing area, chapel	-
14.	Dairiboard Zimbabwe	water purification, activation filters, mixing, packaging	Engineering (machinery, ammonia plant, boilers), Quality control (hygiene)
15.	Chibuku Breweries	Warehouse, mill house, cookers, strainers, fermenters, packaging, dispatch	Engineering Department responsible for O&M
16.	Surface Investments	Receiving bay and warehouse, crushing, actual oil production, packaging, storage/dispatch, effluent treatment	Machinery
17.	CHUBB Union	Metal cutting, assembly of product, painting, lock fitting, dispatch	Of machinery but outsourced
18.	Nico-Orgo	Receiving shed, processing shed (manufacturing), storage	Of machinery but done by Harare Polytechnic Engineering Department
19.	C Kamason Enterprises	-	On all production facilities
20.	Shcennre Foods	-	No operation and maintenance done
21.	Food Incorporated Zimbabwe	-	-

2) Operation and maintenance of facilities

Operation and maintenance of facilities is an important aspect in the manufacturing set up and was found to be a common event to the majority of establishments as indicated in Table 4.4.16. Some establishments in the factories have full-fledged O&M personnel while others outsourced such activities. The outline of facilities, manufacturing facilities and the operation and maintenance of these facilities were presented for each establishment in Table 4.4.16.

(3) Waste generation

1) Type of waste being generated

Based on Table 4.4.17, solid waste was the main type of waste produced by establishments that were surveyed although the majority of the food manufacturing factories also produced liquid waste. Medical wastes were confined to medical institutions.

Table 4.4.17 Type of Waste, Approximate Volume and Disposal Area

	Establishment	Type of Waste	Approximate Volume	Disposal Area
1.	Speciss College	Solid	-	Municipality collects once a week
2.	Mberi Primary School	Solid	Two 20L buckets/day	Burn in school refuse pit
3.	OK	Solid	One 20L bucket/day	Municipality collects daily
4.	FCG	Solid	One 20L bucket/day	Dispose in skip bin at the market
5.	Innscor	Solid	-	Placed in a cage at premises. Municipality collects daily
6.	Munyoro Foods	Solid	-	Dispose in skip bin at the market
7.	Restaurant (backyard-Unit H)	Solid	-	Dispose at nearby dumpsite
8.	The House of Decor café	Solid	Insignificant	Food waste collected by residents what remains is burnt
9.	Hotel Mubaiwa	Solid (lots of cans)	-	Council not collecting-burn but cannot dispose of cans
10.	Makoni Medical Centre	Solid (general, medical)	-	Medical waste disposed by private company and general waste collected by municipality twice/week
11.	St Michaels Clinic	Solid (general, medical)	-	Medical waste disposed by private company and general waste collected by municipality twice/week
12.	South Medical Hospital	Solid (general, medical)	-	Chitungwiza hospital collects medical waste. Municipality collects general waste once a week
13.	Doves Funeral Parlour	Solid	-	Municipality collects once in two weeks
14.	Dairiboard Zimbabwe	Solid, liquid	Half 20L bucket/day	Dispose liquid in drainage system, solid municipality collects
15.	Chibuku Breweries	Solid, liquid	Two and a half 20L buckets/day	All waste collected by private company waste away and dump at municipality dump site
16.	Surface Investments	Solid, liquid	Two skip bins/week	Collected by council. Liquid waste treated and released in nearby stream

	Establishment	Type of Waste	Approximate Volume	Disposal Area
17.	CHUBB Union	Solid (metal cut offs)	-	Municipality collects
18.	Nico-Orgo	Solid	-	Municipality collects
19.	C Kamason Enterprises	Solid, liquid	-	Liquid disposed in drainage system, solid (bottles) recycled
20.	Shcennre Foods	Liquid	20L	Disposed in drainage system
21.	Food Incorporated Zimbabwe	Solid	-	Sells to stock feed manufacturers

