DWA Report Number: P WMA 02/B810/00/1412/7

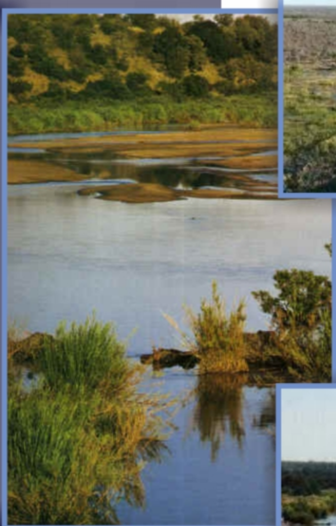
water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: NATIONAL WATER RESOURCE PLANNING

Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System

WATER REUSE REPORT



FINAL

February 2013

WATER RECONCILIATION STRATEGY STUDY FOR THE LUVUVHU/LETABA WATER MANAGEMENT AREA

WATER REUSE REPORT

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water Affairs, South Africa, 2012. ***WATER RECONCILIATION STRATEGY STUDY FOR THE LUVUVHU/LETABA WATER MANAGEMENT AREA*: WATER REUSE REPORT**

Prepared by:

Golder Associates Africa

Report No. P WMA 02/B810/00/1412/7

Title:	***Water Reuse Report***
Authors:	*D Masoabi, L Boyd and T Coleman*
Project Name:	***Water Reconciliation Strategy Study for the Luvuvhu and Letaba Water Supply System***
DWAF Report No:	*P WMA 02/B810/00/1412/7*
Status of Report:	*Final*
First Issue:	*September 2012*
Final Issue:	*February 2013*

Consultants: WRP Consulting Engineers(Pty) Ltd in association with DMM Development Consultants, Golder Associates Africa, Worley Parsons, Kyamandi, Hydrosol and Zitholele Consulting

Approved for the Consultants by:

....

P G van Rooyen

Study Leader

DEPARTMENT OF WATER AFFAIRS & FORESTRY

Directorate National Water Resource Planning

Approved for DWA by:

....

T Nditwani

Chief Water Resource Planner:

(Project Manager)

....

J A van Rooyen

Director: National Water Resource Planning

DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE LUVUVHU AND LETABA WATER SUPPLY SYSTEM

Water Reuse Report

EXECUTIVE SUMMARY

The Department of Water Affairs (DWA) has identified the need for the Reconciliation Study for the Luvuvhu-Letaba WMA. The WMA is almost fully developed and demands from the Letaba River currently exceed the yield capability of the system. Regulation for the Letaba WMA is mainly provided by Middle Letaba, Ebenezer and Tzaneen Dams. In the Luvuvhu WMA the recently completed Nandoni Dam will be used in combination with Albasini, Vondo and Damani dams to be managed as one system. It is expected that the total yield from this combined system will be fully utilized by around 2020, considering only the current planned projected demands. The yield of the Albasini Dam has reduced over the years and as a consequence the dam is over allocated. The Shinwedzi catchment is situated almost entirely in the Kruger National Park and for all practical purposes no sustainable yield is derived from surface flow in the Shingwedzi catchment.

The main objective of the study is to compile a Reconciliation Strategy that will identify and describe water resource management interventions that can be grouped and phased to jointly form a solution to reconcile the water requirements with the available water for the period up to the year 2040 and to develop water availability assessment methodologies and tools applicable to this area that can be used for decision support as part of compulsory licensing to come. The development of the strategy requires reliable information on the water requirements and return flows (wastewater) as well as the available water resources for the current situation and likely future scenarios for a planning horizon of thirty years.

To achieve the above objectives, the following main aspects will be covered in the study:

- *Update the current and future urban and agricultural water requirements and return flows;*
- *Assess the water resources and existing infrastructure;*
- *Configure the system models (WRSM2005, WRYM, WRPM) in the Study Area at a quaternary catchment scale, or finer where required, in a manner that is suitable for allocable water quantification;*
- *To firm up on the approach and methodology, as well as modelling procedures, for decision support to the on-going licensing processes;*
- *To use system models, in the early part of the study, to support allocable water quantifications in the Study Area and, in the latter part of the study, to support ongoing licensing decisions, as well as providing information for the development of the Reconciliation Strategy;*

- *Formulate reconciliation interventions, both structural and administrative/regulatory;*
- *Document the reconciliation process including decision processes that are required by the strategy; and*
- *Conduct stakeholder consultation in the development of the strategy.*

The Luvhuvu/Letaba WMA in total is a water deficit area. The Reconciliation strategies for the area indicates that the current water use is 69.677 Mm^3/a and the current available is 68.918 Mm^3/a. The 2030 water use projections is estimated at 99.517 Mm^3/a.

There is limited information on return flows and planning in relation to wastewater use within the WMA. Only three local municipalities have information on return flows. The Makhado Local Municipality plans to reuse effluent from their wastewater treatment works as an added source of water from 2015 onwards with estimates of 1.33 Mm^3/a for 2015, 1.45 Mm^3/a for 2020, 1.58 Mm^3/a for 2025 and 1.7 Mm^3/a for 2030. However there is no mention on how and where they intend reusing the wastewater. The Greater Tzaneen Local Municipality indicates that a total volume of 5.217 Mm^3/a is discharged from all the wastewater treatment works into the resource. There is no mention on the intentions of reusing the water. Greater Giyani Local Municipality indicates that a total volume of waste water received and treated is 0.95 Mm^3/a. The treated effluent is not recycled and 0.8 Mm^3/a volume of effluent is discharged into the Klein Letaba River.

The assessment of wastewater treatment works in the Luvuvhu/Letaba WMA has indicated the following:

- *Most municipalities in this area do not measure the volume of effluent entering the WWTW or that discharged as treated effluent;*
- *In all cases where data was available the effluent discharged is also of poor quality with high nutrients and faecal contamination; and*
- *There are areas of water deficit where treated wastewater could be considered for agricultural or limited urban use.*

It is recommended that should the option of treated wastewater reuse be considered then the wastewater treatment works in the study area need to be upgraded and their operation optimised to improve the quality of the effluent being discharged. Currently the quality being discharged may have serious human health and ecological consequences and increased eutrophication potential in the study area which will in turn impact on other water users such as irrigation farmers and water treatment plants.

Water Reconciliation Strategy Study for the Luvuvhu/Letaba Water Management Area

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Water Reconciliation Strategy Study for the Luvuvhu/Letaba Water Management Area:

Water Reuse Report

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water Affairs (DWA) has identified the need for the Reconciliation Study for the Luvuvhu-Letaba WMA. The WMA is almost fully developed and demands from the Letaba River currently exceed the yield capability of the system. Regulation for the Letaba is mainly provided by Middle Letaba, Ebenezer and Tzaneen Dams. The recently completed Nandoni Dam located in the Luvuvhu basin will be used in combination with Albasini, Vondo and Damani dams to be managed as one system. It is expected that the total yield from this combined system will be fully utilized by around 2020, considering only the current planned projected demands. The yield of the Albasini Dam has reduced over the years and as a consequence the dam is over allocated. The Shinwedzi catchment is situated almost entirely in the Kruger National Park and for all practical purposes, no sustainable yield is derived from surface flow in the Shingwedzi catchment.

The main urban areas in these catchments are Tzaneen and Nkowakowa in the Groot Letaba River catchment, Giyani in the Klein Letaba River catchment and Thohoyandou and Makhado (Louis Trichardt) in the Luvuvhu catchment. An emergency water supply scheme to transfer water from Nandoni Dam is currently under construction to alleviate the deficits of the stressed Middle Letaba sub-system in the Letaba River basin. Other future developments planned to be supplied from Nandoni Dam will already utilize the full yield available from the Nandoni sub-system by 2021, without supporting Giyani. Supporting Giyani from Nandoni will bring this date forward to approximately 2018

Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment (upstream and downstream of the Middle Letaba Dam), the Groot Letaba (downstream of the Tzaneen Dam) and Letsitele rivers, as well as in the upper Luvuvhu River catchment. Vegetables (including the largest tomato production area in the country), citrus and a variety of sub-tropical fruits such as bananas, mangoes, avocados and nuts are grown. Large areas of the upper catchments have been planted with commercial forests in the high rainfall parts of the Drakensberg escarpment and on the Soutpansberg. The area, particularly the Groot Letaba sub-area, is a highly productive agricultural area with mixed farming, including cattle ranching, game farming, dry land crop production and irrigated cropping. Agriculture, with the irrigation sector in particular, is the main base of the economy of the region. Large scale utilization of the groundwater resource occurs mostly downstream of the Albasini Dam in the Luvuvhu catchment, where it is used by irrigators as well as in the vicinity of Thohoyandou where it is used to supply rural communities. The limited mineral resources in the Luvuvhu basin are dominated by deposits of cooking coal in the northeast near Masisi. In addition to irrigation water supply from the dams in the study area, towns, villages and rural settlements are also supplied with potable water.

DWA and other institutions involved in the management of the water resource and supply systems of the Luvuvhu-Letaba catchments, have in the past carried out various studies on intervention measures to improve the water supply situation. The knowledge base that has been created by these studies provides a sound and essential platform from which the Reconciliation Strategy will be developed. In order to harness this information a Literature Review Report (DWA, 2013) was compiled to summarise the available information in one document and also present a synthesis of the information by highlighting the pertinent aspects of Integrated Water Resource Management that will be assessed and incorporated in the Reconciliation Strategy.

