REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF WATER AFFAIRS

SPECIAL ASSISTANCE FOR PROJECT SUSTAINABILITY (SAPS) FOR KWANDEBELE (WESTERN HIGHVELD) REGION WATER AUGMENTATION PROJECT IN THE REPUBLIC OF SOUTH AFRICA

FINAL REPORT

MARCH 2012

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.

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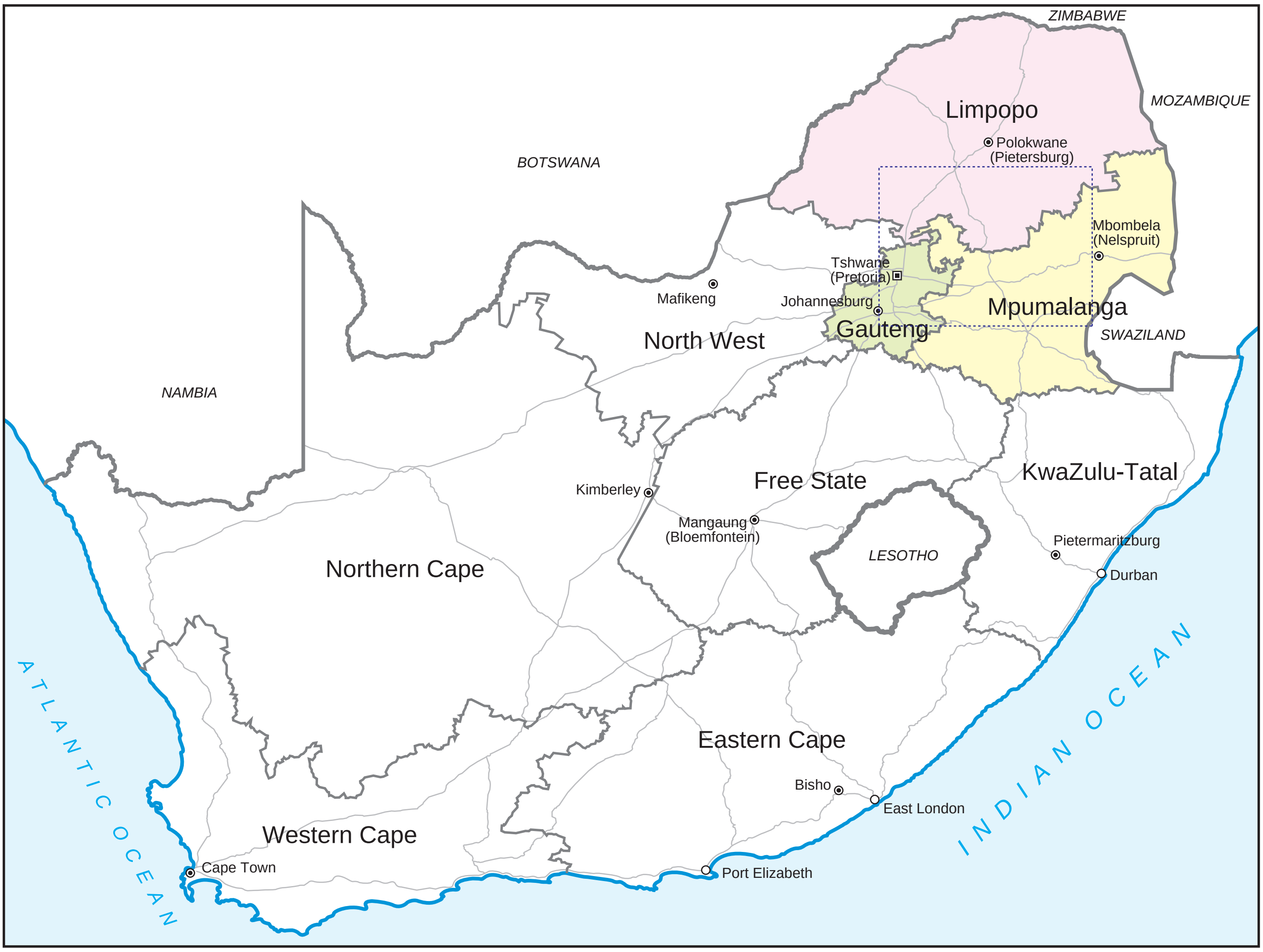
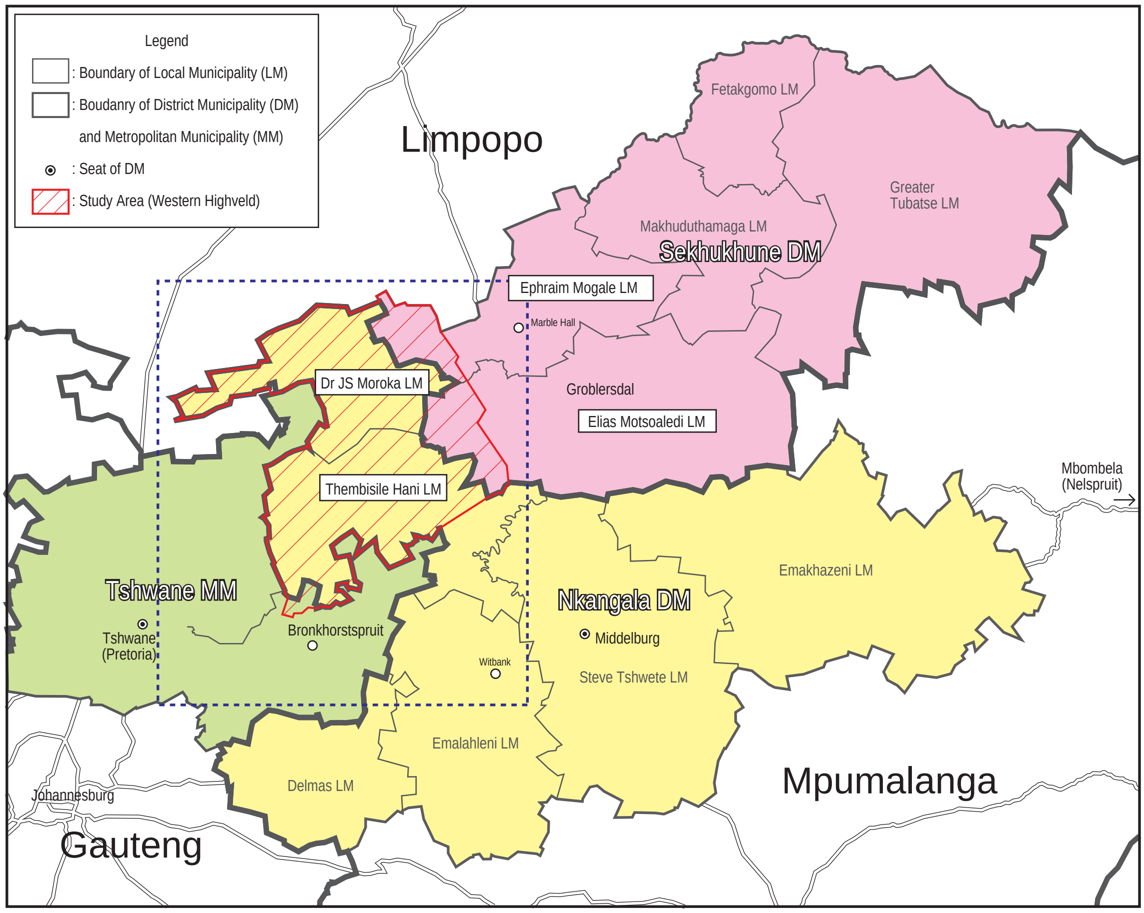


National Map of South Africa and Location of Relevant Provinces



Location Map

CONTENTS

Table of Contents

LIST OF FIGURES AND TABLES

Figures

Tables

ABBREVIATION

BEE	:	Black Economic Empowerment
BHN	:	Basic Human Needs
BQ	:	Bill of Quantity
CIA	:	Central Intelligence Agency / USA
CSIR	:	Council for Scientific and Industrial Research
DBSA	:	Development Bank of Southern Africa
DFID	:	Department for International Development / UK
DM	:	District Municipality
DPLG	:	Department of Provincial and Local Government
DWA	:	Department of Water Affairs
DWAF	:	Department of Water Affairs and Forestry (Former DWA)
ERWAT	:	East Rand Water Care Company
ES	:	Equitable Share
FBW	:	Free Basic Water
FMG	:	Financial Management Grant
F/S	:	Feasibility Study
IDP	:	Integrated Development Plan
IMF	:	International Monetary Fund
IR	:	Institutional Reform
JICA	:	Japan International Cooperation Agency
LCD	:	Liter per Capita per Day
LM	:	Local Municipality
MIG	:	Municipal Infrastructure Grant
MNF	:	Minimum Night Flow
MSIG	:	Municipal System Improvement Grant
NRW	:	Non-Revenue Water
ODA	:	Official Development Assistance
O&M	:	Operation and Maintenance
PPP	:	Public Private Partnership
RDP	:	Reconstruction and Development Programme
PVC	:	Polyvinyl Chloride
SANS	:	South African National Standard
SAPS	:	Special Assistance for Project Sustainability
SMIF	:	Special Municipal Infrastructure Fund
SS	:	Supply Scheme
SSS	:	Sub-Supply Scheme
SW	:	Scope of Works
UFW	:	Unaccounted-for Water
VAT	:	Value Added Tax
VIP	:	Ventilated Improved Pit
WB	:	Water Board or World Bank
WDM	:	Water Demand Management
WHO	:	World Health Organization
WH(R)	:	Western Highveld (Region)
WMA	:	Water Management Area
WRC	:	Water Reserve Commission
WSDP	:	Water Services Development Plan
WSA	:	Water Service Authority

WSP	:	Water Service Provider
WTW	:	Water Treatment Works
ZAR	:	South African Rand

EXECUTIVE SUMMARY

Executive Summary

1. Background, Objective and Scope

1.1 Background

In 1996, the first Japanese Official Development Assistance (ODA) Loan to the Republic of South Africa was extended to finance Kwandebele (currently called "Western Highveld") Region Water Augmentation Project for installation of transmission pipelines, pumping equipment and expansion of a treatment plant to meet the growing water demands in the Kwa-Ndebele Region. The loan was discontinued at the disbursement due in November 2003.

An Ex-Post Evaluation Study in 2006 and a Follow-up Study in 2010 were carried out by Japan International Cooperation Agency (JICA) and identified important and urgent needs still remaining for renewal of degrading distribution pipelines, measures to cope with cathodic corrosion of steel pipes and improvement of the water service and its tariff collection, while the pipeline between Ekangala and Enkeldoornoog and reservoirs installed under the ODA Loan project showed an appreciable performance for betterment of water supply in the area. On basis of these findings, Department of Water Affairs (DWA) requested JICA to undertake the present Study under the "Special Assistance for Project Sustainability (SAPS) for Kwa-Ndebele Region Water Augmentation Project."

In response to this request this SAPS study was carried out from March to November 2011 for the objective and scope agreed between DWA and JICA to help ensure positive impacts of the above-mentioned ODA Loan Project to sustain.

This Executive Summary is intended to present essence of the definitions, findings and proposals to upgrade and strengthen the Western Highveld Water Scheme, which was learned through the present SAPS study.

1.2 Objective of the Study

In order to ensure sustainability of the completed ODA loan project (Kwa-Ndebele Region Water Augmentation Project), this SAPS is objected to propose action plan to improve the water supply service surrounding the Project.

1.3 Study Area and Population

Ex-Kwa-Ndebele Bantustan (Homeland), which later split into 5 local municipality under Gauteng, Mpumalanga and Limpopo Provinces, but still is identically called Western Highveld Region, is a study area of the present SAPS as shown in a table below.

Study Area under the Present Local Demarcation

Province	District Municipality (DM)	Study Area in Local Municipality
Gauteng	ex-Metsweding Tschawane Metropolitan Municipality (since June 2011)	a part of ex-Kungwini Tschawane Metropolitan Municipality (since June 2011)
Mpumalanga	Nkangala	all of Thembisile Hani
		all of Dr JS Moroka
Limpopo	Sekhukhune	a part of Ephraim Mogale
		a part of Elias Motsoaleledi

Estimated Population with/without the Scheme Coverage				
Local Municipality (LM)		Population (thousand person)		
		2010	2015	2020
Dr. J.S, Moroka LM	Covered by Scheme	215.7	225.7	233.5
	Without Scheme Coverage	61.8	65.2	67.9
		277.5	**290.9**	**301.4**
Thembisile Hani LM	Covered by Scheme	306.6	334.1	361.4
	Without Scheme Coverage	10.9	11.3	11.7
		317.5	**345.5**	**373.1**
ex Kungwini LM,	A Tiny Part of	**48.4**	**56.9**	**68.5**
Elias Motsoaledi LM	Mouse East only	**138.5**	**145.5**	**153.7**
Ephraim Mogale LM	Mouse West only	**44.1**	**46.6**	**49.7**
Total for ex Kwa-Ndebele	Covered by Scheme	753.3	808.9	866.8
	Without Scheme Coverage	72.6	76.5	79.6
		826.0	**885.4**	**946.4**

Source: Estimates by SAPS study

Among the Region's population of approximately 850 thousands, nearly 9 percent have no access to the piped water supply from the existing Western Highveld Water Supply Scheme.

1.4 Scope of the Study

To achieve the above-mentioned objective, the SAPS study was agreed to cover the following Scope of the Study:

- Review or develop existing feasibility studies and/or master plans,
- Develop a financial plan for infrastructure development and investment in water supply business,
- Develop an asset management plan, which includes cathodic protective measures for water pipes, an operation and maintenance plan, a plan to reduce non-revenue water, and a system for the asset management plan,
- Develop a customer / consumer management plan,
- Review the institutional arrangements and capacity, and
- Develop a basic plan for the proposed technical cooperation program with JICA.

2. Difficulties and Challenges Found in the Western Highveld Water Scheme

Difficulties and obstacles not only of the water supply scheme but also of the local municipal administration in general may be sourced from:

- Not-yet-fully defined local municipality mandate and administration with premature legal setup,
- Lack of distinction of the public utility service from the general administration,
- Substandard skills and techniques required for the local municipal business in general,
- Not necessarily routinized data-processing, documentation, operation and maintenance,
- Incomplete ledgers/drawings/maps of facilities, equipment, water customers,
- Understaffing in quantity and quality of the local municipal offices,
- Extremely low collection of the municipal invoices including tax and tariffs for water, sanitation and garbage collection, etc., and,
- As a result, the municipal budgets are highly dependent on the Government subsidy and grants.

2.1 Insufficient Information on Water Supply Facilities

In 1990's when new local government setup started, DWA handed over the facilities' inventory to Sekhukhune DM and the other 3 LMs, which were assumed to operate water supply service in each municipality, at the same time, water supply facilities and equipment except some of the large scale were transferred from DWA to each municipality.

SAPS study observed such inventories of the major facilities were not very well preserved. Moreover, drawings, maps and lists of the minor facilities such as distribution networks, which were developed before or later, were not always recorded and filed. This results in improper control of the valves and water flow, and inefficiency in pipe repairs. It was now also made difficult to locate the leakages from pipes.

2.2 Unreliable Operation and Maintenance

The logs for daily operation and maintenance, particularly those for emergency repairs were not found formalized or routinized. Without detailed lists and drawings of facilities and equipment, such operation and maintenance logs are very difficult to record and compile. Daily operation and maintenance are, therefore, made with the personal experience and knowledge of operators, who are not always the same person. They do not always prepare the formalized logs.

Repairs of leaking transmission / distribution pipes are not always immediately addressed, unless leaking volume is significant or causing inundation of houses, etc. The intentional and routinized leak detection programs are not planned and undertaken at all. In addition to the leakage from pipelines, it was observed that leakage from the indoor plumbing seemed significant where water meters were not installed or flat rate water tariff was applied. Many of the existing study reports estimate around 40 percent of water loss.

2.3 No Policing against Water Thefts and Illegal Connections

Methods of water theft are mostly extreme vandalism / destruction of the air valves and sluice valves along the transmission pipelines. Water thus stolen is used mostly for agriculture and stockbreeding. Daily patrolling of transmission lines is not always made, and staff of the municipal water offices is often reluctant in identifying a person/s responsible for the theft.

In some areas, it is reported, unauthorized connection works from the distribution network to private houses are nearly openly carried out. No policing against such illegal connections is undertaken in such areas. It is suspected whether there is no definite criminal law against such illegal connections, or stuff of water offices is reluctant in reporting such cases to the criminal police.

2.4 Pipes are Deteriorating and Many are of Asbestos

The oldest pipelines were laid in 1979. Out of the total length of 683 km, approximately 12% (82 km) were laid before 1980 and will reach the standard service life in 2020.

SAPS study found that almost 64 percent (435 km) of the transmission pipelines are of asbestos, and the same applies for 19 percent (336 km) of the distribution networks. In recognition of the fragileness and toxicity of the asbestos pipes, DWA is recently considering restricting use of asbestos pipes for replacements.

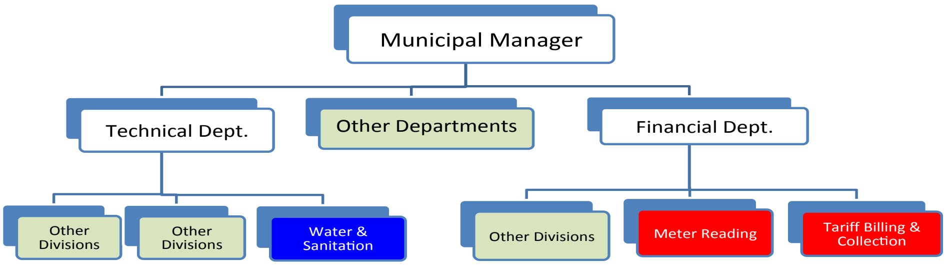
2.5 Transmission Pipelines without Enough Capacity

Some existing transmission pipelines were found to have too small diameter and therefore insufficient capacity to convey the- demanded water. They may be due to obvious design failure, or short of budgeted fund found during construction work. In such cases it is normal measures to increase the flow with manual operation of valves, unless pipeline’s diameter is enlarged or additional parallel pipeline is laid. Since manual control of flow is very complex and delicate, however, such control has not been practiced until now resulting in the short or intermittent supply to certain areas.

2.6 Technical Operation of Water Supply is Separated from Business

In municipality offices, Water Service Division is under the Technical Departments and responsible for technical operation and maintenance alone. It has no responsibility for meter reading, tariff billing and collection. The latter, i.e., business is exercised by the Financial Departments, who issue monthly all-inclusive invoice for rates, taxes, tariffs for water, sanitation, garbage collection, etc., altogether. Average collection (recovery) rate of this invoice in the Region is somewhere between 3 to 7 percent only. This implies that a person / organ responsible for the total income-expense balance of water service is absent.

At present, Who is Responsible for Water Business as a Whole?
Who is Accountable to the Public?



Today's Typical Organization of Municipal Office, where Water Service related Organ/Unit is split into TWO: **Technical** & **Financial**.

2.7 The Then One System by One Operator is Now Operated by 4 Operators

In the Bantustan era, Kwa-Ndebele Water Scheme was one single water supply system operated by one operator, i.e., the then Government of Kwa-Ndebele. Under the new local government setup and the new Water Act, it was split into 5 local municipalities and operated by 4 water service providers. This may explain not only irrelevant and sometimes conflicting operation of cross-border valves and pumps, but also substandard skills and techniques caused by understaffing in quantity and quality without normalized disciplines due to insufficient personnel budgets.

2.8 Lack of Distinction of the Public Utility Service from the General Administration

Under the present local government setup, there is no clear distinction between the public utility service activity (electricity, water supply and sanitation, public bus service, etc.) and the general administration activity (police, fire fighting, basic schooling, etc.). The latter shall be paid by the general budget from taxes paid by everyone, while the former shall be paid by the service charges or tariffs collected from the users of specific service. Without this distinction, today's local municipal offices are invoicing taxes and service charges altogether.

This may explain that almost everyone (93 to 97 percent of residents) do not pay any tax or charge (including water tariff). In most of modern states, the former public utility services are usually operated on the financially independent and autonomous accounts completely separated and distinguished from the general budget to recover costs of the services and to prevent from undue political intervention.

2.9 Apprehended Cathodic Corrosion of Pipeline Constructed by the ODA Loan

Cathodic corrosion of the pipeline constructed with finance by the Japan's ODA Loan was closely investigated by one of SAPS experts in the field. As a result, a detailed design of protection work was prepared.

3. Proposals for Improvement of Water Services: Results of SAPS Study

To attain the agreed objective and fulfill the scope of the study, SAPS study shall be concluded to present several proposals for DWA, relevant district and local municipalities, and other Departments of the Government of South Africa to seriously take note, consider and take steps to bring about. Such proposals can basically be categorized into the following five areas and projects:

i. Cathodic protection for transmission pipeline,
ii. Upgrading levels of operation and maintenance,
iii. Realignment of the water service divisions, and if possible reorganization of municipal offices;

This may include the integration of all the municipal water providers into one entity,

iv. Request JICA to provide the "DWA-JICA Joint Technical Cooperation Project," which is intended to help ensure the above ii. and iii.

v. Replacement and renewal of the degrading facilities and equipment.

3.1 Cathodic Protection for Transmission Pipeline

It is proposed to execute the cathodic protection work to eliminate possibility of the apprehended corrosion as soon as possible using DWA funding. The SAPS study prepared the detailed cost of ZAR 4.5 million for this protection work.

3.2 Upgrading Levels of Operation and Maintenance

Because the personnel turnover of water service offices is quite fast and frequent resulting in the untrained or underskilled personnel to operate and maintain important facilities and equipment, good manuals for daily and emergent operation and maintenance are prepared hopefully for each of specific facilities and equipment. Bases for preparation of such manuals are complete lists of assets, i.e., ledger of facilities and equipment with specifications, maps or drawings. Within the present municipal water offices, preparation of such asset lists will be a very heavy burden and difficult to complete within the limited period of time. Preparation numerous manuals after completion of the asset lists will be much heavier works. These are areas where the "DWA-JICA Joint Technical Cooperation Project," which will be proposed later in this summary, will be able to extend some help.

Unaccounted-for water (UFW), i.e., lost water reportedly consists of approximately 40 percent of the produced and transmitted water. Major causes of water loss are intentional theft and leakage from unknown breach of pipelines buried. Legal sanction and penalty may help reduce the former, while the leakage detection and repair program will be helpful in reduction of the latter. Training of the underground leakage detection technique will be an important part of the Joint Technical Cooperation.

As shown below, ZAR 33 million per year will be saved and a development of a new water source will not be needed in 2020 in the Region, if the UFW is reduced from 40 to 23 percent as desired by DWA. Every effort shall be paid to reduce the UFW.

Water and Cost to be Saved by Reduction of Unaccounted for Water

Items	Cases in 2020		Water and Cost to be Saved
Percentage of UFW*1	If 40 %	If reduced to 23 %	17 % (saved) = 40 - 23 %
Total Water Demand (m^3/day)	108,167	84,286	23,881
Water Cost (ZAR/day)*2	411,034	320,286	90,748 (ZAR 33 million a year)

*1: 40%: the current unaccounted-for water; 23%: Level of UFW in 2020 targeted by DWA
*2: Water price of Rand Water's bulk supply: ZAR 3.8 for 1 m^3
Source: SAPS Study

Last cause of UFW is usage, over-usage or wastage of water from the water taps with no meters, and leakages from indoor plumbing, where flat rates of water tariff are applied. These may be reduced, if water meters are securely installed without vandalism, and the reasonable tariff system is applied. Installment of meters and tariffs requires a very good customer relations and tactful business management. They are also areas of assistance by the Joint Technical Cooperation.

Thus, level of operation and maintenance shall be upgraded through the formalized / routinized operation with the established manuals, and through reduction of UFW.

3.3 Proposed Integration of the Municipal Water Service Offices into One Regional Water Service Entity

To overcome the following challenges and difficulties, integration of the municipal water service offices into one regional water service entity is proposed.

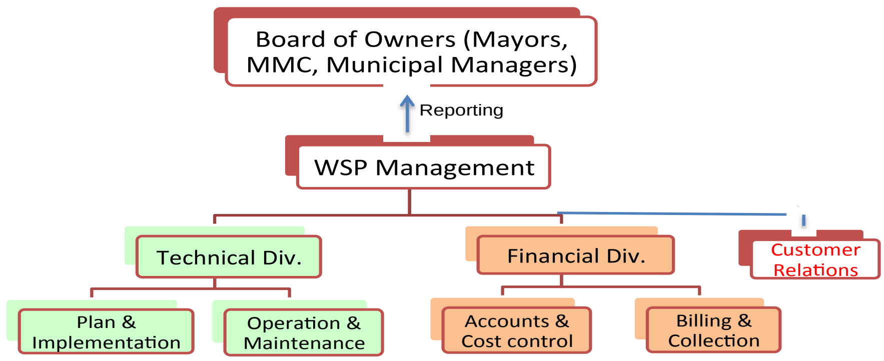
- Understaffing of personnel in quantity and in particular quality,
- Irrelevant and conflicting control of the cross-border facilities and equipment,

- Lack of distinction of the public utility service from the general administration,
- Extremely low rate of tariff collection, as water tariff will be separately billed and collected,
- Kwa-Ndebele Water Scheme was a single scheme that was so designed and installed as to be operated by a single operator technically and administratively.

This newly proposed regional integrated water service entity is not a revised version of the ex-Ikangala Water Board, since it shall be owned and share-holded by the relevant municipalities for the close operation monitoring and financial auditing.

Integrated Regional Water Service Entity
owned and shareholded by local municipalities

The Integrated Entity under a Single Management alone can be Responsible for the services and Accountable to the Public, Mayors and Municipalities.



This organization is only skeleton. Actual one should be more multiplied.

The widening of service area and therefore enlarging scale of the service / business operation through the integration of the municipal water offices is a policy primarily intended to raise a more revenue from the larger population served and to spread the equitable demand / supply balance over every part of the Western Highveld Region. This integrated public utility service entity will be operated more flexibly and in the business-oriented manner with the better customer relations. Improved level of installation and maintenance of the shared facilities, and reinforced and prompt response to the customers' needs as well as emergency / disaster will also be expected.

Unified single business administration will bring about an equitable maintenance level of facilities, strengthened revenue earning and expense control, eased customer accessibility and particularly dignity of professional services of water supply, since it can employ highly qualified personnel with the increased revenue earning. Reinforced bases for engineering and business will extensively support good plannings of facilities, management setup, efficient operation of business, customer relations and all the other layers of the water supply enterprise.

Today's municipality offices will lose water tariff revenue and the subsidies for water supply services. However, they do not need to pay costs for water personnel and their services. Some of their personnel who have been engaged in the meter reading, billing and other water-related services may be moved to the new integrated entity.

An office building for headquarters of the integrated regional water service entity shall be established, where the higher management and engineering staff shall have their own offices. The existing municipal water offices shall stay as they are now, and shall serve as branch / local offices of technical and clerical level personnel and workers.

3.4 Proposal on the DWA-JICA Joint Technical Cooperation Project

This proposal is a focal center of the SAPS outcomes, which may animate all the other project components and proposals, particularly for improved operation and maintenance, and for or through integration of water services into the Regional Public Entity.

Overall Goal of the Technical Cooperation

- effective utilization of water resources is materialized through reduction of unaccounted-for water in Western Highveld
- reduction of the interrupted water supply service through the improved operation and maintenance in Western Highveld
- sound management of the public service enterprises in accordance with the internationally accepted best practices

Objective of the Technical Cooperation

- to help organize a new regional water service provider entity
- to uplift capacity of personnel in the newly integrated entity in formulating and implementing the unaccounted-for water reduction programs
- to strengthen capacity of operation and maintenance of the entity in technical and business terms
- to assist the municipalities with their Municipal Systems Act, Sections 77 and 78 processes to consider internal and external service delivery options: to assist the municipalities with their policies and by-laws relating to: water and sanitation services, tariffs, credit control, debt collection, restriction of services, emergency situations, and so on.

Output through the Technical Cooperation Project

- formulation of draft “Articles of Incorporation” for establishment of integrated entity
- formulation of “business models” for parts and entire organ/s of the new entity
- Persons in charge of major departments and divisions are appointed and set out their activities in accordance with the business models.
- database on existing water supply facilities will be developed in order to facilitate the maintenance as well as leakage detection
- techniques and skill for unaccounted-for water reduction will be transferred to the personnel
- formulation of operation and maintenance programs and their application by the personnel
-
- formulation of a program to establish a public relations unit / division within the entity
- advising in legal issues and drafting of, but not be limited to, the following:
    i. draft bylaws on enforceable installation of water meters.
    ii. draft bylaws against theft of water, illegal connection and vandalism of water facilities, etc.
    iii. draft bylaws to define clear sanctions against ongoing non-payer of water tariff including termination of supply.
    iv. draft “Act of (Local) Public Utility Service Enterprise.”
    v. draft “Articles of Incorporation” for the integration of the municipal water service offices
    vi. other legal advices as and when needed.

Tentative Work Schedule and Expertises to be Mobilized

It is reckoned that if the procedures towards the integration are unhindered, the proposed Technical Cooperation Project may successfully be completed in the field in a three-year period. During these period at least mobilization of experts for 224 man-months will be necessary, being 82 from Japan and 142 from South Africa. DWA will be mobilizing a group of specialists who are qualified and experienced in the local public corporation business, social relations and laws. JICA will be mobilizing a group of specialists who are qualified and experienced in the water service business and its integration, operation and maintenance, UFW reduction, leakage detection, GIS mapping and inventory, public awareness raising, etc.

Prerequisites to invite and launch the Technical Cooperation Project by the Local Municipalittes

- Agreement toward the integration of the municipal water services by the Mayors of the related municipalities, and establishment of an inter-municipal preparatory consultation secretariat.
- The secretariat officers are expected to proceed with necessary preparation of technical, administrative, organizational, business and legal affairs toward the integration, in consultation with the experts mobilized under the proposed Technical Cooperation Project.
- Mobilization and organization of appropriate trainees/participants for activities of the project (who are expected in the later stage to become instructors to train the rest of personnel.)
- Establishment of the project office (desirably shared with the secretariat staff) with furniture and equipment.

Prerequisites to invite and launch the Technical Cooperation Project by the DWA

- Preparation of a budget for the costs to be incurred by the South Africa side.
- Appointment and mobilization of the specified experts.

3.5 Renewal of Facilities and Equipment

It is proposed to replace / renew the asbestos pipes and other pipes over the standard life. They may be undertaken in the well planned stage-wise programs. Since length of asbestos pipes in Thembisile Hani LM and Sekhukhune DM were not identified due to insufficient information, detailed surveys along the networks will be required in planning the stage-wise programs for implementation. Pipeline length and costs shown below do not include consulting services, land acquisition, environmental impact assessment and contingencies, and are indicative only and seen as the rule of thumb.

Replacement / Renewal of Pipelines

LM/DM	Transmission Pipelines		Distribution Networks		Total Cost (ZAR Million)
	Length of Asbestos Pipelines and Pipes over the Age (m)	Cost (ZAR Million)	Length of Asbestos Pipelines (m)	Cost (ZAR Million)	
Kungwini LM	7,130	49	30,205	84	133
Thembisile Hani LM	161,616	385	n.a.	n.a.	385
Dr. JS Moroka LM	242,836	578	305,855	177	754
Sekhukhune DM	59,731	65	n.a.	n.a.	65
Total for Pipeline Replacement	**471,313 (69%)***	**1,077**	**336,060 (19%)***	**261**	**1,338**

Source: SAPS Study

Construction cost of pipeline replacement of ZAR 1,338 million may be difficult to be raised by budgets of municipalities and DWA's RBIG fund alone. In that case, JICA's ODA loan with the highly concessional terms is recommendable. As the ODA loan requires the National Government's guaranty, DWA will need to collaborate earnestly with the National Treasury by showing significance of this renewal work.

MAIN REPORT

CHAPTER 1 OUTLINE OF THE STUDY

1.1 Background of the Study

Kwandebele (currently called "Western Highveld") Region Water Augmentation Project in the Republic of South Africa funded by Japanese Yen Loan intended to meet the growing water demands in the area of Kwandebele and thereby to contribute improvement of the sanitation environment and vitalization of local industries, through installation of conduit and transmission mains, pumping equipments and expansion of treatment. The loan agreement of the Project was made in May 1996, and the Project was discontinued at the disbursement due in November 2003.

The Ex-Post Evaluation Study was carried out in November 2006 and concluded that only four (4) out of eleven (11) components originally planned were implemented. They were construction of transmission mains and distribution reservoirs and procurement of equipments.

The Ex-Post Evaluation Study pointed out two factors. Firstly, procurement of equipment was canceled since the Government of South Africa changed water intake plan due to overestimated water demands and population growth. Secondly, the assets constructed through Yen Loan were not operated and maintained appropriately because relevant municipalities and the then Ikangala Water Board did not have a good capacity for water services, which was expected to take charge of water services on behalf of the Department of Water Affairs along the policy of water sector reform at the time.

In addition, the follow-up study of the ODA Yen Loan Project undertaken by JICA in January and February 2010 identified important and urgent needs still remaining for renewal of degrading distribution pipelines, measures to cope with cathodic corrosion of steel pipes close to the high-voltage power line and improvement of tariff collection of the water service, while the transmission main between Ekangala and Enkeldoornoog and reservoirs installed under the Yen Loan project showed an appreciable performance for betterment of water supply in the area.

The present Special Assistance for Project Sustainability (SAPS) is intended to prepare and propose Action Plans that shall help ensure positive impacts of the above-mentioned Yen Loan Project to sustain. The plans may include improvement of the service providers' asset management and institutional development, and shall be prepared in close collaboration with the Department of Water Affairs (DWA) as an implementing agency, and the relevant municipalities and water boards as major stakeholders.

1.2 Objectives of the Study

The objectives of the SAPS are to ensure sustainability of the water service facilities installed under the terminated ODA Loan project (Kwandebele Region Water Augmentation Project) by proposing implementation of action plans for improved operation and maintenance including measures to protect corroding transmission lines and other plans for improvement of institutional capacity for implementation of the services and for asset management of local municipalities in the water sector.

1.3 Study Area

The study is targeted to the Western Highveld region consisting of parts of municipalities situated in the following Provinces:

- Gauteng
- Mpumalanga
- Limpopo

Shown in Table 1.3.1 below

In this report, we use "Western Highveld" (WH) region or area as the name of study area, not Kwandebele.

Table 1.3.1 Study Area

No	Province	District Municipality	Local Municipality	within Western Highveld
1	Gauteng	**Tshwane Metropolitan Municipality** (former Metsweding)	- (former Kungwini)	Tiny part
2	Mpumalanga	Nkangala	**Thembisile Hani**	Large part
3			**Dr JS Moroka**	exc. West part
4	Limpopo	**Sekhukhune**	Ephraim Mogale (former Greater Marble Hall)	West-end part (alias, Moutse West)
5			Elias Motsoaledi (former Greater Groblersdal)	West-end part (alias, Moutse East)

* Bold-faced municipalities are water service authorities (WSAs) designated by the Department of Water Affairs.

1.4 Scope of the Study

To attain the above-mentioned objectives, the study shall cover the following Scope of Work (SW) as agreed in the Minutes of Discussions between JICA and Department of Water Affairs of the Government of South Africa in September 2010:

- Review of the existing master plans and feasibility studies
- Evaluation of the existing water supply facilities
- Examination on cathodic protective measures and preparation of its basic design
- Formulation of asset management plan (cathodic protective measures, maintenance of the water supply system, measures toward unaccounted-for water, asset management system)
- Formulation of customer management plan
- Review of the present setup of water institutions and an optimal plan
- Proposal for the training program
- Elaboration for betterment of the operational and organizational capacity and proposal thereupon
- Formulation of infrastructure development plan
- Formulation of infrastructure investment plan

CHAPTER 2 REVIEW OF EXISTING MASTER PLAN AND FEASIBILITY STUDIES

2.1 Objective

This chapter is intended to envisage, at the interim stage, whether or not a water supply expansion plan is required in the immediate, mid- or long-term future. The relevant master plans and feasibility studies are reviewed, and some field observations are discussed for this purpose.

2.2 Master Plans and Feasibility Studies Reviewed

Regarding augmentation, extension or rehabilitation of the Western Highveld Water Scheme, the following four reports were reviewed as of April 2011 (first survey). In addition, two reports of new water scheme were reviewed as of October 2011 (second survey):

(1) Western Highveld Region Water Augmentation Pre-feasibility Study, February 2005 reports
(2) Water Service Development Plans of Local Municipalities
(3) Service Delivery from the Western Highveld Scheme: Institutional Reform (IR) for Optimal Institutional Arrangements, May 2008
(4) Western Highveld Scheme Technical Feasibility Report, January 2010
(5) Engineering Study and Solution Provision for the Bulk Water Supply from Rust de Winter to Mathanjana Magisterial District of Dr JS Moroka Local Municipality
(6) Technical Report Bulk Water Supply to Moutse (Moutse East and Moutse West)

Each of the studies are briefly summarised below:

(1) Western Highveld Region Water Augmentation Pre-feasibility Study (WHR Pre-FS)

The aim of the study was to show ways to attain the proper operation of the scheme.

Through analyses of the current operation and problems thereof, proposals were made to:

- rehabilitate treatment plants, particularly the one at Bronkhorstspruit (with estimated cost of ZAR 30 million)
- formulate operation and maintenance programmes
- identify and control of illegal connections and vandalism of facilities

These proposals were scarcely implemented, reportedly due to insufficient fund and vulnerable organisational / institutional arrangement.

(2) Water Service Development Plans (WSDP's) by the Local Municipalities

All the local municipalities under the Western Highveld Water Scheme (WHWS) are expected/ assumed to prepare their own short-term water and sanitation development plans targeted to achieve the "Millennium Development Goals set for year 2015.

Two such WSDP's so far obtained from Dr JS Moroka and Thembisile Hani local municipalities commonly show more emphasis on sanitation rather than water supply, since it is supposedly considered that sanitation facilities shall be reinstalled more urgently than water supply which seems to be nearly sufficiently installed.

Major development items with associated costs of two WSDP's are tabulated below without, however, known progress / achievement thereof.

Table 2.2.1 Dr JS Moroka, Major WSDP Targets

No.	Description	Financial Year		
		09/10	10/11	11/12
		ZAR Million.		
1	Strategic & Operational Programmes and Projects	8.54	8.89	0.59
2	Bulk Water and Sanitation Infrastructure	23.69	13.85	15.2
3	Water Supply Network to Consumers	63.52	31.72	25.3
4	Sanitation Projects: Installation of Ventilated-Improved Pits (VIPs)	122.59	89.35	19.54
	Total	**218.34**	**143.81**	**60.63**

Source: WSDP, Dr. JS Moroka LM

Table 2.2.2 Thembisile Hani LM, Major WSDP Targets

No.	Description	Financial Year				
		06/07	07/08	08/09	09/10	10/11
		ZAR Million.				
1	Strategic & Operational Programmes and Projects	1.07	10.91	7.61	0.04	0.04
2	Bulk Water and Sanitation Infrastructure	0.01	5	0	0	0
3	Water Supply Network to Consumers	8.12	8.12	8.12	8.12	8.12
4	Sanitation Projects: Installation of Ventilated-Improved Pits (VIPs)	57.22	57.22	57.22	57.22	57.22
5	Additional Projects	3	-	-	-	-
	Total	**69.42**	**81.25**	**72.95**	**65.38**	**65.38**

Source: WSDP, Thembisile Hani LM

(3) Service Delivery from the Western Highveld Scheme: Institutional Reform (IR) for Optimal Institutional Arrangements (IR Report)

The purpose of the IR Report is to propose an effective and sustainable institutional setup for the ownership and management of the Western Highveld water scheme.

(4) Western Highveld Scheme Technical Feasibility Report (WHR FS)

This feasibility study has two major components:

- the first contains action plans to recover the original capacity of the existing water supply facilities that are 13 to 25 years old
- the second has extension plans to the 2030 target year, as shown in Table 2.2.3 below

Budget of the rehabilitation work will be funded by central government of South Africa. DWA has contracted with Rand Water to manage the project on the rehabilitation work on March, 2011. A bid tender for selection of the local contractors on the project was completed in September 2011.

This WHR FS emphasises not only the aforementioned infrastructure development plans for future water demand, but also the significance of water demand management, institutional reform and the introduction of the remote control / operation systems.

Table 2.2.3 WHR FS Rehabilitation and Development Plans

No.	Action Plan	Major Items	Costs in million ZAR
1	Action Plans of Rehabilitation of Existing Facilities	▪ Rehabilitation of Bronkhorstspruit bulk water supply system ▪ Rehabilitation of Weltevreden bulk water supply system (Intake pumps, purification plant, rising pumps, booster pumps) ▪ Rehabilitation of bulk pipelines (bulk meter, valves, etc.) and protection of cathodic corrosion of steel pipelines ▪ Rehabilitation of service reservoirs (leakage point, inlet valves, etc.) ▪ Remote control system ▪ Rehabilitation of deep wells ▪ Rehabilitation of distribution pipelines	101*1
2	Strategic extension plan to meet the future (2030) water demand	▪ Extension of bulk pipelines in the southern scheme ▪ Extension of bulk pipelines in the northern scheme	476*2

Note:
*1: Contingency is included but not VAT.
*2: Contingency and escalation are included but not VAT.

(5) Engineering Study and Solution Provision for the Bulk Water Supply from Rust de Winter to Mathanjana Magisterial District of Dr JS Moroka Local Municipality

The western area of Dr JS Moroka is called the Mathhanjana area which is located 70km from Weltevreden water treatment works of northern scheme of Western Highveld water supply system. In addition, the elevation of the area is approximately 200m higher than that of Weltevreden water treatment works. In the Mathhanjana area, groundwater is the primary source of water due to topographical conditions.

The DWA made a plan of water withdrawal from Rust de Winter dam which is located near the southern water service area.

Water supply scheme has been planned with the following facilities for the new bulk water scheme:

- treatment plant
- conveyance pipe
- distribution pipe

The total project cost is R243 million.

The water supplies a population of 63,211 people and the capacity of water treatment is designed to be 11,000m^3/day.

(6) Technical Report Bulk Water Supply to Moutse (Moutse East and Moutse West)

Moutse area goes by another name of Ephraim Mogale LM and Elias Motsoaledi LM in Sekhukhune DM. It is located on the edge of west of Western Highveld area. This area is a hilly zone and because of conditions, people in the area do not receive enough water from the North water supply scheme. Residents of this area feel they receive poor treatment from Limpopo Province.

In 2009, a referendum was held at the request of the inhabitants of Moutse to determine whether they would prefer to stay in the Limpopo Province or move over to the Mpumalanga Province where they resided previously. (The Supreme Court finally had judged that the existing jurisdiction is correct.)

This water supply scheme is designed to expand the existing Groblesdal water treatment plant which is in Groblersdal city. The expansion facilities comprise a pump, transmission pipe and water reservoir.

Total construction cost will amount to R382 million and is expected to be completed by September 2013. The water is required to supply a population of 222,951 people. Maximum design capacity of water treatment is 18,000m^3/d. The additional water treatment plan has already constructed.

2.3 Water Sources

2.3.1 Existing Reports

Development of water sources is reviewed in reference to the following reports:

- Western Highveld Region Water Augmentation Pre-Feasibility Study (WHR Pre-FS)
- Western Highveld Scheme Technical Feasibility Report (WHR FS)

2.3.2 Current Performance of the Existing Facilities compared with the Design Capacities

The design capacities and the current performance of the existing facilities are compared in the table below.

Table 2.3.1 Actual Capacity of Existing Facilities

Facilities	Design Capacity (m^3/d)	Current Performance (m^3/d)
Southern Scheme (Bronkhorstspruit)		
1) Raw water pump station	60,500	53,300
2) Bronkhorstspruit water treatment plant	54,000	43,000
Northern Scheme (Weltevreden)		
3) Raw water pump station (Mtombo weir)	20,900	0
4) Raw water pump station (Weltevreden weir)	68,000	68,000
5) Weltevreden water treatment plant	68,000	68,000
Imported Water		
6) Supply from Rand Water Board	30,000	30,000
Rust de Winter Scheme (New plan)		
7) Raw water pump station	15,000	0.0
8) Water treatment plant	11,000	0.0
Mouse Scheme (**New plan**)		
9) Raw water pump station	9,000	0.0
10) Water treatment plant	18,000	
		0.0
Total quantity of raw water intaken in the area: 1)+3)+4)+7)+9)	**173,400**	**121,300**
Total quantity of treated water to be distributed: 2) +5)+6)+8)+10)	**181,000**	**148,00**

Source: WHS FS, Documents from Dr Js Moroka and Mouse

According to WHR FS, the water demand at the year 2030 is forecasted to be 131,605m^3/day based on the year 2010 estimate (see Table2.4.3 of Section 2.4 Water Demand Forecast). If Rand Water continues to supply water to the Western Highveld scheme in the future, the current capacity of 148,000m^3/day is enough to meet the future water demand. Thus, there will be no need of water supply from Rand Water after construction of planed water treatment plants.

2.3.3 Possible Volume of Water at Drought Risk

It is also discussed in WHR FS, that the drought risk shall be taken into account in the supply vs. demand projections. Possible volume of water to be intaken and hence to be distributed may fluctuate depending upon the probable drought risks, as was known when water level of Bronkhorstpruit dam lowered in the 2003 drought.

In the Table 2.3.2 below, the minimum supply at the probable drought at 100, 50 and 20-year intervals is estimated and compared with demand at year 2010 and 2030. Based on this estimation, WHS FS suggested necessity to develop new source of raw water even before year 2030.

Table 2.3.2 Supply / Demand Balance at 100, 50 and 20-year Drought Risks

Existing Sources	2010			2030		
	Risk of Failure			Risk of Failure		
	1:100	1:50	1:20	1:100	1:50	1:20
Bronkhorstspruit weir	27.6	30.9	38.0	27.6	30.9	38.0
Weltevreeden Weir	19.5	23.8	32.5	19.5	23.8	32.5
Possible Intake Volume	47.1	54.7	70.5	47.1	54.7	70.5
Rand Water	30.0	30.0	30.0	30.0	30.0	30.0
Total Supply (Mm^3/d)	77.1	84.7	100.5	77.1	84.7	100.5
Water Demands Iincl. NRW of 15%)	96.2	96.2	96.2	131.6	131.6	131.6
Surplus/Shortfall (Mm^3/d)	- 19.1	- 11.5	4.3	- 54.5	- 46.9	- 31.1

Source: WHS FS

2.3.4 New Source of Water

For the possible development of a new source of water for the Western Highveld Water Scheme, potential sources under two categories were investigated:

(1) Sources mainly from Surface Water from adjoining areas outside the Western Highveld Region

- Intake from the Vaal River via the Grootdraai Dam
- Water right acquisition of Laskop Dam for portable water
- Groundwater development by community
- Intake from the Apies and/or Pienaars Rivers
- Utilization of Moses River scheme
- Utilization of reclaimed water in Blesbokspruit catchment
- Development of Delmas dolomites
- Augmentation of intake capacity of Bronkhorstspruit Dam

(2) Local Sources within the Western Highveld Region

More effective use of local sources should be pursued:

- to explore groundwater potential in the northern parts of the region
- direct intake at the rust de winter dam
- conversion / redesignation of the Rust de Winter source from irrigation to domestic use
- more effective use of Bronkhorstspruit dam and Rand Water only during drought period
- augmentation of water intake capacity

According to DWA, potential intake flow is approximately 7,000m^3/day, while actual volume intaken is only 50,000m^3/day.

As detailed in Section 3.2.1: It seems to be impractical to utilize this source for potable use, unless water right issue on redesignation of irrigation use to domestic use is settled.

If it is possible to develop alternative water sources above, supply may meet the future water demand, as shown in the table overleaf:

Table 2.3.3 Supply / Demand Balance with Alternative Water Sources

Water Resources	2010			2030		
	Risk of Failure			Risk of Failure		
	1:100	1:50	1:20	1:100	1:50	1:20
Existing resources						
Bronkhorstspruit weir	27.6	30.9	38.0	27.6	30.9	38.0
Weltevreeden Weir	19.5	23.8	32.5	19.5	23.8	32.5
Existing resources(Mm^3/d)	**47.1**	**54.7**	**70.5**	**47.1**	**54.7**	**70.5**
Localized Augmentation Options						
Existing boreholes	5.0	5.0	5.0	5.0	5.0	5.0
Additional groundwater development	3.0	3.0	3.0	3.0	3.0	3.0
Bronkhorstspruit Raw Water Pipeline	8.5	8.5	8.5	8.5	8.5	8.5
Rust de winter Raw Water pipeline	13.6	13.6	13.6	13.6	13.6	13.6
Rust de winter Irrigation Allocation (50%)	2.1	2.1	2.1	2.1	2.1	2.1
Reinstate current allocation from Loskop Dam	7.0	7.0	7.0	7.0	7.0	7.0
Additional Allocation in Loskop Dam	43.0	43.0	43.0	43.0	43.0	43.0
Augmentation Options (Mm^3/d)	**82.2**	**82.2**	**82.2**	**82.2**	**82.2**	**82.2**
Subtotal Resources (Mm^3/d)	**129.3**	**136.9**	**152.7**	**129.3**	**136.9**	**152.7**
Water Demand (Incl.NRW of 15%)	**96.2**	**96.2**	**96.2**	**131.6**	**131.6**	**131.6**
Surplus/Deficit (Mm^3/d)	**33.1**	**40.7**	**56.5**	**- 2.3**	**5.3**	**21.1**

Source: WHS FS

In the meanwhile, De Hoope Dam in Limpopo Province is being constructed by DWA to supply water for domestic and mining purpose. In April 2011, Height of the Dam has reached approximately 50% of the designed height as shown in Figure 2.3.1.

After construction of De Hoope Dam, raw water will be conveyed to Mogalakwena LM and Mokopane, seat of the LM. However, there is no feasible plan to convey raw water to the parts of Elias Motsoaledi LM and Greater Marble Hall LM in the Western Highveld Region.

Figure 2.3.1 De Hoope Dam

2.3.5 Review Comments

It will be advantageous to increase the intake water from the existing facilities and development of new water sources, and through them to decrease the supply from Rand Water, whose cost is expensive.

Some issues in augmentation of the existing facilities and development of new water sources - that are not necessarily clearly argued in these reports reviewed - are as follows:

- it is enough quantity of water supply considered the risk if supply water would be distributed each tap by determined the volume from study team on second survey.
- it is possible to intake the water from the downstream river of Loskop Dam for water supply facility at Moutse area.
- It seems that there is no reliability in groundwater potential. According to the existing report, it is possible to pump up water by community and/or village, but groundwater potential has not been measured or quantified until now.

2.4 Review on Water Demand Forecast

2.4.1 Report on Water Demand Forecast

Water demand forecasts in WHR Pre-FS and WHR FS are reviewed here.

- Western Highveld Region Water Augmentation Pre-Feasibility Study, Sep. 2005 (WHR Pre-F/S)
- Western Highveld Scheme Technical Feasibility Report Jan. 2010 (WHR F/S)

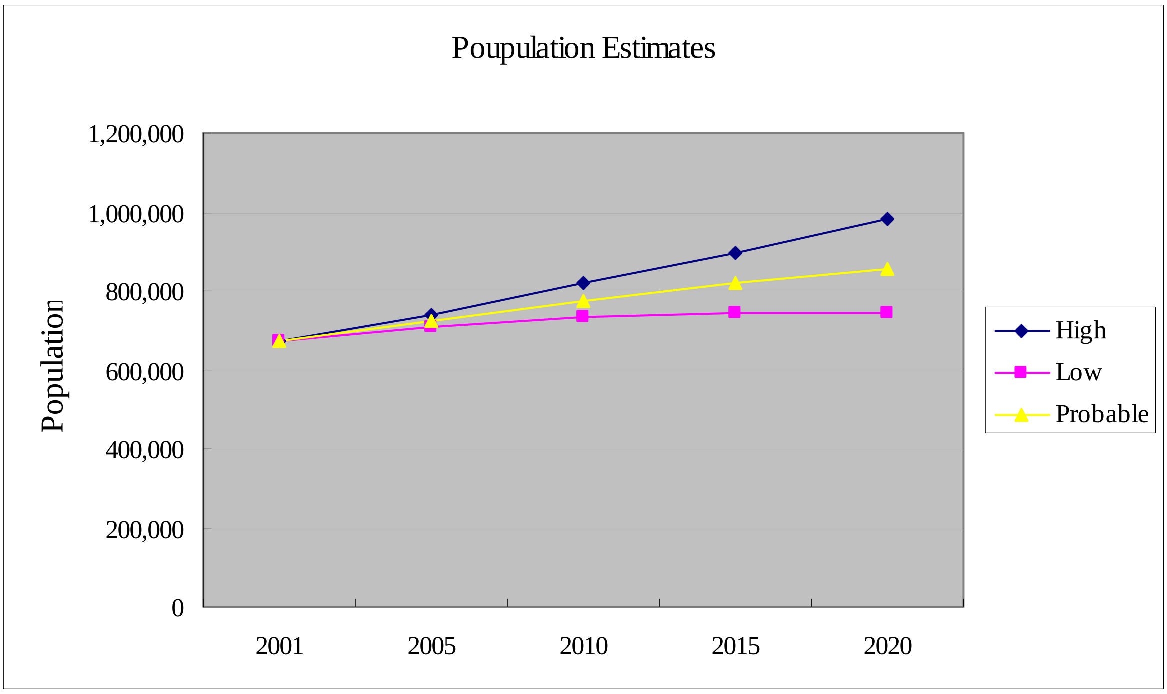
Study team modified the water demand forecast by the documents that are gathered on first and second survey.

- Engineering Study and Solution Provision for the Bulk Water Supply from Rust de Winter to Mathanjana Magisterial District of Dr JS Moroka Local Municipality
- Technical Report, Bulk Water Supply to Moutse (Moutse East and Moutse West)

2.4.2 Population Projection Option 1 in the WHR Pre-FS

Through comprehensive analysis of socio-economic situations and the spread of HIV/AIDS in South Africa, population until 2020 were projected into three (3) scenarios on basis of the year 2001 census results. See the Figure 2.4.1.

A 2.4 to 2.0 percent rate of population growth is defined as High scenario. A 1.2 to 0.5 percent rate of population growth is defined as low scenario and rate between High scenario and Low scenario is defined as Probably scenario.



	2001	2005	2010	2015	2020
High	675,485	740,068	820,020	895,843	980,309
Low	675,485	708,753	734,532	746,575	742,871
Probable	675,485	724,284	776,232	818,056	853,820

Source: WHS FS

Figure 2.4.1 Population Projection

The probable growth scenario results in a population of 853,820 in 2020. Meanwhile, the low growth scenario results in 742,871 due to the epidemic of HIV/AIDS, non improvement in behavior and education and also contraceptive prevalence. The difference between them is up to 110,949. In either case, the projected population in 2020 varies from 740,000 to 980,000.

The following Table 2.4.1 shows the population projection in each local municipality under the probable growth scenario.

Table 2.4.1 Population Projections in Local Municipalities under the Probable Growth Scenario

Municipality	2001	2005	2010	2015	2020
Dr JS Moroka LM	243,304	256,820	269,691	277,857	283,005
Thembisile Hani LM	258,876	280,905	305,626	327,994	349,213
Greater Marble Hall (Ephraim Mogale) LM	42,184	44,802	47,419	49,192	50,426
Greater Groblersdal (Elias Motsoaledi) LM	97,647	104,417	111,466	116,630	120,590
Kungwini LM (Tshwane Metropolitan)	33,474	37,340	42,031	46,383	50,586
Total	675,485	724,284	776,233	818,056	853,820

Source: WHR Pre-FS

2.4.3 Population Projection Option 2 in the WHR FS

The demography of the Western Highveld region was made by application of the latest satellite imagery, and with the number of buildings digitally counted. The buildings were categorized into five (5) groups by function and use.

i) Residential (formal) : equipped with in-house connection of water and flush toilet
ii) Residential (informal) : equipped with yard connection of water and VIP latrine
iii) Schools
iv) Offices and shops
v) Government and municipal offices

The following Table 2.4.2 shows the result of counting.

Table 2.4.2 The Number of Buildings Digitally-counted

Category	No. of Plots
Residential (formal)	33,158
Residential (informal)	138,592
Schools	325
Offices and Shops	645
Government and Municipal Offices	161
Total :	172,881

Source: WHR FS

The household size according to the Census 2001 was 4.4 persons per household. The population in 2010 is calculated as follows:

N = (33,158＋138,592) x 4.4 = 755,700

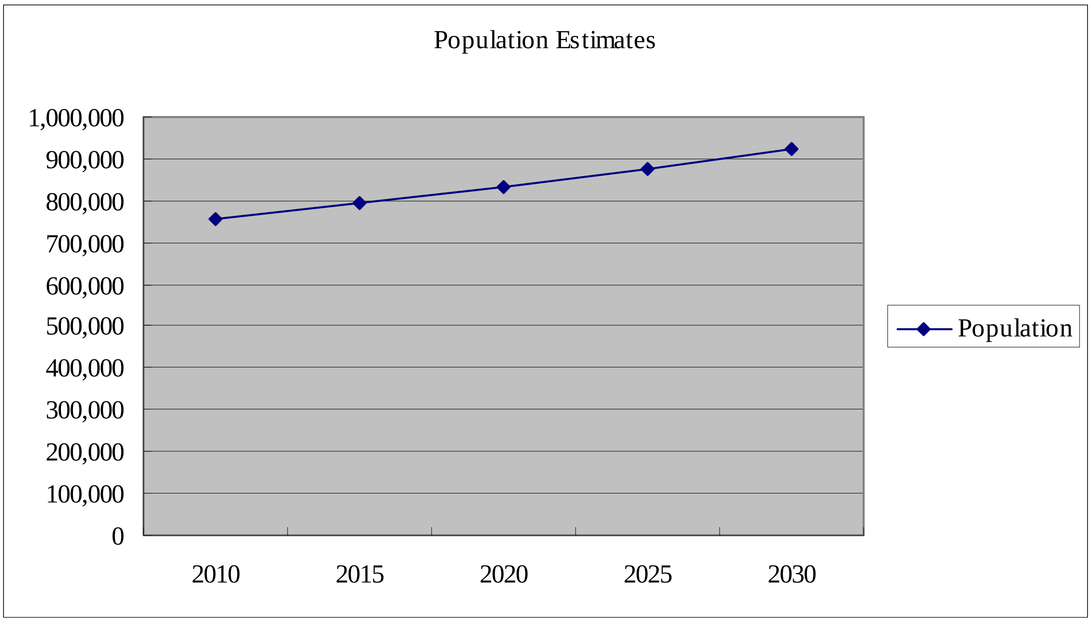
Here, this population in 2010 is compared with the projected one reported in the WHR Pre-FS, September 2005. The population in 2010 projected in the WHR Pre-FS is:

Low Growth Scenario N = 734,532
Probable Growth Scenario N = 776,232
Toal = 1,510,764
Mean value of two scenarios = 1,510,764 / 2 = 755,382

The mean value of the two scenarios is 755,382, which is almost same with the above projection with the digitally counted number of houses and the household size of 4.4 persons.

It is, therefore, assumed that the population grew along the mean value of the both low and probable growth scenarios until 2010.

The following Figure 2.4.2 shows population projection until 2030 with a growth rate of 1.0 % per annum.



	2010	2015	2020	2025	2030
Population	755,700	794,248	834,763	877,344	922,098

Figure 2.4.2 Population Projection, 2010-2030

2.4.4 Water Demand Forecast

2.4.4.1 The Reconstruction and Development Programme (RDP)

The Reconstruction and Development Programme (RDP) distributed in 1994 covered a broad range of policy challenges including sufficiency of basic human needs (BHN), development of human resources, promotion of small-and-medium-sized enterprise, building of a democratic nation and so on. In particular, water was positioned as a priority sector, as all nationals should have the right to be beneficiaries of water and sanitation to secure subsistence right. The RDP pronounced 20 to 30 l/capita/day in the short term and 50 to 60 l/capita/day in the medium-to-long term as standards of required water supply.

2.4.4.2 Current Situation of the Western Highveld Region

Kungwini LM (currently Tshwane Metropolitan Municipality) is a municipality with unique diversity in the region, in which the traditional town of Bronkhorstspruit and urbanized areas of commerce and industry are located. Communities in other municipalities vary in characteristic between rural and peri-urban and have many households poorly-serviced compared with typical urban areas. Water supply services in the municipalities except Kungwini LM in the Western Highveld region have been designed and implemented based on the RDP standard, and service level is currently above the RDP standard. However, excessive water usage and wastage are frequently observed throughout the region, and therefore, consumption is not always consistent with the estimated water demand.

2.4.4.3 Water Demand Forecast

Water demand in Kungwini LM (currently Tshwane Metropolitan Municipality) was forecasted in consideration of additional demands for business and industry, so the study team will look into the additional demands in the second field study.

A purpose of water use in other municipalities is for domestic use only. Both water consumption unit per person and consumption by categorized use were not explicitly stated in the WHS FS report.

However, the water demands of other municipalities until 2030 were forecasted based on the year 2010 by the population growth rate of 1.0% per annum. See Table 2.4.3.

