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Water Affairs and Forestry
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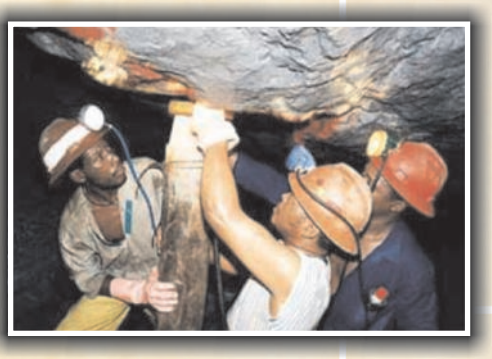
Directorate: Water Use Efficiency

Water Conservation and Water Demand Management Potential Assessment : Business Plan for Implementation - Development in the Upper and Middle Vaal Water Management Areas



MAY 2007

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POTENTIAL SAVINGS THROUGH WC/WDM IN THE UPPER AND MIDDLE VAAL WATER MANAGEMENT AREAS

REFERENCE

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POTENTIAL SAVINGS THROUGH WC/WDM IN THE UPPER

AND MIDDLE VAAL WATER MANAGEMENT AREAS

Project Team:

WRP Consulting Engineers (Pty) Ltd, DMM Development Consultants, and PD Naidoo & Associates in association.

This Report Prepared by:

WRP Consulting Engineers (Pty) Ltd and PD Naidoo & Associates

Report No. P RSA C000/00/4405/02

VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGIES

LIST OF REPORTS

Report No:	Title
P RSA C000/00/4405/01	Urban water requirements and return flows
P RSA C000/00/4405/02	Potential savings through WC/WDM in the Upper and Middle Vaal water management areas
P RSA C000/00/4405/03	Re-use options
P RSA C000/00/4405/04	Irrigation water use and return flows
P RSA C000/00/4405/05	Water resource analysis
P RSA C000/00/4405/06	Dolomite groundwater assessment
P RSA C000/00/4405/07	First stage reconciliation strategy

Above list of reports effective as at December 2006

Title:	*Potential Savings through WC/WDM in the Upper and Middle Vaal Water Management Areas*
Authors:	*R Mckenzie and Willem Wegelin: WRP Pty Ltd and K Haumann: PD Naidoo & Associates*
Project Name:	*WATER CONSERVATION AND DEMAND MANAGEMENT POTENTIAL ASSESSMENT: BUSINESS PLAN FOR IMPLEMENTATION – DEVELOPMENT IN THE UPPER AND MIDDLE VAAL WATER MANAGEMENT AREAS*
DWAF Report No:	*P RSA C000/00/4405/02*
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Project Team: WRP, DMM and PDNA in association

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POTENTIAL SAVINGS THROUGH WC/WDM IN THE UPPER AND MIDDLE VAAL WATER MANAGEMENT AREAS

Executive Summary

INTRODUCTION

Following completion of the study to investigate the Internal Strategic Perspectives (ISPs) for the Vaal River Water Management Areas (WMAa), which was completed in 2004, the Department of Water Affairs and Forestry (DWAF) identified and prioritised several studies to further support Integrated Water Resource Management in the Vaal River System. Although the original ISP Study's water balance assessments indicated that augmentation of the Vaal River System is only required by the year 2025, several factors were identified that could influence this date and required further investigations.

Firstly, it was acknowledged that the water requirement projection scenarios used in the ISP study did not include the influence of potential water conservation and demand management initiatives. As a result, the Directorates National Water Resource Planning and Water Use Efficiency commissioned the Water Conservation and Demand Management Potential Assessment: Business Plan Development for the Upper and Middle Vaal River Water management Areas. The results from this study are documented in the remainder of this report.

Secondly it was recognised that the time required to implement a large water resource augmentation scheme could be as long as fifteen years and coupled with the fact that the future water requirement scenarios exhibit low rates of increase makes the timing of intervention critical.

Finally, a comprehensive Reserve Determination had not been undertaken for the Vaal River System and will have to be incorporated into the balance between the available supply and the projected water requirements.

Given the above factors as well as various other uncertainties identified in the assumptions used in the ISP study, the Directorate: National Water Resource Planning commissioned another major study to reconcile the demand and supply situation in the Vaal River System. Since the water demand projections form one component of the reconciliation between supply and demand, it was agreed that the two studies would be integrated to ensure consistency and to avoid duplication of

effort. The remainder of this report documents the objectives and results from the Water Conservation and Demand Management study.

