

**ASSESSMENT OF THE CUMULATIVE IMPACTS
WITHIN THE KROMDRAAI CATCHMENT AREA
WITH A SPECIFIC FOCUS ON THE POINT
SOURCE DISCHARGES**

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**ASSESSMENT OF THE CUMULATIVE
IMPACTS WITHIN THE KROMDRAAI
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DISCHARGES**

A A VAN DYK

2005

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ABSTRACT

The purpose of this dissertation was to determine if the cumulative impacts from point source discharges in the Kromdraai Catchment area significantly impacting on the fitness of use of the surface water resource.

The Kromdraai catchment area is located within the Upper Vaal Water Management Area and includes the Upper and Lower Wonderfonteinspruit, the Mooi River and the Loopspruit. The catchment area stretches from Krugersdorp to the confluence with the Vaal River and includes the towns of Westonaria, Carletonville, Fochville and Potchefstroom. Various dams are situated within the catchment area, these include the Donaldson Dam, Klipdrift Dam, Boskop Dam, Klerkskraal Dam and the Potchefstroom Dam.

In order to calculate relevant salt loads reference was made to the Best Practice Guideline Document for the compilation of water and salt balances (DWAF, 1999b:16). The assessment made use of the concentration of salts discharged in kg per day (also referred to as the Total Dissolved Salts or TDS in mg/l) in order to assess the levels of impact. The said method described was utilised throughout the assessment.

In order to establish an informed assessment the following methodology was applied.

- Collation of information in order to obtain:
 - Understanding the activities of point source discharge.
 - Localities of discharge.
 - Quantities and qualities of discharge.
- Site visits to:
 - Obtain and clarify information.
 - Obtain additional information.
 - Form a holistic view of the area.
- Review of information:
 - Missing information was sourced.
 - Personal contact with point source dischargers.
- Cumulative impact assessment:
 - Impact was calculated in accordance to the guidelines of DWAF.
- Conclusions
 - Based on the results certain cumulative impact assessments were made, limitations and problem areas were highlighted and certain recommendations made.

The following point source dischargers discharge directly into the surface water resource:

Merafong City Local Municipality

- Oberholzer Sewage Works;
- Khutsong Sewage Works;

- Wedela Sewage Works;
- Welverdiend Sewage Works;
- Fochville Sewage Works;

Mogale City Municipality

- Flip Human Sewage Works;
- Hannes van Niekerk Sewage Works;

Potchefstroom Local Municipality

- Potchefstroom Water Care Works

The following mining activities have a direct point source discharge point into the catchment area:

- GoldFields Limited – Kloof Gold Mine, Driefontein Consolidated Mines.
- AngloGold Ashanti – West Wits
- Durban Roodepoort Deep - Blyvooruitzicht Gold Mine
- Harmony Gold Mine – Deelkraal and Elandsrand, Randfontein Estates

The conclusion that was formed based on the results of the different point source discharges was that:

- No single point of discharge can be identified as a major polluter.
- Certain of the point discharge sources were found to be discharging water containing waste with TDS concentrations above the acceptable Water Research Commission Guideline (1998: 59) for drinking water, however none of these point source discharges ever contained TDS concentrations of a magnitude that poses a risk to human health.
- The point source dischargers are cumulatively responsible for the raised levels of salts found in the surface water resource. It should be noted that this raised level is still not deemed to be a health risk to humans as per the standards.
- It was found that the state of especially municipal water care works is in need of urgent upgrading and maintenance as well as management. This was especially clear from site visits although not evident in the monitoring data.
- The assessment was done with data received from different point source dischargers. Throughout the assessment averaged figures were utilized. It should be noted that a great discrepancy exist in the methods used by the dischargers i.e. dates of sampling, times of sampling, methods of analysis, regularity of sampling and sampling methods.

Final conclusion was that a uniform system of monitoring and analysis throughout the region would provide a much more accurate and clear indication of actual state and possible impact on the surface water resources.

VOORWOORD

Die doel van hierdie verhandeling is om te bepaal wat die kumulatiewe impak van spesifieke puntbronbesoedeling op die waterkwaliteit vir gebruik in die Kromdraai opvangsgebied is.

Die Kromdraai opvangsgebied is geleë binne die Bo-Vaal Waterbestuursgebied en sluit die Bo en Laer Wonderfonteinspruit, Mooirivier en Loopspruit in. Hierdie opvangsgebied strek vanaf Krugersdorp wes tot by die Vaalrivier en sluit in die dorpe van Westonarea; Carletonville, Fochville en Potchefstroom.

Verskeie damme is geleë binne hierdie opvangsgebied nl. Donaldsondam; Klipdriftdam; Boskopdam, Klerkskraaldam asook die Potchefstroomdam.

Verwysing is gemaak na die bestuurshandleiding van die Departement Waterwese & Bosbou (Best Guideline Document for the compilation of water & salt balances: DWAF, 1999b:16) vir die berekening van relevante water en sout balanse. Gedurende die assessering is die soutladings vanaf die puntbronbesoedeling in kilogram per dag gebruik om die totale impak te bereken. (ook bekend as die Totale Opgeloste stowwe / TDS in mg/l).

Metodiek gebruik was as volg:

- Die indiepte vergelyking van inligting is gemaak ten toeligtig van:
 - o Die verstaan van aktiwiteite by puntbronne.
 - o Ligging van puntbronne.
 - o Kwantitatiewe asook kwalitatiewe eienskappe van bronne.
- Besoek is gebring aan die puntbronbesoedelaars ter toeligtig van:
 - o Versameling en klaring van inligting.
 - o Inwin van addisionele inligting.
 - o 'n Holistiese oorsig van die totale area van bespreking.
- Hersiening van inligting:
 - o Onvoldoende inligting is aangevul.
 - o Persoonlike besoek is gebring aan diegene wat puntbronne bedryf.
- Die Kumulatiewe Impak Assessering:
 - o Die impak is bereken volgens die riglyne soos neergelê deur Departement Waterwese en Bosbou.
- Gevolgtrekkings:
 - o Sekere kumulatiewe impakassesserings is gemaak, gebaseer op die ingewinde resultate. Tekortkominge en probleemareas is geïdentifiseer en sekere aanbevelings is gemaak.

Die volgende puntbronbesoedelaars stort direk in die waterbronne van die opvangsgebied:

Merafong Plaaslike Owerheid

- Oberholzer Waterversorgingswerke
- Khutsong Waterversorgingswerke

- Wedela Waterversorgingswerke
- Welverdiend Waterversorgingswerke
- Fochville Waterversorgingswerke

Mogale Plaaslike Owerheid

- Flip Human Waterversorgingswerke
- Hannes van Niekerk Waterversorgingswerke

Potchefstroom Plaaslike Owerheid

- Potchefstroom Waterversorgingswerke

Die volgende myne stort direk in die opvangsgebied:

- GoldField Limited - Kloof Goudmyn; Driefontein Consolidated Myn
- AngloGold Ashanti - West Wits
- Durban Roodepoort Deep - Blyvooruitzicht Goudmyn
- Harmony Gold Mine - Deelkraal en Elandsrand, Randfontein Estates.

Die volgende gevolgtrekkings is gemaak:

- Geen van die puntbronne kan uitgesonder word as 'n enkel groot besoedelaar nie.
- Daar is bevind dat sekere puntbronne water gestort het waarvan die TDS ladings bo die aanvaarbare norm was soos omskryf in die *Water Research Commission Guideline for Domestic Use (1998:59)*. Daar is egter ook bevind dat geen van die ladings die perk oorskry het wat 'n gesondheids risiko sou wees nie.
- Die gesamentlike impak van alle puntbronne is verantwoordelik vir die verhoogde vlakke van opgeloste stowwe (TDS) in die water. Hierdie vlakke is egter nie 'n gesondheidsrisiko vir die mens nie.
- Besoeke aan vernameelik die munisipale waterversorgingswerke het aan die lig gebring dat sommige van hierdie fasiliteite indringend instandhouding; uitbreiding asook effektiewe bestuur benodig. Hierdie feite word egter nie bevestig deur die moniteringsdata nie.
- Assessering is gedoen na aanleiding van inligting ontvang van verskeie puntstortings. In die assessering is gebruik gemaak van gemiddeldes. Daar is egter bevind dat aansienlike onreëlmatighede bestaan ten opsigte van die metodes van inligting versameling bv. datums van assessering; tye ; metodes van analyses; reëlmaat van monitering asook spesifieke metodes wat gebruik word.

Ten slotte is bevind dat 'n enkel monitering; analise en assesserings metode vir die streek as 'n geheel, 'n meer akkurate en duidelike stel feite sal lewer, wat die werklike toestand en enige moontlike impak op die waterbronne beter sal toelig.

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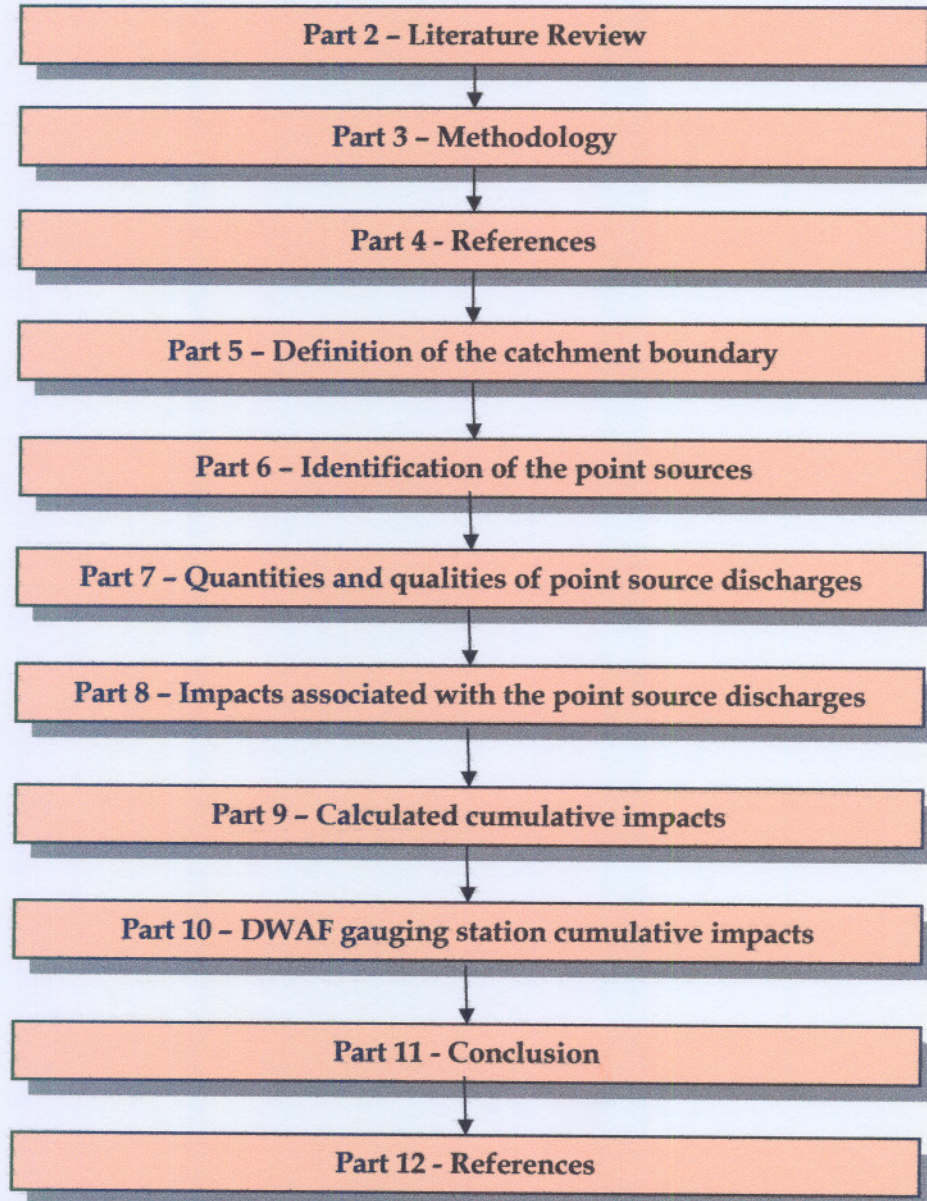
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1.1 PROBLEM STATEMENT

The purpose of this assessment is to determine the impacts from point source discharges on the Kromdraai Catchment.

1.2 STRUCTURE OF THIS DOCUMENT

This document has been structured in the following manner:



2.1 DEFINITION OF A POINT SOURCE

A point source discharge can be defined as a source that comprises of pollution and occupies a very small area, thus having a concentrated polluted output that can be traced back to a single point of origin (DWAf,2005).

2.2 DEFINITION OF A CUMULATIVE IMPACT

Cumulative impacts are defined as the impacts which, on their own, may not be significant, however, when added to many other similar impacts, may be very significant (CSIR, 1996).

Cumulative impacts can also be referred to as the impact on the environment caused by multiple stressors which result in incremental, accumulating and interacting impacts which can be assessed in terms of present and future cumulative impacts (CSIR, 1996).

Lenzen *et al.* (2003:265) refers to the fact that projects may be localised spatially, but their consequences incident on various activities at many spatial levels (local, regional, national, and international) and may have diverse environmental, economical, social and institutional effects or impacts.

Dubé (2003:724) stated that addressing cumulative impacts one should also take into account socio-economic and cultural consequences, and that cumulative impacts may result from the addition or extraction of materials from the environment (mining) as well as from the interaction between man-made and natural stressors.

Cooper and Canter (1997:386) refers to the holistic approach as including geographical boundaries (spatial boundaries), temporal boundaries and the consideration of all projects in the study area (past, present and reasonably foreseeable future).

In summary for the Kromdraai catchment, a cumulative impact can be defined as a point source discharge which on its own may have an insignificant impact, but when assessed within the catchment, the cumulative effect of all discharges can have a significant impact on the receiving water source.