Table 2.4.3 Water Demand Forecast

Municipality	2010	2030
Kungwini LM (Tshwane Metropolitan)	26,840	45,123
Thembisile Hani LM	28,900	35,263
Dr JS Moroka LM	17,642	21,527
Greater Groblersdal (Ephraim Mogale) LM	7,581	9,250
Greater Marble Hall (Elias Motsoaledi) LM	2,684	3,276
Total (kl/d)	**83,647**	**114,439**
Allow for NRW of 15%	12,547	17,166
Total (m^3/d)	**96,194**	**131,605**

Source: WHS FS

2.4.5 Review and Remarks

2.4.5.1 Population Projection

The WHS Pre-FS in 2005 projected the population until 2020 in three (3) scenarios starting from the year 2001 census results to year 2020. These scenarios except low growth scenario applied the growth rates larger than 1.0% per annum.

The WHS FS in 2010 projected the population until 2030 again. The benchmark population in 2010 was almost same as the population in 2010, that was projected in the WHS Pre-FS in 2005 as a mean value of the low growth and the probable growth scenarios. This fact means that the estimated population growth rate applied in WHR Pre-FS in 2005 was slightly high and the actual growth rate was lower than the expected.

According to the review based on the report of WHR FS in 2010, the population growth rate was updated at 1.0% per annum. For reference, the World Bank predicted the population growth rate in 2009 in South Africa at 1.0% too.

A result of second survey, however, rate of population growth is 1.7 to 1.8 percent not 1.0 percent. A result of projection of population on 2020 becomes the similar with Probable scenario.

This is predicted by upgrade of social environment and education for HIV/AIDS

2.4.5.2 Water Demand Forecast

The Council for Scientific and Industrial Research (CSIR) of South Africa pronounced design standard for domestic water consumption in the "Guidelines for Human Settlement, Planning and Design, August 2003 (Red Book)."

As a result of review of the water demand forecasts in both 2010 and 2030, the water demand growth rate was 1.0% except Kungwini LM. It is assumed that the water demand until 2030 was forecasted based on the year 2010 with the population growth rate of 1.0% per annum.

Water demand in Kungwini LM located close to the capital Tswane is higher because of commerce and industry, but breakdown and details has not been confirmed. And, possible social changes were not taken into consideration, such as whether or not water consumption remains the same in the next twenty (20) years and also whether or not land-use planning stays the same. The water demand was, therefore, forecasted based on domestic use in residences only.

CHAPTER 3 CURRENT STATUS OF THE WATER SUPPLY SERVICE

3.1 Overview of Water Supply Service

3.1.1 Service Area and Served Population

Based on Water Services Development Plans (WSDP) and other documents prepared by municipalities, the population in 2010 - residing in communities exclusively within Western Highveld area - has been calculated in the Table 3.1.1

Total population in the area is about 819 000. Approximately 746 000 people of the total (91.1 percent of the total) are being served by the Western Highveld water system. The remaining group of 73 000 people (8.9%) have relied on other water supply such as small piped systems, public hand pumps and privately owned dug-wells.

Parts of the community served by Western Highveld water system use other water supplies due to scarcity of water.

Table 3.1.1 Population served in the Study Area (2010)

Local Municipality (LM)	Total Population in Western Highveld		Population served by Bulk Supply System		Population served by Boreholes	
	Person	%	Person	%	person	%
Tshwane (Metropolitan)	48 397	100.0	48 397	100.0		
Thembisile Hani	318 006	100.0	307 141	96.6	10 865	3.4
Dr JS Moroka	277 452	100.0	215 068	77.5	62 384	22.5
Ephraim Mogale	44 114	100.0	44 114	100.0		
Elias Motsoaledi	131 377	100.0	131 377	100.0		
Total	**819 346**	100.0	**746 097**	91.1	**73 249**	8.9

Source : JICA Study Team

Based on Water Services Development Plans (WSDPs) and other documents prepared by municipalities, Table 3.1.2 shows the number of communities situated in the Western Highveld area.

Table 3.1.2 Number of Community in the Study Area (2010)

Local Municipality (LM)	Total Number of Community in Western Highveld	Total Number of Community served by Bulk System	Total Number of Community served by Boreholes
Tshwane(Metropolitan)	3	3	-
Thembisile Hani	51	49	2
Dr JS Moroka	47	36	11
Ephraim Mogale	12	12	-
Elias Motsoaledi	28	28	-
Total	141	128	13

Source: JICA Study Team

3.1.2 Water Supply Situation by Service Level

Based on interviews with municipalities, Table 3.1.3 shows water service levels in each municipality by category such as house connection, yard connection, public standpipe, and ‘no supply’ from the Western Highveld water system.

Although proportions differ in each municipality:

- yard connection accounts for 54.3% - more than half in the whole Western Highveld area

- public tap stands account for 22.4%
- house connections account for 16.6%
- no supply from the system accounts for the balance of 6.7%

Table 3.1.3 Water Service Level by Category (2010)

Local Municipality (LM)	Population served by Bulk Supply System		House Connection		Yard Connection		Public Standpipe		No Supply by System	
	person	%	person	%	person	%	person	%	person	%
Tshwane (Metropolitan)	48,397	*100.0*	47,638	*98.4*	0	*0.0*	759	*1.6*	0	*0.0*
Thembisile Hani	307,141	*100.0*	14,609	*4.8*	191,470	*62.3*	72,592	*23.6*	28,470	*9.3*
Dr JS Moroka	215,068	*100.0*	58,681	*27.3*	138,399	*64.4*	17,987	*8.4*	0	*0.0*
Ephraim Mogale	44,114	*100.0*	0	*0.0*	26,967	*61.1*	5,283	*12.0*	11,863	*26.9*
Elias Motsoaledi	131,377	*100.0*	2,591	*2.0*	48,559	*37.0*	70,734	*53.8*	9,494	*7.2*
Grand Total	**746,097**	*100.0*	**123,519**	*16.6*	**405,395**	*54.3*	**167,356**	*22.4*	**49,827**	*6.7*

Source : JICA Study Team

3.1.3 Situation of Time-Restricted Water Supply

The Western Highveld water system has been repeatedly expanded to improve basic public services for residents of the former homeland. However, water demand and supply in each supply area has not been well-balanced, possibly because the system has been designed and constructed on an ad hoc basis without master plan or equivalent.

In addition, facilities are not always in good condition because of inappropriate operation and maintenance.

Under this undesirable situation, there are wide beneficiary gaps among communities due to, among others:

- interrupted and suspended supply
- supply restriction
- lack of pressure
- flow by illegal connection

The situation of routine time-restricted water supply is categorized into four categories as shown in the Table 3.1.4 and represented in the Figure 3.1.1.

Table 3.1.4 Category of Time-Restricted Water Supply

Category	Definitions
Equable Supply	: 24 hours supply in 7 days
Marginal Supply	: 12 hours supply in 7 days or 24 hours supply in 5 to 6 days
Unequable Supply	: 3 to 4 days supply in 7 days
Serious Supply	: Almost no supply

42.0% of the total population has received water in 24 hours everyday; meanwhile, 6.5% has not received water practically (see Table 3.1.5 and Table 3.1.6).

Communities located in bulk supply ends in south Scheme and communities located in Dr JS Moroka LM in North scheme (excluding the central part of the LM) have suffered from time-restricted water supply.

In particular, the western area of Dr JS Moroka LM has not been served by the Western Highveld water system but has relied on small systems using groundwater.

The north-eastern area of Thembisile Hani LM is normally served by Walkraal sub-scheme in North scheme, but the area has not been served as planned. The area is served provisionally by South scheme.

Table 3.1.5 Situation of Time-Restricted Water Supply (Local Municipality)

Local Municipality	Population 2010	Equable Supply *1		Marginal Supply *2		Unequable Supply *3		Serious Supply *4		N/A	
	(person)	(person)	(%)	(person)	(%)	(person)	(%)	(person)	(%)	(person)	(%)
Tshwane (Metropolitan)	48,397	48,397	*100.0*	0	*0.0*	0	*0.0*	0	*0.0*	0	*0.0*
Thembisile Hani	307,141	210,034	*68.4*	56,271	*18.3*	32,872	*10.7*	0	*0.0*	7,965	*2.6*
Dr JS Moroka	215,068	55,032	*25.6*	21,867	*10.2*	105,065	*48.9*	30,600	*14.2*	2,504	*1.2*
Ephraim Mogale	44,114	0	*0.0*	2,192	*5.0*	41,922	*95.0*	0	*0.0*	0	*0.0*
Elias Motsoaledi	131,377	0	*0.0*	74,547	*56.7*	38,631	*29.4*	18,199	*13.9*	0	*0.0*
Grand Total (m3/day)	**746,097**	**313,463**	***42.0***	**154,877**	***20.8***	**218,490**	***29.3***	**48,799**	***6.5***	**10,469**	***1.4***

*1 : 24 hours supply in 7 days
*2 : 12 hours supply in 7 days or 24 hours supply in 5 to 6 days
*3 : 3 to 4 days supply in 7 days
*4 : Almost no supply

Table 3.1.6 Situation of Time-Restricted Water Supply (Supply Scheme)

Supply Scheme		Population 2010	Equable Supply *1		Marginal Supply *2		Unequable Supply *3		Serious Supply *4		N/A	
		(person)	(person)	(%)	(person)	(%)	(person)	(%)	(person)	(%)	(person)	(%)
South	South	282,104	201,630	*71.5*	38,656	*13.7*	32,872	*11.7*	0	*0.0*	8,946	*3.2*
North	Walkraal	294,911	93,877	*31.8*	100,691	*34.1*	81,252	*27.6*	18,199	*6.2*	893	*0.3*
	Kameelrivier	42,956	0	*0.0*	13,339	*31.1*	29,451	*68.6*	0	*0.0*	166	*0.4*
	Weltevreden/Kuilen	18,056	17,955	*99.4*	0	*0.0*	0	*0.0*	0	*0.0*	100	*0.6*
	Bloedfontein	108,071	0	*0.0*	2,192	*2.0*	74,915	*69.3*	30,600	*28.3*	364	*0.3*
	Sub-Total	463,993	111,832	*24.1*	116,221	*25.0*	185,618	*40.0*	48,799	*10.5*	1,523	*0.3*
Grand Total (m3/day)		**746,097**	**313,463**	***42.0***	**154,877**	***20.8***	**218,490**	***29.3***	**48,799**	***6.5***	**10,469**	***1.4***

*1 : 24 hours supply in 7 days
*2 : 12 hours supply in 7 days or 24 hours supply in 5 to 6 days
*3 : 3 to 4 days supply in 7 days
*4 : Almost no supply

3.1.4 Situation of Illegal Connections

There are a number of illegal connections to both transmission and distribution (reticulation) pipelines by houses in all parts of the area. The illegal connections have caused an increase of accounted for water and are obstacles to an appropriate water demand management.

The illegal connections are said to have been done by individuals or small contractors having experiences of plumbing, but the number of connections and water consumption has been unknown.

In this surrounding, Figure 3.1.2 shows the existence of illegal connections and the degree to which the community the community operates. To a varying degree, the existence of illegal connections is evident in the whole area.

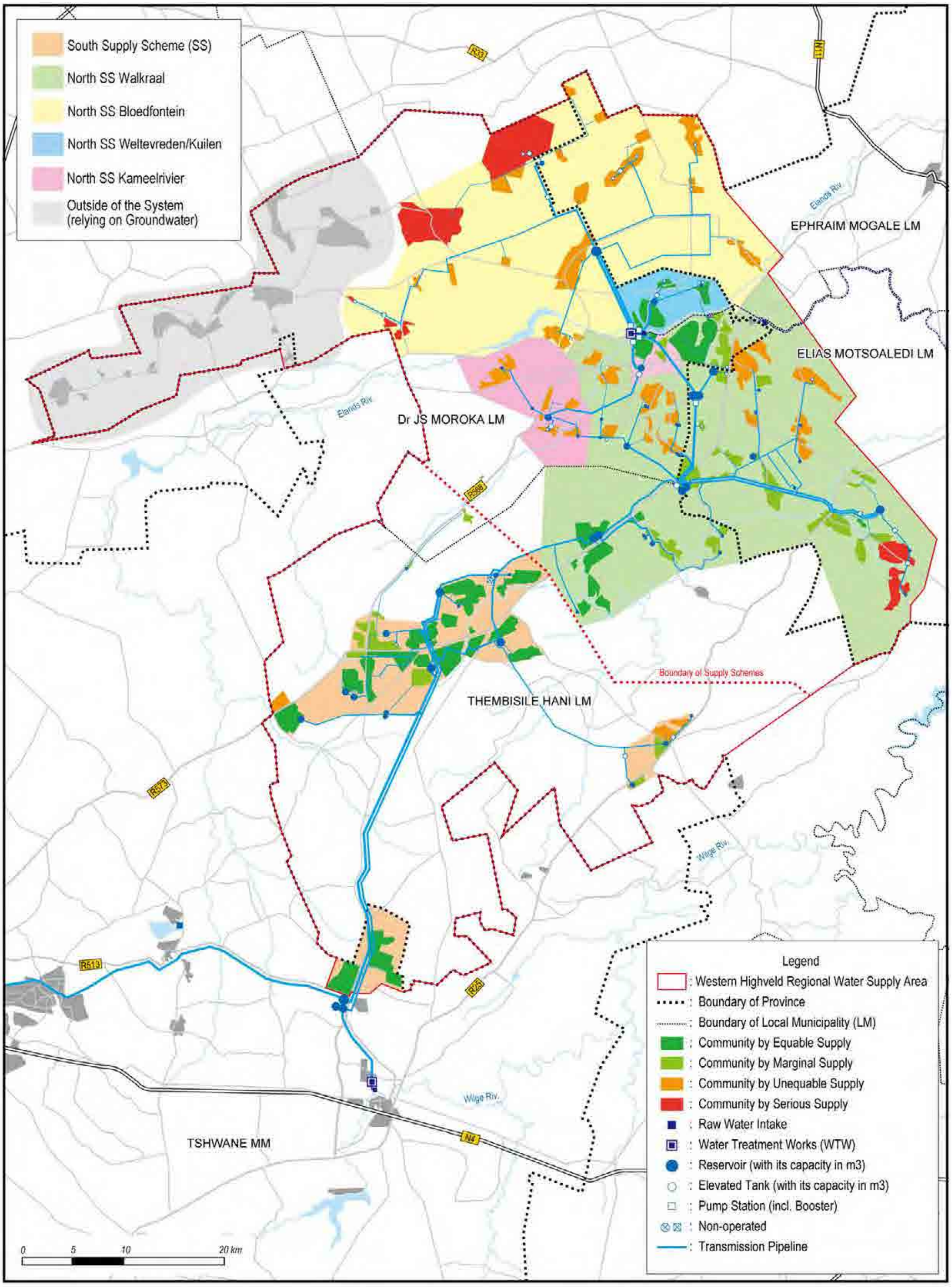


Figure 3.1.1 Situation of Time-Restricted Water Supply by Community

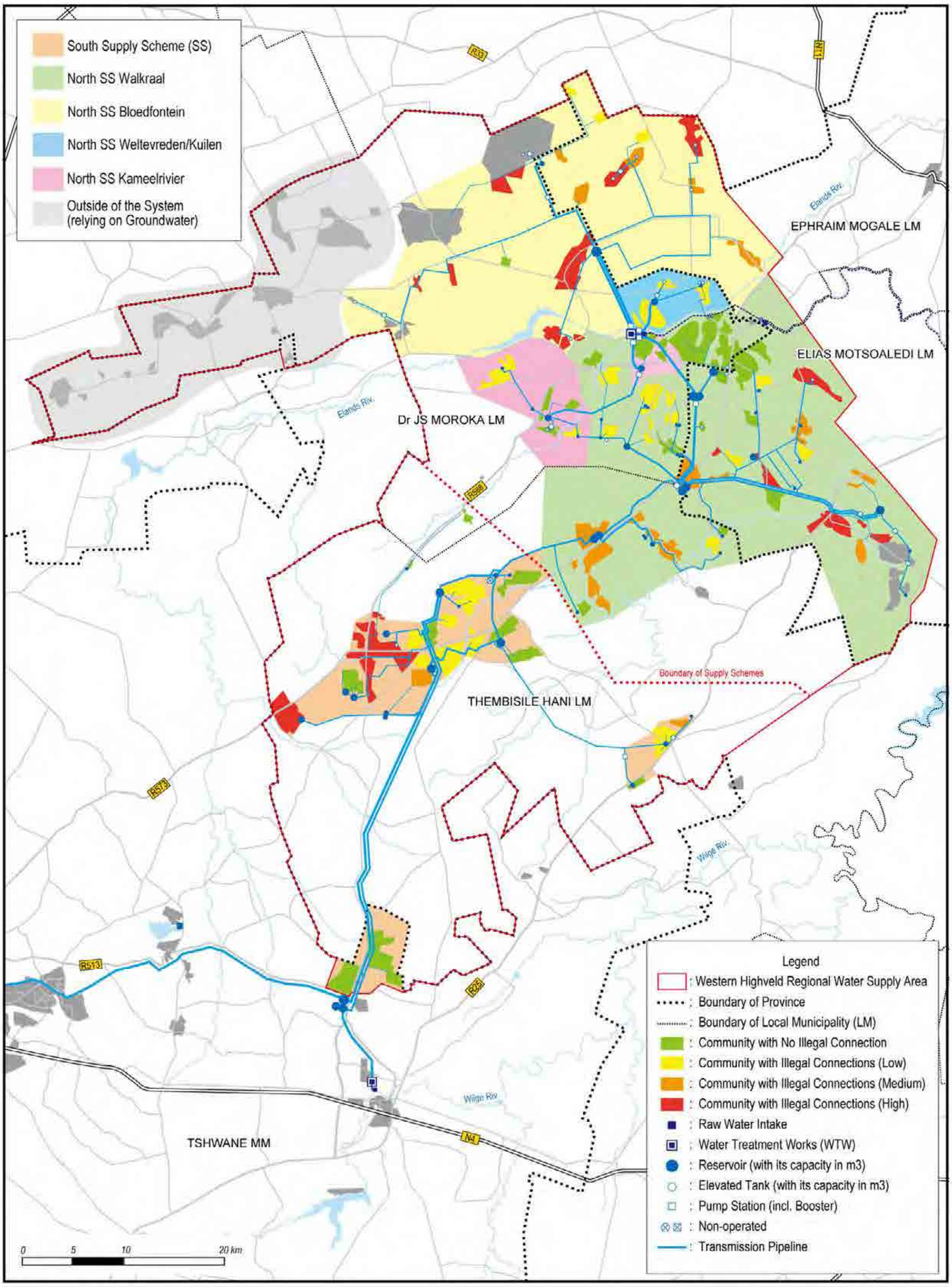


Figure 3.1.2 Situation of Illegal Connection by Community

3.1.5 Design and Actual Capacity of the Western Highveld Regional Water Supply Scheme

The Western Highveld Regional Water Supply Scheme is composed of Southern and Northern schemes. Water service area is divided into 5 sub-supply schemes. Total design capacity of two (2) treatment works with added supply from Rand Water Board is 152,000 m^3/day, while that of all the transmission / booster pumps is 168,000 m^3/day as shown in Table 3.1.7. It is, however, reported that water actually supplied is only 130,0000 m^3/day, which is by approximately 22,000 m^3/day less than the expected supply capacity. Moreover, the design / potential capacity of transmission / booster pumps of 38,600m^3/day is not being fully utilized and therefore idling.

Table 3.1.7 Design Capacity of Transmission Facilities vs. Actual Supply

Scheme	Service Area/ Sub-Supply Scheme	Design Capacity-1) (m^3/day)	Actual Flow-2) (m^3/day)	Balance 1)-2)
Southern	**Total**	**84,000*1**	**70,000*2**	**14,000**
Northern	**Total**	**84,600**	**60,000**	**24,600**
	Walkraal	60,000	41,700	18,300
	Bloedfontein	13,400	7,800	5,600
	Weltervreden	4,900	4,400	500
	Kameelrivier	6,300	6,100	200
Total in Western Highveld Region		**168,600**	**130,000**	**38,600**

Note:
*1: A 30,000m^3/day supply from Rand Water is included in 84,000m^3/day.
*2: Design Capacity of the Northern scheme shows that of the transmission facilities.
Source: WHR Pre-FS

3.1.6 Design Capacity and Supply / Demand Balance in 2010

As mentioned above, the total design capacity of two treatment works - including Rand Water supply and that of transmission facilities - are 152 000 m^3/day and 168 000 m^3/day respectively. This supply capacity is sufficient to meet the year 2010 demand of 72 434 m^3/day under the 40 percent unaccounted for water scenario, as shown in the Table 3.1.8.

Although water is actually supplied at 130 000m^3/day, the area has suffered from water shortages. As described in the Chapter 4, the system has lost a far greater amount of water than we might imagine because of illegal connections, water leakage and gardening.

This situation has probably been caused by low awareness of water conservation and an increase of per capita consumption due to the flat water rate, free basic water and non billing.

Figure 3.1.3 shows the water supply/demand balance in 2010 in each water service area.

Table 3.1.8 Water Supply / Demand Balance of the Western Highveld Water System in 2010

Scheme	Treatment / Distribution	Treatment Design Capacity-1) (m^3/day)	Transmission Pump Design Capacity-2) (m^3/day)	Water Demand (2010) -3) (m^3/day)	Balance 1) - 3)	Balance 2) - 3)
Southern	Bronkhorstspruit WTW	**84 000**	**84 000**	**29 043**	**54 957**	**54 957**
Northern	Weltevreden WTW	**68 000**	**84 600**	**43 391**	**24 609**	**41 209**
	Walkraal	-	60 000	27 269	-	32 731
	Bloedfontein	-	13 400	9 027	-	4 373
	Weltevreden	-	4 900	2 321	-	2 579
	Kameelrivier	-	6 300	4 775	-	1 525
Total of Western Highveld Water System		**152 000**	**168 600**	**72 434**	**79 566**	**96 166**

Source: JICA Study Team

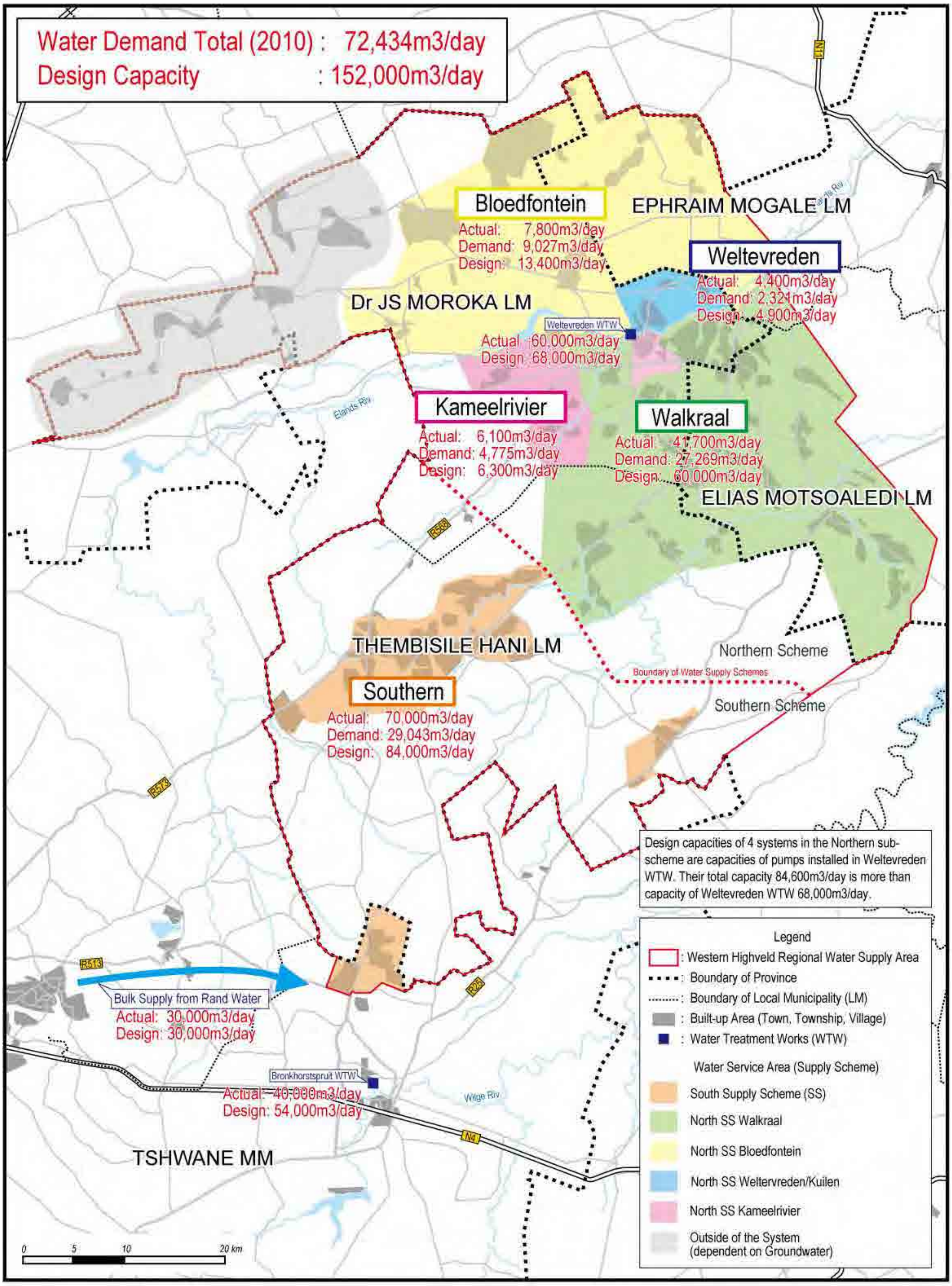


Figure 3.1.3 Water Supply / Demand Balance by Supply Scheme

3.1.7 Overview of Water Supply Service

Water supply system in Western Highveld Region, namely, the Western Highveld Regional Water Supply Scheme falls in a part or all of 5 local municipalities. The Scheme, however, is operated by Kungwini Local Municipality (LM), Thembisile Hani LM, Dr. JS Moroka LM and Sekhukhne District Municipality (DM), that contains a part of Greater Marble Hall LM and Elias Motsoaledi LM under the Scheme.

Sources of raw water in the Scheme are only two, which are located in Kungwini LM and Dr. JS Moroka LM. Each of them, therefore, has a water treatment works. Integrated supply capacity of the two treatment works became insufficient and the Scheme started to procure the treated water supplied by Rand Water Board, that is an outsider water wholesaler. At present, the Scheme has three sources of treated water from Bronkhorstpruit water treatment works in Kungwini LM, from Weltervreden treatment works in Dr. JS Moroka LM and from Rand Water Board. As a result, suppliers of the treated water within the Scheme are 2 LM's and an outsider supplier, all of which produce and supply water to themselves and other LM's. On the contrary to them, Thembisile Hani LM and 2 LM's under Sekhukhune DM procure the treated water from these three and distribute it to the consumers in their own areas.

Raw data obtained from Dr. JS Moroka LM, that show month-wise supply and bills thereof to three major water users alone, are summarized in Table 3.1.9. Water of 351,478 m^3/month in annual average is supplied to three large users including 29,021m^3/month for Thembisile Hani LM, 316,067 m^3/month for Sekhukhne DM and 6,934 m^3/month for Mega, that is the largest private consumer in this LM.

Table 3.1.9 Largest Three Water Users Supplied by Dr. JS Moroka LM

Year	Month	Billed Water Consumption (m^3/month)				Billed Amount (ZAR)			
		Mega	Thembisile	Sekhukhune	Total	Mega	Thembisile	Sekhukhune	Total
2010	Apr	3,923	61,255	395,534	460,712	13,024	203,367	1,313,173	1,529,564
	May	7,685	9,046	268,977	285,708	25,514	30,033	893,004	948,551
	Jun	7,511	20,398	291,655	319,564	24,937	67,721	968,295	1,060,953
	Jul	8,000	32,698	303,854	344,552	26,560	108,557	1,008,795	1,143,912
	Aug	7,992	34,763	401,350	444,105	26,533	115,413	1,332,482	1,474,428
	Sep	7,000	24,789	301,413	333,202	23,240	82,299	1,000,691	1,106,230
	Oct	7,200	28,567	257,729	293,496	23,904	94,842	855,660	974,406
	Nov	7,200	13,363	324,840	345,403	23,904	44,365	1,078,469	1,146,738
	Dec	6,525	n.a.	n.a.	n.a.	21,663	n.a	n.a.	n.a.
2011	Jan	6,785	34,664	615,251	656,700	22,526	115,084	2,042,633	2,180,243
	Feb	6,976	20,657	314,884	342,517	23,160	68,581	1,045,415	1,137,156
	Mar	6,410	68,053	317,311	391,774	21,281	225,936	1,053,473	1,300,690
Total		**83,207**	**348,253**	**3,792,798**	**4,217,733**	**276,246**	**1,156,200**	**12,592,089**	**14,002,874**
Annual Average		**6,934**	**29,021**	**316,067**	**351,478**	**23,021**	**96,350**	**1,049,341**	**1,166,906**

Note: Water consumption on December in Thembisile and Sekhukhune is included in that on January.
Source: Dr. JS Moroka LM

Table 3.1.10 shows the billed water consumption, number of house connections or registered houses / users and the billed amount by category of users such as residential, business, public and large consumer. More than 58,800 houses / users are supplied in Dr. JS Moroka LM. Among them, a little more than 9 percent or nearly 5,500 users are billed on basis of the metered consumption by applying the "progressive water tariff." The rest or more than 90 percent of users are billed on basis of the flat rate per household, which is ZAR 20.83/house/month for the assumed consumption of 12m^3/house/month.

Table 3.1.10 Billed Water Consumption and Billed Amount

Type of Rate	Year	Month	Billed Water Consumption (m^3/month)					Number of households				Billed Amount (ZAR)*[3]				
			Residential	Business	Public	Large Consumer	Total	Residential	Business	Public	Large Consumer	Residential	Business	Public	Large Consumer	Total
Progressive	2010	Apr	45,940	337	114	460,712	507,103	5,434	36	18	3	105,662	1,247	353	1,529,564	1,636,826
		May	858,175	6,599	1,675	285,708	1,152,157	5,434	38	18	3	1,948,315	23,558	4,608	948,551	2,925,032
		Jun	85,886	431	232	319,564	406,113	5,434	38	18	3	180,644	1,538	773	1,060,953	1,243,908
		Jul	93,592	380	315	344,552	438,839	5,434	38	18	3	212,868	1,459	1,077	1,143,912	1,359,316
		Aug	n.a.	n.a.	n.a.	444,105	n.a.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	1,474,428	n.a.
		Sep	n.a.	n.a.	n.a.	333,202	n.a.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	1,106,230	n.a.
		Oct	n.a.	n.a.	n.a.	293,496	n.a.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	974,406	n.a.
		Nov	n.a.	n.a.	n.a.	345,403	n.a.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	1,146,738	n.a.
		Dec	72,143	404	31	n.a.	n.a.	5,433	38	18	3	162,203	1,551	78	n.a.	n.a.
	2011	Jan	308,211	4,723	310	656,700	969,944	5,433	38	18	3	727,516	18,136	1,067	2,180,243	2,926,962
		Feb	n.a.	n.a.	n.a.	342,517	n.a.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	1,137,156	n.a.
		Mar	244,414	1,304	1,737	391,774	639,229	5,434	38	18	3	574,541	5,007	5,190	1,300,690	1,885,428
	Monthly Average*[1] in Progressive Water Tariff		**244,052**	**2,025**	**631**	**351,478**	**598,186**	**5,434**	**38**	**18**	**3**	**558,821**	**7,499**	**1,878**	**1,166,906**	**1,735,105**
Flat	**Monthly Average*[2&3] in Flat Water Tariff**		**639,888**	**0**	**0**	**0**	**639,888**	**53,324**	**0**	**0**	**0**	**1,110,739**	**0**	**0**	**0**	**1,110,739**
	Total		**883,940**	**2,025**	**631**	**351,478**	**1,238,074**	**58,758**	**38**	**18**	**3**	**1,669,560**	**7,499**	**1,878**	**1,166,906**	**2,845,844**

Note
*1: Billed amounts for residential, business and public on April was assumed applying ZAR2.3/m^3, 3.7 and 3.1 respectively, which were average unit cost of the other month.
*2: Residential billed amount in flat rate is figured out applying flat rate tariff of ZAR20.83.
*3: Billed water consumption in flat rate was assumed applying 12m3 per household per month
*4: Excluding TAX

Source: Dr. JS Moroka LM

Table 3.1.11 shows major indices of water supply service of Dr. JS Moroka LM, consisting of water production, production cost and revenue data estimated on basis on water tariff, and billed water ratio, unit production cost, and revenue per billed and paid water estimated on basis of the quantity of billed water and its bill as shown in Table 3.1.10.

Water revenue ratio of approx. 61% in Dr. JS Moroka LM is remarkably lower than average water revenue ratio of approx. 90% in Japan. This is because of water meter accuracy, a gap between actual consumption and billed amount based on flat rate and water leakage. In addition, since unit production cost is higher than revenue per revenue water, it is likely that amounts of the bill are inappropriate to meet water production cost.

Table 3.1.11 Overview of Water Supply Service in Dr. JS Moroka LM

No.	Items	Unit	Current
1	Total Population (2007)	persons	267,748
2	Served Population (2007)*	persons	264,411
3	Water Service Ratio	%	98.8
4	Total households served	houses	58,758
5	Number of Water Meter	meters	5,434
6	Water Production	m^3/d	68,000
7	Revenue Water (Reading + Flat)	m^3/d	41,269
	Domestic	m^3/d	29,465
	Business	m^3/d	68
	Public	m^3/d	21
	Large Consumers	m^3/d	11,716
8	Billed Water Ratio	%	61
9	Unbilled Water Ratio	%	39
10	Daily Domestic Water Consumption Rate	Liter /capita/ day	116
11	Production Cost	ZAR/day	158,000
12	Cost per 1 m^3	ZAR/m^3	3.8
13	Total revenue	ZAR/day	95,000
14	Revenue per billed and paid water	ZAR/m^3	2.3

Note:
* Since service population of the data indicated in above Table such as 3.1.1 was extracted from the revenue water data sheet of Dr. JS Moroka, figures are different from that indicated in other existing documents.
Source: Dr. JS Moroka LM

Meanwhile, some data on water supply service of Thembisile Hani LM is coordinated. Thembisile Hani LM pays ZAR 255,400 daily for Kungwini LM, Dr. JS Moroka LM and Rand Water to provide water but collects ZAR 40,000 per day in revenue, which makes up only approx.15% of total payment (see Table 3.1.12). According to Thembisile Hani LM, approx. 31,000 out of approx. 49,000 registers have water meters, but most of the houses have been imposed to pay at flat rate, because water meters have not been read by meter-readers. To establish the water bylaw is essential so as to read water meters regularly and to collect water tariff appropriately. Thembisile Hani LM anticipates to establish the water bylaw aftertime and drastically to reform water tariff system as shown in Table 3.1.13, in order to improve revenue water.

Table 3.1.12 Water Cost in Thembisile Hani LM and Revenue for Water Supply

Supplier	Purchased Water (m^3/day)	Unit Cost (ZAR/ m^3)	Cost *(ZAR/day)	Revenue (ZAR/day)
Kungwini LM	25,000	2.70	67,500	
Dr. JS Moroka LM	20,000	3.32	66,400	
Rand Water	30,000	4.05	121,500	
Total	**75,000**		**255,400**	**40,000**

Note: Revenue is average value.
*Production does not include internal expenses in Thembisile Hani LM such as O&M cost, etc.
Source: Thembisile Hani LM

Table 3.1.13 Water Tariff System

User	2009/2010	2010/2011
Residential	ZAR61 /month (including ZAR25/month for Free Basic Water of 6m^3)	Houses without water meter: ZAR88/month (including ZAR25/month for free basic water of 6m^3) Houses with water meter: ZAR4.05/ m^3 Indigence (In a case of over Free Basic Water): ZAR4.05/ m^3
Business	ZAR150/month	Beneficiaries without water meter: ZAR300 /month Beneficiaries with water meter: ZAR4.05/ m^3

Source: Thembisile Hani LM

3.2 Existing Water Supply Facilities

Installation of Kwandebele water supply scheme began in the late 1970's, and most of facilities were constructed between the early 1980's and the late 1990's. That is, the facilities constructed earlier are more or less 30 years old, and therefore some of the present facilities still have old cores with surface-covering expansion and rehabilitation works that have been repeated.

The scheme is now called as the Western Highveld Regional Water Supply Scheme. It has 2 schemes. One is Southern scheme sourcing treated water from both Bronkhorstspruit water treatment works and Rand Water, and the other is Northern scheme sourcing treated water from Weltevreden water treatment works. The Northern scheme has four distinctively divided sub-supply schemes such as Walkraal, Bloedfontein, Weltevreden/Kuilen and Kameelrivier.

The Table below shows major facilities of the Western Highveld Regional Water Supply Scheme.

Table 3.2.1 Major Water Supply Facilities

Scheme & Sub-Supply Scheme	Treatment Plant	Pump Station	Transmission Pipeline (m)	Reservoir	Elevated Tank
Southern Scheme	**1**	**4**	**239,150.6**	**18**	**2**
Northern Scheme	**1**	**15**	**443,886.5**	**43**	**17**
Walkraal SSS		7	239,072.1	35	6
Bloedfontein SSS		3	153,629.9	2	7
Weltervreden/Kuilen SSS		2	16,117.8	2	3
Kameelrivier SSS		3	35,066.7	4	1
Total	**2**	**19**	**683,037.1**	**61**	**19**

3.2.1 Water Source

(1) Water Sources in the Western Highveld Region and Rand Water

Possible sources of surface water located in and around the Western Highveld Region are three (3) river basins. The Figure 3.2.1 shows the river basins in combination with water sources in the Western Highveld region.

Weltevreden works of the Northern scheme is located along Elands River and takes raw water from

Weltevreden weir lying downstream of Mkombo Dam in Elands River basin. This works supplies treated water to Dr JS Moroka LM, Thembisile Hani LM, Greater Marble Hall LM and Elias Motsoaledi LM in Sekhukhune DM.

Loskop Dam on the east side of Western Highveld region is located in Olifants River basin.

Bronkhorstspruit works of the Southern scheme is located along Wilge River and takes raw water from Bronkhorstspruit weir lying downstream of Bronkhorstspruit Dam in Wilge River basin. This works supplies water to Kungwini LM and Thembisile Hani LM.

Sources of surface water that have been already developed in and around the Western Highveld Region are abovementioned three basins. This Region is, however, topographically located in Olifants Water Management Area (WMA) legally designated by DWA.

Additionally, there is another source of water being supplied and hence diverted to the Region. As a wholesaler of water or "bulk supplier," Rand Water Board is supplying treated water through transmission pipelines from its Mamelodi water treatment works to Ekandustria reservoir in the Southern subscheme. Source of raw water for this supply / diversion is taken in at Vaal Dam at the south of Johannesburg along another Wilge River.

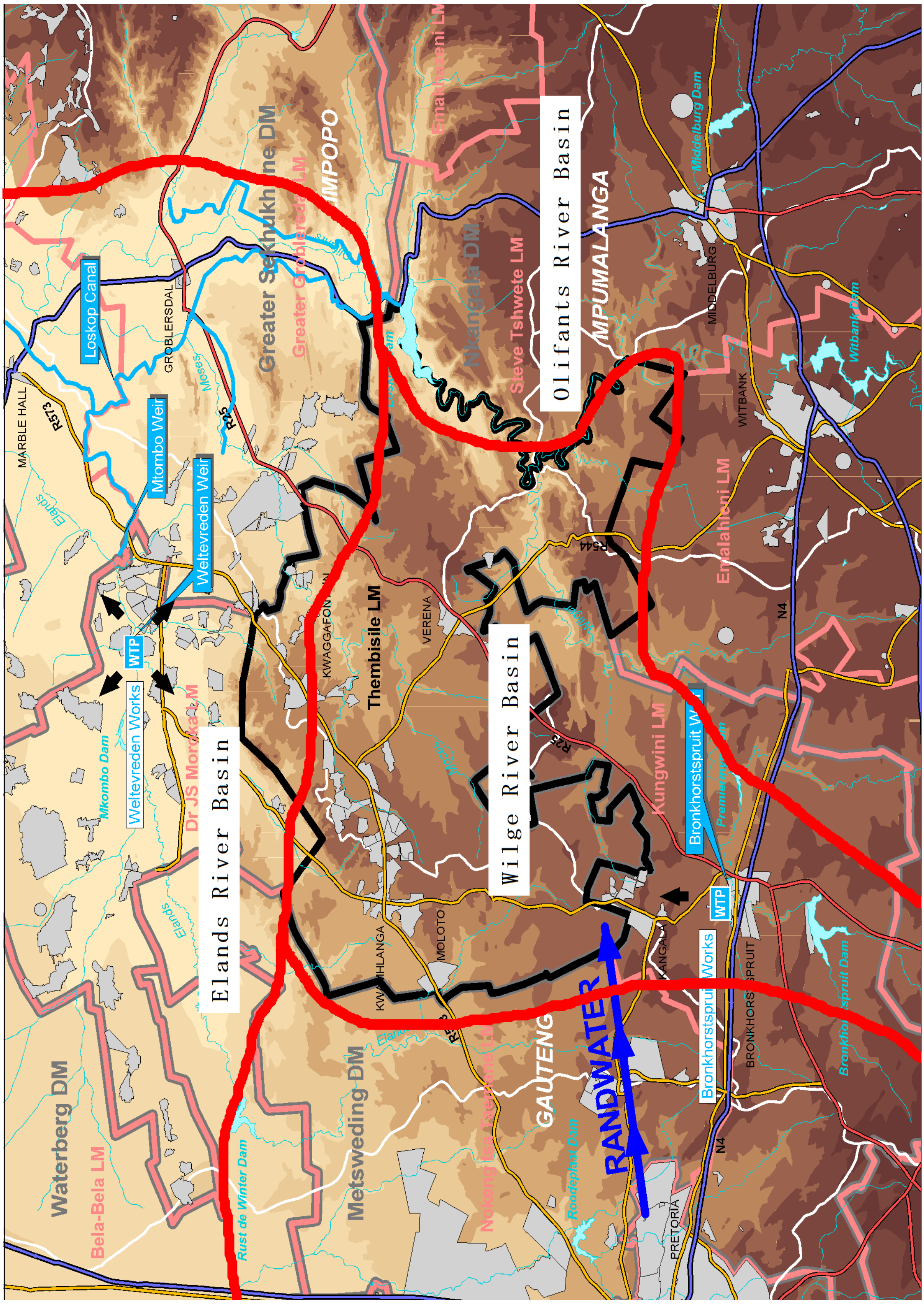


Figure 3.2.1 River Basins in Combination with Water Sources

(2) Terrain Features

Ekangala area at altitudes between 1,500 and 1,600 meters above sea level in Kungwini LM on the north side of national road No.4 is the highest in the Western Highveld region.

In contrast, Siyabuswa area at an altitude of about 900 meters in Dr. JS Moroka LM is the lowest.

Thembisile Hani LM in the middle of the region at altitudes varying from 1,200 to 1,500 meters is relatively high.

Greater Marble Hall LM adjoining to Dr. JS Moroka LM is at an altitude of about 1,100 meters, and Elias Motsoaledi LM at about 1,200 meters.

Thus, the Western Highveld region is in hilly terrain and sketchily inverted cone-shaped, and consists of the southern and the middle area of upland, and the eastern area of slope land and Siyabuswa area of bottom.

(3) Water Source by Area

(a) Water Source in the Northern Area

Weltevreden water treatment works in the northern scheme supplies potable water to 4 local municipalities.

Water source of the works is in Elands River basin, and raw water is taken (68,000 m^3/day) by intake pumps installed on the right bank at Weltevreden Weir (capacity: 50,000 m^3) lying downstream of Mkombo Dam along Elands River.

In addition, raw water released from Loskop Dam in Olifants River basin flows in W10 Regulating Pond (capacity 10,000 m^3) through a right bank conduit of 96 km long and then is pumped up through a pipeline to Weltevreden Weir of some 35 km distant from the pond. Designed gravity flow capacity of the right bank conduit was in between 49,200 and 53,600 m^3/day.

However, an agreement reached with Loskop Irrigation Committee designated that water flowing in the pond should be utilized primarily for irrigation purpose, leaving a 255,000,000 m^3/year intake for domestic use available. This source of water from Loskop Dam has not been used since 1995 due to its high price. Supply from surplus water of the dam to the Western Highveld region is thus hardly expected.

Meanwhile, the west of Dr JS Moroka LM relies on groundwater, but it is difficult to ensure adequate volume of water.

(b) Water Source in the Middle Area

Thembisile Hani LM in the middle area, in which water is supplied from both the Northern and Southern schemes, has no rivers as a water source. As to water intake from Loskop Dam located outside of municipal boundary, a problem associated with water right is remaining.

Because of this situation, feasibility of potential groundwater development in Delmas aquifer was investigated, and concluded that demand from water supply system was hardly met, since potential groundwater yield found was only 200 to 400 m^3/day.

Even if Delmas aquifer is developed, it can contribute a little more than one (1) % of water intake at Bronkhorstspruit water treatment works.

In Table 3.2.2, results of pumping test at dolerite in Langkloof community located on the west side of Verena community in Thembisile Hani LM, that tell barely feasible development of groundwater, are shown, because total yield from 5 boreholes is approximately 200 m^3 per day.

Table 3.2.2 Results of Pumping Test of Groundwater in Langkloof

Borehole No.	Yield (m^3/hr)	Daily Intake Hour (hr)	Available Production (m^3/day)
T 45746	2.000	10	20.0
T 45740	4.831	11	50.4
T 50458	9.480	11	86.4
T 45744	0.680	16	10.9
T 45747	3.600	6	21.6
Total		189.3	

Source: WHS FS

Thembisile Hani LM has thus little source of water for a public supply.

(c) Water Source in the Southern Area

Bronkhorstspruit water treatment works in the southern area supplies potable water to two local municipalities, i.e., Kungwini and Thembisile Hani.

Water source of the scheme is in Wilge River basin, and raw water is taken (53,300m^3/day) by intake pumps on the left bank at Weltevreden Weir lying downstream of Bronkhorstspruit Dam along Wilge River.

(d) Rand Water

Another source of domestic water to the region is a treated water sold by Rand Water Board as a wholesale (bulk) supplier. This water is sent and diverted from a distant catchment to the Region as described in the former section 2.2.1.1.

While Rand Water is not strictly a natural water source, it supplies treated water of 30,000m^3/day, and is considered to be a kind of source of water to the Region.

3.2.2 Water Treatment Works

The Western Highveld Regional Water System has two water treatment works:

- Bronkhorstspruit water treatment works with design capacity of 54 000 m^3/day for the Southern scheme
- Weltevreden water treatment works with design capacity of 68 000m^3/day for the Northern scheme

It should be noted that a significant volume of water from Bronkhorstspruit works is supplied to the wider part of Kungwini municipality, that does not belong to the Region, since only a tiny extent of the municipality belongs to the Region.

Both plants apply rapid filtration system, and have problems of damaged mixing chamber, cracks at filters and leakage from backwashing process. As a result, Bronkhorstspruit works is producing only 75% of design capacity. Weltevreden plant is only producing 88 percent.

Water quality of treated water at Weltevreden works almost meets the quality standard defined by South African National Standard (SANS). Refer to Table 3.2.13.

Locations of water treatment works are shown in Figure 3.2.2.

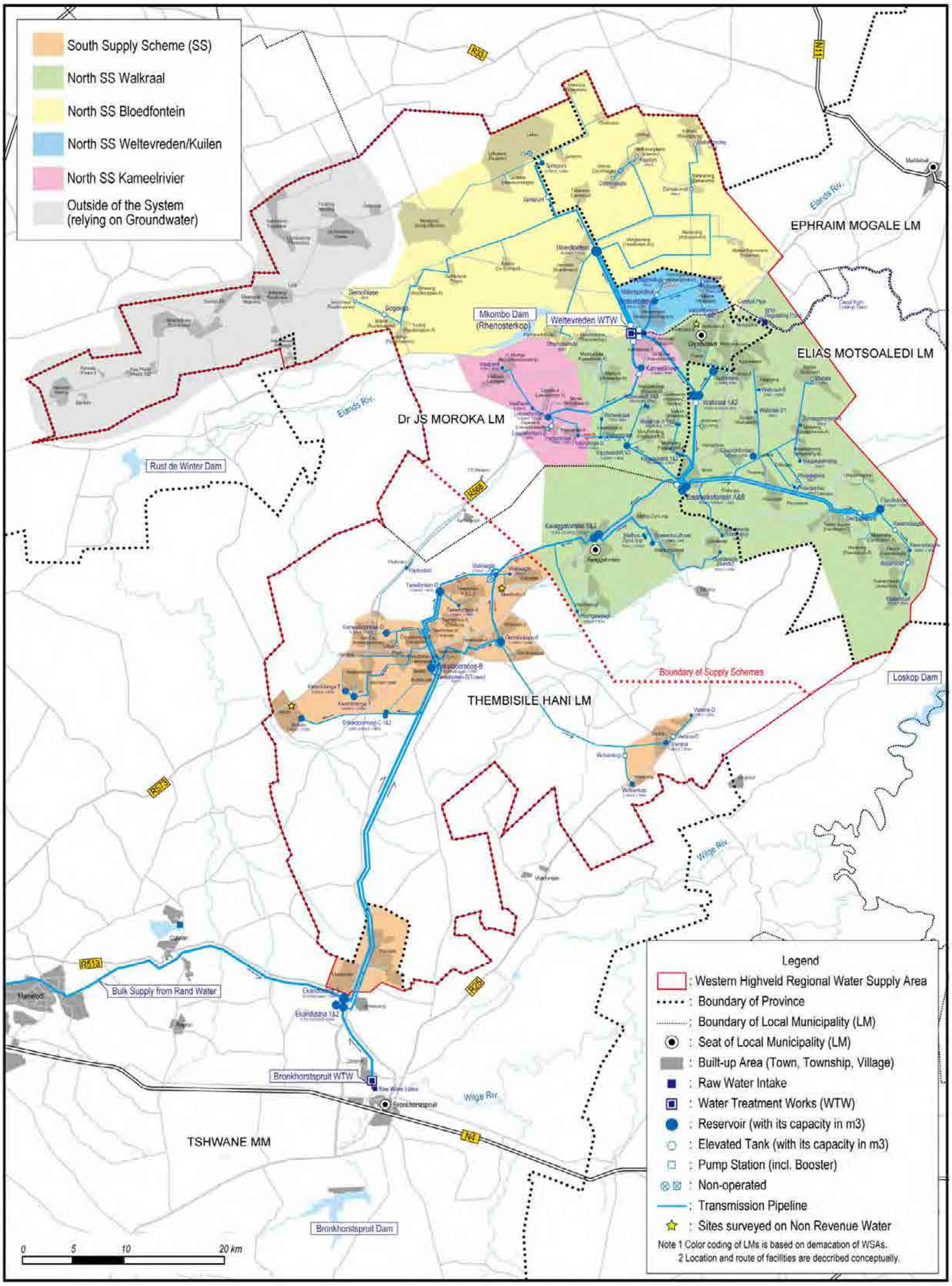


Figure 3.2.2 Location of Water Supply Facilities

3.2.3 Transmission Facilities

(1) Pump Station

Table 3.2.3 shows pump stations and equipment in each supply scheme and sub-supply scheme. There are three types of pumping:

- intake pump of raw water
- high lift pump for conveying water from water treatment works to primary (command) reservoir
- booster pump

Table 3.2.3 Pump Stations and Equipment

Pump Type	No. of Pump Station	No. of Pump Equipment
Southern Scheme		
Intake Pump (Bronkhorstspruit Weir)	**1**	**3**
High Lift Pump	**1**	**5**
Booster Pump	**2**	**4**
Northern Scheme		
Intake Pump (Weltevreden Weir)	**1**	**5**
High Lift Pump	**4**	**12**
Booster Pump	**10**	**22**
Walkraal Sub-Supply Scheme		
Intake Pump (Weltevreden Weir)	1	5
High Lift Pump	1	7
Booster Pump	5	12
Bloedfontein Sub-Supply Scheme		
High Lift Pump	1	3
Booster Pump	2	4
Weltevreden / Kuilen Sub-Supply Scheme		
High Lift Pump	1	1
Booster Pump	1	2
Kameelrivier Sub-Supply Scheme		
High Lift Pump	1	1
Booster Pump	2	4
WH Regional Water Supply Scheme Total		
Intake Pump	**2**	**8**
High Lift Pump	**5**	**17**
Booster Pump	**12**	**26**

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

Apart from the above, there were pumps not operating at the time of 2011 either because of vandalism or (mainly) loss of equipment (see Table 3.2.4).

Table 3.2.4 Non-operating Pump Stations and Equipment

Pump Type	No. of Pump Station	No. of Pump Equipment
Southern Scheme		
Booster Pump (Vlaklaagte)	1	-
Northern Scheme		
Intake Pump (Mtombo Weir)	1	1
Booster Pump / Intake (Valschfontein)	1	1
Booster Pump (Bloedfontein/Lefiso)	1	-

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

Table 3.2.5 shows duty cycle of high lift pumps and primary booster pumps in the Northern scheme.

Pump capacity substantially exceeds volume of water, and pumps have to be operated inefficiently. Many pumps are superannuated and deteriorated.

Appropriate maintenance of them is now urgent. There is a booster pump that is manually operated, but it was designed originally for automatic operation with a pressure switch, which has malfunctioned.

Table 3.2.5 Duty Cycle and Workload of Pumps

Pump Type	Operation (hr/day)	Actual Flow (Ml/day)
Walkraal Sub-Supply Scheme		
High Lift Pump	22-23	41.7
Booster Pump (Walkraal)	15-18	24.0
Booster Pump (Zoetmelksfontein)	5-10	8.0
Bloedfontein Sub-Supply Scheme		
High Lift Pump	24	7.8
Weltevreden / Kuilen Sub-Supply Scheme		
High Lift Pump	24	4.4
Kameelrivier Sub-Supply Scheme		
High Lift Pump	24	6.1

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005

Locations of pumps are shown by type in the Figure 3.2.2.

(2) Transmission Pipeline

Table 3.2.6 shows the length of the installed transmission pipeline in each supply scheme and sub-supply scheme. There are two types of transmission:

- gravity-fed
- pressure by pump

The pipeline length includes small part of pipeline, which is not used currently.

The diameter of the pipelines varies from 75mm to 1 000 mm, a part of which are also used as distribution mains after branching.

Table 3.2.6 Pipeline Length and Percent Distribution by Transmission Type

Scheme	Upper: Pipeline Length (m), Lower: Percent Distribution		
	Gravity-Fed	Pressured by Pump	Total
Southern Scheme	**184 506.5**	**54 644.1**	**239 150.6**
	77.2%	**22.8%**	**100.00%**
Northern Scheme	**324 102.7**	**119 783.8**	**443 886.5**
	73.0%	**27.0%**	**100.00%**
Walkraal SSS	176 373.7	62 698.4	239 072.1
	73.8%	26.2%	100.00%
Bloedfontein SSS	119 431.5	34 198.4	153 629.9
	77.7%	22.3%	100.00%
Weltevreden/Kuilen SSS	10 128.8	5 989.0	16 117.8
	62.8%	37.2%	100.00%
Kameelrivier SSS	18 168.7	16 898.0	35 066.7
	51.8%	48.2%	100.00%
WH Regional Water Supply Scheme Total	**508 609.2**	**174 427.9**	**683 037.1**
	74.5%	**25.5%**	**100.00%**

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

Adequateness of the major transmission pipeline inflowing to treatment works and reservoirs was evaluated as follows: Table 3.2.7 shows water demand forecast (refer to Chapter 8) by JICA Study Team

Table 3.2.7 Water Demand Forecast

Supply Scheme	Supply in 2005 (m^3/day)	Demand in 2010 (m^3/day)	Demand in 2020 (m^3/day)	
			UFW Improved[*1]	UFW Not Improved[*2]
South Scheme (Bronkhorstpurit)	**40 000**	**29 043**	**30 094**	**38 621**
North Scheme	**60 000**	**43 391**	**43 014**	**55 201**
Walkraal SS	41 700	27 269	27 951	35 870
Bloedfontein SS	7 800	9 027	9 124	11 709
Weltevreden / Kuilen SS	4 400	2 321	1 924	2 469
Kameelrivier SS	6 100	4 775	4 015	5 153
Total of Western Highveld	**100 000**	**72 434**	**73 108**	**93 821**

*1 23% of UFW as future target based on WSDP
*2 40% of UFW without improvement, which is commonly recognized by WSDP

If a flow rate of 1.5 m/sec as South African standard is applied, required diameter is calculated as shown in Table 3.2.8. Except for South scheme, the diameters of existing pipelines are adequate compared with actual water supply flow.

South scheme has used another pipeline of 1,000 mm diameter for transmitting water from Rand Water Board (30,000m^3/day), and all transmission pipelines have enough capacity to meet water demand.

Table 3.2.8 Diameter of Existing Key Transmission Pipeline and Required Diameter

Supply Scheme (SS)	Diameter of Pipeline (mm)	Required Diameter (mm)			
		2005	2010	2020	
				UFW Improved	UFW Not Improved
South Scheme (Bronkhorstpurit)	**600**	**627**	**534**	**544**	**616**
North Scheme					
Walkraal SS	700	640	518	524	594
Bloedfontein SS	800	277	298	299	339
Weltevreden / Kuilen SS	300	208	151	138	156
Kameelrivier SS	300	245	217	199	225

* Key transmission pipeline is defined as pipeline from WTW to command reservoirs.
Source: JICA Study Team

South African authorities are concerned about what is regarded as hazardous asbestos pipe, which is widely used in the system. Materials of pipelines and their distribution were examined as shown in Table 3.2.9. Some 64% of the pipelines are of asbestos.

Table 3.2.9 Distribution of Pipeline Material

	Upper: Pipeline Length (m), Lower: Percent Distribution			
	Cast Iron, Steel	PVC	Asbestos	Total
Southern Scheme	**112 043.4**	**0.0**	**127 107.2**	**239 150.6**
	46.85%	**0.00%**	**53.15%**	**100.00%**
Northern Scheme	**59 662.1**	**51 912.3**	**307 526.1**	**443 886.5**
	13.44%	**11.69%**	**69.28%**	**100.00%**
Walkraal SSS	54 460.9	3 416.0	163 795.2	239 072.1
	22.78%	1.43%	68.51%	100.00%
Bloedfontein SSS	4 525.0	44 870.9	96 848.0	153 629.9
	2.95%	29.21%	63.04%	100.00%
Weltevreden / Kuilen SS	240.7	0.0	15 877.1	16 117.8
	1.49%	0.00%	98.51%	100.00%
Kameelrivier SSS	435.5	3 625.4	31 005.8	35 066.7
	1.24%	10.34%	88.42%	100.00%
WH Regional Water Supply Scheme Total	**171 705.5**	**51 912.3**	**434 633.3**	**683 037.1**
	25.14%	**7.60%**	**63.63%**	**100.00%**

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

Besides problems like hazardous asbestos pipes, other problems in the Northern scheme include:

- vandalism
- loss of valves and steel covers of valve chambers
- illegal connections to transmission pipeline

This is especially applicable to Walkraal and Bloedfontein sub-supply schemes.

In the Southern scheme, the problems are:

- backflow from reservoir to inlet transmission pipeline in Kameelpoortnek and Vlaklaagte reservoirs due to inlet from the bottom and the not-yet-installed or not-controllable check valve
- difficulty of bulk supply control due to the not-yet-installed or not-controllable level regulating valve in Enkedoornoog C reservoir were reported by officials in Thembisile Hani LM

The route of transmission pipeline is shown in Figure 3.2.2

3.2.4 Reservoir

(1) Reservoir

Tables 3.2.10 and 3.2.11 below show the number of reservoirs and total capacity in each supply scheme and sub-supply scheme. They are mainly cylindrical shape and reinforced concrete structures except for elevated tanks made with steel panel installed particularly for distribution within community. Some of them have not been in use since April 2011.

The capacity of reservoir varies from less than 500m^3 to the largest Enkeldoornoog B reservoir of 20 000m^3, which was constructed with Yen loan.

Table 3.2.10 Reservoir and Capacity

Scheme	No of Reservoir	Total Capacity (m^3)
Southern Scheme	**18**	**116 670**
Northern Scheme	**43**	**177 480**
Walkraal Sub-Supply Scheme	35	138 740
Bloedfontein Sub-Supply Scheme	2	18 700
Weltevreden / Kuilen Sub-Supply Scheme	2	6 770
Kameelrivier Sub-Supply Scheme	4	13 270
WH Regional Water Supply Scheme Total	**61**	**294 150**

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

Table 3.2.11 Elevated Tank and Capacity

Scheme	No. of Tank	Total Capacity (m^3)
Southern Scheme	**1**	**500**
Northern Scheme	**17**	**2 424**
Walkraal Sub-Supply Scheme	6	638.0
Bloedfontein Sub-Supply Scheme	7	1 171
Weltevreden / Kuilen Sub-Supply Scheme	3	417
Kameelrivier Sub-Supply Scheme	1	198
WH Regional Water Supply Scheme Total	**19**	**2 924**

Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B

The capacities of the five reservoirs receiving water directly from treatment works were examined. Water demand was estimated as shown in Table 3.2.7.

Table 3.2.12 indicates the reservoirs have adequate capacity to meet water demand in 2020 regardless of improvement of unaccounted for water.