MAIN OBJECTIVES OF THE WC/WDM STUDY

The main objectives of the Water Conservation and Water Demand Management study were to:

- investigate the potential influence on future water requirements in the Vaal River System of WC/WDM activities based on reliable information derived from real case studies;
- identify and develop strategies to improve the effective and efficient use of existing and available water resources in all water sectors (urban, industrial and agricultural);
- assess the likely costs associated with the possible WC/WDM activities to enable the savings to be compared with alternative augmentation schemes;
- assess the current and planned WC/WDM measures within the Vaal River Basin in order to provide realistic future demand scenarios to the study team responsible for the reconciliation of demand and supply.

The core of the study area consists of the Upper, Middle and Lower Vaal River Water Management Areas. Due to the numerous inter-basin transfers that link this core area with other WMA's, however, reconciliation planning has to be undertaken in the context of the full Integrated Vaal River System which also includes portions of the Komati, Usutu, Thukela and Senqu River (Located in Lesotho) catchments. In addition, significant water transfers occur to water users in the Olifants and Crocodile (West) River catchments, many of which are totally dependant on the water resources of the Integrated Vaal River System.

In order to assess the potential savings that can be achieved through the various possible WC/WDM interventions, it is first important to establish the existing water demand distribution in the study area. In this regard, the water demand distribution for the Vaal River System is shown in **Figure 1** from which it can be seen that the Rand Water demand is clearly the largest component. It should also be noted, that the Rand Water demand is used almost entirely for urban and industrial purposes. It is also important to note that the bulk of the irrigation demands are supplied with low quality water made up primarily from effluent return flows where the salt concentrations have increased to the level whereby the water cannot be used again for urban purposes. The bulk of this report therefore concentrates on the Rand Water demands which can be distributed among the various municipalities as shown in **Figure 2.**

