Department of Water & Sanitation

Report Number 6

Edition 1

REPORT

# Integrated Water Quality Management Plan for the Olifants River System

## Management Options Report

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Department:
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**DEPARTMENT OF WATER AND SANITATION**

**Water Resource Planning Systems Series**

# Development of an Integrated Water Quality Management Plan for the Olifants River System

# Management Options Report

**Study Report No. 6**

**P WMA 04/B50/00/8916/7**

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# APPROVAL

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# EXECUTIVE SUMMARY

The Department of Water and Sanitation (DWS) from a planning perspective has identified the need to develop an overarching Integrated Water Quality Management Plan (IWQMP) for the Olifants WMA in order to manage the water resources and needs to take cognisance of, and align to a number of studies and initiatives that have been completed to date, and needs to establish clear goals relating to the quality of the relevant water resource in order to facilitate a balance between protection and use of water resources.

The main objective of the study is to develop management measures to maintain and improve the water quality in the Olifants WMA in a holistic and sustainable manner so as to ensure sustainable provision of water to local and international users. The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking the strategies and plans developed at the sub-catchment level into account.

The following aspects of the study have already been undertaken:

- Inception Report (Report No: P WMA 04/B50/00/8916/1);
- Water Quality Status Assessment and International Obligations With Respect To Water Quality Report: (Report No: P WMA 04/B50/00/8916/3); and
- Water Quality Planning Limits Report: (Report No: P WMA 04/B50/00/8916/4).

The following components are now underway:

- Scenario Analysis Report;
- Reconciliation and Foresight Report;
- Management Options Report;
- Integrated Water Quality Management Plans for each Sub-catchment:
  - IWQMP for the Upper Olifants sub-catchment;
  - IWQMP for the Middle Olifants sub-catchment;
  - IWQMP for the Lower Olifants sub-catchment;
  - IWQMP for the Steelpoort sub-catchment; and
  - IWQMP for the Letaba and Shingwedzi sub-catchment
- Monitoring Programmes Report;
- Overarching IWQMP for the Olifants River System; and
- Implementation Plan Report.

The key to the successful management of the water quality in the Olifants River System is the formulation of management measures that will integrate all the relevant aspects that have a bearing on the water resources. In this respect an assessment of the physical, economic, social, institutional, statutory and ecological aspects in the system was undertaken to understand the current situation and therefore be in a position to assess existing management options and proposed new options that will be able to handle the existing as well as anticipated future challenges (DWS Report number: P WMA 04/B50/00/8916/3).

Furthermore it is expected that the growing economy, in the Olifants System, will intensify the pressures on the water quality of the resource and it is therefore necessary to find innovative measures that offer economical and sustainable management solutions. The reconciliation strategies developed for the various systems within the WMA have indicated that extensive augmentation will be needed that may stress the water resources in respect of chemical, physical and microbiological constituents even further.

Scenarios that will have the biggest positive impact in reducing the load are described as:

- Reduction of load due to seepages from the mine, industrial and power station waste storage facilities and mining operations in the Upper Olifants sub-catchment, some load from the Steelpoort sub-catchments and the Ga-Selati in the lower Olifants sub-catchments.;
- Reduction of load due to excess mine water on the mining operations threatening to decant or starting to flood the coal reserves in the Upper Olifants sub-catchment;
- Reduction of load from irrigation return flows in the Upper and Middle Olifants;
- Reduction of nutrient load from domestic WWTW that discharge to the water resources, by considering a reduction of the orthophosphate concentration to 1 mgP/l;
- Reduction of nutrient and sediment load from agricultural areas and areas where changing land uses may be occurring;
- Reduction of nutrient and sediment load from run-off from urban/ densely populated areas; and
- Improved reuse of effluent from domestic wastewater treatment works not designed to meet the general discharge limits.

The determination of management options involved the identification and development of proposed management measures and options that will improve the non-compliance cases and deteriorating trends and utilise the available assimilative capacity to the benefit of the water users and ensure the sustainability of the system. It may be that existing management options are the right ones to follow, however that implementation and enforcement have not been done effectively – this will be assessed. Proposed management options will be evaluated on the basis of their technical, social and economic feasibility. The following options are under consideration and are described in the report and will be taken further as part of the sub-catchment IWQMPs:

- Structural/ physical options
  - Salinity Management
  - Metals Management
  - Nutrient and Microbiological Management
  - Additional weirs
- Institutional Management Options

    - Establishment of the Catchment Management Agency
    - Collaboration within Management Units: Mines, Industries and Power Stations
    - Collaboration within Government Departments: Defunct Mines
    - Operationalising the IWWMP and associated components
    - Load calculations and implementation of the Waste Discharge Charge System
    - Collaboration with Local Government structures
    - Protection of Source Areas
    - Operating rules
    - Emerging Contaminants Management
- Monitoring and Information
    - Collaborative monitoring
    - Monitoring for metals
    - Microbiological Monitoring
    - Emerging contaminants monitoring
    - Regional Laboratories
- Management Information System
- Groundwater Management Options
    - Water treatment options
    - Aquifer protection zoning
- Stakeholder Engagement

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| AIP | Alien Invasive Plants |
| BWPCP | Brugspruit Water Pollution Control Plant |
| CAIA | Chemical Allied Industry Association |
| COGTA | Co-operative Governance and Traditional Affairs |
| CoM | Chamber of Mines |
| CMF | Catchment Management Forum |
| CSIR | Council for Scientific and Industrial Research |
| DMR | Department of Mineral Resources |
| DoA | Department of Agriculture |
| DWA | Department of Water Affairs |
| DWAF | Department of Water Affairs and Forestry |
| DWS | Department of Water and Sanitation |
| EDC | Endocrine Disrupting Compound |
| EFR | Ecological Flow Requirements |
| EWR | Ecological Water Requirements |
| EWRP | eMalahleni Water Reclamation Plant |
| GDS | Green Drop System |
| GIS | Geographical Information System |
| GLOBALG.A.P. | Global Good Agricultural Practice |
| GTT | Government Task Team |
| GWP | Global Water Partnership |
| IWRM | Integrated Water Resources Management |
| IWQMP | Integrated Water Quality Management Plan |
| IWUL | Integrated Water Use Licence |
| IWULA | Integrated Water Use Licence Application |
| IWWMP | Integrated Water and Waste Management Plan |

| | |
|---|---|
| KNP | Kruger National Park |
| LNW | Lepelle Northern Water |
| LOROC | Lower Olifants River Operations Committee |
| MSS | Municipal Support Strategy |
| MU | Management Unit |
| MUTT | Management Unit Task Team |
| MWCB | Mine Water Co-ordinating Body |
| MWRP | Mine Water Reclamation Plants |
| NIP | National Implementation Plan |
| NMMP | National Microbial Monitoring Programme |
| NWA | National Water Act |
| NWRS | National Water Resource Strategy |
| ORS | Olifants River System |
| OWRP | Optimum Water Reclamation Plant |
| PAA | Protected Areas Act |
| PAC | Project Administrative Committee |
| PGM | Platinum Group Metals |
| PMC | Project Management Committee |
| POP | Persistent Organic Pollutant |
| PSC | Project Steering Committee |
| PSP | Professional Service Provider |
| PPECB | Perishable Products Export Control Board |
| RDM | Resource Directed Measures |
| RQOs | Resource Quality Objectives |
| RWQOs | Resource Water Quality Objectives |
| SALGA | South African Local Government Association |
| SANS | South African National Standards |

| | |
|---|---|
| TDS | Total Dissolved Salts |
| TOR | Terms of Reference |
| UFS | University of the Free State |
| WC/ WDM | Water Conservation/ Water Demand Management |
| WITS | University of the Witwatersrand |
| WMA | Water Management Area |
| WMS | Water Management System |
| WQP | Water Quality Planning |
| WQPL | Water Quality Planning Limits |
| WRC | Water Research Commission |
| WRP | Water Reclamation Plant |
| WWTW | Wastewater Treatment Works |

# 1. INTRODUCTION

## 1.1 Background

Over the past few decades, with the increasing concerns of climate change and associated floods and droughts, water is being recognised by all stakeholders as a critical resource, to support social well-being and economic development, which needs to be protected. The severe drought and occasional flash floods over the last few years has highlighted this situation even more, especially the need for consistent integrated water resources management.

The review of the water balances in the Olifants WMA has indicated inconsistencies and critical shortages in several of the sub-catchments. The assumption cannot be made that there will be adequate water to supply all water users with the quality and quantity of water needed, while maintaining the wetlands, and rivers ecosystems.

The Olifants River System which comprises the Upper, Middle and Lower Olifants River sub-catchments, as well as the Steelpoort, Letaba and Shingwedzi sub-catchments, is a highly utilised and regulated catchment and like many other Water Management Areas (WMA) in South Africa, its water resources are critically stressed in respect of bothy water quantity and quality. This is due to an accelerated rate of development and the scarcity of water resources. There is therefore an urgency to ensure that water resources in the Olifants River System are able to sustain their level of uses and be maintained at their desired states.

The Olifants River flows northwards through Witbank Dam down to Loskop Dam. The confluences of the Klein Olifants, Spookspruit, Klipspruit and Wilge Rivers with the Olifants River are between the Witbank and Loskop dams. From Loskop Dam the Olifants River flows some 80 km to Flag Boshielo Dam. The Moses and Elands Rivers join the Olifants River downstream of Loskop Dam from the west while the Bloed River joins from the east. The Steelpoort River confluences with the Olifants about 50 kilometres before the confluence of the Olifants and Blyde rivers after which it confluences with the Ga-Selati on the border of the Kruger National Park (KNP). The Letaba River joins the Olifants River upstream of the border into Mozambique in the KNP, after which it flows into the Massingir Dam about six (6) kilomteres from the border, before it joins the Limpopo River which eventually discharges into the Indian Ocean. The Shingwidzi River flows south east through the KNP becoming the Rio Shingwidzi in Mozambique where it confluences with the Rio Elefantes downstream of the Massingir Dam.

This study focusses on the South African sector of the Olifants River system and does not deal with the Mozambique sector, however the improvement in the South Africa portion of the Olifants River system, will ultimately have a positive impact on the Massingir Dam and the lowest reaches of the Rio Elephantes which is controlled by inflows from upstream (South Africa).

Formal economic activity in the system is highly diverse and is characterised by commercial and subsistence agriculture (both irrigated and rain fed), diverse mining activities, manufacturing, commerce and tourism. Large coal deposits are found in the eMalahleni and Middelburg areas (Upper Olifants) and large platinum group metal (PGM) deposits are found in the Steelpoort, and copper in the Phalaborwa areas. The catchment is home to several large thermal power stations, which provide energy to large portions of the country. Extensive agriculture can be found in the Loskop Dam area, the lower catchment near the confluence of the Blyde and Olifants Rivers as well as in the Steelpoort Valley, and the upper catchments of the Groot Letaba and to a limited extent in upper Selati catchment. A large informal economy exists in the Middle Olifants, Middle Letaba and Shingwedzi, with many resource-poor farmers dependent on ecosystem services. The WMA has many important tourist destinations, including the Blyde River Canyon and the Kruger National Park. Land use in the Olifants River System is diverse and consists of irrigated and dryland cultivation, improved and unimproved grazing, mining, industry, forestry and urban and rural settlements.

The Department of Water and Sanitation (DWS) from a planning perspective has identified the need to develop an overarching Integrated Water Quality Management Plan (IWQMP) for the Olifants WMA, as well as sub-catchment IWQMPs, in order to manage the water resources, the study needs to take cognisance of, and align to a number of studies and initiatives that have been completed to date as part of this project, as well as previous reconciliation and other relevant reports. It needs to establish clear goals relating to the quality of the relevant water resources in each of the sub-catchments identified in order to facilitate a balance between protection and use.

The main objective of the study is to develop management measures to maintain and improve the water quality in the Olifants WMA for the different user types in a holistic and sustainable manner to ensure sustainable provision of water to local and international users. The management measures will be of an overarching nature and will deal with the broader Olifants WMA while taking the strategies and plans developed at the sub-catchment level into account.

The following aspects of the study have already been undertaken:

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- Water Quality Planning Limits Report: (Report No: P WMA 04/B50/00/8916/4);
- Scenario Analysis Report (draft); and
- Reconciliation and Foresight Report (draft); and
- Management Options Report (draft).

The following components are now underway:

- Integrated Water Quality Management Plans for each Sub-catchment:
  - IWQMP for the Upper Olifants sub-catchment;
  - IWQMP for the Middle Olifants sub-catchment;
  - IWQMP for the Lower Olifants sub-catchment;
  - IWQMP for the Steelpoort sub-catchment; and
  - IWQMP for the Letaba and Shingwedzi sub-catchments,
- Monitoring Programmes Report;
- Overarching IWQMP for the Olifants River System; and
- Implementation Plan Report.

## 1.2 Study Area

The spatial extent of the Olifants River System comprises tertiary drainage regions B11, B12, B20, B31, B32, B41, B42, B52, B52, B60, B71, B72 and B73 in the Olifants River catchment, B81, B82 and B83 in the Letaba catchment and B90 in the Shingwedzi catchment. The study area has been sub-divided into the following sub-catchments (Figure 1): Upper Olifants, Middle Olifants, Steelpoort, Lower Olifants; and Letaba and Shingwedzi.

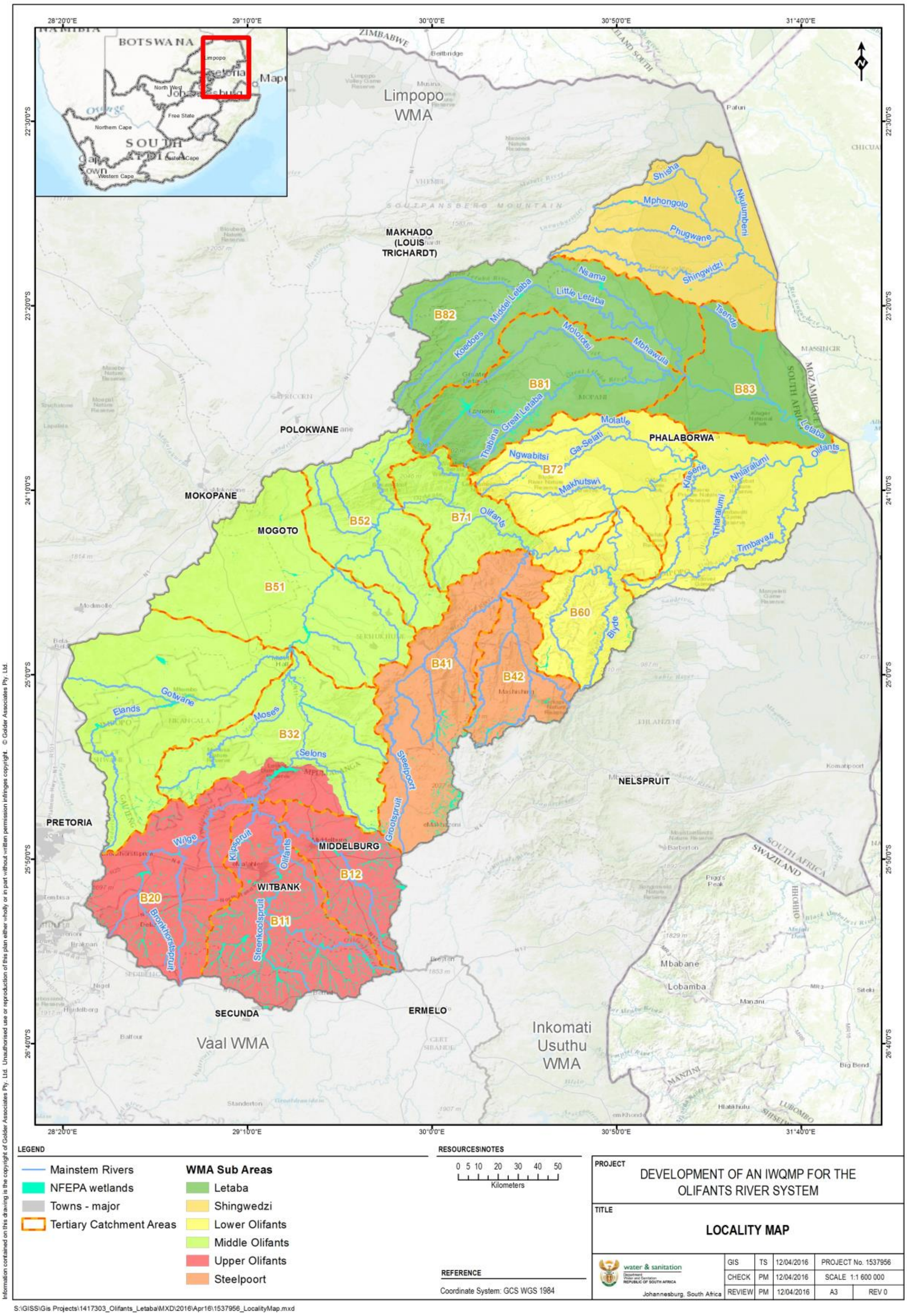


**Figure 1: Study Area**

## 1.3 Adaptive management

The move toward accountability in natural resource management has led to a growing need for a more structured approach to decision-making. Adaptive management is a naturally sensible framework within which learning can take place and is about learning by doing in a scientific way to deal with uncertainty: a structured iterative process of decision-making which guides human interventions in natural ecosystems (Roux et al., 2010). This approach is however very relevant to how the management of the water resources in respect of both quantity and quality is undertaken.

The approach summarised in **Error! Reference source not found.** acknowledges the inherent uncertainty in the dynamics of ecosystems and that as more is learnt, management can evolve and improve. This is because natural systems are complex and dynamic. The variability in natural systems is therefore unpredictable to some extent, as is the uncertainty now around the impacts of climate change.

Nonetheless, management decisions need to be made. Adaptive management proceeds despite this uncertainty by treating human interventions in natural systems as large-scale experiments from which more may be learnt, leading to improved management in the future. The inherent uncertainties associated with various scenarios makes adaptive management an appropriate framework.

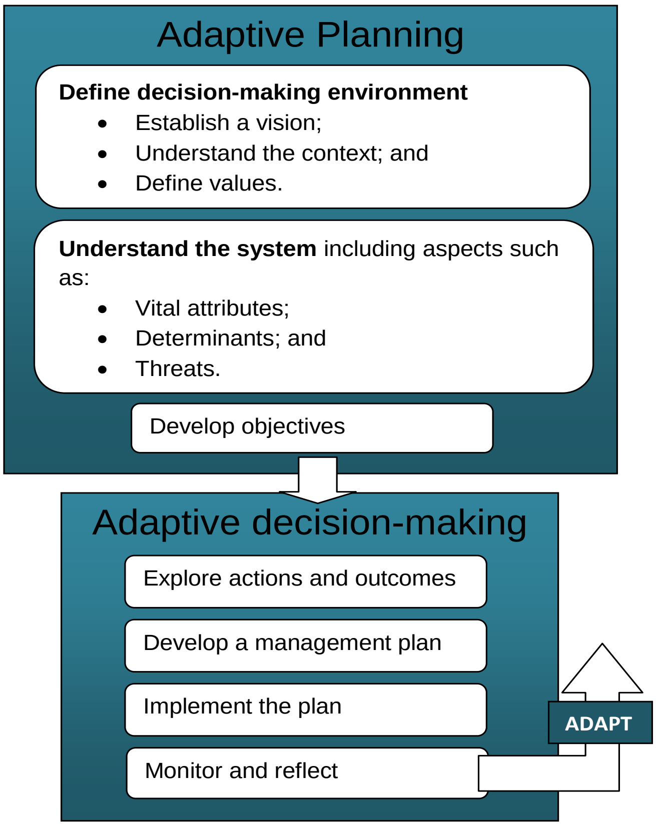


**Figure 2: Adaptive management approach (Roux et al., 2010)**

Adaptive management is forward-looking, explicit in its purpose, inclusive, based on co-learning, realistic, action oriented, flexible, and strives for continual improvement. Thorough planning precedes adaptive decision-making. This involves consciously predicting and documenting the likely outcome of decisions, while acknowledging the uncertainties. The management and associated implementation plan is then a set of actions with targets. Reflection on monitoring results is done against the targets and predicted outcomes. Future plans, objectives or understanding are then adapted accordingly.

No matter how thorough and complete the initial assessment and design may have been, systems may always respond in ways that may not have been foreseen at the planning stage. Ecosystems exhibit long-term, persistent changes over decades and centuries. In this respect recent experience is not necessarily a good basis for predicting future behaviour. The effects of global climatic change on the dynamics of ecosystems, which are to a large extent unpredictable, will pose many such management challenges. Adaptive management programmes therefore need to include a stage of evaluation and adjustment.

Outcomes of past management decisions must be compared with initial forecasts, models have to be refined to reflect new understanding, and management programmes have to be revised accordingly. New information may suggest different uncertainties and innovative management approaches, leading to another cycle of assessment, design, implementation, and evaluation.

Improved clarity around key elements in a decision-making process can help decision-makers focus attention on what, why and how actions will be taken.

Activities in a structured approach to decision-making include:

- Engaging the relevant stakeholders in the decision-making process;
- Identifying the problem to be addressed;
- Specifying objectives and trade-offs that capture the values of stakeholders;
- Identifying the range of decision alternatives from which actions are to be selected;
- Specifying assumptions about resource structures and functions;
- Projecting the consequences of alternative actions;
- Identifying key uncertainties;
- Measuring risk tolerance for potential consequences of decisions;
- Accounting for future impacts of present decisions; and
- Accounting for legal guidelines and constraints.

## 1.4 Purpose of the report

The main purpose of this report is to discuss the existing and proposed management options that are being implemented to improve the water quality as well as proposals that should be considered in collaboration with relevant stakeholders for the various users in the WMA. The adaptive management approach described above should be considered in the development of the management plan and its associated implementation.

However to get to this point, considerable work has been undertaken to get an understanding in respect of the current chemical load to the system (in respect of salinity and nutrients) versus the load that could be expected if the concentrations were to comply with the proposed WQPLs. In addition the recommendations proposed to achieve adequate water supply for the WMA and transfers to the Limpopo WMA for development opportunities as part of the reconciliation strategies are likely to also have an impact on the water quality of the water resources, and need to be discussed. This has all led to proposed scenarios that need to be implemented to make the biggest positive impact. The management options follow on this.

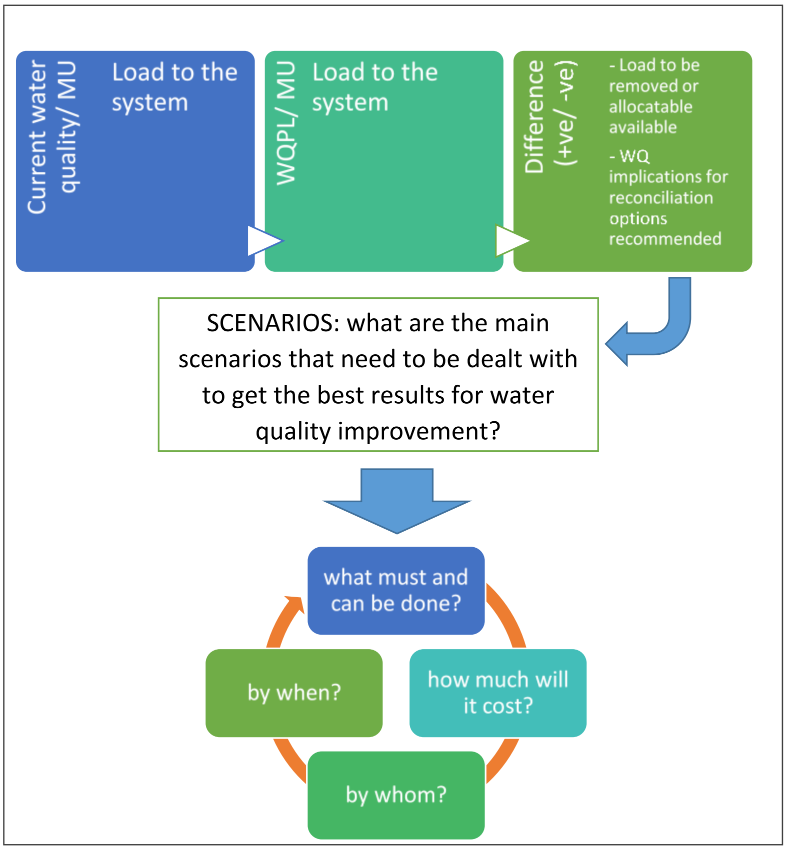


***Figure 3: Report outline***

The *by whom and when* will be dealt with in more detail in the IWQMPs for the sub-catchments' and in the associated implementation plans, however some proposals of who should take the lead and the other supporting institutions/ organisations are considered in this report.