1.2 MAIN OBJECTIVES OF THE STUDY

The main objective of the study is to compile a Reconciliation Strategy that will identify and describe water resource management interventions that can be grouped and phased to jointly form a solution to reconcile the water requirements with the available water for the period up to the year 2040 and to develop water availability assessment methodologies and tools applicable to this area that can be used for decision support as part of compulsory licensing to come. The development of the strategy requires reliable information on the water requirements and return flows (wastewater) as well as the available water resources for the current situation and likely future scenarios for a planning horizon of thirty years.

To achieve the above objectives, the following main aspects will be covered in the study:

- Update the current and future urban and agricultural water requirements and return flows;
- Assess the water resources and existing infrastructure;
- Configure the system models (WRSM2005, WRYM, WRPM) in the Study Area at a quaternary catchment scale, or finer where required, in a manner that is suitable for allocable water quantification;
- To firm up on the approach and methodology, as well as modelling procedures, for decision support to the on-going licensing processes;
- To use system models, in the early part of the study, to support allocable water quantifications in the Study Area and, in the latter part of the study, to support ongoing licensing decisions, as well as providing information for the development of the reconciliation strategy;
- Formulate reconciliation interventions, both structural and administrative/regulatory;
- Document the reconciliation process including decision processes that are required by the strategy; and
- Conduct stakeholder consultation in the development of the strategy.

1.3 STUDY AREA

The study area comprises of the water resources of the catchment of the Luvuvhu, Mutale, Letaba and Shingwedzi rivers linked to adjacent systems as indicated by the inter-basin transfers on **Figure 1.1**. This area represents the entire WMA 2 and includes tertiary catchments A91, A92, B81, B82, B83 and B90. Adjacent areas supplying water to this WMA or getting water from this WMA are also part of the study area.

The Luvuvhu-Letaba water management area (WMA) is located in the north-eastern corner of South Africa, where it borders on Zimbabwe in the north and on Mozambique along the eastern side. It falls entirely within the Northern Province, and adjoins the Olifants and Limpopo WMAs to the south and west respectively. The Luvuhu-Letaba WMA forms part of the Limpopo River Basin, an international river shared by South Africa, Botswana, Zimbabwe and

Mozambique.

Approximately 35% of the land area of the WMA along the eastern boundary falls within the Kruger National Park. The rivers flowing through the park are of particular importance to the maintenance of ecosystems.

The confluence of the Luvuvhu and Limpopo rivers forms the common point where South Africa borders on both Zimbabwe and Mozambique. The Shingwedzi River first flows into the Rio des Elephantes (Olifants River) in Mozambique, which then joins the Limpopo River.

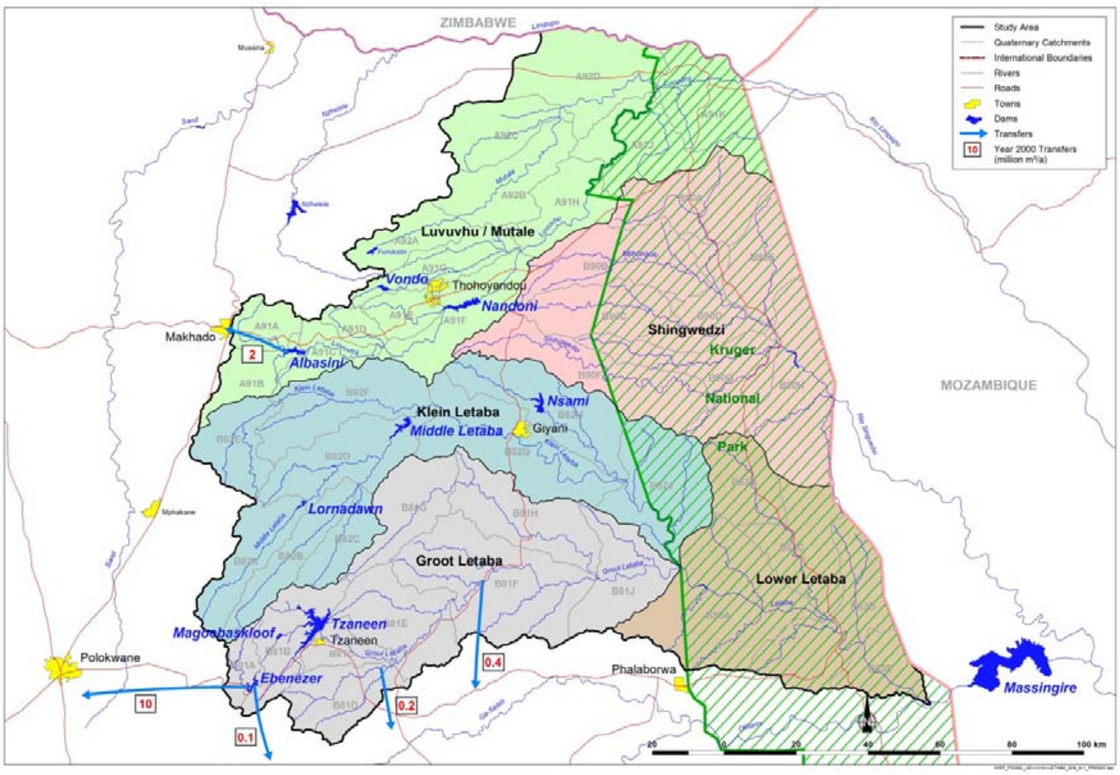


Figure 1.1: Study Area

The two main branches of the Letaba River, the Klein and Groot Letaba, have their confluence on the western boundary of the Kruger National Park. The Letaba River flows into the Olifants River just upstream of the border with Mozambique (**Figure 1.1**).

The topography is marked by the northern extremity of the Drakensberg range and the eastern Soutpansberg, which both extend to the western parts of the water management area, and the characteristic wide expanse of the Lowveld to the east of the escarpment. Climate over the water management area is generally sub-tropical, although mostly semiarid to arid. Rainfall usually occurs in summer and is strongly influenced by the topography.

Along the western escarpment rainfall can be well over 1 000 mm per year, while in the Lowveld region in the eastern parts of the water management area rainfall decreases to less than 300 mm per year and the potential evaporation is well in excess of the rainfall. Grassland

and sparse bushveld shrubbery and trees cover most of the terrain, marked by isolated giant Boabab trees.

The geology is varied and complex and consists mainly of sedimentary rocks in the north, and metamorphic and igneous rocks in the south. High quality coal deposits are found near Tsikondeni and in the northern part of the Kruger National Park. The eastern limb of the mineral rich Bushveld Igneous Complex touches on the southern parts of the WMA. With the exception of sandy aquifers in the Limpopo River valley, the formation is of relatively low water bearing capacity. A wide spectrum of soils occurs in the WMA, with sandy soils being most common.

1.4 PURPOSE OF THIS REPORT

The objective of this task and report is to assess and document the role that re-use of treated effluent from the wastewater treatment plants (WWTP) can play in achieving reconciliation. Opportunities will be identified across the study area.

Wastewater reuse is an important component of both wastewater management and water resource management. It offers an environmentally sound option for managing wastewater that dramatically reduces environmental impacts associated with discharge of wastewater effluent into surface waters. Reuse of treated wastewater will help in maintaining environmental quality and at the same time, relieving the unrelenting pressure on conventional, natural freshwater sources (Adewumi, 2011).

Water reuse is defined as the deliberate application of reclaimed water for a beneficial use. For many, the term ‘water reuse’ more narrowly means the use of treated domestic wastewater effluent. However, in its broader meaning it includes the reclamation and recycling of any water by any entity such as a municipality, industry or commercial establishment. The term ‘recycle’ may mean reuse of water with minimal if any treatment such as in the pollution prevention and waste minimization fields.

Treated municipal wastewater represents a significant potential source of reclaimed water for some beneficial reuses. In developed countries, approximately 73 percent of the population is served by wastewater collection and treatment facilities. Yet only 35 percent of the population of developing countries is served by wastewater collection (USEPA, 2004). This situation presents a good opportunity for the inclusion of wastewater reuse in many sewerage planning projects within developing communities. As developing country populations continue to move from rural to urban areas, the number of centralized wastewater collection and treatment systems will also increase, creating significant opportunities to implement water reuse systems to augment water supplies and, in many cases, improve the quality of surface waters (USEPA, 2004).

1.5 Environmental benefits of wastewater reuse

1.5.1 Protecting water resources from pollution

When pollutant discharges to water bodies are curtailed, the pollutant loadings to these bodies are decreased. Moreover, in some cases, substances that can be pollutants when discharged to a body of water can be beneficially reused for irrigation. For example, recycled water may contain higher levels of nutrients, such as nitrogen, than potable water. Application of recycled water for agricultural and landscape irrigation can provide an additional source of nutrients and lessen the need to apply synthetic fertilizers.

1.5.2 Closing the water balance

Treated wastewater should be considered as a ‘new’ water resource which can be added to the

overall water balance of a region. This ‘new’ source can substitute potable water used for irrigation or for other purposes that do not require water of potable quality, while releasing some of the pressure on the conventional water resources. Reclaimed wastewater helps to close a negative water balance in a country where all the conventional water resources are exploited to their maximum capacity.

1.5.3 Decrease diversion of freshwater from sensitive ecosystems

Plants, wildlife and fish depend on sufficient water flows to their habitats to live and reproduce. The lack of adequate flow, as a result of diversion for agricultural, urban, and industrial purposes and the discharge of poorly treated effluent can lead to deterioration of water quality and ecosystem health. People who reuse water can supplement their demands by using a reliable source of recycled water, which can free considerable amounts of water for the environment and increase flows to vital ecosystems.