Source: JICA Project Team

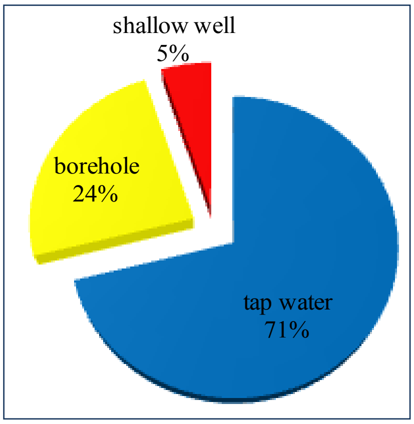
2) Approximate volume and disposal area

Table 4.4.17 also shows the approximate volumes and places of disposal of waste generated by establishments. Of concern however, was the non availability of data on the volume of wastes generated especially the waste that was disposed/ discharged into the drainage system. From the table, it can be gleaned that majority of the establishments had their solid waste collected and disposed of by the council with very few of the establishments engaging in recycling or pre-treatment of waste produced. The establishments that participated in the Waste Amount and Composition Survey were able to provide the approximate volume of waste they produced. The backyard restaurant contributed to illegal waste dumping in Chitungwiza as no proper waste handling facilities were available

(4) Establishment's amenities and hygiene practises

1) Sources of potable water

Municipal tap water (71%) was the primary source of water for majority of the establishments sampled (Figure 4.4.21). It is important to note that establishments that were located in the industrial area do not need to look for alternative sources of water since they were supplied by the municipality throughout the day. Only the establishments that are located in residential areas and shopping centres complained of intermittent supplies and were therefore seeking alternative sources.



Source: JICA Project Team

Figure 4.4.21 Primary Sources of Water for Establishments

Some establishments, e.g., water intensive industries need to consider alternative sources which have, however proved costly as these industries have to frequently buy water. The cost of purchasing water ranges from USD 120.00 to USD 260.00 for 1,000 L. Sources of potable water (primary and secondary) by type of establishment are given in Table 4.4.18.

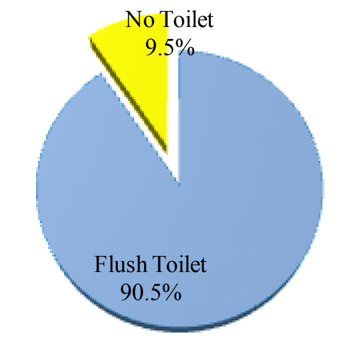
Table 4.4.18 Number of Establishments by Type, By Source of Potable Water

Type of Industry		Educational Institution	Retail Shop	Restaurant	Medical Institution	Hotel	Funeral Parlour	Factory -(Food)	Factory (Alcoholic Beverage)	Factory (Steel Safe)	Factory (Fertiliser)
Primary source of water	tap water	2	1	0	3	1	1	4	1	1	1
	borehole	0	1	3	0	0	0	1	0	0	0
	Shallow well	0	0	1	0	0	0	0	0	0	0
	Total	2	1	1	3	1	1	5	1	1	1
Secondary source of water	tap water	0	0	0	0	0	0	0	0	0	0
	borehole	1	0	0	3	1	1	0	0	0	0
	shallow well	0	0	0	0	0	0	0	0	0	0
	none	1	2	4	0	0	0	5	1	1	1
	Total	1	2	4	3	1	1	5	1	1	1

Source: JICA Project Team

2) Types of toilet used

Majority of the establishments used flush toilets (90.5%) as indicated in Figure 4.4.22. Establishments where there were no toilet facilities were some restaurants. The toilet of one restaurant was still under construction and the toilet was not yet connected to the municipal sewer.