Table 3.2.12 Evaluation of Capacity of Reservoir

Supply Scheme	Existing Capacity (m^3)	Required Capacity (m^3)			Excess and Deficiency of Capacity (m^3)		
		2010	2020		2010	2020	
			UFW Improved	UFW Not improved		UFW Improved	UFW Not improved
Southern	**45 000**	**15 000**	**15 000**	**19 000**	**30 000**	**30 000**	**26 000**
Northern	**52 000**	**22 100**	**21 600**	**27 900**	**29 900**	**30 400**	**24 100**
Walkraal	24 000	14 000	14 000	18 000	10 000	10 000	6 000
Bloedfontein	16 000	4 500	4 600	6 000	11 500	11 400	10 000
Weltevreden/ Kuilen	6 000	1 200	1 000	1 300	4 800	5 000	4 700
Kameelrivier	6 000	2 400	2 000	2 600	3 600	4 000	3 400
WH Area Total	**97 000**	**37 100**	**36 600**	**46 900**	**59 900**	**60 400**	**50 100**

Remarks: Required capacity of reservoir was calculated by 12 hours of daily maximum.

Locations of reservoirs and elevated tanks are shown in Figure 3.2.2.

These reservoirs have problems such as aging, deterioration and leakage, and expansion, maintenance and repairs have been carried out. However, reservoirs and elevated tanks have not always been used according to plans due to possible defects in the past planning or designing. In fact, there are some elevated tanks that have never been used since construction in Ephraim Mogale LM, supplied by Walkraal sub-supply scheme.

The main reservoirs in both Northern and Southern schemes are equipped with telemetry system, which enables monitoring of the water level through computers or mobile phones at the office of the water division. This is relevant to both Thembisile Hani LM and Dr JS Moroka LM as a base of operation and maintenance of each scheme.

In reality, however, the telemetry system is not used in a way that is sustainable and effective due to vandalism such as theft of batteries.

(2) Water Quality at Reservoir

Table 3.2.13 shows water quality analysis at 3 reservoirs. Standard of potable water quality in the South African National Standard (SANS) is slightly different from that of the WHO guidelines. Water quality at Bloedfontein reservoir complies with SANS requirements, but those of other 2 reservoirs exceed the limits in items of color, turbidity and iron. While it cannot be identified through single-day data results, one reason may probably be rust of inner surface of pipes due to their aging or deterioration.

Table 3.2.13 Results of Water Quality Analysis at Reservoir

Parameter	Unit	SANS*1	WHO	Bloedfontein Reservoir	Kameelrivier Reservoir	Walkraal Reservoir
pH	-	5.0-9.5	-	8.4	8.4	8.5
Electrical Conductivity	mS/m	<150	-	28.3	28.3	28.2
TDS	mg/L	<1000	1000	156	166	162
Color (Pt Co Unit)	mg/L	<20	15	9	21	12
Odor	TON	<5	-	<5	<5	<5
Turbidity	NTU	<1	5	0.6	2.3	1.4
Cl	mg/L	<200	250	30	31	30
SO_4	mg/L	<400	250	6	6	5
F	mg/L	<1.0	1.5	0.5	0.5	0.5
N^+	mg/L	<10	50	0.2	0.2	0.2
CN	mg/L	<0.05	0.07	<0.01	<0.01	<0.01
DO	mg/L	<10	-	4.9	5.3	5.6
Tri-Halomethanes	mg/L	<0.200	0.1*2	0.052	0.031	0.038
Phenol	mg/L	<0.010	0.2	<0.010	<0.010	<0.010
Total Coli-form	Count	<10	0	0	0	0
Faucal Coli-form	Count	0	0	0	0	0
Na	mg/L	<200	200	24	24	25
K	mg/L	<50	-	8.0	7.8	8.0
Ca	mg/L	<150	-	19	19	19
Mg	mg/L	<70	-	7	7	8
Al	mg/L	<0.3	0.2	<0.100	<0.100	<0.100
Sb	mg/L	<0.010	-	<0.010	<0.010	<0.010
As	mg/L	<0.010	0.01	<0.010	<0.010	<0.010
Cd	mg/L	<0.005	0.003	<0.005	<0.005	<0.005
Cr	mg/L	<0.025	0.05	<0.025	<0.025	<0.025
Co	mg/L	<0.500	-	<0.025	<0.025	<0.025
Cu	mg/L	<0.100	2	<0.025	<0.025	<0.025
Fe	mg/L	<0.200	0.3	0.037	0.375	0.308
Pb	mg/L	<0.020	0.01	<0.020	<0.020	<0.020
Mn	mg/L	<0.100	0.4	<0.025	0.030	0.042
Hg	mg/L	<0.001	0.001	<0.001	<0.001	<0.001
Ni	mg/L	<0.150	-	<0.025	<0.025	<0.025
Se	mg/L	<0.020	0.01	<0.020	<0.020	<0.020
V	mg/L	<0.200	-	<0.025	<0.025	<0.025
Zn	mg/L	<0.500	3	<0.025	0.371	0.221

Remarks:
*1: South Africa National Standards (SANS) for Drinking Water
*2: EU standard
Yellow-shaded cells: Items exceeded SANS requirements
Source: Dr. JS Moroka LM

3.2.5 Distribution Pipeline and Water Service Level

(1) Distribution Pipeline

Detailed information was not found for material and diameter of pipelines and networks distributing water to customers, including drawings and records of the network expansion. Consequently, it is assumed, the lack of information makes it difficult to efficiently operate and maintain such facilities.

In fact, there were discrepancies between design drawings and actual situation found at sites of the survey on unaccounted for water. It is therefore emphasized that information management including restructuring of databases of the existing distribution network is essential.

In spite of this situation, most communities in the Western Highveld Regional Water Supply Scheme have an existing distribution network, and water is supplied to customers mainly through three service levels:

- house connections
- yard connections
- communal tap stands

Some informal settlements in Thembisile Hani LM are not supplied through pipes, but by municipal water tankers.

(2) Water Quality at Service Pipe Ends

The quality of tapped samples was checked with a simple portable water quality analyser in seven parameters of water quality. Shown in Table 3.2.14.

Turbidity appears to be fine as it satisfies the WHO guidelines while exceeding SANS standard. However, residual chlorine concentration is very low in both Tweefontein-K and Moloto communities. This may cause water-borne diseases.

In Japan, residual chlorine concentration is obligated by law to be more than 0.1mg/liter for disinfection of fecal coliform bacterium and others. For water supply conditions such as the supply to Moloto, chlorine has apparently been diluted during stagnation in reservoir or pipeline.

Discontinuation of water rationing and frequent chlorination will ensure safe water supply.

On the other hand, the reason residual chlorine concentration is higher in Siyabuswa-B is probably because Weltevreden water treatment work is very close.

Table 3.2.14 Water Quality at Service Pipe Ends

Parameter	Unit	SANS	WHO	Siyabuswa-B	Tweefountain-K	Moloto
pH	-	5.0-9.5	-	7.54	7.62	7.81
Water Temperature	℃	-	-	25	23	23
Electrical Conductivity	mS/m	<150	-	0.183	0.251	0.263
TDS	mg/L	<1000	1000	119	163	171
Turbidity	NTU	<1	5	1.7	2.9	0.0
DO	mg/L	<10	-	5.03	4.45	5.54
Residual Chlorine	mg/L	>0.1*1	0.2-0.5	0.43	0.00	0.01

Remarks:
*1: Standard of free chlorine in Japan
Yellow-shaded cells: Items did not apply to SANS requirements
Source: JICA Study Team

3.3 Current Institutional Capacity

Number of personnel in the municipal offices and that in the water and sanitation division thereof, compared with population and households served by the Western Highveld Water Scheme are roughly estimated as follows:

Table 3.3.1 Number of Personnel in Municipal Office and Population Served

	Kungwini LM	Thembisile Hani LM	Dr JS Moroka LM	Sekhukhune DM
Entire Municipal Office	800	300	500	929
Water and Sanitation Div.	50	80	180	690
Population Served	42,000	300,000	267,000	n.a.
Number of Household	n.a.	94,000	57,800	n.a.

Source: Annual Report for Sekhukhune DM, and hearing from other LM's

Sekhukhune, as a district municipality, has a larger number of personnel, particularly in the water and sanitation division. As was explained, Sekhukhune has many stations and facilities scattered over the entire district. It is not known, however, how many of them are engaged in the operations within the Western Highveld Scheme, that shares only small parts of two local municipalities, i.e., Ephraim Mogale and Elias Motsoaledi.

The number of staff in Thembisile Hani is notably small compared to the population served, while this LM does not require operators for the water intake and treatment plants like Kungwini and Dr JS Moroka, transmission and distribution staff are required. It shall also be noted that only a small part of Kungwini falls in the Western Highveld Region.

According to organization charts obtained from a few LM's, the water and sanitation divisions are among the other technical divisions of the Technical or the Infrastructure Department. This division is mandated to carry out physical works on operation and maintenance of water supply facilities and equipments alone. The organization charts showed also that almost half of the designated posts are vacant, and the number of personnel shown in the above table represents the ones actually filled. It is therefore learned that most of these municipal offices, and hence municipal services, are performed / maintained by more or less a half of the required manpower. More notably, managers / chiefs of technical divisions are mostly vacant and deputy or acting managers are factually supervising the divisions. There may be reasons beyond the understanding of this report as to why such important positions cannot be filled, and why the municipal services have to be maintained by only one half of the required personnel.

Another task of the ordinary water supply service, that is to collect the water tariff and recover the costs of its service, is not a business of the water division of the technical / infrastructure department. Under these municipal offices, it is the responsibility of the revenue division of the financial department. A revenue division usually has a force of water meter readers, whose staff members are not always enough to canvass all the water meters at the regular cycle. They do not seem to have unanimous and clear way to bill / charge tariff, and even if billed, collected rate per billed amount is very low. Moreover, it does not seem that municipal office has an organ or officer to supervise both of water division and revenue division together to oversee its water supply services as a whole. No one is, therefore, intentionally watching expense and income of water services.

Against what DWA expects, municipal water service provider (WSP) is not functioning, as it should be. Under the current bookkeeping practices in the relevant municipal offices, it is very difficult to identify and enumerate all the costs for water supply and tariff collection including those for personnel. It seems, therefore, very difficult or virtually impossible to control the expenditure for water supply. As for the revenue from water supply, billing based on the meter reading or on the fixed rates is regularly made in some municipalities. In order to improve the very low rate of tariff collection, however, any organized efforts seem to barely be undertaken.

Thus a water supply service is operated by two separate divisions / departments in municipalities in the Western Highveld Region. The unaccounted-for water, that is water lost by many, mostly unknown reasons, has never been accurately measured by the water division. The unaccounted for water, that is volume of water unable to measure / charge for, and not be paid even if charged, has never been calculated in a defined manner by the revenue division. Many estimations or approximations have been made by many outsourced specialists, but not by the providers / municipalities themselves.

The Western Highveld Water Scheme is operated by four municipal WSP's. None of them, however, is self sustainable, or controlling itself, i.e., technically and financially autonomous or independent.

3.4 Status Quo of Operation and Maintenance

Operation and maintenance of the Western Highveld Water Scheme is made by technical staff of the water and sanitation divisions of four municipal offices as stated as above.

In most cases, leakages and water contamination are reported by dwellers and water supply facilities are repaired by technical staff. It seems that preventive and intentional maintenances are not done by the municipal office.

In addition, the existing drawings & technical documents do not seem to be well preserved and the location of the pipelines & facility's structure are known only by deputy or acting managers of water divisions in these municipal offices, or they rely on the memory of field technical staff members.

Critical emergencies such as broken transmission/distribution pipes, dysfunctional pumps, etc., are dealt with by the municipalities. However, minor and daily irregularities such as small leaks and illegal connections are not always intentionally taken care of.

Under contract with Rand Water Board, DWA employs a qualified engineer. The engineer and his staff patrol the Western Highveld Region and give advice on maintaining a proper level of service operation and maintenance of the Water Scheme.

DWA says the proper maintenance of the scheme by municipal task force must incorporate the use of qualified engineers.

CHAPTER 4 PILOT SURVEY

4.1 Objective

Among the other subjects of studies and investigations, the present Special Assistance for Project Sustainability (SAPS) contains 3 "pilot" surveys to lead the more comprehensive undertakings, if found necessary, of the expanded scales. Such pilots are for:

- Protection from cathodic corrosion of the transmission pipeline installed under the Yen loan,
- Control of unaccounted for water through detection of leakage from distribution networks, etc., and
- Social baseline survey to learn socio-economy of the study area and the people's perception of the water supply services.

These surveys particularly require a sizable manpower and a certain period of time for field investigations and household canvassing. They, however, will find invaluable facts-on-site essential to bring about major objectives of the SAPS set out in the Chapter 1. It is clear that such facts will not be easily obtained through simple deskwork or hearing / interviewing the relevant officials and the other stakeholders.

This chapter presents progress and some interim findings of such pilot surveys and proposes / suggests succeeding activities and the future programs, which are derived from those findings.

4.2 Cathodic Protection Measurement

4.2.1 General description for cathodic protection measurement

(1) Objective of cathodic protection measurement

The objective of cathodic protection measurement is a pipeline running from Ekangala district to Enkeldoornoog district as shown in Figure 4.2.1, which was constructed at 1998 by Yen-loan.

- Pipeline from Ekandustira Reservoir to Enkeldoornoog-B Reservoir
  Diameter 1 000mm
  Length 37.5km (approx.)

- Pipeline from Enkeldoornoog-B Reservoir to Gemsbokspruit Reservoir
  Diameter 600mm
  Length 5km (approx.)

Route and system of the pipeline is shown in Figure 4.2.2 and Figure 4.2.3.

General checking of the pipeline for cathodic protection was carried out the year it was constructed (1998) and again in 2007. Detailed measurements, confirmation of actual corrosion of pipeline, design and construction of cathodic protection system have not been carried out for over 10 years from when the pipeline was constructed to the present time.

The portion of pipeline that is 1 000mm in diameter is over half the distance from Ekandustira Reservoir to Enkeldoornoog-B Reservoir, and has a high voltage electrical power transmission line running alongside it. This may generate a corrosive reaction with the steel pipeline.

Under the current condition mentioned above, the following works will be carried out in this project:

- electrochemical cathodic protection survey
- visual inspection of corrosion for surface of pipeline by excavation of soil
- analysis and evaluation for results of site measurements
- basic design of cathodic protection system

(2) Route and components of pipeline

For pipeline of 1 000mm in diameter, approximately 17.5km of pipeline from Ekandustria Reservoir runs alongside a main road. The remaining 20km of pipeline to Enkeldoornoog-B Reservoir runs alongside a high voltage DC and AC electrical transmission line.

The area of pipeline that is 1 000mm in diameter runs alongside an electrical transmission line that is used mostly for pasture land for cattle and sheep. Two points cross under small streams.

Pipeline that is 600mm in diameter runs alongside a road in residential area. It is connected to an existing pipeline at a point 5km away from Enkeldoornoog-B Reservoir.

The total length of pipeline lies in soil directly underground at a depth of 1m. In addition, air valves and scour valves are located along the length of this pipeline.

Basic specifications of pipeline are as follows:

- Construction year: 1998
- Diameter of pipe: 1 000mm and 600mm
- Material of pipe: Steel
- Thickness of pipe: 8mm for pipe of diameter 1 000mm; 6mm for pipe of diameter 600mm
- Coating of pipe: Cement mortar (inside) + Bitumen fiber glass (outside)
- Scour valve: Total number of scour valve is approx. 15 - installed in a concrete box at the relatively lowest positions of the pipeline
- Air valve: Installed in concrete box at the positions of 500m pitch

(3) Local consultant for cathodic protection

An association for the industry was established in South Africa, called "Corrosion Institute of South Africa". Some cathodic companies joined the association and their business interests spread not only in South Africa but also in other African countries.

The association provides the benefit of being able to verify the ability and capabilities of cathodic companies, as well as confirm their technology and equipment resources. In addition, one can verify their work experience in surveying, design and construction for cathodic project.

The cathodic protection measurement work for the project will be carried out by the company selected from a recognised list of companies from CISA.

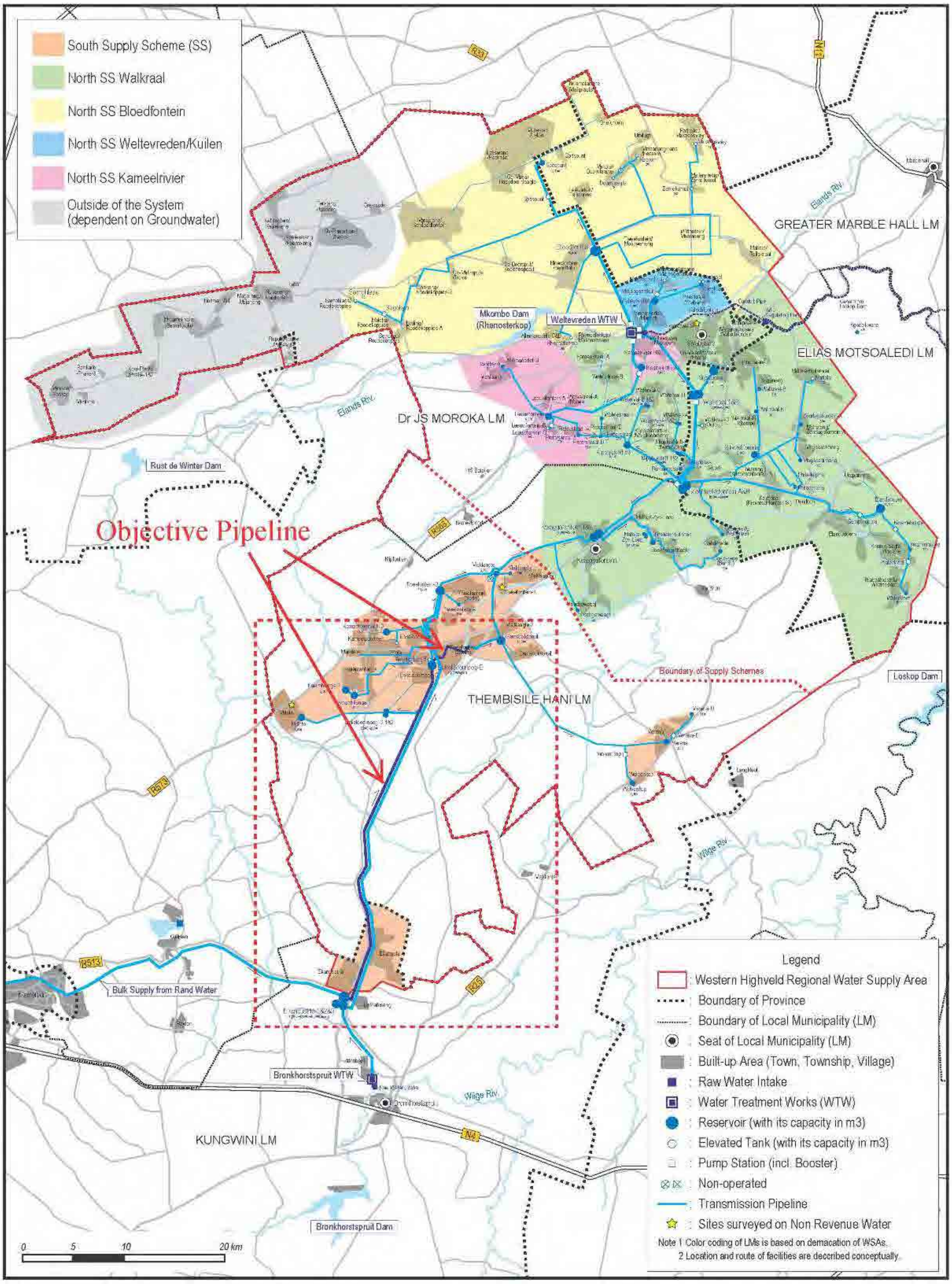


Figure 4.2.1 Location of Objective Pipeline

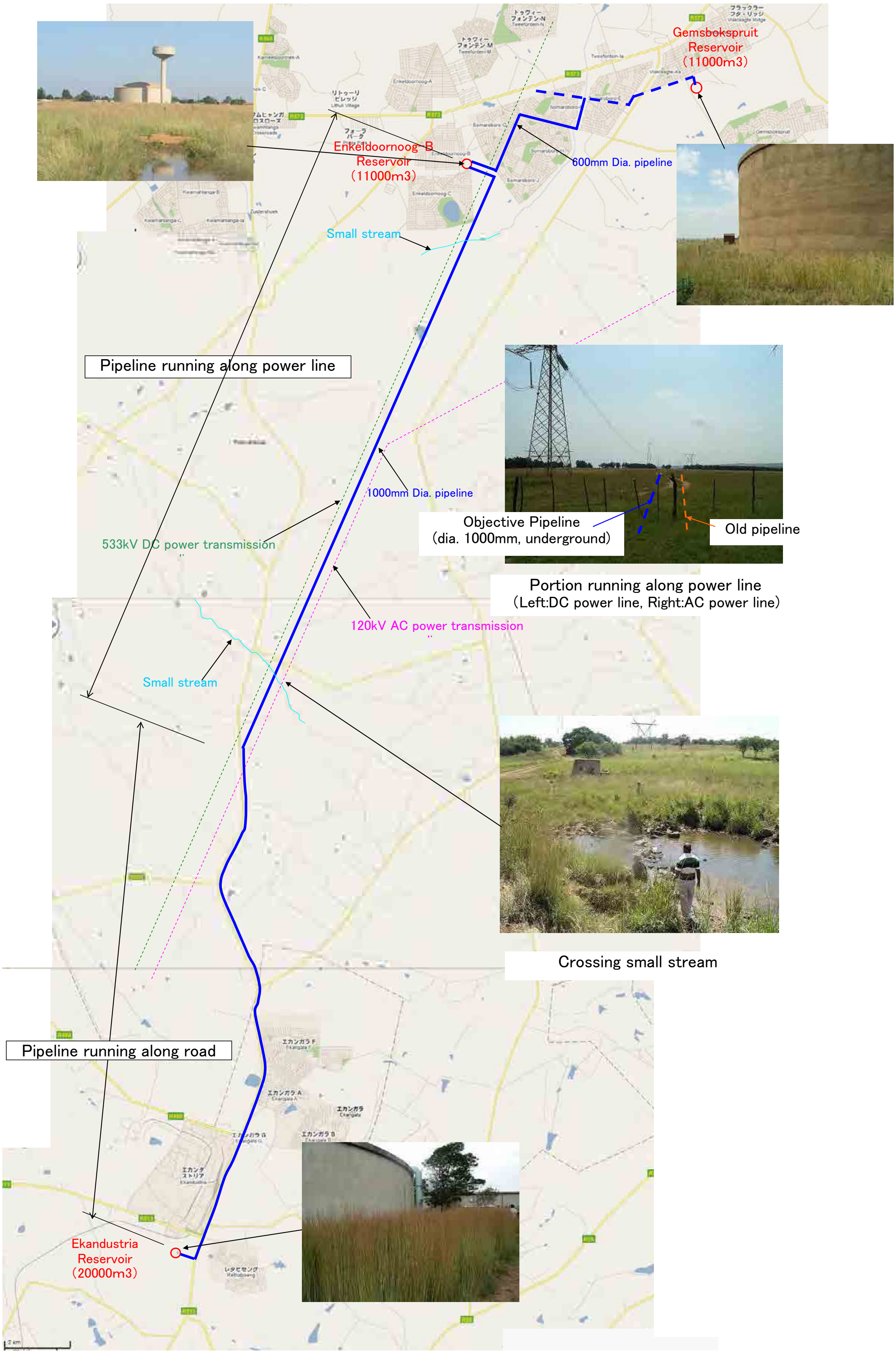


Figure 4.2.2 Route of the pipeline

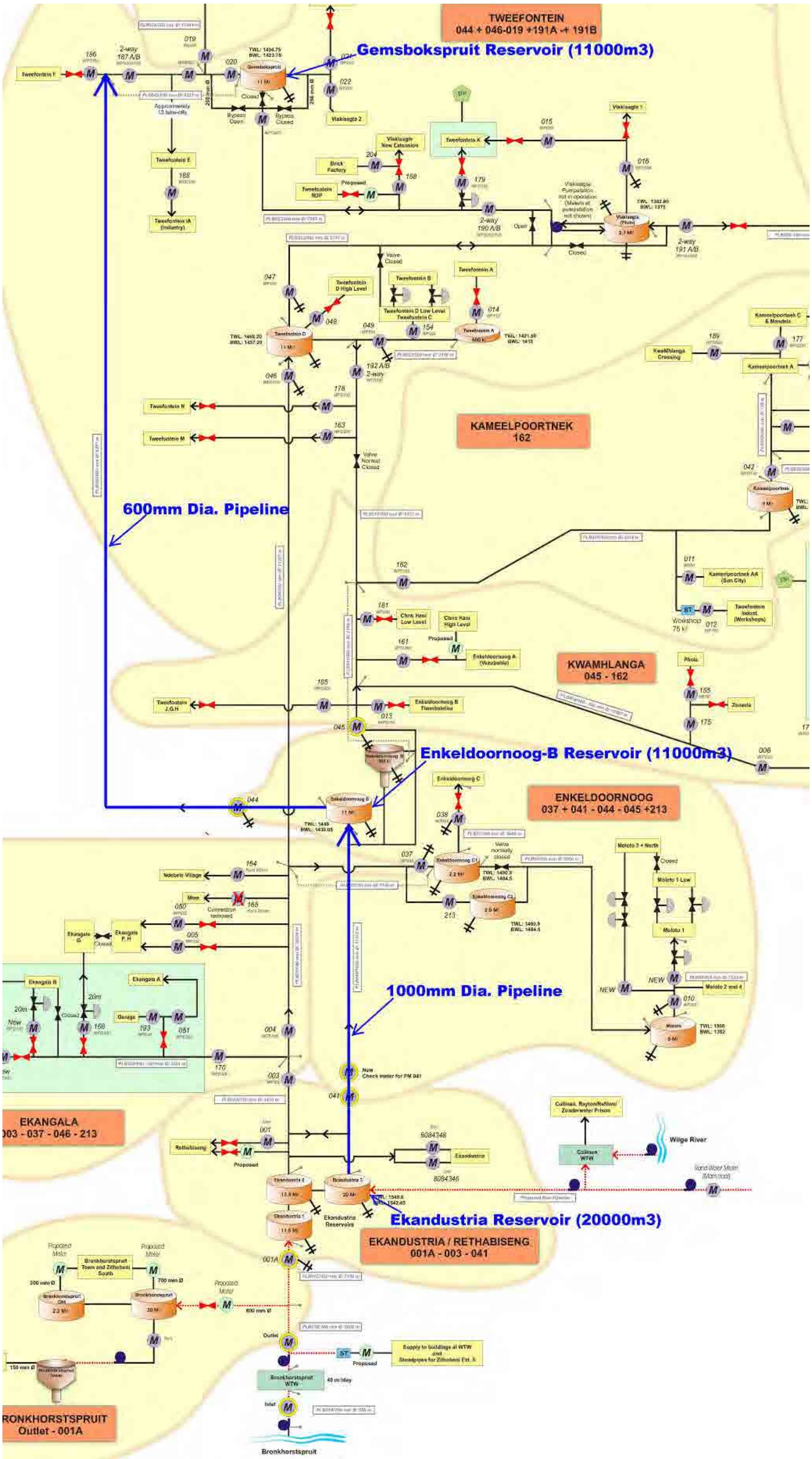


Figure 4.2.3 System of the pipeline

4.2.2 Contents and results of the survey work

(1) Contents of the survey work

After conducting a general survey of corrosion circumstance for pipeline and water leakage on ground level, it is important that the following measurements/surveys are carried out for a cathodic corrosion protection system:

- pipe to soil potential measurement
- soil resistivity measurement
- surface potential gradient at DC transmission line
- AC mitigation at AC transmission line
- visual inspection after excavation
- water leakage detection survey
- soil analysis
- Corrosive bacteria analysis
- Electrical source
- Current drainage test

(2) Schedule of the survey work

The schedule of the survey work which was carried out is shown in Figure 4.2.4.

Month	7				8					9			
Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Survey and measurement													
Preparation	■												
Check of existing pipe route	■	■											
P/S potential and soil resistivity measurement		■	■	■									
Detailed survey and measurement *Visual check for corrosion of surface of pipeline *Mitigation of AC/DC transmission line *Bacteria corrosion				■	■	■	■	■					
Analysis of soil							■	■	■				
Survey of electrical source and current drainage test							■	■					
Survey of water leakage										■	■	■	■
Analysis and evaluation for results of above survey and measurement									■	■			
Basic design										■	■	■	■

Figure 4.2.4 Schedule of the survey work

(3) Route of pipeline measurement

(a) Corrosion circumstance of pipeline

The following power lines are running along the northern portion of the pipeline, 1 000 in diameter:

- 533kV DC electrical power line
- 120kV AC power line

Stray current from high voltage electrical transmission line may affect the buried steel pipe line which is running nearby, and may generate cathodic corrosion - not only to the steel pipeline near electrical transmission line but also to all steel pipeline line which is connected electrically.

Pipeline 600mm in diameter is not connected electrically to pipeline of 1 000mm diameter, but it may be affected by stray current from a 533kV DC transmission line which is running along 2.5km of pipeline of 600mm diameter.

All objective pipeline has no electrical railway crossing point, and the soil condition is generally dry, but it has small stream crossing points which will always make the pipeline circumstance wet.

The old pipeline of 500mm diameter, which was constructed in 1991, is running along the pipeline of 1 000mm diameter.

The material of old the pipeline is steel at high internal pressure, and asbestos at low internal pressure. The distance of the steel portion is approximately 16km.

Cathodic protection system was installed for the old pipeline, but it is not functioning at present. The old pipeline is more risky than pipeline of 1 000mm diameter for cathodic corrosion, because the old pipeline was constructed before the pipeline of 1 000mm diameter.

(b) Current water leakage situation

When the pipeline route from ground level was checked, several wet areas were identified. Surveys for visual inspection after excavation for 10 points including these wet areas were carried out.

In this survey, water is coming out from three excavated holes in wet areas. This water contains chlorine. (Refer to Figure 4.2.5 and Item 4.2.2 (8)). It means the water may be treated water, because chlorine is found in treated water.

The survey of the source of water leakage was carried out for the above 3 places. The sound of water leakage from the pipeline of 1 000mm diameter confirmed a problem at one place. This was an acoustic measurement from ground level (Refer to 4.2.2 (9) used for a detail of survey for water leakage source.

The leakage at one place is from the pipeline of 1 000mm diameter; however water leakages in the other two places are from another pipeline - the old pipeline of 500mm diameter which runs alongside the pipeline of 1 000mm diameter (pipeline or existing pipeline connected at the end of to 600mm diameter pipeline).

The work required to fix water leakage at these three places should be done by DWA as soon as possible, because leaked waters is creating a large wet area or small stream.

When the pipeline was checked at ground level, a lot of water leakage from air valves or scour valves for the 1 000mm diameter pipeline and existing 500mm diameter pipeline (running along 1000mm diameter pipeline) was identified. (Refer to Figure 4.2.5.)

Water leakage from these valves is caused by a lack of repair and a lack of a maintenance system. Repair and maintenance in the water division should be organised as soon as possible.

All pipelines lie underground, but air valves or scour valves for the pipeline are aboveground. An individual number for each valve is used to identify the location of the valve at the survey report in this report.

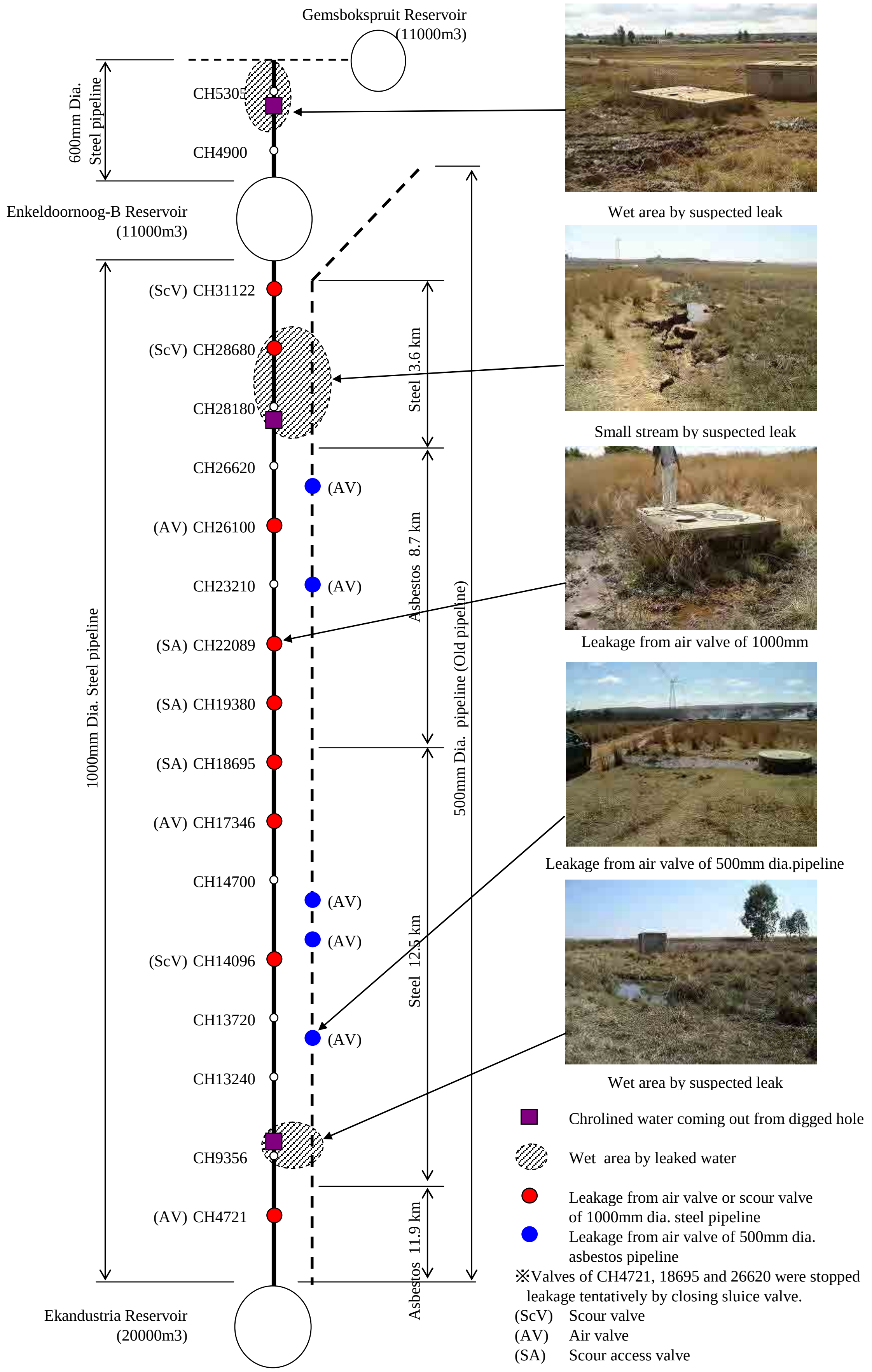


Figure 4.2.5 Location of water leakage

(4) Pipe to soil potential measurement

Pipe to soil potential measurement is one of the most important measurements for cathodic protection. The following can be confirmed for pipe to soil potential measurement:

- macro-cell current for corrosion
- points which stray
- current entering and leaving from/to soil
- pipeline corrosion

Pipe to soil potential measurement is carried out continuously over a 24 hour period at 20 points which is useful for design of cathodic protection system, such as wet area, dry area, power line and reservoirs.

The locations of pipe to soil potential measurement are shown in Figure 4.2.11.

(a) Method of measurement

Pipe to soil potential can be measured as voltage difference between soil and pipeline by using reference electrodes at surface level. The air valve or scour valve - which is connected to the pipeline - was used as the terminal for the pipeline. See Fig. 4.2-6

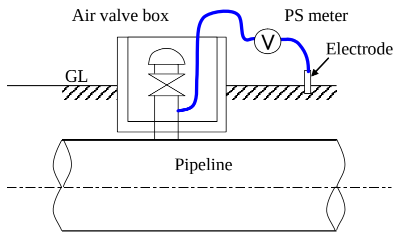


Figure 4.2.6 Method of measurement

(b) Result of measurement

Results of the measurements are shown in Table 4.2.1 and Figure 4.2.7 as maximum, minimum or average. They are shown in Figure 4.2.8 as a graph of 24 hour measurements.

According to the theory of cathodic corrosion, macro-cell corrosion does not generate at the point where the stray current enters the pipeline from the soil. It generates at the point where the stray current is leaving the pipeline to the soil.

The point of low pipe to soil potential is the point the stray current enters the pipeline. The point of high pipe to soil potential is the point the stray current leaves the pipeline.

As shown in Figure 4.2.7, stray current is generally enters the pipeline at the area from point 9 to 20 where the pipeline is running along a power line. It generally leaves the pipeline at the area from point 1 to 8.

Corrosion protection potential should be lower than -0.85V in normal soil, and lower than -0.95V in corrosive soil – as defined in National Association of Corrosion Engineers（NACE).

Red portions in Table 4.2.1 show over -0.85V of potential, and potentials in measured points are mostly over -0.85V. It means that the pipelines need a cathodic protection system.

Table 4.2.1 Measurement of PS potential

Points	PS potential (V)		
	Ave.	Max.	Min.
1	-0.020	0.714	-1.261
2	-0.118	0.706	-1.506
3	-0.374	0.010	-1.019
4	-0.123	-0.112	-0.202
5	-0.186	0.002	-1.030
6	-0.634	-0.492	-1.123
7	-0.607	-0.120	-0.740
8	-0.086	-0.011	-0.264
9	-0.642	0.000	-0.830
10	-0.675	0.000	-0.860
11	-0.543	-0.456	-0.594
12	-0.101	-0.020	-0.198
13	-0.866	-0.242	-1.346
14	-0.602	-0.413	-0.785
15	-0.873	0.000	-1.224
16	-0.896	-0.427	-2.007
17	-0.740	0.000	-3.803
18	-0.297	-0.228	-0.504
19	-0.627	-0.406	-0.779
20	-0.784	-0.415	-1.036

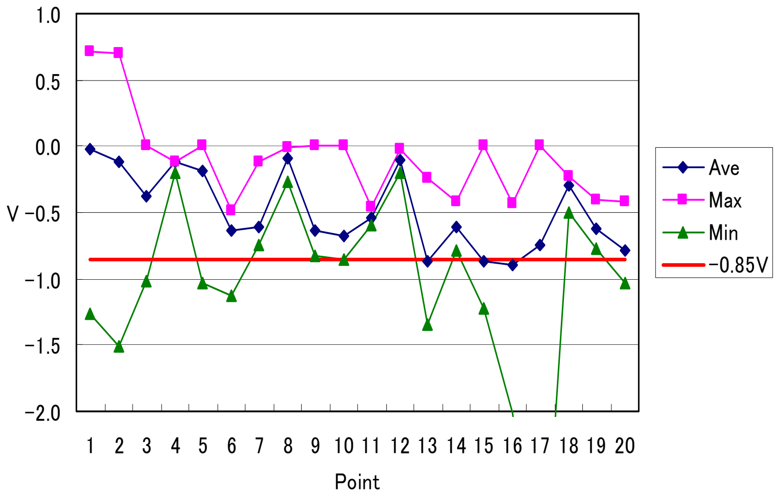


Figure 4.2.7 Measurement of PS potential (Graph)

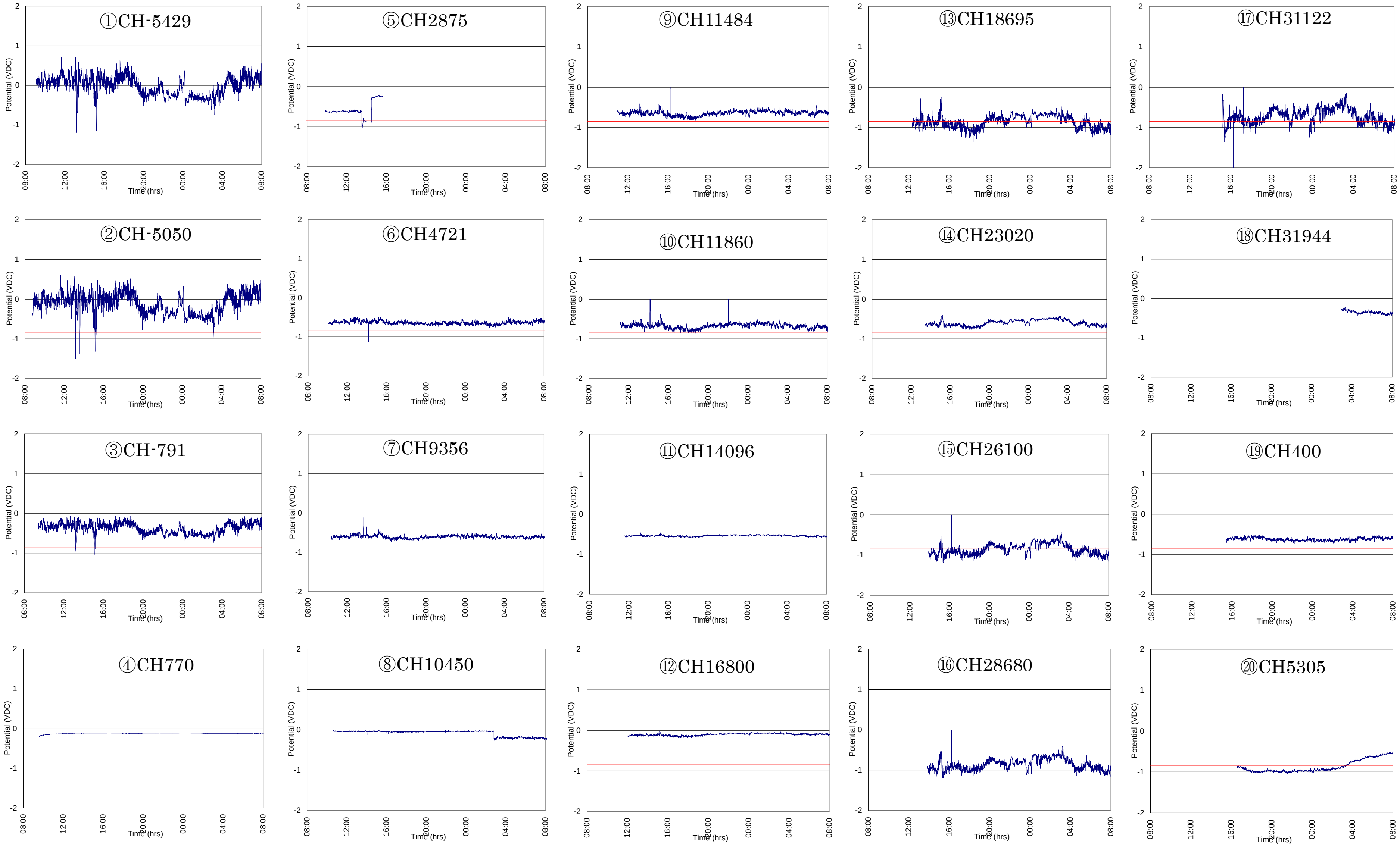


Figure 4.2.8 Pipe to soil potential in 24 hours (Graph)

(5) Soil resistivity measurement

Cathodic corrosion will be accelerated in low soil resistivity conditions, because corrosion current will increase in low electrical resistivity of soil. Soil resistivity measurement is one of most important measurements for judgment of corrosive and is necessary for cathodic protection.

Points of soil resistivity measurement are the same as the 20 points of pipe to soil potential measurements in Item 4.2.2 (4). Locations of soil resistivity measurements are shown in Figure 4.2.11.

(a) Method of measurement

Soil resistivity is measured by a 4-pin method. Soil resistivity averages can reach a depth of D, which is the distance between electrodes. (Refer to Figure 4.2.9)

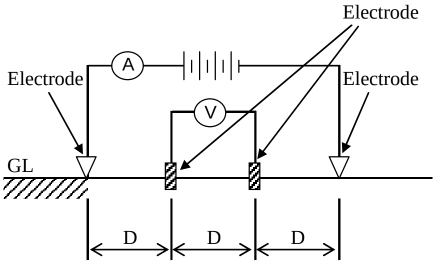


Figure 4.2.9 Method of measurement

(b) Result of measurement

Results of measurements are shown in Table 4.2.2 and Figure 4.2.10

As shown in Table 4.2.2, soil resistivities are generally low and good. In 4 points, soil resistivity is lower than 100m. This needs cathodic protection, especially soil resistivities that are extremely low at 2 points. These are usually wet at the crossing point at a small stream. (Refer to Table 4.2.3). These 2 points can be a weak point for cathodic corrosion.

Table 4.2.2 Measurement of soil resistivity

point	Soil Resistivity (Ωm)
1	169
2	372
3	2091
4	593
5	1367
6	1870
7	48
8	1086
9	5248
10	4031
11	80
12	226
13	349
14	251
15	379
16	48
17	489
18	155
19	322
20	99

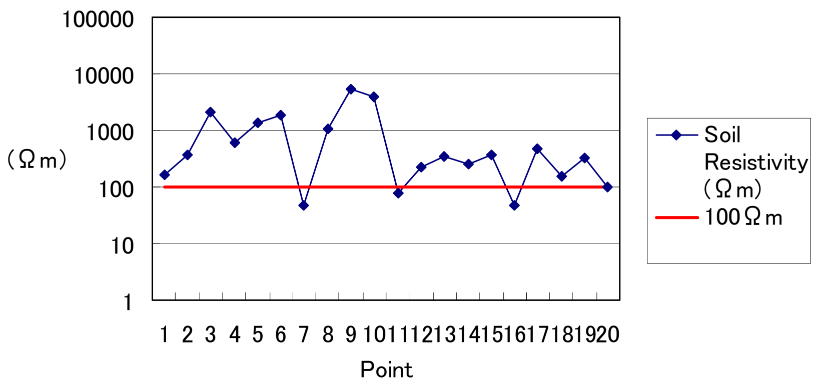


Figure 4.2.10 Measurement of Soil resistivity (Graph)

Table 4.2.3 Relation between soil resistivity and corrosive

Soil Resistivity	Classification	CP Requirements	%
= 20Ωm	Extremely corrosive	Definitely required	0
> 20Ωm but = 50Ωm	Corrosive	Definitely required	10
> 50Ωm but = 100Ωm	Mildly corrosive	Usually required	10
> 100Ωm	Not generally corrosive	Not generally required	80

Source: Corrosion Control in South Africa (2nd Ed; 2004; Corrosion Institute SA

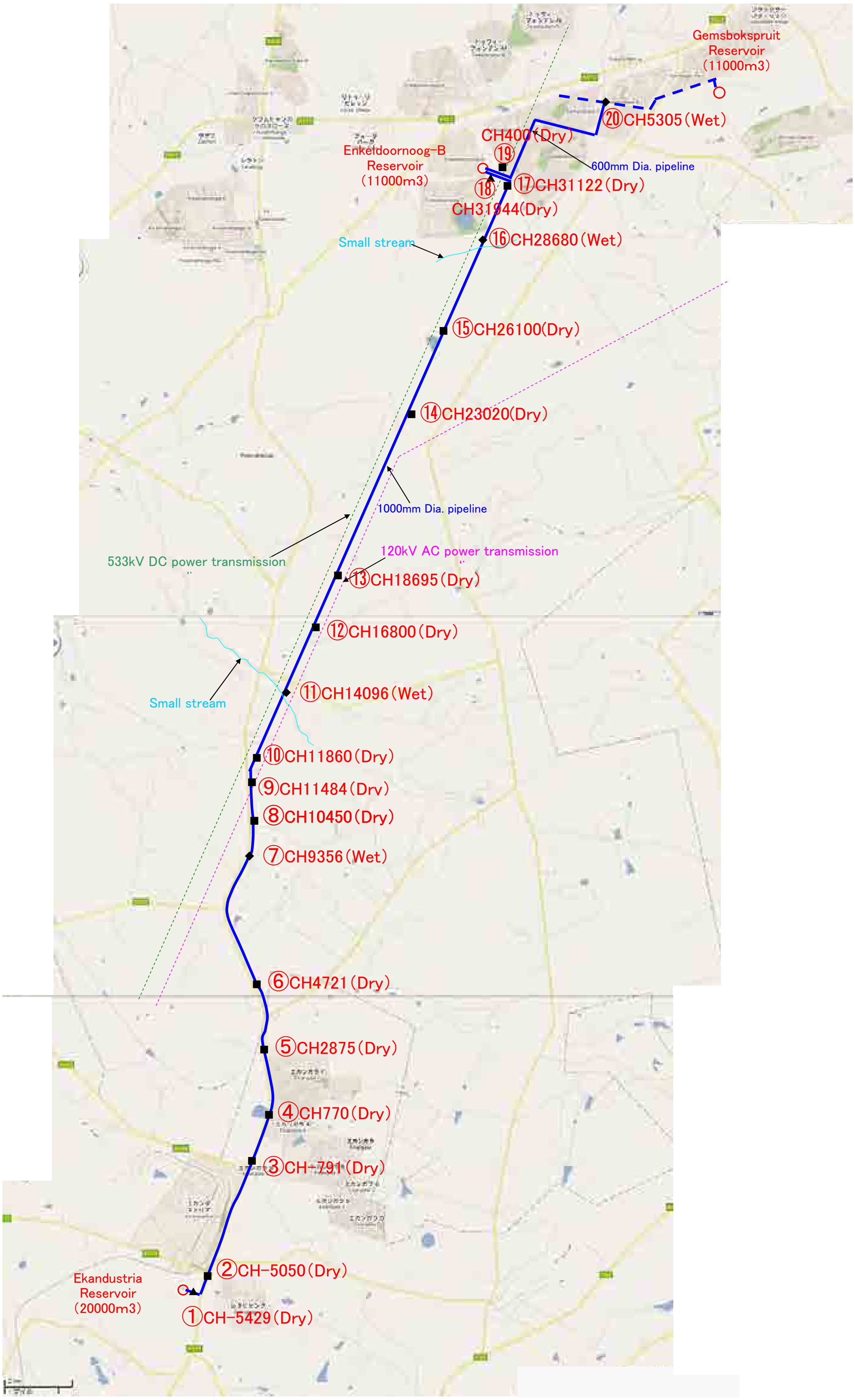


Figure 4.2.11 Measuring points for pipe to soil potential and soil resistivity (20 points)

(6) Surface potential gradient at DC transmission line measurement

The survey of the effect from the DC power line was carried out at the three locations of CH12100, CH25510 and CH28880 of pipeline. This was done by measuring the surface potential gradient from the tower toward the right angle of power line.

(a) Method of measurement

The potential of tower (A point in Figure 4.2.12) to electrode - which is set at the point of 100m from tower (B point in Figure 4.2.12) - was measured.

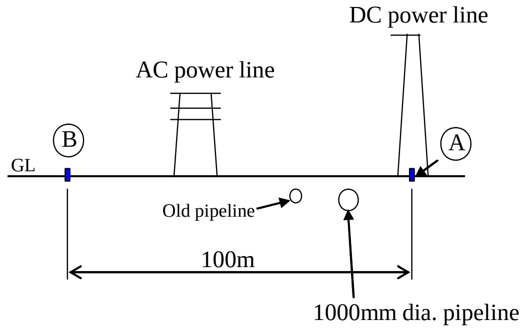


Figure 4.2.12 Method of measurement

(b) Result of measurement

As shown in Table 4.2.3 and Figure 4.2.13, potentials of tower to electrode were measured, minus the points CH12100 and CH25510. This means that the effect of the stray current from the DC power line is very small.

The potential of tower to electrode at the point of CH28860 is measured as dynamically changing between plus and minus, which means that the pipeline is affected by stray current from the DC power line.

The effect of stray current from the DC power line can be mitigated by shifting average of potential to a lower level, which is done by a cathodic protection system.

Table 4.2.4 Result of measurement

CH	DC(mV)		DC tower
	Static	Dynamic	
12100	-240	-	#1APO/CA167
25500	-90	-	#1APO/CA189
28860	0	+20/-30	#1APO/CA206

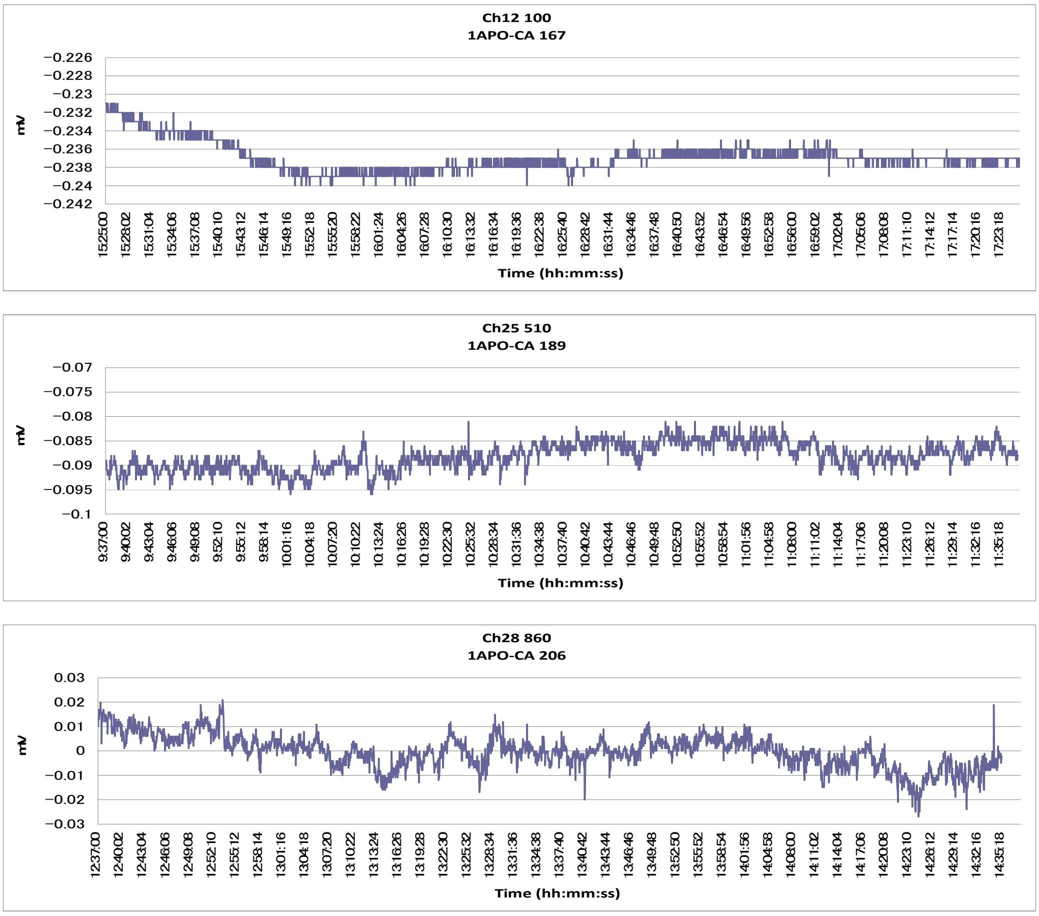


Figure 4.2.13 Measurement at each point (24 hours graph)

(7) AC mitigation at AC transmission line measurement

Changes of AC voltage of pipe to soil are measured by confirming the effect of the AC power line at the same points as the pipe to soil potential measurements. Deep soil resistivities are measured up to 65m under ground level at 3 points.

(a) Method of measurement

The method of measurement for change of AC voltage of pipe to soil is the same as the method of pipe to soil potential measurement in Item 4.2.4 (4).

(b) Result of measurement

The effect for cathodic corrosion was not evident but voltages at 2 points were over 15V. This is the upper limit of safety for the human body in NACE RP0177. (Refer to Table 4.2.5 and Figure 4.2.14.)

As shown in Figure 4.2.15, soil resistivity at ground surface in dry areas is relatively high, which means electrical resistivity is high. Therefore, safety measurements for human bodies and cattle to prevent electric shocks are necessary at the aboveground facility such as air valve and scour valve.

Table 4.2.5 Measurement

Point	AC voltage (V)		
	Ave	Max	Min
1	1.40	2.99	0.39
2	1.83	3.88	0.80
3	3.31	6.93	0.82
4	0.02	0.04	0.01
5	0.10	0.53	0.00
6	4.38	8.89	2.01
7	7.19	14.32	2.50
8	6.10	12.08	2.22
9	9.53	19.45	3.73
10	9.76	19.83	4.19
11	1.40	2.42	0.53
12	1.00	2.51	0.52
13	2.93	6.86	0.78
14	1.45	3.14	0.42
15	1.83	3.60	0.71
16	3.56	6.48	1.67
17	7.20	12.15	0.00
18	0.77	2.47	0.07
19	4.02	9.99	3.10
20	1.34	2.11	0.83

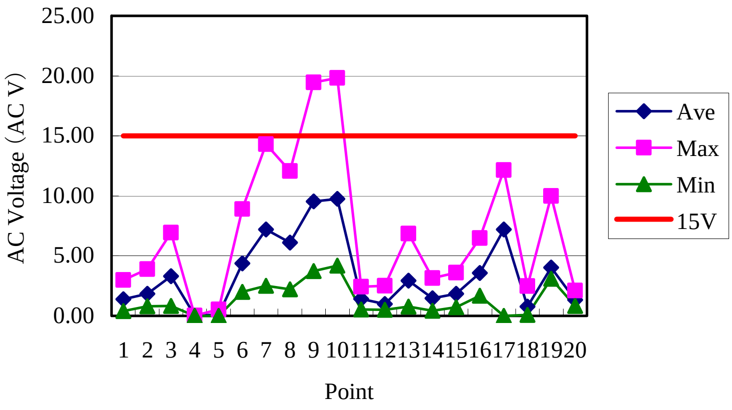
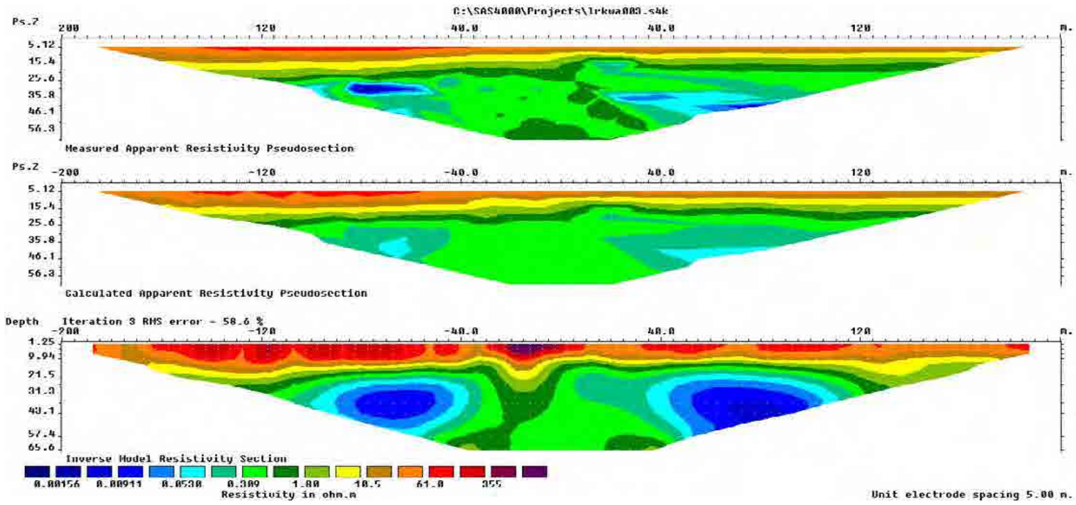
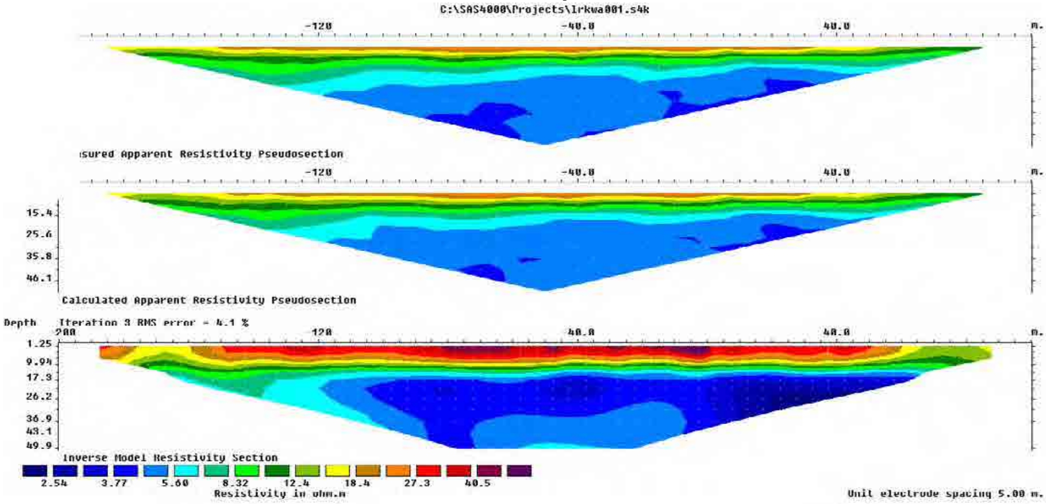


Figure 4.2.14 Measurement (Graph)

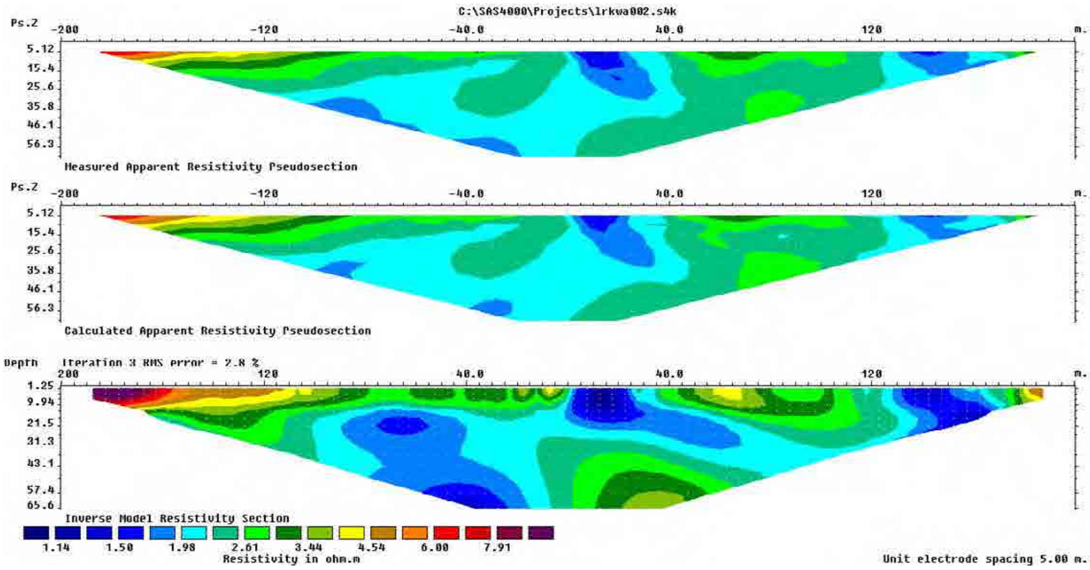


CH12268（Dry area）



CH21495（Dry area）

CH28680



CH28680（Wet area）

Figure 4.2.15　Map of soil resistivity (Longitudinal)

(8) Visual inspection after excavation

(a) Method of measurement

After excavation, visual checks of coating and pipeline surfaces - after taking out coating for 10 points - were carried out at the 10 points in corrosion circumstance that were identified in the pipe to soil potential measurement, soil resistivity measurement, and potential water leakage measurements in the pipeline route survey.