2.3 METHODS USED TO DETERMINE CUMULATIVE IMPACTS

The following cumulative impact methodologies have been documented:

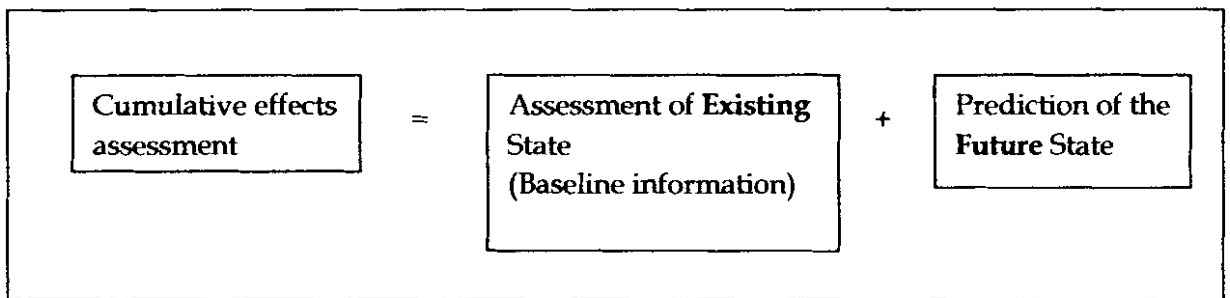
2.3.1 Dube (2003)*Stressor-based method*

This method focuses on predicting the cumulative impact associated with a

specific agent of change and is often descriptive of local, baseline information which is populated with predictions modelled to assess whether a project-related stressor will cause significant or adverse environmental effects. This method lacks the mechanism for incorporating environmental data collected during the follow-up programmes as to determine the accuracy of the predicted impacts.

Dubé (2003:728) referred to “environmental bottom-lines”, “thresholds” or “key environmental indicators” these include the physical, chemical and biological indicators. These require assessment on an on-going basis. During the assessment, focus needs to be placed on how close the indicator is to exceeding the threshold and whether the new development will result in the exceedance of the threshold beyond those currently measured. This emphasises the need to assess the baseline or background information as part of the overall assessment. This will also ensure that predictions are not underestimated due to unknown stressors or that there is a lack of understanding the assimilative capacity of the environment and the interaction with unknown stressors.

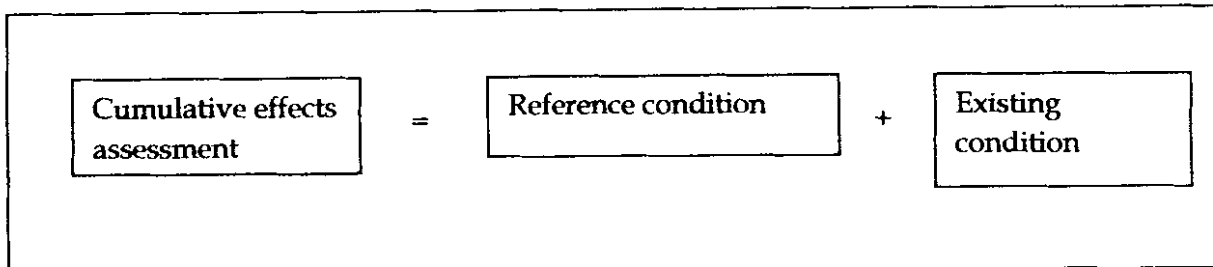
A simplified diagram by Dubé (2003:272) explains this method as follows.



Effects-based Approach

Dubé (2003:728) also refers to the Effects-Based Approach which assess the existing environmental condition relative to a reference condition (assessment of accumulated state). It is argued that this method is suitable for assessing localised impacts and not regional impacts. This approach measures the environments response to stress and as such identify effects that may occur due to unidentified stressors or multiple stressor interactions. It also measures the changes in the environment by comparing it to reference conditions. With assessment of the site over time (pre- and post development) and making a comparison with the reference conditions, one could determine whether the measured change is due to the specific development or due to natural causes.

A simplified diagram by Dubé (2003:727) explains this method as follows.



With the effects-based method, the identification of the stressors causing the effects, occurs after the effects have been measured and therefore limits the predictive capabilities of the method with the cumulative impact assessment. With a cumulative impact assessment, the effects of the proposed new development should be predicted prospectively, not retrospectively.

2.3.2 *Lenzen (2003)*

Lenzen *et al.* (2003:263) refers to the input-output analysis that calculates the indirect effects of a development in terms of several indicator variables. The method allows for the national and international effects to be taken into account in the decision-making process. Lenzen also stated that the total impacts are considerably higher than the on-site impacts for example, during the development of a new airport the results indicated that the indirect energy requirements of the construction of the airport (energy embodiments in material and services) were an order of magnitude higher than the on-site energy use.

The input-output analysis has certain uncertainties such as the use of fixed coefficients representing linear production functions, source data sampling and reporting errors among others (Lenzen *et al.* (2003:272). Time lags of economic and employment effects are often unknown, despite their importance for inter-temporal weighting and discounting of impacts.

2.3.3 *Department of Water Affairs and Forestry (1999)*

With reference to the Best Practice Guideline Document for the compilation of Water and Salt Balances (DWAf, 1999b:16), the basic principles used in the compilation of water and salt balances are indicated as follows:

$$\text{Total salt load in} = \text{Total salt load out}$$

Where:

$$\begin{aligned} \text{Salt load (kg/day)} &= \text{Flow (m}^3\text{/day)} \times \text{Salt Concentration (kg/m}^3\text{)} \\ &= \text{Flow (m}^3\text{/day)} \times 0.001 \times \text{Salt Concentration (mg/l)} \end{aligned}$$

The salt concentration is referred to as the concentration of a specific salt or the TDS concentration.

2.3.4 *Method used*

Taking into account the different methods (mentioned) available for determining cumulative impacts, the uniqueness of the point source

discharges in the Kromdraai catchment, the method utilised and described by DWAF was found to be the most appropriate.

3.1.1 Gold Mining

Large impacts that are associated with the gold mining activities are the deposition of waste material which is a diffuse source of pollution (Mare, 2005). It is mentioned in this report in order to clarify the relation between point source discharges in the catchment and diffuse sources of pollution in order to qualify the impact of point sources in terms of significance.

“Tailings” are slurry of finely ground ore from which the economic minerals have been removed. They are potentially the biggest source of heavy metal pollution resulting from gold mining activity, and are the most difficult by-product to contain (Kennedy, *et al.* 2004).

A common known pollution source from tailings deposits are known as acid mine drainage. Acid mine drainage is a chemical weathering process by which sulphates in the tailings are exposed to air and water – slowly leaching sulphuric acid into the ecosystem. The effects of acid mine drainage is devastating and include destroying of the ecology of an entire river system both by raising acidity to dangerous levels and by releasing dissolved heavy metals into the river system (Kennedy, *et al.* 2004:18).

Cyanide is used to leach gold from ore. A rice-grain sized doze of cyanide can be fatal to humans. Cyanide concentrations of 1 microgram (one-millionth of a gram) per litre of water can be fatal to fish. When exposed to sunlight, some forms of cyanide break down and can be easily recovered and recycled, but others do not and may persist in the environment for decades (Miranda, *et al.* 2004).

Mine waste also include other constituents of concern such as mercury and heavy metals (zinc, lead and copper) that could work their way into the food chain and in the long terms have a health effect (Kennedy, *et al.* 2004).

If containment structures are not well planned and maintained, untreated tailings containing toxic materials can seep into groundwater or escape into nearby streams, seriously affecting the health of local populations (Kennedy, *et al.* 2004).

Within the Kromdraai Catchment area, uranium is also be present as a contaminant for the treatment processes (Winde, *et al.* 2004).

3.1.2 Sewage Treatment Works

Sewage treatment is a multi-stage process to purify wastewater before it re-enters a body of water, is applied to land or is reused. The goal is to reduce or remove organic matter, solids, nutrients, disease-causing organisms

and other pollutants from wastewater. Each receiving water body has limits to the amount of pollutants it can receive without degradation. Therefore, each sewage treatment plant must hold a permit which lists the allowable water quality acceptable for discharge (Mancl, 1996).

Preliminary treatment to screen out, grind up, or separate debris is the first step in wastewater treatment. Sticks, rags, large food particles, sand, gravel, toys etc., are removed at this stage to protect the pumping and other equipment in the treatment plant. The collected debris is usually disposed of in a landfill (Mancl, 1996).

Primary treatment is the second step in treatment and separates suspended solids and greases from wastewater. The solids settle to the bottom and the greases are skimmed off the top for further treatment. The clarified wastewater flows onto the next stage of the wastewater treatment (Mancl, 1996).

Secondary treatment is a biological treatment process to remove dissolved matter from wastewater. Sewage micro-organisms are cultivated and added to the wastewater. The micro-organisms absorb organic matter from sewage as their food supply. Three approaches are used to accomplish secondary treatment, fixed film, suspended film and lagoon systems (Mancl, 1996).

Within the Kromdraai catchment area, the most commonly system present is the suspended film system, and will be discussed further.

Suspended film systems stir and suspend micro-organisms in wastewater. As the micro-organisms absorb organic matter and nutrients from the wastewater they grow in size and number. After the micro-organisms have been suspended in the wastewater for several hours, they are settled out as sludge. Some of the sludge is pumped back into the incoming wastewater to provide "seed" micro-organisms. The remainder is wasted and sent on to a sludge treatment process. Activated sludge, extended Aeration, oxidation ditch, and sequential batch reactor systems are all examples of suspended film systems (Mancl, 1996).

Final treatment focuses on the removal of disease-causing organisms where the final treated effluent is disinfected by adding chlorine or by using ultraviolet light. High levels of chlorine may be harmful to aquatic life in receiving streams. Treatment systems often add a chlorine-neutralising chemical to the treated wastewater before stream discharge (Mancl, 1996).

Advanced treatment is necessary in some treatment systems to remove nutrients from wastewater. Chemicals are sometimes added during the treatment process to help settle out or strip out phosphorus or nitrogen.

Primary sludges, which is the material that settles during the primary treatment process often have a strong odour and require treatment prior to disposal. Secondary sludges are the extra micro-organisms from the biological treatment process. The goals of sludge treatment are to stabilize the

sludge and reduce odours, remove some of the water and reduce volume, decompose some of the organic matter and reduce volume, kill disease causing organisms and disinfect the sludge (Mancl, 1996).

Aerobic and anaerobic digestion is used to decompose organic matter and to reduce volume. Digestion also stabilises the sludge and reduces odours. Caustic chemicals can be added to sludge or it may be heat treated to kill disease-causing organisms. Following treatment, liquid and cake sludges are usually spread on fields, returning organic matter and nutrients to the soil (Mancl, 1996).

In order to investigate the cumulative impacts within the Kromdraai Catchment area, the following methodology was used:

- Collation of information in order to obtain;
 - an understanding of the activities associated with the point source discharges;
 - the locality of the point source discharges; and
 - the quantities and qualities associated with the point source discharges.
- Site visits and discussions in order to;
 - clarify information obtained from permitting and licensing applications;
 - obtain additional monitoring data and water balance information; and
 - a holistic view of the catchment.
- Review of available information and gap analysis.
 - the information obtained was reviewed and gaps identified, additional information was sourced from the Department of Water Affairs and Forestry (DWAF) in an attempt to fill the gaps.
 - Remaining gaps were filled through personal communication with some of the point source dischargers.
- Cumulative impact assessment
 - the cumulative impacts were calculated according to Department of Water Affairs and Forestry, (1999:16):

$$\text{Total salt load in} = \text{Total salt load out}$$

$$\text{Total salt load in} = \text{salt load point sources} + \text{salt load diffuse sources}$$
 this calculation was compared to the DWAF gauging stations.
- Conclusion and recommendation.
 - Based on the results of the cumulative impact assessment, limitations of the investigation has been summarised and recommendations made directing possible future studies on cumulative assessments in a more accurate direction.

Note:

Would the reader kindly note that technical references quoted have been referenced within the text, but due to the complexity of the information collated, references pertaining additional sources both verbal and written have been listed in Part 12.

The Kromdraai catchment area is located within the Upper Vaal Water Management Area and includes the Upper and Lower Wonderfonteinspruit, the Mooi River and the Loopspruit. The catchment area stretches from Krugersdorp to the Vaal River and includes the towns of Westonaria, Carletonville, Fochville and Potchefstroom.

The West Witwatersrand Ridge, locally known as the Gatsrand intersects the area in an east-west direction and divides the Wonderfonteinspruit from the Loop/Leeuwspruit catchment area. The Gatsrand subdivides the area into tertiary drainage regions C23E and C23J. Regional surface water drainage is to the North and South of the Gatsrand watershed, both draining to the Mooi River, which passes through Potchefstroom to join the Vaal River (Goldfields Limited, 2005).

Various dams are situated within the catchment area, these include the Donaldson Dam, Klipdrift Dam, Boskop Dam, Klerkskraal Dam and the Potchefstroom Dam (DWAF, 1999a).