## 1.5 Structure of the Report

This report briefly describes the outcomes of the status assessment and a summary of the impacts of the implementation of the reconciliation strategies on the compliance of the water quality planning limits (WQPLs). It then puts forward the proposed scenarios that need to be dealt with to achieve the most improvement, and considers various management options under the following themes:

- Structural/ Physical options;
- Institutionally related options;
- Monitoring and Information; and

- Awareness creation.

## 2. SUMMARY OF THE STATUS ASSESSMENT OF THE WATER QUALITY OF THE OLIFANTS WMA

In order to determine water quality planning limits (WQPLs) a status assessment of the water quality, against the various user sector requirements, based on the South African Water Quality Guidelines (DWAF, 1996), was undertaken during the initial stages of the project. This was done to get an understanding of the water quality in the different management units and to give weight to the WQPLs subsequently set. In addition, the outcomes of the Reserve determination finalised in January 2017, the classification and Resource Quality Objectives (RQO) were considered when setting the WQPLs.

The results are detailed in the following reports:

- Water Quality Status Assessment and International Obligations with respect to Water Quality Report, Report No. P WMA 04/B50/00/8916/3; and
- Water Quality Planning Limits Report, Report No. P WMA 04/B50/00/8916/4.

The results have indicated specific areas of concern in the six delineated sub-catchments of the Olifants WMA, with the major issues identified as the impacts from mining; wastewater discharge; urban run-off; industrial; and agricultural activities that have a bearing on its future management and operation.

Non-compliant wastewater treatment works contributing to organic, microbiological and nutrient loads are a serious threat to the water resources of the WMA. This situation appears to be continuing unabated, and until such time as this matter is addressed by all the role players at the appropriate levels, water quality management goals will not be achieved. This must be prioritised by the larger municipalities as well as local authorities of the smaller towns and will form part of the implementation plan for this project.

Mining activities are impacting significantly on the water quality of the water resource system which is changing the characteristics of some of the water resources to such an extent that its ecological infrastructure value has been lost. Complete or partial loss of wetlands, and impacts on water quality due to mining activities has, and continues, to impact on the water resource system of the WMA. Decisions around future mining need to be informed by a better understanding of the cumulative long-term effects on the water resource system. In addition a strategy needs to be developed and implemented to deal with the water discharging from the defunct mines as well as existing mines post-closure and will form part of the implementation plan for this project.

Runoff from commercial agricultural areas contains agro-chemicals, which may contribute to eutrophication or contamination of water with pesticides downstream of the irrigated areas. While the impacts from the use of pesticides (including herbicides) are still relatively unknown a strategy must be developed to get a better understanding of these impacts.

Erosion, turbidity and sediment deposition are diminishing the potential of the hydrological system and loss of natural filters such as wetlands are also resulting in an increase in sediments in the water, increased erosion and terrestrial alien invasion.

***Areas of salinity concern***

Figure 4 illustrates those areas in the WMA where salinity is a serious concern and load will need to be removed. This is predominantly related to sulphate, however, chlorides in MU36 and lower end of MU35 and MU38 show some elevated trends so will need to be monitored.

Figure **5** describe and illustrate in more detail the sulphate loads emanating from the various management units, specifically on the Upper Olifants where the major concerns are. Management Units 9, 30, 28, 11, 12, 13, 14, 15, 16, 17, 18, 5, 19, 21, 20 and 26 recording loads of >10 000 t/annum and Management Unit 80 in the Lower Olifants on the Ga-Selati in the Phalaborwa area.

The biggest load is associated with the main stem Olifants River, calculated at the Wolwerkrans weir to be in the order of 80 000 T/a, which receives salinity contributions from MU3 (Koringspruit) and MU5 (Klippoortjiespruit) and the lower portions of MU2 (Rietspruit), MU7 (Steenkoolspruit) and MU8 (main Olifants below the confluence with the Viskuile): about a 30 kilometre radius from the Wolwekrans weir.

Further large contributions emanate from the Klein Olifants: MU14 (an estimated 29 000 T/a) measured on the Klein Olifants, however the major contributions do not emanate in MU14 but are upstream from MU11 (Rietkuilspruit), MU12 (Bosmanspruit) and MU13 (Woestalleenspruit).

In the Lower Olifants sub-catchment the Ga-Selati (measured at Loole weir) contributes and estimated 4 600 T/a.

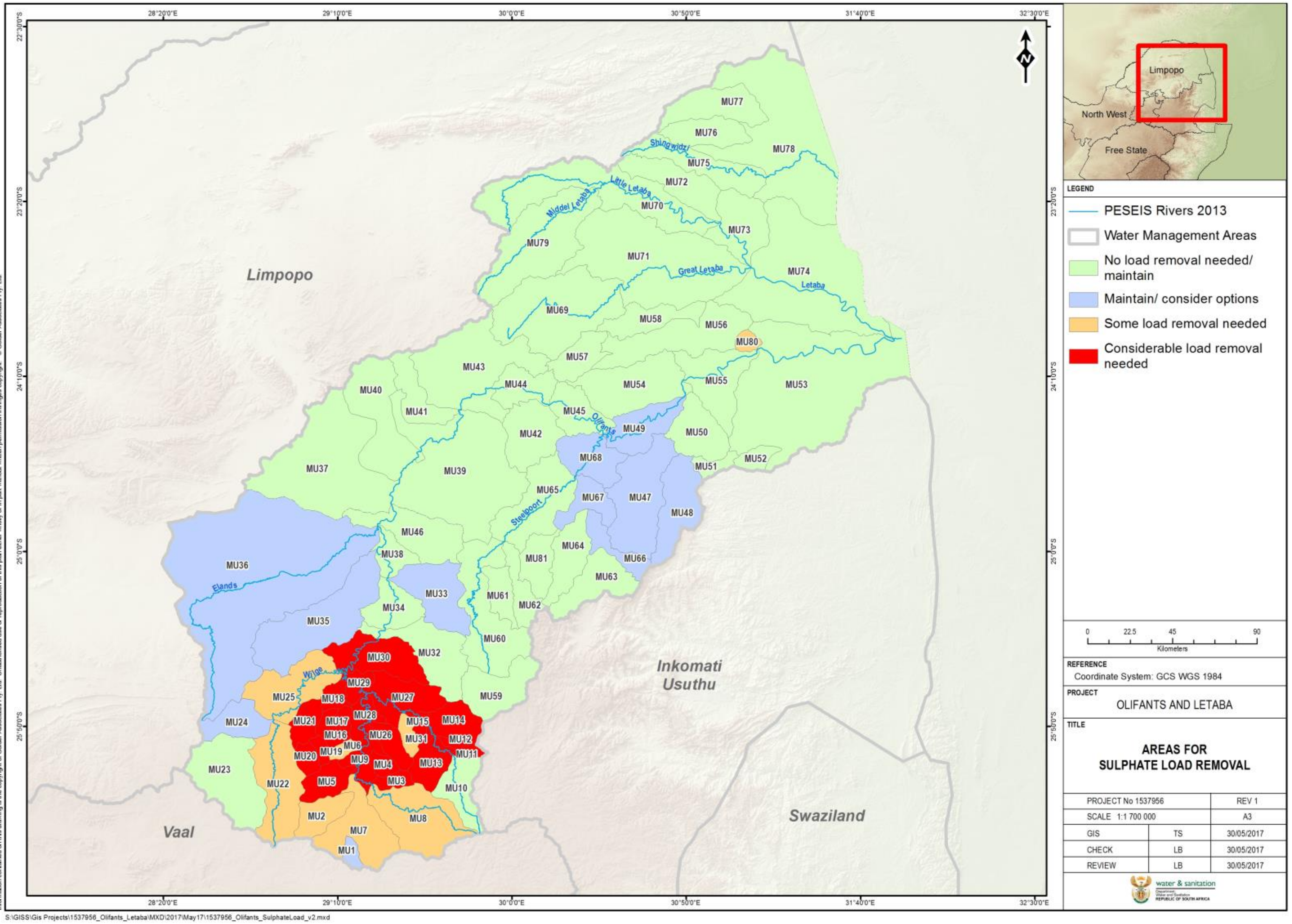


**Figure 4: Areas where salinity load will need to be removed**

**Table 1: Management Units with salinity load concerns**

| MU | Description | Average Loads (tonne/annum) T/a) |
|---|---|---|
| 8 | Olifants River at Middelkraal (B1H18) | 3 424 |
| 26 | Spookspruit @ Elandspruit (B1H2) | 11 184 |
| 9 | Olifants River@ Wolvekrans (B1H5) | 80 399 |
| 2 | Canal from Riet Spruit Dam @ Roodepoort | 2 661 |
| 22 | Wilge River @ Onverwacht (B2H14) | 1 673 |
| 24 | Bronkhorstspruit @ Bronkhorstspruit (B2H3) | 1 006 |
| 14 | Klein Olifants @ Rondebosch (B1H12) | 28 925 |
| 6 | Noupoortspruit @ Naauwpoort (B1H19) | 2 288 |
| 16,17,18 | Klipspruit@Zaaihoek (B1H4) | 16 251 |
| 25 | Wilge River @ Waterval (B2H15) | 6 092 |
| 7 | Steenkool Spruit @ Middeldrift (B1H21) | 7 574 |
| 15 | Town Pipeline @ Rondebosch | 21 886 |
| 5 | Saaiwater Spruit @ Klipplaat | 15 524 |
| 28 | Witbank Municipal Area | 47 076 |
| 4 | Witbank Dam on Olifants River | 8 793 |
| 19, 21, 20 | Waschbank downstream Kromdraai Mine on Kromdraaispruit | 14 682 |
| 30 | Olifants River @ Loskop Nat.Res | 64 481 |
| 81 | Ga-Selati River at Loole (B7H19) | 4 684 |

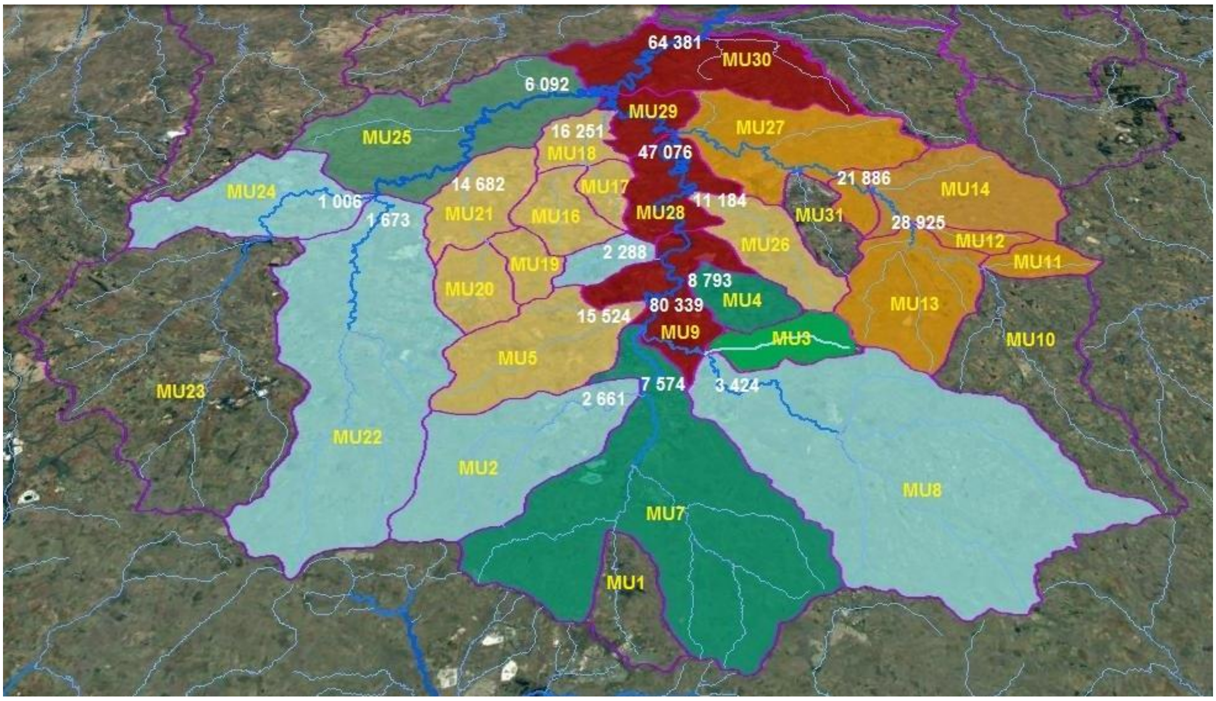


**Figure 5: Management Units where salinity load is a concern in the Upper Olifants**

The mines located in these Management Units include those set out in Table 2.

**Table 2: Mines contributing to Management Units with highest salinity contributions**

| MU | Mines contributing to the salinity load |
|---|---|
| 8 | Ilanga Colliery; HalfGewonnen Colliery; Sudor Coal Mine; De Wittekrans; Forzando Coal Mines (PTY) Ltd; Kranspoort (defunct) |
| 26 | Middleburg Mine; Goedehoop North |
| 9 | Kleinkopje Colliery; Douglas Colliery; New Clydesdale Colliery; Duvha Power Station dams; |
| 3 | Blinkpan; Komati Power Station; |
| 2 | Matla Colliery; South Witbank Colliery; Kriel Colliery |
| 22 | Leeuwfontein/ Lakeside Colliery; Side Minerals; Bankfontein Colliery; Kendal Power Station; Kusile Power Station; New Largo; |
| 11, 12 , 13 (14) | No mines in 14 – impacts from MUs 11, 12 and 13: Arnot Colliery; Optimum Colliery; Woestalleen Mine; Coastal Coal; Kopermyn; Mafube – Wildfontein and Springboklaagte; Zonnebloem; and Vuna; Hendrina Power Station |
| 6 | Greenside Colliery |
| 16,17,18 | Landau Colliery (Kromdraai); Bulpan; defunct mines; Vanchem; Highveld Steel |
| 25 | No mines – impacts from mines in MUs 19, 20, and 21 |
| 7 | Phoenix Colliery; Rietspruit Mine; Tavistock Colliery; Polmaise Colliery; Dorstfontein Coal Mines; Isibonelo |
| 15 | No mines - impacts from mines in MUs 11, 12 and 13 |
| 5 | Boschmans Colliery; Waterpan Colliery; Witcons Colliery; Khutala Colliery; Goedgevonden Colliery; South Witbank Colliery; Rietspruit Mine; Oogiesfontein; Zibulo; Mbali Coal; |
| 28 | No mines – impacts from MU26 (Spookspruit) and MU9 |
| 4 | Eikeboom; Duvha Power Station |
| 19, 21, 20 | Leeuwfontein Colliery; Elandsfontein; Zibulo Opencast; Klipsruit; New Largo; Balmoral Colliery; |
| 30 | No mines – all upstream impacts from Witbank and Middelburg Dams and MU MU26 (Spookspruit), MU16 (Klipspruit) and MU17 (Blesbokpruit). |
| 81 | Phalaborwa Mining Company; Foskor; |

***Nutrient enrichment***

In respect of nutrients, the major contributors are the discharges from the WWTW, run-off from urban/ semi-urban areas and return flows and run-off from irrigated areas.

Figure 6 illustrates the various WWTW types. Those shown as activated sludge and biofilters are likely to have some discharge which may be direct discharge after treatment or possibly irrigation of treated effluent. As indicated in the situation assessment there are no Green Drop certified WWTWs in the Olifants WMA and increased ortho-phosphate concentrations can be linked to WWTWs and urban or semi-urban areas where storm water management is poor. While limited microbiological monitoring is undertaken, these points would also be associated with increased faecal coliform counts. The oxidation pond systems are also linked to groundwater contamination and overflows that would also contribute to increased nutrients and microbiological contamination to the system.

Impacts from intensive irrigation were noted in the Upper Middle Olifants, particularly along the Moses (MU35) and Elands Rivers in MU36, as well as in the Lower Olifants, MU47 (Ohrigstadt River) and MU50 (Blyde River and Rietspruit). While it is not currently very prominent there is also the potential for nutrient enrichment due to irrigation in the upper parts of the Letaba (MU69) (Figure 7).

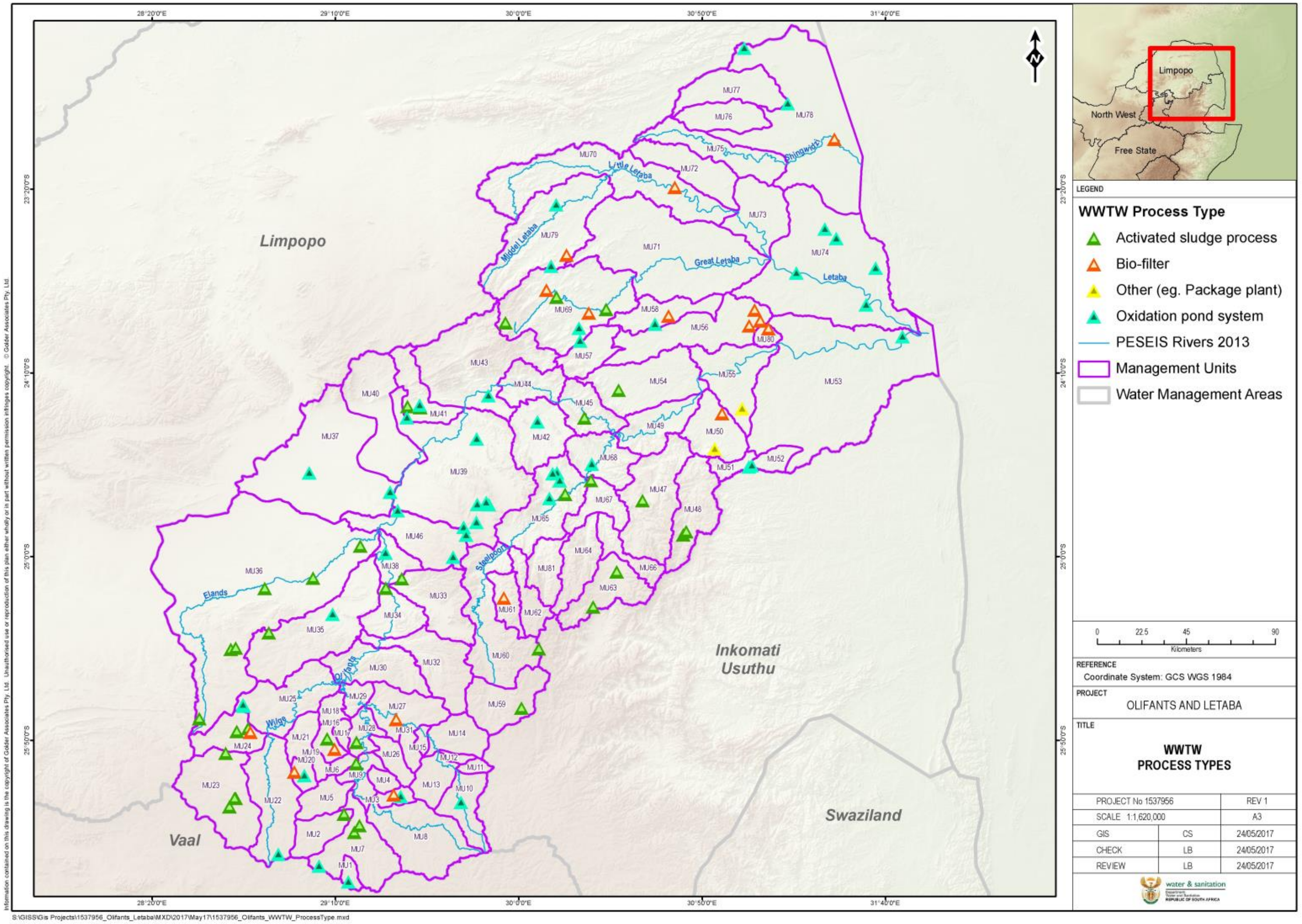


**Figure 6: WWTW Types**

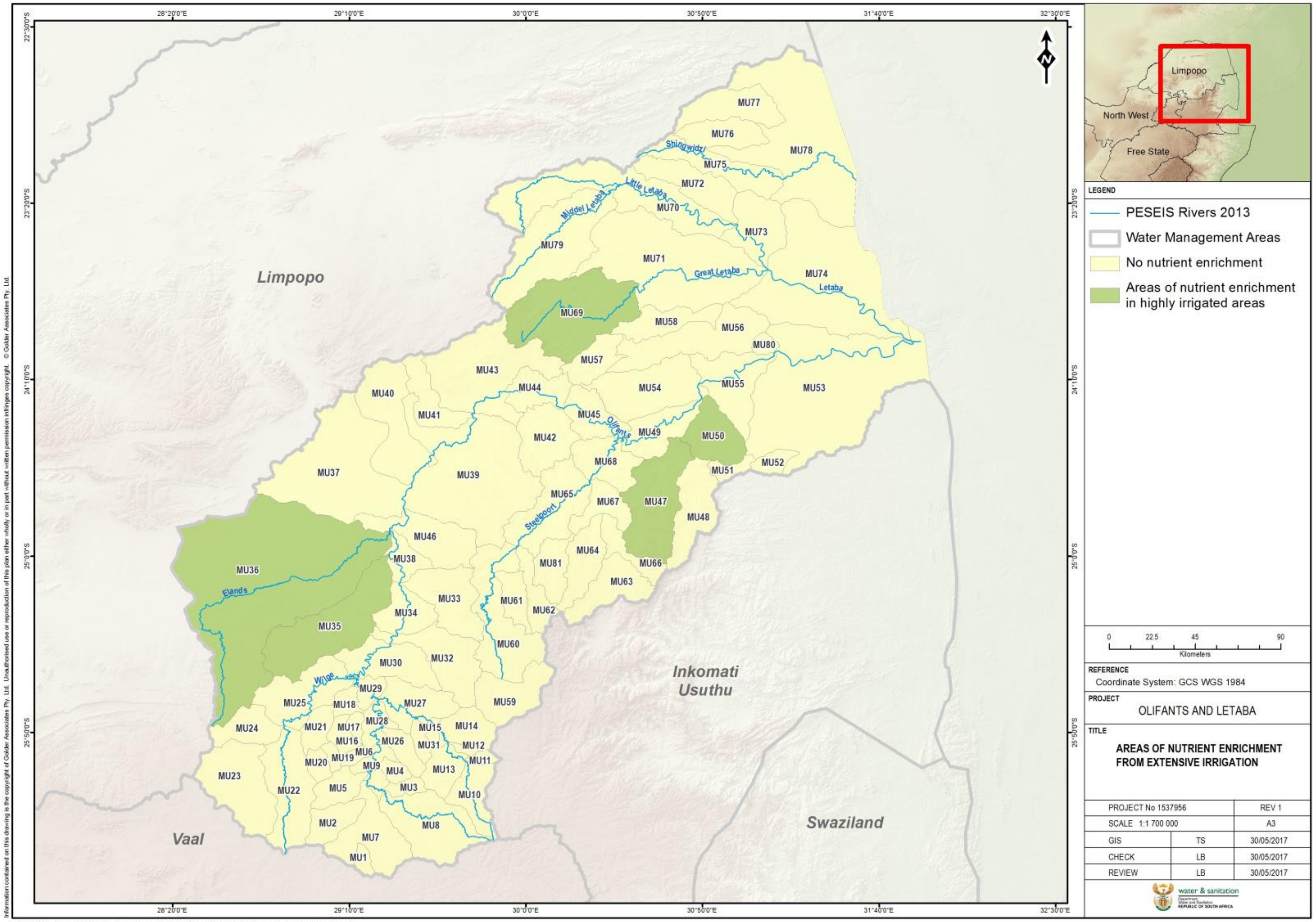


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**Figure 7: Areas of nutrient enrichment from irrigation activities**

# 3. RECONCILIATION AND FORESIGHT

The Reconciliation Strategies developed for the Olifants and Letaba sub-catchments are described in the following documents:

- Department of Water Affairs (2014) *Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System*: Final Reconciliation Strategy. Report No. P WMA 02/B810/00/1412/15
- Department of Water and Sanitation (2015) *Olifants River Water Supply System Reconciliation Strategy.* Report No. P WMA 04/B50/00/8715; and

These studies, informed by several sub-strategies, make a number of recommendations that need to be implemented to ensure that there is adequate water to supply the various sectors. The recommendations do not however consider the implications to water quality. The objective of the reconciliation and foresight task was therefore to assess the implications of the implementation of the reconciliation recommendations on the water quality. Details are described in Report number: P WMA 04/B50/00/8916/5.