Points of visual inspection are shown in Figure 4.2.16

Figure 4.2.16 Points of visual inspection (10 Points)

(b) Result and evaluation

The result of checks and pictures taken when checking are shown in Table 4.2.6 and Figure 4.2.17.

1) Coating measurement

A slight degeneration of coating was evident mainly in wet areas. There are very few portions of decreasing thickness are very few, however portions of coating thickness decreasing to 4mm (Originally 8mm) was evident. Several portions that were damaged by penetration from the root of a tree were evident.

2) Adhesion of coating

The adhesion of coating to pipe surface is generally good. However, in some small portions, bad adhesions were evident.

3) Surface of pipeline

Slight signs of rust on pipe surfaces in small areas were noticed. Welding portions where there is damaged coating or bad adhesion were identified. The amount of rust is considered to be small and a decrease in pipe thickness was not evident.

4) Evaluation

The condition of the coating is generally good, and generations of rust on pipe surface is also generally small. It can be expected that coating will degenerate mainly in wet area in the future as the pipeline has been 13 years after construction.

If the pipe surface makes contact with the soil directly, the corrosion of the pipeline will progress rapidly at the damaged portion by cathodic corrosion.

Table 4.2.6 Result of checking

No.	CH	Soil condi -tion	Coating				Rust generation of pipeline			pipe thickness (mm)
			Adhen -sion	Degene -ration	Damage	Thick -ness	General	Spot	Weld portion	
1	-5429	Dry	○	○	○	○	○	○	○	8.0 ○
2	770	Dry	○	○	○	○	○	○	○	7.8 ○
3	9356	Wet	○	△※2	○	○	○	□	○	7.9 ○
4	10450	Dry	□※1	○	○	○	□※5	○	○	7.8-8.0 ○
5	14096	Wet	○	△	○	○	○	□	○	7.9 ○
6	16800	Dry	○	○	□※3	□※4	○	□	□※7	7.8 ○
7	23020	Dry	○	○	○	○	○	○	○	8.2 ○
8	28180	Wet	○	△	○	○	○	□※6	○	7.9 ○
9	31944	Dry	○	○	○	○	○	○	○	7.9 ○
10	5305	Wet	○	△	○	○	○	○	○	5.9 ○

Legend ○: Generally good, △: Generally degenerated, □: Partially damage generated


Visual inspection (Dry area)


Visual inspection (Wet area)


Bad adhension (※1)


Coating degeneration (※2)


Coating damaged (※3)


Coating decreasing (※4)


Rust generation general (※5)


Rust generation in spot (※6)


Rust generation in weld portion (※7)

Figure 4.2.17 Pictures of checking

(9) Water leakage detection survey

Water comes out from 3 points at the excavated holes using visual inspection in wet area. The three points are:

- CH9356
- CH28180
- CH5305

Chlorine contents are detected from soaked water in all 3 holes. This means that there is the possibility of leakage from the pipeline of 1 000 diameter. A water leakage detection survey from ground level for the pipeline of 1 000 diameter in the above three points was carried out.

(a) Method of survey

Coating defects are detected electronically by the Deep Current Voltage Gradient (DCVG) method. After this, sounds of water flowing out from the pipeline are detected at the coating defect point, using a microphone. (Refer to Figure 4.2.18)

Results of the survey are shown in Table 4.2.7

The sound of water flowing out from 1 000mm diameter pipeline was not recognized in the areas of CH9356 and CH5305, but the sound of water was recognized at one point near CH28680 in the area of CH28180.

DCVG survey

Acoustic survey

DCVG survey (Equipment)

Acoustic survey (Equipment)

Figure 4.2.18 Pictures of water leakage detection survey results of survey

Table 4.2.7 Result of survey

Section of survey	Diameter of pipeline (mm)	Length of pipeline to be surveyed (m)	No. of defect of coating detected	No. of leakage sound detected	Chlorine in water
③CH9356	1000	617	24	0	Positive
⑧CH28180 （CH28680）	1000	1217	21	1	Positive
⑩CH5305	600	428	17	0	Positive
Total		2262	62	1	

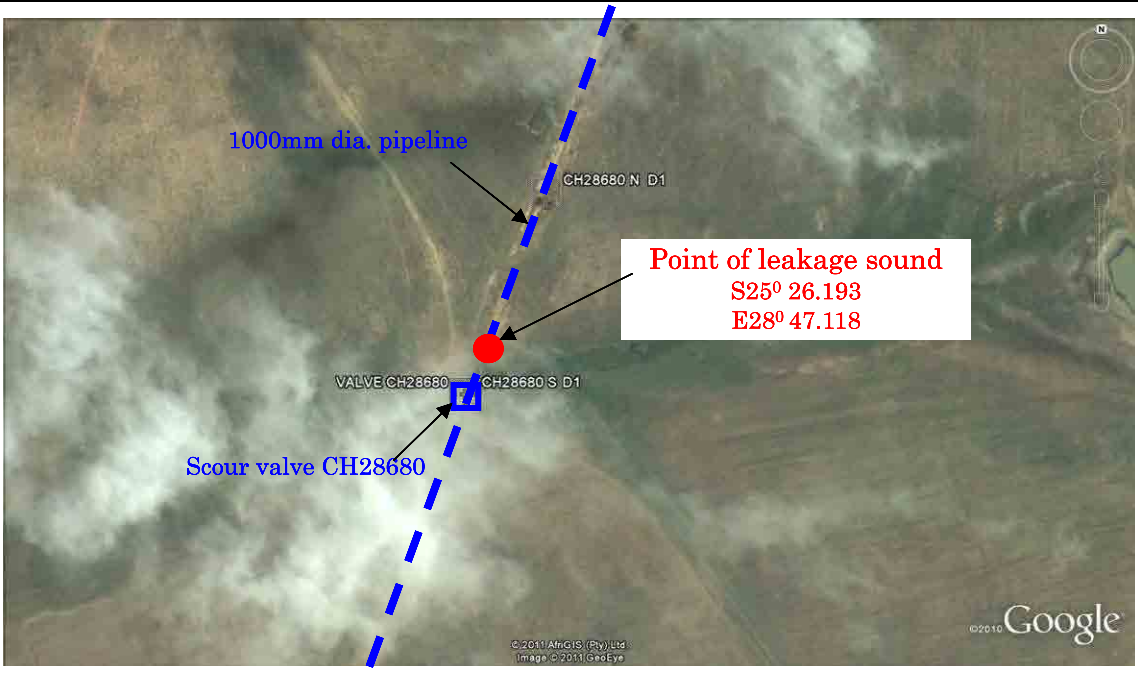


Figure 4.2.19　Point of leakage sound detected

<Evaluation>

<u>③CH9356</u>

The sound of water leaking from the 1 000mm diameter pipeline was not evident in the area of CH9356. Therefore, the water leakage is coming from the old 500mm diameter pipeline which is running along the 1 000mm diameter pipeline.

<u>⑧CH28180</u>

The sound of water leaking from the 1 000mm diameter pipeline was evident by microphone from ground level. (Refer to Figure 4.2.19.). The damage is either from cathodic corrosion or caused by heavy vehicle. The road is rough above the pipeline.

DWA needs to confirm and fix the damaged portion after excavation as soon as possible.

Water leakage in CH28180 spreads to large area. Therefore, it is considerable that another leakage should be from old 500mm diameter steel pipeline.

<u>⑩CH5305</u>

The sound of water leaking from the 1 000mm diameter pipeline was not evident in the area of CH5305. Therefore, the water leakage will be from existing asbestos pipeline which the 600mm diameter pipeline is connected to. Leakages from the pipeline in these three areas are creating a large wet area or small stream, as shown in Figure 4.2.5.

(10)　Soil analysis measurement

Soil analysis for pH, Conductivity, Chlorides, Sulphates, TDS and Alkalinity are carried out at 10 points using visual inspection.

<Result of measurement and evaluation>

Important items to measure in six categories are pH and conductivity. Measured against the judgment standards for corrosion (shown in Table 4.2.9 and Table 4.2.10), soils in four points are corrosive for pH and conductivity (shown in red in Table 4.2.8).

Pipe to soil potentials in these points should be kept at a proper level by a cathodic protection system.

Table 4.2.8 Measurement

Point	pH	Conductivity (mS/cm)	Chlorides (ppm)	Sulphates (ppm)	TDS (ppm)	Alkalinity (ppm)
1	6.64	241	10	16	120	35.6
2	5.34	96	<5	6	18	<35.6
3	6.88	328	<5	14	130	<35.6
4	5.28	48	<5	<5	24	<35.6
5	6.59	364	<5	38	90	<35.6
6	7.21	122	<5	16	60	<35.6
7	5.57	58	<5	8	28	<35.6
8	4.7	78	<5	<5	39	35.6
9	7.46	242	<5	16	120	<35.6
10	6.45	160	10	<5	60	35.6

Table 4.2.9 Relation between pH and corrosive

pH value	Corrosion	Cathodic Protection requirement
<6	corrosive	CP definitely required
6 - 7.5	neutral	CP may not be required
>8	alkaline	CP probably not required.

Source: Corrosion Control in South Africa (2nd Ed; 2004; Corrosion Institute SA)

Table 4.2.10 Relation between conductivity and corrosive

Conductivity (μS/cm)	Corrosivity of soil	Cathodic Protection requirement
>500	Very corrosive	CP definitely required
200-500	Corrosive	CP required
100-200	Mildly corrosive	CP probably required.
<100	Generally non-corrosive	CP possibly not required.

Source: Corrosion Control in South Africa (2nd Ed; 2004; Corrosion Institute SA)

(11) Corrosive bacteria analysis

Anaerobic sulphate reducing bacteria is corrosive to metals. Measurements of sulphate reducing bacteria (SRB) were carried out for soils at ten points, using visual inspection. Contents of SRB in soils are judged by a change in color in culture tubes.

Contents of SRB in soils were not evident at points 2 and 4. Contents of SRB were evident in the soils at the other 8 points. (Refer to Figure 4.2.20 and Table 4.2.11). Therefore, it can be assumed that levels of SRB are in most of the soil along the route of the pipeline. It is necessary that pipe to soil potentials in the pipeline route should be kept at proper levels by a cathodic protection system.

Figure 4.2.20 Measurement (Picture)

Table 4.2.11 Measurement

Point	Interpretation
1	Moderate
2	Insignificant
3	Low
4	Insignificant
5	Moderate
6	Low
7	Moderate
8	Moderate
9	Moderate
10	Moderate

Table 4.2.12 Standard of judgment for corrosive by sulphate reducing bacteria

Days of Incubation		1	2	3	4	5
TUBE APPEARANCE	Completely Black	Heavy $\geq 10^6$	Heavy $\geq 10^5$	Moderate $\geq 10^4$	Moderate $\geq 10^3$	Low $\geq 10^2$
	Narrow zone of black around applicator centre	Heavy $\geq 10^5$	Moderate $\geq 10^4$	Moderate $\geq 10^3$	Low $\geq 10^2$	Insignificant $\geq 10^1$
	No Reaction	$<10^5$	$<10^4$	$<10^3$	Insignificant $<10^2$	Insignificant $<10^1$

Source : Biosan Laboratories, inc USA

(12) Electrical source analysis

As result of survey for an electrical source, it is necessary to provide electricity to 2 points of the transformer rectifier units via a step-down transformer by branching at the points of the existing electrical line as shown in Table 4.2.13.

Table 4.2.13 Electrical sources from existing electrical line

Location	GPS Coordinate	Mast number	Voltage	Distance
GB1	S25 36 03.4 E28 43 06.0	GS/197/96 & ER/AV331/79/96	22kV	460m
GB2	S25 25 56.8 E28 47 05.3	TCC12812 and 75 U1572 75 U087	33kV	520m

(13) Current drainage test

Current drainage tests should be carried out to decide whether it is necessary to implement a cathodic protection system. Potential shift which reflects for design of cathodic protection system is obtained by carrying out a current drainage test which is providing electricity from temporary transformer rectifier unit at assumed ground bed location.

Current drainage test were carried out at CH9356 and CH28680. These points were wet and had low soil resistivity.

<Result of measurement>

- **CH28680**

Measurements at CH28680 are shown in Table 4.2.14 and Figure 4.2.21.

Table 4.2.14 Shift of potential at CH28680

Pipeline	Location	Potential Shift
600mm dia.	Ch5 311	No shift
600mm dia.	Ch0※	No shift
1000mm dia.	Ch31 944	200mV shift
1000mm dia.	Ch14 096	300mV shift
1000mm dia.	Ch9 356	3mV shift

※at Enkeldoornoog-B Reservoir

Length of pipe protected: 14,584m
Pipeline surface area protected: 45,817m²
Average current demand: 2.3amps
Current Density
(Current demand/Surface Area): 50µA/m²

(a) CH9356

Measurements at CH9356 are shown in Table 4.2.15 and Figure 4.2.22.

Table 4.2.15 Shift of potential at CH9356

Pipeline	Location	Potential Shift
1000mm dia.	Ch-5 379	1000mV shift
1000mm dia.	Ch14 096	500mV shift

It has been confirmed that the 1 000mm diameter pipeline is connected to electricity, but the electricity to the 600mm diameter pipeline is disconnected. Therefore, it is necessary to connect this pipeline to electricity for bonding for cathodic protection. Refer to the Section 4.2.4 (4).

According to the measurements, it has been confirmed that electrical conductivity is good with low current input. Potential shift to -0.95V in corrosive soil can be achieved by 50μA/m^2 of current density.

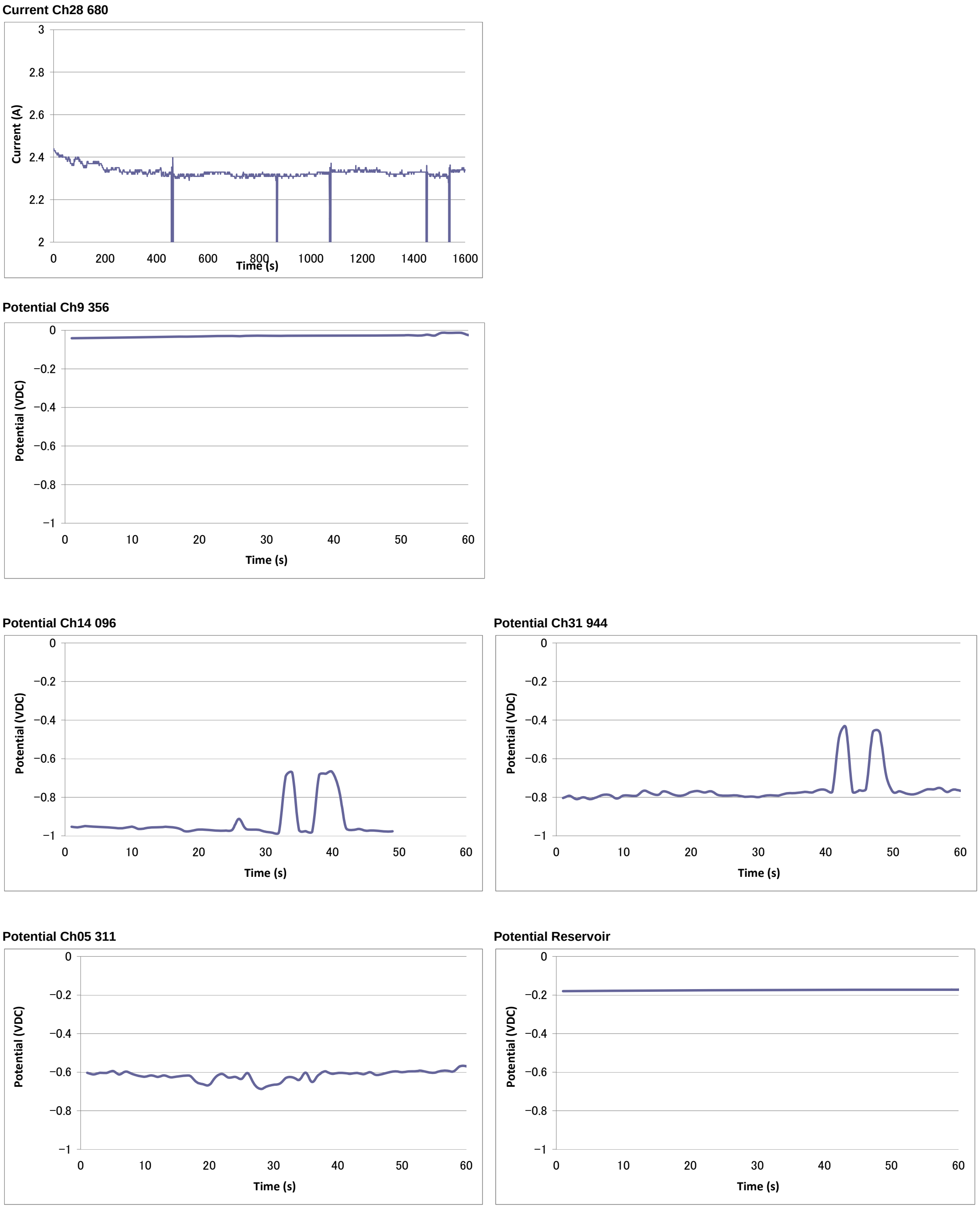


Figure 4.2.21   Shift of potential at CH28680 (Graph)

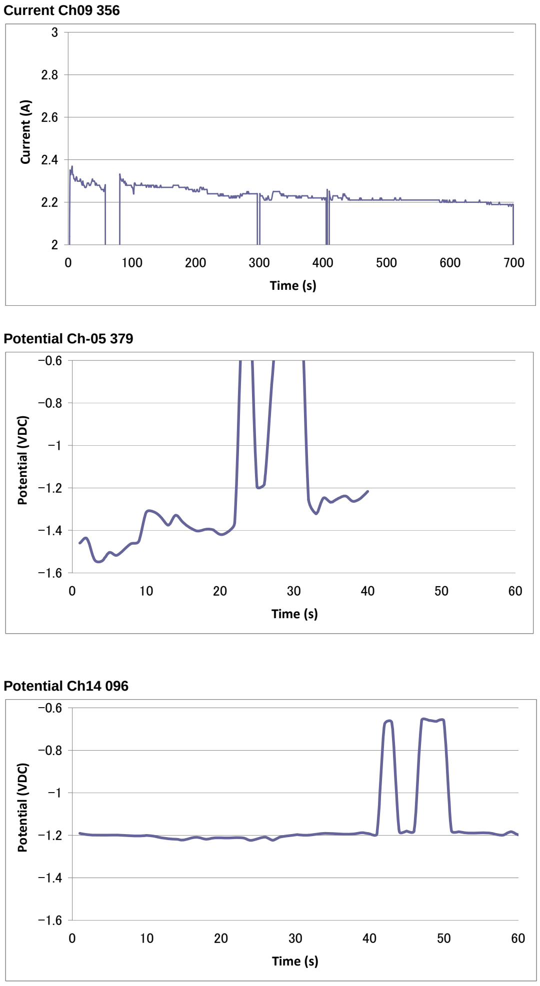


Figure 4.2.22 Shift of potential at CH9356 (Graph)

4.2.3 Summary of measurements and total evaluation

(1) Summary of measurements

According to the survey, water leakages from air valves and scour valves are recognized. Water leakage has created three wet areas, and is leaking from the 1 000mm diameter pipeline at CH28680 and other pipelines. These leakages need to be fixed as soon as possible because there is a lot of water that is going to waste.

The condition of the coatings and pipeline surface is rated as relatively good. This is in spite of some small damage to some coatings and evidence of slight rust on the surface of the pipeline in parts. This was picked up by direct inspection after excavation.

Conditions that effect cathodic corrosion to pipeline were confirmed. The problems causing cathodic corrosion are:

- Measurements of pipe to soil potential are mostly higher than the level of -0.95V which ensures protection potential in corrosive soil. Therefore, pipe to soil potential should be shifted to a level lower than -0.95V by cathodic protection.
- Soils along the pipeline route are generally dry with high soil resistivity, which is good for pipe laying. However, there were some wet areas in small stream crossing where there is low soil resistivity not good for pipe laying. Cathodic corrosion starts in these wet and low soil resistivity areas.
- The condition of coating was generally good, but a slight degeneration of coating was recognized, mainly in wet area. Degeneration of coating in this area will continue as the pipes age and there

are parts damaged by penetration of roots of trees, and where there are portions of bad adhesion to pipe surface.

- The condition of the pipe surface was generally good. However, slight rust on the pipe surface in several small areas was recognized as well as portions of damaged coating and bad adhesion. Cathodic corrosion will occur in these portions by direct contact with corrosive soil.
- The soil analysis from 10 points indicates corrosive pH and conductivity was evident in some points.
- The soil analysis from 10 points indicates sulphate reducing bacteria, which is corrosive to metals, is evident in most points.

(2) Total evaluation

Significant damage by cathodic corrosion is not evident at present. However, the study identified conditions that will promote corrosive circumstances along most of the pipeline route. If corrective measures are not taken to prevent corrosion, damage to the coating will occur in wet areas and the condition of the pipeline will deteriorate rapidly.

If damage to the pipeline by cathodic corrosion is significant, the cost repairing and replacing the pipeline can become prohibitive. It is therefore necessary to implement a cathodic protection system to prevent the condition of the pipeline from rapidly deteriorating.

A cathodic protection system extends the total life of the pipeline, and minimises the long-term cost of operation and maintenance on the pipeline.

4.2.4 Proposed cathodic protection system

From results of survey indicate that the transformer rectifier unit and ground bed is located at 2 points: CH9356 and CH28680 as shown in Figure 4.2.23 for the prevention of cathodic corrosion. To facilitate operation and maintenance, the cathodic protection system will be located at appropriate points.

To prevent humans and cattle from being electrocuted by stray current from the AC and DC power line, a safety grounding facility will be installed in valve boxes (that can be touched by humans or cattle).

(1) Objective of cathodic protection measurement

The objective of a cathodic protection measurement on the pipeline running from Ekangala district to Enkeldoornoog district is shown in Figure 4.2.23. The pipeline was constructed in 1998 by Yen-loan.

- Pipeline from Ekandustira Reservoir to Enkeldornoog-B Reservoir (1 000mm diameter; 37.5km length (approx.))
- Pipeline from Enkeldoornoog-B Reservoir to Gemsbokspruit Reservoir (600mm diameter; 5km length approx.))

In addition to the above pipelines, steel portions of the existing old 500mm diameter pipeline – constructed in 1991 - runs alongside the 1,000mm diameter pipeline. This is included in the cathodic protection measurement. (Refer to Figure 4.2.23)

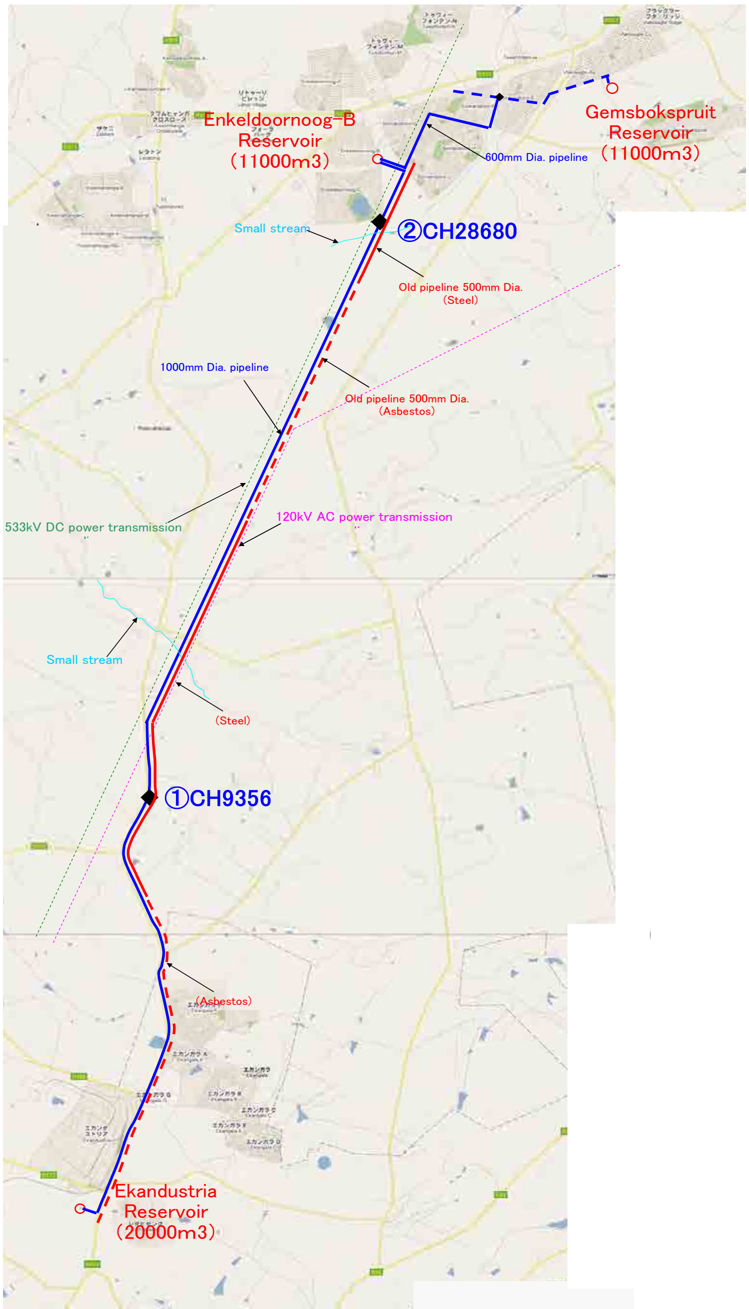


Figure 4.2.23 Locations of transformer rectifier unit and ground bed

(2) Method of cathodic protection measurement

2 types of cathodic protection system are mainly used for buried pipeline, one is sacrifical anode cathodic protection, and another is impressed current cathodic protection.

Descriptions of 2 protection systems are shown herein under.

(a) Sacrifical anode cathodic protection

Sacrifical anode cathodic protection is the simplest method to apply cathodic protection which done by connecting the metal (steel of the pipeline) to be protected with another more easily corroded "sacrifical metal", such as

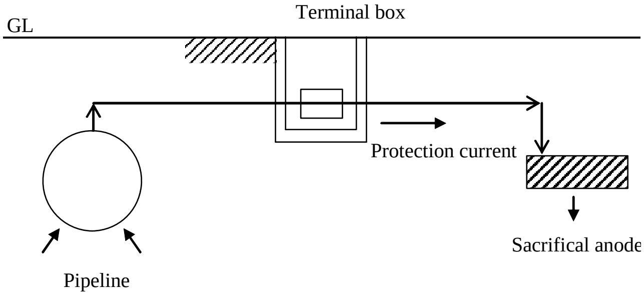


Figure 4.2.24 Impressed current cathodic

magnesium or zinc, to act as the anode of the electrochemical cell (battery). (Refer to Figure 4.2.24.) Magnesium is usually used as sacrifice metal in the case of buried pipeline in soil. This is because magnesium is more effective.

Electrical power is not necessary, and maintenance work is easy with this system. However, the protection capability is very small, and use of this system is limited to small scale projects only.

(b) Impressed current cathodic protection

Impressed current cathodic protection system uses anodes connected to a DC power source. Usually this will be a transformer rectifier unit, which converts an AC power supply to a DC output. (Refer to Figure 4.2.25)

A selenium rectifier or silicon rectifier are applicable for a transformer rectifier unit of cathodic protection. Silicon rectifiers have become popular recently because fewer problems are experiences and it lasts longer.

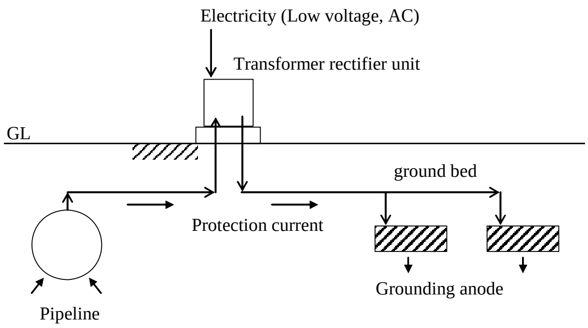


Figure 4.2.25 Impressed current cathodic protection

Iron oxide, high silicon iron or mixed metal oxide coated anodes (titanium) are used for anodes in ground bed. This system can adjust the protection current, and has enough capacity to apply to large scale projects. However, electrical power is needed and maintenance work is necessary. Systems to measure overprotection and effect on adjacent buried structures is necessary because of the high voltage in the system

Impressed current cathodic protection is the most suitable system for this project. This is because the pipeline is very long and the area to be protected is very large.

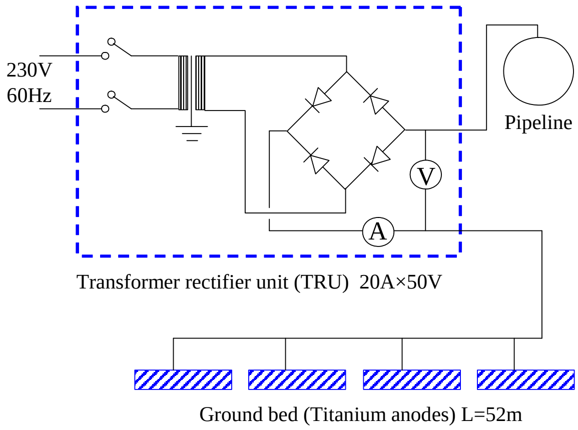


Figure 4.2.26 Transformer rectifier unit

Silicon rectifier and mixed metal oxide coated anodes (titanium) are also appropriate for this project because it guarantees a longer life span. The system of the transformer rectifier unit is shown in Figure 4.2.26.

(3) Safety earthing facility for human and cattle

In the survey of AC mitigation at AC transmission line, AC voltages of stray current from AC transmission line at 2 points are over 15V, which is the upper limit of safety for the human body in NACE. Therefore, some protection measurement is necessary.
The survey indicates the potential load changing of the DC transmission line (which was carried out in 1999), the maximum DC potential was around 300V. (Refer to Figure 4.2.27.)
It is very dangerous for either a human or cattle to receive an electrical shock at this level if they touch either one of the ground facilities; the air valve or scour valve. The safety earthing facility as shown in Figure 4.2.28 is allocated to this project.

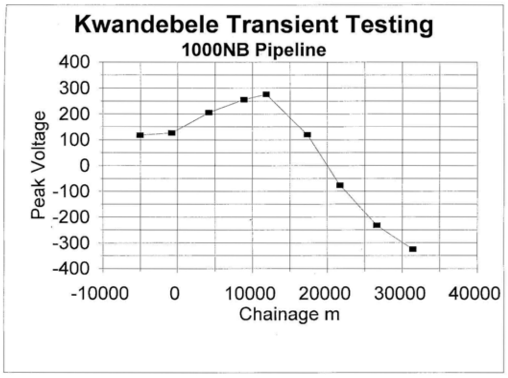


Figure 4.2.28 Change of potential at load changing of DC transmission line(From survey in 1999)

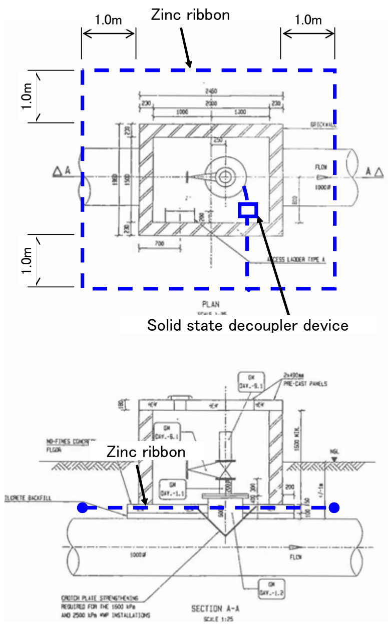


Figure 4.2.27 Safety earthing facility

(4) Bonding

It is evident from this study that the 1 000mm diameter pipeline and 600mm diameter pipeline are not connected to electrical power. The existing 500mm diameter pipeline runs alongside the 1 000mm diameter pipeline and is protected by cathodic protection in this project.

The proposed cathodic protection system applies to all the pipelines. Electrical continuity at stop valves and flow meters on the 1 000mm diameter pipeline is reliable for bonding in this project, as shown in Figure 4.2.29.

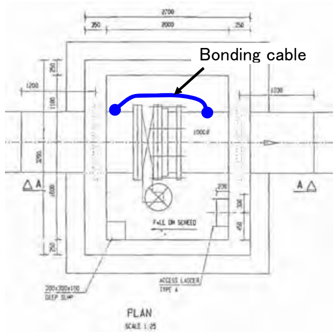


Figure 4.2.29 Bonding

(5) Facility for monitoring for cathodic protection

Conditions of corrosion along the pipeline are mainly judged by pipe to soil potential. If measurements of pipe to soil potential are lower than standard protection potential, it is recommended that potential of pipeline should be shifted to proper potential. It is necessary to monitor pipe to soil potential periodically.

It is recommendable that pipe to soil potential should be monitored once a month, and a 24 hour measurement of pipe to soil should be done at least once per year.

Terminals for monitoring pipe to soil potential are installed at every air valve and scour valve on the 1 000mm diameter pipeline in this project. (Refer to Figure 4.2.30). Monitoring boxes for 24 hour measurements are located at ten important points in this project. The monitoring box has a key and the device is placed in it.

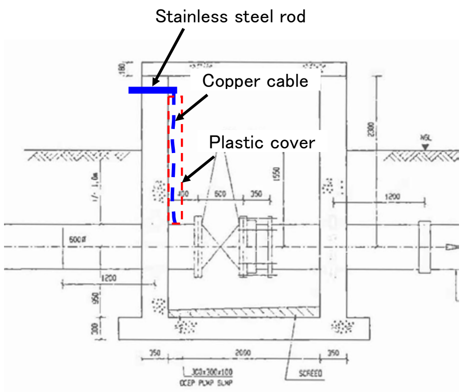


Figure 4.2.30 Terminal for monitoring of CP

(6) Equipment for cathodic protection

The survey indicates that points CH9356 and CH 28680 have low soil resistivity, which is suitable for ground bed. Ground beds and transformer rectifier units are used for draining current from pipe to soil at ground bed, and are located at these points.

Equipment needed for cathodic protection and safety earthing is shown in Table 4.2.16.

Table 4.2.16 List of equipment

Equipment	Speification	Q'ty	Remarks
Equipment for cathodic protection			
Transformer rectifier unit	20A×50V、silicon rectifier	2	
anode at ground bed	L:52m, Mixed metasl oxide coated anode (Titanium	2	
Bonding	Copper cable	30	
Bonding with monitoring box	Copper cable	7	
Monitoring point	Stainless steel rod	81	
Monitoring box	for setting equipment inside	10	
Equipment for safety earthing			
Grounding wire	Material：Copper	3600 (m)	
DC power surge protector		150	
Earth strap		150	

(7) Design calculation

It is confirmed in Item 4.2.2 (13) that the necessary current density for shifting potential to protection potential (-0.95V) is 50μA/m^2.

The locations of transformer rectifier units and ground beds are decided by 50μA/m^2 of current density, but capacities are decided by 200μA/m^2 of current density, taking into account relevant safety factors.

Cathodic protection is necessary for the 600mm diameter pipeline and steel portions of the old existing 500mm diameter pipeline that runs alongside the 1,000mm diameter pipeline, and is connected electrically with 1 000mm diameter pipeline.

(8) Transformer rectifier unit

Calculation of transformer rectifier unit is shown as follows:

ρ : Resistivity of steel（ohm.mm²/m） 0.2

ΔU : Difference between max. and min.polarised potential（V） 0.2

		Maximum Rectifier Spacing : 2L(km)		
Current density : j (mA/m²)		(0.05)	(0.10)	(0.20)
Wall thickness : t (mm)				
600mm dia 6mm wall	(6.0)	31	22	15
1000mm dia 8mm wall	(8.0)	36	25	18

Rectifier spacing (2L) based on formula from Baeckman & Schwenk

$$2L = \sqrt{(8*\Delta U*t)/(\rho*j)}$$ equ 10-5 pg 266

Where

2L : distance between rectifiers (km)

ΔU : Difference between max. and min.polarised potential（V） (SBR present)

t : pipe wall thickness (mm)

ρ : resistivity of steel (ohm.mm²/m)

j : design current density (mA/m²)

Current per rectifier （Current density j=200μA/m²）
（current density x surface area per rectifier at maximum spacing）

600mm dia. pipeline	5.84	amps
1000mm dia. pipeline	11.24	amps

Total current for pipeline（Current density j=200μA/m²）

600mm dia. pipeline	2	amps
1000mm dia. pipeline	26	amps
（500mm dia.existing pipeline）	（6）	amps
Total	34	amps

Therefore,

Nos of transformer rectifier unit	2 units
Capacity of transformer rectifier unit	20A×50V/unit

(a) Anode of ground bed

Length of anode at ground bed is calculated by 2 formulas in NACE:

Formula 1 （General long thin anode resistance calculation)

R = (ρ/2*pi*L)*(ln(4L/r)-1) (Modified Dwight, NACE CP3 equ 4-18

where R : groundbed resistance (ohm)
L : groundbed length (m)
r : equivalent anode radius (0.18m)
ρ : soil resistivity for design (ohm.m)

Groundbed length based on anodes placed at 3m centres in continuous coke backfill
Anode radius and diameter calculated for square trench section 300mm

L : groundbed length (m)	52
r : equivalent anode radius (0.18m)	0.18
ρ : soil resistivity for design (ohm.m)	100
R : groundbed resistance (ohm)	**1.84**

Formula 2 (Groundbed resistance formula for continuous horizontal anode)

R = (ρ/2*pi*L)*(ln(L^2/td)) (Baeckmann & Schwenk equ 24-23 pg 542, NACE CP3 equ 4-23 pg 4-27)

where R : groundbed resistance (ohm)
L : groundbed length (m)
t : groundbed depth below surface (2.5m)
d : equivalent anode diameter (0.38m)
r : equivalent anode radius (0.19m)
ρ : soil resistivity for design (ohm.m)

Groundbed length based on anodes placed at 3m centres in continuous coke backfill
Anode radius and diameter calculated for square trench section 300mm

L : groundbed length (m)	52
t : groundbed depth below surface (2.5m)	2.50
d : equivalent anode diameter (0.38m)	0.38
r : equivalent anode radius (0.19m)	0.19
ρ : soil resistivity for design (ohm.m)	100
R : groundbed resistance (ohm)	**2.43**

Therefore, the length of anode at ground bed is 52m because ground bed resistance at 52m of length is lower than 2.5 ohm(=50V/20A)

(9) Operation and maintenance

Periodical operation and maintenance for cathodic protection system is necessary for keeping pipe to soil potential lower than protection potential.

(a) Contents of operation and maintenance

Contents of operation and maintenance are as follows:

Work to be done once per month

Place 1	Monitoring terminal for pipe to soil potential (located at every air valve and scour valve)
Work	Monitor of pipe to soil potential
Place 2	Transformer rectifier unit at CH9356 and CH28680
Work	Check the conditions of equipment, voltage and current Adjusting output

Work to be done once per year

Place 1	Monitoring box at ten several points
Work	Monitoring pipe to soil potential in continuous 24hours
Place 2	Transformer rectifier unit at CH9356 and CH28680
Work	Check the conditions of equipment, voltage and current Adjusting output Cleaning equipment and fixing damaged portions

(b) Cost for operation and maintenance

Fee of electricity	ZAR0.95×24hr×365days×2units =	ZAR16,644/year
Monthly maintenance	ZAR5,500×12months =	ZAR66,000/year
Annual maintenance		ZAR19,550/year
Total		ZAR102,194/year

(c) Construction cost

Construction cost for cathodic protection system is shown in Table 4.2.17.

Table 4.2.17 Construction cost

Description	Unit Price	Unit	Qty	Total
Internal continuity bond	R7,000.00	each	13	R91,000.00
Cross bonds between pipes (link panels in chamber)	R5,500.00	each	13	R71,500.00
Cross bond via bonding cabinet	R18,000.00	each	7	R126,000.00
Chamber monitoring point	R2,000.00	each	81	R162,000.00
Monitoring cabinets	R15,000.00	each	10	R150,000.00
ICCP Station including TRU & anode groundbed	R500,000.00	each	2	R1,000,000.00
Miscellaneous and statutory requirements		sum		R240,075.00
Total - CP supply & install				R1,840,575.00
Supply of electricity to groundbed 1	R200.00	meter	460	R92,000.00
Supply of electricity to groundbed 2	R200.00	meter	520	R104,000.00
Eskom power contingencies		sum		R19,600.00
Total - Eskom power				R215,600.00
Safety earthing around chamber - zinc ribbon supply & install	R200.00	meter	3600	R720,000.00
Valve chamber structure earthing strap - supply & install	R5,000.00	number	150	R750,000.00
Solid state decoupler device - supply & install	R3,000.00	number	150	R450,000.00
Total - AC mitigation supply & install				R1,920,000.00
Installation supervision		sum		R60,000.00
Commissioning		sum		R100,000.00
O&M manual & handover		sum		R25,000.00
Total - professional fees				R185,000.00
Total for above				R3,945,575.00
Vat	14%			R552,380.50
				R4,497,955.50
				↓
TOTAL - BUDGET ESTIMATE FOR CP				R4,500,000.00

(10) Implementation schedule

Implementation schedule for construction of cathodic protection system is shown in Figure 4.2.31.

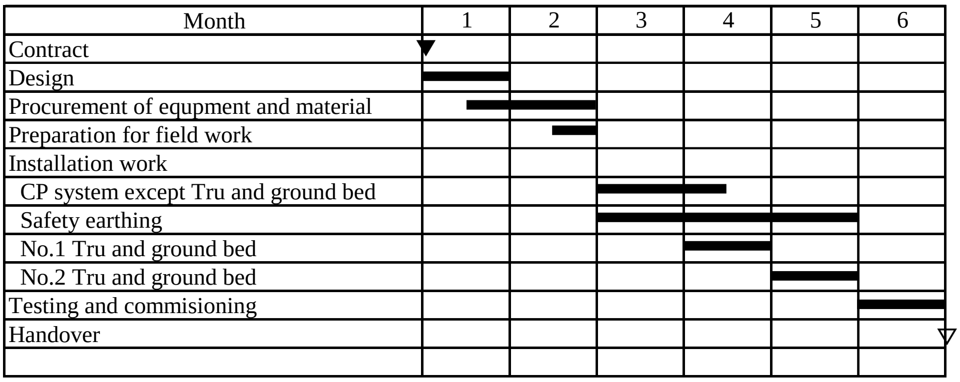


Figure 4.2.31 Implementation schedule

4.3 Survey on Non-Revenue Water Reduction

4.3.1 Leakage Detection and Survey on Water Meters of Households

JICA study team conducted a pilot study, which was composed of leakage detection and survey on water meters. In order to learn rate of leakage on distribution pipelines, Minimum Night Flow (MNF), inlet flow and water pressure were measured for 24 hours. MNF can be found at night, when water consumption is the lowest in a day.

Meanwhile, difference between inlet-flow and outlet flow (water consumption) at water meter was checked based on the results of condition of the water meter's function and water consumption through reading water meter to assess leaked volume.

4.3.2 Selection Criteria for Model Block Candidates

Figure 4.3.1 shows the flow of model block selection.

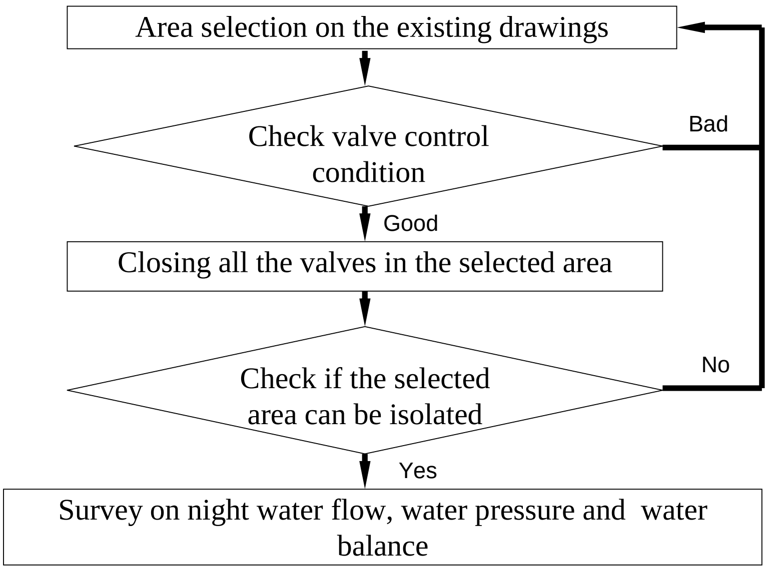


Figure 4.3.1 Model Block Selection

Selection criteria of model block candidates are as follows:

- LMs that DWA desires.
- Areas that LM desires.
- Areas that house connections or yard connections exist.
- Areas that water can be served for at least 48hours

- Areas that there are at least 100 houses.
- Areas that can be isolated by the existing valves.

Table 4.3.1 shows candidate blocks that municipalities proposed. Eight (8) and three (3) candidates in Thembisile Hani LM and Dr. JS Moroka LM respectively were proposed.

Table 4.3.1 Candidates of Model Blocks

LM	Candidate Area	Number of Model Block candidates
Thembisile Hani LM	Moloto	6
	Kwamhlanga	1
	Tweefountain-K	1
Dr. JS Moroka LM	Siyabuswa-B	3

Source: JICA Study Team

However, there were the following serious problems in the candidate areas, it was more difficult to isolate model block than JICA study team expected.

- Valves were buried with soil (see Figure 4.3.3)
- Valve heads were buried with soil (see Figure 4.3.2)
- Discrepancy between valve location in the field and those in the drawings
- There are no some plans layout of water supply facilities
- Valve deficiency (see Figure 4.3.4)

Figure 4.3.3 Buried Valve

Figure 4.3.2 Buried Valve Head

Figure 4.3.4 Deficiency of Valve

4.3.3 Selection of Model Block

It took much time to select model block than the time which had been expected, but each of the model blocks was selected in Siyabuswa-B, Dr. JS Moroka LM and Tweefountain-K and Moloto RDP, Thembisile Hani LM. Figure 4.3.5, 4.3.6 and 4.3.7show the model blocks of Siyabuswa-B, Tweefontain-K and Moloto RDP respectively.

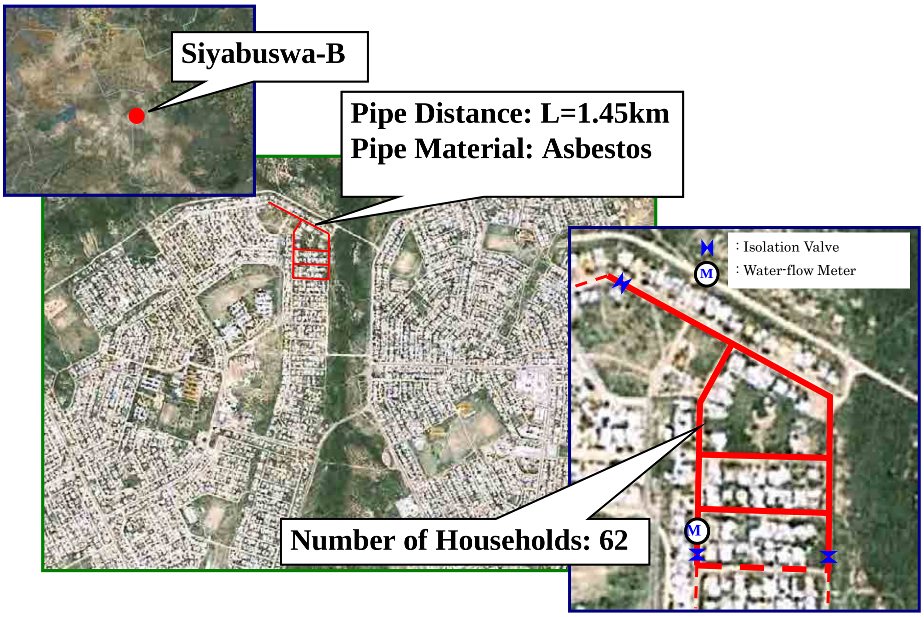


Figure 4.3.5 Model Block in Siyabuswa-B (Dr. JS. Moroka LM)

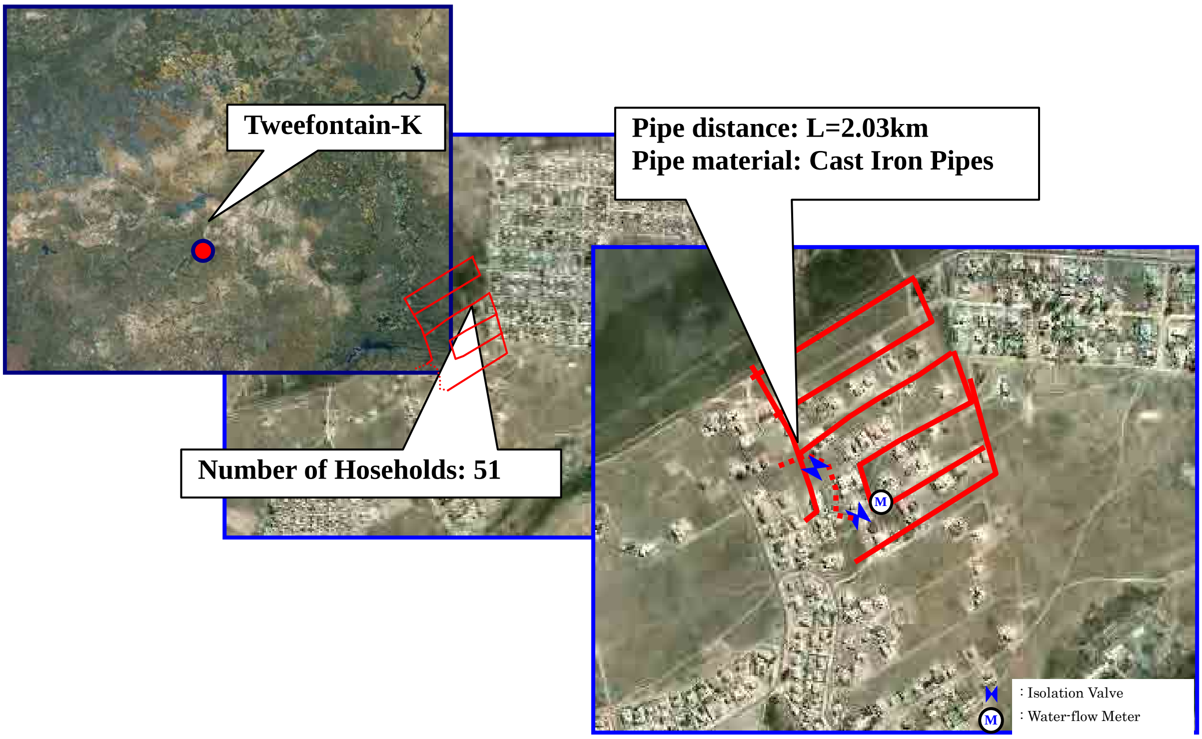


Figure 4.3.6 Model Block in Tweefontain-K, Thembisile Hani LM

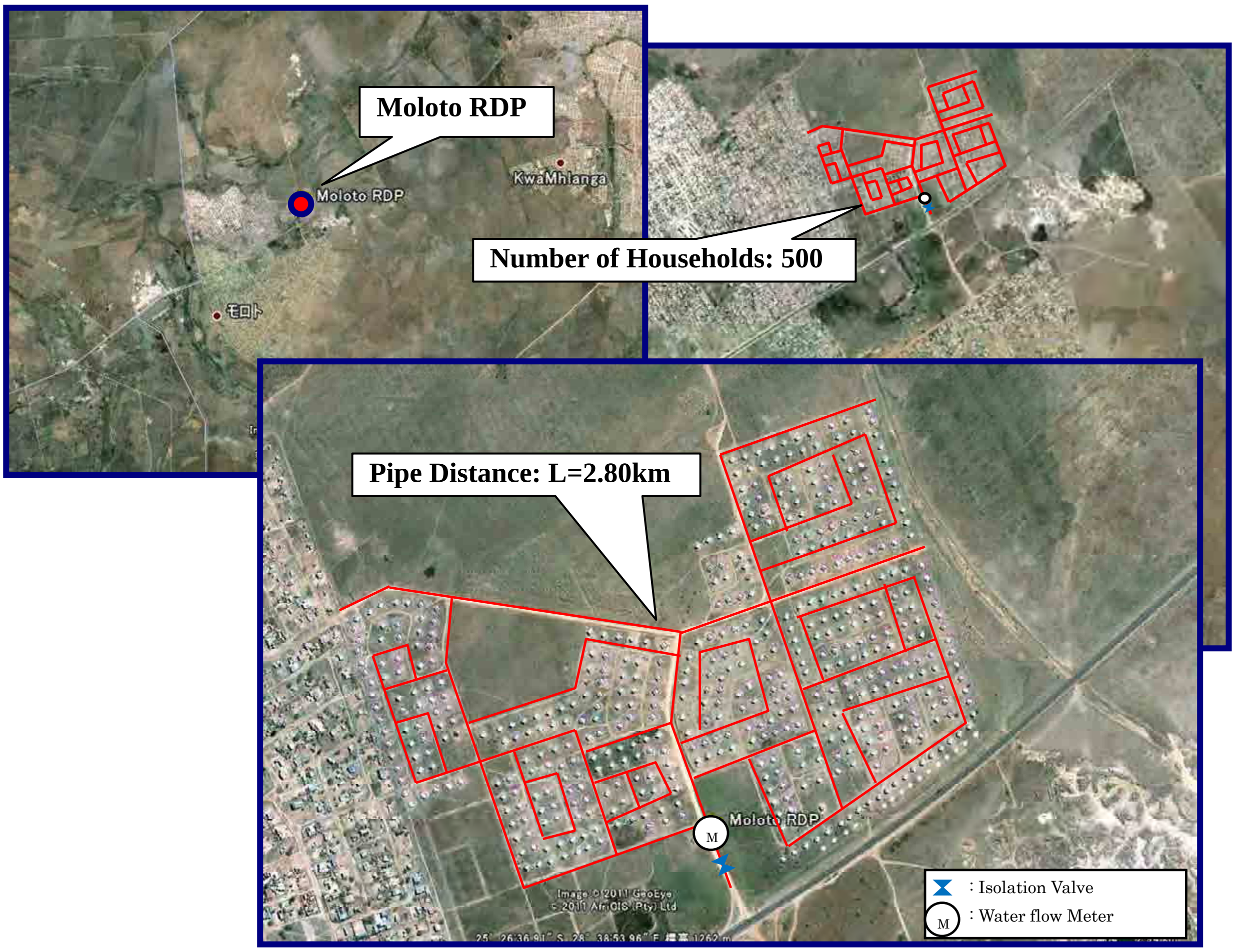
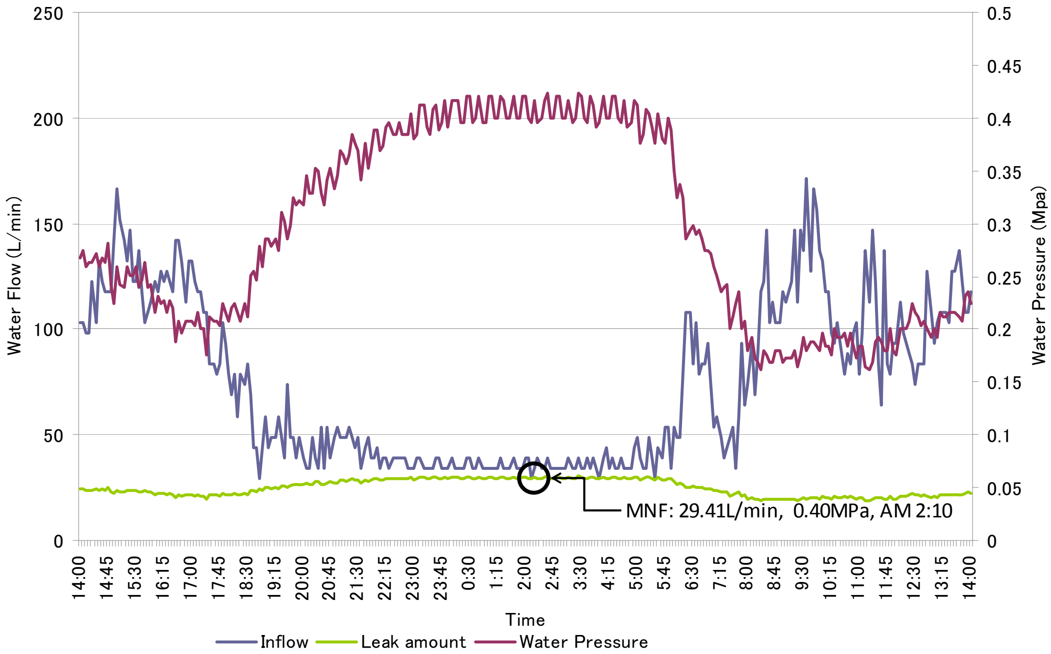


Figure 4.3.7 Model Block in Moloto RDP, Thembisile Hani LM

4.3.4 Measurement of Minimum Night Flow (MNF) and Water Pressure in Model Blocks

(1) Siyabuswa-B, Dr. JS Moroka LM

Figure 4.3.8 shows tendency of inflow and water pressure for 24hours in Siyabuswa-B. Minimum night flow of 29.4 liter/min was observed at 2:10 am. Graph for volume of leaked water calculated on basis of the minimum night flow is shown in yellow-green on Figure 4.3.8. Accumulated quantities of inflow and leaked flow for 24 hours are 106 m^3/day and 36 m^3/day respectively, which resulted in the leakage rate of 34%.



Daily Leak Amount: 36m³/day / Daily Inflow: 106m³/day	= Leak Rate: 34.0% (Including water leakage after water meter)

Figure 4.3.8 Inflow and Water Pressure in Siyabuswa-B

(2) Tweefontain-K, Thembisile Hani LM

Measurement of minimum night flow was suspended 11.5 hours after commencement on account of rain. Inflow rate was sometimes 20 liter/min or less through its measurement (see Figure 4.3.9), which resulted in that such a little inflow was less than the minimum measurement range of the ultrasonic flow-meter. Therefore, JICA study team had to call off to re-measure inflow. Inflow rate was 30 liter/min at its maximum, and 3.3 liter/min in average throughout 11.5 hours. Daily flow was approximately 20 liter/capita/day and leakage was barely found.

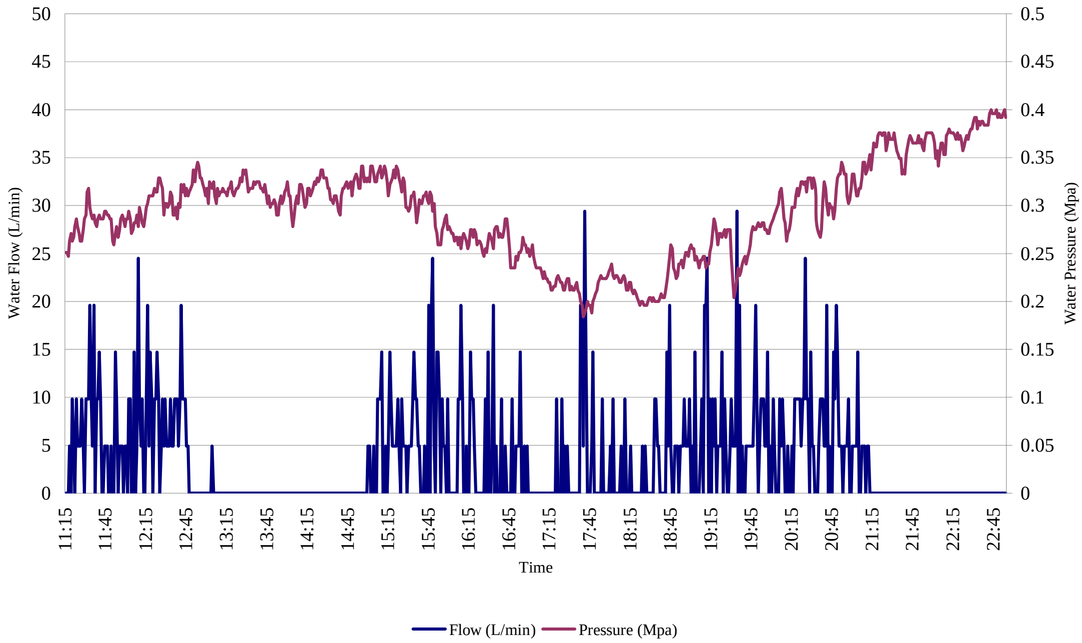


Figure 4.3.9 Inflow and Water Pressure in Tweefontain-K

(3) Moloto RDP, Thembisile Hani LM

A power failure occurred at about 22:00. As a result, the flow data was calculated from the pressure data. The next day, at about noon, we stopped the pressure measurement as we assumed there was no fluctuation of flow rate from 12:00 to 13:30.The Minimum Night Flow 181L/min was observed at 3:32 (am).