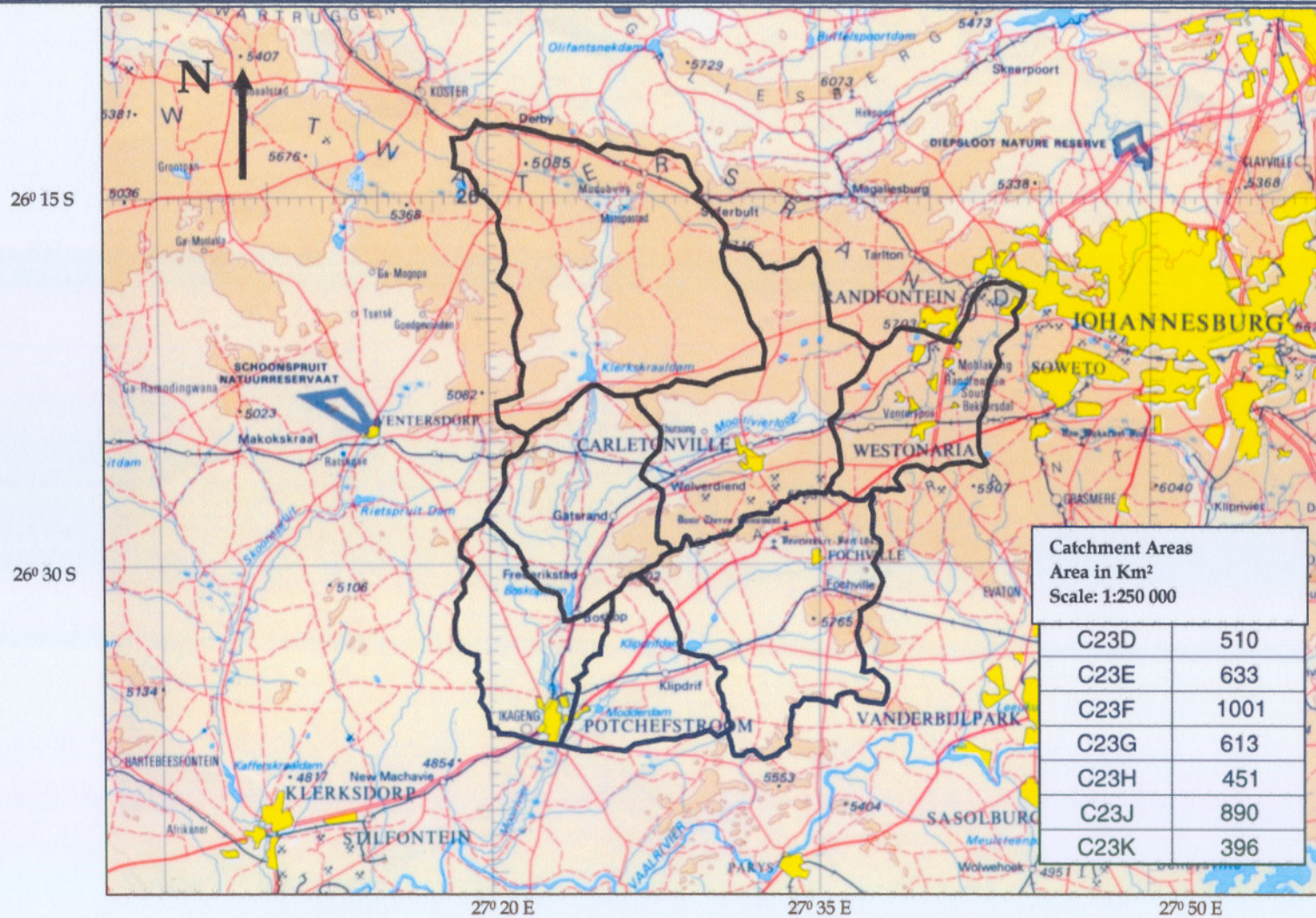
Large portions of the Wonderfonteinspruit catchment area are located on dolomitic formations and the dolomite aquifers are divided into a number of compartments by a series of impervious syenite dykes of Pilanesberg age. These dykes trend roughly north south and vary in width from 6 to 60m. Underground mining within the dolomitic compartments poses a risk to the environment e.g as mines become flooded, it results in dewatering of the mining areas, subsequent re-watering and flooding and associated water quality problems. Intensive dewatering activities accelerated the formation of sinkholes in the area (DWAF, 1999a).

In order to minimise the ingress of water into the dolomitic compartments through the recharge from surface water resources, a pipeline was constructed to convey water over the Gembokfontein, Venterspost, Bank and Oberholzer dolomitic compartments (Stoch, 2005).

This pipeline was constructed in the early 1970s by the Far West Rand Dolomitic Water Association and carries the water from the Wonderfonteinspruit from just below the Donaldson Dam in the vicinity of Bekkersdal to a point where it joins the West Driefontein Canal. The pipeline has a limited capacity of 135 Ml/day and consequently the control of discharges into the Upper Wonderfonteinspruit upstream from the pipeline, as well as directly into the pipeline is of major importance to the management of this part of the catchment (Stoch, 2005).

Refer to Figure 5.1 for the topographical map of the catchment area.

Figure 6.1 Catchment Boundaries (Enhance Group, 2005)



The following point source discharges were identified within the catchment area:

7.1.1 *Municipal and Mining Sewage purification works*

The following municipal sewage purification works discharge directly into the surface water resource:

Merafong City Local Municipality (Mans, 2005)

- Oberholzer Water Care Works;
- Khutsong Water Care Works;
- Wedela Water Care Works;
- Welverdiend Water Care Works;
- Fochville Water Care Works;

Mogale City Municipality (Mogale, 2005)

- Flip Human Water Care Works;
- Hannes van Niekerk Water Care Works;

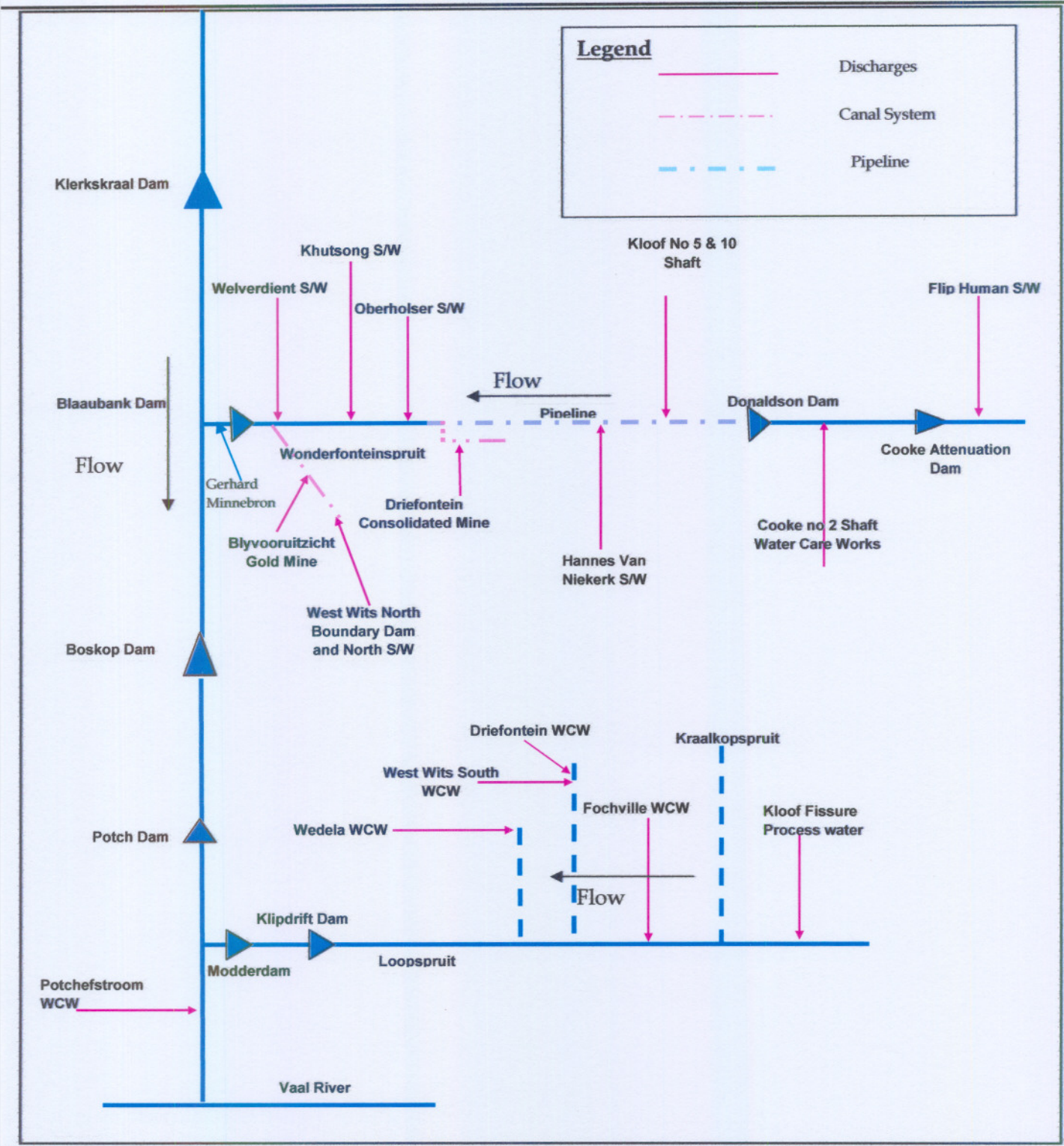
Potchefstroom City Municipality (Kleynhans, 2005)

- Potchefstroom Water Care Works

7.1.2 *Mining activities (Maree, 2005)*

- GoldFields Limited – Kloof Gold Mine, Driefontein Consolidated Mines.
- AngloGold Ashanti – West Wits
- Durban Roodepoort Deep - Blyvooruitzicht Gold Mine
- Harmony Gold Mine – Deelkraal and Elandsrand, Randfontein Estates

Figure 7.1 Locality of discharge points (Stoch, 2005)



8.1 MUNICIPAL WATER CARE WORKS

8.1.1 Hannes van Niekerk Water Care Works (Mogale City Municipality, 2005)

Source of water

The Hannes van Niekerk water care works is managed by the Municipality of Westonaria and purified sewage effluent is discharged into the 1 m pipeline.

Design Capacity

The works has a design capacity of 16 Ml per day. The municipality is currently in the process of expanding the capacity of the works to 25 Ml per day.

Reuse

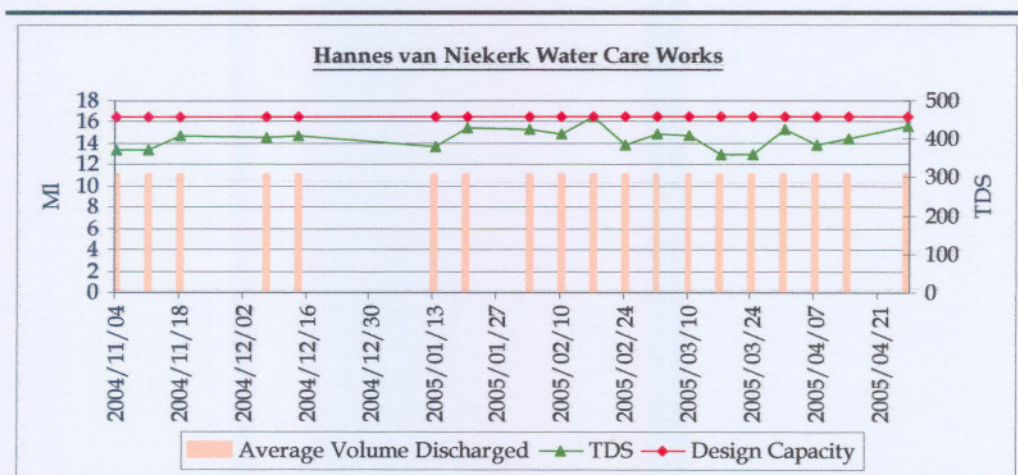
The current permit authorises the irrigation of 5 Ml per day of purified sewage effluent on a site adjacent to the water care works.

Discharge and quality

The water care works is permitted to discharge 16.5 Ml per day of purified sewage effluent into the pipeline to the Wonderfonteinspruit.

For the period November 2004 to April 2005 the Hannes van Niekerk water care works discharged on average between 9 to 11 Ml per day with an average TDS of 401 mg/l.

Figure 8.1 Discharge Quantity and Quality - Hannes van Niekerk Water Care Works



- Average Discharge Volume per day
- Average TDS in mg/l as measured for the specific date
- Refer to Annexure B for the data

8.1.2

Flip Human Water Care Works (Mogale City Municipality, 2005)

Source of water

Raw sewerage emanating from domestic sources within the Krugersdorp area flows to the Flip Human Water Care Works for treatment.

Design Capacity

The Flip Human Water Care Works has a design capacity of 50 *Ml* per day.

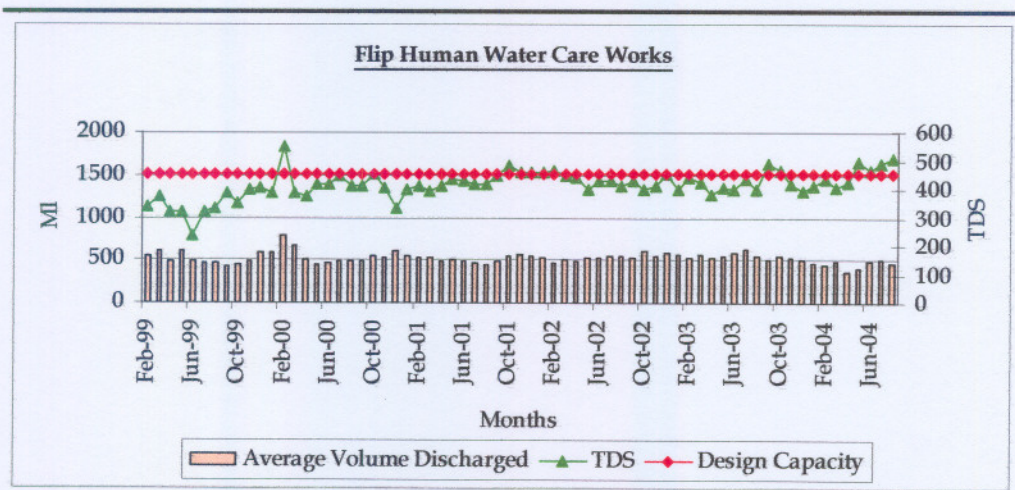
Reuse

Approximately 0.6 *Ml* per day of digested sludge and thickener water is disposed of for the irrigation of 64.5 ha of instant lawn.

Discharge and quality

The works discharge purified sewage effluent into the Wonderfonteinspruit prior to the 1-m pipeline. For the period February 1999 to August 2004 the Flip Human water care works discharged on average 14.84 *Ml* per day with an average TDS of 416 mg/l.