When developing the Reconciliation Strategy for a catchment, a water quality assessment is undertaken, however the recommendations made do not necessarily consider the impacts on water quality. Even for Reserve determinations, while water quality is considered it is currently not integrally linked to the quantity component. The sections to follow therefore try to put into perspective the positive or negative changes that may occur as the recommendations are implemented and water of different chemical and biological quality is either kept out of the system or added to the system.

## 3.1 Water Conservation and Water Demand Management

WC/ WDM is often considered as the savings that can be found in respect of decreasing unaccounted for water. This is specifically the case when undertaking the reconciliation strategies for the catchments. However there are several components that contribute to WC/ WDM. Figure 8 illustrates the various components and those that may have direct impacts on water quality, with some examples given.

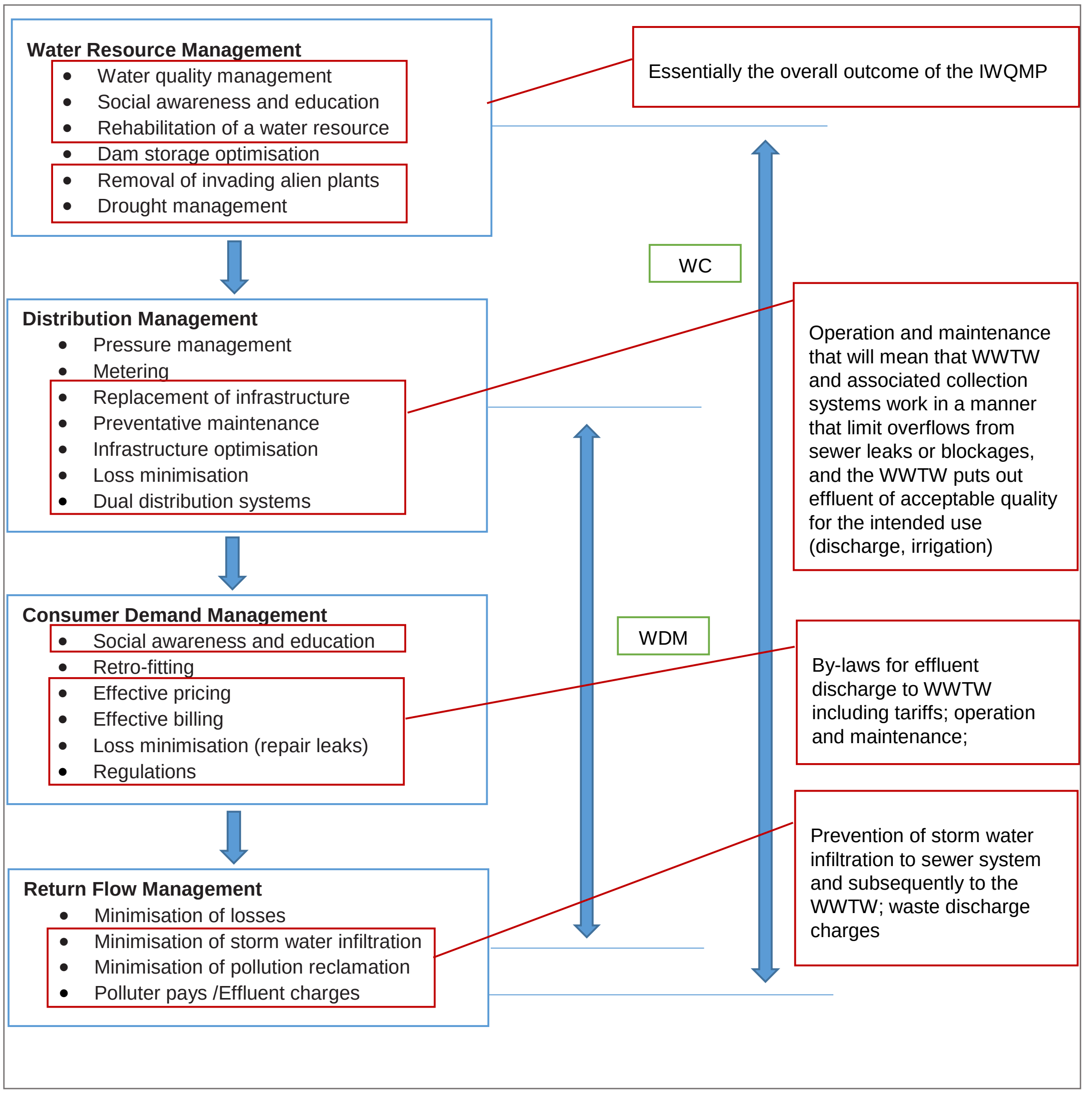


**Figure 8: WC/ WDM and water quality**

Implementation of all the components of WC/ WDM would therefore be of great benefit for improving water quality, not only because of increased water in the system, but also because of effective operation and maintenance plans in the various sectors, as WC/ WDM is not only limited to local government.

## 3.2 Eliminate unlawful use

Water use may be either consumptive or non-consumptive (quality and quantity) as described in Section 21 of the National Water Act (Act 36 of 1998) and includes:

a) Taking water from a water resource;

b) Storing water;

c) Impeding or diverting the flow of water in a watercourse;

d) Engaging in a stream flow reduction activity contemplated in section 36;

e) Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g) Disposing of waste in a manner which may detrimentally impact on a water resource;

h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) Altering the bed, banks, course or characteristics of a watercourse;

j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k) Using water for recreational purposes.

The implementation of assessing whether a water use is unlawful would apply to water quality in respect of designs, operation and maintenance of facilities that may have an impact on water quality of a system in respect of both point and non-point sources of pollution, as well as impacts from the over-abstraction from systems.

## 3.3 Development of groundwater resources

The development of groundwater resources is unlikely to have much of an impact of the water quality of the Olifants system, however would need to be considered in respect of the use for which the water is intended and the water quality required for that use.

It would also be important to know what the surface water/ groundwater interaction is and if abstraction occurs how it will impact on the surface water resources.

## 3.4 Removal of invasive alien plants

Invasive alien vegetation can result in several impacts to river systems, often associated with ecological, economic, management and land use opportunity costs:

- Decreased stream flow;
- Promoting seasonal rather than perennial rivers;
- Increasing sediment supply to rivers;
- Increasing channel and bed erosion in high flows;
- Altering channel shape through;
- Reducing plant and animal biodiversity by altering habitat type;
- Changing soil and water chemistry including nutrient availability;
- Promoting invasion by alien animals (e.g. alien fish species) by changing habitat; and

- Increasing instream shading, creating cooler water and increasing shelter for alien (or indigenous) fauna.

In respect of water quality the method of alien removal is important, for example, when using chemical control, care must be taken to avoid the herbicide causing additional pollution to the downstream water or sediments. Herbicides may contaminate sites used for drinking water, washing or fishing and may affect general river ecosystem health.

Manual removal using mechanical tools may also lead to pollution of water with oils. When undertaking physical clearing, the prevention of erosion is important.

Increased volumes of water could also assist with reducing the contaminant loads.

## 3.5 Treatment of mine water

In respect water quality management mine water treatment has to some extent been quite successful in the Upper Olifants sub-catchments by removing large volumes of contaminated water from entering the rivers, and only discharging water of acceptable quality for the requirements of the Reserve, or having a dilution effect where larger volumes are discharged after treatment.

## 3.6 Municipal effluent re-use

Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams.

However good quality treated effluent should be returned to the system if required by the Reserve and downstream users.

In respect of water quantity, the reconciliation strategies note that reuse of treated effluent is required for Middelburg and eMalahleni while Polokwane, Mokopane and Lebowakgomo need to continue and expand their reuse activities.

## 3.7 Water balance scenario implications for water quality in the Upper Olifants sub-catchment

The sections to follow give a brief description of how the implementation of the reconciliation recommendations will impact (positively or negatively) on water quality in the Upper Olifants sub-catchments.

### 3.7.1 Implications for water quality related to the MUs contributing to Middelburg Dam

The current water quality shows non-compliance against TDS, sulphates and ortho-phosphate in all the MUs contributing to the Middelburg Dam. The biggest salinity load is however from MUs 11, 12 and 13. Table 3 shows how these water quality concerns may be exacerbated or improved when implementing the reconciliation recommendations.

**Table 3: Implications for water quality in the Middleburg Dam MUs of the Upper Olifants sub-catchment**

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| Continuous re-use of mine water from the Optimum Coal reclamation plant (OWRP) | Optimum WRP (located in MU13) is treating water to potable standard to supply to the town of Hendrina. Some of the water is released to water resources in respect of meeting the Reserve and Hendrina not requiring all the water. However, the better quality water does not appear to be improving the system much, or even reaching the Middleburg Dam as would have been expected. |
| Full implementation of Water Conservation/ Water Demand Management (WC/ WDM) | This scenario should mean that there is more water in the system if municipalities are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads. |
| Invasive alien plan (AIP) removal in the Middelburg Dam Catchment | The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils. |
| Future excess mine water re-use | Excess mine water re-use could mean that water is treated and released to Middelburg Dam, which should then have a beneficial impact on the water quality, however if it is treated and reused directly by a town, releasing only that volume required for meeting the EFR, there would be less water is the system thereby potentially increasing the salinity and nutrient loads. |
| Small contribution from groundwater required from 2030 onwards | Will not have an impact on surface water quality. In respect of groundwater use, the quality would need to be assessed prior to domestic use. |

### 3.7.2 Implications for water quality related to the MUs contributing to Witbank Dam

The current water quality shows non-compliance against TDS, sulphates and ortho-phosphate in all the MUs contributing to the Witbank Dam. Only the very upper portions of MU 1, MU 7 and MU 8 are still in an acceptable quality. Table 4 shows how these water quality concerns may be exacerbated or improved when implementing the reconciliation recommendations.

**Table 4: Implications for water quality in the Witbank Dam MUs of the Upper Olifants sub-catchment**

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| Continuous re-use of mine water from the eMalahleni Water Reclamation Plant (EWRP) | The EWRP located in MU 6 is treating water to potable standard to supply to the eMalahleni Local Municipality. Some of the water is released to water resources in respect of meeting the Reserve. This water is discharged to the Noupoortspruit which then flows through an urban area with discharge from a WWTW, so nutrient enrichment and microbiological contamination negate the potential positive impact. |
| Full implementation of Water Conservation/ Water Demand Management (WC/ WDM) | This scenario should mean that there is more water in the system if municipalities are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads. |
| Invasive alien plan (AIP) removal in the Witbank Dam Catchment | The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils. |
| Further excess mine water re-use | Excess mine water re-use could mean that water is treated and released to Witbank Dam, which should then have a beneficial impact on the water quality, however if it is treated and reused directly by a town or on a mine or power station, releasing only that volume required for meeting the EFR, there would be limited benefit |
| Re-use of treated urban/ municipal wastewater | Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams. |

### 3.7.3 Implications for water quality related to the MUs contributing to Loskop Dam

When compared against the proposed WQPLs, the current water quality in the MUs shows compliance for sulphate in the Wilge sub-catchments, however non-compliance for total dissolved solids (TDS) and ortho-phosphate. MUs 20 and 21 (Saalboomspruit) however show considerable non-compliance. MU 26 (Spookspruit) and MUs 15, 16 and 17 (Klipspruit and Brugspruit) show considerable non-compliance for sulphate, TDS and orthophosphate. Table 5 shows how these water quality concerns may be exacerbated or improved when implementing the reconciliation recommendations.

**Table 5: Implications for water quality in the Loskop Dam MUs of the Upper Olifants sub-catchment**

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| Full implementation of WC/ WDM | This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, specifically around the town of Bronkhorstspruit. |
| AIP removal in the Loskop Dam Catchment | The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils. |
| Small contribution from groundwater development | Not applicable to the surface water component. However in terms of groundwater use the water use sector that will be using the water needs to be considered and relevant treatment option included. |

## 3.8 Water balance scenario implications for water quality in the Middle Olifants sub-catchment

The biggest concerns in the Middle Olifants, both up and downstream of Flag Boshielo Dam, are due to nutrients from the wastewater treatment works and domestic related non-point source pollution. Chlorides in MU35, and to a lesser extent MU36, contribute to the salinity in the upper portions of the Middle Olifants. Table 6 shows how these water quality concerns may be exacerbated or improved when implementing the reconciliation recommendations.

**Table 6: Implications for water quality in the Flag Boshielo Dam MUs of the Middle Olifants sub-catchment**

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| Full implementation of WC/ WDM | This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, specifically around the town of Groblersdal, Marble Hall and Lebowakgomo. |
| AIP removal in the Flag Boshielo Dam Catchment | The volume of water expected to be gained from AIP clearing is not expected to have a large impact on the decrease in salinity and nutrient loads, especially in the short |

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| | term. Depending on the type of method used, alien clearing may in fact lead to pollution of water resources by herbicides and oils. |
| Re-use of urban/ municipal wastewater (Polokwane, Mokopane and Lebowakgomo) | Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being removed from the system, thereby reducing the nutrient load entering the rivers and dams. |

## 3.9 Water balance scenario implications for water quality in the Steelpoort sub-catchment

There are no recommendations for augmentation in the Steelpoort sub-catchment. De Hoop Dam’s 1:100 year assured yield, after allowances for in catchment downstream users and EWR requirements, can be utilised by implementing all the ORWRDP phases (conveyance infrastructure) and indirectly augmenting Flag Boshielo Dam sub-system over the medium term.

## 3.10 Water balance scenario implications for water quality in the Lower Olifants sub-catchment

There has been a substantial reduction in the projected water requirement due to reduced mining activity as well as substantial savings in water use through various water saving initiatives implement by Phalaborwa Mining in recent years.

The projected water balance for the Phalaborwa Barrage indicates that the high growth requirements for the Barrage can be met for the entire planning horizon.

## 3.11 Water balance scenario implications for water quality in the Letaba sub-catchment

The biggest water quality concerns in the Letaba are from wastewater treatment works discharge and agricultural run-off, both of which exacerbate nutrient enrichment. Table 7 shows how these water quality concerns may be exacerbated or improved when implementing the reconciliation recommendations.

**Table 7: Implications for water quality in the Letaba MUs**

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| Implementation of WC/ WDM | This scenario should mean that there is more water in the system if municipalities and the downstream irrigation users are abstracting less, so the load should be decreased as more water becomes available. In addition WC/ WDM also includes the impacts of sewer overflows, WWTW operation and maintenance measures so should have a positive impact on nutrient loads, especially in the Tzaneen and Giyani areas. |
| Re-use of urban/ municipal wastewater | Municipal effluent re-use could, in some cases be beneficial to the river system due to the poor quality effluent being |

| Recommended interventions (DWS, 2015) | Implications for water quality |
|---|---|
| | removed from the system, thereby reducing the nutrient load entering the rivers and dams. The WWTW are however small and this would only be feasible in the Tzaneen and Giyani areas. |
| Raising of Tzaneen Dam | Should not have a major impact on water quality, except that it may contribute to lower flows downstream |
| Nwamitwa Dam implementation | Should not have a major impact on water quality in the short to medium term, however the proposed dam site is located on the Nwanedzi and Groot Letaba rivers, both of which flow through urban/ sprawling settlement areas as well as agricultural lands, and the dam may become a sink for nutrients. |
| Groundwater use | Not applicable to the surface water component. However in terms of groundwater use the water use sector that will be using the water needs to be considered and relevant treatment option included. |
| Low flow EWRs implemented | Is not too different from the current scenario so should not have a major impact on water quality. |
| Water from Nandoni Dam | This would mean that the load on Middle Letaba Dam is reduced so that more water will be available to be released downstream, which should be good for downstream water quality as the water quality in the Middle Letaba Dam is good, with the exception of marginally elevated ortho-phosphate levels. |
| Replacement of the canal from Middle Letaba Dam to the WTW at Nsami Dam with a pipeline | This should reduce the water losses in the canals thereby providing increased water for downstream releases. |

## 3.12 Water balance scenario implications for water quality in the Shingwedzi sub-catchment

The majority of the Shingwedzi sub-catchment falls within the KNP. Outside the KNP land use is mainly subsistence agriculture and villages. The reconciliation strategy indicates that surface water use is negligible due to the non-perennial nature of the streams. In general the water quality of the Shingwidzi River and tributaries has remained very good when water is available to be sampled, however shows contamination from the domestic WWTW, as well as general urban pollution from the larger villages, and is unlikely to change, except for improvements if these issued are addressed.

# 4 SCENARIOS ANALYSIS

The evaluation of water quality management scenarios for the major areas of concern noted above forms the core activity for the development of the IWQMP and has the objective of assessing the feasibility of possible management scenarios that could be implemented in the short, medium and long term:

- Options, most likely operational in nature, to be implemented over the first five years (quick wins);
- Medium term strategies that would require further investigations and have the objective of covering a ten to fifteen year planning period; and
- Long term management measures to ensure that the water quality in the system is maintained where it is in an acceptable condition or even improved and considers the planning period up to the year 2040.

The key to successful control of water quality parameters at levels acceptable for water users in the Olifants River System is the formulation of management measures that will integrate all the relevant aspects that have a bearing on all aspects of the water resources. This requires assessments of the physical, socio-economic, institutional, statutory and ecological aspects in the system in order to understand the current situation and be in a position to find management options that will be able to handle the existing as well as anticipated future challenges. Furthermore it has been identified that the growing economy, particularly in the Upper and Middle Olifants sub-catchments and to a lesser extent the upper parts of the Letaba sub-catchment, have and will continue to intensify the pressures on the water quality of the resource. It is therefore necessary to find innovative measures that offer economical and sustainable management solutions.

## 4.1 Proposed intervention scenarios for salinity management

In respect of water quality the strategy for salinity will need to consider: defunct mines, operating mines, industries and power stations and the irrigation return flows in the case of the Lower Moses and Elands rivers. The main sources of pollution contributing to salinity that need to be addressed, and for which scenarios interventions will be considered are:

- Reduction of load due to seepages from the mine, industrial and power station waste storage facilities and mining operations in the Upper Olifants sub-catchment, some load from the Steelpoort sub-catchments and the Ga-Selati in the lower Olifants sub-catchments.;
- Reduction of load due to excess mine water on the mining operations threatening to decant or starting to flood the coal reserves in the Upper Olifants sub-catchment; and
- Reduction of load from irrigation return flows in the Upper and Middle Olifants.

## 4.2 Proposed intervention scenarios for nutrient management

In terms of nutrients the largest impacts are from poorly managed wastewater treatment works and contaminated run-off from urban and agricultural areas. The nutrient management's strategy is to:

- Provide a clear direction and overarching framework for current and future initiatives to improve management of nutrients from both point and diffuse sources;
- Increase awareness of existing initiatives and opportunities for local councils and state government agencies to work collaboratively with community and industry stakeholders;
- Provide strategic guidance for stakeholders with a role in nutrient management by identifying priority nutrient sources, and opportunities for improvement and actions that complement and integrate with existing programs;
- Encourage natural resource managers to consider nutrient management objectives and priorities in strategic planning and investment decisions;
- Improve coordination of nutrient management in the catchment; and
- Provide support and guidance to decision-makers and grant applicants seeking funding for initiatives that can improve nutrient management.

The following scenarios to be considered are likely to have the biggest impact on controlling nutrients (and microbiological contamination):

- Reduction of nutrient load from domestic WWTW that discharge to the water resources, by considering a reduction of the orthophosphate concentration to 1 mgP/l;
- Reduction of nutrient and sediment load from agricultural areas and areas where changing land uses may be occurring;
- Reduction of nutrient and sediment load from run-off from urban/ densely populated areas; and
- Improved reuse of effluent from domestic wastewater treatment works not designed to meet the general discharge limits.

# 5. DETERMINING MANAGEMENT OPTIONS

The key to the successful management of the water quality in the Olifants River System is the formulation of management measures that will integrate all the relevant aspects that have a bearing on the water resources and that will achieve the intent of the scenarios proposed. In this respect an assessment of the physical, economic, social, institutional, statutory and ecological aspects in the system was undertaken to understand the current situation and therefore be in a position to assess existing management options and proposed new options that will be able to handle the existing as well as anticipated future challenges (DWS Report number: P WMA 04/B50/00/8916/3).

Furthermore it is expected that the growing economy in the Olifants System as described by the Reconciliation and Foresight Report (DWS Report number: P WMA 04/B50/00/8916/5) will intensify the pressures on the water quality of the resource and it is therefore necessary to find innovative measures that offer economical and sustainable management solutions.

The determination of management options will involve identifying and developing proposed management measures and options that will improve the non-compliance cases and deteriorating trends and utilise the available assimilative capacity to the benefit of the water users and ensure the sustainability of the system. It may be that existing management options are the right ones to follow, however that implementation and enforcement have not been done effectively – this will be assessed. Proposed management options will be evaluated on the basis of their technical, social and economic feasibility. The economic assessment will comprise cost/ benefit analysis, where the benefits to the water takers are weighed against the implementation costs of the management measures. The economic analysis will further apply measures to balance costs and benefits among polluters, water users and the ecological requirements of the system.

# 6. OVERVIEW OF CURRENT MANAGEMENT OPTIONS

The four main areas where management options are being implemented are:

- Salinity;
- Metals;
- Nutrients; and
- Institutional.

## 6.1 Salinity Management

The main areas of salinity impacts are in the Upper Olifants sub-catchment and the upper portions of the Middle Olifants sub-catchment and the area around Phalaborwa in the Lower Olifants sub-catchment. Coal mining and industry are the major sources of salinity in the Upper Olifants sub-catchment with limited contribution from irrigation return flows and power stations: excess mine water discharges during wet weather periods and diffuse pollution through seepage from waste facilities and mine workings located adjacent to rivers. Irrigation return flows are the primary source of the high salinity levels in the lower Elands and Moses Rivers.

The number of mines and the mining operations have grown significantly in the last 15 to 20 years, resulting in growth increases in excess mine water that needs to be managed. The river systems do not have any assimilative capacity for further salinity pollutant loads. In addition, the water reconciliation and dam system operation and effects of the prolonged drought are such that there is no water available in the dams to provide dilution water to maintain the salinity in the downstream rivers at a suitable level. The end result is that to prevent further deterioration no further diffuse or point source loads can be accepted in the river systems. In fact in the Koringspruit, Boesmanskransspruit, Tweefonteinspruit, Noupoortspruit, Woestalleenspruit, Spookspruit and the Klipspruit, salinity load will have to be removed from the system to achieve the WQPLs determined for the specific Management Units and the downstream dams.

Defunct mines also contribute to the salinity load in the river system. Many of these mines decant saline and acidic water into the water resources. This is of particular concern around the town of Witbank. The rehabilitation options identified in several previous studies were to address the problem at source so as to improve water quality and reduce decant or seepage volumes discharging to the rivers.

The salinity strategy therefore focuses on source control and is divided into a strategy dealing with the defunct mines, operating mines, industries and power stations and the irrigation return flows in the case of the Lower Moses and Elands rivers. The two main sources of pollution contributing to salinity that need to be addressed are:

- Seepages from the mine, industrial and power station waste storage facilities and mining operations; and
- Excess mine water on the mining operations threatening to decant or starting to flood the coal reserves.

### 6.1.1 Operating mines, power stations and industries

A number of mines are addressing the excess mine water volumes by constructing mine water reclamation plants (MWRP) to treat the excess water before release back to the river or in some cases entering into contracts with the local authorities to supply water of potable standards directly to the towns, such as in eMalahleni and Hendrina. The MWRPs include:

- Brugspruit Water Pollution Control Plant (neutralisation only so does not remove salinity) in the Klipspruit (5 ML);
- eMalahleni Water Reclamation Plant in the Witbank Dam catchment (50 ML);
- Middleburg Water Reclamation Plant in the Middelburg Dam catchment (20 ML);
- Optimum Water Reclamation Plant in the Middelburg Dam catchment (6 ML);
- Kriel/ Matla Water Reclamation Plant in the Witbank Dam catchment (24 ML); and
- Xstrata Water Reclamation Plant in the Witbank Dam catchment (15 ML).