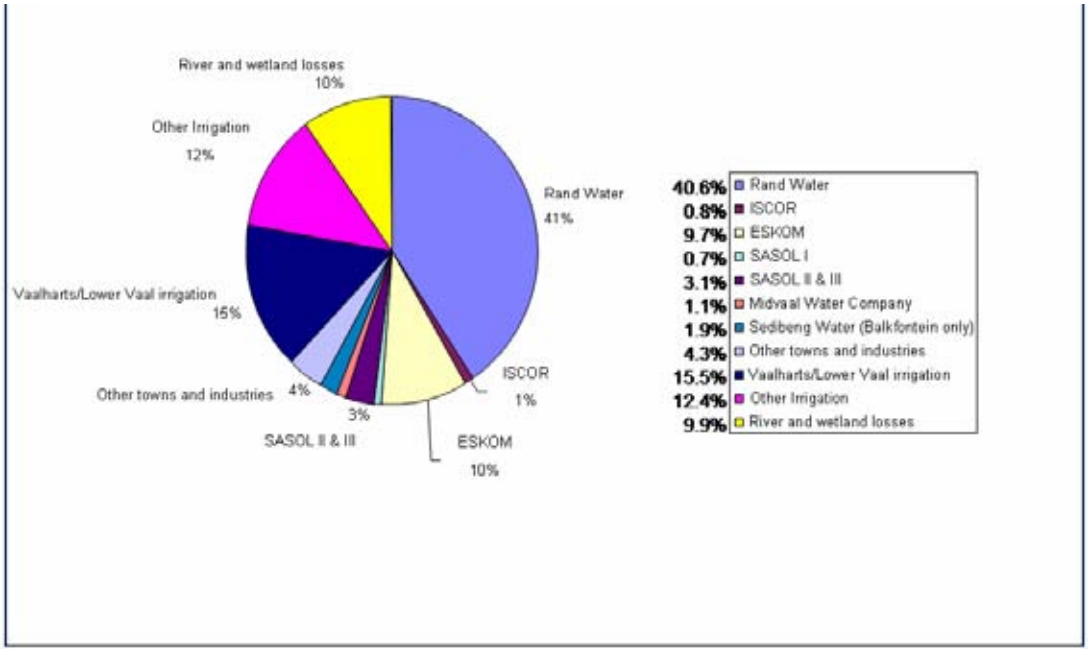

Figure 1: Breakdown of Water Demands in the Vaal River System

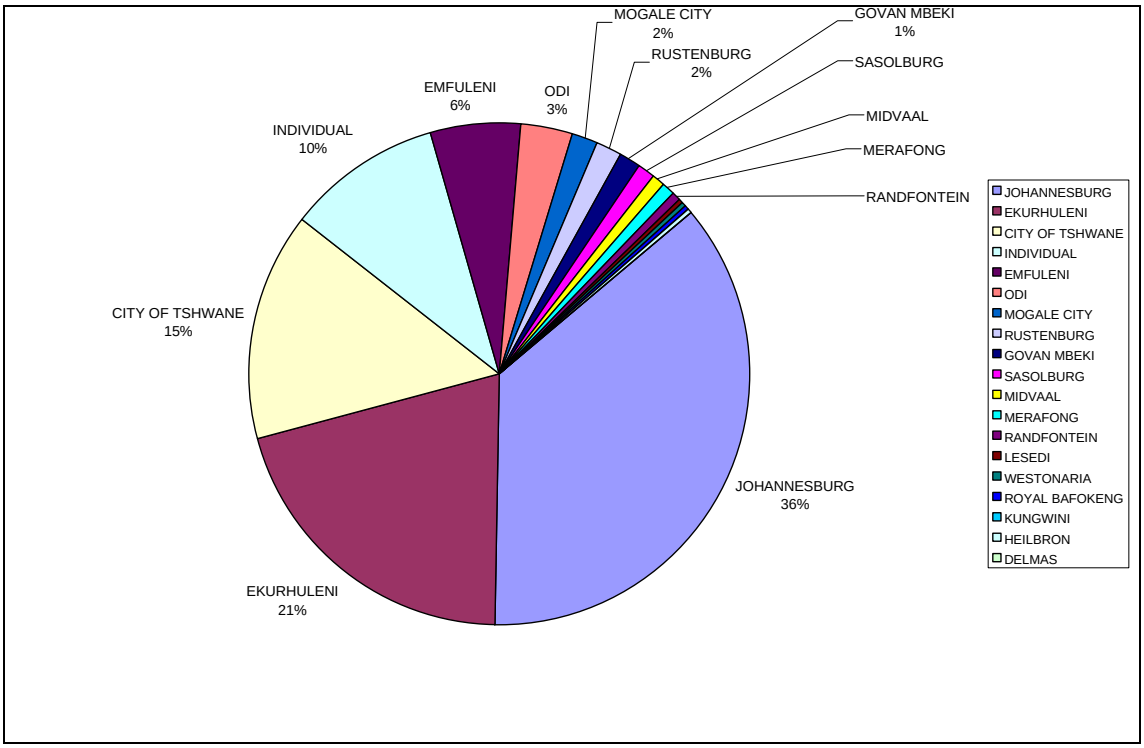

Figure 2: Breakdown of Rand Water's demands

INDUSTRIAL, MINING AND POWER SECTOR

Industrial sector

The major motivational factors for water demand management and water conservation prevalent in the Industrial sector include:

- Sustainability Standards Set by Clients (Regular Inspections - Food, Pharmaceutical & Beverage)
- "Specific Water Consumption" per product is monitored and comparisons with international benchmarks generally compare favourably
- Obtaining relevant ISO accreditation is a priority for a number of consumers
- Part of Large International Organisation (Benchmarked)
- High operating Costs (Water and Energy)
- Quality of Abstracted Raw Water (Steel)
- Quality of Effluent Discharged (National Water Act - DWAF) / Discharge Tax

The stumbling blocks to implementing water demand management and water conservation are:

- Cost of implementing projects prohibitive (pay-back 2 years or less)
- Energy costs significantly higher that water, therefore main focus for improved efficiencies

Potential measures for water demand management and water conservation for the industrial sector include:

- Most large companies are implementing Sustainability / Environmental Policies regarding water
- Water Audits/ Water balance – Although prevalent amongst most large consumers, many medium sized and smaller consumers due not have adequate systems in place. There is subsequently significant potential through improved monitoring and control of water used for various industrial processes. Monitoring of processes and equipment ensures that they are operating within optimum water usage limits.
- Organisations targeted by the study stated that retrofitting/ replacement of existing dated equipment with more efficient equipment would results in a reduction in consumption.
- "Specific Water Consumption" per product is not monitored in all industrial sectors. Industries should be encourage to do so as part of water audits (even if only internal benckmarks are established). Comparisons with international benchmarks are often not considered applicable as type of product and process may vary.

- Scope exists to implement Water Demand Management/ Water Conservation measures for Domestic Usage. Limited uptake of water efficient devices for domestic usage was found.
- Recycling of effluent through treatment. Discharge of waste water with little or no recycling was found to be common practice amongst industrial consumers.
- Retrofit or eliminate once through cooling systems. Options include: re-circulation of cooling water, air cooled systems, discharge to other applications.
- Proper operation and maintenance of hot water and steam systems. Options include: Active leak detection and maintenance, return steam condensate to boiler, discharge blow down through expansion tanks, insulate steam, condensate, hot water pipes and storage tanks.
- Education and Awareness Programs. Promotion of improved water use practices and general awareness regarding the importance of water conservation is not prevalent within the industrial sector.
- Major drivers moving forward are legislation and the cost of water. The most common reason for organisations not implementing water demand measures is financial. Most organisations will only consider capital project with a return on investment period of two years or less.
- A major concern amongst large consumers is growth in demand due to deterioration in water quality.