Figure 8.2 *Discharge Quantity and Quality - Flip Human Water Care Works*



- Average TDS in mg/l as calculated for the month.
- Refer to Annexure B for the data

8.1.3

Wedela Water Care Works (Mans, 2005)

Source of water

The works received domestic effluent from the Wedela residential area.

Design Capacity

The works has a design capacity of 3.03 *Ml* per day.

Reuse

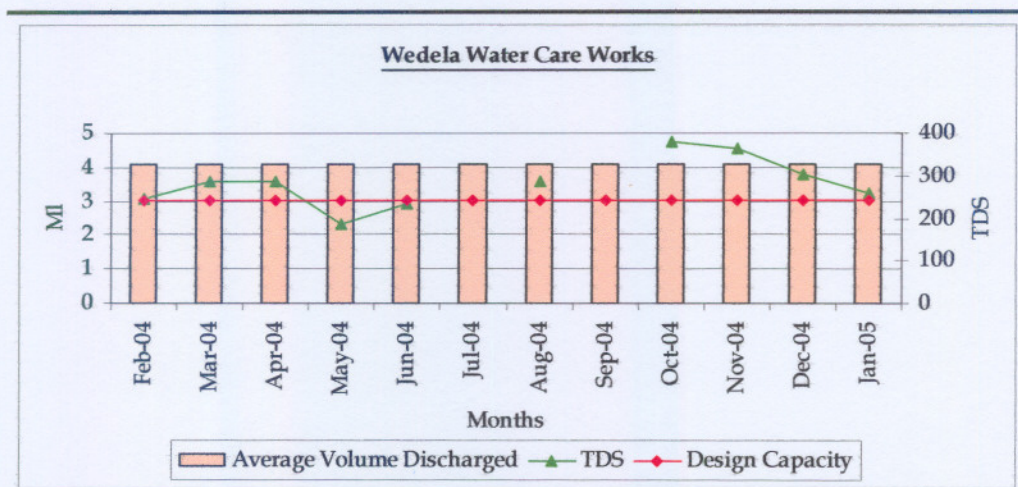
No reuse of purified sewage effluent takes place.

Discharge and quality

Inflow to the works varies from 1.81 to 6.332 *Ml* per day. As such, the works is currently operating above its design capacity resulting in a higher organic load, a direct contributing factor being the extension of Wedela Township. The water care works experiences frequent problems with electricity supply resulting in the discharge of raw sewage. Currently there is no qualified operator on site.

At present the purified sewage effluent is discharged towards the Loopspruit at an average volume of 4.1 *Ml* per day at an average TDS of 284 *mg/l*.

Figure 8.3 *Discharge Quantity and Quality – Wedela Water Care Works*



- The average volume discharged is indicated as a constant due to the fact that the works constantly exceeds its design capacity and inflows are not measured.
- Gaps in the data are also indicated in Figure 7.3.
- For the TDS concentrations in *mg/l* refer to Annexure B for the data.

8.1.4 *Fochville Water Care Works (Mans, 2005)*

Source of water

The Fochville Water Care Works is owned and operated by the Merafong City Local Municipality and serves the towns of Fochville (which has a positive growth rate (Mans, 2005)), Kokosi as well as Greenspark.

Design Capacity

The works has a design capacity of 4 *Ml/d*.

Reuse

No reuse of purified sewage effluent takes place.

Discharge and quality

The current inflow into the works (2005) is calculated to be between 4.5 and 6 MI/d resulting in the works being completely overloaded. Due to the overload, wet weather flow (storm events) floods the works completely.

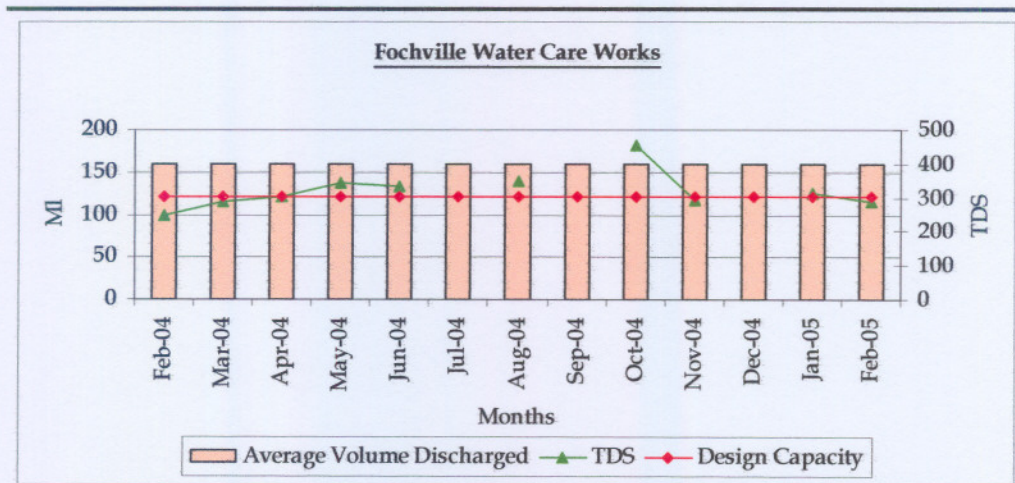
Currently the purified sewage effluent is discharged towards the Loopspruit at an average volume of 5 MI per day with an average TDS of 322 mg/l for the period February 2004 to February 2005.

Operational Problems

The system is designed as a combined biofilter and activated sludge system. A small portion of Kokosi is still on the bucket system. Buckets are emptied into the main feed line to the plant. Two stormwater dams have been constructed prior to the primary inlet works in order to cater for wet weather flow conditions. These dams then gravity feed into the main inlet works.

During the site visit (24 May 2005) the mechanical screens at the inlet works were broken and replaced by a manual screen system. The single primary settler showed operational problems – it is not cleaned on a regular basis. The purified effluent is discharged to a maturation pond which turns anaerobic on a frequent basis due to sludge that finds its way into the ponds. The four concreted drying beds are not enough to handle the sludge. Two more ground drying beds are present on site but they are wrongly designed in the sense that they are too deep and does not allow the sludge to dry.

Figure 8.4 Discharge Quantity and Quality – Fochville Water Care Works



- Based on the fact that the inflow into the works by far exceeds the design capacity, the average volume discharged is indicated as a constant within the graph (Full capacity for the months indicated).
- Gaps in data are also indicated in the graph above.
- Refer to Annexure B for the TDS in mg/l data used in the assessment.

8.1.5 Welverdiend Water Care Works (Mans, 2005)

Source of water

The Welverdiend Water Care Works _____serves the town Welverdiend.

Design Capacity

The works has a design capacity of 0.9 MI per day.

Reuse

No reuse of purified sewage effluent takes place.

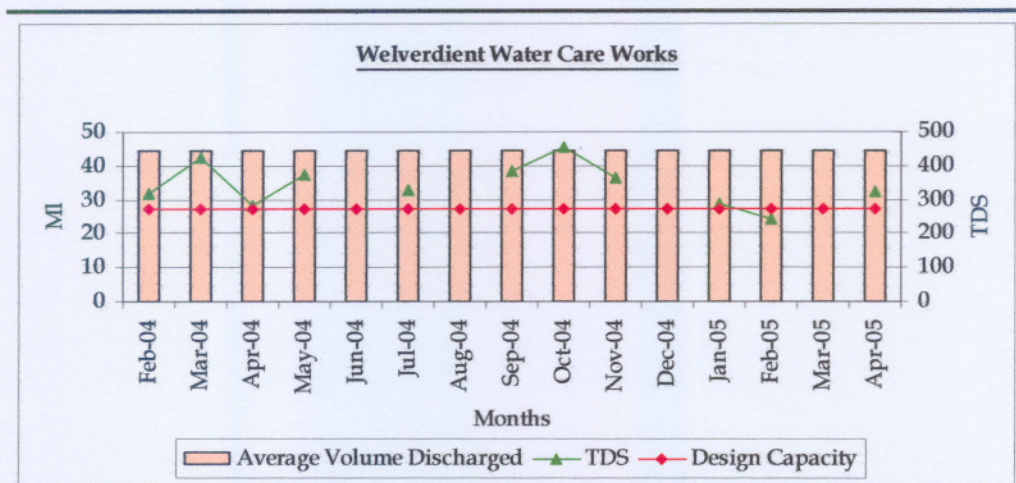
Discharge and quality

The works discharges on average 1.45 MI per day to the Wonderfonteinspruit with an average TDS of 344 mg/l for the period February 2004 to April 2005.

Operational Problems

During storm events, rainwater run-off from the area transports silt into the works. The ingress of this silt reduces the works capacity and removal thereof is difficult as the works cannot be shut down. Currently the works divert the inflow into the adjacent veldt area during storm events, thus allowing raw sewerage into the environment.

Figure 8.5 Discharge Quantity and Quality - Welverdiend Water Care Works



- Based on the fact that the inflow into the works exceeds the design capacity, the average volume discharged is indicated as a constant for each month. The actual flows are not measured.
- Gaps in the data reported are also indicated on the graph
- Refer to Annexure B for the TDS in mg/l data used in the assessment.

Source of water

The Khutsong Water Care Works serves the small town of Khutsong.

Design Capacity

The water care works is designed as a 4 *Ml* per day wastewater treatment plant.

Reuse

No purified sewage effluent is reused.

Discharge and quality

The purified sewage effluent is discharged into the Wonderfonteinspruit at an average quantity of 4 *Ml* per day with an average TDS of 322 mg/l.

Operational Problems

The works experiences problems with blockages at the inlet works and a finer screen is required to improve the quality of the water discharged.

During wet weather conditions, the works experiences a huge problem due to the ingress of mud into the works. Existing mud ingress has already impacted on the overall capacity of the works due to its accumulation at the bottom of the aeration chamber. In order to clean the chamber, the whole works will have to be stopped.

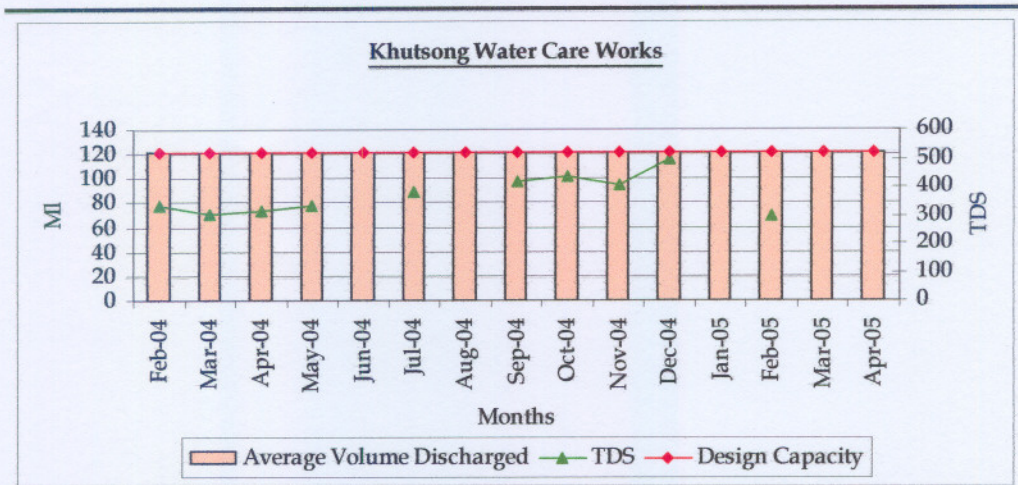
In order to prevent mud ingress into the works during wet weather conditions, the nearby township will require a significant improvement on storm water management and drainage which is not foreseen in the near future due to the capital expenditure required. The works does not have a balancing dam prior to inlet. During high rainfall events, the inlet works are blocked in order to protect the works against the mud ingress and the wet weather flow is discharged into the veldt next to the works as raw sewage.

During the site visit on the 24th May 2005, only three of the five aerators within the aeration chamber were operational.

The plant is overloaded as peak inflows exceed the design capacity.

The works experiences frequent problems with the growth of *Filamentis* bacteria.

Figure 8.6 Discharge Quantity and Quality - Khutsong Water Care Works



- The works operate at full design capacity and the actual average discharge volumes are not measured. For this reason the graph indicates the discharge volume at full design capacity.
- Gaps in the data is also included in Figure 7.6.
- Refer to Annexure B for the TDS in mg/l used in the assessment.

8.1.7 Oberholser Wastewater Treatment Works (Mans, 2005)

Source of water

The works serves the small town of Oberholser.

Design Capacity

The works has a design capacity of 4 MI per day.

Reuse

The Living Gold Rose Farm use 0.006 MI per day of the purified sewage effluent to irrigate roses.

Discharge and quality

Currently the purified sewage effluent is discharged towards the Wonderfonteinpruit at an average volume of 4MI per day at an average TDS of 311 mg/l for the period February 2004 to April 2005.

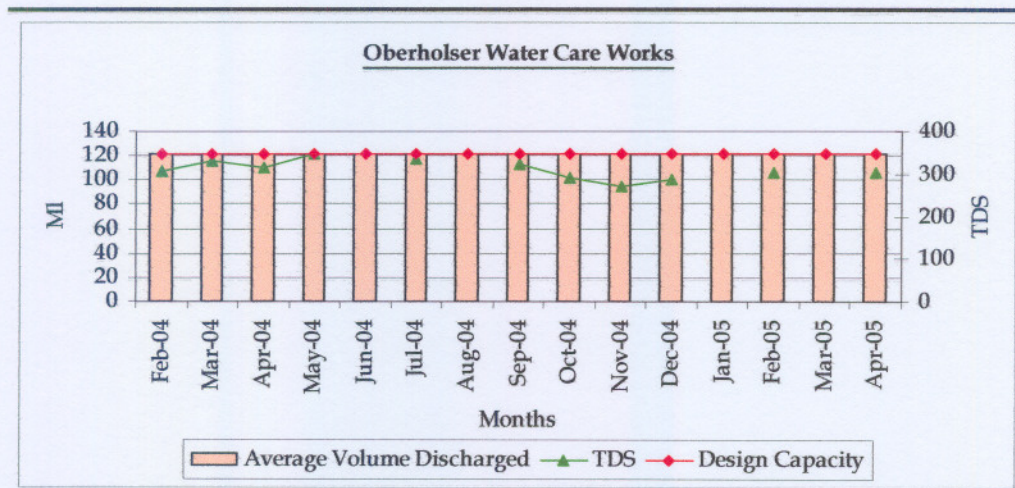
Operational Problems

During the site visit it was evident that wet weather flows flood the primary settler, indicating a problem with storm water ingress into the system.