These measures have to some extent arrested the historical trend of the sulphate concentration (as indicator of salinity) at point B1H19 (Figure 9) in MU6 on the Noupoortspruit just upstream of the Witbank Dam and to a far lesser extent in the Middelburg Dam catchment as indicated at point B1H12 (Figure 10) in MU14 just upstream of Middelburg Dam. Trends of increasing sulphate concentrations at the Loskop Dam wall are shown in (Figure 11).

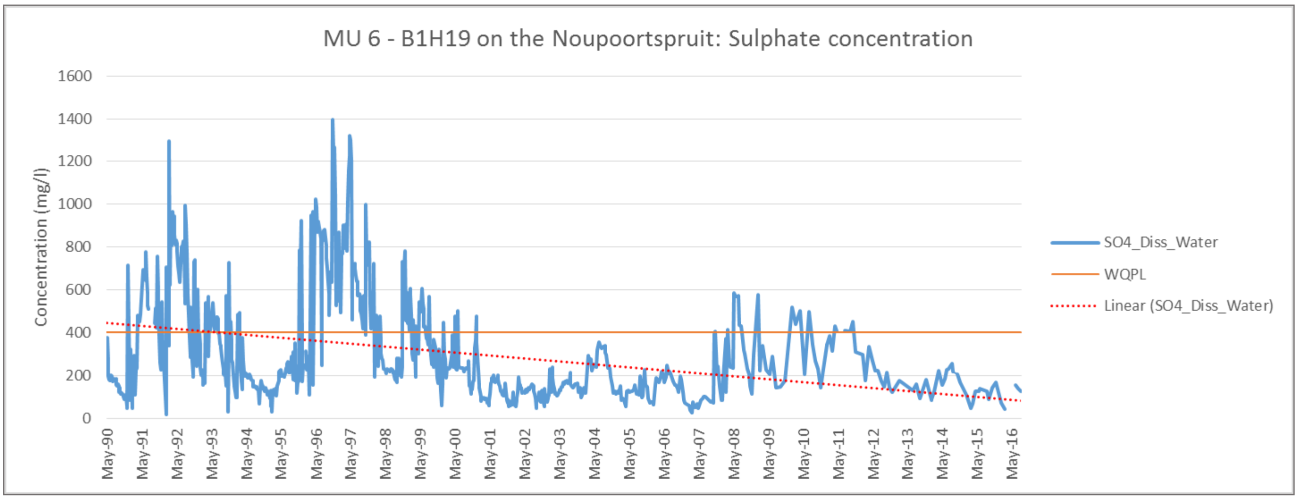


*Figure 9: Sulphate concentrations for the period 1990 to 2016 on Noupoortspruit in MU6*

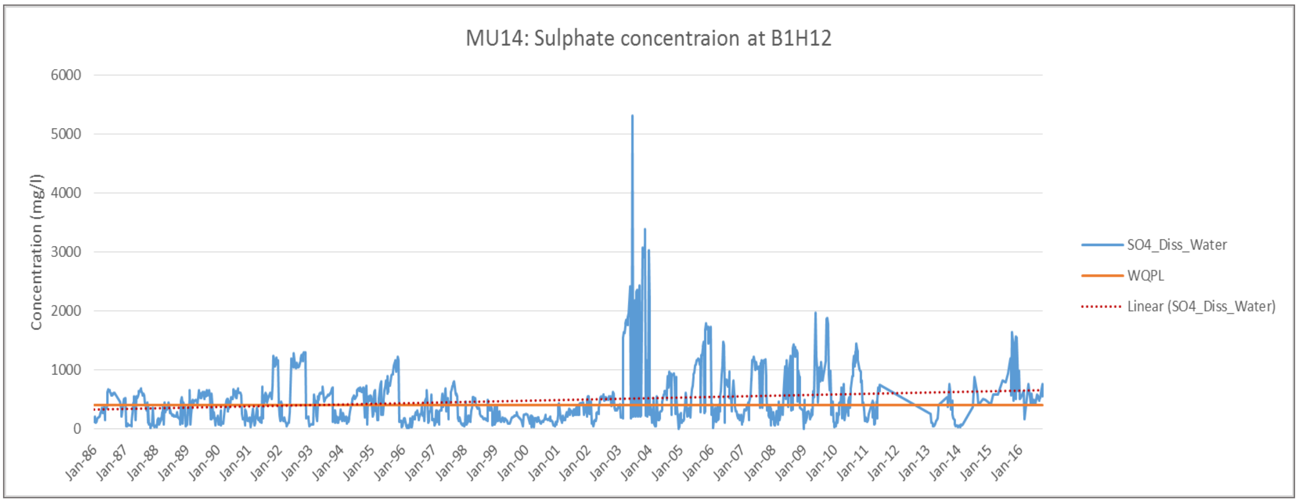


*Figure 10: Sulphate concentrations for the period 1986 to 2016 on Klein Olifants in MU 14*

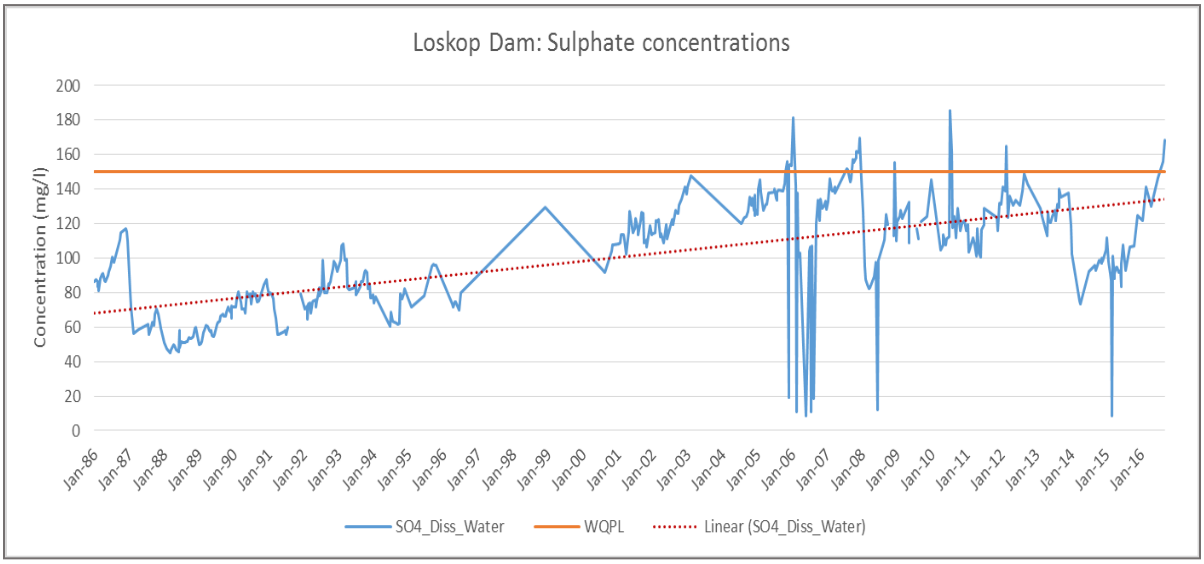


*Figure 11: Sulphate concentrations vs WQPLs for the period 1986 to 2016 at the Loskop Dam wall*

Even with these source interventions, the 95 percentile sulphate concentrations in the Witbank Dam, Middelburg Dam and in several of the Management Units are not meeting the WQPLs developed for the dams or the Management Units as illustrated by the graph in Figure 12 and the loads reaching these areas are substantial as described in Section 2 of this report.

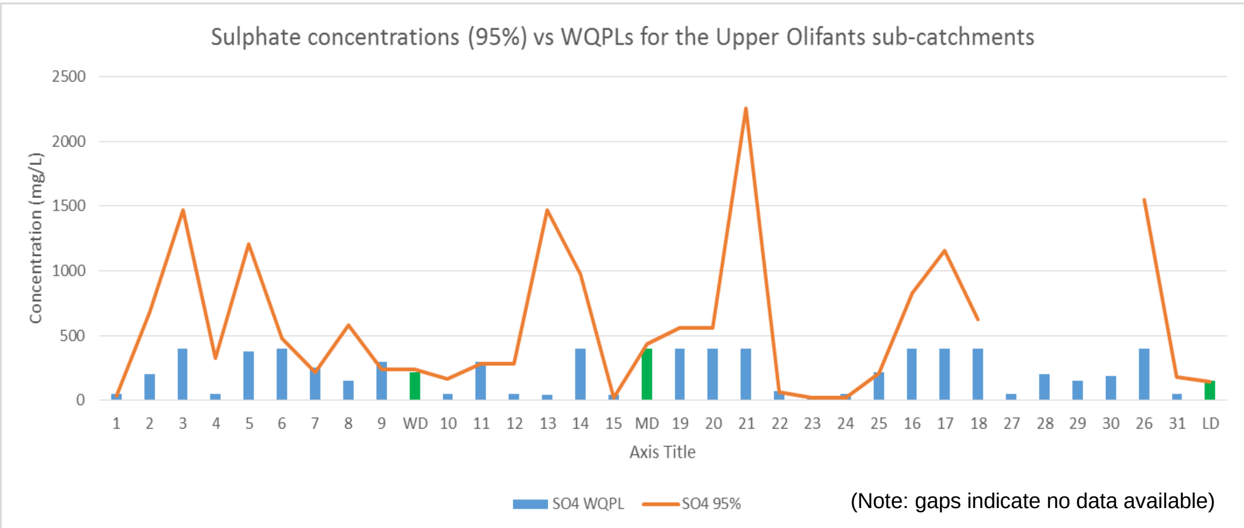


*Figure 12: 95 percentile sulphate concentrations vs WQPLs for the Upper Olifants sub-catchments*

***Controlled Release***

The controlled mine water release scheme was run by DWS Bronkhorstspruit Regional Office in collaboration with individual mines and allowed for the controlled release of excess mine water when it was determined that assimilative capacity was available.

The purpose of the implementation of the controlled release scheme was to manage the excess mine water on the mines and power stations. The scheme has been moderately successful in managing the deterioration in water quality in the study area. However, with the growth in the number and size of the mines, the available assimilative capacity is insufficient to cope with the excess water on the mines, except under extremely high flow conditions. A number of positive initiatives were introduced as part of the controlled release scheme.

- The water quality monitoring program which was extended into the Wilge River catchment was undertaken as a partnership between DWS and the mines so that the full monitoring burden was not placed only on the DWS. The programme included a number of additional parameters not routinely measured, such as dissolved metals. However this programme was stopped in 2013;
- The use of the controlled release scheme licencing process to establish commitments for water management on the mines and power stations as well as implementation schedules for the commitments;
- Auditing of the implementation of the agreed commitments;
- The setting up of report back systems in the Management Units regarding compliance with then resource water quality objectives (RWQO) and sources of pollution;
- Report back on licencing and Environmental Management Programme issues;
- Report back on progress with water management initiatives in the catchment.

The controlled release scheme was not implemented for the period 2002 to 2010. During this period, the licencing and auditing processes applied during the initial stages of the controlled release scheme were not followed. This together with the high staff turnover in the Department meant that the focus on source control measures through the licencing and auditing processes lapsed. The programme was however re-introduced for the period 2011 to 2013. The scheme allows for proactive and ongoing interaction with mines, industries and power stations, however a shortcoming of the controlled release scheme is that not all the mines and power stations were participating in the scheme so did not benefit from the communication and participation in the compliance report back. The scheme re-introduction should be considered by the DWS/ relevant Water Management Institution (WMI).

***Regulatory controls***

The management approach for managing water at the operating mines, industries and power stations is by regulation through the development of Integrated Water and Waste Management Plans (IWWMP) and associated Integrated Water Use

Licences (IWULA) under Sections 40 and 41 of the National Water Act (Act 38 of 1998). The outputs of an IWWMP are incorporated into an IWUL.

An IWWMP considers the principles of integrated water resources management (IWRM) and is therefore linked to the catchment management strategy or integrated water resources management strategy for the catchment under consideration and takes into consideration other relevant legislation under DMR and DEA, as well as additional regulations under the NWA, such as GN 704 which relate to Regulations on use of water for mining and related activities aimed at the protection of water resources.

An IWWMP is therefore a simple, feasible, implementable plan for the specific mines, industries and power stations; taking into account the National Water Resource Strategy (NWRS), the Catchment Management Strategy (CMS) for the catchment in question, Resource Quality Objectives (RQOs); and sensitivity of the receiving water resource. It also considers up- and downstream cumulative impacts of water use activities.

The plan should be based on site specific programmes that will be implemented over time, and must be a living document that should be updated as the activities related to the mines, industries and power stations change.

The objectives of the IWWMP are therefore to:

- Manage the water and waste on the site in support of integrated water resources management (IWRM) by:
    - Identifying the potential pollution sources, and
    - Setting appropriate and effective action plans for the control of these.

An IWWMP in summary should comprise:

- Water uses (existing lawful, previous, exemptions and general authorisations);
- Policies (safety, health, environment, water and waste);
- Environmental context (surface water, ground water, soil and land capability, climate and socio-economic environment);
- Characterisation of activities (operation and method, and waste management);
- Site characterisation at facility level. The site was delineated into individual facilities for appropriate resolution on water and waste related management as well as for improved allocation of responsibility for the management of these aspects;
- Impact assessment (methodology, potential impacts and significance, risk to the environment);

- Matters requiring attention in respect of water and waste management in relation to surface water, process water, storm water, groundwater and waste;
- Performance objectives and associated measures (surface water, process water, storm water, groundwater and waste) for the attainment of the stated performance objectives;
- Environmental monitoring systems addressing process water, ground water, surface water, aquatic health, surface rehabilitation and waste, supported by data management and reporting;
- Continual improvement in terms of the above key themes forming the core of the IWWMP; and
- Operational management addressing the organisational structure, awareness training and communication on waste and water matters.

An IWWMP is therefore a very powerful tool for water quality management at a local level.

The individual mines should set up a database of the existing and potential pollution sources, where the major impacts are expected and what is/ will be done to limit pollution – this should all be part of the IWWMP already. For each source there should be targets set and internal/ external compliance auditing undertaken.

For example:

| **Source** | **Pathway** | **Receptor** | **Targets to achieve to minimise pollution** | **Frequency of monitoring** | **Report (compliance Y/N)** | **If N, mitigation?** |
|---|---|---|---|---|---|---|
| Pollution Control Dam | Overflow | Surface water | Maintain 0.8 m freeboard | Daily inspection | N | Heavy rain event overnight, will pump to WRP for treatment |
| | Seepage | Groundwater | Monitor borehole downstream of PCD | Quarterly | Y | All parameters complaint |

This database needs to be maintained and reported against. The DWS and WMI need to provide a template to the water users that is easy to add data to and report on electronically, so that the regulator can easily see where the concerns are (hotspots).

### 6.1.1 Defunct mines

A number of water pollution and water quality management studies have been undertaken on the defunct and abandoned mines in the Upper Olifants sub-catchments, however the recommendations of the studies have never been fully implemented. A phased strategy was developed for the mines in the Klipspruit catchment. The strategy to deal with the defunct mines was divided into the mines in the Klipspruit catchment and mines in the rest of the study area (DWAF, 2009).

***Management Unit 16: Klipspruit catchment***

The defunct mines in the Klipspruit catchment (Management Unit 16) result in a significant salinity load to Loskop Dam. In 2009 it was noted that the Klipspruit catchment contributed about 33% of the sulphate load to Loskop Dam – based on the current calculations it still seems to be the case. Water management options for the mines in this area were investigated and a phased strategy was developed. However only the first phase of the three phase strategy for the rehabilitation of the catchment was implemented.

Phase 1 involved the restoration of the Brugspruit Water Pollution Control Plant that due to vandalism, had fallen into disrepair and the collection system had blocked. The system was initially constructed to collect the major sources of acidic decants from the area, but did not include the defunct mines in the Blesbokspruit catchment. The Brugspruit Water Pollution Control Plant (BWPCP) is now being operated by the Department, with assistance of an external operator.

The second phase of the project was meant to extend to collect decant from the mines in the Blesbokspruit catchment but this was never implemented.

There are a number of other defunct mines scattered throughout the study area. Twenty seven (27) of the mines were identified and a preliminary assessment and priority ranking undertaken during 2009. In collaboration with Chamber of Mines (CoM) and Department of Mineral Resources (DMR), the findings of that study need to be taken further in this study by extending/ updating the database of defunct mines, prioritising the mines needing rehabilitation, identifying owners, determining the available closure funds and developing management plans and implementation schedules for the mines. The management plans must include rehabilitation and possibly treatment.

Some proposed management actions include:

- Develop a mines water management plan, building on the previous work, incorporating all the defunct mines;
- DMR, CoM and DWS need to consult with active coal mines in the catchment to identify and develop collective mine water management schemes; and

- In collaboration with DMR and CoM, develop and implement a defunct mine water and rehabilitation management plan.

## 6.2 Metals Management

Due to the coal mines and heavy industry in the Upper Olifants as well as around Phalaborwa in the Lower Olifants, metals are of concern. In addition, it has been noted that certain lime used in the agricultural sector results in elevated aluminium and iron concentrations in the Upper Olifants and upper parts of the Middle Olifants.

The routine monitoring undertaken by DWS or the WMI however does not include a wide spectrum of metals measurement. The metals data is therefore only collected by the water users as part of the IWUL conditions, and the current reporting format is not very useful in that users are not able to electronically report the data in a format that could be effectively used by the regulator.

As part of the controlled release scheme some metals data was collected however is not reported on the Water Management System (WMS) managed by the DWS.

This lack of metals data is a gap. For example, aluminium, is strongly pH dependent and is least soluble in pH range (6.5 – 7.5), in the absence of complexing agents. At low pH values (<4) aluminium is largely in the aqua form which is both soluble and toxic (DWAF, 1996). As pH increases (pH 4.5 – 6.5) aluminium undergoes hydrolysis resulting in a series of hydroxide complexes and decreases in solubility. The reason for the construction of the Brugspruit Water Pollution Control Plant was therefore to neutralise the collected acidic water, thereby limiting metals being mobilised in the catchment. The efficient operation of this works is therefore very important.

## 6.3 Nutrient Management

Currently WWTWs are managed by a water use authorisation: in many cases a General Authorisation, due to size, or an integrated water use license. There are at least 103 wastewater treatment works (WWTW) in the Olifants WMA. Of these the following statistics are known:

- Actual hydraulic capacities are only known for 36 of the WWTW;
- 47 are oxidation ponds, of which close to 80% are unlined, therefore contributing to groundwater contamination;
- 34 WWTW are noted to be activated sludge plants, with only the WWTW in Dullstroom having advanced treatment processes;
- 17 WWTW are biofilter plants.

The latest Green Drop data indicates that not one WWTW in this WMA has achieved a Green Drop certificate of which > 70% of the WWTW are rated as being a high risk.

It is noted that based on the data recorded in the Green Drop system, there is capacity to meet the future demand without creating new capacity. However, the findings of the Green Drop assessment suggest that a significant portion of surplus capacity might not be 'readily available' because of inadequate maintenance and operational deficiencies, clearly indicated by the scores achieved (GDS[1]).

Within the two main local municipalities in the Upper Olifants sub-catchment of the study area there is a total operational capacity as follows:

- eMalahleni: 55.9 ML/d; and
- Steve Tshwete: 41.7 ML/d; and

Main contributors to nutrient load from WWTW in the Lower Olifants and Letaba sub-catchments are located in the Mopani District Council and contribute an estimated 29.4 ML/d.

In all cases the constituents of concern are faecal *Escherichia coli*, ammonia, chemical oxygen demand, suspended solids and orthophosphate, indicating poor operation of the works. The orthophosphate has been indicated to be > 5mg/L, therefore simply improving the load of phosphate to the resource by implementing a stricter ortho-phosphate will improve the nutrients situation.

**Table 8: Wastewater treatment in the Upper Olifants with current concerns**

| Name | Treatment Technology | Design Capacity (ML/d) | Operational capacity (ML/d) | Discharge to |
|---|---|---|---|---|
| **EMALAHLENI LOCAL MUNICIPALTY** | | | | |
| Ferrobank | Activated sludge | 18.5 | >18.50 | Brugspruit |
| Klipspruit | Biofilters with Activated sludge | 10 | >10 | Klipspruit |
| Naauwpoort | Biofilters with Activated sludge | 4.2 | 4.50 | Naauwpoortspruit |
| Phola | Biofilters with Activated sludge | 4.5 | 2.80 | Wilge River tributary |
| Rietspruit | Activated sludge | 4 | 3.50 | Rietspruit |
| Riverview | Biofilters with Activated sludge | 11 | >12 | Loskop Dam |
| Wilge | Activated sludge | 0.5 | 0.15 | Loskop Dam |
| Kriel | Activated sludge | 3.0 | 4.40 | Steenkoolspruit |
| **STEVE TSHWETE LOCAL MUNICIPALITY** | | | | |
| Boskrans | Activated sludge & Biofilters | 30 | 22.50 | Klein Olifants River |
| Kwazamokuhle | Activated sludge & Biofilters | 3.8 | 2.10 | Klein Olifants River |
| Komati | Activated sludge | 6.9 | 0.95 | Koringspruit |
| Blinkpan | Activated sludge | 1 | 0.56 | Koringspruit |
| **MOPANI DISTRICT COUNCIL** | | | | |

[1] https://www.dwa.gov.za/Dir_WS/GDS/DefaultAssessmentOverview.aspx?ProvId=9

| | | | | |
|---|---|---|---|---|
| Namakgale | Biofilters | 6.3 | ±9.5 | Tributary of the Ga-Selati |
| Nkowankowa | Biofilters | 4.5 | ±2.52 | Lesitele |
| Phalaborwa | Activated sludge | 8 | ±5 | Ga-Selati |
| Tzaneen | Biofilters | 8 | ±6 | Groot Letaba |
| Ga-Kgapane | Biofilters | 4 | ±1 | Brandboontjies |
| Giyani | Biofilters and Oxidation ponds | 2.1 | ±5.4 | Klein Letaba |

High ammonia concentrations are routinely measured in the Klipspruit, probably due to the WWTWs poor quality discharges. However, the phosphate concentrations fall in the mesotrophic range. The relatively low phosphorus concentrations are probably due to the phosphorus being removed by the extensive wetlands that have developed in the Klipspruit and Brugspruit.

## 6.4 Microbiological management

Microbiological monitoring has not been routinely done and the National Microbiological Monitoring Programme (NMMP) does not cover many sites in the WMA. Currently WWTWs are managed by a water use authorisation: in many cases a General Authorisation due to size or an integrated water use license which would include microbiological monitoring as a condition of the authorisation. It is not clear whether this takes place routinely. Reporting from Local Municipalities to DWS (now the WMI) seems to be inadequate.

## 6.5 Emerging contaminants management

The DWS and WMI does not have a formalised strategy for dealing with emerging contaminants, however this is an aspect that will be discussed and proposals made in this IWQMP.

***Management of Persistent Organic Pollutants***

To be noted is that South Africa is a member of the Stockholm Convention. The Stockholm Convention on Persistent Organic Pollutants (POPs) is an international environmental treaty that was signed in 2001 and effective from May 2004. It deals with the phasing out of the production and use as well as the waste management of POPs.

POPs are chemical substances that bio-accumulate through the food chain, posing a health risk and persisting in the environment, having a negative impact. POPs have a long range and are able to move to areas where they are not produced or used, thereby posing a global threat. As a result, the international community has called for action to be taken to reduce and eliminate the production of these pollutants.

The South African National Implementation Plan (NIP)(DEA, 2012) was developed based on Article 7 of the Stockholm Convention, which was signed on 23 May 2001 and entered into force on 17 May 2004. According to the provisions of the Convention, each party shall develop a plan for the implementation of its obligations under the Stockholm Convention. South Africa, as a party to the Convention, must put in place measures and report on its efforts to meet the objectives of the Convention. This document represents the findings of an investigation into the status of the implementation of the Convention in South Africa.