Mining

The major motivational factors for water demand management and water conservation prevalent in the mining sector include:

- Quality of Effluent Discharged (National Water Act - DWAF)
- International Standards – ISO 14 001
- Part of Large International Organisation – Annual SHE targets set (Benchmarked against other operations)
- Security of supply – Alternatives to potable water are used due to supply limits
- Operating Costs (Water and Energy)

Potential measures for water demand management and water conservation for the mining sector include:

- Current legislation (National Water Act - DWAF) is likely to have an ongoing impact on use within the mining sector.
- Scope exists to implement Water Demand Management/ Water Conservation measures for Domestic Usage (including retrofitting of water saving devices)
- Education and Awareness Programs. Promotion of improved water use practices and general awareness regarding the importance of water conservation is not prevalent within the industrial sector.
- Operating Costs (Water and Energy).
- Non-potable use including partially treated effluent. Additional scope exists for suitably situated mines to make use of partially treated effluent from municipalities for process water.
- Improved efficiency of Effluent Treatment Plants (Reverse Osmosis).
- New technology/ retrofitting. New mining techniques that are specifically suited to water scarce regions are being developed. Upgrading of older workings and equipment will result in a reduction in water consumption.
- Co-operation with other local users (Current legislation/ By-laws may be an obstacle). Mines are investigating the viability of recycling of process and decant water through treatment for supply to other mines/ industrial users as well as municipalities. The use of dual reticulation systems by towns in municipal areas has been implemented on a limited scale to date.

Power sector

Motivation to Implement WDM/ WC

- Operating Costs
- Target of Zero Effluent Discharge
- Current legislation (National Water Act - DWAF)

Potential measures for water demand management and water conservation for the power sector include:

- Significant improvements in efficiency achieved 1980 – 2001 through implementation of Dry Cooling.
- Future improvements in efficiency dependant on technology breakthrough.
- Demand Side Management (DSM) Program implemented in 1994 has continued potential (Currently Working with Dept Energy and Minerals).

IRRIGATION SECTOR

Efforts have been made to identify the causes of water losses in the six schemes in the Vaal catchment in the irrigation sector, and hence to propose achievable water conservation and demand management initiatives. The study reviews the extent of data gaps in the catchment, which, at this stage, presents a stumbling block in water use auditing in the catchment. Analysis of the water balance data obtained from DWAF indicated significant conveyance loss in the catchment. Most of the conveyance losses in the catchment are attributed to operational losses, which can be easily alleviated by equipping water bailiffs with tools which can assist them to release the right amount of water at the right time. The conveyance loss in the Vaalharts scheme, unlike the other schemes, is mainly attributed to canal evaporation and seepage from canals. The high evaporation is reckoned to be due to the length of the channel. The high seepage loss, as people from the area indicated, especially from the North Canal, is due to improper construction.

The potential for water saving by implementing latest technologies has been investigated based on theoretical irrigation application efficiency values. A 2% improvement in each of the six selected schemes would provide a 7.3 million m^3/a saving. This can irrigate an area of 948 ha assuming 7700 m^3/ha/a water requirement. Similarly if the irrigation application is improved by 5% in each of the schemes, 18.0 million m^3/a water, which can irrigate 2 340 ha, which is equivalent to the entire Schoonspruit government water scheme. There are savings in operational costs which can offset the capital costs of improving efficiencies. These are however, closely linked to the types of crops that are being farmed.

As mentioned, while a quota allocation system is in place and while farmers are not using their full allocation, there is little incentive for farmers to implement more efficient irrigation systems, despite the fact that it can be shown that there are sufficient offsets in operational cost savings . It should, of course, be borne in mind that under utilization also serves as a buffer for the risk to farmers of impending drought periods. It would appear reasonable to link the water tariff to assurance of supply, as this is likely to provide the kind of incentive to encourage farmers to balance their risks of supply against using more efficient irrigation systems.

A four-year project titled ” Standards and Guidelines for improved irrigation efficiency from dam wall release to root zone application” is running by a consortium of ten people funded by WRC. The objective of this project is to develop benchmarks for all aspects of irrigation. These benchmarks are imperative to assess irrigation efficiency and hence to quantify the benefits of different water conservation and demand management efficiencies.

There is also huge potential for saving by improving the water management. However, the existing water monitoring system in the whole catchment has to be improved in order to give reliable information, to assist in identifying management problems and to quantify the benefits.