Of the five biofilters, not all were functional.

Due to seismic events over the years, some of the filters have been ringed with steel rings where the concrete of the filter started to collapse.

Figure 8.7 Discharge Quantity and Quality - Oberholser Water Care Works



- The works is operated at full design capacity and discharge volumes are not measured. For the purpose of the assessment the discharge volume as at full operating capacity was used.
- Gaps in the data are also included as indicated in Figure 7.7.
- For the TDS in mg/l data used in the assessment, refer to Annexure B.

8.2 MINING

8.2.1 GoldFields Limited - Kloof Mine (Laas, 2005)

Source of water

- No 5 Shaft mine process water;
- No 10 Shaft mine process water;
- No 1 Shaft Water Care Works;
- No 4 Shaft Water Care Works;
- No 7 Shaft Water Care Works.

Design Capacity

- No 1 Shaft Water Care Works has a design capacity of 6.5 *Ml* per day;
- No 4 Shaft Water Care Works has a design capacity of 1 *Ml* per day;
- No 7 Shaft Water Care Works has a design capacity of 4 *Ml* per day;

Reuse

- An average of 4.7 *Ml* per day of purified sewage effluent from the No 4 Shaft Water Care Works is taken back to 1, 3, 4 and 7 Shafts for reuse.
- An average of 1.57 *Ml* per day of mine water from No 5 Shaft is used for irrigating the golf course.
- An average of 1 *Ml* per day of mine water from No 8 Shaft is used for irrigating the golf course and 9.7 *Ml* per day is reused as process water at No 1 Shaft.

Discharge and quality

- The No 4 Shaft Water Care Works discharges an average of 0.16 *Ml* per day of purified sewage effluent to the Leeuwspruit (part of the Rietspruit catchment area - excluded from the assessment) at an average TDS of 196 mg/l.
- The No 7 Shaft Water Care Works discharges an average of 1.8 *Ml* per day of purified sewage effluent to the Loopspruit at an average TDS of 257.23 mg/l.
- The No 5 Shaft discharges an average of 34 *Ml* per day of mine process water to the Wonderfonteinspruit at an average TDS of 564.34 mg/l.
- The No 10 Shaft discharges an average of 5 *Ml* per day of mine process water to the Wonderfonteinspruit at an average TDS of 1014.51 mg/l.
- The No 1 and 8 Shaft complex discharges approximately 4 to 5 *Ml* per day to the Loopspruit at an average TDS quality of 1000 mg/l.

Gap Analysis

The information obtained from the DWAF is contradicting in terms of water volumes and discharges, thus Kloof's water balance and supplementary information was utilised in compiling this section.

(Due to information limitations no graphical presentation could be prepared.)

8.2.2 Driefontein Mine (Ramsucht, 2005)

Source of water

- No 2, 4, 7 and 9 Shaft Water Care Works;
- Mine fissure and process water.

Design Capacity

- The No 2 sewage works has a design capacity of 4 *Ml* per day.
- The No 4 sewage works has a design capacity of 4 *Ml* per day.
- The No 7 shaft sewage works has a design capacity of 0.2 *Ml* per day.
- The No 9 sewage works has a design capacity of 0.2 *Ml* per day.

Reuse

- An average of 23 *Ml* per day of mine fissure and process water is treated and reused.

Discharge and quality

- A small fraction of the purified sewage effluent emanating from No 9 Shaft Water Care Works discharges an average of 0.1 *Ml* per day to the Loopspruit at an average TDS of 583.65 mg/l.

- A blend of fissure, mine and purified sewage effluent from the No 2, 4 and 7 Shaft areas discharges at an average of 31 Ml per day to the Wonderfonteinspuit at an average TDS of 646 mg/l.

8.3 *ANGLOGOLD ASHANTI - WEST WITS MINE (ANGLOGOLD, 2005)*

8.3.1 *North Water Care Works (Anglogold, 2005)*

During the period 1998 to 2000, the purified sewage effluent from the North Water Care Works was gravity fed to the Nursery Dam (mine process water dam) where it was blended with the process water for reuse (irrigation, residential urinals, mining process and metallurgical processes).

The mine investigated the minimization and reuse options of water through quantification of the water and salt balances on the mine. This led to the identification of the following problems:

- the salinity of the effluent leaving the North Care Works showed increased levels of salinity due to the reuse of process water at the urinals;
- the irrigation of the soils within the residential area altered the soil salinity.

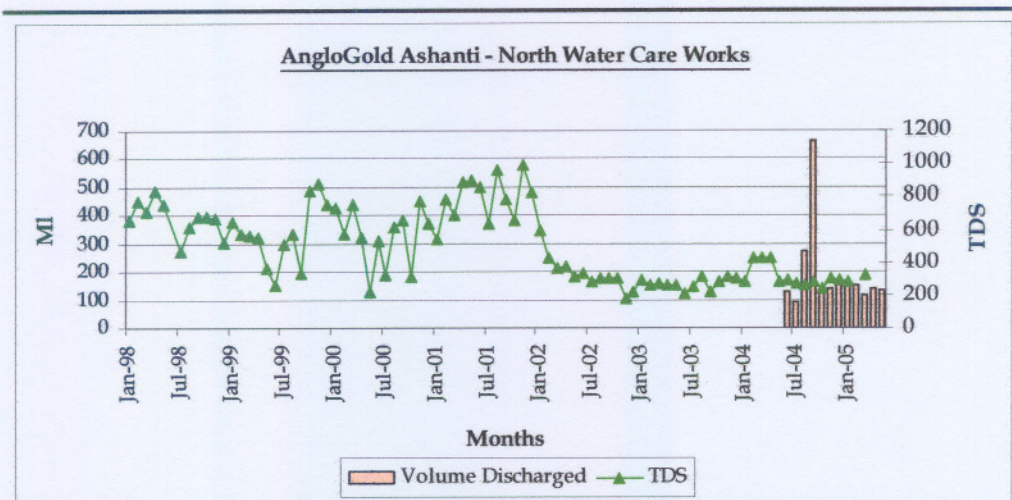
The following management actions were taken in order to improve water management on the mine:

- during 2000 and 2001 West Wits obtained permission to discharge purified sewage effluent into the Wonderfonteinspuit via the Blyvooruitzicht canal system, and
- the process water was replaced, during 2002, with purified sewage effluent at the residences, property gardens and golf course.

The average consumptions were as follows:

- During 1998, 203 590 m³ per month were discharged to the Nursery Dams for reuse (calculated);
- From June 2004 to January 2005 a volume of 147 915 m³ per month were discharged to the Wonderfonteinspuit and 81 764 m³ per month were reused via the Brick Reservoir (measured).
- Total volume = 229 679 m³ per month.

Figure 8.8 Discharge Quantity and Quality - North Water Care Works (Anglogold, 2005)



- It should be noted that although the TDS concentrations are indicated in Figure 7.8, the discharge to the Wonderfonteinspruit only commenced in June 2004 when the re-use of water on the mine was re-evaluated.
- Refer to Annexure B for the TDS and discharged volumes used in the assessment.

8.3.2 Mponeng Water Care Works (Anglogold, 2005)

From 1998 to 2004 purified sewage effluent was pumped from the Mponeng Water Care Works to the Lower Holding Dam where it blended with process water and was pumped onto the Square Reservoir for reuse in the residential urinals, mining process and metallurgical process.

One of the problems identified was that the purified sewage effluent from the water care works reported to the Lower Holding Dam where it blended with process water and overflowed to the Elandsfonteinspruit.

The mine implemented the following management options:

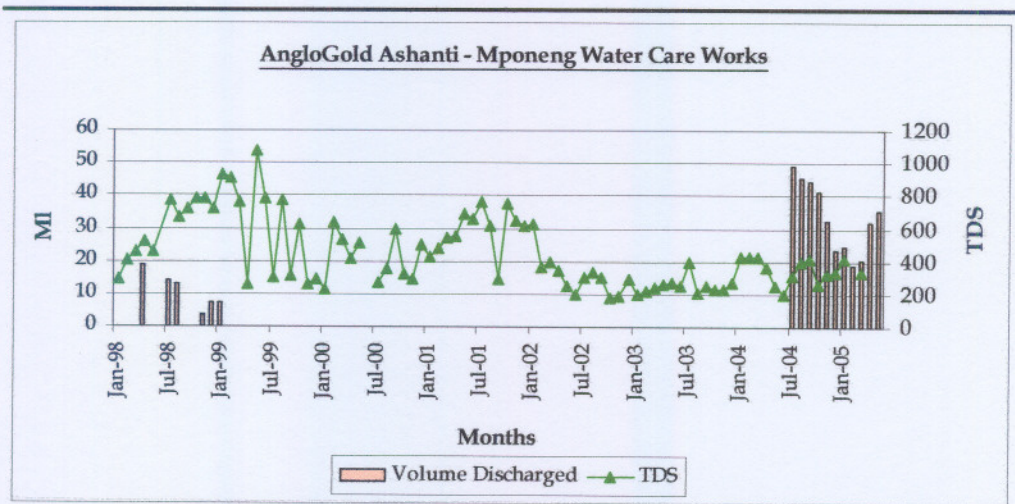
- A level controller and an automatic valve has been installed on the purified sewage line so that purified sewage effluent can maintain the Lower Holding Dam at 80% capacity and discharge excess purified sewage effluent directly to the Elandsfonteinspruit.
- With improved water management infrastructure and subsequent action, Mponeng Gold Plant has prevented the Anti Pollution Dams from discharging to the Elandsfonteinspruit. During 2004 the Plant lined the Anti Pollution Dams and installed a flume to measure any discharge that will now report to the Upper Holding Dam.
- Through the Environmental Water Management Reviews and the Contaminated and Uncontaminated Drainage Analysis, Mponeng Mine has managed to:
 - Separate clean and dirty water systems;
 - Prevent clean water from being contaminated;
 - Prevent environmental pollution due to releases to the environment.

Mponeng Mine has installed measuring devices and measures the water leaving the area via the trenches.

The average consumption is as follows:

- During 1998, the volume of 76 634 m³ per month were discharged to the Lower Holding Dam for reuse and 5 341 m³ per month overflowed to the Elandsfonteinspruit.
- During June 2004 to January 2005, 32 460 m³ per month (estimated) were discharged to the Lower Holding Dam for reuse and 32 460 m³ per month (estimated) to the Elandsfonteinspruit.

Figure 8.9 *Discharge Quantity and Quality - Mponeng Water Care Works (Anglogold, 2005)*



- It should be noted that although the TDS concentrations are indicated in Figure 7.9, the discharge to the Wonderfonteinspruit only commenced in June 2004 when the re-use of water on the mine was re-evaluated.
- Refer to Annexure B for the TDS and discharged volumes used in the assessment.

8.3.3 North Boundary Dam (Anglogold, 2005)

Source of water

The North Boundary Dam receives water from the Savuka Gold Plant in the event of an uncontrolled discharge from the Plant internal anti-pollution control dams. The same applies for the North Old Tailings Storage Facility, Nursery Dams, Three Domain Emergency Dam, Ntshonalanga Residence wash-down water and surface runoff from the area.

Reuse

- Water is pumped back to the Nursery Dams for reuse within the industrial processes.

Discharge Quantity and Quality

In the case of an overflow, the water from the North Boundary Dam discharges to the Wonderfonteinspruit via the Blyvooruitzicht canal system.

- In 1998 a volume of 8 353 m³ per month were discharged into the Wonderfonteinsprui.
- During June 2004 to January 2005, 68 793 m³ per month were discharged into the Wonderfonteinspruit.

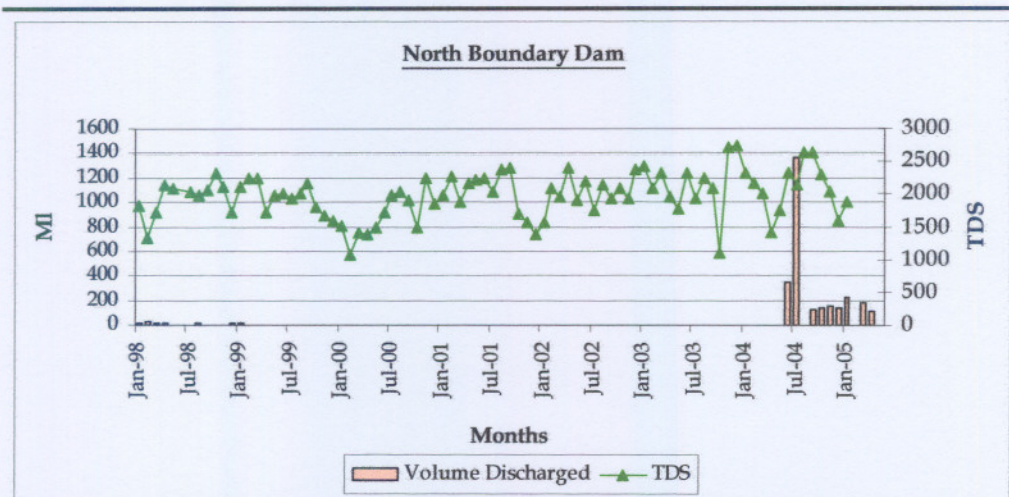
The following problems were identified:

- The North Boundary Dam could not contain the rain water runoff from the area.
- Contamination from mine process water was entering the North Boundary Dam.
- Reduction in the capacity of the Nursery Dams.