The NIP represents the findings of an initial investigation into the status of the implementation of the Convention, the prevalence of use of these chemicals, their accumulation in the environment and the management of their resulting wastes. It also identifies the legislative and management measures available to meet the Conventions objectives and to protect human health and the environment from the effects of these POP chemicals. Gaps in the current management measures have been identified and an action plan developed which will address the gaps and strengthen the current management measures.

In line with the requirements of the Convention and realizing the need to take the necessary measure to prevent the harmful impacts of POPs, South Africa has developed its National Implementation Plan (NIP) with the following expected outcomes:

- To protect South Africans' health from the effect of POPs;
- To promote a cleaner South African environment;
- To improve South Africa's capacity to manage POPs;
- To reduce South Africa's contribution to global pollutant loading; and
- To contribute to meeting South Africa's commitments under the Stockholm Convention.

It is noted that no regulation is in place in South Africa which directly implements the provisions of the chemical Conventions. However, these Conventions, including the Stockholm Convention on POPs can be implemented through the following specific existing legislation:

- Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act Foodstuffs, Cosmetics and Disinfectants Act;
- Occupational Health and Safety Act;
- Hazardous Substances Act;
- International Trade Administration Act;
- Customs and Excise Act;
- National Environmental Management: Air Quality Act; and

- National Environmental Management: Waste Act.

In addition the South African legal framework is supported by the South African National codes of practice which represent voluntary technical standards that become legally binding if incorporated into law.

In addition to the above regulatory measures industry currently also applies certain self-regulatory measures on a voluntary basis. These include among others the ISO 14001 Environmental Management System of the International Organisation for Standardisation, audited by the SABS and the Chemical Allied and Industry Association's (CAIA) Responsible Care Initiative. Many exporting farmer subscribe to the Global Gap requirements, and the forestry sector apply the Forestry Stewardship Councils' Pesticide Policy (DEA, 2012).

### 6.6 Institutional Management

The establishment of the Catchment Management Agency (CMA) is taking place, and currently exists as the Olifants WMI.

# 7. PROPOSED MANAGEMENT OPTIONS

## 7.1 Structural/ physical options

Structural/ physical options that should be considered focus around water reclamation and treatment, upgrades to WWTW and innovation around storm water management structures.

### 7.1.1 Salinity Management

In addition to maintaining those actions already being undertaken (section 6.1) the following are further considerations to include for salinity management to be taken into the Implementation Plans.

***Water Reclamation***

In respect of water reclamation, the feasibility of regional plants will need to be assessed considering both operational and defunct mines; and the sustainability of the existing and proposed plants in respect of what happens post closure must be included. Some successes such as the eMalahleni WRP and the Optimum WRP are noted, where load has been removed and a far better quality water is returned to the system for the EFRs (included in the IWUL) and a larger portion is used directly by the Local Municipalities.

The regulation of the return flows from these WRPs will need to ensure that the better quality water is not illegally abstracted thereby negating the positive impacts.

In respect of defunct mines implementation of the second phase of the original White Paper on the Klipspruit Water Quality Management Plan which involves incorporation of the acid mine drainage in the Blesbokspruit into the Brugspruit Plant needs to be considered. This will require a detailed assessment of the volume of decant that still needs to be collected as well as whether the current plant has adequate capacity.

***Other treatment options***

Consideration of other treatment options such as the use of passive treatment systems that include man-made wetlands, need to be further investigated. This would require collaboration and agreements between research institutes, DMR, Chamber of Mines, DWS and the WMI, to allow research to progress without the need for laborious regulatory processes in the short term.

This option should involve research institutes such as the Council for Scientific and Industrial Research (CSIR), Water Research Commission (WRC) and Universities, such as the University of the Witwatersrand (WITS) and University of the Free State (UFS) that have a long standing association with the mining sector.

### 7.1.2 Metals Management

The management of acidity which is linked to release of metals is also mainly related to the management of the defunct mines. Management actions in this respect include the optimal maintenance and operation of the Brugspruit Water Pollution Control Plant to address the immediate issues related to the threat of the acidic conditions and associated metal concentrations to Klipspruit catchment and Loskop Dam.

### 7.1.3 Nutrient and Microbiological Management

The following are considerations to include for infrastructural/ physical options that need to be considered for nutrient management to be taken into the Implementation Plan. These implementation of several of these options will also improve microbiological contamination.

***Buffer zones in agricultural areas***

There are areas where it is noted that there is limited buffer between ploughed lands and the water resource, as well as areas of intensive animal feedlots. An assessment of buffer zones around irrigation areas and areas where intensive animal feedlots are located should be undertaken and guidelines developed and implemented where they do not exist. An assessment will need to be undertaken on what the optimal buffer zone to removal of nutrients from the water resource will be. This should be undertaken as a collaborative effort between DWS/ WMI, DAFF and relevant WUA/ IBs.

***Storm water management practices***

Innovative ways to collect and treat storm water emanating as run-off from semi-urban areas where subsistence farming is common should be considered. This kind of option will take a mind-set change from both those working in local government as well as the communities themselves. A great deal of support will need to come from COGTA and SALGA, and to a lesser extent DWS/ WMI. Research institutes, and specifically universities/ other tertiary institutes within the areas should be included in discussions and implementation of innovative ideas.

Some ideas are briefly discussed below. These may include:

- Rainwater harvesting or simple landscaping (Figure 13) can help reduce financial costs related to water use. Landscaping within a domestic structure might seem like an expensive or labour intensive task, but it is a simple and efficient way to save water on gardening that allows passive irrigation and erosion control systems (Lancaster, 2010). Soil stores water by means of infiltration, but most times water is lost due to evapotranspiration, when soil and plants don't have the ability to absorb water as fast as it should. Through simple earthworks, digging channels within the garden around plants and trees water is moved through the system allowing for better infiltration (Lancaster, B. 2010). Adding organic matter around plants increases the retention of water and keeps plants and soil moist for a longer period.

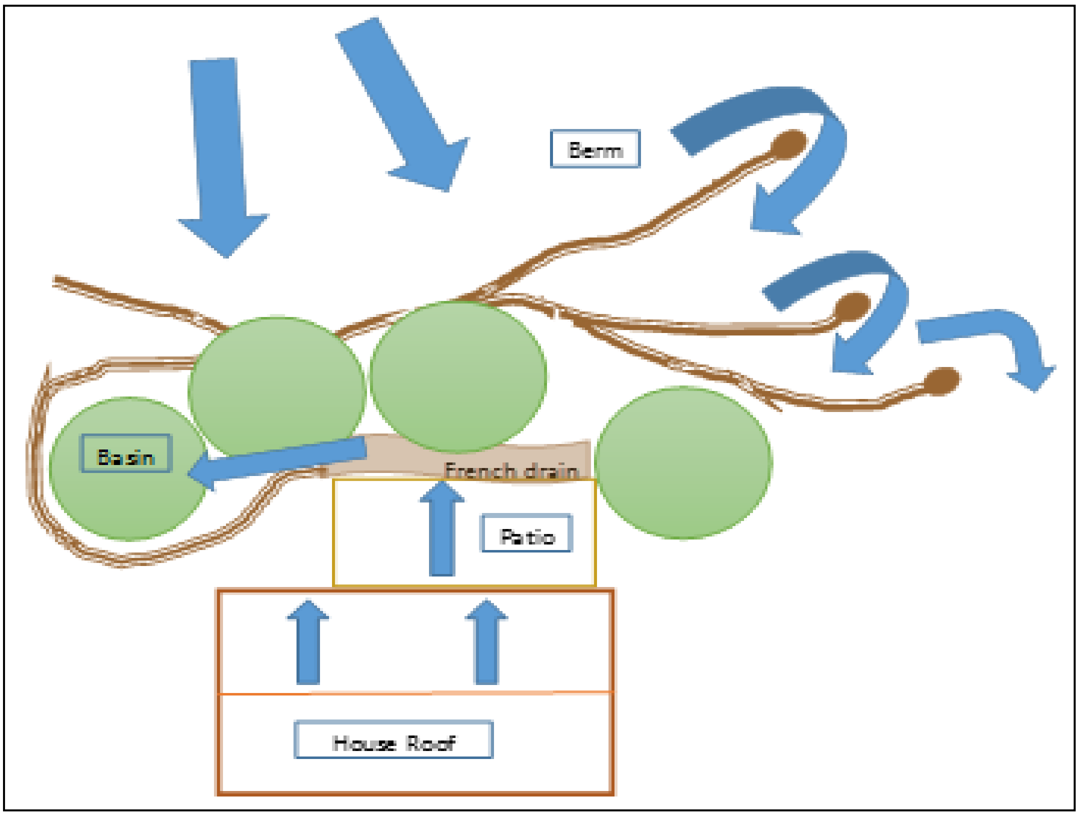


**Figure 13: Aerial view of domestic landscaping (Lancaster, 2010)**

- Retention ponds are designed to store water from surface runoff during rainfall events. They are created by using existing natural depression, or by excavating a new depression (Bogaert & Jantowski, 2014). The retention pond being recommended however, collects water from gutters from houses that drains into a pipe feeding into the retention pond. This infiltrates down into a tank where the water can be stored and then taken out by a connecting well point. Another option could be a simple underground cistern to collect the run-off. On a larger scale, channels that direct water into the cistern could be considered, with overflows then directed via storm water channels to the rivers.

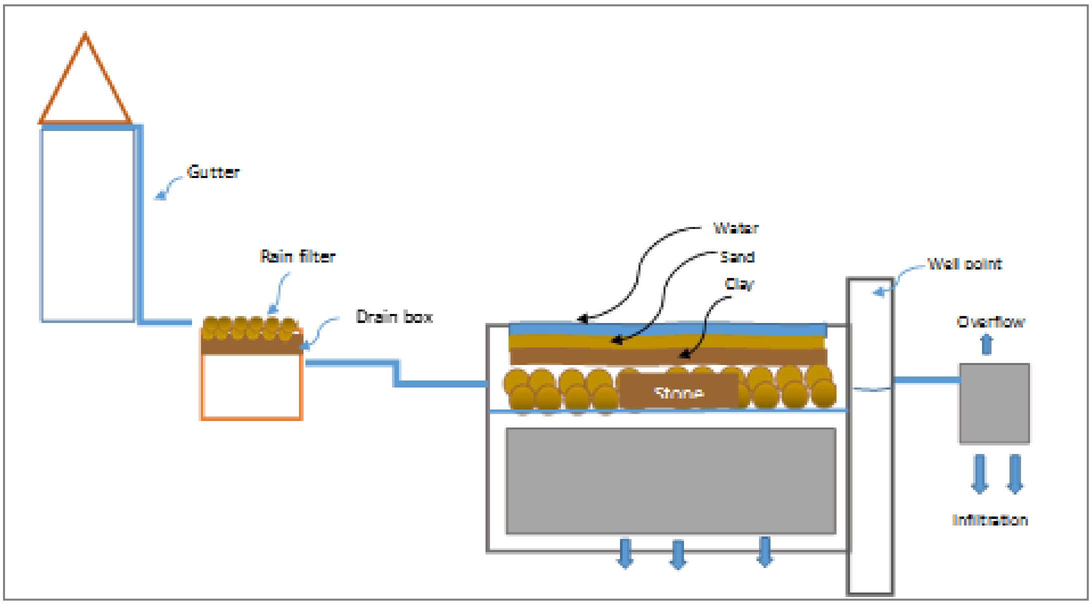


**Figure 14: Cross-section of a retention pond example**

- Stone contour Bunds: from the 1980's onwards, farmers have been using zaï planting pits and stone bunds to increase yields, an extra 80, 000 tons annually (Bogaert & Jantowski, 2014). Innovation and adaption over the years have brought about successful planting methods that can be used for the Olifants catchment. Stone bunds are placed along contour lines with a 3cm layer of clay and sand to capture and slow down run-off allowing for more infiltration.

- Pits: at the beginning of the dry season pits are dug out and lined with a 3cm layer of clay, organic matter and manure (Bogaert & Jantowski, 2014). This attracts many insects like ants and worms creating pockets in the soil allowing for more water retention and infiltration.

- Mulching: plastic mulching has seen a rapid rise over the last twenty years, especially in China. It is essentially a layer of plastic covering the soil around crops. Plastic mulching allows for improved cultivation, especially in areas that are drier (Bogaert & Jantowski, 2014). Mulching ensures that water is kept within reach of crop roots and prevents evapo-transpiration of water by creating a micro-climate. It may be labour intensive and expensive, however it is likely that the crop production will outweigh the cost.

***Actions for Wastewater Treatment Works***

- Upgrades to the WWTW which may in some cases require decommissioning of old technology plants and the development of larger regional facilities using modern treatment technology should be assessed – the needs to include the feasibility of treating to achieve a 1 mg/L orthophosphate standard. The major WWTW which need to be upgraded to achieve the greatest reduction in nutrient load are in the Upper Olifants and Lower Olifants and Letaba, and include Ferrobank, Naauwpoort, Boskrans, Riverview, Kriel, Klipspruit; Namakgale, Nkowankowa, Phalaborwa, Tzaneen, Ga-Kgapane and Giyani. This should be done in collaboration with the possible implementation of the WDCS in these areas; and

- Maintenance and upgrades to collection systems to ensure that sewage reaches the sewage works is critical.

These options would need to be undertaken by local government structures and be supported by COGTA, SALGA and Treasury.

### 7.1.4 Construction of weirs for monitoring network

When assessing the monitoring network it has been noted that additional weirs will be required to expand the network to allow for adequate data collection, especially if the WDCS is to be implemented. At least the following additional weirs will be required.

- Two in the Witbank dam catchment;
- Three in the Middelburg dam catchment;
- One upstream of Loskop dam; and
- Three in the Wilge catchment;

It is expected that instrumentation will be required at the following sites:

- Eight in the Witbank dam catchment;
- Four in the Middelburg dam catchment;
- One upstream of Loskop dam;
- Four in the Wilge dam catchment;
- One in the Klipspruit catchment; and
- One in the Spookspruit catchment.

## 7.3 Institutional Management Options

The institutional aspects considered in this section deal with the establishment and functions of the CMA, as well as collaborative efforts that need to be done by various institutions/ organisations.

### 7.3.1 Establishment of the Catchment Management Agency

The establishment of the Catchment Management Agency (CMA) is taking place, and currently exists as the Olifants WMI. Table 9 sets out the functions that the CMA is required to undertake, as signed off by the Director General in 2016.

The institutional arrangements to fully be able to undertake the CMA functions set out in Table 9 will take some time and will require:

- Adequate skilled staff;
- Commitment by DWS to support the CMA in their role;
- Adequate funding; and
- Building of trust between stakeholders and the CMA staff.

**Table 9: CMA functions**

| | **Function/ Activities** | **WMIs/ CMAs** | |
|---|---|---|---|
| | | **Abstraction activities** | **Waste discharge activities** |
| 1. | Catchment management strategy and Water resources planning | Resources studies, investigations and integrated strategy development at catchment level<br>Communicate, involve and link the Provincial, local government and water users and other stakeholders | |
| | | Water allocation administration | Water quality management plan |
| 2. | Resource directed measures | Implement programmes to monitor Resource Quality Objectives (RQOs);<br>Implement source-directed controls to achieve resource quality objectives<br>Report against the achievement of the Class and RQOs;<br>Report on the water balance per catchment (i.e. water available for allocation after consideration of ecological requirements) | |
| 3. | Water use authorisation | Receive application, process and recommendation of water use authorisation<br>Registration of water use<br>Processing validation and verification of registered water use<br>Approval of validation and verification letters | |
| 4. | Compliance Monitoring | Ensure compliance and inspections | |
| | | Audit the water users | |
| | Control and enforcement of water use (effective enforcement of compliance with water legislation) | Inspections (complaints)<br>Investigations<br>Enforcements<br>Register reported cases on case management system<br>Implementation of strategies | |

| | | | |
|---|---|---|---|
| 5. | Pollution control and emergency incidents (Disaster Management) | Management of disaster incidents, including risk monitoring<br>Gazetting restrictions | Management of pollution control and emergency incidents |
| | Dam Safety Regulation | Registration and Classification of Dams with a safety risk<br>Compliance Monitoring to prevent illegal construction of dams<br>Investigating, confirming or verifying entitlement of water use before a dam safety license can be issued<br>Evaluate Dam Safety license to construct applications for cat I dams and licenses to impound for Cat II dams,<br>Dam safety compliance monitoring inspections of cat I, II and III dams<br>Monitoring progress with the implementation of recommendations of dam safety evaluation reports for existing cat I, cat II and cat III dams<br>Promote public awareness of dam safety<br>Evaluate dam safety evaluation reports<br>Issue instructions for dam safety evaluations of cat II and III dams | |
| 6. | Water resources management programmes | Integrated Water resources programmes | |
| | | Implementing of Water management strategies (e.g. water conservation and demand management) | Implementing of Water management strategies \9e.g. cleaner technologies, dense settlements, waste discharge strategies |
| 7. | Water related institutional development (stakeholder management empowerment) | Stakeholder participation, empowerment, institutional development and coordination of activities<br>Establishment and regulation of water management institutions (e.g. WUAs)<br>Stakeholder consultations<br>Capacity and empowerment of stakeholders | |
| 8. | River health | *Adopting of rivers by doing the following activities:*<br>Removal of solid waste in and around the river<br>Invasive plants removal on the river banks and within the river<br>Identify sources of pollution and other impacts to the river like soil erosion; develop interventions to curb further pollution and degradation of rivers<br>Monitoring (taking samples, in-situ monitoring of water quality, mini SASS, visual assessments) of the rivers<br>Stabilization and restoration of river banks by vegetating indigenous trees<br>Rehabilitation of the eroded river banks | |

| | | |
|---|---|---|
| 9. | Geo-hydrology and hydrology (including water quality) | Groundwater, surface water and ecosystem (quality) monitoring in respective catchment areas<br>Maintaining the geo-hydrological database and compilation of information in respective catchment areas<br>Operate and maintain monitoring and sampling points, collect data and samples where required; process and capture water data and manage data and information; forward water samples to the respective laboratories for analysis |
| 10. | International relations | Operational issues |
| 11. | Administration and Overheads | Administration and overheads for regional office or CMA |

### 7.3.2 Collaboration within Management Units: Mines, Industries and Power Stations

A project in collaboration with mines, industries and power stations to assess the current water management in terms of the Best Practise Guidelines and Regulation 704 to be used to develop a set of agreed actions, commitments and implementation schedules for each management unit. These should be linked to the existing IWWMPs and IWULs for each of the water users in the catchment. This would allow for exchange of ideas, consolidation of various options and will prevent duplication, specifically in areas such as water quality motoring, so could have some cost savings.

This is essential in the Upper Olifants sub-catchment and Phalaborwa area of the Lower Olifants sub-catchment. While there are forums or meetings that may already be taking place, the specific actions and timelines proposed could be monitored by the members of the meeting.

In order to achieve this it would be necessary to establish a Management Unit Task Team (MUTT) with representatives from all of the water users within the Management Unit.

*MUTT – a task team that is established by a group of water users within a MU with the focus of targeting a particular issue; once the issue is resolved it could move on to the next issue, or dissolve if no longer needed. It does not have to be established by DWS/ WMI, rather it is driven by a need to work together to solve a particular problem that would lead to improved water quality in a water resource.*

### 7.3.3 Collaboration within Government Departments: Defunct Mines

The development of a mines water management plan for defunct mines will need to be a co-ordinated effort between DMR, DWS and the CMA or current WMI. DMR is responsible for mine closure and has a number of defunct mines under its control. The DMR also administers the closure funds on behalf of the mines. A management committee needs to be set up which includes the DMR, DWS and relevant mining houses to develop the defunct mine management strategy. The Government Task Team (GTT) and Mine Water Co-ordinating Body (MWCB) structure that is currently in place should be considered as a starting point to set up a sub-committee to specifically deal with the defunct coal mines in the Olifants WMA.

### 7.3.4 Operationalising the IWWMP and associated components

In respect of the IWWMPs the following actions are proposed and the DWS/ WMI will need to take the lead in this respect.

The status of the IWWMP and IWUL regulatory processes described in Section 6.1.1, needs to be assessed and the following question answered in order to use the IWWMP and associated components optimally:

- How can the implementation of the action plans from the IWWMP be maximised, so that the IWWMP is not just a document compiled to get an IWUL.

Operationalisation of water and salt balances: water and salt balances all need to be at the same level of confidence and accuracy and reflect different operating conditions and seasonal variations.

### 7.3.5 Load calculations and implementation of the Waste Discharge Charge System

Quantification of the pollutant loads reporting to the receiving water bodies per management unit has indicated the areas where the biggest wins will be achieved. The actual apportionment to specific facilities will therefore need to be undertaken. The Waste Discharge Charge System (WDCS) will need to determine these loads if it is to be successfully implemented for sulphates in the Upper Olifants sub-catchments and Phalaborwa area.

As > 80% of the salinity load in the catchment is from diffuse sources, specific attention must be given to the identification of diffuse pollution sources and the capturing/ interception of these sources to manageable point sources. It therefore makes sense to collaborate with the other impactors in the area and consider joint solutions.

### 7.3.6 Collaboration with Local Government structures

Collaboration with local government through Co-operative Governance and Traditional Affairs (COGTA) and the South African Local Government Association (SALGA) is critical.

COGTA Mpumalanga is developing a Municipal Support Strategy (MSS) which is in the final stages of development and that will have clear action plans and that has been developed around the *Five Pillars of the Back to Basics Campaign:*

1. Putting people and their concerns first;
2. Supporting the delivery of municipal services to the right quality and standard;

3. Promoting good governance, transparency and accountability;
4. Ensuring sound financial management and accounting; and
5. Building institutional resilience and administrative capability.

It is important that this action plan is incorporated into the implementation plan for this project so that there is synergy in the approach to local government interventions.

***Specific Actions for WWTW***

The status of this area of local government needs to be elevated. Treatment of wastewater is of utmost importance and the products of the process should be seen as a commodity to be used. The following in respect of WWTW in collaboration with COGTA and SALGA programmes need to be considered:

- Awareness creation programmes are critical and this will require a concerted effort from DWS and WMI in collaboration with COGTA and SALGA.
    - At all levels and specifically amongst the managers in local government, about the importance of compliance to the Green Drop requirements;
    - Amongst the officials working at the WWTW itself about the importance of their job (build pride and passion for undertaking the job);
    - Within local communities being served by the WWTW, about the importance of reporting sewer leaks, poor O &M and why it is important to prevent vandalism.
- Staffing of requisite skilled personnel for optimal operation of the works. An effort to resource and train the municipal staff is required. The use of PPP or regional expertise should also be explored to provide sanitation services and assist with staffing and capacity building in the short-term;
- Adequate maintenance contracts for WWTW. Regional contracts could be considered. In this respect it may be possible for COGTA and SALGA to assist with professional staffing to capacitate officials; and
- Ongoing compliance monitoring and review of water use authorisation conditions both internally by the local government officials themselves, as well as the DWS/ WMI.

### 7.3.7 Protection of Source Areas

The protection of water resources is governed by Chapter 3 of the NWA, and Chapter 5 of the NWRS 2 (DWA, 2013) which prescribe the protection of the water resources through resource directed measures (RDM) and the classification of water resources. These are measures which, together, are intended to ensure the protection of the water resource as well as measures for pollution prevention, remedying the effects of pollution while balancing the need to use water as a factor of production to enable socio-economic growth and development.

Chapter 3 (12)(2)(c) under the prescription for the classification system provides for such other matters relating to the protection, use, development, conservation, management and control of water resources, as the Minister considers necessary.

In addition the National Environmental Management: Protected Areas Act (Act 57 of 2003) (PAA) provides for the protection and conservation of ecologically-viable areas representative of South Africa's biodiversity and its natural landscapes and seascapes.

The PAA seeks to ensure that certain geographical areas of environmental and cultural significance located within the borders of South Africa are protected and preserved for future generations.

The PAA provides for–

- The establishment of a national register which will detail and set out all declared national, provincial and local protected areas found on state, private or communal land in South Africa;
- The protection and management of declared national, provincial and local protected areas in accordance with prescribed national norms and standards;
- Inter-governmental co-operation between the national, provincial and local governments;
- The promotion of the sustainable use of these protected areas in a manner that will preserve the ecological character of such areas; and
- The promotion of participation of local communities in the management of these protected areas, where appropriate.