1.5.4 Enhance wetlands and riparian (stream) habitat

Wetlands provide many benefits including wildlife and wildfowl habitat, water quality improvement, flood attenuation and fisheries breeding grounds. For streams that have been impaired or dried due to diversion of water; water flow augmentation can be done with recycled water to sustain and improve the aquatic and wildlife habitat.

1.6 Potential risks

There have been a number of risk factors identified for using reused water for purposes such as agricultural irrigation. Some risk factors are short term and vary in severity depending on the potential for human, animal or environmental contact such as microbial contamination, while other factors have longer term impacts which may increase with continued use of recycled water. An example of this is the saline effects on soil.

1.6.1 Pathogens

The most common human microbial pathogens found in recycled water are enteric in origin. Enteric pathogens enter the environment in the faeces of infected hosts and can enter water either directly through defecation into water, contamination with untreated or poorly treated domestic domestic wastewater effluent or from run-off from soil and other land surfaces that have been impacted on by, for example, sewer overflows.

1.6.2 Viruses

Enteric viruses are the smallest of the pathogens found in water. The majority of these viruses can be commonly detected in faecal contaminated water, for example domestic wastewater effluent. Most enteric viruses have a narrow host range meaning that most viruses in recycled water only infect humans. This means that only human faecal contaminated water need be considered a concern for viral infection of humans. Conversely, water borne human viruses are rarely a problem for other animals (Toze, 1997).

1.6.3 Bacteria

Bacteria are the most common of the microbial pathogens found in recycled waters. There are a wide range of bacterial pathogens and opportunistic pathogens which can be detected in wastewater. Many of the bacterial pathogens are enteric in origin, however, bacterial pathogens which cause non-enteric illnesses such as *Legionella* spp., *Mycobacterium* spp., and *Leptospira,* have also been detected in wastewater. Bacterial pathogens are metabolically active microorganisms that are capable of self-replication and are therefore, theoretically capable of replicating in the environment. In reality however, these introduced pathogens may be prevented from doing so by environmental pressures such as other enteric pathogens. A common transmission route is via contaminated water and food and by direct person to person contact. A number of these bacterial pathogens can also infect, or be carried by wild and domestic animals (Toze, 1999).

Cholera

Cholera is an acute intestinal infection caused by ingestion of food or water contaminated with the bacterium *Vibrio cholera*. It has a short incubation period, from less than one day to five days, and produces an enterotoxin that causes copious, painless, watery diarrhoea that can quickly lead to severe dehydration and death if treatment is not promptly given. Vomiting also occurs in most patients.

In most cases, transmission of cholera occurs through eating food or drinking water that is contaminated with *Vibrio cholera* bacteria. *Vibrio cholera* can get into food or water either naturally or via contaminated faeces. It is very unlikely for cholera to be spread directly from person to person through casual contact.

The endemic and seasonal nature of cholera depends upon the survival of *Vibrio cholera* in a viable state, but not necessarily a state that can be cultured, in ecologic niches in aquatic environments during inter-epidemic periods. In response to environmental stress in aquatic environments, such as low concentrations of nutrients and low temperatures, *V. cholera* adopt a viable state that enables them to carry out metabolic functions and form colonies without being culturable. Once favourable environmental conditions return, *V. cholera* can become culturable again. *V. cholera* in a viable but non-culturable state has produced clinical symptoms of cholera in volunteers, which confirms that it maintains its pathogenicity in aquatic environments despite the inability of the cells to be cultured.

1.6.4 Trace organics and heavy metals

Heavy metals are easily and efficiently removed during common treatment processes and the majority of heavy metal concentrations in raw domestic wastewater end up in the bio-solid fraction of the treatment process with very low heavy metal concentrations present in the treated effluents. Heavy metals are therefore of little concern for irrigation of crops when using treated effluents as a source of recycled water. If the source for the recycled water is from an industrial source or is less treated than normal then the impacts of heavy metals would need to be considered. Heavy metals that are present in effluents used for irrigation tend to accumulate in the soils where there is a potential that they could become bioavailable for crops.

Apart from heavy metals, most of the concern and public comments regarding trace contaminants revolve around pharmaceutically-active compounds (PhAC), endocrine disrupting compounds (EDC) and disinfection-byproducts (DBP). These PhACs and EDCs originate either from industrial or domestic sources while DBPs are a by-product, usually formed from chlorination during and post treatment of reused water. These chemicals tend to be present at very low concentrations in the treated reused water (generally in the range of ng/L). However, the impacts of even very small quantities are still unknown, especially in the developing phases of humans, and may not, like carcinogens require ingestion of large doses over long time periods to produce a clinical effect.

1.6.5 Nutrients

Major contaminant types commonly found in wastewater are organic and inorganic nutrients. The most common organic nutrient is dissolved organic carbon (DOC). DOC can take various forms depending on the source of the wastewater. The source of the organic carbon can also influence the bioavailability of the nutrient. For example DOC from drainage water is likely to be more recalcitrant than DOC present in the effluent from a domestic wastewater treatment works or from a food processing plant. It has been noted that the organic carbon present in recycled water can stimulate the activity of the soil microorganisms and that the organic and inorganic nutrients in treated effluent that had a high carbon to nitrogen ratio stimulated the soil microorganisms which, in turn, decreased the hydraulic conductivity of the irrigated soil. Evidently, while the additional nutrients can be a bonus as additional fertiliser, excess nutrients, particularly carbon and nitrogen, can have an adverse effect through excessive microbial activity and growth. Care therefore needs to be taken in the concentrations of nutrients in the recycled water to avoid detrimental impacts on the porosity of soils.

1.6.6 Salinity

The physical characteristics of recycled water can have an impact on the environment in which it is used. Physical characteristics of interest include pH, dissolved oxygen (DO) and suspended solids (SS). By far the most important, especially for water that is to be used for irrigation purposes, is the salinity of the recycled water, in particular the concentrations of sodium. Sodium and other forms of salinity are the most persistent in recycled water and are among the most difficult to remove from water, usually requiring the use of expensive cation exchange resins or reverse osmosis membranes.

The other issue relating to elevated sodium levels in recycled waters, particularly effluents such as treated domestic wastewater, is the effect that sodium has on certain salt sensitive crops. Grain crops such as wheat have been observed to be more resistant to saline soils, with less drop in yield over a wide range of electrical conductivities. Increases in soil salinity due to sodium accumulation in the soil can be more problematic and would require increased soil management practices; for example, leaching the sodium from the soil structure by periodic irrigation with water of a lower salinity.

1.6.7 Endocrine disrupting compounds (EDCs)

Endocrine disrupting compounds (EDC) are compounds outside of an organism which can impact on the structure and function of an organism's endocrine system causing effects on the organism or its progeny. Known EDCs that can be found in wastewaters and the environment include the estradiol compounds commonly found in the contraceptive pill, phytoestrogens, pesticides, industrial chemicals such as Bisphenol A and nonyl Phenol, and certain heavy metals. Untreated domestic wastewater effluent is a major source of these compounds and contains higher concentrations than most other water sources.

In the Luvuvhu/Letaba area DDT (1,1,1-trichloro-2,2-bis(chlorodiphenyl)ethane) has been used annually for malaria control since 1945. DDT is one of the few affordable and effective tools against malarial vector mosquitoes, hiowever has DDT has been detected in aquatic systems. Of concern is a known EDC, acting on the endocrine system.

While EDCs are present in untreated domestic wastewater effluent in concentrations much lower than natural hormones within the body; many of these chemical have endocrine capabilities at concentrations that are up to several thousand times lower than natural hormones.

The low concentrations of endocrine disrupting chemicals in treated recycled water and the potential short environmental half-lives of these compounds means that there is virtually no risk for EDC relating to using recycled water for crop irrigation; rather it is the use of contaminated water directly from a contaminated resource that would have an impact on humans and that is having an impact on the ecology.

1.6.8 Public concerns

A major issue relating to all water reuse schemes is public opinion. Communities tend to be favourable in general for water reuse. However, as the water reuse scheme gets physically closer to a person and his/her family questions arise that may make the option less favourable. In other words, they are very supportive of the irrigation of public open spaces in some ill-defined area, but baulk at the use of reused water in the household or when the chance of personal physical contact increases (Toze, 1995).

The amount of public unease about water reuse also depends on the type of reused water and treatment levels. For example, people have less concern about using untreated collected storm water than they have about highly treated domestic wastewater effluent. While the actual physical risk from the treated domestic wastewater effluent can be similar or less than that of untreated storm water, the public perception can lead to a belief within the community of a greater risk from the effluent.

It could be considered that public opinion for water reuse would be more favourable when it involves distance concepts such as crop irrigation. Consumers and exporters, however, are still concerned about the potential for negative health and environmental impacts with crops and recycled water and treated domestic wastewater sludge/compost.

1.7 Management possibilities

The principle mechanism for overcoming difficulties relating to reuse of water is the pre-treatment of the recycled water. The advantages of pre-treating recycled water are the significant reduction of microbial pathogens; the concentration of organic and inorganic nutrients, trace organics and heavy metals. The major contaminant that is difficult to remove from recycled water is salt and other cations and anions. The only effective treatment mechanism to remove salt molecules and ions is reverse osmosis membrane filtration. Such a high level of treatment is far too expensive for most municipalities to be economically viable for irrigation of crops. Alternatively water with a lower salinity can be blended with recycled water to reduce the concentration of salt.

1.8 Objective of the reuse component

The objective of the water reuse task was to assess the role that reuse of treated domestic wastewater effluent from the wastewater treatment works (WWTW) can play in achieving reconciliation for the Luvuvhu/Letaba area.