The success of water conservation and demand management initiatives mainly depends on the awareness and, responsibility and accountability of water control officers and the end users. As in Australia, a shift from thinking of productivity in the traditional way, from yield per hectare to yield per m^3 can bring about a substantial improvement in water use. Thus huge efforts are required to address these shortcomings.

URBAN SECTOR

From the assessment of the scope for WC/WDM in the Upper and Middle Vaal River Basin several key issues were identified from which the following conclusions and recommendations were made:

- WC/WDM can provide a significant reduction in the water demands in the area if the measures are implemented properly and maintained indefinitely.
- The cost of implementing WC/WDM measures is often less that the maintenance costs which are often overlooked with the result that the WC.WDM interventions fail within a year or two of being implemented.
- The projected Rand Water demand in the year 2024-25 is estimated to increase from its current value of approximately 1 200 million m^3/annum to more than 1 500 million m^3/annum in the event that no WC/WDM measures are implemented.
- The potential savings that can be achieved in the study area range from a maximum optimistic estimate of approximately 400 million m^3/annum in Scenario c in the year 2024 (i.e. demand drops to approximately 1 100 million m^3/annum) to a more conservative and possibly realistic estimate of 200 million m^3/annum for Scenario e.
- Significant savings can be achieved in Johannesburg, Ekurhuleni, Tshwane and Emfuleni while small savings are achievable in Mogale and Govan Mbeki. High savings relative to the overall water use are also achievable in Rustenberg and Matjhabeng although the volumes involved are small relative to the 4 large Metro's/Municipalities.
- WC/WDM can be effective and sustainable as shown by several large projects.
- Garden irrigation using potable water must be discouraged in all cases unless the resident specifically chooses to pay for the water used through a properly metered supply.

- Government Departments must co-ordinate their efforts with regard to WC/WDM. The Department of Agriculture must stop promoting the use of hosepipes in urban areas which already experience water shortages.
- DWAF should encourage WDM activities and discourage the use of low quality fixtures in township retrofitting projects. Only high quality fittings should be used in areas of such high usage.
- Lack of maintenance will result in many systems deteriorating into intermittent supply if action is not taken quickly ;
- Municipalities should be encouraged to combine technical and financial services into a single unit .

Potential Savings in Urban Sector from WC/WDM Interventions

Considerable effort was spent analysing over 60 areas in detail to assess the potential savings that can be achieved in the study area from various WC/WDM interventions. For each area, a full water balance was undertaken after which all available logging results (supplied by the municipalities from previous investigations) were analysed to asses potential savings. Since it is not possible to predict the savings with any certainty, the project team developed 3 plausible scenario's which are referred to as Scenario C, Scenario D and Scenario E in order to tie in with the main water reconciliation study. The scenarios are discussed individually below.

Scenario C: 5 Years water loss programme and efficiency

Scenario c is the most optimistic of the three scenarios and assumes that the full potential WC/WDM savings to eliminate wastage can be implemented over a 5-year period and that significant improvements in the level of efficiency in the domestic sector can be achieved – e.g. use of dual flush toilets and low flow showers etc. The results for **Scenario c** are summarised in **Table 1 and Table 2**

Table 1: Scenario c: Summary of potential savings

Year	Demand without WC/WDM (mcm/a)	Demand with WC/WDM (mcm/a)	Reduction (mcm/a)	% Reduction
2004-05	1 165.8	1140.0	25.8	2%
2009-10	1 248.1	1063.2	184.9	15%
2014-15	1 337.5	1053.1	284.4	21%
2019-20	1 434.6	1080.7	353.9	25%
2024-25	1 540.3	1109.1	431.2	28%

Table 2: Scenario c: Budget requirements

Year	CAPEX (R million /a)	OPEX (R million /a)	Total (R million /a)	Savings (R million /a)	CBR*
2004-05	480.0	487.6	967.7	71.2	
2009-10	402.3	487.6	890.0	510.3	
2014-15	230.5	487.6	718.1	784.9	
2019-20	230.5	487.6	718.1	976.8	
2024-25	230.5	487.6	718.1	1190.2	
Annual average	**307.1**	**487.6**	**794.7**	**552.3**	**1.4**
25 year total	3992.0	6339.3	10331.4	7179.7	1.4

* Cost benefit ratio (CBR) = Total Implementation Cost / Savings

The results from **Scenario c** indicate a total reduction in demand of approximately 30% or 420million m^3/annum year 2025. This reduction will reduce the average consumption per capita per day from 330 to 250l/c/d or the consumption per household from 36 to 26m^3/property/month.