This legislation needs to be further investigated by the DWS and WMI in collaboration with DEA as an avenue for declaring certain areas, no-go zones.

### 7.3.8 Operating rules

An important aspect to consider is the use of operating rules of the dams and associated networks for water quality considerations. A good example is shown in the box below[2].

In recent years the Olifants River has shown signs of non-compliance with the legal requirements of the Ecological Reserve or environmental water requirements (EWR). Serious concerns were raised in January 2016 during extreme drought

[2] Contributions from KNP (E Ridell) and AWARD (H Retief)

conditions when the flow of the Olifants River at Mamba weir (B7H015) dropped close to 1m$^3$/s, representing less than 25% of the EWR at 99% assurance (highest drought severity).

Collaborative efforts and a rapid response was created through the establishment of a Lower Olifants River Operations Committee (LOROC) that includes DWS, KNP, AWARD, Lepelle Northern Water (LNW), other water users and Ara-Sul in Mozambique. Agreement from the Acting DG allowed for temporary shifts of some of LNW demands from the Blyde Dam to De Hoop Dam during these times of stress. Flow releases were determined using the AWARD/ RESILIM-O De-Hoop release model. These were tested and adjustments were made accordingly. In the main, compliance with the Reserve requirements was met from 23rd September to 18th October 2016. As part of the process, agreements were also secured from commercial farmers for no uptake of the additional flows. Post release sampling indicated significant improvements in water quality and riverine health within the KNP.

This indicates that such a management system can greatly improve IWRM for the Olifants under extreme stress conditions. These are anticipated to increase under climate change. It is anticipated that there will be greater reliance on such co-operative activities in the years to come in order to ensure sustainable management of the Olifants system.

#### 7.3.9 Emerging Contaminants Management

The management of emerging contaminants will need to be a collaborative effort between various level of government and other relevant organisations including: DoA, WUA and IBs, Local Government, National and Provincial Departments of Health, National and Provincial Departments of Environmental Affairs. Emerging contaminants and perceptions by stakeholders should not be underestimated. This is particularly with respect to pesticide use in the upper reaches of the Middle Olifants, Lower Olifants and Letaba sub-catchments, as well as contaminants from WWTW, such as hormones and pharmaceutical products that are not routinely monitored. It is proposed that emerging contaminants management be undertaken using best management practices, and linking to research being undertaken:

The following aspects are relevant for pesticide management:

- Pesticide use is regulated by Global Gap certification (GLOBALG.A.P.)[3] that would include aspects such as:
    - concentrations allowed;
    - withholding periods; and

[3] GLOBALG.A.P. today is the **world's leading farm assurance program**, translating consumer requirements into Good Agricultural Practice in a rapidly growing list of 0ver 100 countries; available for 3 scopes of production: Crops, Livestock, Aquaculture and consisting of a total of 16 standards.

  - spray records keeping (also checked by DAFF).

- Certain pesticides are not permitted for use if fruit is to be exported;
- Fruit is tested for residue for verification for export by PPECB[4];
- Strict rules, for example, cabbage and lettuce where water can get trapped between leaves; would be specifically relevant to microbiologically contaminated water;
- Citrus uses micro sprays and drip irrigation so less chance of run-off;
- The following actions are also proposed:
- Spraying is seasonal; varies in different areas of the Olifants; Loskop area is all year round. The CMS should be notified of the schedule of spraying or at least when spraying will occur; what is being sprayed when? Is it a known EDC/ carcinogen etc? once again GIS MIS would be useful here;
- Pesticides are also regulated by South African National Standards (SANS), however after 10 years the licence falls away and generics come into the picture which are not SANS accredited; cheaper but use does lead to poorer yields. Need to consider discussions with SANS on this aspect.
- It would be useful to have a link on the CMA MIS to suppliers who should have data on when certain products are used and in what volumes; DAFF does not have this data. This will require further collaboration efforts with DAFF.
- Based on the above the CMA should consider a monitoring programme at very specific sites and at specific times throughout the year to get a better understanding of water pollution from pesticide use. This may also be in collaboration with the WRC.

The key regulatory measures relevant for the management of the POPs life cycle included in the NIP for the Stockholm Convention on POPs need to be included in the Implementation Plan.

- Regulations which provide a wide range of controls and measures that include the authorisation of certain listed processes and activities that relate to chemicals management; atmospheric emission licensing; registration of agricultural remedies and chemicals, development of industrial waste management plans for certain identified industries, identification for priority waste streams; import controls and import permit requirements for certain listed products as well as the ability to implement import restrictions on certain identified products and wastes;

[4] South Africa's official export certification agency for the perishable produce industry

- Norms and standards which include remediation standards, air quality and emission standards for listed activities and technical specifications for the management or use of certain products;
- Directives and compliance notices requiring that reasonable measures are taken to prevent and remedy pollution or degradation of the environment;
- Market based management instruments such as the water pricing strategy which includes charges for waste discharges and incentives for introducing new technologies; and
- Public participation requirements in licensing, permitting and environmental authorisation processes.

## 7.4 Monitoring and Information

One of the most important aspects of the IWQMP is the development of a monitoring and information plan – this is one of the deliverables that will emanate from this project. The situation assessment has identified the following gaps in respect of monitoring and information:

- Not all parameters are measured, for example metals, microbiology and emerging contaminants are lacking, and nutrients, specifically ortho-phosphate and nitrates are not adequately monitored;
- Certain MUs do not have a dedicated monitoring point;
- Additional weirs will be required as discussed under Section 7.1;
- Compliance monitoring in the local government sector is totally inadequate;
- Laboratory contracts are not adequately budgeted and maintained; and
- There is no electronic system that can be used for water users to load compliance data.

These need to be considered at various levels described in the sections to follow.

### 7.4.1 Collaborative monitoring

The DWS/ WMI needs to consider all the monitoring required at the various levels within the WMA. A monitoring task team consisting of representatives from each sub-catchment needs to be set up to workshop a collaborative programme for monitoring that should see all users, including communities, participating and contributing to monitoring. Overall this should result in cost savings at all levels.

### 7.4.2 Monitoring for metals

There is a lack of data relating to metals. A programme considering the following aspects needs to be implemented:

- Include a broader spectrum of metals at catchment level;
- The DWS/ WMI needs to enable the consolidation and upload of existing metals data from mines and industries.

### 7.4.3 Microbiological Monitoring

The following aspects relating to microbiological contamination need to be implemented by the DWS/ WMI and local government structures, and are linked closely to nutrient management:

- Compliance enforcement of the microbiological standards at all WWTW;
- Routine microbiological monitoring at points downstream of WWTWs, villages and towns. It may even be an option to consider the use of microbiological kits to at least get an indication of the extent of the microbiological pollution taking place;
- Hotspot identification and communication via a GIS based information management system;
- A groundwater monitoring programme needs to be implemented to assess the impacts on groundwater around specific oxidation ponds as well as where sanitation systems, such as pit latrines, are still used, to ascertain:
    - The extent of microbiological contamination; and
    - The need for treatment of water from boreholes where water is used by communities for domestic purposes.

### 7.4.4 Emerging contaminants monitoring

Based on the discussion in Sections 6.5 and 7.3 above the CMA should consider a monitoring programme at very specific sites and at specific times throughout the year to get a better understanding of water pollution from pesticide use as well as emerging contaminants, such as hormones and other pharmaceutical by-products from WWTW. This may also be in collaboration with the WRC.

### 7.4.5 Regional Laboratories

It has been proposed by regional staff at several of the offices that the department should operate its own laboratories, or at least have contracts with the local laboratories. This may also help with supplying and calibration of field instrumentation.

#### 7.4.6 Management Information System

A GIS based management information system needs to be developed (or the existing WMS upgraded, if feasible) to:

- Link to field instruments so that data collected is uploaded automatically;
- Link to management actions set out in IWWMPs;
- Allow water users more access to input data, specifically related to their IWUL;
- Allow DWS and the WMI to draw data and reports from the system without having to ask the water users for a hard copy report;
- Allow water users a comparison/ snap shot of other users in the catchment;
- Ensure hotspots/ and incidents are flagged; and
- Act as an early warning system.
- Link to an app that would allow other stakeholders to upload incidents (including the location and a photograph). This will also allow a more rapid response time.

# 8. PROPOSED MANAGEMENT OPTIONS FOR GROUNDWATER

Based on the assessment of the groundwater quality in the Olifants WMA the current status of the groundwater is impacted specifically by the following constituents:

- Total Hardness – not specifically a health risk up to Class 2 maximum concentration levels, however, warm water systems and certain industrial water uses may be impacted significantly;
- Salinity (TDS due to mainly dissolved Na/Mg-Cl salts) – Health and aesthetic (taste) ;
- Toxic nitrate concentrations due to anthropogenic activities; and
- Toxic fluoride concentrations due to specific rock-aquifer decomposition (or weathering, specifically certain granites and granite-gneisses.

Proposed management options to address the above-mentioned specific groundwater quality issues are discussed in the sections to follow.

## 8.1 Total Hardness (TH as $CaCO_3$)

A catchment wide phenomenon and probably due to over-abstractions from boreholes/ aquifers cause an increase in the mobility of $Ca^{++}$ and $Mg^{++}$ concentration levels. The management option to control the mobilisation of these constituents should be coupled with the recent Determination, Review and Implementation of the Reserve in the Olifants WMA (DWS WP 10540, 2016).

Several quaternary catchments have been identified where groundwater abstraction is already over the allocable volume with a negative water balance.

It is however important that the TH hotspots are mapped and specific reasons for the significant increases/ concentration levels investigated. This activity would require physical “on-site” investigations and assessments. The opinion is that the “recovery” process would depend on long-term aquifer “resetting” and is a long-term process.

Treatment for TH is possible but requires a chemical-flocculation process which can only be applied through a controlled water treatment process such as reverse osmosis.

## 8.2 Salinity (Natural origin)

Natural elevated salinity concentrations are present in crystalline rock formations (gabbro, norite and anorthosite of the Rustenburg Layered Suite and gneiss of the Goudplaats Hout River and Makhutswi Gneiss Suites), sedimentary formations (shales, mudstones and tillies of the Karoo SPGRP), and extrusive lavas (Letaba Basalts of the Karoo SPGRP), and correlates with high salinity levels in groundwater.

Groundwater resources used in irrigation practices in areas underlain by these formations should be mapped and zoned and a monitoring programme network established. As a mitigation measure, frequent monitoring (say quarterly) is proposed to assess the long-term impact of water containing elevated concentrations of Na-Cl on soil and return flows to surface water resources.

Treatment options for elevated groundwater salinity due to natural conditions can only be done by de-salination (viz. reverse osmosis applications) or dilution with a fresher water source (if available).

## 8.3 Salinity (Anthropogenic origin)

Based on long-term point source hydrochemical data, several sources of sodium (Na), magnesium (Mg) and chloride (Cl) occur, and probably as a result of land use activities such as mining, industries, agriculture practices and waste storage facilities.

Throughout the study area significant elevated values for the said hydrochemical constituents occur. These are mainly at point source areas and these sites should be mapped (GIS) for further investigations and setting of mitigation measures to prevent pollution of the local groundwater systems. These mitigation measures should include a dedicated rehabilitation of the land surface as well as decontamination of the local aquifer system through pump-treatment or evaporation and removal of residual salts.

Treatment options for saline groundwater resources encompasses the removal or dilution of the salts concentration by reverse osmosis or adding of fresher water respectively. Both processes require high-tech applications, however, in the former application, dealing with the waste stream (a salty brine) requires certain protocols to prevent further sources of pollution in the area.

## 8.4 Nitrates in groundwater ($NO_3$ as N)

A high percentage of the groundwater resources in the Olifants WMA have elevated nitrate concentrations, varying from a Class 2 and higher (WRC, 1998). As indicated above, the source of the nitrate is from natural sources, agricultural activities, and inadequate sanitation systems/ management.

Elevated nitrate sources needs to be mapped throughout the water management area and the different sources of nitrate pollution specified. Natural sources of nitrate in groundwater (e.g. the Letaba Basalt Formation), are difficult to treat and these sources need to be identified and the use of groundwater for human consumption discontinued.

Nitrate sources generated by agricultural activities need to be investigated and the different sources, such as animal feedlots (rural areas), and fertilisers (irrigated areas) identified and mitigation measures developed and implemented.

Insufficient sanitation systems/ management should be addressed in terms of the correct sanitation system(s) used – specifically in the rural areas. It is a common phenomenon that pit latrines and water supply boreholes (especially privately owned) are a few metres apart. The minimum distance should be according to a distance based on a 50 day travel time for bacteria through the groundwater flow path between the resource (pit latrine) and the receptor (abstraction borehole).

The discharge of treated grey water from water treatment facilities into local drainages feeding groundwater resources (specifically dolomite and fractured rock formations) needs to be controlled/ monitored and managed accordingly.

Identification of the source(s) of nitrate pollution at any mining, industrial, agricultural, sanitation, and/or from natural sources, is possible through the analyses of the variation between the nitrogen isotope $^{15}N$ and the stable nitrogen ion of $NO_x$. This method distinguishes between the actual sources of nitrate in groundwater. Through this analyses, specific mitigation measures to manage nitrate pollution could be recommended/ implemented.

Treatment for elevated nitrate concentrations in a water resource is difficult and cannot be removed by mechanical filtration or chemical disinfection. Ion exchange, distillation, and reverse osmosis are the only methodologies which can be applied successfully – thus a high-tech application in a water treatment facility.

## 8.5 Dissolved fluoride in groundwater (F)

Unless specifically dumped/ wasted fluoride containing wastes on land or in a water resource, comes from decaying rock formations containing phosphate minerals (fluor-apatite). When present in high concentrations (>1.5 mg/l), fluoridated water may cause dental and/ or skeletal fluorosis. A secondary source of fluoride in groundwater is from phosphorus fertiliser.

Granite, granite-gneiss and diabase contain various concentrations of fluorapatite and occurs in the Olifants WMA. Mapping of potential areas where the fluoridated groundwater occurs is needed to identify areas that could pose a risk to human health if consumed.

Treatment of high fluoride concentrations in water can only be achieved through special treatment, i.e. ion exchange and/ or reverse osmosis. These methods require high-tech water treatment facilities and are only economical when high volumes from a well field are treated.

## 8.6 Aquifer protection zoning

The hydrochemistry datasets indicate that elevated concentrations of total hardness, salinity (Ca-Mg-Cl), Nitrates ($NO_3$–N) and fluoride occur in both regional context (due to geological conditions, i.e. specific rock formations) and point source areas (extremely elevated concentrations).

Dealing with elevated hydrochemical concentrations on a regional context in terms of aquifer protection zoning would not solve the problem, however, using water from aquifer systems in these formations should be managed to prevent enrichment of the specific hydrochemical constituent. It is therefore recommended to conduct mapping of these rock formations and investigate the actual impact on the users and environment should this water be used for domestic, stock water and/or irrigation. In the case of mine dewatering, managing of this “naturally contaminated” groundwater should be based on a protection zoning concept to prevent the water reaching the environment.

Proposing a system for protection zoning in the case of point source areas will require detailed mapping of these sites and setting a series of protocols for protecting the environment. These sites will have to be rehabilitated according to the best practices applied for surface pollution rehabilitation where the local water resources are at risk.

# 9 STAKEHOLDER ENGAGEMENT

Of utmost importance is the aspect of stakeholder engagement and creating awareness at various levels. This is an aspect that can be done in the short to medium term. The goals of stakeholder engagement are to:

- Enhance knowledge and understanding;
- Build trust and credibility;
- Encourage dialogue; and
- Influence attitudes, decisions and behaviour.

This section is included to give the reader an understanding around aspects related to stakeholder engagement which is essentially risk communication: a two-way exchange of information about threats, including health threats such as those related to the impacts from the high salinity loads, emerging contaminants and poorly operated WWTWs, as well as what the risks are of implementing various options and how their participation can benefit their communities. Some ideas on developing a communication and implementation plan are included.

## 9.1 Communicating risk

Risk communication is the process of informing people about potential hazards to their person, property or community. People under stress typically want to know that you care before they care about what you know. Research has shown that people under stress typically have greater difficulty hearing, understanding and remembering information; risk communication is therefore central to informed decision-making (Covello and Allen, 1988).

A central proposition of risk communication is that people's perceptions of the magnitude of risk are influenced by factors other than numerical data. This often results in two problems:

- Risks that are likely to harm people do not upset them so they fail to take appropriate precautions.
- Risks that are not likely to harm people nevertheless still upset them so they take unnecessary precautions.

Dr. Peter Sandman, a risk communication expert pointed out that there is a low correlation between the technical seriousness of a risk, that is the *risks* that kill *people,* and its cultural seriousness, that is the *risks* that *upset people*; one never knows whether it upsets them or not, or how badly it upsets them (Sandman, 1987).

In the mid-1980s Sandman coined the formula *'Risk = Hazard + Outrage'* which reflected a growing body of research that indicated that people assess risks according to measures other than technical seriousness. Factors such as trust, control, voluntariness, dread and familiarity (widely known as outrage factors) (Table 10) are as important as mortality or morbidity (Sandman, 1987).

**Table 10: Factors that influence people's perception of risks**

| **Risk characteristics that prompt people to be *more accepting* and *less fearful* of the risk** | **Risk characteristics that prompt people to be *less accepting* and *more fearful* of the risk** | **Reasoning** |
|---|---|---|
| Voluntary | Coerced/ imposed | A voluntary risk is far more acceptable to people than a coerced risk, because it generates no outrage. Consider the difference between getting pushed down a mountain on slippery sticks and deciding to go skiing. |
| Under an individual's | Controlled by others | Almost everybody feels safer driving than being |

| Risk characteristics that prompt people to be *more accepting* and *less fearful* of the risk | Risk characteristics that prompt people to be *less accepting* and *more fearful* of the risk | Reasoning |
|---|---|---|
| control | | a passenger. When prevention and mitigation are in the individual's hands, the risk (though not the hazard) is much lower than when they are in the hands of a government agency. |
| Fairly distributed | Unfairly distributed | People who must endure greater risks than their neighbours, without access to greater benefits, are naturally outraged – especially if the rationale for so burdening them looks more like politics than science. Greater outrage, of course, means greater risk. |
| Has clear benefits | Has little or no benefit | |
| Part of an open, transparent, and responsive risk-management process | Part of a secretive, unresponsive process | Does the organisation come across as trustworthy or dishonest, concerned or arrogant? Does it tell the community what's going on before the real decisions are made? Does it listen and respond to community concerns? |
| Generated by trustworthy, honest, and concerned individuals or organisations | Generated by untrustworthy, dishonest, or unconcerned individuals or organisations | |
| Natural | Manmade or industrial in origin | Most people perceive natural products as being good while man-made or industrial products are seen as being less beneficial or bad. |
| Statistical and diffused over time and space | Catastrophic | Hazard A kills 50 anonymous people a year across the country. Hazard B has one chance in 10 of wiping out its neighbourhood of 5 000 people sometime in the next decade. Risk assessment tells us the two have the same expected annual mortality: 50. 'Outrage assessment' tells us that A is probably acceptable and B is certainly not. |
| Affects adults | Affects children | In most societies children are perceived as being more vulnerable than adults to 'risky' activities. |
| Familiar/ understood | Unfamiliar/ exotic/ dreaded | Exotic, high-tech facilities provoke more outrage than familiar risks (such as one's own home, car, food in the home).<br><br>Similarly, certain illnesses are more dreaded than others. |
| Moral | Immoral | Society has decided over the past two decades that pollution isn't just harmful – it's evil (EPA, 1987). But talking about cost-risk trade-offs sounds very callous when the risk is morally relevant. Imagine a police chief insisting that an occasional child-molester is an 'acceptable risk'. |
| Unremarkable | Memorable | A memorable accident makes the risk easier to imagine, and thus more 'risky'. A strong symbol, such as large oil drums, can do the same thing. |

(Adapted from Covello et al., 1988 and Sandman, 1987)

As described by Sandman (1987) these 'outrage factors' are not distortions in the public's perception of risk; rather, they are fundamental parts of what is meant by risk. They explain why people worry more about well-publicised contaminated sites than geological radioactivity; and more about industrial emissions than aflatoxin in peanut butter.

There is inconsistency here in that many risk experts resist the pressure to consider outrage in making risk-management decisions, insisting that 'the data' alone, and not the 'irrational' public, should determine policy. However, experience and data generated over the past few decades has indicated that voluntariness, control, fairness and the other aspects tabled above are important components of society's definition of risk. When a risk manager continues to ignore these factors – and continues to be surprised by the public's response of outrage – it is worth asking just whose behaviour is irrational (Sandman, 1987).

The solution is contained in reframing of the problem: since the public responds more to outrage than to hazard, risk managers must work to make serious hazards more outrageous and modest hazards less outrageous. For example, the campaign against smoking in public places was a successful effort where public concern was increased regarding the serious hazard of smoking by feeding the outrage. Similarly, to decrease public concern about modest hazards, risk managers must work to diminish the outrage.

When people are treated with fairness, honesty and respect for their right to make their own decisions, they are a lot less likely to overestimate small hazards. At that point risk communication can help explain the hazard. But when people are not treated with fairness, honesty and respect for their right to make their own decisions, there is little that risk communication can do to keep the public from making trouble, regardless of the extent of the hazard.

## 9.2 Communication mechanisms

As discussed above, many of the obstacles to effective risk communication stem from the complexity, incompleteness and uncertainty of data. In addressing uncertainty, the following guidelines are useful:

- Acknowledge rather than hide uncertainty;
- Explain that risks are often hard to assess and estimate;
- Explain how the risk estimates were obtained and by whom;
- Announce problems and share risk information promptly, with appropriate reservations about uncertainty;
- Tell people that what you believe is either:
  - Certain;
  - Nearly certain;
  - Not known;
  - May never be known;

  - Likely;
  - Unlikely; and
  - Highly improbable
- Tell them what can be done to reduce the uncertainty; and
- Tell people that what you believe now may turn out to be wrong later.

In this respect some fundamental rules for effective risk communication are described (Covello et al., 1988):

- Accept and involve the receiver of risk information as a partner as people have the right to participate in decisions that affect their lives;
- Plan and adapt risk-communication strategies as diverse goals, stakeholders, and communication channels require different risk-communication strategies;
- Listen to your stakeholders: people are usually more concerned about psychological factors, such as trust, credibility, control, voluntariness, dread, familiarity, uncertainty, ethics, responsiveness, fairness, caring and compassion, than about the technical details of a risk. To identify real concerns, a risk communicator must be willing to listen carefully to the stakeholders and understand the stakeholders;
- Be honest and open as trust and credibility are among the most valuable assets of a risk communicator;
- Coordinate and collaborate with other credible sources as communication about risks is enhanced when accompanied by referrals to credible, neutral sources of information. Few things hurt credibility more than conflicts and disagreements among information sources;
- Plan for media influence as the media play a major role in disseminating risk information. It is critical to know what messages the media deliver and how to deliver risk messages effectively through the media; and
- Speak clearly and with compassion as technical language and slang are major barriers to effective risk communication. Abstract and unfeeling language often offends people. Acknowledging emotions such as fear, anger, and helplessness are typically far more effective.

## 9.3 Risk-communication tools

Ideally, risk communication is a two-way conversation in which a group or organisation informs and is informed by affected community members. Risk-communication tools are written, verbal or visual statements containing information about risk. They should place a particular risk into context, try to add comparisons to other risks, include advice about risk-reduction behaviour, and encourage a dialogue between the sender and receiver of the message. The best risk communication occurs where stakeholders are informed, the process is fair, and the stakeholders are free and able to solve whatever communication difficulties arise.

It is of utmost importance that those drawing up 'risk messages' remember that a programme that addresses one source of conflict may fail to address another. Messages addressed to resolve disparities for one particular group of stakeholders might be different for another group because the issue may involve different values, from one individual or community to another, or there may be mistrust of certain experts.