2 SCOPE OF WORK FOR WATER REUSE

The purpose of the water reuse task was to:

- Assess the quantity and quality data of the treated wastewater from the wastewater treatment works in the study area; and
- Compare the available WWTW planning and discharge information with the water requirement projections and yields of the current supply systems in order to determine the contribution that reuse can make in achieving reconciliation.

3 WASTEWTAER TREATMENT WORKS ASSESSMENT

3.1 Introduction

Domestic wastewater needs to be treated to:

- Free it of disease-causing organisms;
- Stop it from smelling and make it look pleasant for further use;
- Make it suitable for discharge to a river or other body of water so that it does not harm the organisms naturally present in the receiving water, or deleteriously affect the quality of such water;
- Render it fit for reuse. This is becoming increasingly important nowadays, particularly in southern Africa;
- Comply with the legal requirements as regards standards for discharge to a watercourse or to sea; and
- Convert the domestic wastewater solids present into a stable form and to dispose of them in a safe manner, from both a pollution and health point of view.

Data for the wastewater treatment works (WWTW) in the Luvhuvu/Letaba WMA were obtained from the Department of Water Affairs (DWA) Water Management System (WMS) as well as from the 2011-2012 Green Drop assessment reports. Of concern is that the majority of the wastewater treatment works do not measure the quantity of domestic wastewater reaching the WWTW or being released to a water resource.

3.2 Wastewater treatment works types in the area

There are mainly three types of wastewater treatment works in the WMA.

- Oxidation ponds;
- Biofilters; and
- Activated sludge plants without nutrient removal.

3.2.1 Oxidation ponds

Oxidation pond systems comprise relatively shallow bodies of wastewater in which self-purification processes are used under controlled conditions, to purify raw or settled wastewater. The ponds systems may be aerobic or anaerobic and should be a series of at least four ponds. The effluent from such ponds is generally of a poor quality and will seldom comply with the requirements of the General Standards set out in the General Authorisations (Table 1).

Table 1: Wastewater limit values applicable to discharge of wastewater into a water resource (DWAF, 2004)

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Faecal Coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75 (i)	30(i)
pH	5,5-9,5	5,5-7,5
Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	6	2
Nitrate/Nitrite as Nitrogen (mg/l)	15	1,5
Chlorine as Free Chlorine (mg/l)	0,25	0
Suspended Solids (mg/l)	25	10
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10	1 (median) and 2,5 (maximum)
Fluoride (mg/l)	1	1
Soap, oil or grease (mg/l)	2,5	0
Dissolved Arsenic (mg/l)	0,02	0,01
Dissolved Cadmium (mg/l)	0,005	0,001
Dissolved Chromium (VI) (mg/l)	0,05	0,02
Dissolved Copper (mg/l)	0,01	0,002
Dissolved Cyanide (mg/l)	0,02	0,01
Dissolved Iron (mg/l)	0,3	0,3
Dissolved Lead (mg/l)	0,01	0,006
Dissolved Manganese (mg/l)	0,1	0,1
Mercury and its compounds (mg/l)	0,005	0,001

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Dissolved Selenium (mg/l)	0,02	0,02
Dissolved Zinc (mg/l)	0,1	0,04
Boron (mg/l)	1	0,5

However, in the oxidation pond process domestic wastewater is purified to such a degree that the effluent can be advantageously used for irrigation of crops that are not eaten raw.

3.2.2 Biofilters (Trickling filters)

Aerobic attached-growth treatment processes are those processes that utilise microorganisms that grow on a medium, such as stones and discs, to remove organic matter found in wastewater. They can also be used to achieve nitrification – the conversion of ammonia to nitrate/nitrite.

The effluent quality from biofilters may be acceptable for discharge if the plant is optimally maintained and not overloaded. In most cases however nitrification is low. The effluent can be advantageously used for irrigation of crops that are not eaten raw.

3.2.3 Activated sludge processes

The activated sludge process is a biological process of developing an activated sludge biomass of microorganisms capable of stabilising waste aerobically. Organic waste is introduced into a reactor where a bacterial culture (biomass) is maintained in suspension. The reactor content is referred to as the 'mixed liquor' or activated sludge.

The effluent quality from a well operated activated sludge plant should easily achieve the General Standards set out in the General Authorisations that would allow discharge (Table 1).

3.3 Wastewater treatment works per catchment

Table 2 lists the WWTW in the study area and the locations are illustrated in Figure 1.

Table 2: List of wastewater treatment works

Resource Units	Responsible municipality	Wastewater treatment works	Type	Capacity	Location
Luvuvhu Mutale catchment	Thulamela LM	Donald Fraser WWTW	Oxidation ponds	2 Ml/d	22.89694 S and 30.50056 E
		Malamulele WWTW	Bio filter	2 Ml/d	23.00694 S and 30.71556 E
		Maunavhathu Military Base WWTW	Oxidation ponds	2 Ml/d	23.719358 S and 27.695771 E
		Mhinga WWTW	Oxidation ponds	2 Ml/d	22.777812 S and 30.888514 E
		Muledeni WWTW	Oxidation ponds	NI	23.003336 S and 30.475961 E
		Siloam Ponds WWTW	Oxidation ponds	2 Ml/d	23.20000 S and 29.99722 E
		Vuwani Ponds WWTW	Oxidation ponds	0.75 m3/d	23.11806 S and 30.42139 E
		Tshifulanani Ponds WWT (Dzindi)	Oxidation ponds	2 Ml/d	23.01833 S and 30.39750 E
		Vondo WWTW	Oxidation ponds	2 Ml/d	23.00139 S and 30.48583 E
	Makhado LM	Hlanganani Ponds WWTW	Oxidation ponds	2 Ml/d	23.228249 S and 30.278040 E
		Louis Trichardt WWTW	Oxidation ponds	2 Ml/d	23.058908 S and 29.898007 E
		Makhado (V) WWTW	Oxidation ponds	2 Ml/d	22.90056 S and 30.04750 E
		Waterval WWTW	Activated sludge	10 Ml/d	23.15222 S and 30.08000 E
		Dzanani oxidation ponds	Oxidation ponds	NI	

Resource Units	Responsible municipality	Wastewater treatment works	Type	Capacity	Location
	Mutale LM	Mutale WWTW	Oxidation ponds	NI	22.74528 S and 30.51722 E
		Masisi Septic tanks	Septic tanks	NI	
		Tshikondeli Ponds	Oxidation Ponds	NI	
Groot Letaba catchment	Greater Tzaneen LM	Tzaneen WWTW	Bio Filter & Activated sludge	8Ml/d	30.17139 S and -23.82306 E
		Nkowankowa WWTW	Bio Filter	4.5 Ml/d	30.31722 S and -23.89361 E
		Lenyenye WWTW	Oxidation ponds	1 Ml/d	23.964342 S and 30.274041 E
Klein and Middle Letaba Catchment	Greater Letaba LM	Ga- Kgapane WWTW	Bio filter	4 Ml/d	
		Giyani WWTW	Bio filter	2.1 Ml/d	23.324913 S and 30.709301 E
		Hlanganani Ponds WWTW	Oxidation ponds	2 Ml/d	23.228249 S and 30.278040 E
Shingwezi Catchment	NI				