A graph for estimated leaked volume calculated on the basis of Minimum Night Flow is shown in yellow and green lines on Figure 4.3.10.

Accumulated quantities of inflow and estimated leak volume for 24 hours are 334m3/day and 256m^3/day respectively, which resulted in the leakage rate of 76%.

In addition, the pressure average is 0.81MPa. It is that the pipelines are placed under unnecessary stress.

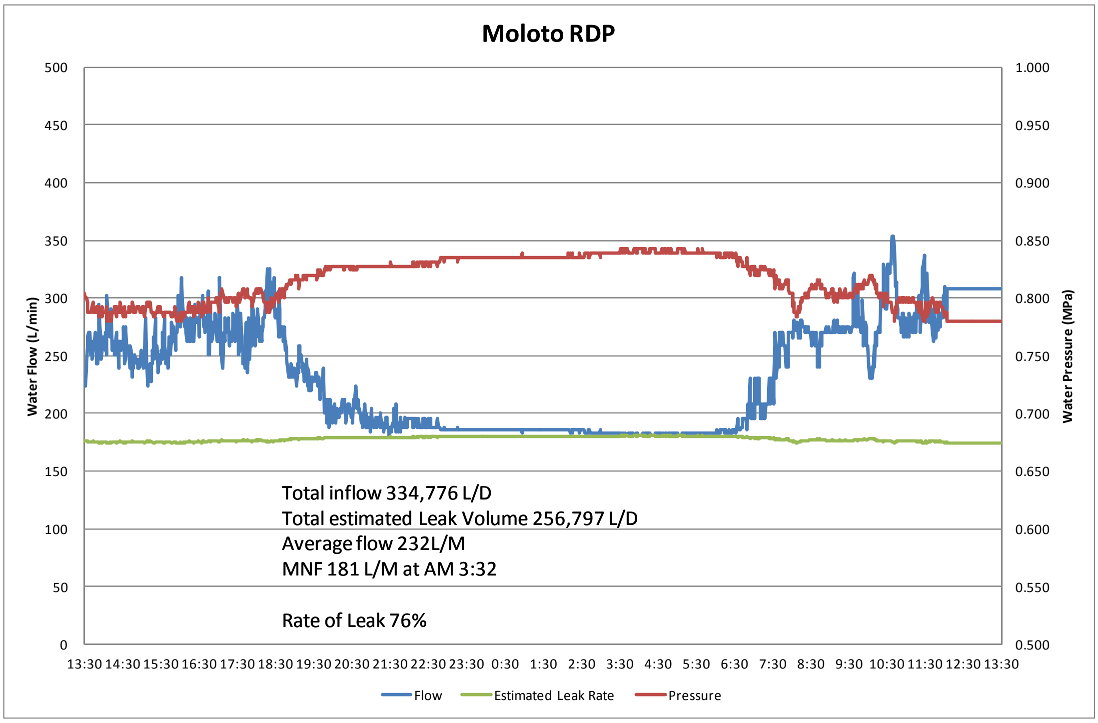


Figure 4.3.10 Inflow and Water Pressure in Moloto RDP

4.3.5 Survey Result of Water Meters in Model Block

(1) Siyabuswa-B, Dr. JS Moroka LM

Sixty-two houses out of 69, which were indicated in the plan drawings, actually exist in the model block of Siyabuswa-B. Of 62 houses, some 48 houses or 77 percent have functional water meters (see Table 4.3.2). While, the houses without water meters make up approx. 8% and entirely, there were 14 houses the water meters of which could not be read by LM.

Table 4.3.2 Condition of Water Meters in Siyabuswa-B

No.	Items	Houses	%	
1.	All the houses that are indicated in the plan drawings of model block area (Household size: 4.7persons)	69	100	-
2.	Functional water meters	48	69.6	(77.4)
3.	Deficiency of water meters	5	7.2	(8.1)
4.	No surveyed due to the locked water meters	4	5.8	(6.5)
5.	No water meters	5	7.2	(8.1)
6.	No houses	7	10.1	-

Note: ( ) shows ratio in a case of denominator to be 62 households that were checked in the field.

As shown in Table 4.3.3, inflow and water consumption measured by JICA study team for 24 hours were 106,177 liter/day (106m^3/day) and 87,595 liter/day (88m^3/day) respectively. Since water meters at 14 houses could not be read, water consumption has to be estimated in order to reach a water balance in model block. Common measures to estimate total water consumption of block of houses, where a few number of houses has no data, are to estimate the total water consumption of 62 houses applying average water consumption of houses actually measured. However, 15 houses were found to have vast leakage with the average consumption of 2,453 liter/capita/day. Therefore, it was impractical to apply the average water consumption of 48 houses to estimate total water consumption of 62 houses. Actually, the estimated total water consumption was more than the total inflow. In addition, though the average water consumption under the condition of No.6 and No.7 are applied to water consumption of non-measured 14 houses, total water consumption was much more than the total inflow. Condition of water consumption rate as show in No.8 is based on design criteria of DWA. If condition No.8 is applied, the estimated water consumption will be 94,927 liter/day, which shows a loss of 11,250 liter/day, i.e., 10 percent of inflow. In this pilot study, a ratio of leakage depends on the estimated water consumption rate for non-measured houses, but since 120 liter/capita/day (DWA's design criteria) as shown in No.8 is considerably adequate value, water leakage seems to be low in this model block.

In order to measure the accurate leakage on distribution pipelines, all the house connections must have accurate water meters.

As far as JICA study team checked the historical bill for 62 households including 14 non-measured houses in Dr. JS Moroka LM, it was found that water tariffs were not charged to 38 houses in certain months.

Table 4.3.3 Current Status of Non-Revenue Water and Unaccounted-for Water

No.	Items	Data	Remarks
1.	Inflow to model block (L/day)	106,177	
2.	Water consumption measured in the pilot study (L/day)	87,595	48 houses
3.	Gap between inflow and water consumption (L/day) (1-2)	18,582	
4.	Water consumption rate that water leakage was observed inside the houses such as toilets (L/capita/day)	2,453	15 houses
5.	Total estimated water consumption applying average water consumption rate measured in the pilot study to 14 non-measured houses (L/day)	131,267	Applying 483L/capita/day
6.	Total estimated water consumption applying average water consumption rate measured except quite a little water consumption due to leakage inside the houses in the pilot study to 14 non-measured houses (L/day)	109,891	Applying 172.3L/capita/day
7.	Total estimated water consumption applying average water consumption rate (source: existing report) of Walkraal water system to 14 non-measured houses (L/day)	108,357	Applying 150L/capaita/day
8.	Total estimated water consumption applying design criteria of DWA for water consumption rate to 14 non-measured houses (L/day)	94,927	Applying 120L/capita/day

(2) Tweefontain-K, Thembisile Hani LM

JICA study team confirmed 188 households of model block, Tweefontain-K in the plan layout. However, As result of the survey, only one (1) house of 51 houses, which were observed in the field, has a water meter (see Table 4.3.4).

Table 4.3.4 Condition of Water Meters (Tweefontain K)

No.	Items	Households	%	
1	All the houses that are indicated in the plan drawings of model block area (Household size: 4.4persons)	188	100	-
2	Functional water meters	1	0.5	(2.0)
3	Deficiency of water meters	-	-	-
4	No surveyed due to the locked water meters	-	-	-
5	No water meters	50	26.6	(98.0)
6	No houses	137	72.9	-

Note: ( ) shows ratio in a case of denominator to be 51 households that were checked in the field.

(3) Moloto RDP, Thembisile Hani LM

This model block consists of 500 houses as indicated in the block drawings. We implemented a sample survey of house meters in this area because this area has intermittent supply for 2 days in one week (7 days). We experienced some difficulty trying to accumulate an accurate record of consumption per one day in this pilot area.

We surveyed the condition of 116 houses meters. Refer to Table 4.3.5.

Table 4.3.5 Condition of water meters in Moloto RDP

No	Items	Household	%
1.	All the house numbers of pilot area	500	
2.	Confirmed number of household composition (interview) Average household composition: 3.8 persons	140/500	28
3.	Total surveyed meter numbers	166/500	33.2
4.	Functional Water Meters	155/166	93.3
5.	No meter	5/166	3.0
6.	No surveyed due to locked water meters	6/166	3.6
7.	No stop meter after tap close	87/166	52.4
8.	Visible Leaks (includes wet soil condition)	98/166	59.0

Model block consists of 500 houses: we surveyed as a sample survey of 166 houses:

- 115 meters were in working condition
- 5 houses did not have a meter,
- 6 meters were not surveyed because they were locked

A noteworthy fact is measurement did not stop on 87 meters (52.4%) after water taps were closed in 166 houses. It shows there is possibility of internal leakage in 52.4% houses. However, we confirmed that most of the houses had a stop cock before the meter so that there was no internal leakage.

Table 4.3.6 Meter reading survey in Moloto RDP

No	Items	Household	%
1.	Total meter readings	121/500	
2.	Positive movement (plus direction)	85/121	70.2
3.	Negative movement (minus direction)	36/121	29.7
4.	Meter number of more than 1000L/D	16/85	18.8
5.	Average consumption per day except for the highest one.	1,294L/D	
6.	Average consumption per person (÷3.8)	340L/D	

The above is the meter reading survey result:

Table 4.3.6 shows the result of meter reading. 36 out of 121 meters checked: almost 30% of meters were turned to a minus direction. This can be explained by the misreading of the meter reader or abnormal reverse movement. All the meters were the revolving needle type and not digital meters. This results in misreadings by beginner meter readers who do not have enough training to read the revolving type meters.

4.4 Socio Economic Survey

4.4.1 Objectives

The objectives are to collect basic information on socio economic situations and actual water usage at household level in the survey areas and to figure out inhabitant awareness of water use and water services, and then to make efficient use of outcomes for improvement of water services in the Western Highveld region. In particular, indicators to be made known will be useful to evaluate the appropriateness of living standards of inhabitants, demand forecasting, water supply per person, water tariff and so forth, and also to provide recommendations on improvement of the services.

4.4.2 Survey Method

Method of survey is household survey by interview with questionnaire.

The study team selected specific areas in three communities, where unaccounted for water survey was or will be conducted, to ensure the consistency with this survey. The Table 4.4.1 below shows name of community, number of samples and survey period.

Table 4.4.1 Survey Areas, Number of Samples and Survey Period

	Name of Community	Local Municipality	No. of Samples	Survey Period	Remarks
1	Siyabuswa-B	Dr. JS Moroka	99	2011/4/09-11	Non-revenue water survey was already done.
2	Tweefontein-K	Thembisile Hani	108	2011/4/12-14	
3	Moloto	Ditto	100	2011/4/15-17	Not yet done.

4.4.3 Content of Survey and Results

Content of the survey is composed of the following items:

a. Household head, size and living conditions,
b. Household income and expenditure,
c. Water usage patterns,
d. Payment for water services,
e. Customer satisfaction,
f. People's Understanding, pay-for-services principle and willingness to pay, and
g. Toilet facilities

(1) Household Head, Size and Living Conditions

(a) Household Head and Size

Average household (HH) size in Siyabuswa-B, Tweefontein-K and Moloto is respectively 4.3, 4.3 and 4.6. Refer to Table 4.4.2.

Table 4.4.2 Household Head and Size

	Community	Head (%)		Ave.	Adult*1(%)		Underage (%)			HH Size
		Male	Female	Age	Male	Female	Male	Female	Infant	(persons)
1	Siyabuswa-B	54.5	45.5	50.9	26.5	31.2	13.0	13.5	15.8	**4.3**
2	Tweefontein-K	67.0	33.0	47.2	31.8	29.9	11.0	17.3	10.0	**4.3**
3	Moloto	55.1	44.9	50.2	27.8	34.8	12.4	9.6	15.4	**4.6**

*1：18 years old or over

Siyabuswa-B Tweefontein-K Moloto

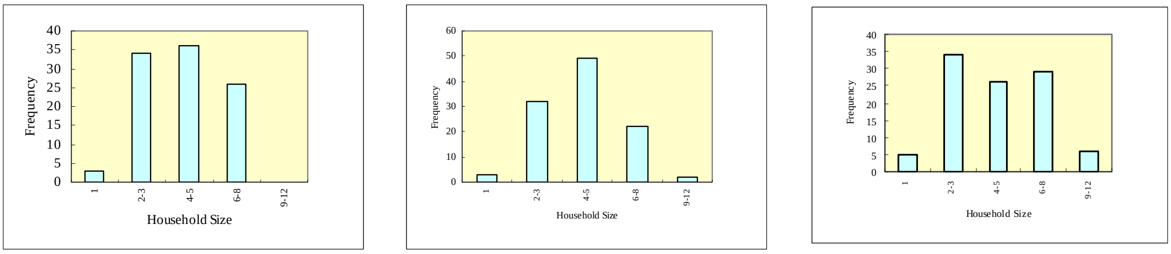


Figure 4.4.1 Frequency Distribution of Household Size

These outcomes are close to the average size reported by Community Survey 2007, 4.3 persons/ household in Dr JS Moroka LM and 4.2 in Thembisile Hani LM. The value of Moloto is a little higher but well acceptable.

(b) Type of Housing and Major Housing Material

Most of the surveyed households have their own house in all the surveyed areas, and houses of all the surveyed households in Siyabuswa-B and Tweefontein-K are masonry structures except Moloto having some houses made with zinc only or combined with masonry. Refer to Table 4.4.3

Table 4.4.3 Type of Housing and Major Housing Material

	Community	Type of House Holding (%)			Major Housing Material (%)		
		Owned	Rented	Other	Masonry	Zinc	Combination
1	Siyabuswa-B	94.9	4.1	1.0	100	0	0
2	Tweefontein-K	94.4	4.7	0.9	100	0	0
3	Moloto	98.0	1.0	1.0	69.7	22.2	8.1

The reason why housing material in Moloto is different from others is because it has more low-income households than other two. Refer to the section 4.4.6 below.

(c) Living Facilities and Equipment, and Basic Public Services (except Water)

In all three (3) areas, most of the surveyed households are equipped with toilet, electricity, TV and refrigerator. Possession of propane gas, vehicle, washing machine, etc varies in degree by area (see Table 4.4.4).

Table 4.4.4 Living Facilities and Equipment, and Basic Public Services

	Community	Living Facilities and Equipment, and Basic Public Services [*1] (%)									
		Water Storage	Toilet	Electricity	Generator	Telephone	Gas	Vehicle	TV	Fridge	Wash Machine
1	Siyabuswa-B	1.0	100.0	100.0	0.0	4.0	9.1	33.3	92.9	96.0	44.4
2	Tweefontein-K	0.0	97.2	99.1	2.8	4.6	45.4	63.0	98.1	98.1	74.1
3	Moloto	15.2	87.9	93.9	3.0	0.0	4.0	25.3	94.9	90.9	34.3

*1: Multiple answers

The possession degree of propane gas, vehicle, washing machine, etc increases in proportion to average household income. Refer to the section 4.4.6.b below.

(2) Household Income and Expenditure

(a) Employment Rate and Income Sources

Employment rate[*1] in Siyabuswa-B, Tweefontein-K and Moloto is respectively 24.4%, 45.7% and 31.7%. And employment rate by household[*2] is respectively 60.6%, 95.4% and 70.0%, stated differently, the households which have no employed member are respectively 39.4%, 4.6% and 30.0%. Refer to Table 4.4.5

Income sources are mostly salary by employment or self-employment as a labor income, and subsidy such as pension and child care allowance as a non-labor income. In particular, 21.2% and 19.0% of the surveyed households respectively in Siyabuswa-B and Moloto rely on non-labor incomes only.

Table 4.4.5 Employment Rate and Income Sources

	Community	Employ. Rate (%)		Income Sources of Income gain Household*3 (%)				Non-labor Income gain Household (%)
		People*1	HH*2	Employed	Self-Employed.	Subsidy	Remittance	
1	Siyabuswa-B	**24.4**	**60.6**	54.5	8.1	34.3	7.1	21.2
2	Tweefontein-K	**45.7**	**95.4**	81.5	20.4	14.8	0.0	2.8
3	Moloto	**31.7**	**70.0**	65.0	9.0	49.0	3.0	19.0

*1: Proportion of working population in productive-aged population (15–64 years old) of the surveyed households
*2: Proportion of working household having a working member or more in the surveyed households
*3: Multiple answers

The household size obtained in this survey is categorized into adult population (18 years old or over) and underage population, so the study team estimated productive-aged population (15–64 years old) necessary for calculating employment rate, with national productive-aged population ratio "65.8%" estimated in the CIA World Fact Book 2011. If not productive-aged population but adult population obtained in this study is applied for calculating adult employment rate in each area is respectively 27.9%, 48.8% and 33.3%.

For reference, the estimated national unemployment rate in South Africa in 2011 is 24.4% according to World Economic Outlook, October 2010 of the International Monetary Fund. This indicates that the employment rate in the survey areas is at a much lower level, and the households depend on limited incomes of employed member/s.

(b) Average Monthly Household Income (among Income gain Households only)

Average monthly household income among income gain households only in Siyabuswa-B, Tweefontein-K and Moloto, which were calculated separately divided into labor and non-labor incomes, is respectively ZAR5,110, ZAR8,132 and ZAR3,513. Proportion of non-labor income in average household income is respectively 17.8%, 6.9% and 23.1%. For reference, average monthly household income among the total surveyed households is respectively ZAR2,904, ZAR7,303 and ZAR2,296. Refer to Table 4.4.6 and Figure 4.4.2.

Table 4.4.6 Average Monthly Household Income
(among Income gain Households and effective answers only)

	Community	Average Monthly HH Income (ZAR)			Proportion of Non-Labor Income (%)	
		Labor*1	Non-Labor *2	Total	in income	in expenditure*3
1	Siyabuswa-B	4,199	911	**5,110**	17.8	27.1
2	Tweefontein-K	7,570	561	**8,132**	6.9	10.2
3	Moloto	2,701	812	**3,513**	23.1	30.7

*1: Labor income by wage or salary by employment or self-employment
*2: Non-labor income by remittance or government subsidy such as pension (ZAR1,060), child care allowance (ZAR260)
*3: Refer to the following section of household expenditure.

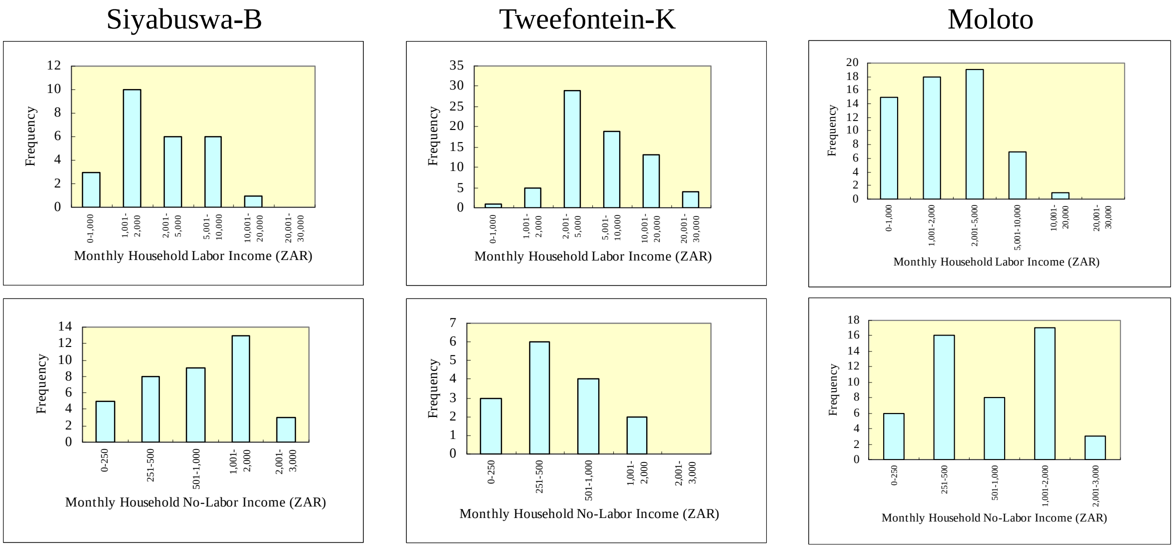


Figure 4.4.2 Frequency Distribution of Labor Income (Upper) & Non-Labor Income (Lower)

The income amount related to money should be used as reference by comparing the expenditure mentioned below, because of difficulty in acquisition of correct information and also insufficient valid answers such as 26, 71 and 60 for labor incomes and 38, 15 and 50 for non-labor incomes in each area respectively. The expenditure amounts are as follows, and proportion of non-labor income in expenditure is 27.1%, 10.2% and 30.7% in each area respectively.

According to World Economic Outlook, October 2010 of the International Monetary Fund, nominal GDP per person of South Africa in 2010 is estimated at US$7,101 equaling about ZAR3,900 per person per month by the exchange rate of US$1=ZAR6.6.

(c) Average Monthly Household Expenditure

Average monthly household expenditure in Siyabuswa-B, Tweefontein-K and Moloto is respectively ZAR3,358, ZAR5,507 and ZAR2,645. Refer to Table 4.4.7.

Table 4.4.7 Average Monthly Household Expenditure

	Community	Average Monthly Household Expenditure (Upper:ZAR,. Lower:%)										
		Water	Elect.	Cook Fuel	Cloths	Food	Transp't	Comm.	Medical	Educat.	Vehicle	Total
1	Siyabuswa-B	162	193	76	678	673	414	134	417	612	0	**3,358**
		4.8	*5.7*	*2.3*	*20.2*	*20.0*	*12.3*	*4.0*	*12.4*	*18.2*	*0.0*	*100.0*
2	Tweefontein-K	224	290	90	826	898	555	221	805	651	946	**5,507**
		4.1	*5.3*	*1.6*	*15.0*	*16.3*	*10.1*	*4.0*	*14.6*	*11.8*	*17.2*	*100.0*
3	Moloto	0	156	66	591	679	419	104	276	354	0	**2,645**
		0.0	*5.9*	*2.5*	*22.3*	*25.7*	*15.8*	*3.9*	*10.4*	*13.4*	*0.0*	*100.0*

In this survey, average monthly household expenditure is combined by all average expenditures on each item, so expenditures on furniture, housing and loan of all areas and vehicle of Siyabuswa-B and Moloto were excluded due to limited samples or insufficient valid answers.

Although it is the average of valid answers by the households paying for water, expenditure on water accounts for more than 4% of total expenditure

(d) Household Savings

34.7%, 64.4% and 22.4% of the surveyed households save up in respectively Siyabuswa-B, Tweefontein-K and Moloto. Refer to Table 4.4.8.

Table 4.4.8 Household Savings

	Community	Household Savings (%)	
		Yes	No
1	Siyabuswa-B	34.7	65.3
2	Tweefontein-K	64.4	35.6
3	Moloto	22.4	77.6

(3) Water Usage Patterns

(a) Potable Water

In all three (3) areas, most of the surveyed households use tap water for drinking. Refer to Table 4.4.9.

Table 4.4.9 Access to Potable Water

	Community	Type of Access to Potable Water *1 (%)					
		House *2	Water Truck	Rain	Comm. Tap	Neighbor	Other
1	Siyabuswa-B	**98.9**	0.0	0.0	0.0	1.1	0.0
2	Tweefontein-K	**100.0**	0.0	0.0	0.0	0.0	0.0
3	Moloto	**92.8**	1.0	0.0	1.0	5.2	1.0

*1: Multiple answers
*2: House connection to in-house or yard

(b) Water Service Level and Per Capita Consumption (Per Capita Supply)

In all three (3) areas, water service level is mostly in-house or yard connections for the surveyed households.

Through these individual connections, the average consumption is 116.9 liter/capita/day (LCD), 160.0 LCD and 76.0 LCD in Siyabuswa-B, Tweefontein-K and Motolo respectively. The average consumption is calculated with total household consumption inclusive of water for drinking/cooking, washing, bathing and toilet, divided by household size. Refer to Table 4.4.10.

Proportion of the households using water for gardening in the surveyed households is 57.1%, 26.2% and 10.0% in Siyabuswa-B, Tweefontein-K and Moloto respectively. Average consumption for gardening is respectively 248.1lit, 197.2lit and 192.1lit per household per day.

Table 4.4.10 Water Service Level and Average Consumption

	Community	Water Service Level*1 (%)			Q	Consumption for Garden	
		In-House	Yard	Comm. Tap	(LCD)	HH (%)	Q (L/D)
1	Siyabuswa-B	43.8	62.9	2.2	**116.9**	57.1	248.1
2	Tweefontein-K	96.2	24.0	0.0	**160.0**	26.2	197.2
3	Moloto	16.1	88.2	2.2	**76.0**	10.0	192.1

*1: Multiple answers

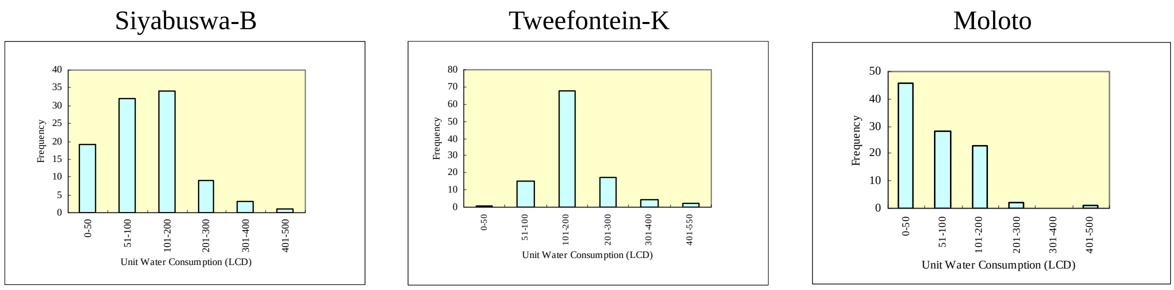


Figure 4.4.3 Frequency Distribution of Per Capita Consumption

As a result, the degrees of service level and average consumption have proportional relationship each other, and together with improvement of living facilities and equipment and also household incomes. Concerning lower average consumption in Moloto, the current poor water supply has probably caused it in Moloto located in the west end of Thembisile Hani LM.

For reference, the constitutionally-guaranteed minimum water supply in South Africa is 25 LCD, and Western Highveld Water Augmentation Pre-feasibility Study, February 2005 reported the average water supply including unaccounted for water by supply scheme as follows. Refer to Table 4.4.11.

Table 4.4.11 Comparison of Average Supply with Average Consumption

Scheme or Community	Average Supply (UFW inclusive) (LCD)	Average Consumption in this survey (LCD)
Northern Scheme	152.8	-
Waklraal SSS	172.3	-
1 Siyabuswa-B	-	116.9
Bloedfontein SSS	80.4	-
Kameelrivier SSS	162.3	-
Weltevreden / Kuilen SSS	275.6	-
Southern Scheme	180.2	-
2 Tweefontein-K	-	160.0
3 Moloto	-	76.0
Average in Total	162.7	117.6

(c) Water Meter, Leakage and Wastage

Proportion of the households having water meter installed in the surveyed areas is 96.9%, 74.3% and 76.6% respectively in Siyabuswa-B, Tweefontein-K and Moloto. Except Moloto, installed water meters function without fault. Refer to Table 4.4.12.

36.5%, 22.8% and 10.8% of the surveyed households acknowledged the leaks and wastage from pipes within house or in their property, in respectively Siyabuswa-B, Tweefontein-K and Moloto.

Table 4.4.12 Water Meter, Leakage and Wastage

	Community	Water Meter (%)		Meter Function (%)		Water Leakage & Wastage	
		Existence	Non-Existence	Yes	No	Yes	No
1	Siyabuswa-B	96.9	3.1	95.8	4.2	36.5	63.5
2	Tweefontein-K	74.3	25.7	96.1	3.9	22.8	77.2
3	Moloto	76.6	23.4	25.0	75.0	10.8	89.2

Function of water meters was not confirmed visually in this survey, so the results may not represent the actual conditions of water meters, as well as water leakage and wastage because of people's low consciousness of conserving water in South Africa. It is not known if the respondents have correct awareness of water leakage and wastage.

(4) Payment for Water Services

In Siyabuswa-B, while most of the surveyed households are billed for water, 42.3% of the surveyed households pay for it. The amount of payment is averagely ZAR161 per month. Refer to Table 4.4.13.

In Tweefontein-K, while 38.8% of the surveyed households are billed for water, 35.7% of the surveyed households pay for it. The amount of payment is averagely ZAR217 per month.

In Moloto, most of the surveyed households are not billed and do not pay for water.

Concerning the impression of water tariff among the households billed, the households do not always regard it as expensive in the survey areas except Moloto where tariff has not been collected.

Table 4.4.13 Payment for Water Services

	Community	Billed (%)		Payment (%)		Ave. Amount *1	Impression on Tariff (%)*2			
		Yes	No	Yes	No	(ZAR/month)	cheap	fair	high	N/A
1	Siyabuswa-B	86.6	13.4	42.3	57.7	**161**	18.0	36.0	28.0	18.0
2	Tweefontein-K	38.8	61.2	35.7	64.3	**217**	2.9	71.4	20.0	5.7
3	Moloto	2.1	97.9	1.1	98.9	-	0.0	0.0	0.0	100.0
3	Moloto	2.1	97.9	1.1	98.9	-	0.0	0.0	0.0	100.0

*1: Among the households having paid. As a result of question about water tariff only here, expenditures on water differ from them obtained in section 4.4.6 c but they are nearly same amount.

*2: Part of the households billed

(5) Customer Satisfaction

(a) Customer Satisfaction with Water Services

Customer satisfaction is generally high in the survey areas except Moloto where 27.6% were resulted in because of damage of transmission pipeline to Moloto reservoir and consequently interrupted or intermittent supply. Refer to Table 4.4.14. Water supply in Moloto has been unstable according to the person in charge in LM.

Table 4.4.14 Customer Satisfaction with Water Services

	Community	Customer Satisfaction (%)	
		Yes	No
1	Siyabuswa-B	**87.4**	12.6
2	Tweefontein-K	**90.2**	9.8
3	Moloto	27.6	**72.4**

(b) Reasons of Dissatisfaction with Water Services

In Moloto where customer satisfaction is lower, they stated mainly interrupted supply and poor services as the reasons for their dissatisfaction, and also low pressure, weak flow, taste, smell and color. Refer to Table 4.4.15.

In other two (2) areas where customer satisfaction is higher, some households, which showed dissatisfaction, stated taste, smell, color, water price and poor service were reasons for dissatisfaction.

Table 4.4.15 Reasons of Dissatisfaction with Water Services

	Community	Reasons of Dissatisfaction *1(%)									
		Low Pressure	Weak Flow	Intermittent Supply	Leakage	Water Outage	Taste	Smell	Color	Price	Poor Services
1	Siyabuswa-B	0.0	0.0	8.3	8.3	8.3	41.7	33.3	50.0	25.0	58.3
2	Tweefontein-K	10.0	0.0	10.0	0.0	0.0	10.0	10.0	30.0	0.0	70.0
3	Moloto	21.9	39.1	10.9	1.6	64.1	32.8	21.9	21.9	0.0	59.4

*1: Multiple answers

(6) People's Understanding, Pay-for-Services Principle and Willingness to Pay

(a) People's Understanding of Water Services

50.5%, 65.7% and 31.0% of the surveyed households know local municipality as a Water Service Provider correctly in Siyabuswa-B, Tweefontein-K and Moloto respectively. Refer to Table 4.4.16.

31.3%, 36.1% and 20.0% of the surveyed households recognize water treatment works correctly, which have provided water, in Siyabuswa-B, Tweefontein-K and Moloto respectively.

13.1%, 19.4% and 25.0% of the surveyed households recognize free basic water in Siyabuswa-B, Tweefontein-K and Moloto respectively. And only 9.1%, 11.7% and 6.0% of the surveyed households understand the mechanism of free basic water correctly.

Table 4.4.16 People's Understanding of Water Services

	Community	WSP (%)		WTWs (%)		FBW (%)		FBW Mechanism (%)	
		Correct	False	Correct	False	Yes	No	Correct	False
1	Siyabuswa-B	50.5	49.5	31.3	68.7	13.1	86.9	9.1	90.9
2	Tweefontein-K	65.7	34.3	36.1	63.9	19.4	80.6	11.7	88.3
3	Moloto	31.0	69.0	20.0	80.0	25.0	75.0	6.0	94.0

Local municipalities are not sufficiently recognized as Water Service Providers, as well as water treatment works in relation to water tariff. Siyabuswa-B is located adjacent to a treatment works.

Furthermore, despite a decade from the introduction of free basic water policy, the system and mechanism have not been recognized in all the survey areas.

(b) Pay-for-Services Principle and Willingness to Pay for Water Services

69.2%, 71.9% and 40.4% of the surveyed households approve pay-for-services principle in Siyabuswa-B, Tweefontein-K and Moloto respectively. Refer to Table 4.4.17.

83.2%, 88.4% and 59.2% of the surveyed households are willing to pay for water services in Siyabuswa-B, Tweefontein-K and Moloto respectively.

Table 4.4.17 Pay-for-Services Principle and Willingness to Pay for Water Services

	Community	Pay-for-Services Principle (%)		Willingness to Pay for Water Services (%)	
		Approval	Not Approval	Yes	No
1	Siyabuswa-B	69.2	30.8	83.2	16.8
2	Tweefontein-K	71.9	28.1	88.4	11.6
3	Moloto	40.4	59.6	59.2	40.8

Regardless of facts of payment for water services obtained in the section 4) above, they have high awareness of pay-for-services principle and high willingness to pay. But, the current poor water supply has probably caused their lower awareness in Moloto.

In spite of high awareness, however, when water tariff is collected aggressively or forcibly, their awareness may be weakened unless water is supplied stably and evenly. Therefore, multifaceted and drastic approach is essential such as optimization and renovation of water supply services in terms of technology, operation and maintenance, water demand management, measures on unaccounted for water, awareness-rising activities and so on.

(7) Toilet Facilities

(a) Type of Toilet Facilities

Flush toilet inside or outside of house are popular in Siyabuswa-B and Tweefontein-K, but ordinary pit latrine and VIP latrine or shared one in Moloto. Refer to Table 4.4.18.

Table 4.4.18 Type of Toilet Facilities

	Community	Type of Toilet Facilities [*1] (%)					
		No toilet	Flush inside	Flush outside	VIP	Ordinary Pit	Shared
1	Siyabuswa-B	0.0	51.5	65.7	0.0	0.0	0.0
2	Tweefontein-K	0.0	95.3	6.6	0.0	0.0	0.0
3	Moloto	1.0	5.1	2.0	34.3	47.5	15.2

*1: Multiple answers

(b) Problem Awareness of Toilet Facilities

73.7% of the surveyed households have no problem with toilet, but 19.2% stated water leakage and wastage as a reason for problem with toilet in Siyabuswa-B. Refer to Table 4.4.19.

Most of the surveyed households have no problem with toilet in Tweefontein-K.

34.0% of the surveyed households have no problem with toilet, but others stated insect and smell as reasons for problem with toilet in Moloto because of types of toilets.

Table 4.4.19 Problem Awareness of Toilet Facilities

	Community	Problems with Toilet[*1] (%)						
		No problem	No water	Insect	Smell	Blockage	Full	Leakage/ Wastage
1	Siyabuswa-B	73.7	1.0	0.0	0.0	6.1	0.0	19.2
2	Tweefontein-K	95.2	0.0	0.0	0.0	1.0	0.0	2.9
3	Moloto	34.0	2.1	34.0	44.3	0.0	6.2	1.0

*1: Multiple answers

CHAPTER 5 CONSUMER MANAGEMENT

5.1 Water Demand Management

According to WHR FS, water demand of the Western Highveld Region for year 2010 was forecasted as 96,194 m^3/day against the current supply capacity of 130,000m3/day. The capacity is, therefore, by approximately 33,000m^3/day higher than the water demand.

DWA sets out water consumption rates by the water service levels or the types of connections such as house connection, yard connection and public tap. Their water consumption volumes are 120, 60, 25 liter/capita/day respectively. Their weighted average water consumption will be 55 liter/capita/day against the 167 liter/capita/day average current supply flow that is by 112liter /capita /day greater than the average consumption. Table 5.1.1 shows the current supply of water and estimated water consumption per capita per day with variety of assumed rates of unaccounted-for water (UFW). Suppose that average water consumption of some 60 liter/capita/day is required in the Western Highveld Region, this table indicates that rate of unaccounted-for water[1] may be around 60 percent.

Causes of the unaccounted-for water are as follows:

- Leakage from water supply facilities including treatment works, transmission and distribution network, etc.
- Leakage from in-house plumbing and utensils like flush toilet, kitchen sink, etc.

In this pilot study, water leakage observed was almost 10 percent through a sampled pipeline with length of approximately 3.5km, which corresponds to 5 percent of all the pipeline length of 683 km in the Western Highveld Regional Water Supply Scheme. On the other hand, however, some municipalities claim their leakage from pipeline is almost 30 - 40 percent and others claim 50 - 60 percent. Judging from current situation of chronic water rationing, it is likely that supply may be in short somewhere sometime due to large amount of leakage. There is a high possibility that frequent water leakage occurs on water supply system in Western Highveld region. Accordingly, it is essential issues that water leakage detection should systematically be carried out based on such information as installed year and pipe materials of the existing pipelines.

Meanwhile, as was learned in the pilot study, there is also high possibility of large leakage within the consumers' houses, where connections are not metered. The presently supplied volume of water is extremely high compared with actually consumed water. If leaks inside the houses are reduced by repair, it will be possible to reduce the volume of supply. Accordingly, it is considered that development of new water sources will be next issue after reduction of water leakage.

Table 5.1.1 Estimated Per-Capita Consumption with Varied Rates of UFW Assumed

Items		Data
Served population[*1]		777,600
Current water supply (m^3/day)		130,000
Estimated water consumption with assumed rates of unaccounted-for water (liter/capita/day)	Ratio of unaccounted-for water: 0%	167
	Ratio of unaccounted-for water: 25%	125
	Ratio of unaccounted-for water: 40%	100
	Ratio of unaccounted-for water: 50%	84
	Ratio of unaccounted-for water: 60%	67
Average water consumption rate (for reference)[*2]		55

Note:
*1: Population served through house connections, yard connections and public taps
*2: Average water consumption estimated based on design criteria of DWA
Source: IR Report and calculation by JICA study team

Reduction of unaccounted-for water including physical leakage is one strong measure of the water

[1] Unaccounted-for Water: This includes not only water leakage from water supply facilities such as transmission, distribution pipelines, etc., but also from in-house plumbing, flush toilet, etc.

demand management in its broad sense. It is of importance very much to reduce water loss so as to resolve the water shortage.

5.2 Free Basic Water Policy and the Pre-paid Water Meter

At the outbreak of the cholera epidemic, with over 100,000 cases in the year 2000, the African National Congress (ANC) promised the free basic water policy during the local government election campaign. In July 2001 a revised tariff structure was suggested that included 6 m^3 (6,000 liters) of free water per month per household. That is 40 liters/capita/day for a 5 member household or 25 liters/capita/day for an 8 member household. The policy, however, was a challenge to many water service providers, which are local municipalities. Since the water tariff table / structure are what should be sanctioned only by the local municipal councils, the policy was not practiced immediately by all the local municipalities, and still is in the course of being applied gradually and partially.

Particularly in the Western Highveld Region, political propaganda or official paperwork on the free basic water (FBW) was barely mentioned. The basic idea of FBW or a give-the- minimum-water to the poor spirit is broadly exercised. Examples are free supply up to 10 m^3 /month for the poor (Dr. JS Moroka LM), no charge from anyone (Sekhukhune DM), collect from the affordable only (Thembisile Hani LM), neglect of meter reading and billing, etc. In many municipalities in the Region, consumption (meter) based billing system is not always legalized, and the municipal offices have insufficient manpower to canvass all the installed water meters regularly.

Pre-paid meters, which cut off water supply above the 6 m^3 per month limit if no payment is made, were introduced in Johannesburg, in Soweto, and in other cities as part of management contracts with private operators. These meters sparked substantial protests in poor neighborhoods, particularly in Phiri. In Johannesburg they were maintained even after the management contract expired in 2005. While pretesting against the pre-paid meters, residents of Phiri appealed the case in the legal procedure. In April 2008 the South African High Court ruled this practice unconstitutional, and decided that denying the poor access to adequate water “is to deny them the rights to health and to lead a dignified lifestyle.” Further, the judge stated that “25 liters per person per day is insufficient for the residents of Phiri,” and ordered the city to provide free basic water in the amount of 50 liters per person per day with the option of an ordinary credit-metered water supply (instead of pre-paid) for more use. The Court apparently assumed a household size of eight. In October 2009, however, the Constitutional Court overturned the case and declared pre-paid meters to be lawful.

While expanding the area of pre-paid meter installed, the Johannesburg Water Authority carried out, with its own budget, the leak reduction works including repair of in-house plumbing, particularly of the toilets, which was the largest source of leakage. According to what was explained by the Johannesburg Water, due to growth of earning derived from thus reduced leakage or unaccounted-for water, costs spent for repair of in-house plumbing were recovered, and the ratio of accounted-for water has been improved greatly.

5.3 Consumer Metering and Billing

With guidance and assistance by DWA, installations of water meters have been progressed in the Western Highveld Region since 2004. Extent of installations and their operation, i.e., reading and billing vary by much depending upon capacity and circumstances given to each municipality.

5.3.1 Kungwini Local Municipality

Kungwini LM has 100 percent meters installed. In Ekangala Township, a part of the Western Highveld Regional Water Supply Scheme, however, has 10 to 20 percent of meters not working. All these meters are read monthly and billed based upon these meter readings. The payment rate is less than 5 percent of billed amount, but no credit control or supply control (restriction or suspension) is applied.

5.3.2 Thembisile Hani Local Municipality

The municipality has meters installed on about 50 percent of yard connections, but none are read or billed based upon these meter readings. It has recently started to bill customers based on fixed rate per month. A number of meters have recently installed to non-domestic customer connections with which the municipality has started billing. The payment rate is around 3 percent of billed amount, but no credit control or supply control (restriction or suspension) is applied. A key issue here is a development of the organized customer ledger (database), upon which meter reading, billing, payment record and credit control may be enabled.

5.3.3 Dr. JS Moroka Local Municipality

This municipality has some 5,000 meters installed in villages where customers have waterborne sanitation, but it will still be needed to set up a completely organized meter database, after which the regular meter reading and billing may become possible. With shortage of human resources and hence the basic data that make organized database applicable, only irregular and sporadic meter reading and billing are being tried

5.3.4 Sekhukhune District Municipality

Sekhukhune has some meters installed in some villages where customers have waterborne sanitation, but it still needs to set up a complete meter debtor database, after which regular reading and billing can start. It is a possibility to implement bulk water supply control, i.e., to restrict supply to a village by using a metering system that will close after a preset quota for the day is surpassed. At the moment, no billing is implemented to any customers in two municipalities within the Western Highveld Region.

5.4 Tariffs and Credit Control

A proposed water tariff table so far obtained from Dr. JS Moroka LM is shown in Table 5.4.1. Customers are classified into 5 categories, of which three are further divided depending on degrees of richness / poverty. Incremental curves of tariff per consumption are shown in Figure 5.4.1.

Table 5.4.1 Proposed Tariff Table - Dr. JS Moroka LM

Business and Government Departments	Non-profit organizations, Schools, Crèches & Churches	Residential	Destitute Indigent	Indigent
R36.23 basic charge	R24.16 basic charge	R12.68 basic charge	Nil basic charge	Nil basic charge
R3.57 per m^3	0 - 10 m^3 = R1.69	0-10 m^3 = R1.69	0-10 m^3 = free	0-6 m^3 = free 7-10 m^3 = R1.69
	11 - 20 m^3 = R2.00	11 - 20 m^3 = R2.00	11 - 20 m^3 = R2.00	11 - 20 m^3 = R1.75
	21 - 30 m^3 = R2.11	21 - 30 m^3 = R2.11	21 - 30 m^3 = R2.11	21 - 30 m^3 = R2.11
	31 - 40 m^3 = R2.24	31 - 40 m^3 = R2.24	31 - 40 m^3 = R2.24	31 - 40 m^3 = R2.24
	40 m^3 + = R2.29	40 m^3 + = R2.29	40 m^3 + = R2.29	40 m^3 + = R2.29
Flat Rate Tariff (not metered) R54.70 per month	Flat Rate Tariff (not metered) R47.88 per month	Flat Rate Tariff (not metered) R19.37 per month	Flat Rate Tariff (not metered) R0.00 per month	Flat Rate Tariff (not metered) R18.23 per month
Availability Charge (not connected) R23.93 per month	Availability Charge (not connected) R23.93 per month	Availability Charge (not connected) R23.93 per month	Availability Charge (not connected) R23.93 per month	Availability Charge (not connected) R23.93 per month
Water Tankering R96.86 per tanker within 10km radius plus R5.70 per km for distances more than 10 km	Water Tankering R96.86 per tanker within 10km radius plus R5.70 per km for distances more than 10 km	Water Tankering R96.86 per tanker within 10km radius plus R5.70 per km for distances more than 10 km	Water Tankering R96.86 per tanker within 10km radius plus R5.70 per km for distances more than 10 km	Water Tankering R96.86 per tanker within 10km radius plus R5.70 per km for distances more than 10 km

Water connection:
Business and Government Departments: R 542.00
Non profit organization, schools, crèches, and churches: R 342.00
Residential: R 57.00

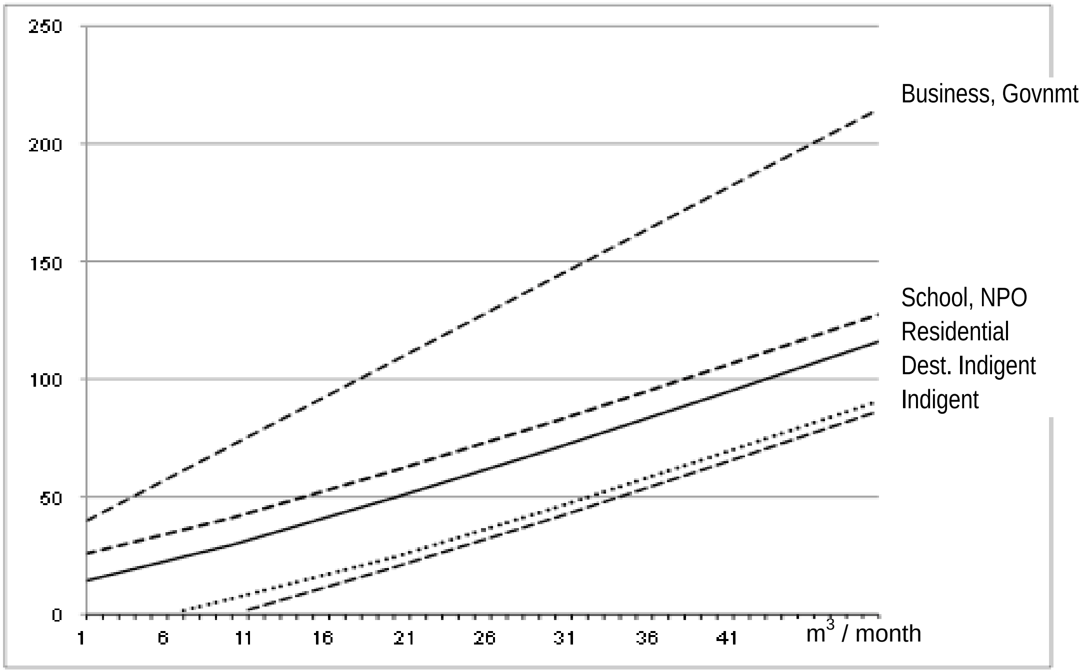


Figure 5.4.1 Incremental Tariff per Monthly Consumption

It is the fact that more than 90 percent of customers / residents are defaulters for the water services which they are endlessly accredited to be provided without factual collateral, but, upon some solid historical grounds that are not explicitly acknowledged.

It is noted that the general income level in this area is low, which means that little cash can be generated from domestic customers. The main purpose of metering under these circumstances is not to generate revenue as such, but rather to identify and check problematic (high) consumers and to address and control them, as and when required. If such measures are possibly taken, the equitable and minimum-required volume of water can be supplied as shown in the supply / demand forecast. Another hint may be adoption of much more steeply incremental tariffs such as of the logarithmic curve than rather broadly curved tariffs shown in Table 5.4.1 and Figure 5.4.1.

If the new tariff and billing system, that is based on the meter-measured consumption, is acknowledged by the public, the richer households tend to consume more, it can be said, than the less rich. Whereas a steeply incremental, that may be near to the logarithmic curve, tariff will be able to be implemented. It will be a very good tariff structure, as it will (1) check and save any over consumption for wasteful use of water, (2) redistribute the income from the rich to the poor in a sense, and (3) increase the billed amount and then possible revenue to the water supply service provider.

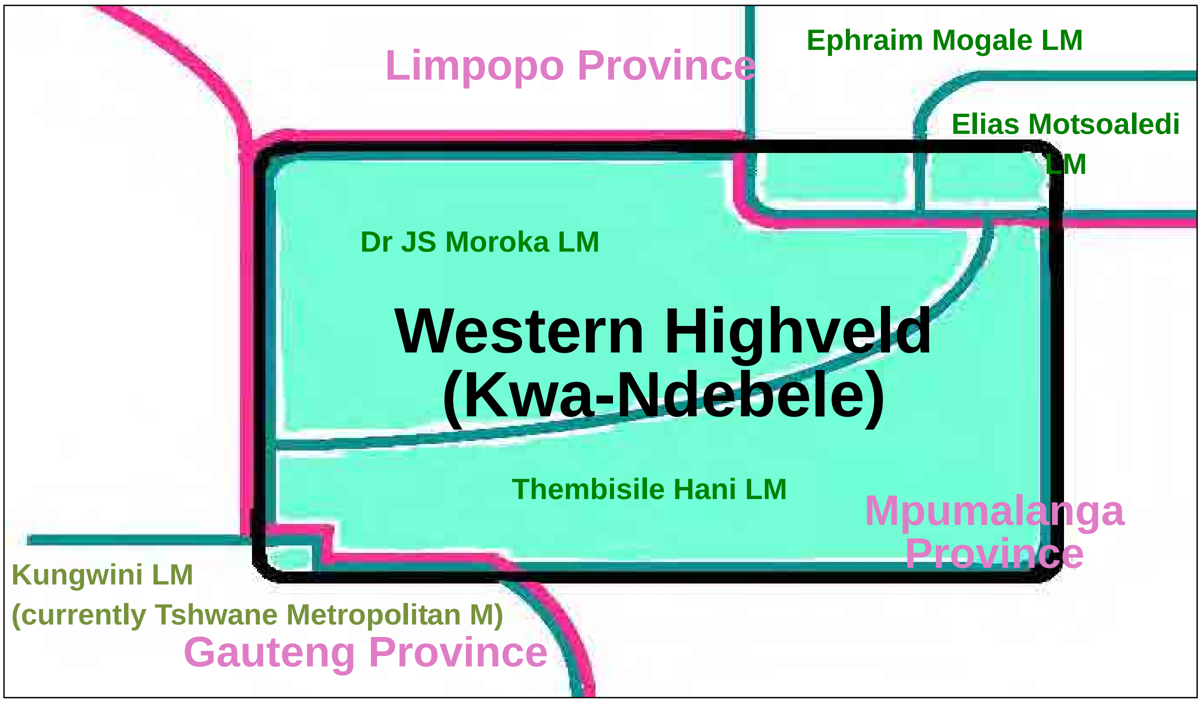
CHAPTER 6 INSTITUTIONAL SETUP AND CAPACITY

6.1 Brief History and Socioeconomic Background

The area to be studied by this Special Assistance for Project Sustainability (SAPS) commissioned by Japan International Cooperation Agency (JICA) is the Western Highveld Region. It is, however, not a local region demarcated and defined by the present Local Government Act. It has hence no single local administrative body (municipal office) to administrate or govern itself as a whole.

It was named Kwa-Ndebele Homeland or Bantustan, one of the infamous segregation enclaves, to which all the black ethnic groups or the assumed to be so were forced to immigrate from the 1960's. It was not a territory of South Africa, or claimed to be so. Pseudo independence as well as government was also forced upon them. The thus created Government of Kwa-Ndebele operated the whole system of the Kwa-Ndebele Water Supply Scheme in those days.

In the course of democratization with the fading segregation policy in 1990's, it came to be fragmented into five local municipalities belonging to three separate Provinces of South Africa by a new Local Government Act.



Note: The Region (ex homeland) boundary, Local Municipality and Provincial boundary

Figure 6.1.1 Western Highveld Region (Kwa-Ndebele) Fragmented into 5 LMs

Thus it was fragmented into:

An entire Dr. JS Moroka local municipality and
An entire Thembisile Hani local municipality under Mpumalanga Province, and
A small part of Ephraim Mogale local municipality and
A small part of Elias Motsoaledi local municipality under Sekhukhune district municipality of Limpopo Province, and
A tiny part of Kunwini local municipality (now part of Tshwane Metropolitan Municipality) under Gauteng Province.

The Western Highveld Region, even if it was renamed, is not any of legal existence now. Its ethnic demography, however, barely changed, and no significant developments in its socioeconomy were achieved even after introduction of the Black Economic Empowerment policy in 2004. It is therefore very difficult to deny that the Western Highveld Region stays as one contiguous and homogeneous area clearly distinguished from others. Majority of the working population have only two options to maintain the marginal farm or pasture, or to get jobs in the large cities sometime very remote.

The Government of Kwa-Ndebele was forcibly organized during the homeland era. This government was the single integrated operator of the Region (homeland) wide water supply scheme that connected a part of supply from the Bronkhorstspruit water treatment plant and the whole supply from the Weltevreden water treatment plant with some additional supply from boreholes. Since 1994, the authority of domestic water supply was mandated to each local municipality (LM), and the one inseparable scheme came to be partially owned and being separately operated by three (Kungwini, Thembisile Hani and Dr. JS Moroka) LM's and Sekhukhune district municipality (DM), that contains two LM's within itself in Limpopo Province.

6.2 The Institutional Capacity of the Moment

6.2.1 Technical Department Operating Facilities and Equipments

According to the guidelines by DWA, the water authority is mandated to the local municipality. A local municipality may appoint, employ or contract a water service provider/s. All three LM's and a DM relevant to the Western Highveld Regional Water Supply Scheme have their own Water and Sanitation Divisions under the Technical or Infrastructure Departments operate as the water service operators without exception. None of these municipalities have outsourced or contracted operator or service provider.

The few organization charts so far obtained from some municipalities revealed that most of Directors of Departments as well as Managers of Divisions are vacant and the deputy or the acting chief is presiding over each department or division. Vacancies occur, it is observed, more on the higher and responsible posts, but such vacancies are not limited in only higher posts, but at many positions along layers of hierarchy of the municipal offices including the water divisions. It may be reckoned that 40 to 60 percent of the municipal posts are left vacant. Due to the aforementioned Black Economic Empowerment policy, it could be understandable, liquidity of qualified or competitive black manpower was heightened quickly, and closeness to the huge private job marketplaces accelerated the brain drains.

Administering thus understaffed taskforces, the deputy / acting managers of the water and sanitation divisions are, observably, paying utmost efforts to operation and maintenance of facilities and equipments. They are in fact overseeing and responsible for the technical side of water supply service. They have, at the same time, no responsibility for the financial side.

6.2.2 Financial Department Reading Meters, Billing and Collecting Tariffs

It may be common practice in the local governments in South Africa that the revenue division of the financial department of the municipal office collects all the revenue including rates and tariffs. In all the municipalities in this region, the revenue divisions have meter readers, whose members look insufficient in many cases for number of meters to read regularly. Some divisions are now developing a customer registry database for more organized billing and collection of water tariff as well as debt control. They are in charge of the financial side of water supply service and nothing to do with the technical side. One division under the financial department and another division under the technical department are independent from each other and very distantly organized in a municipal office.

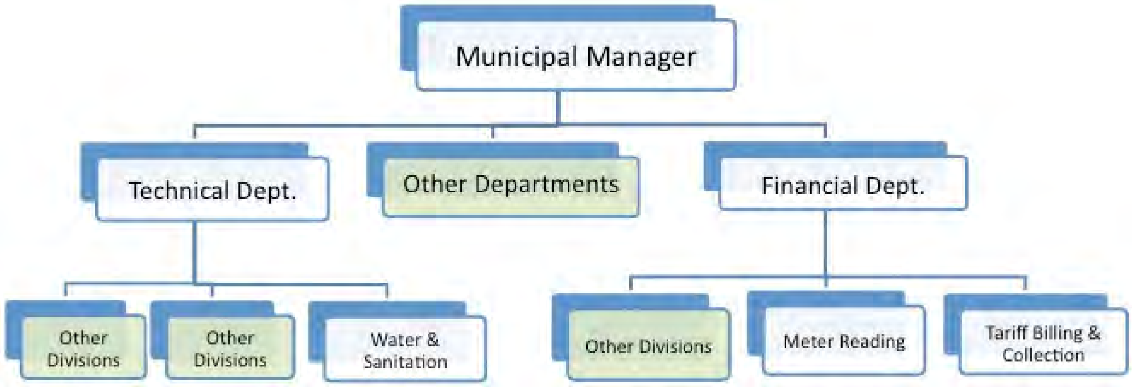


Figure 6.2.1 Typical Organization of Municipal Office

6.2.3 Water Service is not Operated by One Organization - Absent Concept of Public Service Enterprise

There is no single water service provider, in any municipality in, or relevant to, the Western Highveld Regional Water Supply Scheme, who tries to operate and maintain the water supply service with the costs recovered through tariff from customers. There is no one organization supplying water and at the same time collecting tariff for the target of financial autonomy independent from the municipal budget, despite the repeated advices by DWA. Supplying potable water, that is selling a commodity, and collecting tariff, that is receiving a price, are being done by separate organs and no one seems to coordinate both sides.

In review of the municipal statement of account and accounting practices, it seems extremely difficult to isolate (or ring fence in local terms) costs of water supply and tariff collection. Costs spent for material, consumable, energy and particularly personnel of the water supply division are deeply embedded in those of the technical department. Expense and personnel costs for meter reading, billing and collection of tariff are also difficult to isolate from those in the financial department.

As for the revenue side of water services, water supply and sanitation tariff is not billed alone, but with charge for the solid waste removal, the rates and taxes, VAT and interest upon the delayed payment. Such an all-inclusive bills / invoices are mailed monthly to all the residents. In all the municipalities under the Western Highveld Region, ratio of payment or collected amount versus billed / invoiced amount is so low as 3 to 7 percent. It was explained by a financial officer that thus little collected amount could not be allocated simply proportionately to the ratios of billed / invoiced amount under each item of bills / invoices. To isolate collected water tariff, therefore, a complex and difficult calculation shall be made and is not actually made. The collection rate of the all-inclusive invoice is considered to be the collection rate of water bills.

As total costs of water supply service including those of tariff collection are not known, it is not clear what the total amount of water bills represents. In Sekhukhune district municipality, no customer in the Western Highveld Regional Water Supply Scheme is billed. While installation of water meters is not sufficient, meters are not read and therefore not billed by volume of consumption in some places. Majority of residential customers have no meters installed, and pay for the fixed, and therefore, minimum amount of tariff. Some individual officers are observed to be very serious in raising tariff collection, but as a whole municipality, including councilors, none in the Western Highveld Regional Water Supply Scheme seemingly is working on organized effort to recover the cost of water supplied.

No customer was terminated or restricted the supply of water due to non-payment. Concept of the public service enterprise, which pays for itself, is absent in the water supply sector. Rather, the water supply services are considered as a part of public services like road, police, fire fighting, etc.

6.3 The Vulnerable Institutional Setup

While DWA is encouraging and advising the recovery of costs for water supply, the National Government including itself is providing enormous amount of grants and subsidies to municipalities in the Western Highveld Water Scheme, and no municipality is motivated to raise its revenue by itself, as shown in a Table below.