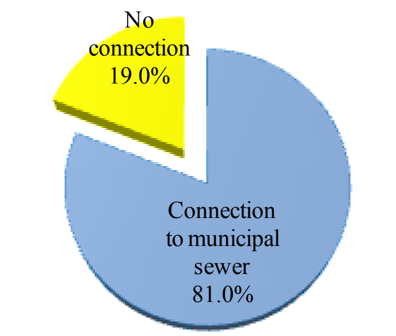
Source: JICA Project Team

Figure 4.4.22 Types of Toilets Used by Establishments

About 90% of the establishments reported that their facilities had water to flush the toilets all the time, while 10% reported that often the toilets had no supply. One of the schools (Mberi Primary School) reported that lack of an alternative source of water resulted to a miserable situation, yet there was nothing that could be done. The medical centre also experienced water shortages; some activities have to be suspended until supply resumes.

3) Sewerage system connection

Based on Figure 4.4.23, most of the establishments were connected to the municipality’s sewer system (81%). 90% reported that their establishments were not connected to the municipality sewer system.



Source: JICA Project Team

Figure 4.4.23 Connection to Municipal Sewer

Of those not connected, two (Surface Investments and Species College) indicated that they used septic tanks while one of the restaurants (backyard restaurant) reported that their employees often went back home to access the toilets. The backyard restaurant was not connected to the municipal sewer system because it was being operated illegally.

Those connected, indicated that the condition of the sewer was good (100%) and the same percentage also indicated that the sewer was well-maintained (Table 4.4.19).

Table 4.4.19 Sewer Condition, Maintenance and Drainage Facilities at the Establishments

Condition	Good		Bad		Total
	Number	%	Number	%	Number
Sewer	19	100.0	0	0.0	19
Maintenance	19	100.0	0	0.0	19
Drainage	20	95.2	1	4.8	21

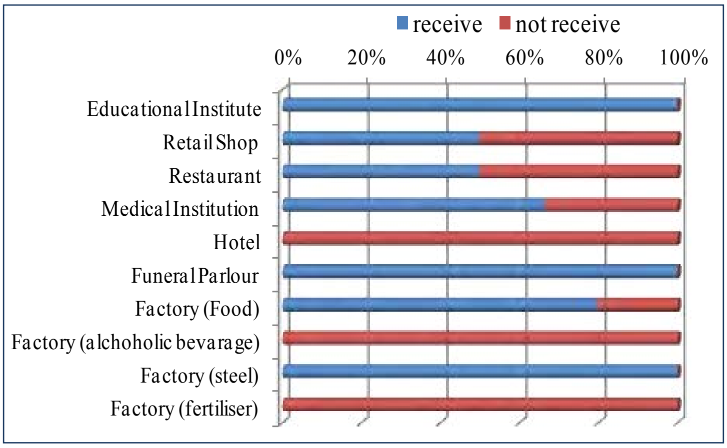
Source: JICA Project Team

4) Drainage facilities

Majority of the establishments reported that there were adequate drainage facilities within their facilities and surrounding areas (95.2%), while the rest indicated that they were not satisfied. The Funeral Parlour which is built in a water-logged area reported that their premises were usually flooded during the rainy season.

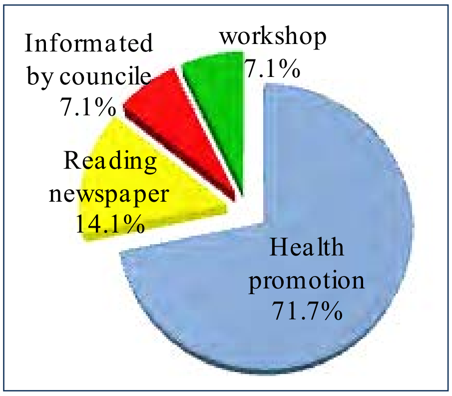
(5) Hygiene practises

Most of the establishments reported to receive some Hygiene Education, (61.9%) while others had never received any. Analysis by type of establishment revealed that food manufacturing, followed by educational and medical institutions as well as restaurants had received hygiene education compared to the other types of establishments as shown in Figure 4.4.24. Figure 4.4.25 shows that a greater part of the establishments that received some form of hygiene education received it through health promotion sessions (72%) conducted at their institutions. Other forms of hygiene education were in the form of reading newspapers and workshops.