NI – No Information available

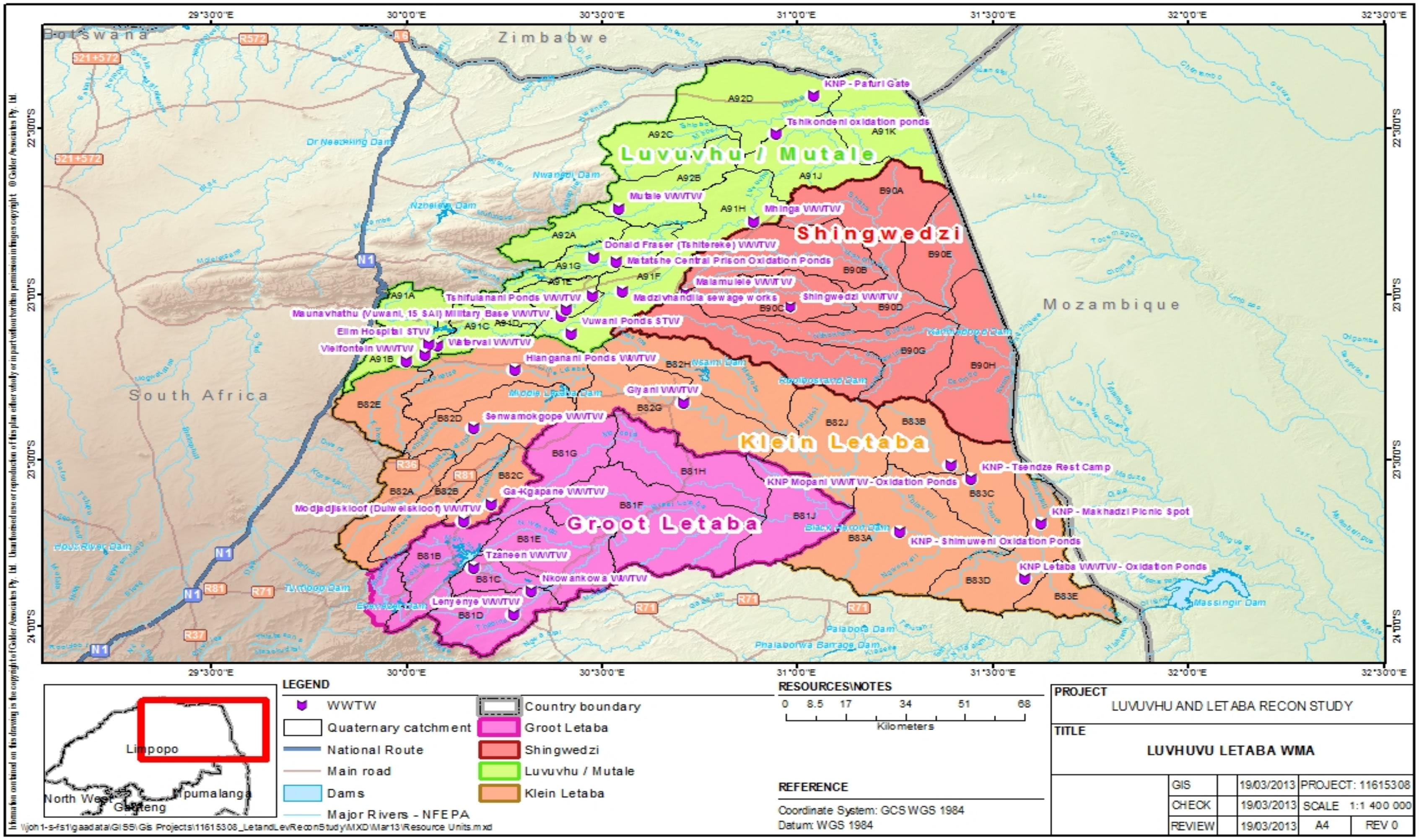


Figure 1: Location of the wastewater treatment plants

3.4 Categorisation of watewater treatment works

It is generally accepted that the wastewater treatment works can be categorised as follows:

- Micro size plants: < 0.5 Ml/d;
- Small size plants: 0.5-2 Ml/d;
- Medium size plants: 2-10 Ml/d;
- Large size plants: 10-25 Ml/d; and
- Macro size plants: >25 Ml/d

Table 3 gives a breakdown of all the WWTW in the Luvuvhu/Letaba WMA.

Table 3: Breakdown in terms of size of the wastewater treatment works in the Luvhuvu/Letaba WMA

Micro size plants 0.5 Ml/d	**Small size plants** 0.5 – 2 Ml/d	**Medium size plants** 2 – 10 Ml/d	**Large size plants** 10 – 25 Ml/d
Vuwani Ponds WWTW	Donald Fraser WWTW	Nkowankowa WWTW	Waterval WWTW
Lenyenye WWTW	Malamulele WWTW	Ga- Kgapane WWTW	
	Maunavhathu Military Base WWTW	Giyani WWTW	
	Mhinga WWTW	Tzaneen WWTW	
	Siloam Ponds WWTW		
	Tshifulanani Ponds WWT (Dzindi)		
	Hlanganani Ponds WWTW		
	Makhado (V) WWTW		
	Louis Trichardt WWTW		

3.5 Luvuvhu main and mutale catchment area

3.5.1 Brief background

The Luvuvhu/Mutale area is located in the in the north of the Water Management Area (WMA), and comprises the catchment of the Luvuvhu River together with its main tributary the Mutale River. The Luvuvhu River catchment covers a total area of 3 800 km² and the Mutale River covers a catchment of 2 150 km².There are seventeen (17) wastewater treatment works in this catchment area. The majority are oxidation ponds (82%), 11% are septic tanks and only 6% are activated sludge. The locations of the WWTW are indicated on the map (figure 2) in relation to the nearest stream, river and/or dam.

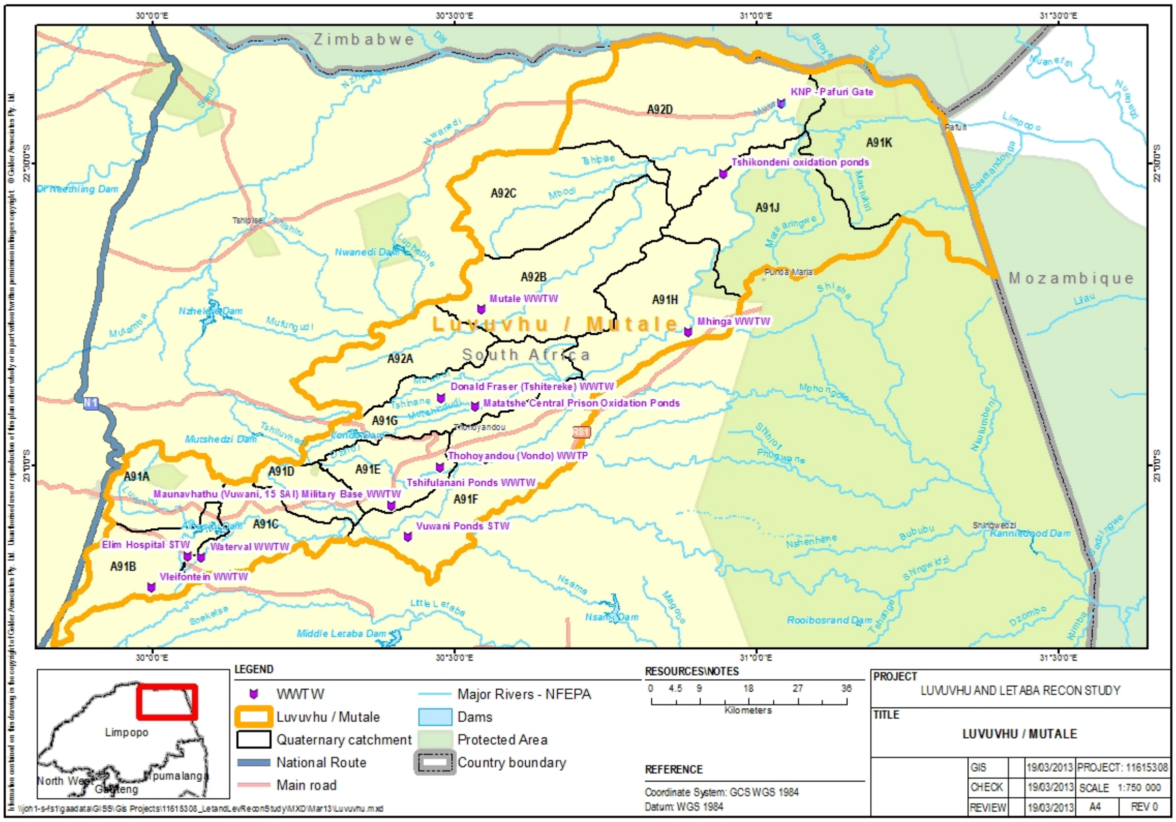


Figure 2: Levhuvu Main and Mutale catchment areas

Table 4 provides information on the types of the works, the quality of the effluent, indicated by the constituents of concerns and the future plans for the wastewater treatment works. The information on future plans was obtained from the Introduction to Green Drop PAT, National Overview Report (2012).

Table 4: Wastewater treatment works in the Levhuvu Mutale catchments

Wastewater treatment works	Type	Constituents of concerns	WWTW future plans
Donald Fraser WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI
Malamulele WWTW	Oxidation ponds	*E. coli*, FC, SS, NH_4	Standby generators, refurbishment of distribution lines, replacement of one sludge pipe and a repair of the chlorination system of the final pond.
Maunavhathu Military Base WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI

Wastewater treatment works	Type	Constituents of concerns	WWTW future plans
Mhinga WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	Sludge removal, lining of ponds, chlorine system.
Muledeni WWTW	Oxidation ponds	NI	NI
Siloam Ponds WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI
Vuwani Ponds WWTW	Oxidation ponds	NI	Refurbishment of ponds, fencing, removing of vegetation, replacement of collapsed walls, installation of chlorination tanks, removal of sludge.
Tshifulanani Ponds WWT (Dzindi)	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI
Vondo WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI
Hlanganani Ponds WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	NI
Louis Trichardt WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	New screen, renovation of primary settling tank, new chlorination system, distributor arm of biological filter.
Makhado (V) WWTW/ Dzanani	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_5	Repairing of walls of the ponds, removal of sludge, replace of the storage tanks of the chlorine chips and repairs of six aerators. There are plans to reuse effluent from the Makhado Waste Water Treatment Works as an added source of water from 2015 onwards with estimates of 1.33 Mm^3/a for 2015, 1.45 Mm^3/a for 2020, 1.58 Mm^3/a for 2025 and 1.7 Mm^3/a for 2030.
Waterval WWTW	Activated sludge	NI	Refurbishment of maturation ponds, Removal of sludge.

Wastewater treatment works	Type	Constituents of concerns	WWTW future plans
Mutale WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_2, COD, NH_4, O-PO_4	Only fencing due to vandalism, the inlet screens were replaced.
Masisi Septic tanks	Septic ponds	NI	NI
Tshikondeli Ponds	Oxidation tanks	NI	NI
Makuya Septic tanks	Septic ponds	NI	NI

NI - No Information available

3.5.2 Effluent quality

The effluent discharged from the majority of these works is of poor quality as indicated in the 2011 Green Drop report. The main constituents of concern are faecal coliforms (FC), electrical conductivity (EC), pH, suspended solids (SS), nitrate $(NO)_2$, chemical oxygen demand (COD), ammonia (NH_4) and orthophosphate (O-PO_4). At the monitoring point just downstream of the Thohoyandou WWTW the water quality results indicate that the works is discharging poor quality effluent with water quality in the river at that point: nitrate: 9.9mg/l; phosphate: 3.1mg/l and ammonia: 8.6 mg/l).