In any form of communication, it is important to note the content of the message. The following points are important to remember when communicating a message:

- Know the stakeholders (specialists; non-specialists; young; elderly; and women looking after the home);
- Determine what the stakeholders know;
- Get an understanding of what the stakeholders can be expected to understand;
- Ascertain what action or response is wanted from the stakeholders;
- Simplify complex information but make sure that the message content includes what you need to say to the particular stakeholders so that in this way you target the person(s) you are trying to influence; and
- Know how (in what format) you want to pass the message on.

## 9.4 Developing a communication and implementation plan

Some basic questions to ask are:

- Who do you want to reach;
- What information do you want to distribute or communicate; and
- What are the most effective mechanisms to reach your stakeholders?

Developing a communication and implementation plan will help to ensure that all the important elements have been covered before starting out. The plan itself provides a blueprint for action and does not have to be lengthy or complex. The plan will be most effective when a variety of people are involved in its development. These may include the following:

- A communications specialist or someone who has experience in developing and implementing a communications plan;
- Technical experts in the subject matter (both scientists and policy experts, if necessary);
- Someone who represents the stakeholders (i.e. the people or groups you want to reach); and
- Key individuals who will be involved in implementing the plan.

In developing the plan, consider whether there are any other organisations to partner with - for example national and provincial departments of environmental affairs, health, mineral resources and agriculture. In addition to these strategic partners, other potential partners might include local businesses, environmental organisations, schools and associations. Partnerships can be valuable mechanisms for leveraging resources while enhancing the quality, credibility and success of communication and implementation efforts.

Developing a communication and implementation plan is a creative and iterative process that will involve a number of interrelated steps that can be revisited and refined until an integrated, comprehensive and achievable plan is realised.

Figure 15 summarises the communication mechanism steps.

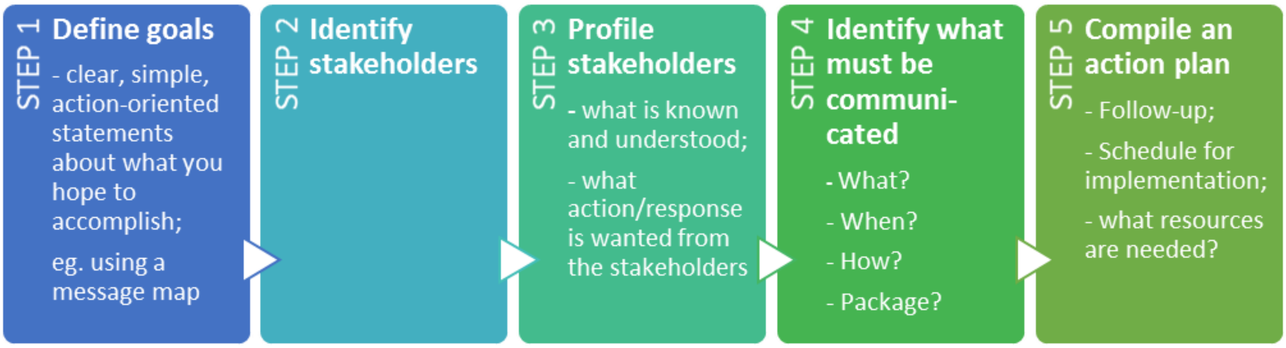


**Figure 15: Diagrammatic summary of communication mechanism steps**

***Define the goals***

Defining communication and implementation goals is the initial step in developing any plan. The goals should be clear, simple, action-oriented statements about what you hope to accomplish. Once the goals have been established, every other element of the plan should relate to those goals. Using the following format can help in deciding on how to structure a message.

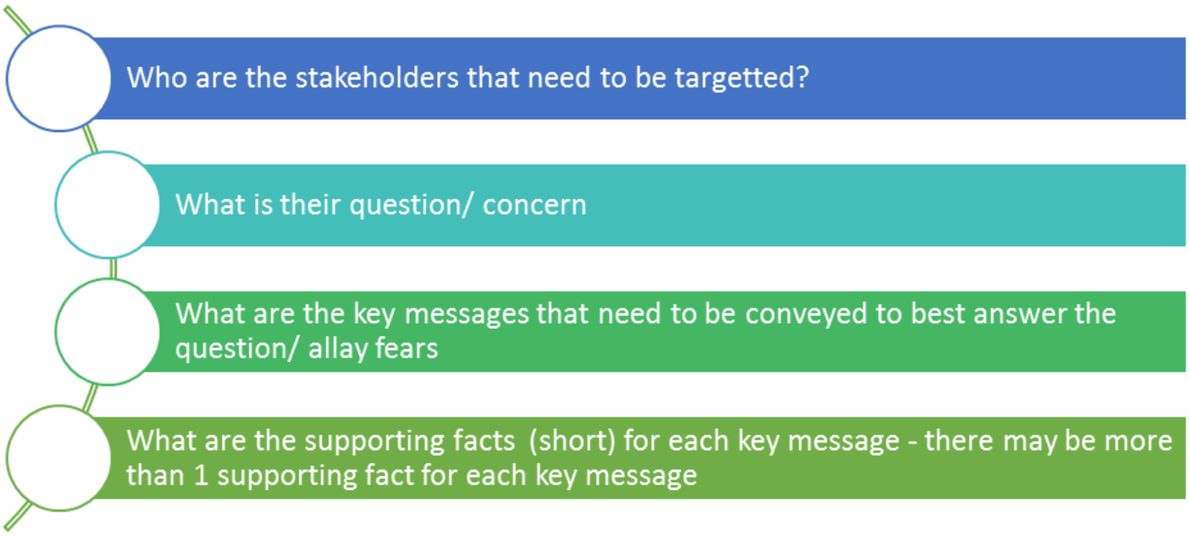


*Figure 16: Summary of how to go about defining goals*

***Identify the stakeholders***

The next step in developing the communication and implementation plan is to clearly identify the stakeholders. It may be necessary to refine and add to the goals once the stakeholders have been defined. In the Olifants WMA there are already a number of Catchment Management Forums (CMF) and other forums that means that there is a good understanding of who the stakeholders are and can be built on.

Stakeholders for such programmes should include:

- Local communities;
- Local government;
- Provincial and national government;
- Researchers, educators and students;
- Industries; and
- Special interest groups such as non-governmental and environmental organisations.

It is important to note that some stakeholders may serve as conduits for dissemination of information to other stakeholders.

***Profile the stakeholders***

Once the stakeholders have been identified, the next step is to develop a profile of their situations, interests and concerns as well as their cultural or linguistic backgrounds. The programme will be most effective if the type, content and distribution of products are specifically tailored to the characteristics of the stakeholders. Developing a profile will help with the identification of the most effective ways of reaching the stakeholders. For each stakeholder group, consider the following questions:

- What is their current level of knowledge regarding the risk;
- What do you want them to know about the risk;
- What actions would you like them to take regarding the risk;
- What information is likely to be of greatest interest to the stakeholders;
- What new information will the stakeholders almost certainly want to know once they develop more awareness of the risk;
- How much time are they likely to give to receiving and assimilating the information;
- How (in what format) does this group generally receive information;
- In what professional, recreational and domestic activities does this group typically engage that might provide avenues for distributing the communication and implementation plan; and
- Are there any organisations or centres that represent or serve the stakeholders and may be routes for disseminating the communication and implementation plan?

***Message content: What do you want to communicate?***

Based on the stakeholder profiles, the contents' that must be communicated must be planned, in particular the key points, or messages, that must be communicated. These messages are the 'bottom line' information that the stakeholders need to take away, even if they forget the detail.

A message is usually phrased as a brief (often one-sentence) statement, for example in respect of trying to prevent communities looking after the sanitation facilities:

- Do not dispose of used oil into your toilet;
- A vandalised sewage works is detrimental to your health;
- Report sewage leaks immediately etc.

A communication and implementation programme will often have numerous related messages such as those bulleted above. Consider what messages you want to send to each stakeholder group. Slightly different messages may be needed for the various stakeholder groups, for example the communities, municipal and agriculture sectors may be very different.

***Message medium***

Following on the development of the key messages, the next step will be to consider the types of medium ('products') that will be most effective for reaching each stakeholder group. There are many different types of media such as:

- Print;
- Audio visual;
- Electronic (social media);
- Events; and
- Even novelty items (such as soaps for a hand-washing programme).

A communications professional would be able to provide valuable guidance when choosing the most appropriate media to meet the goals within resource and time constraints, so collaboration with national DWS that has a communications directorate is important. Some pertinent questions to ask include:

- How much information does your stakeholder group actually need;
- How much does your stakeholder group need to know now; a simple, effective, straightforward product is generally the most effective;
- How easy and cost-effective will the product be to distribute or, in the case of an event, organise;
- How many people is this product likely to reach. For an event, how many people are likely to attend;
- What time frame is needed to develop and distribute the product;
- How much will it cost to develop the product; do you have access to the talent and resources needed for development;

- What other related products are already available; can you build on existing products; are there web-sites that you should link to (local and international) that could also add value to your message;
- When will the material be out of date;
- Would it be effective to have distinct phases of products over time; for example, an initial phase of products designed to raise awareness, followed by later phases of products to increase understanding – also the different phases of the drought; and
- How newsworthy is the information; information with integral news value is more likely to be rapidly and widely disseminated by the media?

***Effective distribution***

Effective distribution is essential to the success of any communication and implementation plan. There are many avenues for distribution. Some examples are:

- Mailing list;
- Partner mailing lists upon request;
- Phone/ fax/ e-mail/ SMS;
- Internet: social media sites such as Facebook and Twitter;
- Journals or newsletters of partner organisations;
- Meetings, events, or locations (e.g. Libraries and schools);
- Television/ radio; and
- Print media.

It is important to consider how each product will be distributed and to determine who will be responsible for distribution. Some points to consider in selecting distribution channels include:

- How do the stakeholders typically receive information;
- What distribution mechanisms have been used in the past for this stakeholder group and were these mechanisms effective;
- Can you identify any partner organisations (for example, cell phone companies) that might be willing to assist in the distribution;
- Can the media play a role in distribution;
- Will the mechanism you are considering actually reach the intended stakeholders; for example, the internet can be an effective distribution mechanism, but some groups might have limited access to it;
- How many people is the product likely to reach through the distribution mechanism you are considering; and
- Are sufficient resources available to fund and implement distribution via the mechanisms of interest?

***Follow-up mechanisms***

Successful communication should result in requests for more information or expressing concern about issues that have been addressed. It is therefore necessary to consider whether and how this interest will be handled and to indicate on the product where people can go to for further information (for example, provide a contact name, number, or address, or establish a hotline, web-page, Facebook or twitter account).

Who will do this and keep relevant information updated is very important to ensure credibility and trust.

***Schedule for implementation***

Once the goals, stakeholders, messages, products and distribution channels have been identified and agreed upon, an implementation schedule will need to be drawn up. For each product consider how much time will be needed for development and distribution (factor in sufficient time for product review);

Wherever possible, build in time for testing and evaluation by members or representatives of the stakeholders in focus groups or individual sessions so that you can get feedback on whether you have effectively targeted the material for the stakeholder groups.

***Resources***

Environmental topics are often technical in nature and scientific terminology is generally used. Nevertheless, technical information can be conveyed in simple, clear terms to those in the general public not familiar with water quality or other environmental fields. The following principles should be used when conveying technical information:

- Avoid using scientific terminology; rather translate technical terms into everyday language the public can easily understand;
- Use the active voice;
- Write short punchy sentences; and
- Use headings and other formatting techniques to provide a clear and organised structure – infographics are very useful.

When developing communication materials for the various stakeholder groups, remember to adapt the information to consider what the stakeholders are already likely to know, what else you want them to know, and what they are likely to understand. The most effective approach is to provide information that is valuable and interesting to the stakeholders.

Also, when developing communication products, be sure to consider any special needs of the stakeholders. For example, does the stakeholder group have a large number of people who speak little or no English? If so, prepare communication materials in the relevant language.

***Community boundaries***

It is important to know the boundaries when dealing with risk (Table 11). These boundaries may be the natural, physical, administrative, social and economic characteristics that separate one community from another.

**Table 11: Examples of community boundaries**

| Boundary type | Notes/examples |
|---|---|
| **Natural** | Geological features (catchments, mountain range) and landscape features (river, grasslands, foothills) |
| **Physical** | Features created by humans (major transportation corridors and bridges); characterised by location or use (rural, urban, peri-urban/ villages) |
| **Administrative** | Features created by government entities for political jurisdiction and for providing public services (local municipality; district municipality) |
| **Social** | Ethnic/cultural complexion of a particular place and organised social relationships around a place (civic associations) |
| **Economic** | Economic (blue- and white-collar workers) |

These boundaries coexist at different scales; therefore, various risks can overlap between the boundaries. It is important to know about community boundaries in relation to risk, understanding where various risks lie and the perceptions of the risk.

# 10 RESOURCES

The resources required for each of the options described will vary and cannot be set out in detail and would need to be considered by the different government departments and other relevant organisations/ institutions.

For example, the operation and maintenance of a WWTW is regulated under Regulation 2834 that sets out the specific requirements for skills and number of Process Controllers required for a specific type of WWTW. This will need to be assessed for each WWTW to assess the resource gaps.

In respect of the CMA, the CMA has the mandate to develop capacity to fulfil the functions set out in Table 9, which is an onerous task. In respect of those aspects specifically related to dealing with impacts on water quality, the following positions are needed to allow officials to carry out their functions optimally:

- Catchment Manager (responsible for several sub-catchments);
- Officials dealing with:
    - Water use licences;
    - Compliance;
    - Monitoring;
    - EIA reviews; and

- WDCS implementation.

Another consideration that must be taken into account is the potential to collaborate with other departments/ organisations/ institutions to harness regional expertise.

# 11 COSTING

As described above and as part of the situation assessment, poor water quality can have a wide range of highly significant impacts on human health, social development, environment and downstream use values. All of these carry with them large economic costs and wider development implications.

Various options are currently being assessed for costing, however not all are included here and it is important to note that many of the costs are affected by the volatility of the Rand. These include:

- Monitoring programme/ network extension:
  - Surface water; and
  - Groundwater
- Water reclamation:
  - Regional WRP; and
  - Package WRP
- Wastewater treatment:
  - Upgrades;
  - Construction of a new WWTW;
  - Operation and maintenance; and
  - Training for Process Controllers
- Storm water management infrastructure;
- Community Awareness programmes; and
- Development of an integrated Management Information System.

## 11.1 Surface water monitoring programme/ network extension

***Surface water monitoring programme***

In addition to the current sampling being undertaken as per the variables listed on the WMS system, the extension of the monitoring programme will include:

- Additional variables such as metals and microbiological contaminants per sample collected; and

- Construction of additional weirs in certain Management Units where none exist and where load will need to be calculated more accurately, specifically when the WDCS is implemented;

The estimated cost for one sampling event per sub-catchment area is set out in Table 12 and is based on current average prices for the variables listed in the WQPLs. The estimated cost per sample therefore may be slightly different in the various sub-catchment areas.

**Table 12: Estimated cost per sampling event (2017 average laboratory costs)**

| **Sub-catchment** | **Units (1 sample/ month/ MU)** | **Estimated Cost (R/ sample)** | **Estimated cost per sub-catchment area per sampling event** |
|---|---|---|---|
| Upper Olifants | 31 | 3 200 | 99 200 |
| Middle Olifants | 15 | 3 200 | 48 000 |
| Lower Olifants | 12 | 3 200 | 38 400 |
| Steelpoort | 11 | 3 200 | 35 200 |
| Letaba | 8 | 3 200 | 25 600 |
| Shingwedzi | 5 | 3 200 | 16 000 |
| Estimated total cost for one sampling event throughout the Olifants WMA | | | 262 400 |

It has also been mentioned that it will be useful to build up a history of the pesticides detected, specifically in the Upper Olifants (a MUs), upper Middle Olifants (MU35 and 36), upper Letaba (MU69) and the Lower Olifants (MU 47 and 48) sub-catchments.

The cost to undertake pesticide sampling at 10 points throughout the WMA on a three-monthly basis would be in the order of R 1 500.00 per sample if the following were included:

- Organochlorine pesticides (33 compounds)(the cost is the same whether 1 or 33 samples are included);
- Organophosphorus pesticides (21 compounds)(the cost is the same whether 1 or 33 samples are included); and
- Atrazine and Simazine.

This amounts to R 61 200.00 per annum.

***Surface water monitoring network extension***

When assessing the monitoring network it has been noted that additional weirs will be required to expand the network to allow for adequate data collection, especially if the WDCS is to be implemented. At least the following additional weirs will be required.

- Two in the Witbank dam catchment;
- Three in the Middelburg dam catchment;
- One upstream of Loskop dam;
- Three in the Wilge catchment;

It is expected that instrumentation will be required at the following sites:

- Eight in the Witbank dam catchment;
- Four in the Middelburg dam catchment;
- One upstream of Loskop dam;
- Four in the Wilge dam catchment;
- One in the Klipspruit catchment; and
- One in the Spookspruit catchment.

A capital cost of R 54 000 000 is anticipated for setting up the monitoring network in the catchment.

## 11.2 Groundwater monitoring programme/ network extension

It has been noted that the groundwater monitoring network is limited and additional monitoring boreholes will need to be drilled in specific areas. This is particularly important in areas where sanitation systems are thought to have impacted on the groundwater and where water is also used for domestic purposes. This will be a costly exercise with drilling of one borehole costing up to R 2 600. 00 per metre.

## 11.3 Water reclamation

***Regional Scheme***

For a regional water reclamation plant, a 40 ML/day plant treating water with a TDS concentration of approximately 6 000 mg/L and sulphate concentration of approximately 3 500 mg/L was used as a basis for the costing. The following assumptions have been made (Figure 17).

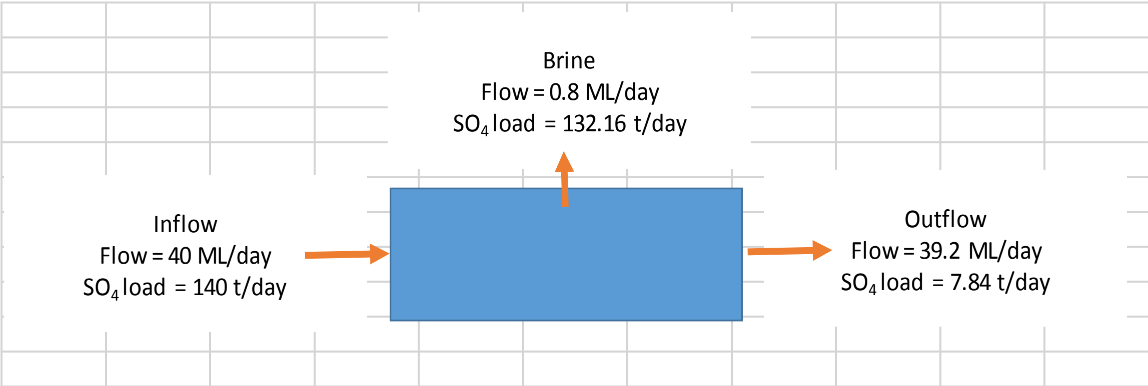


**Figure 17: Flow and load balance used for calculations for a regional WRP**

The treatment process is based on high recovery membrane treatment process currently being used at the eMalahleni Water Reclamation facility with a recovery rate of 98 %, and based on the following:

- The target TDS for the treated water is 450 mg/L;
- The target sulphate level for the treated water is 200 mg/L;
- Brine management will be in the form of double lined brine evaporation ponds with a 5 year life;
- Sludge will be stored in line storage dams;
- Treated water will be discharged to the river; and
- Recoverable costs from saleable products have not included in the calculations.

**Table 13: Cost for a regional water treatment scheme**

| Unit | Cost (R/ m$^3$) | (R/ tonne $SO_4$ removed) |
|---|---|---|
| Treatment plant | R 5.31 | 1 700 |
| Collection system | R 0.83 | 300 |
| Brine management | R 0.65 | 200 |
| Sludge management | R 0.35 | 200 |
| Total | R 7.14 | 2 400 |

### Costing for a package plant

For a package plant (Figure 18), a 5 ML/ day plant treating water with a TDS concentration of approximately 6 000 mg/L and a sulphate concentration of around 3 500 mg/L was used.

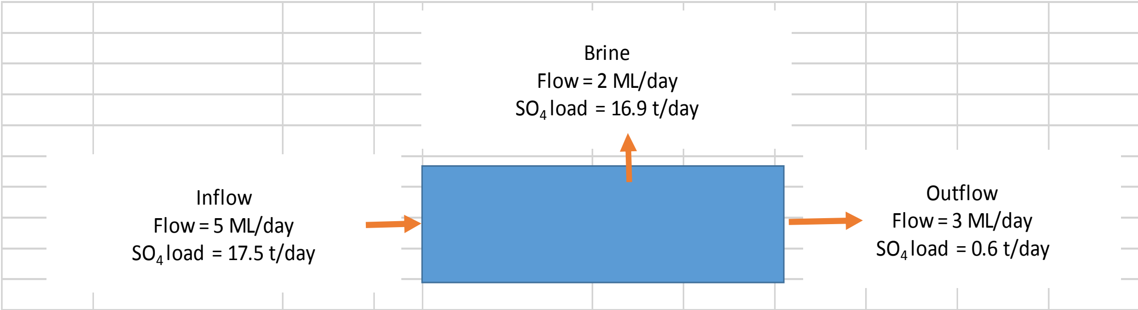


**Figure 18: Flow and load balance used for calculations for a package WRP**

The following assumptions have been made in developing the costs:

- A recovery of 60 %;
- The target TDS for the treated water is 450 mg/L;
- The target sulphate concentration for the treated water is 200 mg/L;
- Brine management will be in the form of double lined brine evaporation ponds with a 5 year life;
- Package plants will not have pre-treatment and thus there will be no sludge handling;
- Treated water will be discharged to the river; and
- Recoverable costs from saleable products have not bene included in the calculations.

**Table 14: Cost for a package water treatment plant**

| Unit | Cost (R/m3) | (R/tonne SO4 removed) |
|---|---|---|
| Treatment plant | R 3.27 | 1 300 |
| Collection system | R 0.83 | 400 |
| Brine management | R 6.08 | 2 400 |
| Total | R 10.18 | 3 012 |

## 11.4 Storm water management

Storm water management costs are extremely site specific and depend on the following.

- Catchment size and topography,
- Type of landscape, including aspects such as soils, vegetation, infrastructure, paving and roads;
- Water quality of the storm water; and
- Type of channel.

A typical discard dump and measures associated with capturing runoff and seepage from the dump and containing this water in a lined pollution control dam was used as an example for calculating these costs. The following assumptions have been made:

- A 35 000 $m^3$ lined pollution control dam will be used to contain the contaminated water;
- A lined channel will be used the capture the storm water;
- Storm water from a 50 ha waste dump will be collected for storage in the pond;
- The water contained would have a sulphate concentration of 3 000 mg/L;
- The water will be abstracted from the pond for use on the mine;

Based on the above assumptions, a storm water management system would cost in the region of R 3 065/ ton $SO_4$ removed.

## 11.5 Wastewater treatment

There are several aspects related to costs around wastewater treatment. These include:

- Upgrades to the WWTW;
- Construction of a new WWTW;
- Operation and maintenance costs; and
- Appointment of skilled Process Controllers.

Table 15 sets out some estimated costs

**Table 15: Estimated costs for various tasks related to WWTW**

| | Task | Notes | Estimated cost (Rand) |
|---|---|---|---|
| 1 | Assess all WWTW in the Olifants WMA that are not achieving the 1mg/l standard i.e. to get a first order estimate of what may be required | 1 day site visit | 10 500 per day |
| 2 | Review and model the existing design data to assess whether the current design can achieve the 1mgP/l standard | 1 day data review plus 3 days for modelling of design data to assess additional requirements | 31 360 |
| 3 | Upgrade of WWTW to 1mgP/l: This could vary from simply dosing ferric to remove the P to having to redesign the WWTW | Dosing system added | 150 000 |
| | | New units added (estimated from new costs) | 5 000 000 |
| 4 | Appoint skilled process controllers to conform to relevant regulations | 1 operator (median salary) per annum | 145 595 |
| 5 | Build new Activated Sludge Plant | Per ML estimated cost based on recent 10ML plant (R 110M to R 120M) | 12 000 000 |

### 11.6 Community awareness programmes

An important aspect of this project is the development of material for community awareness that would include:

- Training for field personnel to run the workshops; and
- Development of workshop material, including posters.