It can also be seen that almost 50% of the savings can be achieved in Johannesburg, mainly because of Soweto. The other three focus areas should be Tshwane, Ekurhuleni and Emfuleni. It should be noted that the potential savings in the other areas is relatively small which can help to prioritise where most funding should be directed to derive the greatest benefit from WC/WDM interventions.

Scenario D : 5 Year Water Loss Programme

Scenario d is similar to **Scenario c** except that the additional savings achieved through greater water use efficiency in the home has been excluded from the analysis. It is assumed that the implementation of dual-flush toilets and low flow taps and showers etc will not take place due to

financial constraints of the residents. In Australia where the dual-flush toilet was developed, the implementation of water efficient fixtures was promoted by massive government subsidies and this may not be possible in the South African environment. The results for **Scenario d** is summarised in **Table 3 and Table 4.**

Table 3: Scenario d - Summary of potential savings

Year	Demand without WC/WDM (mcma)	Demand with WC/WDM (mcma)	Reduction (mcma)	% Reduction
2004-05	1 165.8	1140.2	25.6	2%
2009-10	1 248.1	1063.5	184.6	15%
2014-15	1 337.5	1137.0	200.4	15%
2019-20	1 434.6	1224.0	210.6	15%
2024-25	1 540.3	1317.6	222.7	14%

Table 4: Scenario d : Budget requirements

Year	CAPEX (R million /a)	OPEX (R million /a)	Total (R million /a)	Savings (R million /a)	CBR*
2004-05	489.0	500.0	989.0	70.7	
2009-10	410.6	500.0	910.6	509.6	
2014-15	236.5	500.0	736.5	553.2	
2019-20	236.5	500.0	736.5	581.2	
2024-25	236.5	500.0	736.5	614.6	
Annual average	**312.9**	**500.0**	**812.9**	**435.5**	**1.9**
25 year total	4067.9	6500.1	10568.0	5661.2	1.9

Cost benefit ratio (CBR) = Total Implementation Cost / Savings

The results from **Scenario d** indicate a total reduction in demand of approximately 15% or 220million m^3/annum year 2025. This reduction will reduce the average consumption per capita per day from 330 to 290l/c/d or the consumption per household from 36 to 31m^3/property/month.

Scenario e : 10 Year Water Loss Programme

Scenario e is the same as the previous scenario with the exception that the WC/WDM interventions are introduced over a 10-year period and not a 5-year period. Many experts consider that the introduction and implementation of WC/WDM interventions cannot be achieved in 5-years

and that 10 years is a more achievable time-frame. The results from **Scenario e** are provided in **Table 5 and Table 6**.

Table 5: Summary of potential savings

Year	Demand without WC/WDM (mcma)	Demand with WC/WDM (mcma)	Reduction (mcma)	% Reduction
2004-05	1 165.8	1140.8	25.1	2%
2009-10	1 248.1	1137.4	110.7	9%
2014-15	1 337.5	1138.1	199.3	15%
2019-20	1 434.6	1224.1	210.6	15%
2024-25	1 540.3	1317.7	222.7	14%

Table 6: Scenario e Budget requirements

Year	CAPEX (R million /a)	OPEX (R million /a)	Total (R million /a)	Savings (R million /a)	CBR*
2004-05	372.0	500.1	872.1	69.2	
2009-10	431.9	500.1	932.0	305.5	
2014-15	420.5	500.1	920.6	550.2	
2019-20	250.8	500.1	750.9	581.2	
2024-25	232.5	500.1	732.6	614.6	
Annual average	**316.0**	**500.1**	**816.1**	**351.9**	**2.3**
25 year total	4107.7	6501.9	10609.6	4575.0	2.3

The results from **Scenario e** indicate a total reduction in demand of approximately 15% or 220million m^3/annum year 2025. This reduction will reduce the average consumption per capita per day from 330 to 290l/c/d or the consumption per household from 36 to 31m^3/property/month. The results are the same as for **Scenario d**, except that the savings are achieved only after 10 years and not 5 years as in **Scenario d** and **Scenario c**

CONCLUSIONS AND RECOMMENDATIONS

Industrial sector

The major motivational factors for water demand management and water conservation prevalent in the Industrial sector include:

- Sustainability Standards Set by Clients (Regular Inspections - Food, Pharmaceutical & Beverage)
- "Specific Water Consumption" per product is monitored and comparisons with international benchmarks generally compare favourably
- Obtaining relevant ISO accreditation is a priority for a number of consumers
- Part of Large International Organisation (Benchmarked)
- High operating Costs (Water and Energy)
- Quality of Abstracted Raw Water (Steel)
- Quality of Effluent Discharged (National Water Act - DWAF) / Discharge Tax

The stumbling blocks to implementing water demand management and water conservation are:

- Cost of implementing projects prohibitive (pay-back 2 years or less)
- Energy costs significantly higher that water, therefore main focus for improved efficiencies

Potential measures for water demand management and water conservation for the industrial sector include:

- Most large companies are implementing Sustainability / Environmental Policies regarding water
- Water Audits/ Water balance – Although prevalent amongst most large consumers, many medium sized and smaller consumers due not have adequate systems in place. There is subsequently significant potential through improved monitoring and control of water used for various industrial processes. Monitoring of processes and equipment ensures that they are operating within optimum water usage limits.
- Organisations targeted by the study stated that retrofitting/ replacement of existing dated equipment with more efficient equipment would results in a reduction in consumption.
- "Specific Water Consumption" per product is not monitored in all industrial sectors. Industries should be encourage to do so as part of water audits (even if only internal benckmarks are established). Comparisons with international benchmarks are often not considered applicable as type of product and process may vary.
- Scope exists to implement Water Demand Management/ Water Conservation measures for Domestic Usage. Limited uptake of water efficient devices for domestic usage was found.
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- Education and Awareness Programs. Promotion of improved water use practices and general awareness regarding the importance of water conservation is not prevalent within the industrial sector.
- Major drivers moving forward are legislation and the cost of water. The most common reason for organisations not implementing water demand measures is financial. Most organisations will only consider capital project with a return on investment period of two years or less.
- A major concern amongst large consumers is growth in demand due to deterioration in water quality.

Mining

The major motivational factors for water demand management and water conservation prevalent in the mining sector include:

- Quality of Effluent Discharged (National Water Act - DWAF)
- International Standards – ISO 14 001
- Part of Large International Organisation – Annual SHE targets set (Benchmarked against other operations)
- Security of supply – Alternatives to potable water are used due to supply limits
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Potential measures for water demand management and water conservation for the mining sector include:

- Current legislation (National Water Act - DWAF) is likely to have an ongoing impact on use within the mining sector.
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- Education and Awareness Programs. Promotion of improved water use practices and general awareness regarding the importance of water conservation is not prevalent within the industrial sector.
- Operating Costs (Water and Energy).
- Non-potable use including partially treated effluent. Additional scope exists for suitably situated mines to make use of partially treated effluent from municipalities for process water.
- Improved efficiency of Effluent Treatment Plants (Reverse Osmosis).
- New technology/ retrofitting. New mining techniques that are specifically suited to water scarce regions are being developed. Upgrading of older workings and equipment will result in a reduction in water consumption.
- Co-operation with other local users (Current legislation/ By-laws may be an obstacle). Mines are investigating the viability of recycling of process and decant water through treatment for supply to other mines/ industrial users as well as municipalities. The use of dual reticulation systems by towns in municipal areas has been implemented on a limited scale to date.

Power sector

Motivation to Implement WDM/ WC

- Operating Costs
- Target of Zero Effluent Discharge
- Current legislation (National Water Act - DWAF)

Potential measures for water demand management and water conservation for the power sector include:

- Significant improvements in efficiency achieved 1980 – 2001 through implementation of Dry Cooling.
- Future improvements in efficiency dependant on technology breakthrough.
- Demand Side Management (DSM) Program implemented in 1994 has continued potential (Currently Working with Dept Energy and Minerals).

Irrigation Sector

Efforts have been made to identify the causes of water losses in the six schemes in the Vaal catchment in the irrigation sector, and hence to propose achievable water conservation and demand management initiatives. The study reviews the extent of data gaps in the catchment, which, at this stage, presents a stumbling block in water use auditing in the catchment. Analysis of the water balance data obtained from DWAF indicated significant conveyance loss in the catchment. Most of the conveyance losses in the catchment are attributed to operational losses, which can be easily alleviated by equipping water bailiffs with tools which can assist them to release the right amount of water at the right time. The conveyance loss in the Vaalharts scheme, unlike the other schemes, is mainly attributed to canal evaporation and seepage from canals. The high evaporation is reckoned to be due to the length of the channel. The high seepage loss, as people from the area indicated, especially from the North Canal, is due to improper construction.

The potential for water saving by implementing latest technologies has been investigated based on theoretical irrigation application efficiency values. A 2% improvement in each of the six selected schemes would provide a 7.3 million m^3/a saving. This can irrigate an area of 948 ha assuming 7700 m^3/ha/a water requirement. Similarly if the irrigation application is improved by 5% in each of the schemes, 18.0 million m^3/a water, which can irrigate 2 340 ha, which is equivalent to the entire Schoonspruit government water scheme. There are savings in operational costs which can offset the capital costs of improving efficiencies. These are however, closely linked to the types of crops that are being farmed.