Vondo oxidation ponds in the area, receiving domestic wastewater from the villages are situated adjacent to a water quality site just downstream of some agricultural lands. Results from this site show some pollution: phosphate 1.4 mg/l, ammonia 3 mg/l and nitrate of 1.2 mg/l indicating potential impacts from agricultural run-off and diffuse pollution from the oxidation ponds.

3.5.3 Water requirement and projections

The current water use and projected requirements for Luvhuvu/Mutale catchment sourced from the All Towns Study Report are indicated in

Table 5. Information from the 2007 population figures was used to estimate population growth. This is built on the high scenario of population growth and more equitable distribution of wealth leading in time to higher average levels of water services. A base scenario was selected for estimating the most likely future water requirements for the period until 2030.

Table 5: Current water use and projections for the Luvhuvu main and Mutale catchments

Local Municipality	Current water use (Mm^3/a)	2030 water use projections (Mm^3/a)		Current available water (Mm^3/a)
		Low projections	High projections	
Thulamela	9.258	12.77	14.11	9.744
Mutale	4.007	5.234	5.757	5.004
Makhado	13.606	17.556	19.309	14.487
Total	**26.871**	**35.56**	**39.176**	**29.235**

3.5.4 Water supply and yields

Vondo, Albasini, Damani, Mukumbane, Nandoni and Tshakhuma Dams are located in the upper tributaries of the Luvuvhu River. The Luvhuvu main and Mutale catchments are dominated by irrigation. The current water use in the area is 26.871 Mm^3/a and the available yields is 29.235 Mm^3/a. The projected requirements for the year 2030 (based on high population growth) is calculated as 39.176 Mm^3/a, rendering the area in high deficit by 9.941 Mm^3/a.

There is limited information on the return flows of almost all the WWTW, Vhembe WSDP (2010–2015), indicates that a total of 10.3 Ml/d (3.759 Mm^3/a) is returned to 7 different resources. However there are plans by Makhado Local Municipality to reuse effluent from the Makhado WWTW as an added source of water from 2015 onwards with estimates of 1.33 Mm^3/a for 2015, 1.45 Mm^3/a for 2020, 1.58 Mm^3/a for 2025 and 1.7 Mm^3/a for 2030.

3.6 Groot letaba catchment area

3.6.1 Brief background

The Groot Letaba sub-area, includes the catchment of the Groot Letaba River down to the confluence with the Klein Letaba River. There is only three wastewater treatment works in this catchment area, and their locations within the catchment are indicated on the map (Figure 3).

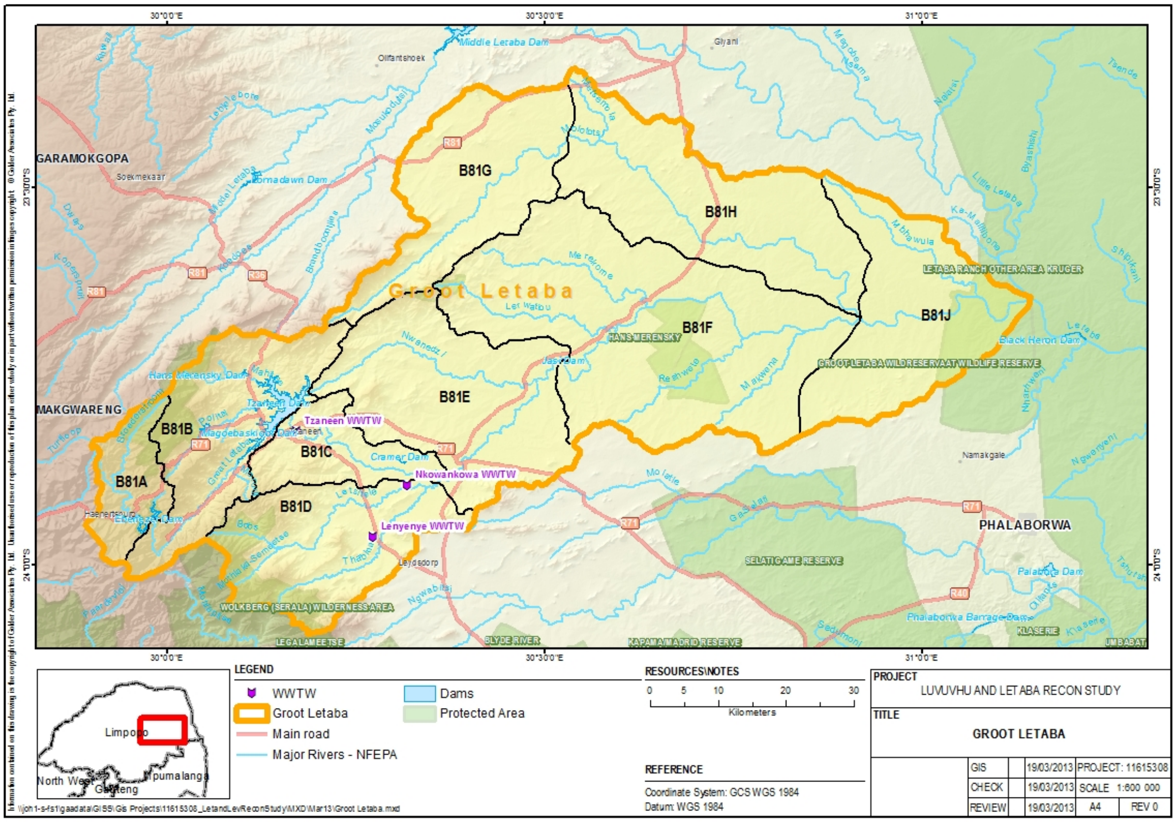


Figure 3: Groot Letaba catchment area

Table 6 provides information on the types of the works, the quality of the effluent or plant performance as indicated by the constituents of concerns and the future plans for the wastewater treatment works in the Groot Letaba area.

Table 6: Wastewater treatment works in the Groot Letaba area

Wastewater treatment works	Type	Constituents of concerns	WWTP future plans
Tzaneen WWTW	Bio Filter & Activated sludge	*E. coli*	Plans to increase the capacity from 8 Ml/d to 15 Ml/d.
Nkowankowa WWTW	Bio Filter	EC, NH_4	Tender has gone out for construction of expanding works.
Lenyenye WWTW	Oxidation ponds	*E. coli*, COD, NH_4	Plant being relocated and possibly upgraded/refurbished.

3.6.2 Effluent quality

The effluent discharged from these WWTW is of poor quality as indicated in the 2011 Green Drop report. The main constituents of concern are *E. coli*, chemical oxygen demand and ammonia. The poor water quality at points downstream of the Tzaneen domestic wastewater treatment works indicates poor effluent quality discharged from the works into the resource.

At the water quality point just before the confluence with the Letsitele tributary nutrients are elevated. Water quality results show the impacts from the Nkowankowa WWTW. The discharge quality is poor with phosphate (7 mg/l), ammonia (13 mg/l) and nitrates of (15.6 mg/l). The Thabina tributary joins the Letsitele River just before it's confluence with the Groot Letaba. The Thabina flows through the Leyenye settlement and water quality shows impacts from the oxidation ponds and urban run-off.

3.6.3 Water requirement and projections

Table 7 indicates the current water use in the catchment, the 2030 projections and the available water for the Groot Letaba catchment.

Table 7: Current water use and projections for Groot Letaba area

Local Municipality	Current water use (Mm^3/a)	2030 water use projections (Mm^3/a)		Current available water (Mm^3/a)
		Low projections	High projections	
Greater Tzaneen	15.947	22.968	22.519	17.766

3.6.4 Water supply and yields

Dap Naudé, Ebenezer, Magoebaskloof, Vergelegen Merensky and Tzaneen Dams are situated in the upper reaches of the Groot Letaba River catchment. The catchment as a whole is in deficit although users upstream of the Tzaneen Dam enjoy a relatively high level of assurance while users downstream experience shortages. The current water use in the area is 15.947 Mm^3/a and the available yields is 17.766 Mm^3/a. The projected requirements for the year 2030 (based on high population growth) is calculated as 22.519 Mm^3/a, rendering the area in high deficit by 4.753 Mm^3/a.

The All Towns study for Greater Tzaneen Local Municipality (2010) indicates a total volume of 5.217 Mm^3/a discharged from all the wastewater treatment works into the resource. This presents an opportunity of water reuse for downstream irrigators where there are water shortages.

3.7 Middle and klein letaba catchment area

3.7.1 Brief background

The Klein Letaba area includes the catchment of the Klein Letaba River down to its confluence with the Groot Letaba River. There is only three wastewater treatment works in this catchment area, and their locations are indicated on the map (Figure 4).