The following management actions have been taken:

- Savuka Gold Plant
With improved water management infrastructure and philosophy Savuka Gold Plant has prevented the Anti Pollution Dams from discharging to the North Boundary Dam.
- Nursery Dams
The silt deposited in the Nursery Dams was removed in 2003 and 2004 as part of a maintenance programme to recover storage capacity.

Figure 8.10 Discharge Quantity and Quality - North Boundary Dam (Anglogold, 2005)



- It should be noted that although the TDS concentrations are indicated in Figure 7.8, the discharge to the Wonderfonteinspruit only commenced in June 2004 when the re-use of water on the mine was re-evaluated.
- Refer to Annexure B for the TDS and discharged volumes used in the assessment.

Sources of water (Esterhuisen, 2005)

- No 4 Shaft fissure and mine process water;
- No 6 Shaft fissure and mine process water;
- No 2 Shaft Water Care Works;
- No 5 Shaft Water Care Works

Reuse

- An average of 0.3 Ml per day of purified sewage effluent from No 6 Shaft Water Care Works is used to irrigate the slimes dams.
- An average of 4.3 Ml per day of fissure and process water from No 4 and 6 Shaft is used for irrigation.

Design Capacity

- The No 2 Water Care Works is designed for approximately 4 Ml per day.
- The No 5 Water Care Works is designed for approximately 2.5 Ml per day.

Quantity and quality (Van der Merwe, 2005)

- The No 2 Shaft Water Care Works discharges an average of 5.576 Ml per day of purified sewage effluent to the Wonderfonteinspruit at an average TDS of 447.17 mg/l.
- The No 5 Shaft Water Care Works discharges an average of 1.12 Ml per day of purified sewage effluent via the Doorndraai/Blaauwbank Dam to the Wonderfonteinspruit at an average TDS of 623.92 mg/l.
- The No 4 and 6 Shaft discharges an average of 5.7 Ml per day of fissure and process water into the Wonderfonteinspruit at an average TDS of 1027 mg/l.

Gap Analysis

The information obtained from the DWAF is contradicting in terms of water volumes and discharges, thus Blyvooruitzicht's water balance and supplementary information was utilised in compiling this section.

Figure 8.11 Discharge Quality - No 2 Shaft Water Care Works

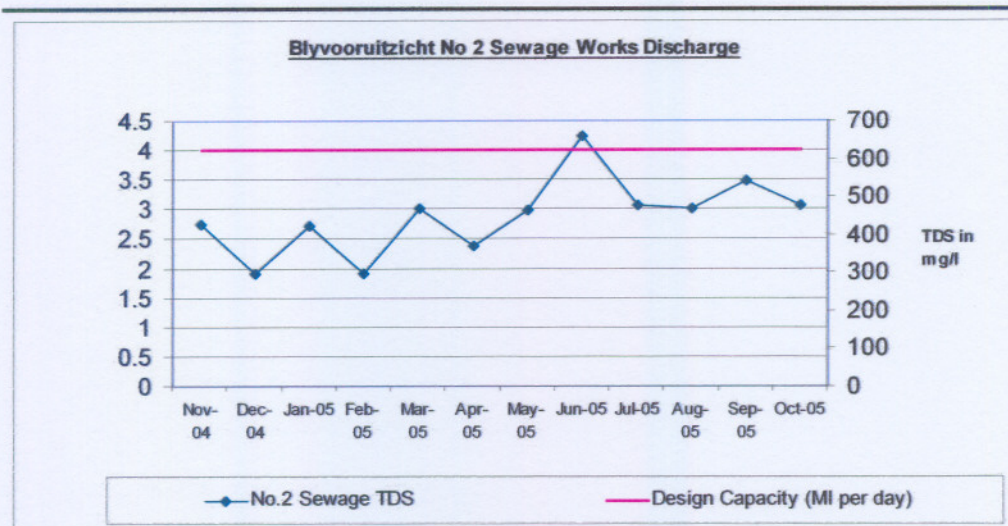


Figure 8.12 Discharge Quality - No 5 Shaft Water Care Works

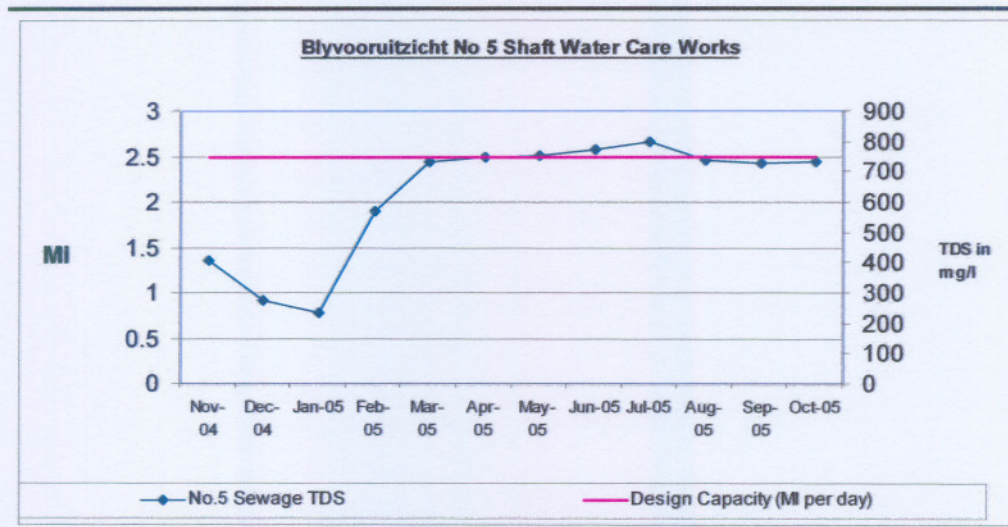
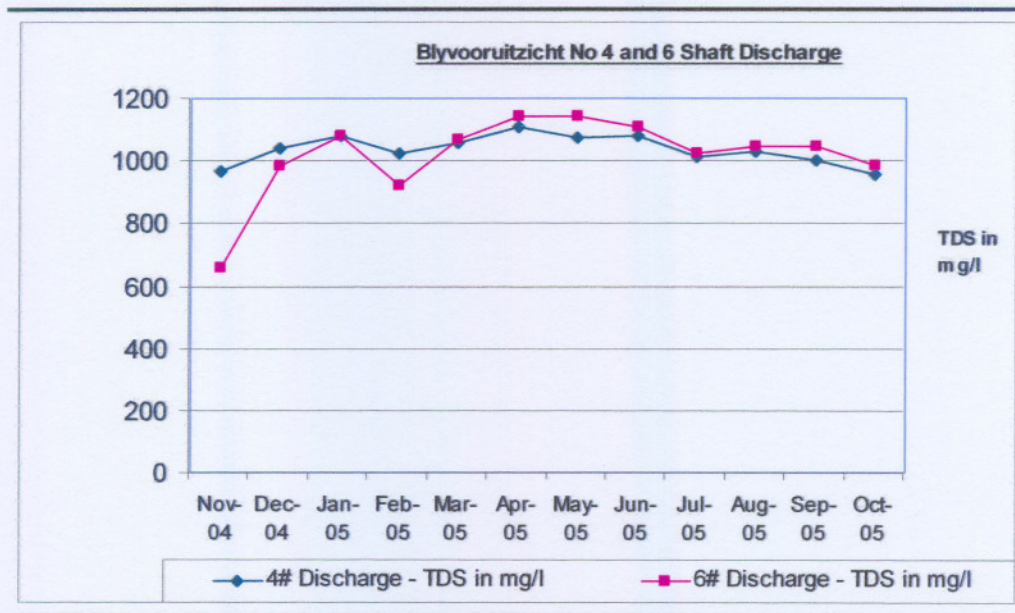


Figure 8.13 Discharge Quality - No 4 and 6 Shaft



8.5 HARMONY GOLD MINE (HARMONY, 2005)

8.5.1 Randfontein Estates Limited

Sources of water

- Cooke 2 Water Care Works.

Design Capacity

- The works has a design capacity of approximately 3 Ml per day.

Reuse

- 0.06 Ml per day of purified sewage effluent from Cooke 2 Water Care Works is reused for the irrigation of non-edible crops.

Discharge Quantity and Quality (Maree, 2005)

- Cooke 2 Water Care Works discharges an average of 2.94 Ml per day of purified sewage effluent into the Wonderfonteinspruit at an average TDS of 428.8 mg/l.

The salt loads contributed by each point source were calculated by a mathematical equation, (DWAF, 1999:16).

$$\begin{aligned} \text{Salt load (kg/day)} &= \text{Flow (m}^3/\text{day)} \times \text{Salt Concentration (kg/m}^3) \\ &= \text{Flow (m}^3/\text{day)} \times 0.001 \times \text{Salt Concentration (mg/l)} \end{aligned}$$

From the volumes being discharged from each point source and the average concentration of salts measured as TDS, the overall salt load was calculated for both the Wonderfontein spruit and the Loopspruit, a) firstly individually and b) later combined for an overall view.

In order to determine the salt loads within the Wonderfontein spruit prior to any discharge, the flow data from DWAF Gauging station C2H023 were used. Salt load were calculated based on the average flow as measured during the period 1992 to 1996.

Table 9.1 Cumulative Impacts – Wonderfontein spruit (Input A)

TOTAL DISCHARGE ON THE WONDERFONTEINSPRUIT (A)	TDS (mg/l)	Average Volume Discharged (Ml/day)	Salt Load (kg/day)
Upstream	479.67	32.4	15541.3
Flip Human Water Care Works	416	14.84	6173.44
Cooke No 2 Shaft Water Care Works	429	2.94	1261.26
Sub-total 1		17.78	7434.70
Kloof No 5 Shaft	564.34	34.00	19187.56
Kloof No 10 Shaft	1014.51	5.00	5072.55
Sub-total 2		56.78	31694.81
Hannes van Niekerk Water Care Works	402	11	4422.00
Sub-total 3		67.78	36116.81
Driefontein PSE, fissure and process water	646	31	20026.00
Sub-total 4		98.78	56142.81
Oberholser Water Care Works	311	4.00	1244.00
Sub-total 5		102.78	57386.81
Khutsong Water Care Works	322	4.00	1288.00
Sub-total 6		106.78	58674.81
Welverdiend Water Care Works	344	1.45	498.80
Sub-total 7		108.23	59173.61
Anglogold Ashanti - North Boundary Dam	1980	4.48	8870.40
Anglogold Ashanti - North Water Care Works	496	7.11	3526.56
Sub-total 8		119.82	71570.57
Blyvooruitzicht - No 2 Shaft Water Care Works	447.17	5.567	2489.40
Blyvooruitzicht - No 5 Shaft Water Care Works	623.92	1.12	698.79
Blyvooruitzicht - No 4 and 6 Shaft discharge	1027.00	5.7	5853.90
Sub-total 9		132.21	80612.66
Gauging Station - Blaawbank Dam (2005) - Excluding impact from retainment facilities such as the Donaldson Dam and inflow from the Gerhard Minnebron and Turffontein Eyes	737	17.1	12602.70

Based on Table 9.1, it can be calculated that for the Wonderfonteinspruit:

$$\text{Salt Load In (Upstream from Point Source Discharges)} + \text{Salt Load (Discharges)} = \text{Salt Load Out} + \text{Losses}$$

$$(15\,541.3) + (80\,612.66) = (12\,602.70) + (\text{Losses})$$

Losses = Unknown Inflows, contributions from dolomitic eyes such as Gerhardminnebron, vegetation uptakes

$$\text{Losses} = 83\,551.26 \text{ kg/day}$$

Input A

According to the Guideline: Quality of Domestic Water Supplies (1998:59), TDS loads up to a maximum load of 450 mg/l complies with the norm for drinking; food preparation; bathing and laundry standards. Although the average TDS load as calculated at Blaawbank Dam exceeds the acceptable norm of 450 mg/l, no significant impact as determined by the Guideline is recognisable in all the categories of use i.e. drinking; food preparation; bathing and laundry at this point. This does not exclude the fact that some of the point source discharges have significant high TDS loads which may impact negatively on the four categories of use as described, if utilised at the point of discharge.