Source: JICA Project Team

Figure 4.4.24 Hygiene Education Received by Type of Establishment



Source: JICA Project Team

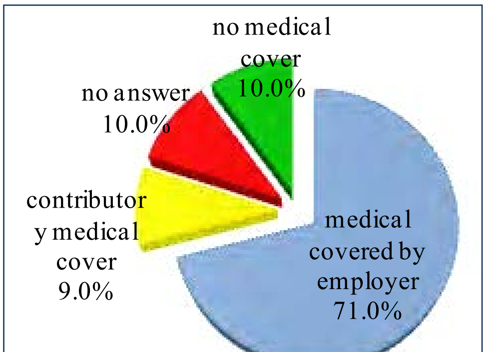
Figure 4.4.25 Methods Used for Conducting Hygiene Promotion in Establishments

The content of the hygiene sessions included disease prevention, good hygiene practises and general cleaning. The duration of hygiene education sessions varied across the establishments ranging from as short as 15minutes up to a week long. The duration of sessions was dependent on the line of products and the establishment's operation and maintenance procedures. For example at Dairibord-Nutriplus plant, the sessions were daily before production starts for about 30minutes to remind the employees of their core business and how much hygiene plays a role in whole production process.

(6) Awareness of establishments about health implications

All the surveyed establishments were very much aware of water-borne diseases such as typhoid, cholera and diarrhoea, etc, their causes as well as their prevention. They linked the causes to drinking contaminated water and food, and bad hygiene practises. All the establishments indicated that in the event that one contracted water-borne disease, the first point of call was visiting the clinic.

According to the sampled establishments (Figure 4.4.29) 71% of establishments covered their employees medical expenses, 10% indicated that they did not cover while 10% contributed towards their medical cover without company assistance. The establishments that did not cover medical expenses reported that in the event that an employee got ill whilst working, the company meets the medical expenses.

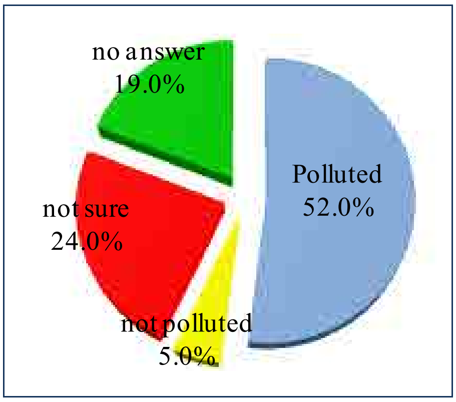


Source: JICA Project Team

Figure 4.4.26 Establishment Medical Cover

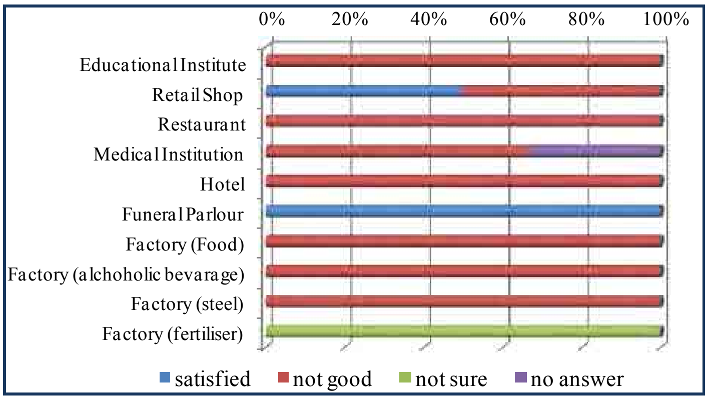
(7) Awareness of establishments about water pollution

Majority of the establishments were not aware of the source of drinking water for Chitungwiza. Figure 4.4.30 shows the perception of the establishments towards the state of the water sources. Most of the establishments indicated that they perceived the water sources as polluted (52%). Causes of pollution mentioned included sewage, industrial waste and uncollected domestic waste with a significant number displaying lack of knowledge on the issue. Only the funeral parlour (maybe because of the nature of their work) and retail shops (4.8%) were satisfied with the present water quality of the water sources, while the rest were not (Figure 4.4.31). Among the establishments who were not satisfied with the quality of the water sources for Chitungwiza were the restaurants (19%)).