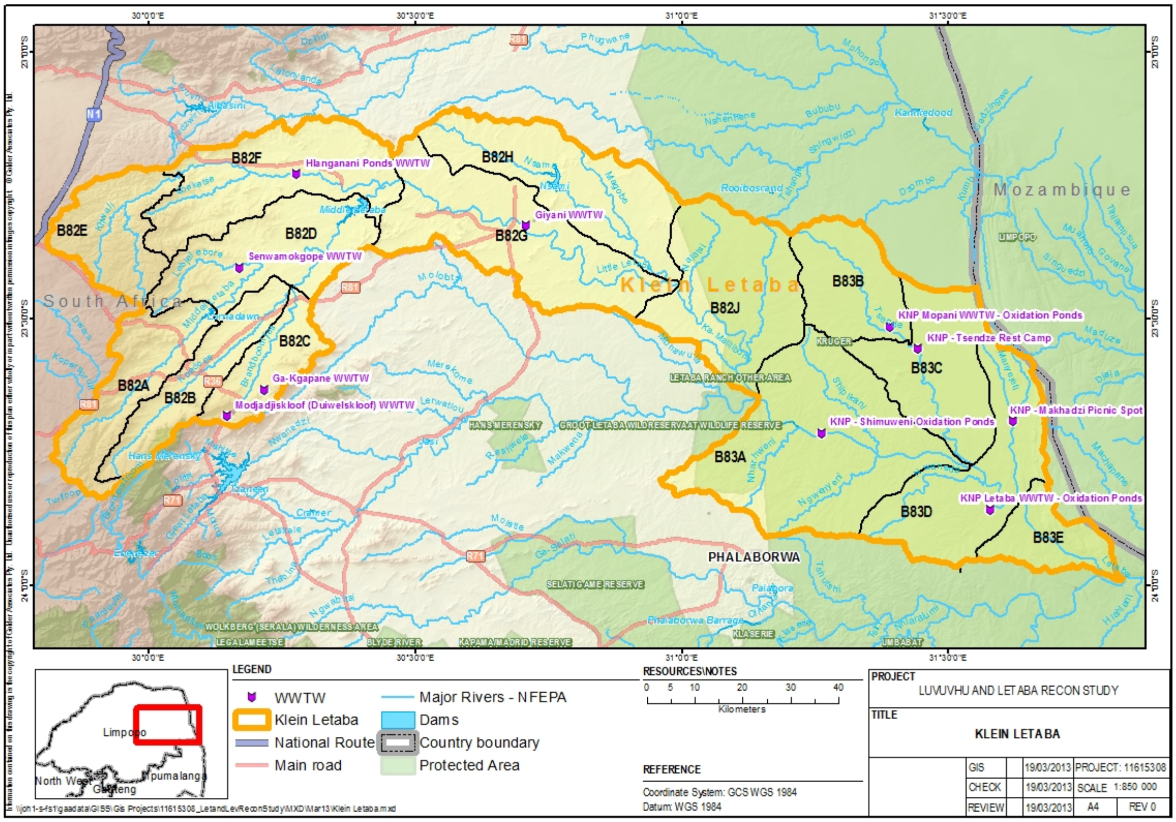


Figure 4: Middle and Klein Letaba catchment areas

Table 8 provides information on the types of the works, the quality of the effluent or plant performance as indicated by the constituents of concerns and the future plans for the wastewater treatment works.

Table 8: Wastewater treatment works in the Middle and Klein Letaba area

Wastewater treatment works	Type	Constituents of concerns	WWTP future plans
Hlanganani Ponds WWTW	Oxidation ponds	*E. coli*, FC, EC, pH, SS, NO_4, COD, NH_4, $O\text{-}PO_4$	NI
Giyani WWTW	Bio Filter	*E. coli*, FC, SS, NH_4	Upgrading in process to 5 Ml/d, delays experienced due to financial/contractual problem

Ga-Kgapane WWTW	Bio Filter	*E. coli*, FC, pH, SS, NO_4	NI

NI – No Information available

3.7.2 Effluent quality

The effluent discharged from these treatment works is not of good quality as indicated in the 2011 Green Drop report. The main constituents of concern are faecal coliforms, electrical conductivity, pH, suspended solids, nitrate, chemical oxygen demand, ammonia and orthophosphate. This is also supported by the poor water quality with high levels of nitrates (23.2 mg/l), ammonia (5.3 mg/l), and phosphate (7.4 mg/l) at a water quality sampling point downstream of the domestic WWTW. The water quality monitoring point downstream of the Giyani WWTW also shows increased concentrations of phosphate (8.4 mg/l), nitrate (7.5 mg/l) and ammonia (27 mg/l).

3.7.3 Water requirement and projections

Table 9 indicates the current water use in the catchment, the 2030 projections and the available water for the Middle and Klein Letaba catchments as outlined in the All Towns Study for Greater Giyani Local Municipality.

Table 9: Current water use and projections for the Middle and Klein Letaba area

Local Municipality	Current water use (Mm^3/a)	2030 water use projections (Mm^3/a)		Current available water (Mm^3/a)
		Low projections	High projections	
Greater Giyani	21.359	28.574	31.433	18.939
Greater Letaba	5.5	5.81	6.389	2.977
Total	**26.859**	**34.384**	**37.822**	**21.916**

3.7.4 Water supply and yields

Lorna Dawn, Rietspruit, Middle Letaba and Nsami dams are located in the Klein Letaba River catchment. Original estimates of the yield of the Middle Letaba Dam were much higher than is now believed to be the case. This, together with rapidly increasing supply from this dam to meet domestic requirements has resulted in irrigators downstream of the dam experiencing serious deficits, to the extent that they have ceased operating (DWAF, 2001). The current water use in the area is 26.859 Mm^3/a and the available yields is 21.916 Mm^3/a. The projected requirements for the year 2030 (based on high population growth) was calculated as 37.822 Mm^3/a, rendering the area in high deficit by 15.906 Mm^3/a.

It is indicated in The Reconciliation Strategy for Greater Giyani Local Municipality that a total volume of wastewater received and treated is 0.95 Mm^3/a. The treated effluent is not recycled and 0.8 Mm^3/a volume of effluent is discharged into the Klein Letaba River. There are no plans for the municipality to reuse this effluent. This presents an opportunity for water reuse in this area.

3.8 Shingwidzi river catchment area

3.8.1 Brief background

The sub-area is situated mostly in the Kruger National Park. In the Shingwedzi sub-area, most of the requirements for water are associated with the population concentration in the western part of the area. The Kruger National Park portion of the water management area, which includes most of the Shingwedzi and Lower Letaba sub-areas, is still in its natural state with only small quantities of water required for game watering and eco-tourism. Water requirements for maintenance of the eco-system are part of the Reserve, which is separately provided for.

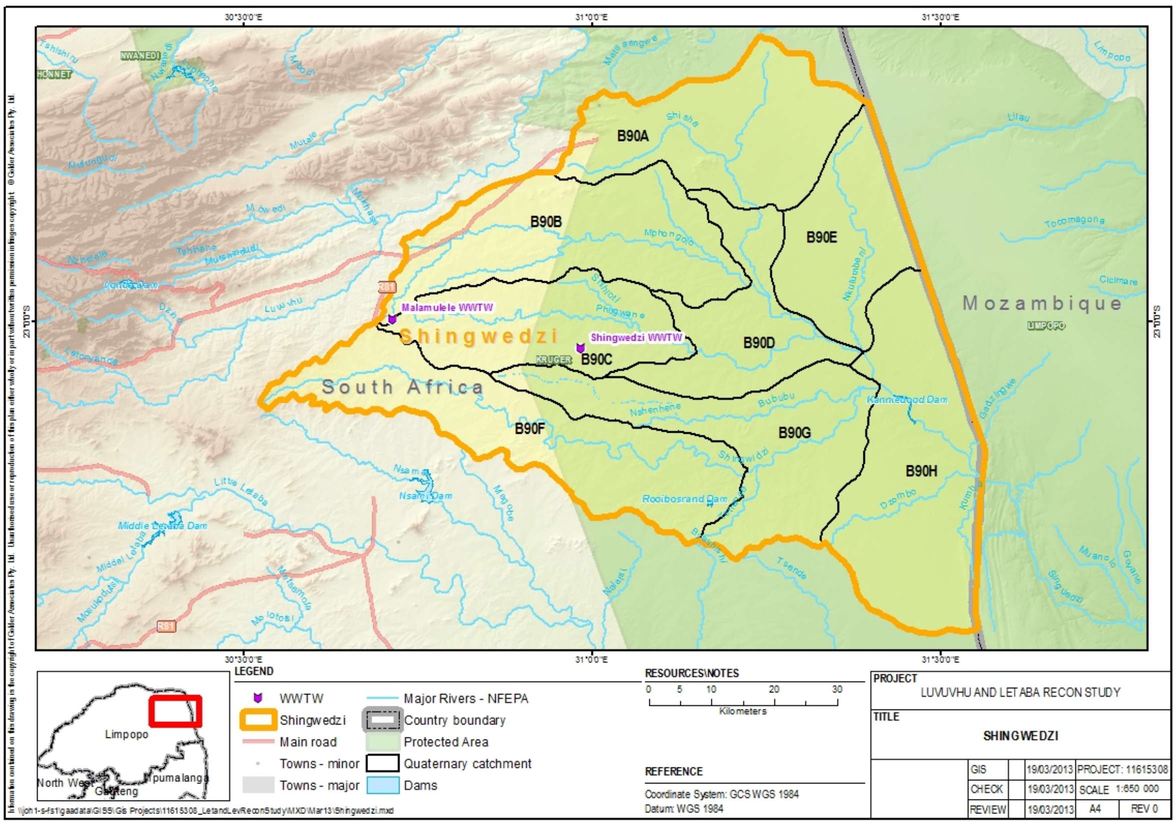


Figure 5: Shingwezi catchment area

3.8.2 Effluent qualities

The water quality point downstream of the town and the WWTW of Malamulele shows elevated levels of electrical conductivity (92 mS/m); TDS (644 mg/l); pH 8.4; phosphate (6.2 mg/l); nitrate (7.9 mg/l) and ammonia (13 mg/l) clearly indicating poor management of the WWTW (biofilter) which enters a small irrigation dam.