Table 6.3.1 Revenue and Expenditure - 2006 / 2007

	Budget		Actual	
REVENUE		%		%
Grants and Subsidies	129,199,594	78.7	72,169,069	66.5
Revenues from Tariffs, Service Levies, etc.	33,945,000	20.7	11,457,714	10.6
Interest Earned	725,000	0.4	4,868,806	4.5
Sundry Income	188,500	0.1	19,816,386	18.3
Rentals	45,250	0.0	192,427	0.2
TOTAL INCOME	164,103,344	100.0	108,504,402	100.0
EXPENDITURE				
Salaries and Allowances	35,158,850	22.0	26,659,741	32.3
General Expenditure	54,213,386	34.0	44,189,080	53.6
Repairs and Maintenance	2,492,179	1.6	1,082,536	1.3
Contribution to Fixed Assets	67,678,273	42.4	9,724,983	11.8
Contribution to Provisions	70,931	0.0	775,460	0.9
TOTAL EXPENDITURE	159,613,618	100.0	82,431,800	100.0
NET SURPLUS / (DEFICIT) *	4,489,726	2.7%	26,072,602	24.0%

Source: Thembisile Hani Local Municipality Annual Report, Fiscal Year: 2006 / 2007
* Percentage = Net surplus / Total income

No one knows accurate volume of unaccounted-for and non-revenue water, as no effective leakage control and demand control are made.

Making the costs and revenues of water supply clearly separated or ring-fenced from others of municipality is not done, due probably to understaffing in quantity and quality. Likewise, organization of one water service provider as financially autonomous public service enterprise seems difficult, due to similar reason, plus limited scale of business and hence insufficient money flow.

Understaffing also causes inappropriate maintenance of facilities. Routinely preventive maintenance is neither planned nor exercised.

While ratio of collected bills is marginal, no effective debt control is made. It is suspected that the free water practice may be derived from that under the homeland regime.

During the homeland era, the water scheme for the whole Kwa-Ndebele was operated by a single operator. It is the Local Government setup and the Water Services Act that fragmented the scheme and its operator into plural parts. Municipal water divisions are too small and have too little fund to maintain the sufficiently capable manpower in quantity and quality.

Taking into consideration these distinct circumstances of the ex-homeland area, DWA is launching the Refurbishment Action Plan for rehabilitation of the Western Highveld Water Scheme specially by spending the national budget. Specific reason to do so is not explicitly told, but known by everyone.

CHAPTER 7 FINANCING

7.1 Financing Capacity of the municipalities

The replacement cost of the obsolete transmission and distribution pipelines that need to be replaced is R1.3 billion (ref. 10.2.4' Cost of Infrastructure Development Plan ').

The Western Highveld Region covers the whole or parts of five (5) municipalities which belong to three (3) provinces. Thembisile LM and Dr JS Moroka LM account for 80 percent of the total population of the Region, and the whole area lies within the Western Highveld Region.

The study examines whether these two municipalities have the financing capacity to generate the replacement cost of the water supply facilities by themselves.

As for Thembisile LM, the JICA team obtained the preliminary draft of the Financial Statement for 2010/7-2011/6.

The administration of the Thembisile LM was taken over by the Mpumalanga Province, on April 2010, because of the industrial action which lasted for three months and led to the standstill of the service delivery and allegations of mismanagement. Thembisile LM virtually fallen in a state of bankruptcy. (South African Government Information 'Thembisile Hani Local Municipality put under administration' April 16, 2010).

This situation is the most likely reason why the financial statement of Thembisile LM has not yet been finalised. The following is the cash flow analysis based on the figures in the preliminary draft:

Table 7.1.1 Cash flow of Thembisile LM (2010/7～2011/6)

Inflow	Million Rand
(Revenue)	
Government Subsidy	232
（Equitable Share Grant）	（173）
（Municipal Infrastructure Grant）	（47）
（DWA Grant）	（8）
（Other Grant）	（ 4）
Service Charges	29
（Water Tariff）	（26）
Other Revenue	25
Total Revenue	**286**
Total Inflow	**286**

Outflow	Million Rand
（Expenditure）	
Debt Impairment	37
Bulk Purchase	83
General Expenses	48
Employment Cost	58
Repair and maintenance	7
Total Expenditure	234
Additions of assets (property, plant and equipment)	65
▲Debt Impairment	▲37
Total Outflow	**262**

Source: JICA Team

Eighty-one (81) percent of the revenue of Thembisile LM comes from the government subsidy. The majority is made up of Equitable Share Grant and Municipal Infrastructure Grant (MIG). The DWA

Grant is not a significant size, most likely because Thembisile LM does not have many bulk water facilities which are eligible for the Regional Bulk Infrastructure Grant of DWA. This is because Thembisile LM does not have its own water sources.

On the expenditure side, the cost of bulk water purchases amounts to R83 million and comprises of one third of total expenditure, which is paid by water tariff revenue of R26 million. This is supplemented by the proceeds of Equitable Share Grant of R57 million.

Repair and Maintenance is only R7 million. This indicates that almost the entire Equitable Share Grant is consumed by the bulk purchase of water, general expenses and employment costs, and the fiscal room for the repair/maintenance and for the development of infrastructure is very small.

The value of the infrastructure (the addition of assets in the balance sheet) is R65 million, which is smaller than that of Dr JS Moroka LM. It is financed almost entirely by the government grant such as MIG.

Assuming that 100 percent of the DWA Grant and 54 percent of MIG is used for water and sanitation, the amount of investment in water and sanitation is calculated as R33 million (Yen350 million). This is far smaller than the required amount for the replacement cost of the obsolete transmission and distribution pipelines as stated above.

The financial statement of Dr JS Moroka for FY2010 (2009/7-2010/6) is available. The following table is the cash flow of the municipality made by the JICA team, based on the figures in the financial statement.

Table 7.1.2 Cash flow of Dr JS Moroka LM (2009/7-2010/6)

Inflow	**Million Rand**
(Revenue)	
Government subsidies	267
（Equitable Share Grant）	（146）
（Municipal Infrastructure Grant）	（65）
（DWA Grant）	（52）
（Other Grant）	（ 4）
Service Charges	20
（Water Tariff）	（15）
Other Revenue	20
Total Inflow	**307**

Outflow	Million Rand
（Expenditure）	
Debt Impairment	17
Depreciation/amortization	27
General Expenses	51
Employment Cost	67
Remuneration councilors	10
Repair and maintenance	45
Others	6
Total Expenditure	223
Additions of assets (property, plant and equipment)	108
▲Debt Impairment	▲17
▲Depreciation	▲27
Total Outflow	**287**

Source: JICA Team

As shown in the above, Dr JS Moroka LM relies on a national subsidy for 87 percent of its total revenue. The infrastructure investment (addition of assets on the Balance Sheet), amounting R108 million, is slightly below the total of the Municipal Infrastructure Grant and the DWA Grant (R117million). This implies that the infrastructure investment of the municipality is totally dependent on the national subsidy.

The figures of the sector wise allocation of the investment amount are not available on the financial statement. Assuming that the whole of the DWA Grant and 54 percent of the Municipal Infrastructure Grant are used for the water and sanitation, the amount of investment in water and sanitation is calculated to be R87 million (Yen930 million), which is larger compared to Thembisile LM.

However, Dr JS Moroka LM needs to respond to the financing requirement for maintenance of its own water purification plant and the financing requirement of its backlog of the basic sanitation facilities. Therefore, this amount is considered to be insufficient to cover the replacement cost of the obsolete transmission and distribution pipelines as stated above.

Dr JS Moroka LM received an Equitable Share Grant which accounted for almost half of the total cash inflow to the municipality. The major part of this grant was consumed by:

- general expenses
- employment costs
- remuneration of councilors

Dr JS Moroka LM managed to use a part of this grant for repair and maintenance, but failed to manage to use any part of it for investment.

Thus, the municipalities in the Western Highveld Region do not have any capability to finance investment for infrastructure by means of their own revenue and the size of the infrastructure investment is decided solely by the amount of national subsidies.

7.2 The size of the financial resources which can be appropriated for the water services of the municipalities in the Western Highveld Region out of the National Budget of the Republic of South Africa

7.2.1 Expenditure for the water sector in the National Budget of the Republic of South Africa (DWA Budget)

- Total expenditure of the RSA National Budget for FY2011/12 is R979.3 billion (Yen10,478 billion @10.7)
- Department of Water Affairs (DWA) is responsible for all aspects of water resource management from water resource development to the water supply (from the dam to the tap) and sanitation.

Total budget allocation to DWA for FY2011/12 is R9.9 billion (Yen105.9 billion).

Out of this amount:

- R2.7 billion (Yen29 billion) is allocated to the construction and management of the bulk infrastructures such as dams owned by DWA as Water Infrastructure Management
- R5.8 billion (Yen62 billion) is used for water resource management and for the establishment of water related institutions at the local level as Regional Implementation Support

- The Regional Bulk Infrastructure Grant (RBIG) is a budget item under Regional Implementation Support. RBIG supports the bulk water supply project by which multiple municipalities gain benefits. In FY2011/12, R1.8 billion (Yen19 billion) is appropriated for RBIG.

Table 7.2.1 Expenditure Budget of DWA (FY2011/12)

Programme	**2011/12 (R million)**
Administration	862.1
Water Sector Management	718.7
Water Infrastructure Management	2 608.0
Regional Implementation and Support	5 608.9
(Sector Support and Intergovernmental Relations)	(1 182.3)
(Natural Resource Management Programs)	(1 269.5)
(RBIG)	(1 775.3)
(Transfer of Water Schemes)	(685.7)
In (Water Services Projects)	(344.5)
(Others)	(351.6)
Water Sector Regulation	112.4
International Water Cooperation	26.1
Total	**9 936.2**

The typical feature of the DWA Expenditure Budget is that the expenditure for water resource development such as dams and for bulk water supply takes up a major portion of the DWA budget, while the budget for the distribution is very limited.

As a result, although the financial resources such as RBIG are readily available for the development of the bulk water supply facilities in the Western Highveld Region, the appropriate budget item cannot be found in DWA Expenditure Budget for the substantial development of the distribution networks by the municipalities in the Region.

The following table is the list of the projects related to the Western Highveld Region included in FY2011/12 DWA Budget. The total project cost is estimated to be R700 million (Japanese Yen 7.5 billion) and is basically for the bulk water supply. It is estimated that the required amount of the replacement of the water supply facilities, obsolete transmission and distribution pipelines alone is R1.3 billion (Japanese Yen 14 billion).

If R700 million from DWA's RBIG budget can be used for this purpose, the financing gap will be R600 million (Japanese Yen 6.4 billion).

Table 7.2.2 Expenditure in DWA FY2011/12Budget on infrastructure related to the Western Highveld Region (R million)

Project name	**Service delivery outputs**	**Current project stage**	**Total project cost**	**Expenditure in 2011/12**
Western Highveld regional bulk water supply	Water treatment works and additional water supply	Feasibility	486.0	20.0
Western Highveld regional bulk supply	Pipeline	Feasibility	210.0	-

7.2.2 Resource transfer from the central government to the municipalities (Municipal Infrastructure Grant (MIG), Equitable Share Grant)

The Constitution of South Africa stipulates that the water supply service is the responsibility of municipality. Actual transfer of the water supply service to municipalities began in 2003 when the municipality administration took shape after the first local election in 2000. Therefore, the implementation capacity of the water supply services in many municipalities is still very weak.

The municipality is responsible not only for water supply services, but also other public services such as sanitation, solid waste and road services. In some municipalities in rural areas where the percentage of the indigent population is high, the collection of the service charges for these public services, such as the water tariff, is considered to be difficult and it is feared that the public services will not be delivered in an appropriate manner.

With regards to water supply services, since the Free Basic Water policy was declared in 2001 and water consumption up to 6kl per/month per household was declared free of charge, the associated cost of supply to be incurred on the municipality side needed to be supplemented.

Taking these into consideration, the Government of South Africa established the transfer scheme of financial resources from the central government to the local government in order to supplement the resources for the development of infrastructure and the operation and maintenance of these infrastructures for these public services.

The Municipal Infrastructure Grant (MIG) aims to supplement the investment expenditure of municipalities for infrastructures for public services.

As for the sector wise allocation of MIG, according to the MIG FORMULA (Policy Framework for the Introduction of the Municipal Infrastructure Grant (MIG) Appendix A (5 Feb 2004)), 75% of MIG will be allocated to Basic residential infrastructure (Component B).

Of this amount 72% will be allocated to water and sanitation:

- 23% for road
- 0% for electricity
- 5% for street lighting and solid waste

Thus, 54% of MIG is assumed to be allocated to the water and sanitation services conducted by municipalities.

Municipal Infrastructure Grant (MIG)
[Funding Institution]
Department of Corporative Governance and Traditional Affairs (CoGTA)

[Purpose of Funding]
The Municipal Infrastructure Grant (MIG) is a conditional grant to support municipal capital budgets to fund municipal infrastructure and to upgrade existing infrastructure, primarily benefiting poor households. The primary aim is to fund basic water and sanitation services in areas that had no services.

[Conditions for Funding]
a. Cross-cutting conditions

- a-1 Conformity with the pre-existing Integrated Development Plan (IDP) of the municipality.
- a-2 The MIG Grant can only used for capital investment and cannot be used for finance the operating expenditure.
- a-3 Spending of MIG funds is restricted to those categories of infrastructure, beneficiaries and levels of service identified to provide basic and essential services.
- a-4 The municipality must invest an appropriate proportion of the funds on rehabilitating existing infrastructure.
- a-5 The MIG Grant can not be used to pay off a loan to a particular lending organization.
- a-6 Achievement of specific service coverage targets.
- a-7 Temporary and permanent job creation arising for municipality infrastructure investments.
- a-8 MIG funds to be allocated in the municipality budget.

b. Sector Specific Conditions set by DWAF

- b-1 The basic water service means those defined in the Strategic Framework for Water Service approved by the Cabinet on September 2003.
- b-2 Project to be funded must be within the framework of the municipality’s Water Services Development Plan (a part of IDP).

b-3 The project must be proven to be feasible based on a proper feasibility study.
b-4 The operating, finance and management arrangements must be in place and committed.

CoGTA administers, apart from the usual MIG, the Special Municipal Infrastructure Fund (SMIF) to support innovation and regional investments in infrastructure implementations. The conditions for SMIF Funding are as follows;

a. The project must contain an innovative concept that constitutes new practice within the municipality area.
b. Be aligned to the strategic objectives of IDP.
c. Involve multiple stakeholders such as local business and community groupings.
d. Demonstrate tangible and sustainable outcomes, within a three year period.
e. Be unlikely implemented without the grant funding.
f. Reflect cost-sharing on the part of the municipality either in finance or in-kind.

According to the Division of Revenue Act, 2011, which determines the allocation of the transfer of financial resources to local governments in FY 2011/12, R11.4 billion (Yen122 billion) is allocated for MIG. In the case of the Equitable Share Grant, the concrete allocations among Provincial Government and Local Government (District Municipality, Local Municipality) are stipulated in the Act (explained later).

In the case of MIG, the municipality wise allocations are not stipulated. In reality, since about two hundred fifty (250) municipalities in the whole country will fight for the allocation of this fund, the allocation for each municipality will fall between R40-50million (Yen400-500million).

About half of this amount is assumed to be usable for water and sanitation investment. That is R20-25million (Yen200-250million), which will not be enough for the substantial investment for distribution network development or replacement.

Although MIG is the Conditional Grant which will be provided only when certain conditions are fulfilled, it is reported that, since the monitoring mechanism of MIG is insufficient, it is sometimes used for other items which are not related to the original purpose. The strengthening of a monitoring mechanism remains the unsolved issue.

The Equitable Share Grant is to supplement the operation and maintenance cost for public services conducted by local governments. The allocation amount for each local government is calculated using a certain formula which takes into consideration the number of the indigent population in the municipality and other factors.

The allocation amount is stipulated in the Division of Revenue Act. For many municipalities, the water supply service is the most important public service. Therefore, the required cost for the provision of the basic water service is included in the calculation basis of the Equitable Share Grant.

Equitable Share

[Funding Institution]
National Treasury and CoGTA

[Purpose of Funding]
To fund the costs of basic services. The purpose of the basic services component is to enable municipalities to provide basic services and free basic services to poor households. Poor households earning less than R800 per month and indigents that are approved by the municipality also qualify for free basic services. The fund is used to pay for the costs incurred in providing these services.

According to the Division of Revenue Act, 2011, in FY2011/12:

Firstly, the total national revenueR888.9 billion (Yen9,511 billion), is divided into:

- National R566.3billion (Yen6,059 billion)

- Provincial R288.5billion (Yen3,087 billion)
- Local R34.1billion (Yen365 billion)

Secondly, these amounts are divided and allocated to each provincial governments and local governments (District governments and Local governments and those amounts are stipulated in the Act.

In FY 2011/12, the allocations of the Equitable Share Grant to Thembisile LM and Dr JS Moroka LM are R197 million and R206 million respectively

The Equitable Share Grant is an Unconditional Grant and the municipality can use this resource at their will and are not limited to water services - even if the calculation of the amount is based on the cost of the water service.

Considering the actual financial situation of Dr JS Moroka LM as described above, almost the total amount of the Equitable Share Grant is allocated to general expenses, employment cost and councilors' remuneration and very little is used for the development of infrastructure.

Thus, no available financial resources, which can be used for the substantial investment for the development or replacement of the water distribution network in the Western Highveld Region, can be found in the RSA's financial transfer programme to the local municipalities.

7.3 Development Bank of Southern Africa (DBSA)

DBSA's exposure to the water and sanitation in South Africa is R4.4 billion for water and R2.5 billion for sanitation which comprises 15% and 8% of total. It is a DBSA's priority area.

Looking at the exposure per client type:

- 34% of water projects are in metropolitan municipalities
- 52% of water projects are in secondary municipalities
- only 4% are in under-resourced municipalities

Province-wise portfolio is not so diversified: 60% of water projects are in KwaZulu Natal Province.
The challenge DBSA is facing now is that, while meeting with the ever-increasing demand of metropolitan municipalities and secondary municipalities, DBSA are required to create the lending needs by increasing the implementing and borrowing capacity of under-resourced municipalities. (DBSA eDigest Edition One 'Water Sector' June 2011 p.11

http://www.dbsa.org/Research/EDigest/html/index.html)

Development Bank of Southern Africa (DBSA)

DBSA is a development bank established in 1983 by the government of South Africa. DBSA does not only provide loans and equities for the infrastructures and other activities in South Africa, but also provide loans to the development projects in other countries in Southern Africa. The lending amount (disbursement) in 2009/10 was Rand 8,257million.

DBSA considers the water sector as the strategic sector and puts focus on the wastewater treatment infrastructures and on the measures for NRW reduction from the viewpoints of improving profitability of the water utilities.

DBSA's basic approach toward the water sector is to make the project loan-able by engaging in the project development at its early stage and by collaborating with stakeholders including DWA, which will eventually ease approval of the loan provision. Even after the project formulation, if the project turns to be not loan-able, DBSA helps the municipality to apply for the grant funding by the government of South Africa.

A typical example of the water supply project, for which DBSA provided loan financing, is the DBSA loan to eThekwini City in the suburban area of Durban. In this project, DBSA funded the

NRW reduction activity and helped in success in reduction of NRW from 45 percent to 30 percent.

DBSA used to implement the Siyenza Manje Programme, a kind of technical cooperation programme, in which DBSA employed engineers, technicians, financial experts, planning experts and young professionals and mobilised them to the local municipalities, by using its financial surplus reserve.

These experts supported local municipalities to obtain the MIG Grants. The programme, however, was transferred to CoGTA in FY2011, following the decision of the Government of South Africa to use the DBSA's financial surplus reserve for reducing DBSA's lending interest rate.

Pursuant to the Treasury's Circular No.51 on the Municipal Finance Management Act (Feb 2010), which allows the pledging of the Conditional Grant transfer by a municipality, DBSA is trying to increase its financing of the water projects by the municipalities.

However, the range of the grant transfers which can be pledged are limited to the grant transfers for the coming three (3) years. Only the municipalities which will become financially self-sustainable within three (3) years can benefit from this regulatory change.

Such under-resourced municipalities as those in the Western Highveld Region will not be eligible for DBSA financing even under the new regulation.

CHAPTER 8 WATER DEMAND FORECAST

8.1 Forecast Conditions

To estimate the future water demand in the study area, we used as references to forecast conditions from:

- Water Service Development Plans (WSDP)
- Integrated Development Plans (IDP)
- DWA criteria

The Table 8.1.1 shows benchmark population, annual population growth rate and water service level.

Table 8.1.1 Water Demand Forecast Conditions (Population, Growth Rate, Service Level)

Local Municipality (LM)	Reference Documents	Benchmark Population	Annual Population Growth Rate (%)				Water Service Level
			Area	2006-10	11-15	16-20	
Tshwane (Metropolitan)	IDP	2007	Ekandustria	0	0	0	Water demand is calculated on the assumption that water service level of communities improves in phases, and finally the level is upgraded to yard or house connection in 2020, except the communities served by the bulk system in Dr JS Moroka LM.
			Ekangala	1.6	1.6	1.6	
			Rethabiseng	8.7	8.7	8.7	
Thembisile Hani	WSDP	2007	Tweefontein	0.88	0.55	0.31	
			Southern	1.27	0.86	0.62	
			Kwamhlanga	3.73	3.32	3.08	
Dr JS Moroka	WSDP	2007	Central	1.35	0.94	0.70	
			Kameelpoort	1.33	0.92	0.68	
			Northern	1.55	1.14	0.90	
			Siyabuswa	1.15	0.74	0.50	
			Western	1.40	0.99	0.75	
Ephraim Mogale Elias Motsoaledi	Technical Report, Bulk Supply to Moutse (Sekhukhune)	2010	Growth rates are not described, but population in 2015 and 2020 were forecasted by growth rates calculated based on population in 2020 and 2030.				

Water service levels such as house connections, yard connections and public standpipes have been designed in consideration of local circumstance of each community, so we reflected the service level on demand forecast. Per capita consumption by the service level is shown in the Table 8.1.2.

Table 8.1.2 Water Demand Forecast Conditions (Per Capita Consumption)

	House Connection (lit/cap/day)	Yard Connection (lit/cap/day)	Public Standpipe (lit/cap/day)
Per Capita Consumption	120	60	25

* DWA's design criteria.

We applied 0.3% of total water consumption as consumption of commercial water equally to all municipalities, which was obtained in the Water Service Development Plan (WSDP) of Dr JS Moroka LM.

We applied Unaccounted for Water (UFW) ratios of three scenarios equally to all municipalities.

Shown in Table 8.1.3
Non revenue water in 2010 is 40%, commonly evident in the study area:

- scenario 1 is the case of no intervention for UFW improvement
- scenario 2 is the case of technical cooperation for UFW improvement
- scenario 3 is the case of both technical cooperation and replacement of reticulation pipelines

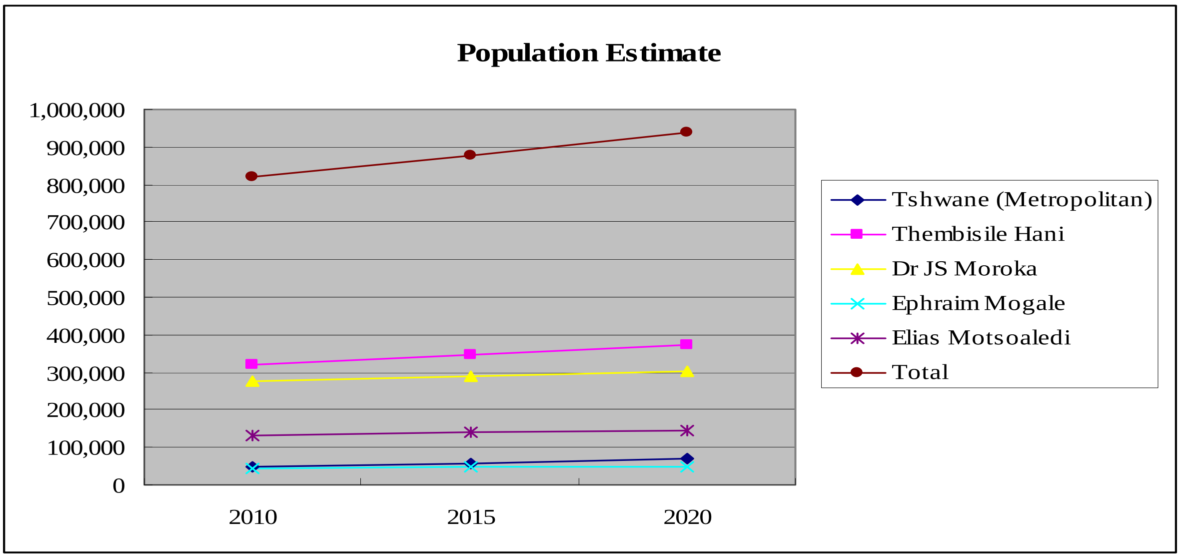
Table 8.1.3 Water Demand Forecast Conditions (UFW Ratio)

	Non Revenue Water Ratio (%)		
	2010	2015	2020
Scenario 1 (No Intervention)	40	40	40
Scenario 2 (Technical Cooperation)	40	35	23
Scenario 3 (Technical Cooperation &Reticulation Replacement)	40	25	15

8.2 Population Projection

We have improved accuracy of population projection through assembling population in community level and reviewing existing documents.

Population projections in the Western Highveld are from 2010 to 2020. Shown in the Figure 8.2.1.



Local Municipality	2010	2015	2020
Tshwane (Metropolitan)	48 397	56 916	68 480
Thembisile Hani	318 006	346 005	373 679
Dr JS Moroka	277 452	290 899	301 408
Ephraim Mogale	44 114	46 634	49 672
Elias Motsoaledi	131 377	138 174	146 291
Total	**819 346**	**878 629**	**939 530**

Figure 8.2.1 Population Projection in the Western Highveld Area

Annual population growth in the whole area is not 1.0% but 1.8% and 1.7%

Projected population in 2020 approximates the one under probable scenario by WHR Pre-FS. In particular, growth rate 2.1% and 1.9% of Thembisile Hani is prominent.

8.3 Future Water Demand

Both Table 8.3.1 and the Table 8.3.2 show water demand forecast respectively per LM and supply scheme in 2015 and 2020 in each scenario under the above conditions.

Table 8.3.1 Water Demand Forecast in the Study Area (per LM)

Local Municipality	Population			Sceonario 1			Sceonario 2			Sceonario 3		
Year	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
NRW (%)	(person)	(person)	(person)	40	40	40	40	35	23	40	25	15
Western Highveld Water System												
Tshwane (Metropolitan)	48,397	56,916	68,480	9,588	11,352	13,737	9,588	10,479	10,704	9,588	9,082	9,697
Thembisile Hani	307,141	334,665	361,983	25,169	28,054	31,073	25,169	25,896	24,213	25,169	22,443	21,934
Dr JS Moroka	215,068	225,105	232,836	26,405	27,591	28,490	26,405	25,468	22,200	26,405	22,073	20,111
Ephraim Mogale	44,114	46,634	49,672	2,926	3,930	4,982	2,926	3,627	3,882	2,926	3,144	3,517
Elias Motsoaledi	131,377	138,174	146,291	8,346	11,744	15,539	8,346	10,840	12,108	8,346	9,395	10,969
Total (m3/day)	**746,097**	**801,495**	**859,263**	**72,434**	**82,670**	**93,821**	**72,434**	**76,311**	**73,108**	**72,434**	**66,136**	**66,227**
Outside of Western Highveld Water System												
Thembisile Hani	10,865	11,340	11,696	182	391	590	182	361	460	182	313	417
Dr JS Moroka	62,384	65,794	68,571	4,075	6,599	13,756	4,075	6,092	10,719	4,075	5,279	9,710
Total (m3/day)	**73,249**	**77,134**	**80,267**	**4,256**	**6,990**	**14,346**	**4,256**	**6,452**	**11,179**	**4,256**	**5,592**	**10,127**
Grand Total (m3/day)	**819,346**	**878,629**	**939,530**	**76,690**	**89,660**	**108,167**	**76,690**	**82,763**	**84,286**	**76,690**	**71,728**	**76,353**

Table 8.3.2 Water Demand Forecast in the Study Area (per Supply Scheme)

Supply Scheme		Population			Sceonario 1			Sceonario 2			Sceonario 3		
	Year	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
	NRW (%)	(person)	(person)	(person)	40	40	40	40	35	23	40	25	15
Western Highveld Water System													
South	South	282,104	316,141	353,883	29,043	33,423	38,621	29,043	30,852	30,094	29,043	26,738	27,262
North	Walkraal	294,911	307,556	319,660	27,269	31,476	35,870	27,269	29,055	27,951	27,269	25,181	25,320
	Kameelrivier	42,956	44,875	46,326	4,775	4,990	5,153	4,775	4,606	4,015	4,775	3,992	3,637
	Weltevreden/Kuilen	18,056	18,734	19,207	2,321	2,408	2,469	2,321	2,223	1,924	2,321	1,926	1,743
	Bloedfontein	108,071	114,189	120,187	9,027	10,374	11,709	9,027	9,576	9,124	9,027	8,299	8,265
	Sub-Total	463,993	485,354	505,380	43,391	49,248	55,201	43,391	45,459	43,014	43,391	39,398	38,965
Total (m3/day)		**746,097**	**801,495**	**859,263**	**72,434**	**82,670**	**93,821**	**72,434**	**76,311**	**73,108**	**72,434**	**66,136**	**66,227**
Outside of Western Highveld Water System													
Thembisile Hani		10,865	11,340	11,696	182	391	590	182	361	460	182	313	417
Dr JS Moroka		62,384	65,794	68,571	4,075	6,599	13,756	4,075	6,092	10,719	4,075	5,279	9,710
Total (m3/day)		**73,249**	**77,134**	**80,267**	**4,256**	**6,990**	**14,346**	**4,256**	**6,452**	**11,179**	**4,256**	**5,592**	**10,127**
Grand Total (m3/day)		**819,346**	**878,629**	**939,530**	**76,690**	**89,660**	**108,167**	**76,690**	**82,763**	**84,286**	**76,690**	**71,728**	**76,353**

8.4 Future Water Supply / Demand Balance

There is considerable distinction in water demand forecast between as a result of the first survey and the second survey. This distinction is due to a difference in calculation and conditions.

In the first survey, water demand of approximately 131 000 m^3/day was calculated based on 4.4 persons per household and per capita consumption 120 lit/person/day

In the second survey, water demand in 2020 was calculated according to a scenario based on degree of development and per capita consumption in three different types of water service level and different unaccounted for water ratios:

- approximately 108 000 m^3/day in scenario 1
- approximately 84 000 m^3/day in scenario 2
- approximately 76 000 m^3/day in scenario 3

Current supply is 130 000 m^3/day in total including supply from Rand Water Board of 30 000 m^3/day for both South and North schemes. Therefore, the supply can meet demands regardless of scenarios.

However, due to increased per capita consumption by gardening and numerous unaccounted-for water wastage - such as water leakage along pipelines, inside houses and water loss by illegal connection - water demand has exceeded supply and consequently water scarcity has persisted. Therefore, it's easy to imagine this disadvantage cannot be solved without:

- an appropriate water fee collection
- water demand management
- measures against water leakage and loss

CHAPTER 9 PROBLEMS ON WATER SUPPLY MANAGEMENT AND NECESSITY OF THEIR IMPROVEMENT

9.1 Future Development of Water Sources

9.1.1 Maximum water demand forecast and existing facility

A maximum water demand forecast from "**2.3 Water Sources**" and "**2.4 Review of Water Demand Forecast"** is;

- Water demand forecast in the documents reviewed (UFW: 15%) 132,000m^3/day

A maximum water demand forecast 2020 in scenario 1 by the JICA study team is;

- Water demand forecast in the JICA study (UFW: 40%) 108,000m^3/day

As a reference, in case of all households being served through house connections (120lit/cap/day), a maximum water demand forecast 2020 in scenario 1 by the JICA study team is;

- Water demand forecast in the JICA study (UFW: 40%, all house connections) 172,000m^3/day

On the other hand, design capacity of water supply facilities including the planned for both the west area of Dr Js Moroka LM (11,000m^3/day) and Moutse area in Sekhukhune DM (18,000m^3/day) is;

- Intake Capacity 173,000m^3/day
- Treatment Capacity 181,000m^3/day (including bulk supply from Rand Water, 30,000m^3/day)

9.1.2 Result

Compared with the difference between the above maximum water demand, 172,000m^3/day and intake water capacity, 173,000m^3/day, the intake water capacity is over 1,000m^3/day above the maximum demand. Actually, the intake capacity gets low in consideration of leakage from conveyance pipe and discharge from treatment works, but development of new water sources is not necessary if unaccounted for water is improved through reduction of in-house water leakage and illegal connections, and also water demand management.

On the other hand, there is a potential that designed water supply is not distributed adequately and appropriately in some areas due to defects of water service pipe and pumping facility or equipment, such as undersized pipe diameter or luck of pumping capacity.

9.2 Development of Information on Water Supply Facilities

DWA handed over the facility's list to DM and LM which were managing water supply service in Western Highveld area at the same time that water supply facilities were transferred from DWA to each municipality.

The facility's list is like to be an inventory but it is not in detail. Information on bulk pipelines have been developed in each municipality but information has not been supplied for reticulation pipelines which are required for maintenance that has been done with exception of some LMs as shown in Table 9.7.1.

This results in difficulties in the flow control and inefficiency in pipe repairs. Their circumstances were verified through a pilot survey in this study, as it took a long time to find some valves for area isolation.

Lack of inventories on layout drawings and pipe information mislead the distribution system, which results in improper control of the valves and water flow. Performance of repair work for damaged pipes is remarkably low because it takes long time to find valves and to control it due to the fact that valve handles are covered by soil.

It is impossible to effectively detect leakage on pipelines without any drawings. The missing pipes should be detected by using after-mentioned pipe locators prior to leakage detection.

In order to control water flow appropriately and to maintain the existing water supply facilities, information on the existing water supply facilities must be clarified by using a water supply inventory and mapping system, which is required for a water supply asset management plan.

9.3 Appropriate Maintenance System of Water Supply Facilities

Maintenance of the water supply facilities depends on the experience of the field work staff because there is a lack of layout plan drawings, etc. Daily work on the water supply system by the maintenance team is an emergency measure and the detail repair and maintenance records are not introduced in the maintenance team.

The detail maintenance record is one of effective data for future diagnosis of the water supply facilities. It is significant that the water supply entity should understand enough about their necessity.

Only a short period has past since the water supply facility was transferred from DWA to Municipality. As an inventory, plan layout drawings and specification list of the facilities is developed, and preparation of the maintenance plan and introduction of their measures enables effective action to be taken by the municipalities in order to develop a proper maintenance system.

9.4 Establishment of Leakage Detection Group

Regarding reduction of water leakages, as shown in Figure 9.4.1 and Figure 9.4.2, the technical office of LM and DM only carry out emergency measures for water leakages that are reported by dwellers. Intentional water leakage detection, replacement of pipes and preparation of the action plan for pipe rehabilitation are not taken at all.

As far as the JICA project team could establish, the distance of the existing pipes cover approximately 2 500km of the Western Highveld area. As long as water leakage detection and rehabilitation of the pipes are not carried out efficiently and intentionally, a drastic water leakage reduction will not be achieved.

Urgent discovery of underground water leakage and pipe rehabilitation plan through the introduction of technical measures such as a distribution audit, quantity survey of water leakage, pipe and valve location detection as well as an emergency measures for visible water leakage are important measures for water leakage reduction. The result of the existing pipe detection is useful for water supply inventory.

Figure 9.4.1 Seeped water leakage on ground surface

Figure 9.4.2 Damaged asbestos pipe

9.5 Dissolution of Illegal connection

The loss of large quantities of water is caused by:

- illegal connections and theft of water

- water leakages
- refusal to pay water tariff bills due to low quality water service

The number of households that have illegal connections was not clarified by the technical office of municipality. Figure 9.5.1 and Figure 9.5.2 shows the signs of water theft on the transmission pipelines, which are connected to Moloto service reservoir in Thembisile Hani LM.

Methods of water theft are radical vandalism of the air valves and sluice valves as well as illegal connection, and stagnate water leaked from the damaged valves is used incorrigibly.

Since water loss by illegal connection and theft is defined by some as unaccounted for water, it is urgent that a monitoring team is established in order to learn number of illegal connection and theft of water.

Figure 9.5.1 Signs of theft of water on air valve chamber

Figure 9.5.2 Damaged air valve

9.6 Water Tariff System to Be Improved

According to the study report which was carried out by DWA from March to November 2010, water meter reading has been done for 36 percent (5,370houses) of 14,730 households, but not been done for the remaining houses (9,360 houses) because of circumstances such as defective water meters and non-water meters.
In addition, according to the existing data (year 2007) on a scale of water supply service in Dr. JS Moroka LM, there are water meters in only about 9 percent (5,434houses) of the entire area of 58,758 houses which are connected to the water supply service. Some of the water meters are damaged.
Thus, the ratio of water meter reading is very low and tariff collection is mostly carried out on a flat rate basis or not collected at all
Through the pilot study, it is observed that there is a lot of in-house leakage. This may be caused by lack of water meters and a flat rate collection which result in low awareness on water conservation.

Water tariff is not billed and collected by itself, not together with the sewerage tariff like in many countries. Every resident in the municipality receives monthly an all-inclusive bill / invoice, that contains rates and taxes, tariffs for water, sanitation and solid waste removal, and VAT, interest upon delayed payment and “rebate” or “adjustment.” Therefore, what is meant by “rate of collected water tariff” is actually rate of collected all-inclusive invoice from the local municipality.

Residents have to go and pay for such invoice at the municipal office or its branch office, which is not always closely located. The average rate of payment within the Western Highveld Region is as low as 3 to 7 percent, while it is the Ward Councilors who are assumed to urge residents not paying. It is not very clear how and to which item of bill / invoice the thus little collected payment shall be allocated. An example of the billed and collected amount of a municipality is shown below, Table 9.6.1.

Table 9.6.1 Collected vs. Billed (Water tariff) Amount

FY 2010/11	Billing for Rates, Water, Sanitation, Refuse, Etc.			Collection	
Month	*Total Billed*	*Of which Water*	*Water/Total*	*Total Collected*	*Collected /Billed*
July 2010	2,951,185.40	1,587,945.32	53.8%	188,354.08	6.4%
August	3,063,646.80	1,588,514.00	51.9%	112,841.77	3.7%
September	3,100,134.69	1,588,577.00	51.2%	97,357.26	3.1%
October	2,753,029.11	1,588,640.00	57.7%	87,600.84	3.2%
November	3,118,946.73	1,589,212.00	51.0%	116,996.87	3.8%
December	3,135,768.48	1,589,464.00	50.7%	119,434.80	3.8%
January 2011	3,201,029.32	1,589,611.00	49.7%	77,328.14	2.4%
February	3,181,955.26	1,589,737.00	50.0%	117,292.45	3.7%
March	3,190,337.17	1,590,163.00	49.8%	112,047.67	3.5%
April	3,273,934.69	1,590,415.00	48.6%	73,948.76	2.3%
May	992,424.67	108,007.00	10.9%	63,857.03	6.4%
June	5,784,725.20	3,072,785.00	53.1%	136,444.04	2.4%
TOTAL	37,747,117.52	19,073,070.32	50.5%	1,303,503.71	3.5%

Source: Thembisile Hani LM, Unit: ZAR

This all-inclusive billing / invoicing system is practiced in most of municipalities including Johannesburg Metropolitan Municipality, and making it very difficult to separate (ring-fence) the recovered costs of water supply, against the recommendations by DWA. It is vital to establish the concept of the local public service enterprise (or public service delivery) distinctly separated from the general public administration.[1]

9.7 Replacement of Deteriorated Pipes and Asbestos

9.7.1 Status-quo of the Information on the Existing Bulk Transmission Pipes and Reticulation Network

JICA Project Team studied the installation year of pipes, pipe material and diameter for the water supply system of:

- Kungwini LM, Thembisile LM
- Dr JS Moroka LM
- Sekhukhune DM (Elias Motsoaledi LM & Marble Hall LM)

Status-quo of the data on the existing transmission and reticulation pipes is shown in Table 9.7.1.

Table 9.7.1 Condition of the Water Supply Facility's Data

LM and DM	Data for Transmission Pipes				Data for Reticulation Pipes			
	Distance	Diameter	Material	Installation Year	Distance	Diameter	Material	Installation Year
Kungwini LM	A	A	A	C	A	A	A	C
Thembisile Hani LM	A	A	A	B	B	B	C	C
Dr JS Moroka LM	A	A	A	B	A	A	B	B
Sekhukhune DM	A	A	A	C	C	C	C	C

Legend:
A: Most of data is available, B: partially, data is available, C: No Data
Source: JICA Study team

Information on bulk transmission pipes is reported in Western Highveld Region Water Augmentation Pre-Feasibility Study (WHS Pre-FS), etc. but inventory - which includes comprehensive information

[1] According to Japan's Act of the Local Public Service Enterprise, the general public administration, e.g., police, fire fighting, public schooling, construction and maintenance of roads, etc., delivers services to satisfy the public needs, that are not required by specific individuals, and therefore its costs shall be sourced from the general taxes charged and collected from the residents. However, delivery of goods and services by the public service enterprises such as supply of gas and water, hospital, public bus and railroad transportation, etc., does not provide equal quantity of goods and services to all the residents evenly, and effects thereof are delivered to specific individuals. It is, therefore, fair and justified that costs of the latter shall be recovered from individuals who receive such goods and services.

on water supply facilities comprehensive - has not been developed with the exception of that for Dr JM Moroka LM.

The existing bulk transmission pipe was coordinated based on the above WHS Pre-FS. For the installation year of particular pipes which are not classified, JICA Project Team considered the construction year of some of service reservoirs.

Data on reticulation pipelines is lacking compared with that on bulk transmission pipelines. In addition, the quality on reticulation pipelines depends on Municipality.

Reticulation information has been developed in municipalities that operate according to an asset management plan, but there is a shortage of data on reticulation pipelines in the other local municipalities. In particular, there is a remarkably lack of information on the installation year of the reticulation pipelines at the dams with exception of Dr JS Moroka.

Study on the existing pipelines was focused on the distance as shown in Table 9.7.2

Table 9.7.2 Total Distance of the Bulk Transmission and Reticulation Pipelines in Western Highveld

LM & DM	Total Distance of the Bulk Transmission (m)	Rate of Occupation in Pipelines by LM/DM (%)	Total Distance of the Reticulation (m)
Kungwini LM	49 000	7.2	225 000
Thembisile Hani LM	226 000	33.1	850 000※
Dr. JS Moroka LM	304 000	44.5	719 000
Sekhukhune DM	104 000	15.2	N/A
Total	**683 000**	**100**	**1 794 000**

Note: Round-down in 10^3. *Total distance of the pipes in Thembisile Hani LM does not include the distance of the unclear pipe.
Source: Western Highveld Region Water Augmentation Pre-Feasibility Study, Feb 2005, Appendix B and each LM and DM

9.7.2 Status-quo of the Existing Bulk Transmission Pipelines

Kungwini LM

Total distance of the bulk transmission pipelines in Kungwini LM is approximately 49 000m. Of this amount:

- steel pipes make up approximately 93 percent
- cast iron pipes make up approximately 7 percent

Approximately 78 percent of the entire pipeline was laid in 2001 to 2005. Meanwhile, pipe diameter composed of 500mm to 700mm, of which 500mm makes up approximately 78 percent of all of the bull transmission pipes. Refer to Figure 9.7.1.

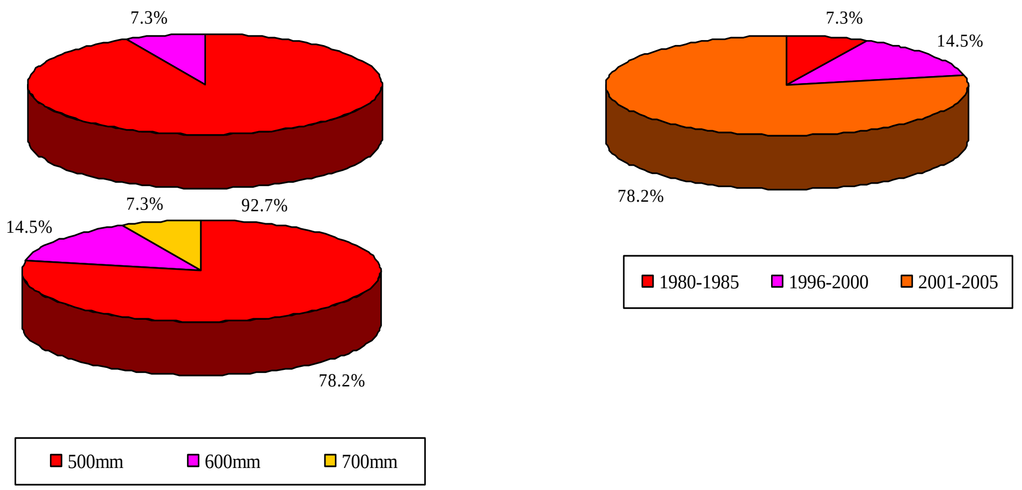


Figure 9.7.1 Status-Quo of Bulk Water Pipelines in Kungwini LM

<u>Thembisile Hani LM</u>

Total distance of the bulk transmission pipelines in Thembisile Hani LM is approximately 226 000m:

- asbestos pipes make up approximately 70 percent (158 000m)
- steel pipes make up approximately 30 percent

Approximately 57 percent of entire pipelines were laid in 1990 to 2000. Meanwhile, pipe diameter is composed of 125mm to 1 000mm. Refer to Figure 9.7.2.

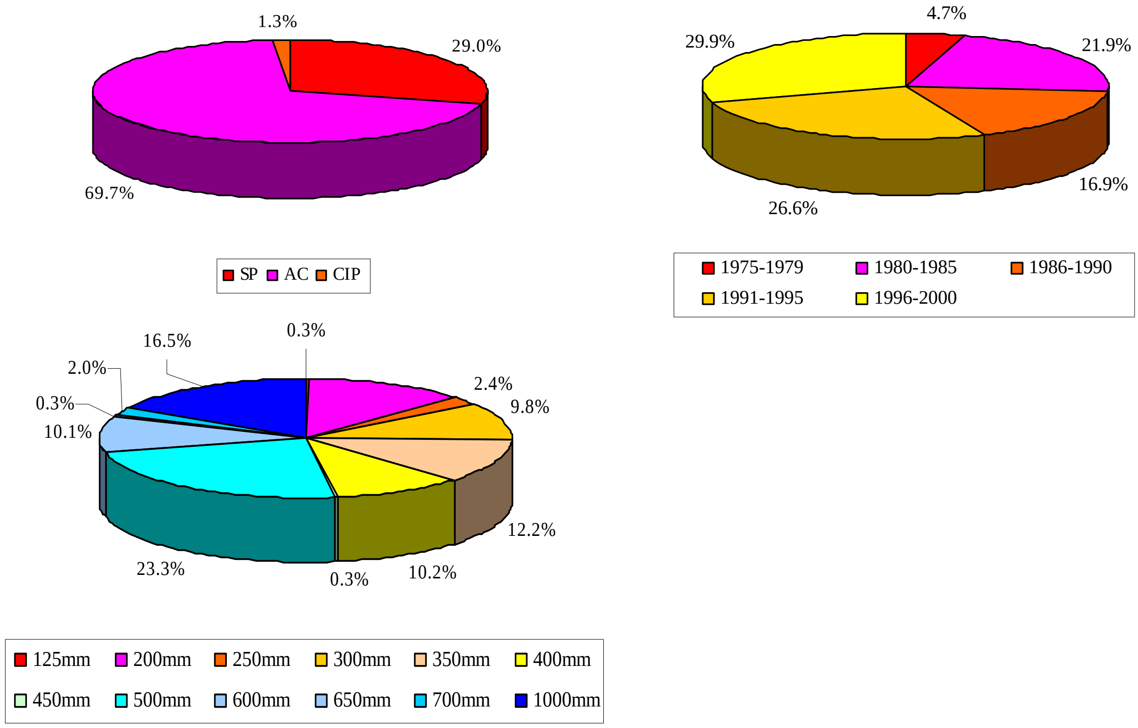


Figure 9.7.2 Status-Quo of Bulk Water Pipelines in Thembisille Hani LM

<u>Dr JS Moroka LM</u>

Total distance of the bulk transmission pipelines in Dr JS Moroka LM is approximately 304 000m:

- asbestos pipes make up approximately 71 percent (214 000m) of the total distance (which is the similar composition with Thembisile Hani LM)
- steel and PVC pipes make up approximately 12 percents

According to only verified information, approximately 32 percent of entire pipeline was laid out between 1980 and 1985. Pipe diameter is composed of 90mm to 700mm. Refer to Figure 9.7.3.

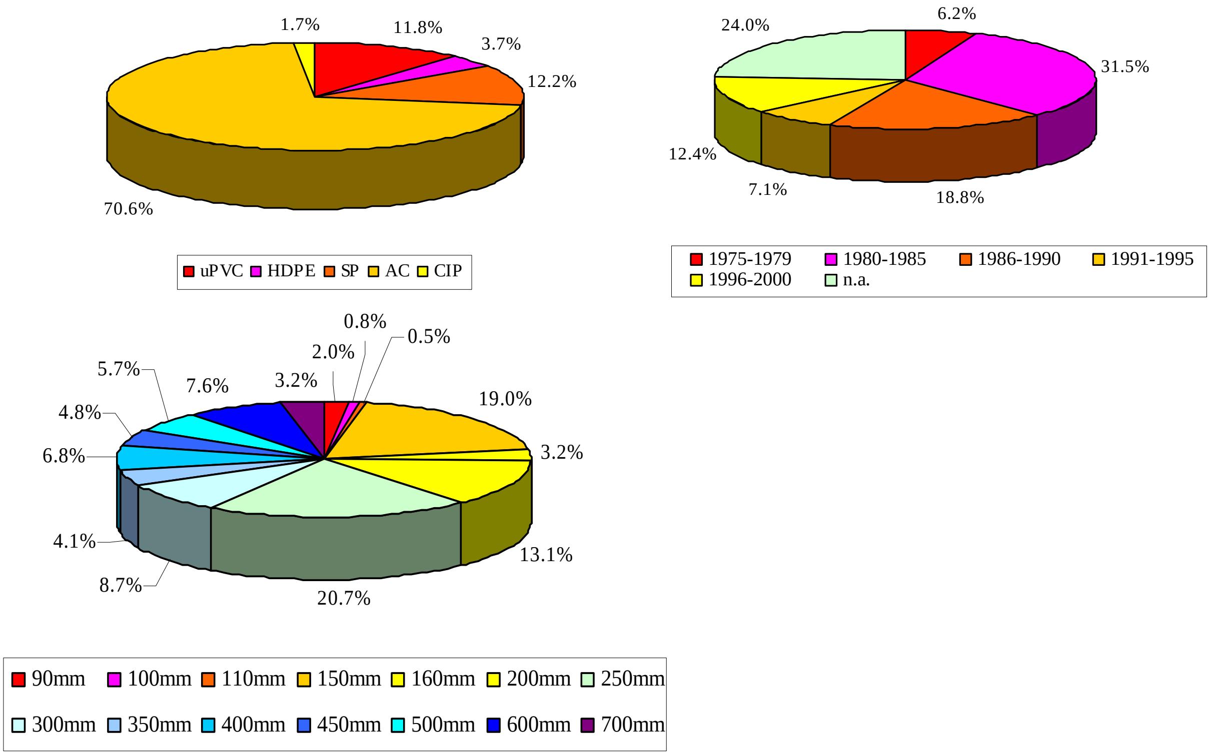


Figure 9.7.3 Status-Quo of Bulk Water Pipelines in Dr. JS Moroka LM

<u>Sekhukhune DM</u>

Total distance of the bulk transmission pipelines Elias Motsoaledi LM and Greater Marble Hall LM in Sekhukhune DM is approximately 104 000m:

- asbestos pipes make up approximately 57 percents
- PVC pipes make up approximately 28 percents

Approximately 66 percent of the entire pipeline was laid out between 1991 and 1995.

Information on the installation year is not clarified for approximately 34 percent of the pipeline. Pipe diameter is composed of 150mm to 500mm; 500mm makes up approximately 33 percent of the all the bull transmission pipes. Refer to Figure 9.7.4.

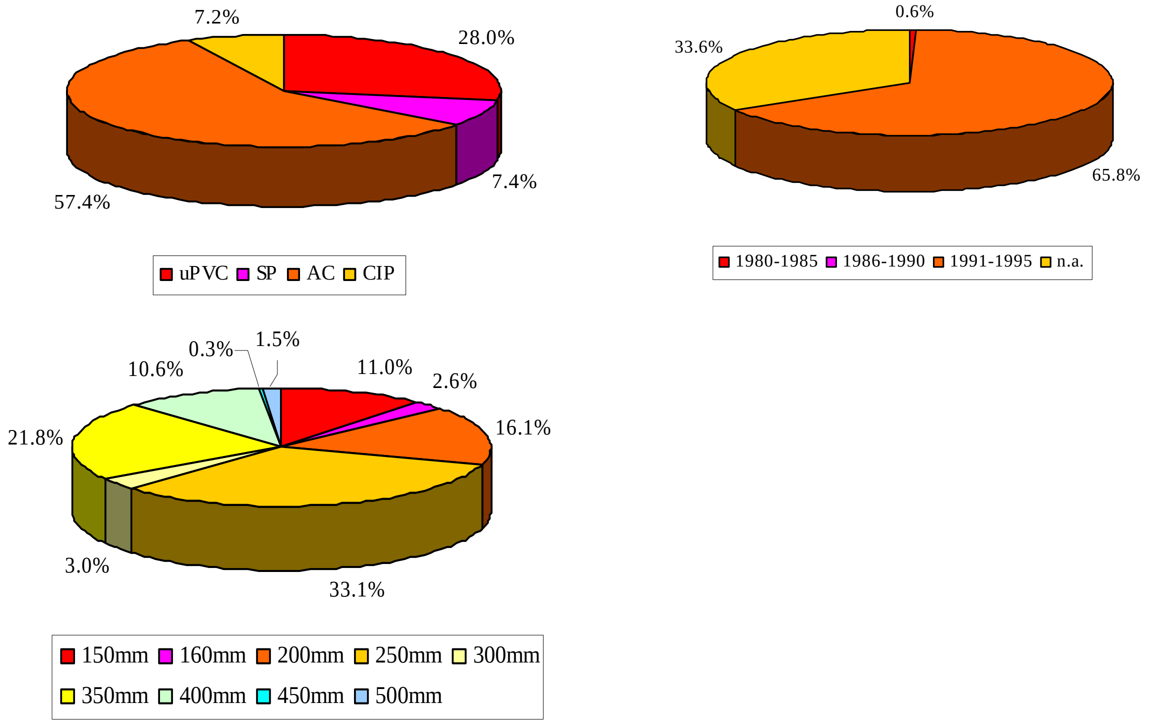


Figure 9.7.4 Status-Quo of Bulk Water Pipelines in Sekhukhune DM

9.7.3 Status-quo of the Existing Reticulation Pipelines

Kungwini LM

Information on pipe material and diameter of the reticulation network in Kungwini LM is available. Out of total distance of the reticulation network in Western Highveld area (which is approximately 25 000m), approximately 73 percent of the material of PVC.

Steel and asbestos makes up only 20 percent, while unclear material is about 13 percent. Reticulation pipe diameter is composed of 63mm to 700mm; 75mm make up about 33 percent. Refer to Figure 9.7.5.

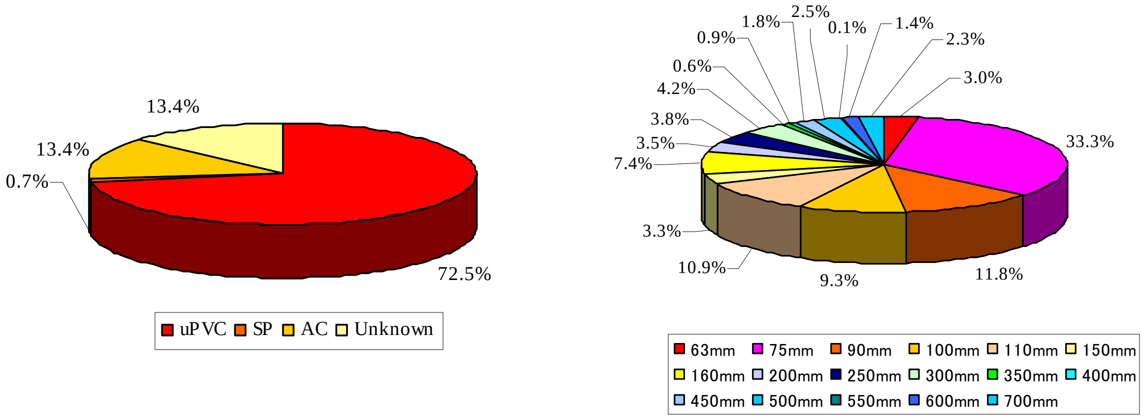


Figure 9.7.5 Status-Quo of Reticulation Water Pipelines in Kungwini DM

Thembisile Hani LM

Total distance of the reticulation network in Thembisile Hani LM is about 850 000m:

- 75mm diameter makes up approximately 91 percent

There is unfortunately no data available on material and the installation year of the reticulation network in Thembisile Hani LM. Refer to Figure 9.7.6.

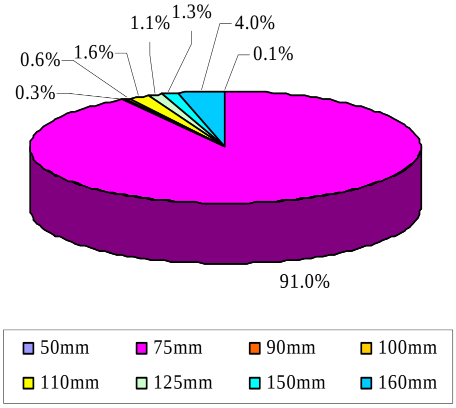


Figure 9.7.6 Status-Quo of Reticulation Water Pipelines in Thembisile Hani LM

Dr JS Moroka LM

Out of total distance of the reticulation network which is approximately 719 000m, approximately 50 percent and 43 percent are steel pipe and asbestos pipe respectively. Fifty percent of the total network was laid before 1990. Most of reticulation pipe diameter is 75mm. Refer to Figure 9.7.7.

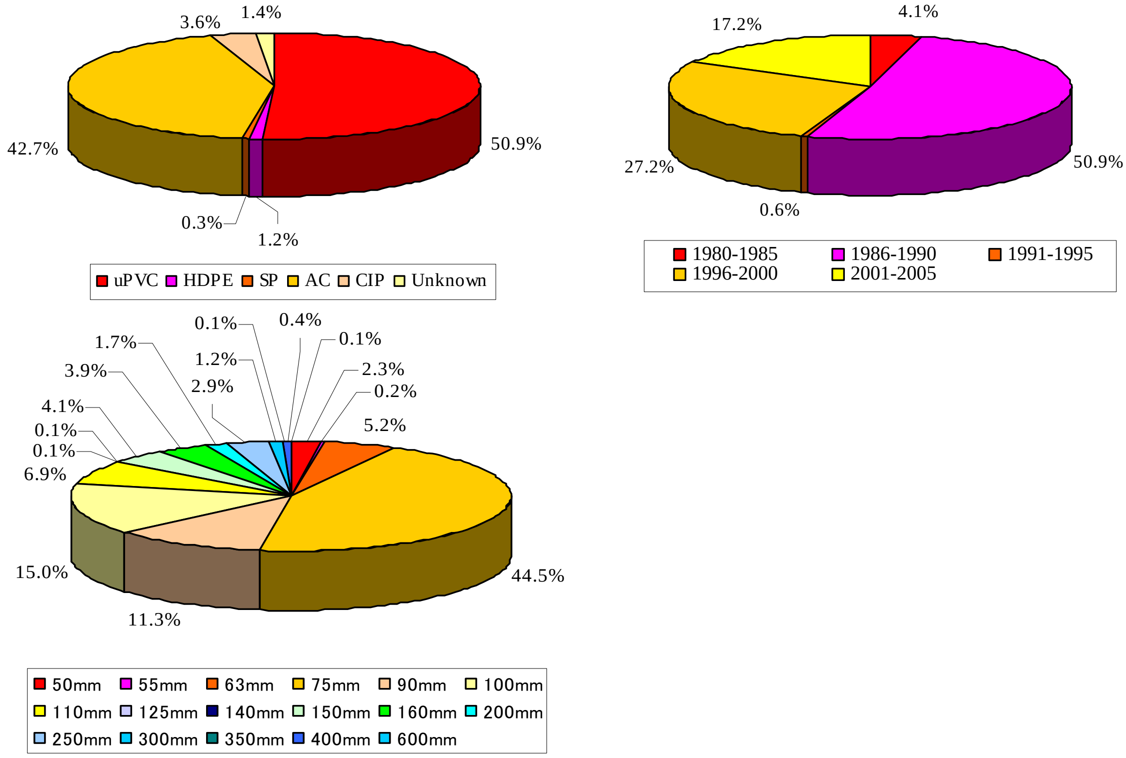


Figure 9.7.7 Status-Quo of Reticulation Water Pipelines in Sekhukhune DM

Sekhukhune DM

There is no data on the existing reticulation pipelines for part of Elias Motsoaledi LM and Greater Marble Hall LM, whose water supply has been managed by Sekhukhune DM.

According to technical officer of Sekhukhune DM, it is probable that data was lost due to negligence in management of the transfer during a transfer of water supply system from DWA.

9.7.4 Necessity of Pipe Replacement

The oldest pipes for the bulk transmission and reticulation were laid in 1979. Out of the total distance of 683 000m, approximately 12% (a distance of 82 000m) were laid out before 1980 and will reach the legal service life in 2020.

Asbestos pipes make up approximately 64 percent (about 435 000m) of the total distance of the bulk transmission pipes and approximately 19 percent (about 336 000m) of the reticulation pipes. This was clarified through this study.