Source: JICA Project Team

Figure 4.4.27 Water Sources Pollution Rate



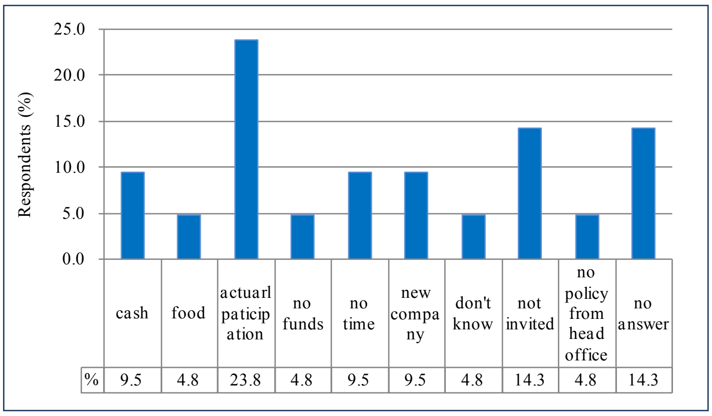
Source: JICA Project Team

Figure 4.4.28 Towards State of Water Sources by Type of Establishment

Establishments like Dairibord indicated that it had a pre-treatment plant for treating water before using in production. All the establishments surveyed found it necessary to install water pollution control devices/mitigation measures. All respondents from factories could not provide a response as to the causes of pollution of the water source, while sewage was mentioned mostly by hotel and educational institutions.

(8) Experiences and willingness to participate in municipal affairs related to health and environment concerns

Only 33% of the establishments participated in municipal affairs related to health and environmental concerns. A number of non participating establishments gave wide ranging reasons for not participating in municipal related activities on health and environment. From Figure 4.4.29, the reasons for not participating in municipal activities ranged from lack of



	cash	food	actuarl paticip ation	no funds	no time	new compa ny	don't know	not invited	no policy from head office	no answer
%	9.5	4.8	23.8	4.8	9.5	9.5	4.8	14.3	4.8	14.3

Source: JICA Project Team

Figure 4.4.29 Reasons for Participating/Not Participating in Municipal Activities Related to Health and Environment Establishment funds, not being invited by the municipality, being new in the area and lack of company policies regarding attending such activities. As indicated in Table 4.4.20, the activities that were carried out by those who participated in the municipality's environment and health activities included cash donation, food donation, typhoid sensitisation and actual clean up.

Table 4.4.20 Establishment Participation Activities

Activity	Frequency	% Number
Cash or donation in kind towards a cleanup session	2	28.6
Food donation	1	14.3
Sensitization sessions for typhoid	3	42.9
Clean Up	1	14.3
Total	7	100.0

The establishments suggested the following water pollution mitigation measures: 1) industry should pre-treat effluent; 2) the municipality should enforce laws on illegal dumping; 3) make people pay for waste disposal; 4) upgrading the sewer system; 5) collection of waste; and 6) budget for environmental issues (Table 4.4.21)

Table 4.4.21 Suggested Ways on How Authorities Can Improve the Situation

Suggestions	Overall Frequency	%
Be consistent in collecting solid waste	10	12.2
Replace old pipes with new ones/upgrade sewer system to reduce the incidences of burst pipes	35	42.7
Attend to burst pipes promptly, do constant checks	15	18.3
Constant supply of safe water	14	17.1
Employ professionals who will not ask for money from residents to do their work.	8	9.8
Total	82	100.0