Figure 9.1 Cumulative Impacts - Wonderfonteinspruit

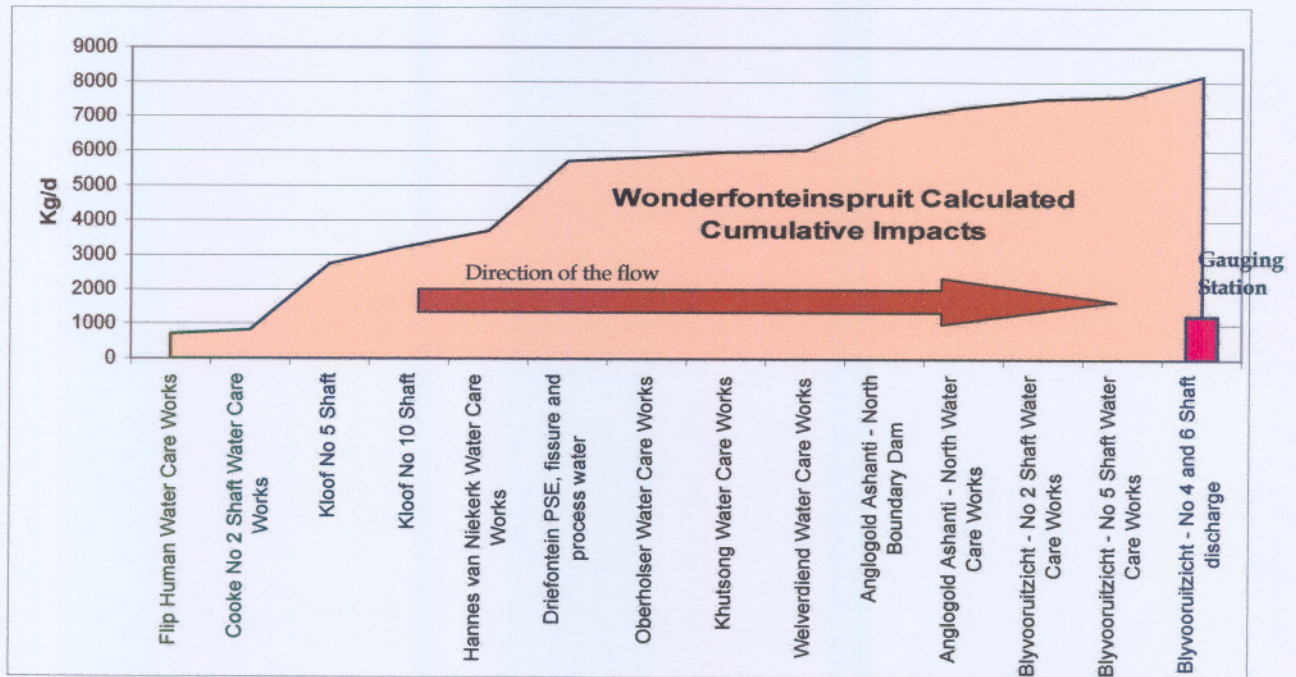


Table 9.2 Cumulative Impacts - Loopspruit (Input B)

TOTAL DISCHARGE ON THE LOOPSPRUIT (B)	TDS (mg/l)	Average Volume Discharged (Ml/day)	Salt Load (kg/day)
Kloof Mine - No 1 and 8 Shaft	1000	5.00	5000.00
Kloof Mine - No 7 Shaft Water Care Works	257.23	1.80	463.01
<i>Sub-total 1</i>		<i>6.80</i>	<i>5463.01</i>
Fochville Water Care Works	322	5.25	1690.50
<i>Sub-total 2</i>		<i>12.05</i>	<i>7153.51</i>
Anglogold Ashanti - Mponeng Water Care Works	445	0.55	7418.15
<i>Sub-total 3</i>		<i>12.60</i>	<i>14571.66</i>
Driefontein PSE No 9 Shaft Water Care Works	583.65	0.10	58.37
<i>Sub-total 4</i>		<i>12.70</i>	<i>14630.03</i>
Wedela Water Care Works	284	4.10	1164.40
<i>Sub-total 5</i>		<i>16.80</i>	<i>15794.43</i>
Gauging Station - Klipdrift Dam (2005)		No available data	0.00

Salt Load In (Upstream from Point source discharges) + Salt load (Discharges) = Salt Load Out + Losses (Flow created by discharges) + (15794.43) = (No Data) + (Losses)

For the purpose of the assessment, the total salt load from the discharges were used as the input for the Mooi River system (Input B)

As with the Wonderfonteinspruit, Figure 9.2 clearly indicates that the salt load (kg per day) load is once again in an upward/increase trend towards downstream water users. The marked increase in the salt load at the AngloGold point of discharge is not due to a high TDS load but rather due to large volumes of water discharged along with a moderate TDS load which add significantly to the total Kg per day ratio.

Figure 9.2 Cumulative Impacts - Loopspruit

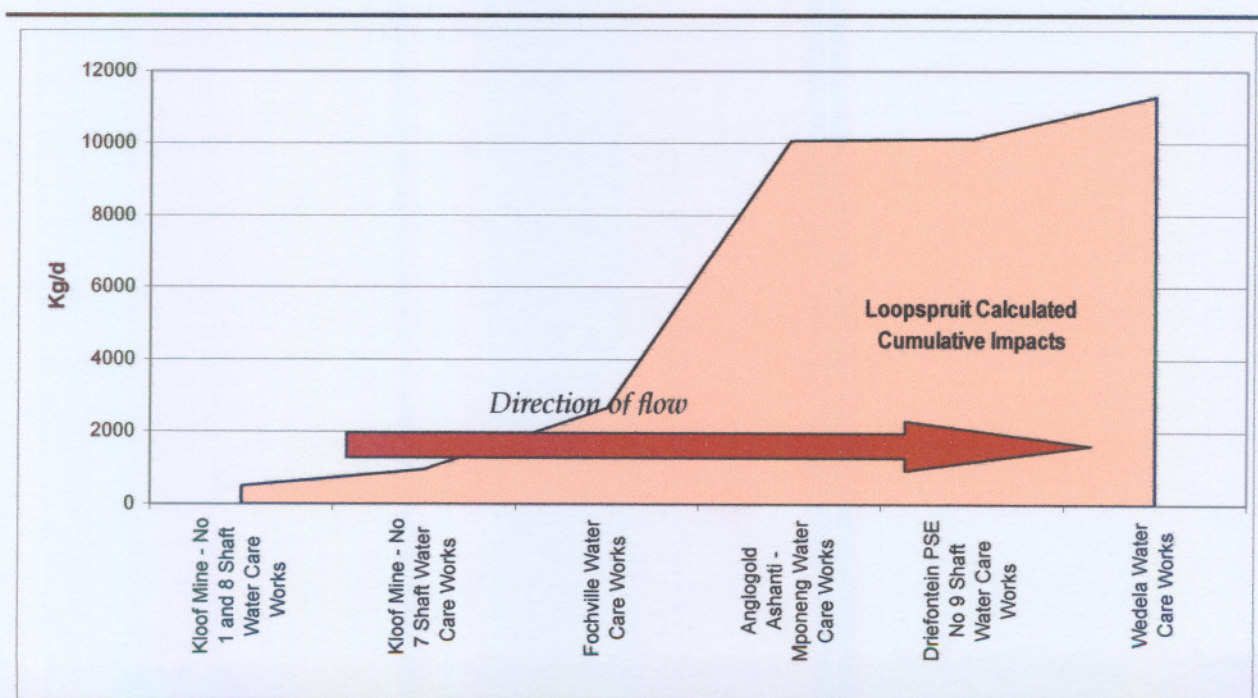


Table 9.3 Cumulative Impacts - Kromdraai

TOTAL DISCHARGE ON THE MOOI RIVER (KLERKSRAAL DAM TO VAAL RIVER) (C)	TDS (mg/l)	Average Volume Discharged (Ml/day)	Salt Load (kg/day)
Klerkskraal (C2H006) Gauging Station (Salt Load In)	220	33.70	7414.00
Wonderfontein confluence (Input A)	737.00	17.10	12602.70
<i>Sub-total 1</i>		<i>50.80</i>	<i>20016.70</i>
Loopspruit confluence (Input B)	402.95	16.8	15794.43
<i>Sub-total 2</i>		<i>67.60</i>	<i>35811.13</i>
Potchefstroom Water Care Works	636	20	12720.00
<i>Sub-total 3</i>		<i>87.60</i>	<i>48531.13</i>
Kromdraai Gauging Station (C2H085)	500	165.4	82700.00

Based on Table 9.3, it can be calculated that for the Mooi River up to the confluence with the Vaal River:

$$\begin{aligned} \text{Salt Load In (Upstream from Point Source Discharges)} + \text{Salt Load (Discharges)} &= \text{Salt Load Out} + \text{Losses} \\ (7414.003) + (41\ 117.13) &= (82\ 700.00) + (\text{Losses}) \\ \text{Losses} &= \text{Unknown Inflows, contributions from dolomitic eyes, vegetation uptakes} \\ \text{Losses} &= 34\ 168.87 \text{ kg/day} \end{aligned}$$

Notwithstanding the above, the average TDS load as defined by the Guideline document is categorised as marginal impact on water for drinking and food preparation.

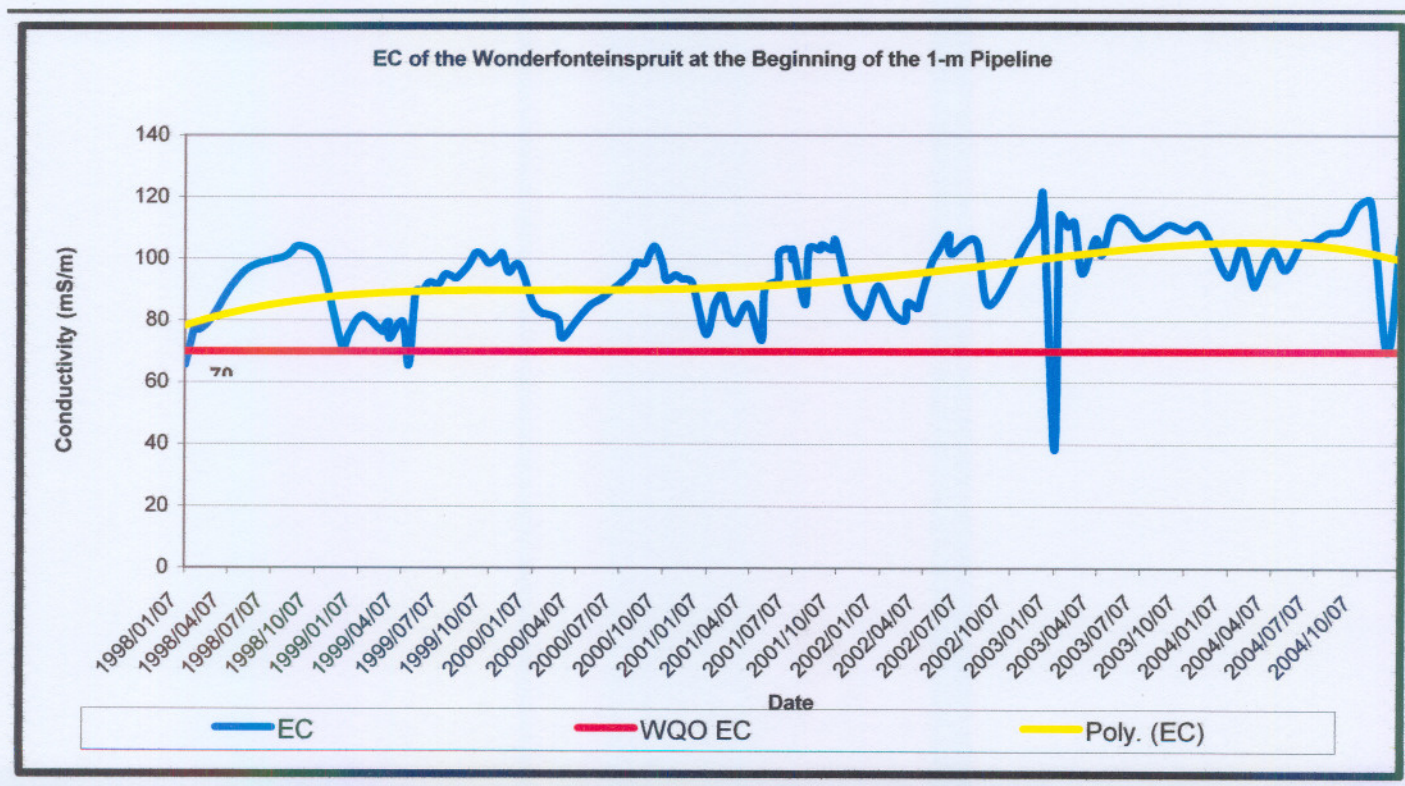
Water quality data from the DWAF database were assessed for the period 1998 to 2005 for stations where data are available for the period in order to determine the qualities of water within the river system over a period of time.

Wonderfonteinspruit at the beginning of the 1m Pipeline. (Anglogold, 2005)

The 1-m pipeline begins just below the Donaldson Dam where the overflow of the Donaldson Dam is channelled into a 1-m diameter pipeline. A controlled overflow (16.4 ML/day) from Donaldson Dam feeds the 700 mm Venterspost pipe which has a maximum capacity of 71 ML/day. The overflow canal also receives water directly from Bekkersdal in the form of stormwater. The Flip Human Water Care Works discharges into the Upper Wonderfonteinspruit upstream of the pipeline. The Hannes van Niekerk sewage works discharges into the 1 metre pipeline. The Libanon Gold Mine discharges water from the dewatering process into the pipeline.

The Electrical Conductivity (EC) measured since 1998 to 2004 is indicated in the graph below. The water quality objective for EC is indicated by the solid red line and the yellow line indicates the polynomial trend of the time period. The average EC value for the measured time period is around 93mS/m (TDS of 623 mg/l).