In this study, steel bulk transmission pipeline of 1 000mm in diameter between Ekandustria and Enkeldoornoog service reservoir were surveyed inspect the level of corrosion and condition of the pipes and to identify any leakage points.

Leakage points were not observed on steel bulk pipelines of 1 000mm but two leakage points was found under humid conditions of soil on the asbestos bulk transmission of 500mm in diameter, which exists in parallel with that of 1 000mm in diameter.
The asbestos pipe was laid in 1991. The deterioration of the asbestos pipes is noticeable and is due to aging and soil conditions. Technical managers of municipalities have recognised that leakage points are mainly found on the asbestos pipelines.

Considering the strength and toxicity of the asbestos pipe, DWA has recently focused on restricting the placement of asbestos pipes as replacements. Currently pipelines of the mid- to small size, which have been replaced, are composed of polyethylene and PVC instead of asbestos.

9.8 Reduction of In-House Leakage

In-house leakages such as leakages from toilets, kitchens and other taps are one of the issues the study looked at. This was proved through pilot survey. Leakage is not defined in water supply service but has been wasted without any utilities.

To estimate water demand, LM and DM applies 120 liter per capita per day as the maximum for a house connection. Therefore, there is a gap between the estimated water supply plan and actual water consumption. This would result in trouble the water supply service and water scarcity. Actually the water supply service in Western Highveld area depends on not only water sources in their area but also expensive water of the Rand Water.

Reduction of in-house leakage as well as leakage on the bulk transmission and reticulation is required to manage appropriate water supply service.

9.9 Review on the Existing Transmission & Distribution System and Improvement on Maintenance System

9.9.1 Proper Operation Management of Bulk Transmission System

There are the existing bulk transmission pipes which are a shortage of diameter. It is obviously envisaged that such problems were caused by design failure. In this study, the entire system capacity was not studied. However, since particular bulk system were issued by technical office in Thembisile Hani LM.

A typical example is introduced as follow:

Figure 9.9.1 shows schematic system drawings with some problems.

Originally, water should have been transmitted from Enkeldoornoog-B service reservoir to Verena and Wolvenkop service reservoir. However, unless water level of 80 percent from ground in Enkeldoomoog-B is achieved in service reservoir, water cannot be provided Enkeldoomoog-B to point 'E' and is not stored in Verena and Wolvenkop service reservoirs.

For the time being water flow should be controlled, otherwise pipe diameter between 'E' and 'D' must be made larger. However, water flow is very difficult to control in the case where bulk meters are not installed on the bulk transmission pipelines. Therefore, water has been provided without a solution. This situation was found in other bulk transmission system.

In order to control water flow, the technical office of the municipality is required to know how to operate the existing system.

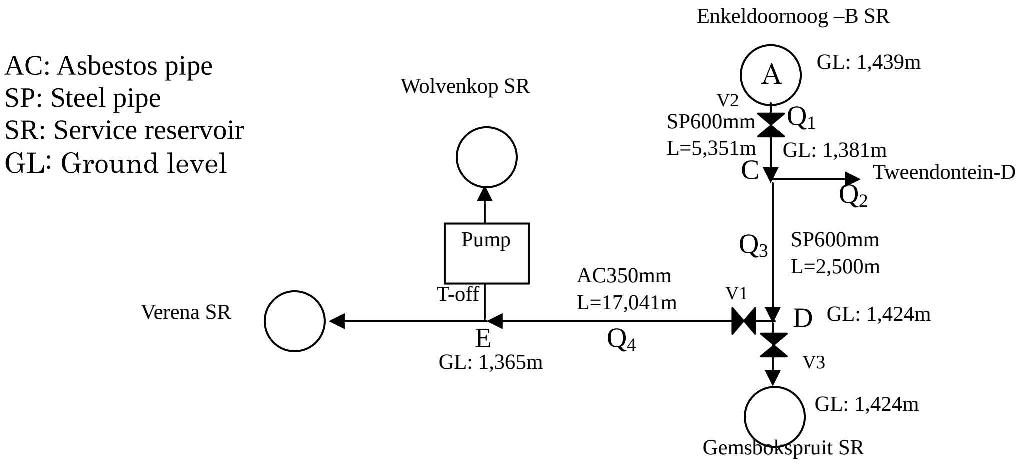


Figure 9.9.1 Example of Transmission system (Thembisile Hani LM)

9.9.2 Review on Appropriateness of Capacity of the Existing Reservoirs

The study reviewed capacity of the existing reservoirs in comparison with the required capacity corresponding to 12 hours water demand in 2020 for direct distribution and plus 1 hour water demand for indirect distribution as necessary. The result of the review in the Table 9.9.1 shows the most of reservoirs have capacity more than enough.

However, excessive capacity may have caused difficulty in distribution management if the reservoir has a role of relay function for indirect distribution; because it takes time to heighten and keep a certain water level for gravity conveyance.

The reason why many reservoirs largely exceeding required capacity have been designed and constructed seems connected to unstable bulk water supply, consequently fosterage of reservoir prioritizing storage function.

Table 9.9.1 Review on Appropriateness of Capacity of Existing Reservoirs

		Name of Reservoir	Type	Capacity (m3)	Operation	Demand in 2020 (m3/day)			Required Capacity in 2020 (m3)			Balance in 2020 (m3)		
						Scenario-1	Scenario-2	Scenario-3	Scenario-1	Scenario-2	Scenario-3	Scenario-1	Scenario-2	Scenario-3
Southern	1	Ekandustria 1	Ground	11,500	Yes	14,512	11,312	10,249	7,256	5,656	5,125	17,744	19,344	19,875
	2	Ekandustria 2	Ground	13,500	Yes									
	3	Ekandustria 3	Ground	20,000	Yes	6,285	4,909	4,452	3,143	2,454	2,226	16,857	17,546	17,774
	4	Enkeldoornoog C 1	Ground	2,200	Yes	869	677	613	434	338	307	1,766	1,862	1,893
	5	Enkeldoornoog C 2	Ground	2,000	Yes	2,101	1,637	1,483	1,050	819	741	950	1,181	1,259
	6	Moloto	Ground	5,000	Yes	2,101	1,637	1,483	1,050	819	741	3,950	4,181	4,259
	7	KwaMhlanga 1	Ground	6,000	Yes	3,722	2,937	2,676	1,861	1,468	1,338	9,139	9,532	9,662
	8	KwaMhlanga 2	Ground	5,000	Yes									
	9	Kameelpoortnek	Ground	9,100	Yes	3,105	2,455	2,240	1,552	1,228	1,120	7,548	7,872	7,980
	10	Klipfontein	Ground	?	Yes	180	140	127	-	-	-	-	-	-
	11	Tweefontein D	Ground	11,000	Yes	1,508	1,175	1,065	754	588	532	10,246	10,412	10,468
	12	Tweefontein A	Ground	500	Yes	533	417	379	267	209	189	233	291	311
	13	Gemsbokspruit	Ground	11,000	Yes	2,193	1,708	1,548	1,096	854	774	9,904	10,146	10,226
	14	Vlaklaagte (Pluto)	Ground	2,700	Yes	1,394	1,088	987	697	544	493	2,003	2,156	2,207
	15	Enkeldoornoog B	Ground	11,000	Yes	1,984	1,546	1,401	992	773	700	10,008	10,227	10,300
	16	Enkeldoornoog B Tower	Elevated	500	Non	-	-	-	-	-	-	-	-	-
	17	Wolvenkop	Ground	3,100	Yes	265	207	187	133	103	94	2,967	2,997	3,006
	18	Verana	Ground	1,800	Yes	667	520	471	334	260	236	1,466	1,540	1,564
	19	Verana D	Ground	770	Yes	684	543	496	342	272	248	428	498	522
Walkraal	20	Kwaggafontein 1	Ground	12,000	Yes	4,086	3,187	2,888	2,043	1,593	1,444	21,957	22,407	22,556
	21	Kwaggafontein 2	Ground	12,000	Yes									
	22	Vrisgewaagd	Ground	500	Yes	341	266	241	171	133	120	329	367	380
	23	Matthys-Zyn-Loop 1	Ground	750	Yes	469	366	331	235	183	166	515	567	584
	24	Boekenhouthoek (1)	Ground	500	Yes	473	369	334	237	184	167	763	816	833
	25	Boekenhouthoek (2)	Ground	500	Yes									
	26	Boekenhouthoek A(B)	Ground	1,800	Yes	493	387	351	246	193	176	1,554	1,607	1,624
	27	Goederede (Bundu)	Ground	750	Yes	462	424	411	231	212	205	519	538	545
	28	Goederede (Matshipe)	Ground	750	Yes	156	130	121	78	65	60	672	685	690
	29	Walkraal 1	Ground	12,000	Yes	1,521	1,188	1,077	760	594	539	23,240	23,406	23,461
	30	Walkraal 2	Ground	12,000	Yes									
	31	Walkraal (Oorlog)	Elevated	?	Yes	27	21	19	-	-	-	-	-	-
	32	Zoetmelksfontein B(A?)	Ground	12,000	Yes	6,096	4,753	4,306	3,048	2,376	2,153	18,952	19,624	19,847
	33	Zoetmelksfontein B Level	Ground	10,000	Yes									
	34	Ramaphosa	Ground	400	Yes	-	-	-	-	-	-	-	-	-
	35	Ramaphosa Tower ET	Elevated	100	Non	-	-	-	-	-	-	-	-	-
	36	Kikvorschfontein (Taiwan)	Ground	5,800	Yes	3,024	2,356	2,135	1,512	1,178	1,067	4,288	4,622	4,733
	37	Walkraal B1	Ground	300	Yes	269	209	190	134	105	95	166	195	205
	38	Walkraal B	Ground	750	Yes	-	-	-	-	-	-	-	-	-
	39	Magakadimeng B	Ground	300	Yes	864	673	610	432	337	305	-132	-37	-5
	40	Zondagsfontein A	Ground	300	Yes	1,489	1,161	1,051	745	580	526	-445	-280	-226
	41	Matlala ET	Elevated	132	Yes	397	309	280	198	155	140	-66	-23	-8
	42	Philadelphia	Ground	300	Yes	-	-	-	-	-	-	-	-	-
	43	Philadelphia Tower ET	Elevated	80	Yes	-	-	-	-	-	-	-	-	-
	44	Klipplaatdrift 1 (A)	Ground	800	Yes	-	-	-	-	-	-	-	-	-
	45	Klipplaatdrift 2 (B)	Ground	800	Yes									
	46	Waterval A ET	Elevated	58	Yes	-	-	-	-	-	-	-	-	-
	47	Waterval A1	Ground	800	Yes	1,263	985	892	632	492	446	968	1,108	1,154
	48	Waterval A2	Ground	800	Yes									
	49	Klipplaatdrift V3	Ground	5,000	Yes	697	543	492	349	272	246	4,651	4,728	4,754
	50	Pieterskraal B	Ground	770	Yes	434	338	306	217	169	153	553	601	617
	51	Pieterskraal Tower ET	Elevated	238	Non	-	-	-	-	-	-	-	-	-
	52	Wolwekraal	Ground	770	Yes	1,624	1,265	1,146	812	633	573	-42	137	197
	53	Waterval B1	Ground	800	Yes	-	-	-	-	-	-	-	-	-
	54	Waterval B2	Ground	800	Yes	-	-	-	-	-	-	-	-	-
	55	Elandsdoorn	Ground	10,700	Yes	3,029	2,360	2,138	1,514	1,180	1,069	9,186	9,520	9,631
	56	Kwarrielaagte	Ground	750	Yes	1,296	1,010	915	648	505	457	102	245	293
	57	Waterkloof	Ground	750	Yes	643	501	454	321	250	227	429	500	523
	58	Siyabuswa	Ground	12,000	Yes	9,501	7,403	6,706	4,750	3,702	3,353	7,250	8,298	8,647
	59	New RDP ET	Elevated	?	Yes	100	78	71	-	-	-	-	-	-
	60	Siyabuswa ET	Elevated	30	Yes	-	-	-	-	-	-	-	-	-
Weltevreden	61	Weltevreden	Ground	6,000	Yes	1,646	1,283	1,162	823	641	581	5,177	5,359	5,419
	62	Vrieskraal	Ground	770	Yes	515	402	365	258	201	182	512	569	588
	63	Vrieskraal ET	Elevated	?	Non	-	-	-	-	-	-	-	-	-
	64	Matjesgoedkuil	Ground	193	Yes	343	267	242	171	134	121	22	59	72
Kameelrivier	65	Kameelrivier	Ground	6,000	Yes	1,567	1,221	1,106	784	611	553	5,216	5,389	5,447
	66	Leewufontein	Ground	6,000	Yes	1,059	826	748	530	413	374	5,470	5,587	5,626
	67	Pieterskraal A	Ground	770	Yes	377	295	268	188	148	134	582	622	636
	68	Vaalbank	Ground	5,000	Yes	2,422	1,887	1,709	1,211	944	855	3,789	4,056	4,145
	69	Leewufontein B ET	Elevated	198	Yes	-	-	-	-	-	-	-	-	-
Bloedfontein	70	Bloedfontein	Ground	16,000	Yes	6,211	4,840	4,384	3,105	2,420	2,192	12,895	13,580	13,808
	71	Rhenosterkop	Ground	166	Non	-	-	-	-	-	-	-	-	-
	72	Zamenkomst ET	Elevated	198	Yes	669	521	472	335	261	236	-137	-63	-38
	73	Makeepsvley ET	Elevated	370	Yes	678	528	478	339	264	239	31	106	131
	74	Keerom ET	Elevated	200	Yes	315	245	222	157	123	111	43	77	89
	75	Doornlaagte ET	Elevated	79	Non	305	237	215	152	119	108	-73	-40	-29
	76	Spitspunt	Ground	2,700	Yes	1,407	1,100	998	703	550	499	1,997	2,150	2,201
	77	Lefiso ET	Elevated	120	Non	602	469	425	301	235	212	-181	-115	-92
	78	Semohlashe ET	Elevated	38	Yes	17	14	12	9	7	6	29	31	32

CHAPTER 10 PLANNING THE ASSET MANAGEMENT

10.1 Organisation to Operate the Western Highveld Water Scheme

Issues the institutional development shall address are (1) cultural, (2) socioeconomic and (3) legal frameworks, and "organization" with its (a) operational, (b) human and (c) financial resources. In other words, if the improvement of an organisation of the water service provider is challenged, application of the institutional development will be the most comprehensive approach.

This approach shall address not only what the organisation has i.e.

a. operational resources such as facilities and equipment for water supply
b. human resources that is its personnel or manpower
c. financial resources debt/asset, revenue/expenditure and cash flow, all of which derive usually from the customers/consumers

But also where it is located, i.e.

a. cultural framework including historical backgrounds, religious disciplines, traditional behavior of the communities and other cultural standings
b. socioeconomic framework, wherein how the societies and communities are organized and how the people earn and spend moneys
c. legal framework, that is how the laws and regulations control behavior of people and organisations

Thus, the organisation for the Western Highveld Water Scheme is looked at as follows:

(1) Cultural framework

1. It is located in a "segregation area" very close to the largest job markets
2. Water supply was and is virtually free, and much more hidden in the history.
3. A pseudo state of Kwa-Ndebele Bantustan was forced, and the pseudo government ruled the territory nominally; the discontinuation of apartheid split this contiguous land into 5 local municipalities in 3 provinces
4. Republic of South Africa installed and gave the Water Scheme to the Kwa-Ndebele Government, which used to (only nominally) operate it for the entire territory; after democracy was established, parts of water supply facilities were transferred separately to individual municipalities, who then were mandated to own and operate thus split facilities independently

(2) Socioeconomic framework

1. Many of the residents depend on pensions or help from absent family member/s working at remote workplace, while a few up-to-date marketplaces (supermarket, fast foods, etc.) are shown in the region
2. High poverty and jobless rates are demonstrated by the extremely low rate of tax/tariff collection
3. Degraded ability and willingness to pay for water derived from the poverty, further deteriorated by often interrupted and lasting suspension of supply of water
4. No significant evolution of ethnic demography during 17 years since democracy was established

(3) Legal framework

1. The Free Basic Water policy
2. Thefts of water and illegal connections are nearly publicly made; WSP has no lawful enforcement
3. Exorbitant grants and subsidy reaching 70 to 90 percent of the municipal revenue
4. Thembisile Hani LM became insolvent due to undefined loss of a large amount of cash a couple of years ago. No one was accused and no one tried to accuse anyone for the responsibility, while the LM has since been under the administration of the Department of Cooperative Governance and Traditional Affairs
5. Premature and yet-to-be defined governance of the local municipal administration; one example may be no distinction between the general public administration and the service delivery of the public service enterprise

"Organisation" as such:

1. The Water Service Provider (WSP) is split into two within the municipality. One in the technical (or infrastructure) department is solely in charge of operation and maintenance of the water supply facilities, whereas another wing in the financial department is generally responsible for the income and expense of the municipality including, among others, reading of water meters, billing and collection of water tariff
2. The Municipal Manager, the head of public servants in municipality, is an only supervisor common to these two wings of WSP. He can hardly coordinate and advise the technical operation and financial balance-making of the WSP
3. The one, who can represent the ownership of WSP, and can be responsible and accountable for the entire business of the water supply services, is, therefore, absent

(a) Operational resources

1. Insufficient pressure, irregular supply, interruption and suspension of supply for hours and days in many places
2. Insufficient maintenance brought the superannuation of facilities and equipment; majority of transmission and distribution pipes are of asbestos
3. Small leakages from pipes are often unattended for a prolonged period of time, unless large enough to cause inundation
4. Plans and drawings, as well as list of facilities and equipment are not sufficiently present / prepared
5. A single and comprehensive water supply system, which was so planned and installed as to service the entire Kwa-Ndebele as a whole, is now divided into pieces and operated separately by individual municipalities without always sufficient coordination

(b) Human resources

1. A half of the posts are vacant; this applies to the entire municipal office
2. Turnover of the personnel, particularly of the high ranked personnel is quite fast; few stay more than 10 years in the municipal office
3. Capacity of manpower is well below standard in quantity and in quality, as competent and competitive black manpower drained away into the private sector under the Black Economic Enforcement (BEE) policy; there is no qualified water supply engineer in the region

(c) Financial resources

1. Water meters are not evenly installed in each of municipalities, wards and communities; comprehensive lists of customers are not always prepared.
2. There are many areas where water meters are vandalised immediately upon installation; where no meters are installed, a flat rate water tariff is applied - this often triggers wasteful use and in-house leakage of water
3. Tariff billings are not evenly made either in municipalities; water tariff is a part of all-inclusive invoice from the municipalities, and the all-inclusive payment rates are from 3 to 7 percent in the region - thus collected amounts are not allocated to each item of billing/invoicing, but added up to the municipal revenue in general
4. Rate of physical loss from the network or "unaccounted-for water" is reportedly 40 percent; the remaining 60 percent is "accounted-for water," which is billed for collection rate of 3 to 7 percent
5. "Revenue water" may, therefore, be calculated as: $0.6 \times 0.03 \sim 0.07 = 0.018 \sim 0.042$

   Thus, 2 - 4 % is "revenue water," and 96 to 98 percent is "non-revenue water"; this implies that water in this region is virtually free, and the Western Highveld Water Scheme is operated by money of the national treasury (through grants and subsidies)
6. DWA has been advising and recommending "ring-fence" (separation and isolation) of accounting of the water supply business; immediate application thereof may be systematically and technically difficult

The institutional development shall address all the above enumerated difficulties. The cultural and socioeconomic frameworks, i.e. (1) and (2) are already given and not operable. One can only respect and learn from them.

The legal framework (3) and the following difficulties are targets of addressing or operations for development.

History of Japan's water service providers may provide many suggestions here. Many of the small and powerless providers in small municipalities in Japan repeated merging and integration by themselves, and continuously reinforced technical and financial strength.

The service providers of today's Japan recover nearly all the costs of the supply of water from their tariff revenue. Their national average of non-revenue water is more or less 10 percent.

There are four steps or modes towards the integration:

- shared facilities
- unified clerical (and technical) management
- unified business management
- integration of entire operation

Many took the appropriate steps and achieved the complete integration of many small providers, and thereby widened the area of service and obtained more population served. They now enjoy the advantage of unified and cooperated resources.

They enjoy the more effective management through widened scale of business (financial resources), added facilities (operational resources) and reinforced technical capacity (human resources). For details, refer to Annex 2.

These experiences of Japan can be easily applied to the Western Highveld, since its water supply system was historically planned and installed as one single water supply scheme. The first steps of the shared facilities are already there.

The most notable difference between South Africa and Japan, among others, is that Japan has the Act of Local Public Service Enterprise, which is absent in South Africa. The public service delivery by Japan's local municipality is obligated to run on an independent account and recovery of costs from users.

South Africa does not seem to have a clear distinction between the general public administration and the public service enterprise of the municipality. If there is no legal concept of public service enterprise, it has to be legislated in the near future.

To make this mandate clear, WSP in each municipality may be reorganized as shown below:

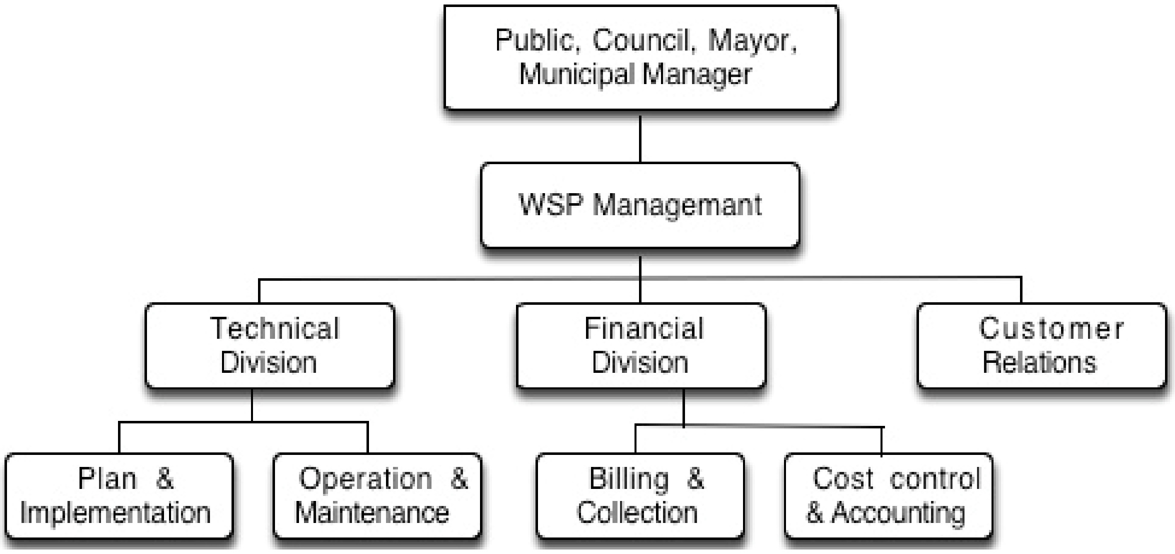


Figure 10.1.1 Basic Organisation of Water Service Provider

A more independent entity shall be targeted by equipping it with a financial division and customer care unit. The personnel of the current financial department, who are engaged in meter reading and billing, can be transferred at first.

Water bills have to be issued separately from the present all-inclusive invoice, and tariffs for water have to be collected separately. Accounting of the water service business shall be a separate exercise and independent, through which a public service entity (business) shall be clearly distinctive from the general public administration.

Even if the entity is reorganised, the present difficulties – in particular, human resources being substandard in quantity and quality - will not be improved.

A more efficient operation and maintenance of facilities (operational resources), increased income of tariff revenue from the increased number of the served population (financial resources), and provision of highly qualified manpower (human resources) may be brought about through widening of the served area and integration of service entities of municipalities.

If immediate integration seems difficult, then loose cooperation or partial unification of specific functions may be tried in the beginning. For tight and firm integration, that is most efficient and advantageous, they can advance step by step.

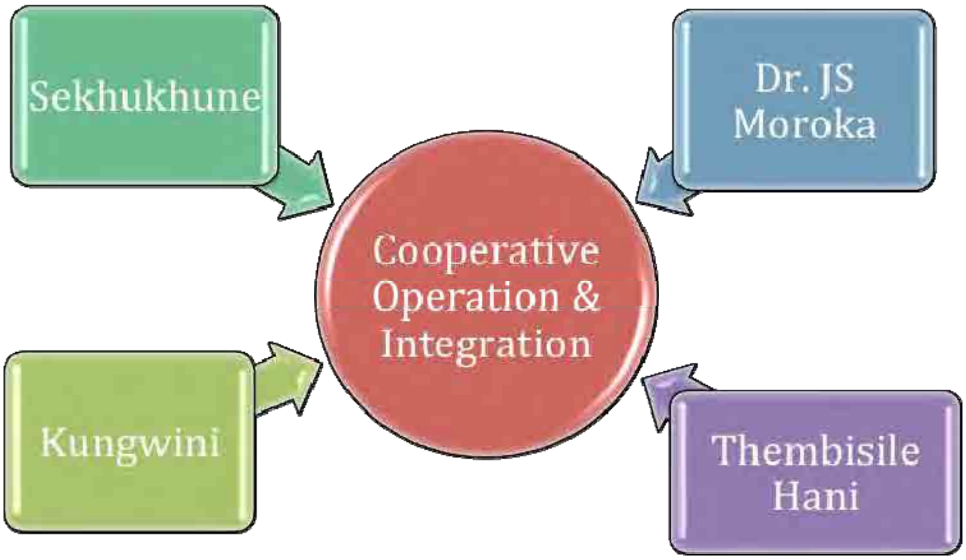


Figure 10.1.2 From Loose Cooperation to Firm Integration

Anyone who is not serious about improving the aforementioned difficulties can make this process politicised, and cause much disruption to the system. However, it is difficult to deny that such integration is the easiest way to improve the Western Highveld Water Scheme, since it was once a single system successfully operated by a single operator that was once the government of Kwa-Ndebele.

It is important that the relevant municipalities agree to try the target of integration. They need to commence talking about its preparation, and establish an organisation as the Secretariat to this preparatory talk.

Once this Secretariat is established, it can be a counterpart organisation to a technical cooperation project from Japan, which will be proposed in detail in the Item 14.1.

It is hereby proposed to invite the technical cooperation from Japan, through which people of Western Highveld may have an opportunity to learn from Japan's success in the water supply sector.

10.2 Infrastructure Development Plan

10.2.1 Selection Criteria for Targeting Infrastructure Plan

Transmission and reticulation pipelines targeting infrastructure plan was planned based on the following selection criteria.

Criteria	Reasons for Criteria
Information on the existing pipes is clarified	Installation year, diameter and distance of the pipe are very important to plan a rehabilitation, etc.
Pipes other than the pipes which is rehabilitated in Refurbishment and Upgrading of Bulk Water System in Western Highveld (DWA Gauteng Province)	To avoid duplication of the project
Existing pipes which was laid before 1980	Service life of the pipe will reach in 2020
Asbestos pipes	There is no a policy that regulates replacement of the asbestos pipe in South Africa but DWA noted that the main causes of the leakage is asbestos

Criteria	Reasons for Criteria
Even if leakage is reduced, the pipe whose diameter of the trunk main (treatment plant to base reservoir) of the bulk transmission pipes will be short in 2020	Even if unaccounted for water is reduced to 23 per-cents in 2020 which is advocated in WSDP, flow quantity will negatively be affected due to a shortage of diameter of the pipe.

Source: JICA Study Team

10.2.2 Plan of the Pipe Replacement by DWA

Scope of development for the bulk transmission and reticulation pipe, which will be carried out by DWA through the project of Refurbishment and Upgrading of Bulk Water System in Western Highveld is shown in Table 10.2.1 and Table 10.2.2. The place and pipe distance of the project was not specified because of a bid tender stage in September 2011.

In order to estimate pipe distance in the project of Refurbishment and Upgrading of Bulk Water System in Western Highveld and avoid duplication of the project, unit price of 250m in diameter - which is old pipe aging and the longest distance in terms of the bulk transmission pipe - was applied and that of 75-100mm in diameter which is long distance out of the network was applied.

As a result of the estimation, bulk transmission of approximately 2,600m and reticulation of approximately 7 700m were excluded from the infrastructure plan respectively.

Table 10.2.1 Replacement Plan of Bulk Transmission Pipes in Refurbishment and Upgrading of Bulk Water System in Western Highveld

Municipality	Targeted Area for Pipe Replacement	Cost (ZAR)	Estimated Pipe Distance (m)*
Dr. JS Moroka LM		2,600,000	2,600

Note*: Unit price of 250mm (ZAR1,000/m, including VAT) was applied.
Source: Sekhukhune DM

Table 10.2.2 Replacement Plan of Reticulation Pipes in Refurbishment and Upgrading of Bulk Water System in Western Highveld

Municipality	Targeted Area for Pipe Replacement	Cost (ZAR)	Estimated Pipe Distance (m)*
Thembisile Hani LM	KwaMhlanga、Tweefountein K、Moloto	2,000,000	3,800
Dr. JS Moroka LM	DuToitskraal、Libangi	411,000	800
Sekhukhune DM	Motei、Elandsdoorn、Kwarrielaagte、Walkraal	1,600,000	3,100
Total		**4,011,000**	**7,700**

Note*: Unit price of 75-100mm (ZAR520/m, including VAT) was applied.
Source: Sekhukhune DM

10.2.3 Distance of the Pipe Replacement to be Proposed

The distance of the pipe replacement to be proposed is shown in Table 10.2.3

The distance of the pipes that will be replaced through the DWA's project was deducted from the distance to be proposed. Total distance of the bulk transmission and reticulation pipes to be replaced is approximately 470km and 340km, which is about 19 percent of the total existing reticulation pipes.

Table 10.2.3 Distance of the pipes to be replaced

Municipality	Bulk Transmission Pipes					
	Total Distance of the Existing Pipes (m)	Distance of the Pipes to be Replaced Considering Installation Year and Material (m)	Distance of the Pipes to be Replaced due to a Shortage of Diameter of Trunk Lines (m)	DWA Project* (m)	Distance to be Replaced (m)	Rate of Replace ment (%)
	1)	2)	3)	4)	5)=2)+3)-4)	6)=5)/1)
Kungwini LM	49,203	0	7,130	0	7,130	14.5%
Thembisile Hani LM	226,015	161,616	0	0	161,616	71.5%
Dr. JS Moroka LM	303,553	245,436	0	2,600	242,836	80.0%
Sekhukhune DM	104,121	59731	0	0	59,731	57.4%
Total	**682,892**	**466,783**	**7,130**	**2,600**	**471,313**	**69.0%**
Municipality	Reticulation Pipes					
	Total Distance of the Existing Pipes (m)	Distance of the Pipes to be Replaced Considering Installation Year and Material (m)	DWA Project* (m)	Distance to be Replaced (m)	Rate of Replacement (%)	Remarks
	1)	2)	3)	4)=2)-3)	5)=4)/1)	
Kungwini LM	225,280	30,205	0	30,205	13.4%	
Thembisile Hani LM	850,151	n.a.	3,800	n.a.	n.a.	
Dr. JS Moroka LM	718,948	306,655	800	305,855	42.7%	
Sekhukhune DM	n.a	n.a.	3,100	n.a.	n.a.	
Total	**1,794,379**	**336,860**	**7,700**	**336,060**	**18.8%**	

Note: * Refurbishment and Upgrading Project
Source: JICA Study Team

For the future, the distance by diameter of the bulk transmission and reticulation pipes to be replaced is summarized in Table 10.2.4 and Table 10.2.5 respectively.

Table 10.2.4 Distance by Diameter of the Pipes to be replaced (Bulk Transmission Pipe)

Kungwini LM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
600	Steel	7,130
Total		**7,130**

Thembisile Hani LM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
125	Asbestos	780
200	Steel	4,025
	Asbestos	22,806
250	Asbestos	5,288
300	Asbestos	22,219
350	Asbestos	26,152
400	Asbestos	21,429
500	Asbestos	37,908
600	Asbestos	16,555
700	Asbestos	4,455
Total		**161,616**

Sekhukhune DM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
150	Asbestos	11,280
200	Asbestos	15,037
250	Asbestos	17,762
300	Asbestos	3,085
350	Asbestos	5,257
400	Asbestos	5,782
500	Asbestos	1,529
Total		**59,731**

Dr JS Moroka LM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
100	Asbestos	2,448
150	Asbestos	57,509
200	Asbestos	28,652
250	Steel	80
	Asbestos	59,764
300	Steel	241
	Asbestos	24,037
350	Asbestos	7,966
400	Asbestos	935
450	Asbestos	11,414
500	Asbestos	17,187
600	Steel	21,055
	Asbestos	1,812
700	Steel	9,736
Total		**242,836**

Table 10.2.5 Distance by Diameter of the Pipes to be replaced (Reticulation Pipe)

Kungwini LM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
100	Asbestos	5,200
150	Asbestos	5,835
200	Asbestos	835
350	Asbestos	1,270
400	Asbestos	1,230
450	Asbestos	3,975
500	Asbestos	5,395
600	Asbestos	1,470
700	Asbestos	4,995
Total		**30,205**

Dr JS Moroka LM

Diamter (mm)	Existing Pipe Material	Pipe Distance (m)
75	Asbestos	151,522
90	Asbestos	12,854
100	Asbestos	89,450
110	Asbestos	181
125	Asbestos	924
150	Asbestos	20,583
160	Asbestos	3,631
200	Asbestos	6,556
250	Asbestos	11,432
300	Asbestos	7,454
350	Asbestos	1,010
400	Asbestos	533
600	Asbestos	525
Total		**306,655**

10.2.4 Cost of Infrastructure Development Plan

Table 10.2.6 shows the cost of pipe replacement estimated based on the unit cost of laying the pipe. This was obtained from Tshwanae Metropolitan Municipality.

The total cost of the pipe replacement is ZAR1,34 billions;

- bulk transmission pipe - approximately ZAR 1,08 billions
- reticulation pipe - approximately ZAR 0,26 billions

Unit cost includes indirect cost and VAT but not the cost of the following items:

- consultant fee
- contingency
- environmental impact assessment
- land acquisition

As a condition of the cost estimation, unit cost for diameter of the existing pipe was applied for overall cost estimation with the exception of pipe with a diameter of about 7 130m in Kungwini LM.

The unit cost for PVC was applied for a diameter of 50 to 400mm, while unit cost of HDPE was applied for at least 450mm.

Table 10.2.6 Cost of Pipe Replacement

LM/DM	Bulk Transmission Pipe		Reticulation Pipe		Cost (ZAR Mil.)
	Distance of the Pipe required for Replacement (m)	Cost (ZAR Mil.)	Distance of the Pipe required for Replacement (m)	Cost (ZAR Mil.)	
Kungwini LM	7,130	49	30,205	84	133
Thembisile Hani LM	161,616	385	n.a.	n.a.	385
Dr. JS Moroka LM	242,836	578	305,855	177	755
Sekhukhune DM	59,731	65	n.a.	n.a.	65
Total	**471,313 (69%)***	**1,077**	**336,060 (19%)***	**261**	**1,338**

Source: JICA Study Team

* Rate of the total distance of the existing pipes. However, the total distance of the pipes includes only that of reticulation pipes, which is only clarified through the study.

10.3 Proposal on Reduction of the Unaccounted for Water

According to water demand prediction by the JICA study team, water demand for the year 2020 was estimated to be 108 167m^3/day (in case of 40 percent for unaccounted for water).

If unaccounted for water is reduced from 40 to 23 percent, which was targeted in WSDP, approximately 23 881m^3/day and approximately ZAR 90 748/day (ZAR33Millions/year) will be conserved and result in cost savings. (see Table 10.3.1).

The cost saving is equivalent to about 10 percent of the annual financial expenditure of Thembisile Hani LM or Dr. JS Moroka LM.

Table 10.3.1 Water and Cost to be Saved by Unaccounted for Water

Items	Water Demand for 2020		Water Quantity and Cost to be saved
UFW (%)*1	40	23	17
Total Water Demand (m^3/day)	108,167	84,286	23,881
Water Cost (ZAR/day)*2	411,034	320,286	90,748 (ZAR 33Millions a year)

*1: 40%: In case of current unaccounted for water, 23%: In case of that unaccounted for water is reduced
*2: Water tariff of Rand Water: ZAR3.8/m^3
Source: JICA Study Team

Reduction of unaccounted for water not only has a financial impact for a municipality but also prevents improvidence development on new water sources, which are issued with huge development cost and social environment.

The causes of unaccounted for water are considered mainly to be:

- water leakage on pipes
- water leakage on service reservoirs
- illegal connection and water theft
- meter accuracy
- gap between billed quantity of water and actual consumed water
- defective tariff collection system

The quantity of water lost by the above causes has not been clarified. In order to solve unaccounted water, status-quo of the causes should be studied and counter measures should be enforced positively.

Table 10.3.2 Survey on Unaccounted for Water and Measures

Main Causes of Unaccounted for Water	Survey	Measure
Water leakage on pipes	▪ Detection of the existing pipe location ▪ Water leakage detection ▪ Measure of minimum night flow ▪ Water consumption survey	Repair of pipes and valves (Record of the repair should be regulated) Replacement of pipes and valves (Record of the replacement should be regulated) Preventive measures (Formulation of the action plan should be formulated)
Water leakage on service reservoirs	Physical inspection of crack and leakage on service reservoir	Repair of service reservoirs (Lining etc.)
Illegal connection and water theft	▪ Illegal connection survey ▪ Physical inspection on bulk transmission and reticulation pipe	Repair of pipes and valves (Record of the repair should be regulated) Enhancement of penalty based on a by-law of water supply service Tentative introduction of the water trucks in non-service area
Meter accuracy	Water meter condition survey	Repair and/or replacement of water meters (Record of the repair and/or replacement should be regulated)
Gap between billed quantity of water and actual consumed water	▪ Water audit analysis ▪ Survey on status-quo of water meter reading (Number of staff members, reading frequency, water meter reading method and budget for water meter reading)	Abolishment of flat rate system Spreading the installation of water meters Enhancement of progressive billing system
Defective tariff collection system	Survey on status-quo of water meter reading (Number of staff members, frequency and budget)	Improvement of water tariff collection system Establishment of Independent accounting system on water supply service

Source: JICA Study Team

If the unaccounted-for water - which consists of physical leakage and theft through the illegal connections - is 40 percent, then accounted-for water being delivered to the customers will be 60 percent.

The collection rate of billed water of accounted-for water (60 percent) is 3 to 7 percent, whereas the rate of non-revenue water will be much more than 96 percent. This is excluding the case of Sekhukhune DM where water is not billed and Free Basic Water is applicable to the households.

While the measures against leakage and theft may improve the rate of unaccounted-for water, i.e., 40 percent, the remaining accounted-for water consisting of more than 56 percent shall be improved by the improved business operation or more appropriate laws and regulations.

The improved business management system may be challenged through steps towards integration of WSPs. Appropriate legal enforcement may cover the following items:

- clear penalty against illegal connection
- enforceable installation of water meters (these two may be addressed through bylaws at provincial level)
- once meters are installed at all the customers, households consuming a large volume continuously are considered to be the richer ones; the present tariff table with mildly progressive curve may be gradually remodeled to the more steeply progressive, like logarithmic curve
- legislature of an act of (local) public service enterprise, that makes clear principles of cost recovery from the users and financial autonomy of the public service business by the public organisation, and enables suspension/termination of services to the customers who do not pay

None of the above can be implemented in a short span of time in the Western Highveld region and South Africa. Japanese experts, who consult as members of the proposed technical cooperation project, will find the most practical and sustainable solutions for the Western Highveld region.

10.4 Proposal of Asset Management System

Dr JS Moroka LM prepared an asset management plan on water supply facilities in 2007. This is the five year-rehabilitation plan of the existing water supply facilities from 2008 to 2012 through the study for a capacity and specification of the existing water supply facilities.

The report on asset management plan is equivalent to an asset management inventory and very useful for the rehabilitation project.

Asset management inventory as well as water supply inventory contains a main specification and quantity of the water supply facilities. It is indispensable for regular maintenance and appropriate operation of the facilities.

Water meters and gate valves on the drawings of the water supply network are indicated in the water supply inventory.

There is a shortage of the information on water supply facilities as shown in Table 10.4.1.

Asset management inventory has not been developed with the exception of Dr JS Moroka LM in Western Highveld.

In order to effectively operate and maintain the water supply system and to rehabilitate it in the Western Highveld area, development of asset management and water supply inventory is required.

Records of maintenance should be reflected in the asset management inventory. Database management is an effective measure used to prepare the asset management and water supply inventory.

The following table shows the items required for an asset management system It is proposed that an asset management system is promptly introduced to Western Highveld area.

Table 10.4.1 Proposal of the Management Items on Asset Management Inventory

Facility	Management Items	
Intake	[Structure] ▪ Installation Year ▪ Location (Coordinate) ▪ Depreciation ▪ Asset Value	[Mechanical Equipment] ▪ Pump Specification ▪ Number of Pump ▪ Installation Year ▪ Year of Inspection ▪ Year of Rehabilitation ▪ Annual depreciation ▪ Asset Value
Conveyance, Transmission and, Reticulation pipeline	▪ Pipe Distance ▪ Pipe Diameter ▪ Pipe Material ▪ Installation year ▪ Year of Replacement ▪ Annual depreciation ▪ Asset Value	
Treatment plant	[Structure] ▪ Installation year ▪ Location (Coordinate) ▪ Annual depreciation ▪ Asset Value	[Mechanical Equipment] ▪ Specification ▪ Number of equipment ▪ Installation year ▪ Year of Inspection ▪ Year of Rehabilitation ▪ Annual depreciation ▪ Asset Value
Service Reservoir	[Service Reservoir] ▪ Capacity of Reservoir ▪ High Water Level ▪ Low Water level ▪ Attitude ▪ Service Area ▪ Main Function ▪ Installation Year ▪ Location (Coordinate) ▪ Annual depreciation ▪ Asset Value	[Valve and Flow Meter] ▪ Specification of Valve and Flow Meter ▪ Diameter ▪ Work Condition ▪ Installation year
Pump station	[Pump House] ▪ Installation year ▪ Location (Coordinate) ▪ Annual depreciation ▪ Asset Value	[Pump] ▪ Pump Specification ▪ Number of Pump ▪ Name of the Route ▪ Installation year ▪ Year of Inspection ▪ Year of Rehabilitation ▪ Annual depreciation ▪ Asset Value
Valve and Flow Meter, etc.	▪ Specification ▪ Diameter ▪ Location (Coordinate) ▪ Service Area ▪ Work Condition ▪ Installation year ▪ Annual depreciation ▪ Asset Value	

10.5 Infrastructure Investment Plan

10.5.1 Investment Resource Needs and Financing

Investment resources are needed for the improvement of the water supply service in the Western Highveld Region. The areas in need are outlined below:

(1) Cathodic Protection Works of the Transmission Main (Ref. 4.2.4 ‘Basic Design for the Cathodic Protection Works)

- Cathodic Protection Works Rand 3.945 Million

(2) Replacement of the water pipelines (Ref. 10.2.4 Infrastructure Development Plan (Cost Estimate)

- Bulk Transmission Pipeline R1,077 million
- Distribution Pipeline R 261 million
- Total R1,338 million

The cathodic protection works of the transmission main as stipulated above (1) shall be conducted by using the South Africa's own resources. The appropriate financial source may be DWA's Regional Bulk Infrastructure Grant.

It is desirable that the replacement of the water pipelines as stipulated above (2) shall be conducted simultaneously with the implementation of the Technical Cooperation Project which the JICA team is proposing in another Chapter of this report.

The financial resource as stipulated above in (2): Bulk Transmission Pipeline might be the DWA's regional Bulk Infrastructure Grant.

In DWA's Budget for FY2011/12, two (2) projects for the bulk water supply in the Western Highveld Region are listed, the total project cost of which is R698 Million. Assuming that the whole of this amount can be used for the purpose of the above-mentioned (2), the financing source for the balance of R640 Million (1,338-698) needs to be found.

As analysed in Chapter 7: Financing, the relevant municipalities do not have the capacity to generate the financial resources by themselves. There is no central government's subsidy - except the Regional Bulk Infrastructure Grant as mentioned above - which can respond to such voluminous investment resource needs.

DBSA financing cannot be accessed for the under-resourced municipalities in the Region. Therefore, in order to fulfill the investment resource needs, the JICA team would like to propose the creation of the financial mechanism for the water projects by the South African municipalities and for utilising Japan's ODA loan to support it.

10.5.2 The necessity of creating a financing mechanism for the water projects by municipalities

As the financing sources for the water projects by the municipalities in South Africa, there exist schemes such as:

- the subsidies from the central governments, namely DWA's Regional Bulk Infrastructure Grant and Department of Cooperative Governance and Traditional Affaires (CoGTA)'s Municipal Infrastructure Grant
- the fiscal transfer to the local governments (CoGTA's Equitable Share Grant)

In addition to these schemes, Development Bank for Southern Africa (DBSA) financing is also available. Since DBSA provides its financing only for the bankable project, the water projects which DBSA can finance are limited to those in the metropolitan municipalities and the secondary municipalities. It is not accessible for the under-resourced municipalities such as those in the Western Highveld Region.

The subsidies and fiscal transfers from the central government are limited and lack proper monitoring mechanism by the central government. Therefore, it is said that they are not effectively utilised for the water supply services. There is a concern on the possible moral hazard in the heavy dependence on the subsidies as the resource for the water supply service as it should theoretically be financially self-dependent.

In order to accelerate the development of water services by South African municipalities, it is essential to create the loan-financing system which is accessible even for under-resourced municipalities. In the long run, the repayment of loans should be covered by the water tariff revenue.

In the meantime, such a measure should be considered as the under-resourced municipality can borrow the funding for the water supply project by earmarking the subsidies and the fiscal transfer from the central government to the local government as the resources for the repayment or as securities for borrowing.

In South Africa, although municipalities are allowed to securitise the conditional grant for borrowing by the Treasury Circular (Feb., 2010), only the municipalities which can become financially independent within three (3) years, can utilise this scheme, since the condition for application is very tight.

In Japan, loan financing schemes such as the Fiscal Investment and Loan Program, Postal Saving Account Loan and Japan Finance Corporation for Municipal Enterprises play an important role in providing financial resources for water projects by the municipalities in Japan. Japan's experience can be the reference for the creation of a financing system in South Africa.

In order to make such financial system workable, however, it is necessary to obligate a specific code of conducts to the business management of the water service entity. Japan has the Act of Local Public Service Enterprise, which obligates local/municipal governments to separate the tax based general account form the special account of the public service delivery business, that is generally derived from the service charges paid by the service recipients., The implementation of the financial interdependence or autonomy of such public service enterprise, that should be ditinctively separated from the municipal general account, is being monitored by the central government. If such code of conducts defining the 'financial independence/autonomy' of the public service enterprises is not established, it is difficult to provide the business oriented management disciplines to the water service entitiy under the local/municipal government. Nobody, therefore, dare to provide a loan to such water serves entities.

Until such an appropriate financing system is introduced to South Africa, the investment resource needs for the water supply facilities for the bulk water supply facilities in the Western Highveld Region can be drawn from the DWA's Regional Bulk Infrastructure Grant. However, there is no financial institution or financial mechanism that can provide the financing for the substantial investment for the replacement of the asbestos distribution pipelines managed by the municipalities.

Therefore, it is the view of the JICA team that there is a room for the government of South Africa to consider the utilisation of Japan's ODA loan for the development and rehabilitation of the distribution network in the Western Highveld Region. It is desirable that Japan's ODA loan be utilised in a way to support and supplement the creation of the financing mechanism for the water projects by the municipalities in South Africa.

10.5.3 Possibility of the provision of Japan's ODA to South Africa

(1) Eligibility for the provision of ODA

South Africa is categorised as the developing country in the DAC categorisation. Therefore, South Africa is eligible for technical cooperation. Since Grant Aid for General Project is for the low income countries, South Africa is not eligible as the recipient of the Grant Aid for General Project.

As for the possibility of the provision of Japan's ODA Loan, the per capita GNI of South Africa in 2009 was US$5,730 (World Bank Atlas), therefore South Africa is categorised as an Upper-Middle Income Country (the per capita GNI in 2009 is US$3,946~6,885) in Terms and Conditions of Japanese ODA Loans (Effective from April 1, 2011).

For the provision of ODA Loan to the Upper-Middle Income Countries in Sub-Saharan Africa, there is a policy paper by three (3) Ministries concerned with policy making for Japan's ODA Loan (Ministry of Foreign Affairs, Ministry of Finance and Ministry of Industry and Trade) titled: 'On the utilization of ODA Loan for the assistance to Africa'.

The development of Africa where the wide spread poverty still prevails is one of the most urgent issue for the global community. Japan hosted TICAD IV in May 2008 and pledged its ODA Loan assistance amounting to a total of US$4 billion for 5 years for regional infrastructure and agricultural development.

Based on this commitment made at TICAD IV,

the ODA Loan to Upper-Middle Income Countries (1) is directed to, in addition to four areas (environment, human resource development, disaster prevention and disaster mitigation, reduction of regional income disparities), those areas in the regional infrastructure which contribute to the poverty reduction by economic development, agriculture and rural development project, etc. They are eligible as long as the commitment of an ODA Loan is made before the end of FY 2012.

1) Upper Middle Income Country is a country whose per capita GNI in 2008 was US$3,856-6,725 - in accordance with the World Bank Lending Guideline

2) In many developing countries and not limited to African countries, the poverty statistics are not well developed and, therefore, it is sometimes difficult to calculate precisely the percentage of the poor population relative to total number of beneficiary. In such a case, the project will be considered as a project for the reduction of regional income disparity if the income level of the direct or indirect beneficiaries is substantially lower than the average income level of the country.

As for the personal income level by the municipalities, there is a data from the Community Survey 2007. According to the survey, the nation-wide distribution of populations according to income level is outlined below.

The weighted average income (monthly) is calculated by using this data is R1,797 (using the figure R204,801 for the highest income group/ R204 801 and more).

Table 10.5.1 Distribution of population according to income level (South Africa nation-wide)

Income Range	**Population**
No income	22 281 148
R 1 - R 400	8 049 256
R 401 - R 800	2 367 582
R 801 - R 1600	5 721 410
R 1601 - R 3200	2 296 539
R 3201 - R 6400	1 824 969
R 6401 - R 12800	1 425 850
R 12801 - R 25600	659 318
R 25601 - R 51200	285 283
R 51201 - R 102400	89 257
R 102401 - R 204800	46 741
R 204801 or more	26 734
Sub Total	**45 074 087**
Response not given	2 776 204
Institutions	651 770
Total	**48 502 061**

The distributions of populations according to the income level of Thembisile Hani LM and Dr JS Moroka LM - which are the LMs whose whole territories are within the Western Highveld Region - are as follows:

Table 10.5.2 Distribution of population according to income level (Thembisile Hani LM)

Income Range	**Population**
No income	130 350
R 1 - R 400	70 948
R 401 - R 800	15 322
R 801 - R 1600	37 776
R 1601 - R 3200	11 244
R 3201 - R 6400	4 169
R 6401 - R 12800	2 258
R 12801 - R 25600	721
R 25601 - R 51200	164
R 51201 - R 102400	60
R 102401 - R 204800	229
R 204801 or more	104
Total	**273 345**

Table 10.5.3 Distribution of population according to income level (Dr JS Moroka LM)

Income Range	**Population**
No income	126 093
R 1 - R 400	56 292
R 401 - R 800	14 453
R 801 - R 1600	29 298
R 1601 - R 3200	7 887
R 3201 - R 6400	4 142
R 6401 - R 12800	2 706
R 12801 - R 25600	442
R 25601 - R 51200	241
R 51201 - R 102400	0
R 102401 - R 204800	0
R 204801 or more	0
Total	**241 554**

Using the same calculation method as South Africa nation-wide, the JICA team calculated the average income (monthly) as R800 for Thembisile Hani LM and R570 for Dr JS Moroka LM - which is far below the national average R1 797.

Therefore, this case is applicable for ‘the income level of the direct or indirect beneficiaries’ as it is substantially lower than the average income level of the country’ as stipulated in above (2). The water supply project in the Western Highveld Region fulfills the eligibility criteria for the reduction of the regional income disparity to which the provision of ODA Loan is possible.

Possibility of the acceptance of the provision of Japan’s ODA loan by the Government of South Africa

As mentioned above (1), South Africa is a country that qualifies as eligible of Japan’s ODA Loan. If there were an obstacle, it would be on the South Africa side.

According to JICA South Africa office, the government of South Africa restricts the provision of the government guarantee to the foreign loan, and this hampers the realisation of the provision of ODA Loan which normally requires the government to be a borrower or the government to provide the government guarantee.

There is a hesitation to borrow the loan dominated in Yen as it is accompanied by the foreign exchange risks.

The JICA team has learnt that recently the Land Bank, a state financial institution for agriculture sector, was given the certain provision for the government guarantee, and the discussion between the Government of Japan and the Government of South Africa on the provision of the ODA Loan is on-going.

Accordingly, it would be essential for DWA to acknowledge the effectiveness of the ODA Loan for the water supply project in the Region and to the Treasury firmly in order to realise the provision of the ODA Loan.

CHAPTER 11 FORMULATION OF THE CONSUMER MANAGEMENT

11.1 Measures in Water Demand Conservation

Water conservation is not common to the culture of the people and there is limited understanding among dwellers that water resources is a precious commodity.

There is even less understanding of water leakages (and preventing them). The pilot study notices how much water is wasted as a result.

According to a result of the water meter survey in the model block area, Dr JS Moroka, in-house leakage was observed in 15 out of 48 houses. This appeared to be due to a lack of understanding of water conservation among the sample group.

It is probable that low awareness among water users of water leakage, and thus wasting water, is caused by the fact that there is no incentive in place to compel users to save water. This is due to the fact that a flat water rate water tariff system is used and the billing system is vague.

It is very important to reduce the amount of water leakage in order to resolve the shortage of water supply. It may be approached from both of the supply side and the consumer side. Such items, targets and measures are tabulated as below.

Table 11.1.1 Water Demand Control and its Measures

No.	Measures of water demand reduction	Contents	Measures	Water Suppliers	Water Consumers
A.	**Proposal for Water Demand Control**				
A-1	Promotion of water saving equipments	Reduction of water consumption rate with water saving equipments	Introduction of Subsidy arrangement and loan system are required because of measure to poverty	○	○
A-2	Establishment of adequate water tariff system	Establishment of water tariff system is effective measures to reduce water demand. Setting up water tariff makes it possible to control water consumption through water tariff collection.	Installation of water meters and establishment of water tariff system based on water by-law and Retail Water And Sanitation Tariff Guidelines should be promoted.	○	
A-3	Advocacy on water conservation	Willingness of dwellers on water leakage inside the houses should be raised. Reduction of supplied water through water conservation makes it possible to decrease water production cost as well as the cost of water which is provided from Rand Water.	Metered water tariff makes it possible to improve willingness for water conservation. In addition, water consumers should promote through advertising the necessity of water conservation though advertisement, etc. Education on water conservation in schools is very effective way. Students who study it may convey the message to their family. Water conservation should be part of the education curriculum.	○	○
A-4	Repair on water equipments inside the houses	Water consumption rate can be reduced through the repairs of water equipments inside the houses.	Introduction of Subsidy arrangement and loan system are required because of measure to poverty	○	○

No.	Measures of water demand reduction	Contents	Measures	Water Suppliers	Water Consumers
A-5	Installation of water meters	Awareness on water conservation water users will be improved by installation of water meter and water consumption rate will be decreased	Subsidy or lean should be applied to water supply entity to cover the cost of water meter installation	○	
B.	**Proposal on Reduction of Water leakage**				
B-1	Intentional Rehabilitation on deteriorated pipelines	Adequate maintenance system on pipelines should be established	The existing data of pipelines should be coordinated and developed by special maintenance team. Rehabilitation of the existing pipelines should be prioritised based on the existing information and experiences of staff members because leakage points have not been clarified. For instance, asbestos pipelines must be replaced preferentially.	○	
B-2	Sustainable analysis on water consumption and supplied water	Non-revenue water should be learnt through measurements of actual water consumption and the supplied water	Water balance between inflow and water consumption through installation water meters in each of the households and public taps should regularly be recorded	○	
B-3	Introduction of leakage detection technology	Water leakage detection team should be established with leakage detectors required for early detection of leakage	Measurement of minimum night flow and inflow should be promoted through introduction of detectors such as pipe locators, acoustic bars for the other than pilot areas. Repairs of water equipments inside the houses are one of the pre-conditions for taking measurements of inflow and minimum night flow.	○	

Source: JICA Study Team

11.2 Credit Control

The credit control exercise at the Ward Councilors' urges non-payers to pay, or it writes-off in the book of accounts receivable (on "adjustment" item in the all-inclusive invoice / bill). This is for residents whose payment is over the limit. Neither of brings a true increase of revenue. It is not possible to enforce payment from the truly poor.

The credit control shall primarily address non-payers who can afford to pay, but are not willing to pay due to a culture of non-payment that originates from the segregation era.

In the estimated population of 830 000 and households of 180 000, more than 96 percent are assumed non-payers. Within Sekhukhune DM, none of 40 000 households belonging to the region are billed or are tariffs collected. If they are billed suddenly, the issue will be immediately politicised.

Persuasion or "consciousness raising" toward individuals will not be very effective, if it is made sporadically and discontinuously. Institutional and organised approaches over a long period of time are required to better the payment/collection ratios, including the separate billing of water charges.

In addition to the appropriation of lawful enforcement mentioned in Section 10.3, can an "income supplement policy" for the place of the present "free water (or free public services) for the poor" be applied?

If the historical background and economic situation of this region is taken into account, none can raise an immediate increase of tariff revenue. Time consuming efforts towards the target of cost recovery and a sustainable service entity shall be paid through improvement of lawful enforcement, institutional systems, organisational structures and customer relations.

11.3 Customer Care Functions

Even though profit is not a primary target, the water supply service is a business and a price is charged for a commodity that is water. Where water tariffs are not billed, paid and collected satisfactorily, significant effort shall be required to establish a unit to interact customers.

In general, no organisational efforts are observed to raise not only the ratio of collected/billed tariffs, but also the rate of regular billing. While Ward Councilors are expected to urge non-payers to pay, they are not able to canvass the average number of 2 000 of households in every ward.

If they are too hard on non-payers, they will lose votes in the next election. This is believed to be part of the difficulty resulting in a payment rate as low as 3 to 7 percent.

In the ordinary water supply office in many places in the world, there is usually a public or customer relation unit. The most basic and important role of such a unit generally includes, among others, the following:

- to have the public know how the safe portable water is produced, conveyed and distributed to the consumers
- to show how much it costs for the above activities
- to encourage the customers to participate in the recovery of the above costs, so that the safe and ample water may be continuously supplied
- to process and convey important complaints and claims of the customers to the management and/or the relevant units of the water supply office, so that the customers' voices may be properly addressed to, etc.

The municipal offices in the Western Highveld Region do not have such a unit or an officer responsible for the public or customer relations who are/is responsible for the customer care functions. It shall, therefore, be discussed in detail in the proposed technical cooperation project from the JICA team as to how to incorporate such a functional unit into the Western Highveld Regional Water Supply Scheme.

CHAPTER 12 PROPOSAL ON INSTITUTIONAL IMPROVEMENT

Operable items among difficulties in the institutional development are proposed items to be addressed and operated for the improvement of the Western Highveld Water Scheme. While a number or items to be challenged and improved are enumerated hereunder, the most significant are re-organization of merging of technical and financial wings of WSPs, thereby an organization of water service enterprise to be financially autonomous will be brought about; and the regional integration of the present municipal WSPs to be ultimately incorporated into an larger and firmer regional water service provider. These two re-organizations or evolution are prerequisites to set to improve the others.

12.1 Laws and regulations

- Free Basic Water policy is a typical example, in which a temporal idea of politicians heavily influenced the income redistribution, financial and administrative systems of the national and local governments. The present SAPS is not intended to discuss such issues.
- There should be a clear distinction between the general public administration, in that national or local government addresses the nationals or the residents in general, and the public service enterprises, in which only specific peoples are serviced or degree / quantity of services are not even to each of the service recipients. The former shall be funded by tax revenues, whereas the latter shall be funded by the service charges to be paid by recipients.
- Clear penalty upon illegal tapping of water, vandalization to the public facilities and equipment like water meters, non-payment of service tariff.
- Enforceable installation of water meters.

12.2 Organization for the water scheme

- The primary proposal of the present report is to reorganize itself as a public service enterprise with financial division separated from the general public administration.
- Today’s vulnerable WSPs with small scale and personnel shall be integrated for firmer and efficient operation.

12.3 Operational resources

- Complete maps, drawings and ledgers of facilities and equipment.
- Reinforced measures against water leakage.
- Replacement of superannuated pipes, particularly of asbestos shall be implemented in steps as a part of preventive maintenance.
- Implementation of the other investment plans proposed in this report.
- Unified operation within the entire region by the integrated service entity.

12.4 Manpower of the water service entity

- Qualified water supply engineer who can plan, implement, operate and maintain the entire scheme in a long time perspective is needed. Not only one, but plural numbers are preferred.
- Competent staff members in the business management are needed. They can be engineers, financial experts or of any qualifications.
- Practical knowledge on leakage detection should be learned by participating in trainings to be given in the proposed technical cooperation project as counterpart members. The more

members, the better.

- Likewise, formulation of business models should be learned in practical manner by assisting the business advisor.
- Likewise, many should participate in activities of the customer relations advisor and become initial organizers of the customer relations division.