As mentioned, while a quota allocation system is in place and while farmers are not using their full allocation, there is little incentive for farmers to implement more efficient irrigation systems, despite the fact that it can be shown that there are sufficient offsets in operational cost savings . It should, of course, be borne in mind that under utilization also serves as a buffer for the risk to farmers of impending drought periods. It would appear reasonable to link the water tariff to assurance of supply, as this is likely to provide the kind of incentive to encourage farmers to balance their risks of supply against using more efficient irrigation systems.

A four-year project titled ” Standards and Guidelines for improved irrigation efficiency from dam wall release to root zone application” is running by a consortium of ten people funded by WRC. The objective of this project is to develop benchmarks for all aspects of irrigation. These benchmarks are imperative to assess irrigation efficiency and hence to quantify the benefits of different water conservation and demand management efficiencies.

There is also huge potential for saving by improving the water management. However, the existing water monitoring system in the whole catchment has to be improved in order to give reliable information, to assist in identifying management problems and to quantify the benefits.

The success of water conservation and demand management initiatives mainly depends on the awareness and, responsibility and accountability of water control officers and the end users. As in Australia, a shift from thinking of productivity in the traditional way, from yield per hectare to yield per m^3 can bring about a substantial improvement in water use. Thus huge efforts are required to address these shortcomings.

Urban Sector

From the assessment of the scope for WC/WDM in the Upper and Middle Vaal River Basin several key issues were identified from which the following conclusions and recommendations were made:

- WC/WDM can provide a significant reduction in the water demands in the area if the measures are implemented properly and maintained indefinitely. The cost of implementing WC/WDM measures is often less that the maintenance costs which are often overlooked with the result that the WC.WDM interventions fail within a year or two of being implemented.
- The projected Rand Water demand in the year 2024-25 is estimated to increase from its current value of approximately 1 200 million m^3/annum to more than 1 500 million m^3/annum in the event that no WC/WDM measures are implemented. The potential savings that can be achieved in the study area range from a maximum optimistic estimate of approximately 400 million m^3/annum (Scenario c) in the year 2024 (i.e. demand drops to approximately 1 100 million m^3/annum) to a more conservative and possibly realistic estimate of 200 million m^3/annum – i.e. demand drops to approximately 1 300 million m^3/annum (Scenario e).
- Savings are extremely limited in Mogale and Govan Mbeki as indicated by the relatively low ILI values of 3.4 and 2.6 respectively. In contrast the ILI values for Johannesburg, Ekurhuleni, Tshwane and Emfuleni are 7.2, 4.5, 5.2, and 7.3 which indicate relatively high levels of leakage/wastage in these systems. Rustenberg also has high leakage/wastage as indicated by its ILI value of 8.6 as does Matjhabeng with an ILI of 8.0.
- WC/WDM can be effective and sustainable as has been shown by several large projects undertaken in the study area including:
    - The Sebokeng/Evaton pressure management project

- The Soweto leak repair, retrofitting and pre-paid metering project;
- The Kagiso pre-paid metering project.

- Garden irrigation using potable water is a huge problem issue in many low income areas where indiscriminate use of hosepipes and potable water is creating both supply and pressure problems. The use of hosepipes must be either banned completely in such areas or the use restricted to an hour or two every 2nd day during off-peak periods. Irrigation during the hottest part of the day (from 10h00 to 18h00) should be prohibited simply on efficiency grounds.
- Government Departments must co-ordinate their efforts with regard to WC/WDM. The efforts of DWAF where the Department is spending large budgets to educate consumers on the evils of hosepipe irrigation is being undermined by the efforts of the Department of Agriculture where it is providing free hosepipes to the same consumers to grow vegetables. Those wishing to grow vegetables in such areas should be provided with buckets or watering cans which can still be used with good effect without causing the system problems mentioned previously. Alternatively, roof tanks should be provided to capture rainwater which is ideal for such irrigation.
- DWAF should encourage WDM activities – e.g. fund projects like Sebokeng, provide subsidies for roof tanks and low flush toilets etc. The Department should not encourage use of low quality fixtures in township retrofitting projects and should rather use the highest quality pipes, meters and fittings for poor areas since the taps and toilets in these areas experience highest use and lower quality fittings will not last.
- Lack of maintenance will result in many systems deteriorating into intermittent supply if action is not taken quickly – particularly in township systems where lack of maintenance has occurred over past 30 years.
- Municipalities should be encouraged to combine technical and financial services into a single unit – current trend of separate billing/treasury from water supply/technical is causing major problems and a proper water audit is often not possible since the split between Real and Apparent losses cannot be established with confidence.