As described in Section 9 to be effective stakeholder engagement will require skilled personnel. It is important therefore that the CMA has a section that is dedicated to stakeholder engagement and that would engage and create partnerships with other national, provincial and local governments as well as external organisations/ institutions. This group should have at least one Professional Stakeholder Liaison Officer with junior officers who would be trained and be responsible for awareness creation and other relevant stakeholder engagement within the six sub-catchments of the Olifants WMA.

The cost would be the salaries for the officials and then development, and in certain cases printing, of material. This is likely to involve some external skills. A value of R 15 000 000 per annum (including salaries for 7 officials and 6 meetings per annum per sub-catchment) is estimated for stakeholder engagement.

### 11.7 Development of an integrated Management Information System

Existing Management Information Systems already being used by the Department could be adapted. The cost to develop a new system would be in the order of R3 500 000.

## 12 SUMMARY OF PROPOSED OPTIONS AND PARTNERS

Table summarises the potential options that should be considered to improve the chemical, physical and microbiological quality in the water resources of the Olifants WMA. The table includes the proposed lead organisation/(s)(first/ second organisations listed) and supporting partners (subsequent organisations listed) that should be involved. These options will be taken forward into the development of the IWQMP for the sub-catchments and may therefore be refined after the workshops to be held.

The following timelines have been included in the summary:

- Immediate - is addressing/ or can address a concern now;
- Short term - should address a concern within the next 3 - 5 years;
- Medium term - should address a concern within the next 5 - 15 years; and
- Long term - should continue to address a concern after 15 years.

In respect of the cost considerations, it is difficult to define what very expensive/ expensive and nor excessively expensive is, however should be seen in the following context, for example:

- Capital costs for new, refurbishment/ upgrades to WRP or WWTW or associated pipelines are very expensive and will require considerable budget over several years and considerable collaboration with various partners;
- Laboratory analysis of samples or operation of a WRP is expensive but should be budgeted as part of the day to day running of the facility or project;
- Relatively inexpensive/ not excessively expensive means that it should be part of the day to day tasks/ functions of an organisation/ institution so should be budgeted for or it will be a reasonable once-off cost.

**Table 16: Potential management options, lead organisations and supporting partners**

| Broad area | | Main action | Role players (lead, supporting) | Timeline | Cost considerations |
|---|---|---|---|---|---|
| Structural/ physical options | Salinity Management | Existing WRP ongoing O & M | Individual mines; Eskom | Immediate to long term | Expensive but already a budget item for the relevant operators |
| | | New WRPs; should consider regional WRPs | Individual mines; DMR; DWS; Eskom | Medium to long term | Very expensive capital costs |
| | | Other options such as passive treatment | Individual mines; DMR; DWS; CoM | Medium to long term | Expensive and efficacy not tested; research needed |
| | Metals Management | Brugspruit O & M | DWS/ WMI; DMR | Immediate to long term | Expensive but already a budget item for the DWS |
| | | Brugspruit Phase 2 | DWS/ WMI; DMR | Medium to long term | Very expensive capital costs for pipeline - not clear of capacity of the Brugspruit WPCP, an upgrade may be needed |
| | Nutrient and Microbiological Management | Buffer strips | DoA; WUA/ IBs | Short to long term | Not excessively expensive, however some land may be lost so an assessment will need to be done on what the optimal buffer zone to removal of nutrients from the water resource will be |
| | | Storm water management practices within local government areas | Local Government; COGTA; SALGA; DWS/ WMI; Treasury | Short to long term | Expensive if a large area is to done; however the smaller landscaping options should not be excessively expensive |
| | | WWTW upgrades | Local Government; COGTA; SALGA; DWS/ WMI; Treasury | Short to long term | Expensive capital costs |
| | | Regional WWTW | Local Government; COGTA; SALGA; DWS/ WMI; Treasury | Medium to long term | Very expensive capital costs; |

| Broad area | | Main action | Role players (lead, supporting) | Timeline | Cost considerations |
|---|---|---|---|---|---|
| | | Maintenance of and upgrade to collection systems | Local Government; COGTA; SALGA; DWS/ WMI; Treasury | Short to long term | Expensive capital costs; maintenance costs should already be part of the budget |
| | Additional weirs | Construction of weirs for monitoring network | DWS/ WMI | Short to long term | Very expensive capital costs, however could be phased in over several years |
| Institutional Management Options | Establishment of the Catchment Management Agency | Develop the relevant resources for catchment management with specific reference to monitoring, licensing, EIA review and compliance | DWS/ WMI | Short to long term | Expensive to get adequate skilled personnel to undertake all the functions |
| | Collaboration within Management Units: Mines, Industries and Power Stations | Assess the current water management in terms of the Best Practise Guidelines and Regulation 704 to be used to develop a set of agreed actions, commitments and implementation schedules | Mines, Industries, Power Stations, DWS/ WMI | Short to long term | Not excessively expensive |
| | Collaboration within Government Departments: Defunct Mines | Development of a mines water management plan for defunct mines | DMR; GTT; MWCB; DWS; COM | Short to long term | Not excessively expensive |
| | Operationalising the IWWMP and associated components | Maximise the implementation of the action plans from the IWWMP | DWS/ WMI; Mines, Industries, Power Stations | Short to long term | Not excessively expensive |
| | | Operationalisation of water and salt balances | DWS/ WMI; Mines, Industries, Power Stations | Short to long term | Not excessively expensive |
| | Load calculations and implementation of the Waste Discharge Charge System | Apportionment of load to specific facilities | DWS/ WMI; Mines, Industries, Power Stations | Short term | Not excessively expensive |

| Broad area | | Main action | Role players (lead, supporting) | Timeline | Cost considerations |
|---|---|---|---|---|---|
| | | Implement WDCS | DWS/ WMI | Short to long term | Not excessively expensive |
| | Collaboration with Local Government structures | Collaboration with local government through Co-operative Governance and Traditional Affairs (COGTA) and the South African Local Government Association (SALGA) | Local Government; COGTA; SALGA; DWS/ WMI | Immediate to long term | Not excessively expensive |
| | | Specific actions for WWTW including: awareness creation; staffing of requisite personnel; adequate maintenance contracts; compliance monitoring | Local Government; COGTA; SALGA; DWS/ WMI | Immediate/ short to long term | Expensive |
| | Protection of Source Areas | Investigating by the DWS and WMI in collaboration with DEA the legislation for declaring certain areas, no-go zones | DWS (National) and DWS (Regional) / WMI and DEA | Medium to long term | Not excessively expensive |
| | Operating rules | Use of operating rules of the dams and associated networks for water quality considerations | DWS (National) and DWS (Regional) / WMI | Immediate to long term | Not excessively expensive |
| | Emerging Contaminants Management | Regulation by Global Gap certification | DoA; DoH; WUA/ IBs; DWS/ WMI | Short to long term | Not excessively expensive |
| | | Implementation of the National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants | DoA; DoH; DEA; DWS/ WMI | Short to long term | Expensive, however would be a shared cost and should be undertaken as part of the day to day tasks of officials in the various departments |
| Monitoring and Information | Collaborative monitoring | Set up a monitoring task team consisting of representatives from each sub-catchment | Water users in each MU | Short term | Not excessively expensive |

| Broad area | | Main action | Role players (lead, supporting) | Timeline | Cost considerations |
|---|---|---|---|---|---|
| | Monitoring for metals | Include broader spectrum of metals | DWS/ WMI; Mines, Industries, Power Stations | Immediate to long term | Not excessively expensive |
| | Microbiological Monitoring | Compliance enforcement of the microbiological standards at all WWTW | DWS/ WMI | Immediate to long term | Not excessively expensive |
| | | Routine microbiological monitoring at points downstream of WWTWs, villages and towns | Local Government; DWS/ WMI | Immediate to long term | Not excessively expensive |
| | | Hotspot identification and communication | DWS/ WMI | Immediate to long term | Not excessively expensive |
| | | Groundwater monitoring programme needs to be implemented to assess the impacts on groundwater around specific oxidation ponds as well as where sanitation systems, such as pit latrines, are still used | DWS/ WMI; Local Government | Immediate to long term | Not excessively expensive |
| | Emerging contaminants monitoring | Monitoring programme at very specific sites and at specific times throughout the year to get a better understanding of water pollution from pesticide | DoA; WUA/ IBs; DEA; DWS/ WMI | Short to long term | Not excessively expensive |
| | Regional Laboratories | Laboratory contracts | DWS/ WMI | Short term | Not excessively expensive |
| | | Operate a regional laboratory | DWS/ WMI | Medium to long term | Very expensive to start up and recruit staff and get accreditation if needed |
| Management Information System | | Develop a GIS based management information system | DWS/ WMI | Short to long term | Not excessively expensive |

| **Broad area** | | **Main action** | **Role players (lead, supporting)** | **Timeline** | **Cost considerations** |
|---|---|---|---|---|---|
| Groundwater Management Options | Water treatment options | From direct use without treatment to desalination | Local Government; DWS/ WMI | Immediate to long term | Not excessively expensive to very expensive if required for domestic consumption |
| | Aquifer protection zoning | Detailed mapping of these sites and setting a series of protocols for protecting the environment | DWS/ WMI | Short term | Not excessively expensive |
| Stakeholder Engagement | | Develop material for awareness creation at various levels | DWS/ WMI | Short to long term | Not excessively expensive |
| | | Engage specialists permanently or on contract | DWS/ WMI | Short to long term | Not excessively expensive |
| | | Develop a stakeholder engagement plan | DWS/ WMI | Short to long term | Not excessively expensive |

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# APPENDIX A:

# PROJECT STEERING COMMITTEE MEMBERS

| Title | Surname | First Name | Organisation |
|---|---|---|---|
| Mr | Atwaru | Yakeen | Department of Water and Sanitation |
| Mr | Bierman | Bertus | Joint Water Forum/ Lebalelo WUA |
| Dr | Burgess | Jo | Water Research Commission |
| Dr | Cogho | Vic | Glencore |
| Mr | Dabrowski | James | Private Consultant |
| Mr | De Witt | Pieter | Dept. of Agriculture, Forestry and Fisheries |
| Dr | Driver | Mandy | SANBI |
| Ms | Fakude | Barbara | DWS |
| Mr | Gouws | Marthinus NJ | Depart. Of Agriculture, Rural Development and Land Administration |
| Mr | Govender | Bashan | Dept. of Water and Sanitation |
| Mr | Govender | Nandha | Strategic Water Partnership Network |
| Mr | Grobler | Geert | Dept. of Water and Sanitation |
| Dr | Gyedu-Ababio | Thomas | IUCMA |
| Mr | Harris | James | Olifants River Forum |
| Mr | Hugo | Retief | AWARD |
| Mr | Jezewski | Witek | Dept. of Water and Sanitation |
| Mr | Keet | Marius | Dept. of Water and Sanitation: Gauteng |
| Mrs | Kobe | Lucy | Dept. of Water and Sanitation |
| Mr | Kruger | Dirko | Agri-SA |
| Ms | Kubashni | Mari | Shanduka Coal |
| Mr | Le Roux | Roelf | Magalies Water |
| Mr | Leballo | Labane | Lepelle Water |
| Mr | Lee | Clinton | South 32 |
| Mr | Linstrom | Charles | Exxaro |
| Mr | Liphadzi | Stanley | Water Research Commission |
| Mr | Llanley | Simpson | DST |
| Mr | Mabada | Hangwani | Dept. of Water and Sanitation: Limpopo |
| Mr | Mabalane | Reginald | Chamber of Mines |
| Mr | Mabogo | Rudzani | Dept. of Mineral Resources |
| Mrs | Mabuda | Mpho | Dept. of Water and Sanitation |
| Mr | Mabuda | Livhuwani | Dept. of Water and Sanitation |
| Mr | Macevele | Stanford | Dept. of Water and Sanitation: Mpumalanga |
| Mr | Machete | Norman | Limpopo Provincial Administration |
| Mr | Madubane | Max | Dept. of Mineral Resources |
| Mr | Maduka | Mashudu | Dept. of Mineral Resources |
| | | | |
| Mr | Malinga | Neo | Dept. of Water and Sanitation |
| Mr | Mannya | KCM | Dept. of Agriculture, Forestry and Fisheries |
| Mr | Masenya | Reuben | Dept. of Mineral Resources |
| Ms | Maswuma | Z | Dept. of Water and Sanitation |
| Mr | Mathebe | Rodney | Dept. of Water and Sanitation |
| Ms | Mathekga | Jacqueline | Dept. of Mineral Resources |
| Ms | Mathey | Shirley | Dept. of Mineral Resources |
| Ms | Matlala | Lebogang | Dept. of Water and Sanitation |
| Mr | Matodzi | Bethuel | Dept. of Mineral Resources |
| Mr | Mboweni | Manias Bukuta | Department of Agriculture, Rural Development and Land Administration |
| Mr | Meintjies | Louis | National Water Forum TAU SA |
| Mr | Mntambo | Fanyana | Dept. of Water and Sanitation: Mpumalanga |
| Mr | Modipane | B J | House of Traditional Leadership |
| | Modjadji | N | Lepelle Water |
| Dr | Molwantwa | Jennifer | IUCMA |

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|---|---|---|---|
| Mr | Mongwe | Victor | Dept. of Economic Development, Environment and Tourism |
| Mr | Moraka | William | SALGA – National |
| Mr | Morokane | Molefe | Dept. of Mineral Resources |
| Mr | Mortimer | M | Dept. of Agriculture, Fisheries and Forestry |
| Mr | Mosefowa | Kganetsi W | Dept. of Water and Sanitation |
| Ms | Mosoa | Moleboheng | Dept. of Water and Sanitation |
| Mr | Mphaka | Matlhodi | SANBI |
| Mr | Mthembu | Dumisani | Dept. of Environmental Affairs |
| Ms | Mudau | S | Chamber of Mines |
| Ms | Muhlbauer | Ritva | Anglo |
| Ms | Muir | Anet | Dept. of Water and Sanitation |
| Mr | Mulaudzi | M | Dept. of Water and Sanitation |
| Mr | Musekene | Lucky | Dept. of Water and Sanitation |
| Dr | Mwaka | Beason | Dept. of Water and Sanitation |
| Mr | Nditwani | Tendani | Dept. of Water and Sanitation |
| Ms | Nefale | Avhashoni | Dept. of Water and Sanitation |
| Mr | Nethononda | B | Dept. of Environmental Affairs |
| Mr | Nethwadzi | Phumudzo | Dept. Mineral Resources |
| Mr | Nico | Dooge | Glencore |
| Mr | Nokeri | Norman | Lepelle Water |
| Mr | Oberholzer | Michael | Dept. of Mineral Resources |
| Ms | Olivier | Dorothy | Dept. of Mineral Resources |
| Mr | Opperman | Nic | Agri-SA |
| Mr | Parrott | Brenton JS | Delmas WUA: Representing irrigators in the Upper Olifants Area |
| Mr | Phalandwa | Musa | Eskom |
| Mr | Po | Jan | Dept. of Agriculture, Fisheries and Forestry |
| Mr | Potgieter | Jan | National Dept. of Agriculture |
| Ms | Ralekoa | Wendy | DWS |
| Mr | Ramatsekia | Rudzani | Dept. Mineral Resources |
| Ms | Rammalo | Albertina | MDW |
| Mr | Ramovha | Matshilele | Dept. Mineral Resources |
| Mr | Ramphisa | Philip | Platreef Mine |
| Mr | Raphalalani | Israel | Dept. of Water and Sanitation |
| Mr | Riddel | Eddie | SANPARKS – KNP |
| Mr | Roman | Henry | DST |
| Mr | Rossouw | Ossie | Lebalelo WUA |
| Mr | Schmahl | Carel | Lepelle Water |
| Mr | Selepe | Marcus | IUCMA |
| Mrs | Shai | Caroline | Dept. of Water and Sanitation |
| Dr | Sharon | Pollard | Award |
| Ms | Shaw | Vicki | Mine Water Coordinating Body (MWCB) |
| Ms | Sigwaza | Thoko | Dept. of Water and Sanitation |
| Ms | Sinthumule | Ethel | Dept. of Mineral Resources |
| Ms | Sithole | Nelisiwe | Mpumalanga Provincial Department of Agriculture |
| Ms | Skosana | M | Dept. of Water and Sanitation |
| Mr | Stephinah | Mudau | Chamber of Mines |
| Mr | Surendra | Anesh | Eskom |
| Mr | Surmon | Mark | Palabora Mining Company |
| Mr | Tloubatla | L | Dept. of Water and Sanitation |
| Mr | Tshivhandekano | Aubrey | Dept. of Mineral Resources |
| Mr | Tshukudu | Rabeng | Mpumalanga Provincial Government |

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|---|---|---|---|
| Ms | Ugwu | Phindile | DMR |
| Mr | Van Aswegen | Johann | Dept. of Water and Sanitation |
| Mr | Van Den Berg | Ockie | Dept. of Water and Sanitation |
| Mr | Van der Merwe | Alwyn | Eskom |
| Mr | Van Niekerk | Peter | Dept. of Water and Sanitation |
| Mr | Van Rooyen | Marius | Mpumalanga Provincial Department of Agriculture |
| Mr | Van Stryp | Johan | Loskop Irrigation Board: representing irrigators in the Middle Olifants Area |
| Mr | Van Vuuren | Jurie | Lower Blyde WUA: representing irrigators in the Lower Olifants Area |
| Mr | Venter | Jacques | SANPARKS – KNP |
| Mr | Viljoen | Pieter | Dept. of Water and Sanitation |
| Ms | Willard | Candice | DST |
| Ms | Zokufa | T | Dept. of Water and Sanitation |

# APPENDIX B

# SUB- CATCHMENT STAKEHOLDERS WHO HAVE CONTRIBUTED TO THE PLAN

| Name | Organisation |
|---|---|
| Adivhaho Rambuda | DWS, Bronkhorstpruit |
| Adolph Maredi | DWS |
| Alistair Collier | Olifants Joint Water Forum |
| Alta van Dyk | Lonmin Akanani |
| André Venter | Letaba Water User Association |
| Aneshia Sohan | Sasol |
| Angelika Möhr | SRK |
| Anna-Manth | OFF (MCCI) |
| Ansia de Jager | JWF |
| Avhafuni Ratombo | DWS, Bronkhorstspruit |
| Avril Owens | SRK |
| Ayanda Mtatwa | DWS: MWM |
| Betty Marhaneleh | LDARD: Mopani |
| Betty Nguni | DWS |
| Bongani Mtzweni | Samancor |
| Brenda Lundie | Sasol Satellite Operations |
| Cara | Kungwini Wise |
| Carina Koelman | DARDLEA |
| Caroline Shai | DWS, Compliance |
| Cecilia Mkhatshwa | City of Tshwane |
| Celiwe Ntuli | DWS |
| Charles Linström | Exxaro |
| Charlotte Khoza | Lepelle Northern Water |
| Christo Louw | DWS |
| Craig Zinn | Mpumamanzi Group |
| Danny Talhami | Clover Hill Club Share block |
| David Paila | Glencore Lion |
| Dayton Tangwi | DWS |
| Decia Matumba | SALGA |
| Derrick Netshitungulu | Nkwe Platinum |
| Dr James Meyer | Topigs SA |
| Eben Ferreira | Keaton Energy Mining Vanggatfontein Colliery Delmas |
| Eddie Ridell | KNP |
| Edwin Mamega | DAFF |
| Elmien Webb | Glencore |
| Emile Corradie | Bosveld Phosphate |
| Faith Mugivhi | ASA Metals/ Dilokong Chrome Mine |
| Farah Adams | Golder Associates Africa |
| Gavin Tennant | Agri-Letaba |
| Geert Grobler | DWS |
| Gloria Moloto | DWS, Bronkhorstspruit |
| Gloria Sambo | Agriculture |

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| Heather Booysen | Samancor |
| Hugo Retief | AWARD |
| Imani Munyai | Wescoal Mining |
| Jakes Louw | Joint Water Forum |
| James Ndou | Modikwa Platinum Mine |
| Jan de Klerk | Sasol |
| Jaques Venter | SANparks |
| Jerry Penyene | AFASA |
| Johan van Stryp | Loskop Water Forum |
| Johanes Mathungene | LEPELLE/ farmer |
| Johannes Senyane | Two Rivers Platinum Mine |
| John Gearg | Wescoal/JKC |
| Joseph Phasha | DWS, Compliance |
| Kamo Meso | DWS |
| Karabo Motene | Glencore Mototolo Platinum Mine |
| Kerry Beamish | Rand Carbide |
| Kgaowelo Moshokwa | Anglo American Coal- Goedehoop Colliery |
| L.D Mutshaine | DWS: MWM |
| Leah Muoetha | Lepelle Northern Water |
| Lebo Mosoa | DWS |
| Lebohang Sebola | Lepelle Northern Water |
| Lee Boyd | Golder Associates Africa |
| Lee-Ann Ryan-Beeming | Glencore Eastern Chrome Mines |
| Lerato Maesela | LEDET |
| Linda Desmet | Palabora Mining Company |
| Love Shabane | DAFF |
| Lucas Masango | Private |
| Lulu Moya | Greater Giyani Municipality |
| M.S Makuwa | LEDET |
| Mahlakoane Foletji | DAFF: LUSM |
| Marcia Mofokeng | DWS: Letaba CMF |
| Marie Helm | DA Councillor, Mopani District Municipality |
| Martha Mokonyane | Mbuyelo Group (Pty)Ltd (Vlakvarkfontein and Rirhandzu Collieries) |
| Mashweu Matsiela | Industrial Development Corporation |
| Mathabo Kgosana | DWS, Planning and technical support |
| Michelle Proenca | GS Schoonbee Estates |
| Mologadi Mpahlele | Mbuyelo Group (Pty)Ltd (Vlakvarkfontein and Rirhandzu Collieries) |
| Moses Sithole | SBBC |
| Movwape Ntchabeleng | DAFF |
| Mpho Makgatha | Steve Tshwete Local Municipality |
| Musa Lubambo | DWS, Bronkhorstspruit |
| Ndwamato Ramabulama | DAFF |
| Nico Dooge | Glencore |

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|---|---|
| Nnzumbeni Tshikalange | DWS |
| Nomathemba Mazwi | Resource Protection and Waste |
| Nonceba Noqayi | DWS, Mbombela |
| Nonki Lodi | AFASA |
| P.K Dzambuken | DWS: Tzaneen |
| Palo Kgasago | DAFF |
| Percy Ratombo | DWS |
| Phillemon Mphahlele | Municipal Health Services |
| Phuti Mabotha | LEDET |
| Pieter Pretorius | Loskop Irrigation Board |
| Pieter Viljoen | DWS |
| Portia Munyai | DWS |
| Pumale Nkuna | DWS:Mpumda |
| Raisibe Morudu | Thembisile Hani LM |
| Ramasenya Meso | DWS |
| Reginah Kganyago | DWS |
| Resenga Shibambo | DWS, Enforcement |
| Reynie Reyneke | EXXARO |
| Robert Davel | Mpumalanga Agriculture (provincial affiliate Agri SA) |
| Sabelo Mamba | Small Enterprise Finance Agency |
| Sakhi Mamashole | FOSKOR |
| Sakhile Mndaweni | DWS, National Office |
| Salome Sathekge | Polokwane Municipality |
| Siboniso Mkhaliphi | DWS |
| Simon Moewg | NEPRO |
| Solomon Tshikovhele | DWS: HO |
| Stanford Macevele | DWS: MP |
| Stephan Kitching | Wescoal Processing |
| Steven Friswell | Clover Hill Club Share block |
| Tanya Botha | Evraz Highveld |
| Tendani Nditwani | DWS: NWRP |
| Thabiso Mpahlele | Lepelle Northern Water |
| Thia Oberholzer | Evraz Highveld |
| Thomas Napo | LDARD |
| Timothy Marobane | Steelpoort Business Bridge Chamber |
| Tintswalo Ndleve | DEA (NRM) |
| Tony Bowers | Mpumamanzi Group cc |
| Tshepo Magongwoto | LEDET |
| Tshidi Mamotja | Department Environmental Affairs |
| Vinesh Dilsook | Anglo American Platinum |
| Wilna Wepener | Lonmin Akanani |
| Zama Ramokgadi | Tubatse Chrome |
| Zonke Miya | Mpumamanzi Group cc |