12.5 Revenue from business operations

- Even if all the measures to raise revenue water by prevention of leakage, theft, etc., are implemented, a very long period of time is expected to reach a level to earn enough income to sustain. The integrated service entity has to depend upon the grants and subsidies from the national government for the time being. Intensive efforts shall be paid continuously till recovery of the thorough cost is achieved.

12.6 Objectives or expected achievements of the integrated water service entity

Objectives are always to give solutions to the existing problems or difficulties. By establishing financially separated WSPs with financial wing, it may become a public water supply service enterprise, which may take a comprehensive responsibility on water supply and can be accountable to every stakeholder. Likewise, once the regional integration of today's municipal WSPs is achieved, it is expected to provide a homogeneous level of services to the entire region by now uplifted level of capacity in operational, human and financial aspects.

If operation of water supply is controlled by a single command, an equitable technical standard as well as level of services will be applied to every corner of the region (served area). Equalization always means equalization to the highest level or standards, that is present. To ensure this, the new organization's first task will be to enhance the service facilities towards areas of poor supply today. There should not be any are which receive poor water supply and every area should be supplied with sufficient pressure without interruption, which are provided to a certain selected areas enjoy at present.

As an integrated enterprise with multiplied number of customers, its amount of revenue shall also be multiplied. With help of tactful business management to be mentioned below, it should become to afford to employ qualified engineers, who can in turn train technicians and other technical personnel. They are expected particularly to "plan" to upgrade part of the facilities and equipment, which are deteriorated and inferior today. Among their roles expected, it is also important to plan a daily, a weekly, a monthly, an annual and a long term operation and maintenance programs, with which they take charge of the entire system and thereby any complaints from customers should be barely left unaddressed.

Under the new business models, its revenue from customers should be enhanced through installed meters, regular billing and collection of tariff by its own taskforce. A short to a long terms financial plans should make it much easier to raise funds and subsidies for new investment on rehabilitation and expansion of facilities, and enhancing capacity of the personnel, and to set aside the funds for the future development.

These expected achievements were attained only through integration of smaller providers in Japan. It may be learned, should the municipalities agree on it and invite a proposed technical cooperation project from Japan.

CHAPTER 13 PROPOSAL ON MANPOWER DEVELOPMENT PROGRAMS

Various manpower development programs, schoolings, education and trainings of the municipal officers for variety of subjects are currently carried out in many places. Some are sent to universities for quite a long time. Once these trainees gain capacities, skills and technologies, and come to show their competence, then they drain out to the private sector for the better wages. Municipalities has to raise wage rates to check these brain drains, or to give them such educations as to become aware of satisfaction with public services in the municipal office.

Being adjacent and commutable to huge job markets of Johannesburg and Tshwane, it is difficult to keep competent black manpower within the region. Betterment of the region's environments shall be tried so that people may love their home villages / towns, and stay satisfactorily with public services within their home.

Trainings on subjects, which is not applicable to the private sector, e.g., upon the local government acts, will not invite brain drains and help strengthen capacities for the municipalities. Manpower development in the water service provider may tend to train on mechanical and technical subjects in general. May it not invite brain drains? Subjects have to be chosen carefully within the subjects, that are applicable to operations and businesses of water service alone. Visits and trainings at successful water supply services within and out of country have to be planned.

13.1 Manpower development on skills for water service technology

- Technique and practical knowledge for leak detection by participating the proposed technical cooperation project by JICA.
- Skills for planning, operation and maintenance through visits to the overseas water services.

13.2 Manpower development on skills for business management of water service

By participating as counterpart members in activities of the business advisors and the customer relations advisor, practice and obtain knowledge and methodologies of the following:

- Preparation and maintenance of customer ledger and asset ledger, and structuring and building systems therefor.
- Formulation of plans for installation of water meters, meter reading, billing and collection of tariff. These plans shall include designing, structuring and building of systems therefor.
- Planning the cost control including systems and organizations therefor.
- Formulation of financial plans including organization and system therefor.
- For the purpose of betterment of customer relations, to formulate operational targets, public affinity program, organizing user groups and so on, including their practices, systemization, designing and building organizations needed.

Visits to the integrated or integrating water service entities within and out of country to learn from their experiences.

13.3 Manpower development on the local administration in general

The region is a countryside adjoining to the big cities, whose residents may prefer to visit. There are many natural parks and resorts around the region. Due to, however, bias against the ex homeland, there are no many visitors without specific business. Making the region a very attractive land, where many tourists visit and spend money, residents can raise their businesses, and outside investors seek for their opportunities. This can be a high and large target of the municipal offices here.

There could be manpower development programs for activation of village and towns economy, or so called “village encouraging or town encouraging.” For example, by visiting “one village, one product movement” in Japan, or visiting very famous but small villages and towns everywhere in Europe, their experience and knowledge shall be learned and applied to the region. This could be a good training program.

In sum, to make the region happy to live, attractive to outsiders and active in economy can be a big target of the local public administration, and at the same time, target of individual officers and residents. This target has to be clearly known, and any manpower development programs and any of daily activities shall be carried out with this clear understanding.

CHAPTER 14 POLICY ON IMPROVEMENT OF THE MANAGEMENT AND CAPACITY OF WATER SUPPLY BY SERVICE PROVIDER

14.1 Proposal on Technical Cooperation Project

The study reveals the current status and capacity of water supply by the service provider.

Analysis of the results and issues that arise has highlighted the need for a comprehensive management system in order to appropriately operate and maintain the water supply system.

The JICA study team proposes to solve various problems through the introduction of a technical cooperation project. The following outlines of the technical cooperation project:

14.1.1 Outlines of the Project

(1) Overall Goal

- effective utilization of water resources is materialized through reduction of unaccounted for water in Western Highveld
- reduction of the interrupted water supply service through unaccounted for water reduction in Western Highveld
- sound management of the public service enterprises in accordance with the internationally accepted best practices

[Assessment Index]

- percentage of reduction in unaccounted for water during the project in Western Highveld
- income / expense balance of the entity

(2) Project Objective

- to help organize a new regional water service provider entity
- to uplift capacity of personnel in the newly integrated entity in formulating and implementing the unaccounted for water reduction programmes
- to strengthen capacity of operation and maintenance of the entity in technical and business terms
- to assist the municipalities with their Municipal Systems Act, Sections 77 and 78 processes to consider internal and external service delivery options
- to assist the municipalities with their policies and by-laws relating to:
    - water and sanitation services
    - tariffs
    - credit control
    - debt collection
    - restriction of services
    - emergency situations

[Assessment Index]

- degree of integration / consolidation of the new regional entity
- development of a digital inventory of water supply facilities
- formulation of unaccounted for water reduction programme by recipient organization
- implementation of unaccounted for water reduction activities by recipient organization
- percentage of the unaccounted for water in the region
- growth of revenue to recover costs of the operation
- improved level of service delivery accepted by customers

(3) Output through the Project

- formulation of draft Articles of Incorporation for establishment of integrated entity
- Persons in charge of major departments and divisions (including the customer relations unit) are appointed and set out their activities in accordance with the business models.
- information on existing water supply facilities such as bulk pipelines, service reservoirs, pumps, reticulation will be developed in order to facilitate the maintenance as well as leakage detection
- database of the exiting water supply facility's information will be established
- skill for unaccounted for water reduction will be transferred to the recipient organisation through the in-service training that takes place in the model block
- skill for the method of leakage detection and illegal connection surveying will be transferred to recipient organisation through the in-service training that takes place in the model block
- formulation of maintenance programs and their application by the personnel of the new entity
- formulation of business models for the new regional water service entity
- formulation of a program to establish a public relations unit / division within the entity
- assistance on legal issue

(4) Area to be covered by the Project

Western Highveld area

(5) Key Activities of the Project

a. Assistance on promotion of integration of entity
b. Development of the Water Supply Facility's Inventory
c. Establishment of a Database on the Water Supply Facility's Information
d. In-service training in asset management plan formulation in the model block
e. In-service training in leakage detection and illegal connection surveying in the model block
f. Formulation of maintenance programs and their application by the personnel of the new entity and in-service training on periodic and preventive maintenance of facilities and equipment
g. Formulation of business models for the new regional water service entity
h. Formulation of a program to establish a public relations unit / division within the entity
i. Assistance on legal issue

14.1.2 Work Activities by Sector

Following contents of key activities which were summarised in the Section 14.1.1 5), work activities by the Japanese and South Africa side are shown in Table 14.1.1 and Table 14.1.2 respectively.

Table 14.1.1 Activities expertise (Japan side)

	Expertise	Activities / Job Descriptions
1	Chief advisor/ water supply service management	Management of the entire project and, in consultation and collaboration with the deputy chief advisor 2, do the following: ▪ Check every stage of progress in integration and widening of WSP services. ▪ Provision of knowledge, information and advice for promotion of the integration. ▪ All the other activities needed for promotion of the integration
2	Deputy chief advisor 1	▪ Management of technical aspects of the project.
3	NRW reduction management I (Illegal connection)	▪ Data collection ▪ Establishment of survey team ▪ Proposal of survey measures ▪ Selection of model block to survey status of illegal connections ▪ Illegal connection survey ▪ Proposal of countermeasures to protect illegal connections ▪ Monitoring after disconnection ▪ Others
4	NRW reduction management II	▪ Data collection ▪ Analysis of the existing water supply facilities

	Expertise	Activities / Job Descriptions
	(Leakage detection)	・ Selection of model block to detect leakage and measure minimum night flow ・ Leakage detection and flow measure ・ Others
5	Maintenance of facilities and equipment	・ Observation and review of the current maintenance procedure / practices ・ Formulation of a maintenance program for category of facilities and equipment ・ In-service training in maintenance in accordance with programs formulated above
6	Asset management of water supply facilities	・ Proposal in preparation of water supply facility's inventory ・ Formulation of the asset management plan ・ Others
7	GIS management	・ Establishment of database and mapping ・ Others
8	Raising public awareness	・ Selection of model block to conduct workshop ・ Conduct workshop ・ Others

e: JICA study team

Table 14.1.2 Activities by expertise (South Africa side)

	Expertise	Activities / Job Descriptions
1	Deputy Chief Advisor 2	Management of the activities by South African side, and, in consultation and collaboration with the chief advisor, do the following: ・ Check every stage of progress in integration and widening of WSP services. ・ Provision of knowledge, information and advice for promotion of the integration. ・ All the other activities needed for promotion of the integration
2	Business Advisor	Required to formulate business models readily acceptable by the councils and the customers by incorporating: ・ review and rebuilding of a customer ledger, ・ an asset ledger of all facilities and equipment to be updated annually, ・ a reasonable and revenue maximizing tariff table, ・ a water meter installation program that can prevent vandalism, ・ a meter reading, tariff billing and collection program with design and installation of the system/s thereof, ・ a cost control program including its system, ・ financial plans of the water service provider, that shall be prepared annually, in the immediate future, mid-term and long-term time spans, and ・ any other programs / systems to ensure cost recovery in a practicable manner
3	Customer relations builder	A Customer Relations Unit / Division shall be set up in an integrated / renovated water service provider entity. It shall be positioned so that it shall report to the top management of the entity. It shall be expected to facilitate favourable relations between the customers and the WSP entity by accepting whatever reasonable requests and claims by the customers, and ensure the customers are aware of and respect the mandates of the entity. The customer relations builder/s is/are required to lay a foundation for such a unit / division by formulating and applying: ・ target/s, that the entity's operation shall pursue in a year, a quarter or a month to be evolved periodically by reflecting voices of the customers ・ the "public affinity program" to be reviewed from time to time to fit the public or customers, that shall permeate the grass roots communities through media, municipal and ward councillors, community leaders, NGOs and so on ・ programmes to organise user groups that share a standpipe or a yard connection with an installed water meter, in which customers help each other in efficient use of water supplied ・ any other public mobilisation programmes as well as internal staff / personnel orientation programmes to put the better public utility services into practice By the end of the above trial and error programs, a customer relations builder/s shall prepare a layout, design and implementation program to establish a public relations unit / division. Such programme shall include but not be limited to the terms of reference, scale and quality of manpower, organisation and job descriptions of the leading members.
4	Legal advisor	Legal advisor shall do the following:

	Expertise	Activities / Job Descriptions
		▪ Formulation of draft bylaws on enforceable installation of water meters. ▪ Formulation of draft bylaws against theft of water, illegal connection and vandalism of water meter, etc. ▪ Formulation of draft bylaws to define clear sanctions against ever-lasting non-payer of water tariff including termination of supply. ▪ Formulation of draft Act of (Local) Public Service Enterprise. ▪ Provision of advices on draft Articles of Incorporation for the Integration of the Municipal Water Service Providers. ▪ Other legal advices as and when needed.

Source: JICA study team

14.1.3 Workforce and Implementation Schedule

Since field of assistance varies, it is proposed that the technical cooperation project will be carried out by the South African team as well as the Japanese team. The advantages of the two teams will be applied to both the business and pubic relations issues:

- the Japanese advantage is experience and technology that will be applied to development of data on the water supply facilities and water leakage detection
- the South African advantage is the experience of the experts who are familiar with the water supply service in Western Highveld area

It is anticipated the project period will be approximately three (3) years.

The man hours of the project will be approximately 224MM

- Japan: 82MM
- South Africa: 142MM

Table 14.1.3 Workforce for Implementation of the Project

Activities	Japan	DWA	1st year						2nd year						3rd year						Total by Japan	Total by DWA
a. Chief advisor/ water supply service management			2				2				2			2				2			10	0
b. Monitoring of Integrated entity and coordination for DWA and Municipality		Deputy chief advisor	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		0	34
c. Management of water supply services and Development of Water Supply Facility's Inventory	Deputy chief advisor		3			2				2			2				2				11	0
d. Establishment of Database on Water Supply Facility's Information	GIS management					4				3				3							10	0
e. In-service training in asset management plan formulation in the model block	Asset management of water supply facilities						4			4				3							11	0
f. In-service training in leakage detection and illegal connection surveying in the model block	NRW reduction management I (Illegal connection)						4				4				2						10	0
	NRW reduction management II (Leakage detection)						4				4				2						10	0
g. In-service training on periodic and preventive maintenance of facilities and equipment	Maintenance of facilities and equipment							3						3				2			8	0
h. Assistance on establishment of exploratory unit g. Development of business management		Business Advisor I				2	2	2	2	2	2	2	2	2	2	2	2	2			0	26
		Business Advisor II				2	2	2	2	2	2	2	2	2	2	2	2	2			0	26
i. Establishment of customer relations unit / division		Customer relations builder I					2	2	2	2	2	2	2	2	2	2	2	2	1		0	25
		Customer relations builder II					2	2	2	2	2	2	2	2	2	2	2	2	1		0	25
	Raising public awareness						3				3			3				3			12	0
j. Assistance on legal issue		Legal advisor		1			1			1			1			1			1		0	6
Total																					**82**	**142**
Grand Total																					**224**	

▭ : Japan
▭ : DWA

Source: JICA study team

14.1.4 Equipments for the Project

It is anticipated that the following equipment is required for implementation of the project (see Table 14.1.4):

Table 14.1.4 Equipments for the Project

No.	Equipment Name	Total Quantity	Japan	South Africa
1	Leakage survey equipment			
2	▪ water leak detector ▪ digital sound detector ▪ acoustic listening stick ▪ correlator ▪ portable ultrasonic flow meter ▪ water pressure data logger ▪ pipe locator ▪ non-metallic pipe locator	2 2 4 2 2 2 2 2	○ ○ ○ ○ ○ ○ ○ ○	
3	Software: asset management system	3	○	
4	Software: finance management system	3		○
5	Notebook computer	3	○	
6	Projector with screen	1	○	
7	Plotter	1	○	
8	Other Equipment			
9	▪ Copy machine (with printer & scanner) ▪ Software: Microsoft Office ▪ Software: GIS ▪ Water meters for house connection	1 3 3 1 000	○ ○ ○ ○	 ○ ○

Source: JICA study team

14.1.5 External Conditions

The following actions by the South Africa side are required before the project may be launched:

- Preparation of a budget for the costs to be incurred by the South Africa side.
- Agreement toward the integration of WSPs by the Mayors of the related municipalities, and establishment of an inter-municipal preparatory consultation committee.
- Establishment of the secretariat office for the above committee, which should be, at the same time, a counterpart organization to the present (technical cooperation) project.
- Mobilization and organization of appropriate trainees/participants for activities of the project
- Establishment of the project office (desirably shared with the committee's secretariat) with furniture and equipment.

14.2 Possibility of the application of Private-Public-Partnership (PPP) scheme

Based on the location of the project, the Western Highveld Region, it is a high poverty area in South Africa and the fiscal situations of the concerned municipalities are extremely weak. It is unlikely that there is a private enterprise, Japanese or not, who is interested in this project.

What should be pursued for the foreseeable future would be the Public-Public Partnership between the municipalities in the Region and other public enterprise in the water sector in South Africa which is relatively well managed (Water Boards such as Rand Water Board or the water utilities in metropolitan municipalities such as Johannesburg Water and Tshwane Water), leveraging off JICA's assistance and DWA's support.

Except for a few water utilities in a few metropolitan municipalities, the majority of water supply services by municipalities share the same problem as the water supply service in the Western Highveld Region, namely:

- weak institutions
- lack of human resources
- weak financial positions
- the necessity of Reduction of Non-Revenue-Water

These issues become obstacles for the introduction of PPP. Therefore, if the solutions to these problems are found through this intervention, the possibility of introduction of PPP- including Japanese enterprise - is expected to increase.

ANNEXES

Annex: Water Supply Service Institutions and the Non-Revenue Water Control of Japan

As it was suggested by DWA and will be helpful to provide some salient features of Japan's water supply service institutions and technologies for the non-revenue water reduction, summaries of such information are annexed hereto.

A.1 Water Supply Services in Japan

[Regulatory, rigid responsibility for uninterrupted supply of water]

In Japan, water supply services are primarily defined and regulated by the "Act of Water Supply" and the "Act of Local Public Service Enterprise." Therefore, anyone, who intends to operate and manage a water supply service, shall be authorized by the Minister of Health, Labor and Welfare or the Governor of the respective Prefecture. A water supply service operator, thus authorized, shall (1) operate and maintain the operational plan that consists of water's intake, conduction, treatment transmission and distribution to house connections, (2) shall not refuse to enter into a contract to supply water to anyone who needs water and applies for a supply contract in a area of the authorized operational plan, unless there is a justifiable reason, and (3) shall supply water to a consumer continuously and uninterruptedly in principle. Almost all of such water supply services / businesses are owned by local municipal governments (cities, towns and villages), by prefectural governments (upper local municipal bodies similar to provinces or districts in the case of South Africa), or by group / combination of them.

[Water supply service as local public service enterprise / business that shall run on its own income-and-expense balance independent from the local municipality's operating budget]

At present, almost all of the water supply services in Japan are operated by business entities (local public business entities), that are managed by local public municipalities, on the basis of the independent income-expense accounting (whereby they are responsible for the operational and financial management separated and independent from the local public municipalities). Local public servant engaged in the water supply service, therefore, shall be paid with salary and allowances from the income from the water supply service, as he is an employee of the local public business entity. Any subsidy or grants from and also any contribution to the municipality or central government is discouraged and not expected nor desired.

[Retail of water by the local municipality level business and wholesale (bulk supply) by the wide-area prefectural government level business]

In most areas, "retail of water" that is to supply water to individual consumers on the contracts with them are operated by the water supply service business entities under the local public municipalities (like WSP). In other areas where wide-area water supply services are operated by the prefectures, they usually operate as "wholesalers of water (like bulk supplier)" to the water supply entities under the local public municipalities. However, in the extended capital areas such as Tokyo, Osaka, etc., such prefecture-operated water supply service entities (bulk suppliers) supply water to consumers, exceptionally, on basis of the direct contracts.

[Entities / organizations to operate water service business, and current trends / needs to integrate themselves into a firmer, larger and stronger organization]

It has been a practice in most of the cases that a department or a division of the respective prefectural or local municipal government was an entity (WSP) to carry out the water supply business on basis of independent accounting. In the recent years, however, grouping of plural entities (WSPs) through cooperation, collaboration or integration is being progressed, for the intentional advantages of shared efforts to cope with soaring costs of water right, replacement / rehabilitation of overaged facilities, repayment of construction bonds, and the revised tariff table due to merged local municipalities and to encourage water saving, and so on.

A. 2 Integration of Water Supply Services in Japan

For the purposes of consolidation of smaller local municipalities, enlarging of business scale, reinforcement of technical / engineering capacity, effective use of scarcely utilized resources, etc., widening of service areas through integration of water supply business organizations has been recently being progressed in Japan. To the present Western Highveld Region, lessens of Japan seem to be applicable and effective in significant enhancement of water supply services there. Various types / degree of integration and their expected achievements iterated in a handbook of "Japan Waterworks Association" are outlined here.

A.2.1 Types / Degree of Integration of Water Supply Business Organizations

Types / degree of integration may be classified, from slack to tight, into 9 types under four modes.

Mode A: Shared facilities

- Type 1: Mutual assistance in emergency
  A loose cooperation arrangement to help each other in disaster, etc.
- Type 2: Connected transmission line for emergency
  To connect a pipeline to enable water transmission to either side in emergency.
- Type 3: Shared facilities
  To install and maintain shared facilities such as water intake, conduit, treatment plant, distribution reservoir, laboratory for water quality analysis, etc.

Mode B: Unified clerical (and technical) management services

- Type 4: A wide-area wholesaler (bulk supplier) to unify clerical (and technical) managements of the retailing organizations (WSP's)
  Retailing organizations (WSP's) in local municipalities to commission their clerical (and technical) management services to a wide-area bulk supplier.
- Type 5: Collective commissioning of clerical (and technical) managements to a management organization
  A management organization (cooperative or private corporation) to render services of plural local retailers (WSP's).
- Type 6: Unified clerical (and technical) management by a large and strong organization (like large city)
  A single or plural smaller organizations (small WSP's at small LM's) commission their clerical (and technical) managements to a large WSP, which has firmer clerical and technical force.

Mode C: Unified business management

- Type 7: Single business entity to manage businesses of plural water supply organizations
  Plural WSP's or water schemes commission their business administration to a larger WSP, i.e., a wide-area or a prefectural supplier (like bulk supplier).

Mode D: Integration of entire operation

- Type 8: Integration of WSP/s and a wide-area or bulk supplier (vertical integration)
  A bulk supplier merges retailer/s who receive water from it and supplies water to the end users or consumers.
- Type 9: Integration of plural WSP's (horizontal integration)
  Integration of plural WSP's into a single authorized WSP (of large scale).

A.2.2 Expected Achievements of the Service Area Widening through the Integration of WSP's

The widening of service area and therefore enlarging scale of the service / business operation through the integration of WSP's was a policy primarily intended to spread the equitable demand / supply balance over every part of Japan. In the recent years, however, concerns for the wider-area water supply services are gradually changing as follows:

a. To equalize the demand / supply balance through widening or joining the service area
↓
b. To equalize level of services and quality of installed facilities
↓
c. To strengthen financial / business basis and technical / engineering basis through the integrated or collaborative management
↓
d. To seek integration to strengthen management and service levels, given the respective locality allows

Thus varied modes and types of the service-area widening through integration have been developed. As a result, it was learned that each mode of integration had attained a sort of similar advantages or achievements as follows:

Mode A: Shared facilities
Improved level of installation and maintenance of the shared facilities, and reinforced response to emergency / disaster will be expected.

Mode B: Unified clerical (and technical) management services
Bettered management of the unified scope of services, operations and customer-relations is expected.

Mode C: Unified business management
Unified single business administration will bring about an equitable maintenance level of facilities, strengthened revenue earning and expense control, eased customer accessibility and particularly dignity of professional services of water supply.

Mode D: Integration of entire operation into a single corporation
Reinforced bases for engineering and business, that extensively cover installation of facilities, management setup, efficient operation of business, customer relations and all the other layers of the water supply enterprise, are expected.

The present Western Highveld Water Scheme has already achieved the Mode A: Shared Facilities. If further integration through other modes towards desired achievements is chosen, the above summarized lessens in Japan may help in the detailed manners.

A.3 Non-Revenue Water Reduction Approach and ODA Projects of Japan

A.3.1 Leak Reduction Approach of Japan

Non-revenue water, which is composed of leak itself, insensible meter water, illegal usage, fire fighting and so on is the lost water as well as non-beneficial water quantity for a water authority. Especially the leak does not only make any profit, but also bring about the traffic accident due to the road cavity. For that reasons, water authority in Japan has been made every effort to reduce leakage. Thereafter, the average leak rate in Japan is less than 10%, especially bureau of water works of Tokyo metropolitan government achieved the leak rate about 3.6%.
However, average leakage ratio in the many of Asia’s metropolises is about 30%, those of even Hongkong or Seoul city is 20% or more. More and more water authorities in Asia cities are learning leak reduction on Tokyo these days.

Leak reduction activities on water works in Japan are detailed below.

(1) Leak Reduction Program

It is necessary to progress leak prevention program in the middle and the long term schedule. We need to consider the actual conditions of each water authority, and the records from the past activities. Therefore, it is important to clarify the cause and tendency of the leakage from the detailed research. From that detailed record, we are able to conduct a water system renovation in line with business plan such as the review of pipe materials, the plan on pipe replacement to improve our water distribution system.

We need three (3) comprehensive and continuous approaches to the leak prevention. The first is fundamental approach such as distribution analysis, second is supportive approach such as leak detection, and the third is preventive approach such as facility improvement.

Specific plan should be made for the each approach in accordance with the following points.
The leak reduction plan is adequate for the three (3) to ten (10) years approach guided by plan for Non-revenue water reduction, and the [leak reappearing] on the leak repaired pipelines.

Table A.3.1 Leak Prevention Measures

Approach	Item	Countermeasure
Fundamental approach	Preparation of Leak reduction	Financial resource / Organization Documents (Pipe mapping, Area mapping Area set up, Metering facility
	Actual situation research	Distribution amount, analysis, Pressure measurement Cause of leaks, Leak analysis
	Improvement of pipe material,	Selection of material main line and service connection, joints, couplings, pipe fittings.
	Technical development	Measurement method of water leak amount Locating method of pipelines Leak detection method, Repair method,
Supportive approach	Mobile work,	Immediate repair of visible leakage
	Planned work	Finding underground leak in early stage, and the repair
Preventive approach	Business plan on water authority	Distribution system designing plan prioritize for water leak prevention.
	Distribution designing and constructing	Earthquake proof, Time proof, Corrosion proof, Water tightness.
	Replacement of end of life pipelines （Replacement of leak repetition pipelines）	Replacement of main / service pipe （Alternation on pipe material）
	Structural improvement of service lines	Consolidated road crossing pipes, bundled pipes
	Protection of pipelines	Setting up meter near the border line of public and private. Attaching of anti-corrosion, anti-leakage core, reinforcing the joints and bends of service pipe
	Disposal of used pipe	Complete disposal from the branch point. Water supply equipment control
	Beware of Pipe	Supervise the excavation of the other utility company
	Pressure control,	Partition of distribution area, Installation of pressure control valve

(2) Measure of Leak Amount and Audit of Distribution Water

It is necessary to measure accurate leak amount to prepare the annual leak reduction plan. There are two (2) ways to measure the leak amount. One is to measure the leakage quantity directly by the water meter, other is to analyze the amount using audit of distribution water.
Followings are the audit of distribution water by IWA (International Water Association).

Table A.3.2　Distribution Audit

(1)System Input Volume	(2)Authorized Consumption	(4)Billed Authorized Consumption	(8)Billed Metered Consumption (including water exported)	(17)Revenue Water
			(9)Billed Unmetered Consumption	
		(5)Unbilled Authorized Consumption	(10)Unbilled Metered Consumption	(18)Non-revenue Water
			(11)Unbilled Unmetered Consumption	
	(3)Water Loss	(6)Apparent Losses	(12)Unauthorised Consumption	
			(13)Customer Metering Inaccuracies	
		(7)Real Loss	(14)Leakage on Mains	
			(15)Leakage and Overflows at Utility’s Storage Tanks	
			(16)Leakage on Service Connections to point of Customer metering	

(3) Necessary Map for Leak Surveying

1) Distribution system map（scale 1:10000- 1:20000）

This map is for all the distribution network of supplying area with 1 or 2 pages.

This map shows material of pipes, diameter, fire hydrant, valves and so on, it is useful for distribution control, planning for water distribution.

＜Entry＞・・・Distributing reservoir, pump station, distribution network, contour line

2) Distribution piping map (scale 1:2500)

This map is useful to obtain detail of connection of each line, pipe fittings as valves, fire hydrants, air valve and cocks. The map is used for planning of leak surveying, planning of pipe replacement.

<Entry>・・・Distribution main, diameter, valve, hydrant, air valve, stop valve, district name, address.

3) Customer map (scale 1:1000, 1: 1500)

This map is the most detailed map for water maintenance which indicates not only distribution pipe, service connection but also pipe location, and the depth. The each house has meter number or 4) customer number that indexes customer records.

<entry>・・・distribution pipe (main and sub-main), diameter, valve, fire hydrant, air valve, stop cock, service T joint, service pipe location, meter, meter number, district name and address.

- Valve and fittings record (1/200, 1/300)

This is 3 point off set map of valves, hydrants, air valves.

- Customer records

This is a record of each customer in-house pipelines, meter and the pipeline to main pipe.

(4) Planning for Leak survey

Flow shows the basic procedure for leak surveying.

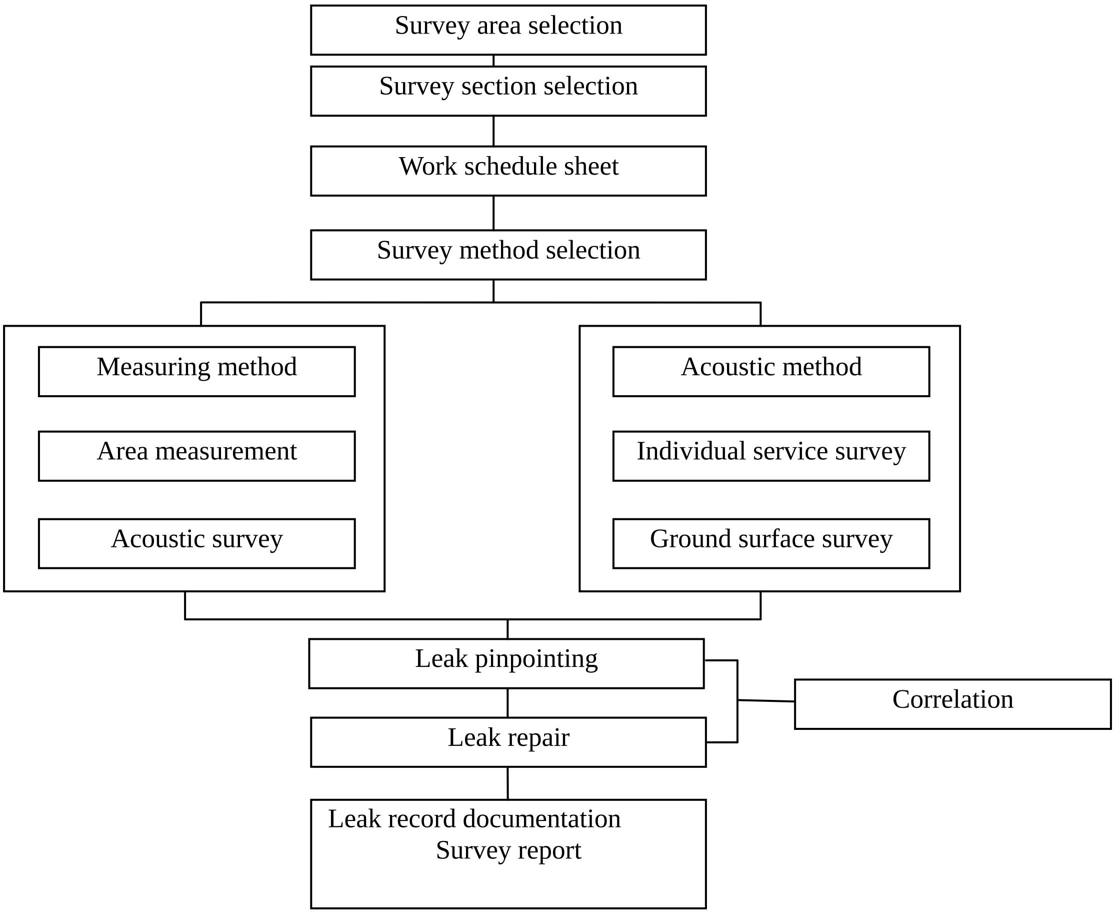


Figure A.3.1 Basic Leak Surveying Flow

(5) Selection of survey area and size

After the selection of the survey area, the survey section should be selected with the consideration of 1 day workload. The survey section per day is about 2-3 km on the distribution pipe, thus this is the standard work load.

1) Methods of leak survey

- Area method, measure method

Large block: 10km over, Middle block: 4km – 9km, Small block: about 3km

To obtain minimum night flow per each block, section for measure inflow and pressure.

- Line method.

Pipe fitting survey and hydrant noise level recording survey.

Listen all the valves, fire hydrants, fittings and discriminate the possibility of leakage line.

- Pinpoint method, Ground surface listening survey

Using ground microphone, it captures the leak noise which reached to ground surface from the leak point.

Using correlation type leakage detector, it captures the leak noise from the 2 fittings by 2 sensors near the leakage, then it measures the time difference on each points, and calculates the distance to leakage.

Table A.3.3 shows the difference of leak survey method depends on effectively used water ratio.

Table A.3.3 Leak Survey Method for Respective Effectively Used Water Ratio

<table>
<tr><th colspan="2">Effective rate</th><th>Under 75%</th><th>Under 85%</th><th>Over 85%</th></tr>
<tr><td rowspan="3">leak</td><td>Part</td><td>Main: Service</td><td>Main: Service</td><td>Main: Service</td></tr>
<tr><td>Number</td><td>4 : 6</td><td>3 : 7</td><td>1 : 9</td></tr>
<tr><td>Quantity</td><td>7 : 3</td><td>6 : 4</td><td>3 : 7</td></tr>
<tr><td colspan="2">Characteristic</td><td>High quantity leaks on main scattering</td><td>Leaks on main, service, intermixed</td><td>Small leaks scattering</td></tr>
<tr><td colspan="2">Survey concept</td><td>Broadly for big main leaks</td><td>Intensively for selected area</td><td>Closely investigation for all area</td></tr>
<tr><td colspan="2">Flow measure</td><td>Large block (system)</td><td>Middle block</td><td>Small block</td></tr>
<tr><td colspan="2">Survey method</td><td>Fittings and Surface surveying</td><td>Flow measurement + line selection</td><td>Flow measure (acceptable) + fitting surveying</td></tr>
<tr><td colspan="2">Object of survey</td><td>Focus on main</td><td>Main & service pipe</td><td>Service pipe</td></tr>
<tr><td colspan="2">Effect</td><td>Improvement in short period</td><td>Small improvement and stagnation</td><td>Maintain high effective rate</td></tr>
<tr><td colspan="2">Intent</td><td>Leak detection</td><td>Leak detection</td><td>Scheduled survey</td></tr>
<tr><td rowspan="3">Subject</td><td>Large facility</td><td colspan="2">Highly effective due to Large quantity leak detection.
Repeatedly continuous survey for all area</td><td>Continuous survey needed. Large quantity leak influence on effective rate.</td></tr>
<tr><td>Middle Facility</td><td>Mainly main pipe leaks survey. Repeatedly continuous survey</td><td rowspan="2">Select suspected leak area, repeatedly continuous survey.</td><td rowspan="2">Flow measurement in each small block. Detailed survey in short term cycle.</td></tr>
<tr><td>Small Facility</td><td>All area survey in short term.</td></tr>
</table>

1) Area measurement, Leak quantity zone survey

Estimate leak quantity of isolated, blocked area by inflow measurement.

<u>Indirect method (Night measurement)</u>

There are two (2) methods of measuring isolated area. Direct method is to close stop cocks on each service connection completely for no supply of water for consumers. Indirect method is not to close stop cocks so that continuously supplying water to consumers during the measurement. On this measurement we use flow and pressure data logger to obtain the minimum night flow and estimate the leak quantity based on the minimum flow value.

This indirect method is comparatively easy to set up the extent of the area. However, the larger area reduces the time of no using water, increases the valves to isolate the area, increases the possibility of making low pressure zone near the isolated area, and increases the possibility of large diameter flow mete, which affects the accuracy to the Leak quantity measurement.

From the view of the work performance, pipelines of about 3 to 4km are recommendable in the isolated area.

The survey area of leak quantity is 1 to 1.5m^3/km/h or more when pressure 0.2Mpa. It is desirable to close inlet valves and stop cocks of storage tank or water receiving tank for large usage customer in the area because of the accuracy minimum night flow measurement. It is necessary to choose small consumption season and consumption time to the wide extended isolated area measurement so that it is better to choose by the each distribution lines or distribution reservoir. The flow measurement should be implemented by the permanently fixed bulk meter or the temporarily flow meter with pressure logger. For the fixed district meter, it should be high prioritize not to reduce the water supply to the adjacent area.

At present in Japan 2011, it is common way that water leakage detection is implemented by only the acoustic listening survey not with leak amount measurement. The reason is leak rate reduced since 1980s, the priority comes to early detection and the early repair, isolation work forces consumer no water, the night time work load piles up in proportion to valve numbers, so that most of the water authorities have switched into acoustic leak survey from leak volume measurement.

However, some water authority keeping on minimum night flow measurement until the area to being leak quantity per km area (m^3/km/h) falls below the acceptable threshold level.

(6) Method of leak survey

1) Site preliminary investigation

- Object

Preliminary investigation is to check off the map and actual site field of planed leak survey area. In this investigation aims to grasp water facility condition, to offset the buried distribution of main pipe lines, confirm the moved pipeline, especially bended pipeline and dead pipeline. Also check the noisy facility or environment which makes interferences to the ground surface survey.

- Procedure

The survey area for one week, (4 survey section / 15 km) or more should be investigated in one day. It is important to offset the distance from the boundary to the pipes which buried under traffic road. Use pipe locator for branch or complicated pipelines and offset the points and directions.

- Equipment

Pipe locator PL-960

Non-metallic pipe locator NPL-100

Valve & Box locator F-90M

2) Individual service connection survey

- Object

This meter listening or stop cock listening work is mainly for the purpose to find leakage from the service connection and water supplying devices. This survey is able to capture the leakage sound from the T connection “ferrule” at the main line to meter or stop cocks. In country wide, many leaks occur from the ferrule to meter or stop cocks. The smaller leak is also detected by this survey. This work is implemented during the day time due to entering to the each and every house.

- Procedure

One day workload is 1 section about 3.5km per one team.

One party consists of two investigators, and use listening device. Then listen to the sound carefully at the house meter or stop cock. If the abnormal noise is detected from the fitting, close the stop cock and listen again to distinct from using water sound or leak sound.

Open the meter box or valve box, then listen to the sound at the meter or stop cock.

- Equipment

Listening stick LSP-1.5m

Electric Listening stick FSB-8D

3) Ground surface survey

- Object

This is mainly to find leakage from buried main or service line from the ground surface using the ground microphones. The main object is to find the leak from distribution main and service lines until the meter so that all the captured abnormal noise from the ground surface should be examined by the experienced investigator. Therefore, night time is optimum conditions to implement the ground surface sounding due to the less traffic/environmental noise, less using water, the higher water pressure makes the louder leak noise.

- Procedure

One party investigates 1 survey section (about 3.5km) per one night.

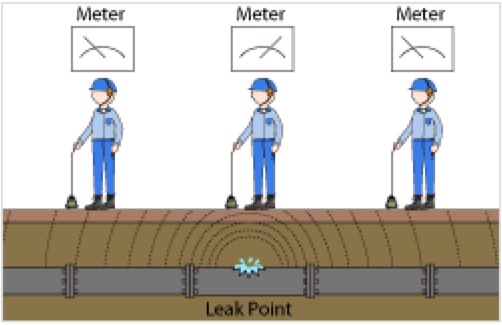
One party consists of two persons, each person use ground microphone, apart for certain distance, and listen carefully the sound from the pipe line from the ground surface not to lose any suspected leak sound. Furthermore, even in night time, listen to the sound at the accessible valves, hydrants, stop cocks, every pipe fittings as much as possible for the leak sound.

This is the essential part of leak surveying, it is necessary to listen to the sound from accurately above the buried pipelines. The detected "noise occurrence points" are the suspected leak points, so that the points on ground surface and maps should be marked, and the marked point should be re-confirmed by the confirmation survey.

Normally, it is considerable risky to decide the leak point by the ground surface survey only by ground microphones due to various conditions of soil and surface that causes no leak excavation.

- Equipment

Water Leak Detector DNR-18



4) Correlation
There is a method to capture the leak noise at the two points between the pipelines and to measure distance to the leakage point from the sound capturing sensors.
a. Attaching two (2) sensors on the fittings such as valves, hydrants between suspected leakage on the pipeline.

b. The sound captured by the each two (2) sensors transmitted to correlation type leakage detector, and measuring the time difference of the leak to the each sensor.

c. The figure shows relation to the sensors and leakage point.
L = (D-N)/2
Distance to the leak is able to calculate as the above formula.

d. N equals to time delay (Td) multiplied by Velocity (V),
N = V * Td

e. Correlation type leakage detector implements these calculations automatically with the input data such as pipe material and distance to the sensors, and shows the leakage point.

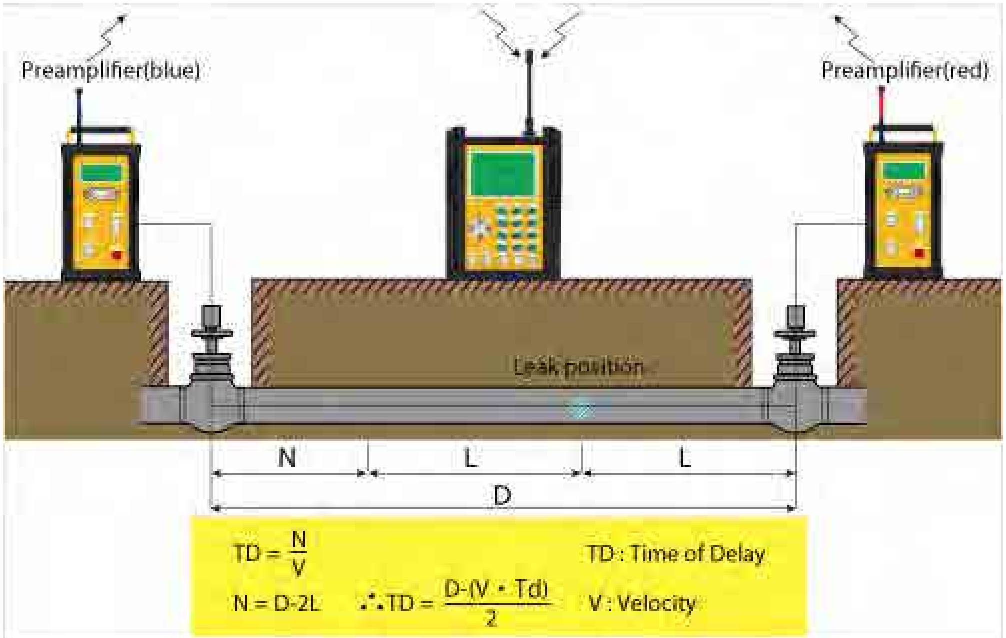


Figure A.3.3 Correlation Method

- Equipment


Leak noise correlator LC-2500

5) Confirmation
Confirmation is the key to success of the leak pinpointing. This is to re-confirm the “noise occurrence points” which detected during the surveying was leakage or not. The confirmation aims to avoid

no-leak excavation, and to point out at the center of leak.

Confirmation is mainly done during the daytime, with boring from the surface, closing stop cock, checking of pipe and valve, inspecting water flow of drainage and ditch.

- Procedure

To investigate into the marked / offset point in advance as following procedures.

a. Making some 20mm diameter holes by electric hammer drill and insert boring bar until nearer to the pipe itself for the suspected leak point on pipe and ferrule. After that, inserting listening stick 1.5m into the holes, and confirm the sound which point is the center of the leakage.

b. On the leak from service line, when there is noise at stop cock, close the cock and check if the sound comes after the cock (internal leakage) or before the cock.

c. It is necessary to investigate water flow in manhole of sewage, if suspected flow has seen, check the chlorine and conductivity to distinguish ground water or leak water from the water pipe.
After the confirmation, the definite accurate leak point should be reported by the leak record sheet

- Equipment
  - Water Leak Detector DNR-18
  - Listening stick LSP-1.5m
  - Electric Listening Stick FSB-8D
  - Boring bar 1.0m
  - Electric hammer drill (Hitach Koki)
  - Generator (2.0KVA)

(7) Actual conditions of Leak and the report

The leak forms, conditions, and the classification of the cause need to be reported and documented correctly as it is necessary to feed back to daily leak reduction plan such as new pipe designing, and plumbing so that we could prevent and reduce the leak itself. Therefore, we need to consider the detail of leak record sheet for the basic data analysis.

The content of leak record sheet as follows.

1) Cause of leak and the condition, 2) Material, 3) Diameter, 4) Pressure, 5) Type, 6) Photo or sketch, 7) Size of orifice, 8) Estimated leak amount

At least the above eight (8) contents are necessary.

Through that leakage sheet, we are able grasp the cause and recurrent pipe line of leak, and able to feed back them to the leak prevention plan, leak reduction activity plan, pipe replacement plan, and pipe plumbing procedure.

(8) Leak prevention approach

The supportive approach such as leak detection and the repair is necessary for early leak detection and early repair, however it has limitation to improve effective water quantity of the pipeline due to re-occurrence of leak and time-related deterioration.

Therefore, the leak preventive approach to be an anti-leak water distribution network system is needed aggressively. The preventive approach often starts as a countermeasure for cause of leaks and conditions. In addition, the old pipe replacement or renovation of preventive approach is time and money consuming. Therefore, it is also necessary to approach economically.

<u>Work items</u>

There are a lot of work items and some are easy and some are not. For newly established pipelines, it is easy to use preventive approach. However, it is hard to use it for the renovation of existing pipelines.

Work items as follows;

Table A.3.4 Preventive Measure Work Items

Items	Contents
Plan	・Distribution network design, optimization of area ・Pressure control ・Flow and pressure monitoring system・Distribution support plan
Distribution system design and construction	・Selection of pipe (anti-earthquake, endurance, anti-corrosion, anti-leakage)・Construction (depth, pipe support, surface cover, the other utility combination)・Completion test (Pressure, Leak test)・Anti-earthquake
Pipe replacement and renovation	・Old pipe replacement or renovation・Vulnerable pipe replacement ・Anti-slip out joint, anti-leak joint・Pipe relocation for the other utility work ・Flexible joint
Pump	・Pump controlled by number・Water hammer control
Service pipe	・Selection of pipe material・Connection method (ferrule with saddle, Split T joint)・Re-locate stop cock ・Removal of remaining pipe, Complete stop at ferrule・Adequate meter diameter, early replacement・Service lines replacement to common line
Pressure control	・Separation of distribution area by contour・Pressure control valve, pressure control reservoir・Area re-organization for pressure control ・Pipe system maintenance, (by-pass line, pipe cleaning)
Others	・Hydrant Inspection・Illegal connection control・Drainage pipe inspection ・Customer map preparation (1/500, 1/1000)

A.3.2 Japan's ODA Programs on Non-Revenue Water Control

Cases of the non-revenue water reduction or non-revenue water control among from the recent Official Development Assistance (ODA) Programs of the Japanese Government are tabulated below, and salient features thereof are depicted in this Section.

Table A.3.5 Project Cases of NRW Control / NRW Reduction

	Country	Project name	Period of cooperation,	Summary
a.	Jordan	The capacity development project of non-revenue water reduction in Jordan	From August 1, 2005 to July 31 2008	Completed, project report disclosed
b.	Egypt	The Project for Improvement of Management Capacity for Operation and Maintenance of SHAPWASCO	From November 1, 2006 to October 30, 2009	Completed, project report disclosed
c.	Brazil	The Project for Capacity Development of Non-Revenue Water Control for Sanitation Company of the State of Sao Paulo (SABESP)	From July 1, 2006 to July 14, 2010	Completed, project report yet to be disclosed to public

a. The Capacity Development Project of Non-Revenue Water Reduction in Jordan

a-1 Project background

Water Authority of Jordan (WAJ) was obliged a nationwide water supply rationing due to a rapid demand growth added to the chronic scarcity of water resource, and high level non-revenue water exceeding 50 percent of its produced water. Its accumulated deficit caused by NRW reached a 10 percent of GDP.

Recognizing the significance of NRW reduction, WAJ carried out a series of studies and works for rehabilitation and replacement of water pipelines and distribution networks as steps to reducing NRW. Despite such efforts, WAJ was still not able to sufficiently address the NRW problems due to lack of organized programs and task force competent to implement the NRW reduction and leakage detection techniques.

Under these circumstances, the Government of Jordan requested a technical assistance from Japan.

Japan International Cooperation Agency (JICA), in response, provided a study on an integrated capacity development project for NRW reduction supported by the technical assistance team with short- and long-term experts.

a-2 Objectives and targeted achievements

Upper level objectives	Project targets	Targeted achievements
To reduce non-revenue water in command area of WAJ	To develop non-revenue water reduction capacity of WAJ	• To institute an organ of NRW control within WAJ. • WAJ engineers and technicians acquire basic techniques for NRW reduction. • Senior staff and engineers of WAJ acquire capacity to train WAJ personnel on NRW reduction and leakage detection techniques. • Senior staff members of WAJ acquire knowledge of NRW management, and take necessary actions to reduce NRW. • Enhance the public awareness of NRW reduction.

a-3 Achievements of the project

The following were achieved:

- Eleven engineers and 27 technicians of WAJ acquired basic techniques for NRW reduction, and 90 percent of these engineers became trainers for the other WAJ personnel.
- Six competent trainers were authorized and they prepared the training materials.
- In the selected in 7 pilot areas, NRW reduction was accomplished by 50 percent.
- Cooperation with a local NGO, Jordan Aqua Conservation Association (JACA) made the public awareness activities well acceptable by residents.

b. The Project for Improvement of Management Capacity for Operation and Maintenance in SHAPWASCO

b-1 Project background

In 1990 all the Prefectural Governments in Egypt seceded and corporatized their water and sanitation departments into financially independent enterprises. Despite efforts toward independence of management and financial autonomy including revision of tariff, operation of newly corporatized enterprises ran at a large and chronic loss, inviting total lack of fund for proper operation and maintenance. This left maintenance of facilities and equipments unattended, and resulted in their superannuation and deterioration.

In Sharkiya Prefecture, Sharkiya Economic General Authority of Water & Sanitary Drainage (SHEGAWASD), one of thus corporatized enterprises, was suffering from continuing deficit. The causes, everyone knew, were, excessive personnel costs due to superfluous employments, high operating costs due to inefficient operation, insufficient revenue due to underpriced tariff, low rate of collection and high rate of NRW.

Upon request by the Egyptian Government, JICA mobilized a technical cooperation project to improve operation of SHEGAWASD.

b-2 Objectives and targeted achievements

Upper level objectives	Project targets	Targeted achievements
To uplift management capacity of operation and maintenance of water and sanitation facilities in Sharkiya Prefecture	To improve management capacity of operation and maintenance of SHEGAWASD	• To reduce non-revenue water in the pilot project areas • To reinforce capacities for operation and maintenance of water supply services

a-4 Achievements of the project

The following were achieved:

- Distribution network analyses were performed by the personnel under supervision by

JICA team in 9 pilot project areas and they learned techniques of the analysis.
- Rate of NRW was reduced to 15 percent from 29 percent by leakage detection, repair and other activities.
- Relevant employees learned water leakage detection techniques.

c. The Project for Capacity Development of Non-Revenue Water Control for Sanitation Company of the State of Sao Paulo (SABESP)

c-1 Background

Sanitation Company of the State of Sao Paulo (SABESP) supplies water to 25 million consumers in 386 cities with its manpower of 17,300 for annual revenue of 2,500 million Dollars. Its size of business is among the largest in the world, similar to that of the Tokyo Metropolitan Water Supply Authority. It, however, suffered from high rate of non-revenue water, as high as 10 times of that in Tokyo.

Upon request by the Government of Brazil, JICA mobilized a technical cooperation project for the control of non-revenue water.

c-2 Objectives and targeted achievements

Upper level objectives	Project targets	Targeted achievements
Reduced non-revenue water and stabilized water supply in the SABESP command areas.	Strengthened capacity of SABESP to control non-revenue water very effectively.	• SABESP personnel to know necessity of non-revenue water control and to build a manpower development system for NRW control. • To learn basic measures to reduce NRW through practices in the pilot area. • To learn symptomatic treatment to control NRW through practices in the pilot area. • To learn preventive approach to control NRW through practices in the pilot area.

c-3 Achievements of the project

Project report is not yet disclosed to the public until June 2011.

d. Other Projects

Table A3.6 shows JICA projects with component of the non-revenue water control in progress.

Table A.3.6 Non Revenue Water Reduction related Project Outline

	Country	Project	Counterpart	Period	Objectives	Achievements
1	Bangladesh	Project for Advancing NRW reduction initiative (PANI) of Chittagong WASA	Chittagong Water Supply and Sewerage Authority (CWASA)	- Jun 2012	Improve non-revenue water reduction capacity	To improve non-revenue water reduction technique and practical management capacity
2	El Salvador	Capacity Development Project for the Operational Improvement of ANDA	Administracion Nacional de Acueductos y Alcantarillados	Jan 2009 - Dec 2011	Improvement of operation & maintenance capacity on ANDA	To improve operation & maintenance capacity. To enhance planning on non-revenue water reduction
3	Indonesia	The Project for Water Supply Service Improvement in the Mamminasata Metropolitan Area	Ministry of Public Works, Directorate General of Human Settlement/ South Sulawesi Province	May 2009 - Feb 2012	Improve operation & maintenance capacity of Mamminasata metropolitan water works	To improve regional cooperation & coordination system. To improve capacity of financial management To improve non-revenue water reduction capacity To strengthen capacity to build database
4	Sri Lanka	The Capacity Development Project for Non-Revenue	National Water Supply and Drainage Board	Oct 2009 - Sept	To uplift capacity to implement measures to control non-revenue water	Senior staff to improve planning and implementing capacity. To improve technical and

	Country	Project	Counterpart	Period	Objectives	Achievements
		Water Reduction in Colombo City	(NWSDB)	2012		supervisory capacity to undertake non-revenue water control activity.
5	Kenya	The Project for Management of Non-Revenue Water in Kenya	Ministry of Water and Irrigation (MoWI) etc.	Nov 2009 - Sept 2013	To improve non-revenue water reduction capacity and prepare the system for country wide spread supervision, enforcement of it.	To establish NRW reduction action plan manual, NRW reduction supervision manual. To establish NRW management standard. Strengthen the non-revenue water management guidance.

A.3.3 Cases of other Notable NRW Management in Developing Countries

In Japan, the world-most comprehensive NRW control measures are taken widely. The NRW ratio of 10 percent is the average of all of some 1,000 water utilities in Japan. The NRW control measures in England and France, other industrial countries, are not seemed so comprehensive as in Japan. The NRW ratio in London, reportedly, is 40 percent. This implies that the capability of controlling NRW is not dependent on the level of the economic development but dependent on the difference of the business strategy of the water utilities.

Turning eyes to Asia, the national average of NRW in China is reported to be almost 20 percent. Chinese delegates to the international conferences on water issues often refer to the NRW ratio. Therefore, China seems to be another country, where the NRW control is important.

According to the ADB's reporting to the 5th World Water Forum in 2008, the NRW ratio in most of Asian countries except Japan and China (+Korea, maybe) is about 50 percent (%), and there are only 3 water utilities, whose NRW ratio are below 20%, namely, Pnom Phen Water and Sewerage Authority (PPWSA) of Cambodia, Manila Water Company of the Philippines and Hai Phong Water Supply Company of Vietnam. What is noticeable is that, although there are such countries as Thailand and Malaysia, whose level of economic development is higher than Cambodia or the Philippines, there are no water utilities, whose NRW ratio is below 20%, in Thailand and Malaysia. Cambodia is a least developed country, one of the poorest countries in Asia. This also suggests that the capability of controlling NRW is not dependent on the level of the economic development but dependent on the difference of the business strategy of water utilities.

The two cases detailed below, PPWSA in Cambodia and Manila Water Company in the Philippines, the former being a public utility and the latter a private operator, are examples of successfully managing water supply services by utilizing the NRW reduction measures as the core of their business strategy. In both cases, the initial conditions of these water utilities were no better than those in the Western Highveld Region. Therefore, their stories can be good lessons for the water utilities in the Region, who are willing to improve their business management.

a. Pnom Phen Water and Sewerage Authority (PPWSA) in Cambodia

Cambodia experienced the regime of Khmer Rough (Maoism communist), the subsequent military intervention by Vietnam and the civil war during 1975～1991. The national economy collapsed completely. Peace was restored in 1993 and reconstruction of the national economy was resumed. The water utility in Pnom Phen, the capital city, was no exception. The service coverage was only 25%, water supply hours/day was limited to 10 hours and the NRW ratio was 72% in 1993. In 2006, the coverage increased to 90%, 24 hours supply was achieved and the NRW ratio was reduced to 8%.

Table A.3.7 Performance Indicators of PPWSA

Items	1993	2006
Employee/1,000 connections	22	4
Supply capacity (m^3/day)	65,000	235,000
Service coverage in the service area	25%	90%
Water supply hours/day	10	24
Water supply pressure (average)	0.2kg/cm^2	2.5kg/cm^2
House connection	26,881	147,000
NRW ratio	72%	8%
Rate of water tariff collected	48%	99.9%

Japan provided a series of technical assistance (TA) programs to PPWSA through JICA, and many water supply engineers from water utilities of municipalities in Japan such as Kitakyushu City, Yokohama City, etc., were mobilized. The NRW control was one of major objectives of training courses in JICA's TA programs. But the most important factor for the success of PPWSA was its excellent management. Its excellence may be summarized in the following three features:

i) The central government was obliged to acknowledge the managerial independence of PPWSA. The General Director had a supreme authority to decide employment, discharge and promotion of all the personnel. The salary of an employee, who contributed to reduce NRW, was raised, and another, who was corrupt and tried to undermine the effort to reduce NRW, was fired.

ii) The top management was solidly disciplined. Mr. Ek Som Shan, General Director, prohibited the utility personnel from a long-lasting practice of free water. He suspended water supply to house of an influential cabinet minister, who failed to pay water tariff. These actions contributed to regain the public trust and raise the citizens' willingness to pay for water.

iii) The financial independence was secured. Many water utilities in the developing countries are forced to help the operating budget of the central government or the municipal government with their meager income, if any. Therefore, they are unable to use their revenue for re-investment. PPWSA faced the same problem but managed to secure its financial independence, resulting in reinvesting their revenue in rehabilitation and expansion of distribution network to prevent leakage and address to the growing demand.

b. Manila Water Company in the Philippines

The water supply service in Manila, capital city of the Philippines, was privatized in 1997, by dividing the city's service area into two (East Zone and West Zone) and giving concessions to two private operators through competitive process. Manila Water Company became the concessionaire in the East Zone. Majority shareholder of this Company is the Ayala Group, a prominent local entrepreneur. Minority shareholders are United Utility, UK and Mitsubishi Corporation, Japan. It became a very successful water service operator in the East Zone, and its share came to be listed in the Manila Stock Exchange since 2003.

On the other hand, the Suez Company (France) and a local investor established a Maynilad Water Service and became a concessionaire operator in the West Zone. But, it was not successful as an operator, and the Suez Company retreated from Manila by transferring its share to a local investor in 2007.

Manila Water Company also succeeded in reduction of NRW ratio from 62% (1997) to 16% (2009). As is a private company, it naturally had the three features of the management structure that PPWSA of Cambodia had to willfully acquire (independent management, disciplined management, financial independence from the government).

Table A.3.8 Performance Indicators of Manila Water Company

Items	1997	2010
Served population	3 Million	6.1 Million
Percentage of population with 24 hour supply / total	26%	99%
NRW ratio	63%	16%
Employee/1,000 connections	9.8	1.4

However, not all private operators were successful in controlling NRW. Maynilad in the West Zone of Manila and two concessionaires (Palyja and Aetra) in Jakarta, Indonesia as well failed to control the NRW.

The factors for the success of Manila Water Company in the NRW control, which other private concessionaires do not share, are considered to be the following three (3) points.

i) It built a flat organizational structure, where the decision making was decentralized. The Company divided its service area into 8 business zones, in each of which a Business Center was located. Each Business Center had power to make investment decision up to an appropriate limit so that the Company can respond and address to the quick needs such as application for a new connection and repair of leakages immediately. The Company succeeded to uplift its employee's working motivation by introducing the management techniques such as QC (Quality Circle) and 5S, which were originated from Japan and widely applied in many successful businesses including such a leading company as Toyota.

ii) It was successful in extending house connections to more than 1 million slum residents by utilizing a low-cost house connection technology that was developed by itself and by organizing slum residents in collaboration with local NGOs. The NRW ratio was reduced as the result of extended installation of house connections for the place of community taps, which caused a large NRW.

iii) Its active investment was addressed to the distribution networks. Almost all of US$1 Billion, that was all of its capital investments in the past 10 years, was spent for the rehabilitation and expansion of the distribution networks, and almost none was spent for the water treatment plants. As the result, it became successful in efficient distribution of water. While its treatment plants were producing continuously same volume of water as in the past, the volume of water actually distributed to customers became doubled.