3.8.3 Water requirement and projections

The sub-area is situated mostly in the Kruger National Park, water requirements are limited and these are met from groundwater. There are no major dams in the catchments of the Shingwedzi and Lower Letaba Rivers. Some dams have, however, been constructed in the Kruger National Park for the purpose of game watering. Most notable are the Kanniedood Dam on the Shingwedzi River and the Engelhard Dam on the Letaba River. No sustainable yield is derived from surface flow in the Shingwedzi catchment. There could be small yields derived from small farm dams but these would probably be of very low assurance due to low and variable rainfall. Water use in the catchment is negligible, so return flows do not contribute to the water resource (DWAF, 2001).

4 PLANNING INFORMATION ON REUSE OPTIONS

The Luvhuvu/Letaba WMA in total is a water deficit area. The primary land use is agriculture with pockets of extensive organised agriculture in other parts. There is limited information on return flows and planning in relation to wastewater use within the WMA. Only three local municipalities have information on return flows.

- The Makhado Local Municipality plans to reuse effluent from their wastewater treatment works as an added source of water from 2015 onwards with estimates of 1.33 Mm^3/a for 2015, 1.45 Mm^3/a for 2020, 1.58 Mm^3/a for 2025 and 1.7 Mm^3/a for 2030. However there is no mention on how and where they intend reusing the wastewater.

- The Greater Tzaneen Local Municipality indicates that a total volume of 5.217 Mm^3/a is discharged from all the wastewater treatment works into the resource. There is no mention on the intentions of reusing the water. The water can be reused by irrigators downstream as there are already water shortages.

- Greater Giyani Local Municipality that a total volume of waste water received and treated is 0.95 Mm^3/a. The treated effluent is not recycled and 0.8 Mm^3/a volume of effluent is discharged into the Klein Letaba River.

4.1 Assessment of reuse options

One of the key considerations for wastewater reuse is to understand the treatment requirements for producing safe and reliable reclaimed water that is suitable for its intended applications. The amount of wastewater generated and treated will determine the potential for wastewater reuse and it varies from place to place depending on water availability and the quality of treated wastewater (USEPA, 2004).

Direct reuse options

Direct reuse of water refers to the introduction of reclaimed water via pipelines, storage tanks, and other necessary infrastructure directly from a water reclamation plant to a distribution system. For example, treating wastewater and then piping it to an industrial centre or a golf course for use would be considered direct reuse.

Indirect reuse options

In indirect wastewater reuse, treated wastewater is discharged into a water reservoir – either an aquifer or a surface water body for mixing and assimilation with the objective of providing an environmental buffer.

4.1.1 Options for Wastewater Reuse

Agricultural reuse

The supplier of reclaimed water must be able to quantify agricultural demands with their seasonal variation, as well as any fluctuation in the reclaimed water supply (USEPA, 2004). Agriculture in South Africa is a very important activity that contributes significantly to the economic growth of the nation and plays a major role in poverty reduction in rural areas. The Luvhuvu/Letaba WMA is dominated by agriculture which means that there potential for wastewater reuse for this sector. However, the WWTW would need to be upgraded and the operation optimised considerably to produce a safe, stable effluent.

Urban reuse

Reclaimed water demand in an urban system can be grouped into indoor and outdoor demand. The main indoor application of reclaimed water is toilet flushing and the demand for this activity is highly dependent on the population to be served and the type of sanitary appliances. Outdoor applications on the other hand involve landscape irrigation and recreational water use in ornament and water fountains (USEPA, 2004).

Opportunities for urban reuse in the main towns in the Luvuvhu/Letaba area may include irrigation of sports fields or municipal gardens. The option for using reclaimed water for toilet flushing is possible. However this activity is highly dependent on how such an option will be received by the population to be serviced. It can also be costly as it will require infrastructure for treating and directly piping it to households.

However, in all of these options the WWTW would need to be upgraded and the operation optimised considerably to produce a safe, stable effluent.

Industrial reuse

There may be limited opportunities for reuse of effluent by industries in the larger towns. However, the quality requirements for industrial use are often very stringent and the parameters, such as metal concentrations, that need to be measured, are currently not done on the effluent leaving the WWTW. Further assessment on this would need to be undertaken if this option was to be considered.

5 CONCLUSION AND RECOMMENDATIONS

The assessment of wastewater treatment works in the Luvuvhu/Letaba WMA has indicated the following:

- Most municipalities in this area do not measure the volume of effluent entering the WWTW or that discharged as treated effluent;
- In all cases where data was available the effluent discharged is also of poor quality with high nutrients and faecal contamination; and

- There are areas of water deficit where treated wastewater could be considered for agricultural or limited urban use.

It is recommended that should the option of treated wastewater reuse be considered then the wastewater treatment works in the study area need to be upgraded and their operation optimised to improve the quality of the effluent being discharged. Currently the quality being discharged may have serious human health and ecological consequences and increased eutrophication potential in the study area which will in turn impact on other water users such as irrigation farmers and water treatment plants.

6 GLOSSARY

Term	**Definition**
Alkalinity	Capacity of water to neutralize acids by its content of bicarbonates, carbonates, and/or hydroxides – The buffer capacity of a water body.
Chemical Oxygen Demand	Measurement of the amount of oxygen used in the chemical break-down of organic matter in water. Is a good indicator of the total amount of organic waste.
Direct reuse	Treating wastewater and directly incorporating the reclaimed water into the distribution system (potable or non-potable).
Effluent	The treated water discharged by a wastewater treatment plant.
Heavy metals	Metallic elements with high atomic weights e.g., copper, mercury, chromium, cadmium, arsenic or lead. Heavy metals can damage living things at low concentrations and tend to accumulate in the food chain.
Indirect Reuse	Introduction of treated wastewater into a water reservoir, either an aquifer or a surface water body for mixing and assimilation with the objective of providing an environmental buffer
Nutrients	Elements essential for plant or animal growth. Major nutrients include nitrogen, phosphorus, carbon, oxygen, sulphur, and potassium.
Pathogens	Disease-causing biological agent such as a bacterium, virus, or fungus.
Pollution	An undesirable change in the physical, chemical, or biological characteristics of air, water, soil, or food that can adversely affect the health, activities, or survival of humans or other living organisms.
Reclaimed water	Wastewater that has been treated to levels suitable for reuse
Salinisation	Is the process by which the concentration of dissolved solids in inland waters is increased.
Suspended Solids	Material suspended in water, which includes a wide range of sizes of material, from colloids (0.1 μm) through to large organic and inorganic particulates.
TDS	Total dissolved solids – a measure the inorganic salts (and organic compounds) dissolved in water.

Toxicant	A chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides, heavy metals and biotoxins.
Wastewater	Liquid waste discharged by domestic residences, commercial properties, industry, agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources.
Water quality	Describe the physical, chemical, biological and aesthetic properties of water which determines its fitness for use and its ability to maintain the health of farmed aquatic organisms.

7 REFERENCES

Adewumi R.J (2011) Decision support system for assessing the feasibility of implementing wastewater reuse in South Africa, PhD Thesis submitted to Faculty of Engineering, Wits University.

Department of Water Affairs (2010) Development of a Reconciliation Strategy for All Towns in the Northern Region Mopani District Municipality: Greater Tzaneen Local Municipality, Developed by SRK Consulting.

Department of Water Affairs (2011) Development of a Reconciliation Strategy for All Towns in the Northern Region Mopani District Municipality: Greater Letaba Local Municipality,– Developed by SRK Consulting.

Department of Water Affairs (2009) Municipal Wastewater Treatment Base Information For Targeted Risk-Based Regulation: Limpopo Province.

Department of Water Affairs (2011) Development of a Reconciliation Strategy for All Towns in the Northern Region Vhembe District Municipality: Thulamela Local Municipality, Developed by SRK Consulting.

Department of Water Affairs (2011) Development of a Reconciliation Strategy for All Towns in the Northern Region Mopani District Municipality: Greater Giyani Local Municipality, Developed by SRK Consulting.

Department of Water Affairs (2011) Development of a Reconciliation Strategy for All Towns in the Northern Region Vhembe District Municipality: Mutale Local Municipality, Developed by SRK Consulting.

Department of Water Affairs (2012) Green Drop progress Report, Introduction to Green Drop PAT, National Overview Report.

Department of Water Affairs and Forestry (2001) Water Resources Situation Assessment Studies: Water Resources Situation Assessment - Luvuvhu and Letaba WMA: DWAF Main Report No 02000/00/0301.

Department of Water Affairs and Forestry, South Africa (2004) Luvuvhu/Letaba Water Management Area: Internal Strategic Perspective. Prepared by Goba Moahloli Keeve Steyn (Pty) Ltd in association with Tlou and Matji, Golder Associates Africa and BKS on behalf of the Directorate: National Water Resource Planning. DWAF Report No. P WMA 02/000/00/0304.

Development of a Reconciliation Strategy for All Towns in the Northern Region Vhembe District Municipality: Makhado Local Municipality, January 2011 – Developed by SRK Consulting.

Overview of Water Resources Availability and Utilisation, Luvuvhu and Letaba Water Management Area, Report No. P WMA02000/00/0203.

Simon Toze (1997) Microbial pathogens in wastewater. CSIRO Land and Water Technical report 1/97.

Simon Toze (2003) Reuse of effluent water – Benefits and Risk, CSIRO Land and Water, CSIRO Centre for Environment and Life Sciences - Wembley, Perth, WA 6913. www.clw.csiro.au.

USEPA, United State Environmental protection Agency (2004). Guidelines for Water Reuse. EPA/625/R-04/108.

Vhembe District Municipality (2010-2015) Water Services Development Plan.