Figure 10.1 EC of the Wonderfonteinspruit at the beginning of the 1-m pipeline

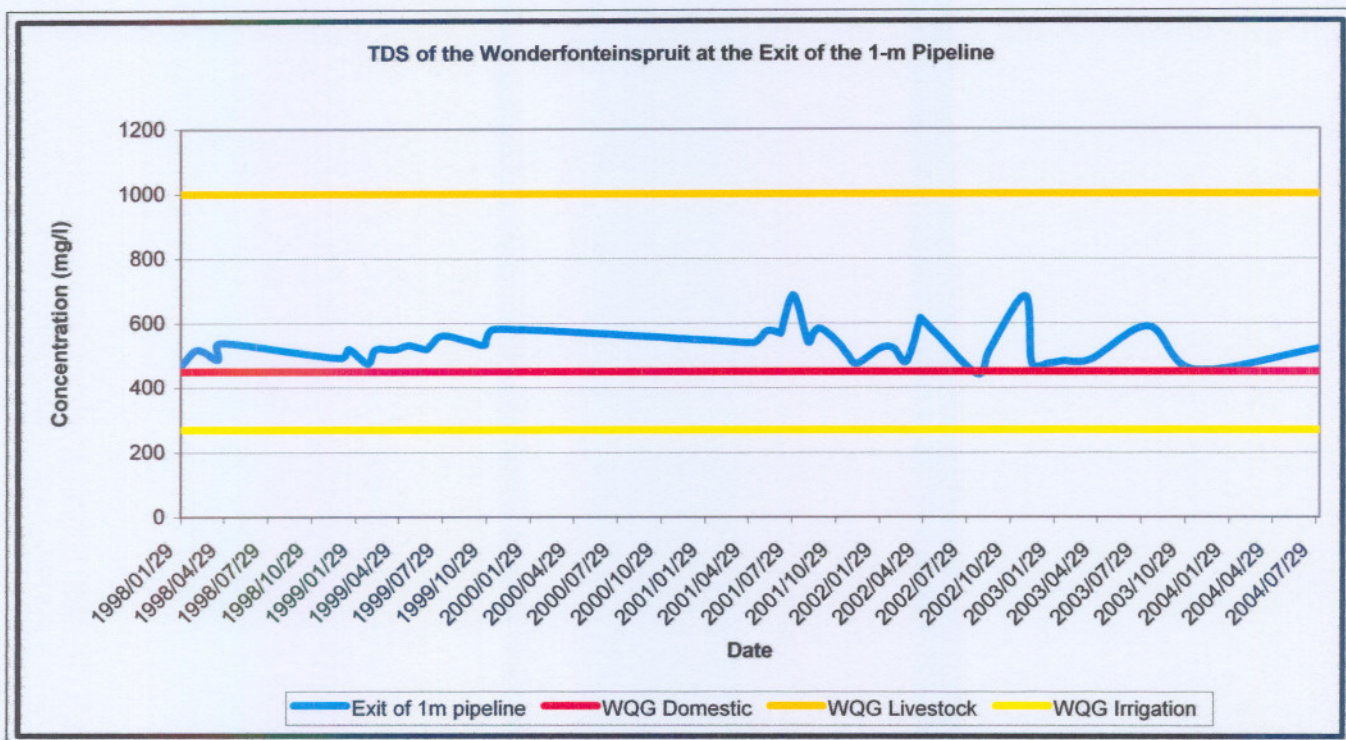


Wonderfonteinspruit at the exit of the 1-m pipeline (Anglogold, 2005)

The Wonderfonteinspruit leaves the 1-m pipeline near Carletonville approximately 21 km downstream of the Donaldson Dam. The Hannes van Niekerk Water Care Works, Driefontein Consolidated Mines as well as Venterspost Gold Mine (part of Kloof Gold Mine) discharge into the 1-m pipeline.

The graph below indicates the water quality in terms of EC at this point. The water quality objective is indicated in a solid red line and the polynomial trend is indicated with a yellow line. The average EC concentration is around 80mS/m at the exit of the 1-m pipeline.

Figure 10.2 TDS of the Wonderfonteinspruit at the exit of the 1-m pipeline



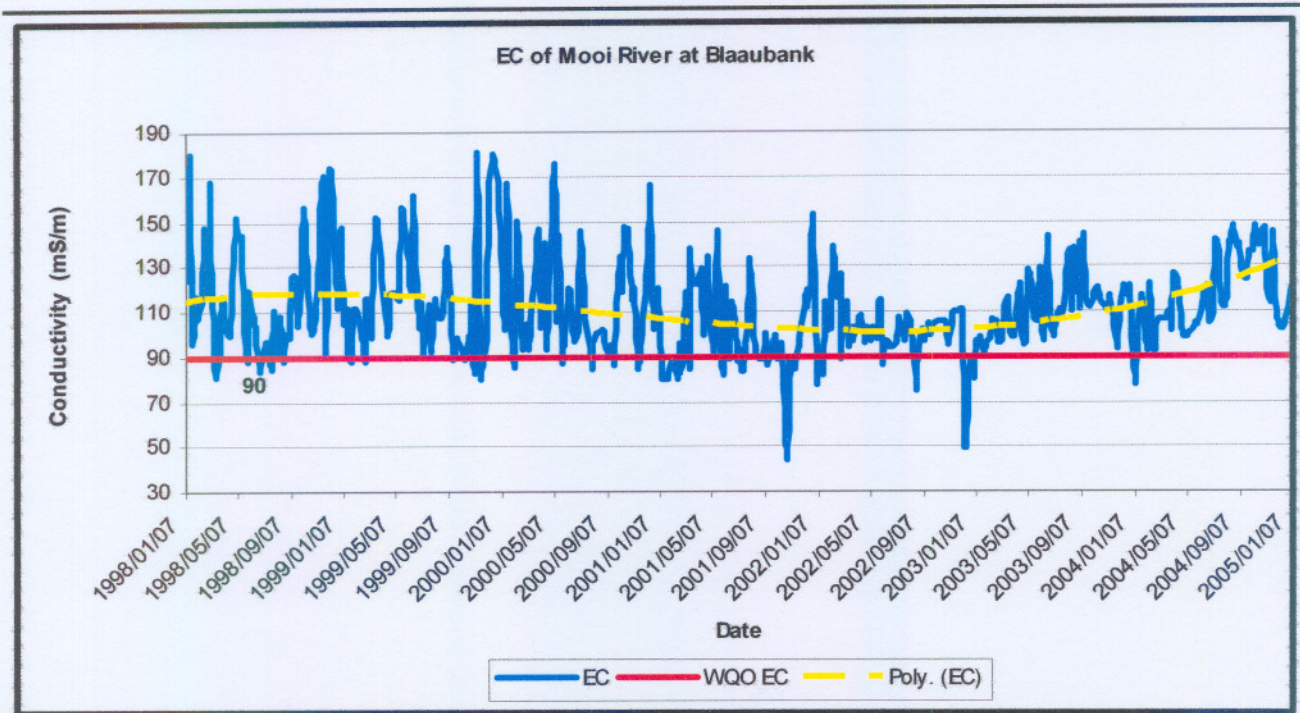
Mooi River at Blaaubank (Anglogold, 2005)

The monitoring point of the Mooi River at Blaaubank is of strategic importance as it is the first point downstream of the majority of the dischargers in the Kromdraai catchment. The Doornfontein canal, as well as the Oberholzer and Welverdiend sewage purification works, discharges into the Mooi River just upstream of the monitoring point at Blaaubank. At this point there is a Department of Water Affairs and Forestry continuous monitoring station (C2H069) that measures flow, electrical conductivity and temperature.

The electrical conductivity (EC) since 1999 to 2004 is displayed as a blue line and the yellow line displays the polynomial trend. The average EC

value for this time period is around 110mS/m and is nearly 20% higher than at the exit of the 1m pipeline.

Figure 10.3 TDS of the Mooi River at Blaaubank

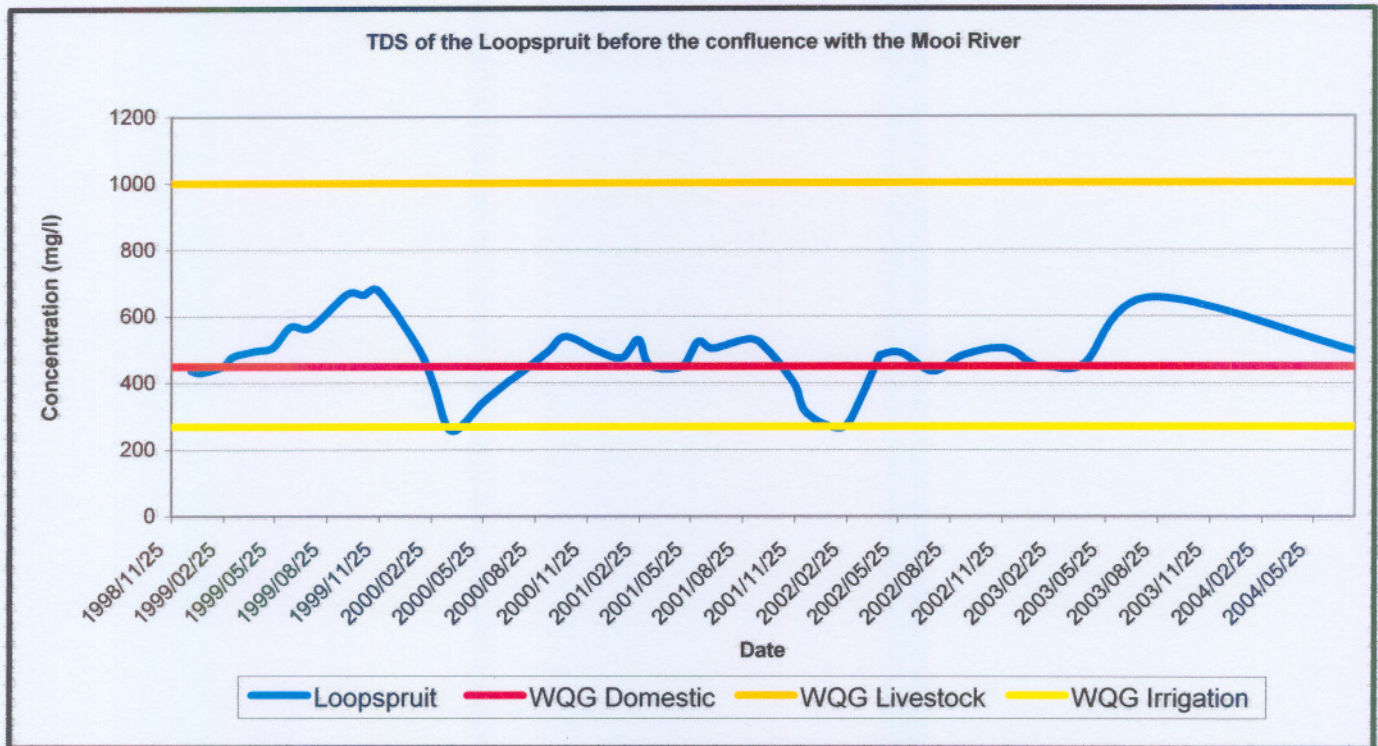


Loopspruit before the confluence with the Mooi River

The lowest monitoring point in the Loopspruit is just before the confluence with the Mooi River. This point will give a good indication of the impact on the water quality in the Loopspruit as the Fochville Sewage Works and Kloof Gold Mine's mixture of process water and final sewage effluent are discharged into the Loopspruit. AngloGold Ashanti's Mponeng Water Care Works discharge via the Elandsfonteinspruit into the Loopspruit.

The electrical conductivity (EC) of the Loopspruit before the confluence with the Mooi River is indicated in the graph below for the period 1998 to 2004. The graph indicates a great variance which could be contributed to different discharge patterns of the mine and sewage works. The yellow line indicates the polynomial trend. The average EC is around 500 mS/m.

Figure 10.4 TDS of the Loopspruit before the confluence with the Mooi River

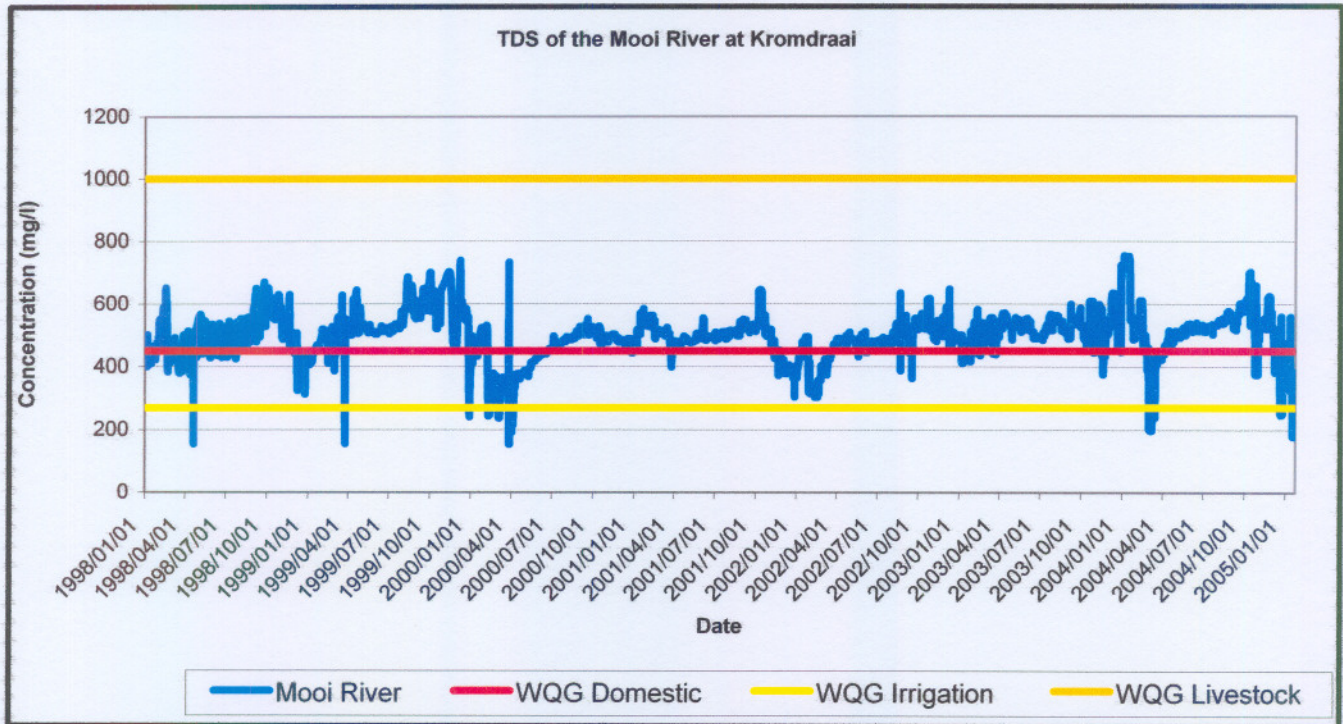


Mooi River at Kromdraai (Anglogold, 2005)

This monitoring point is one of the strategic important points in the whole Kromdraai catchment as it is the lowest point in the Mooi River just before the confluence with the Vaal River. The Department of Water Affairs and Forestry has a monitoring station at this point that measured electrical conductivity (EC), flow and Total Dissolved Solids (TDS) on a continuous basis. Pollution loads from the Kromdraai catchment to the Vaal River System can be calculated at this point with the available data.

The TDS value of the Mooi River at Kromdraai from 1998 to 2005 is indicated in the graph below with the solid red line indicating the water quality objective.

Figure 10.5 TDS of the Mooi River at Kromdraai



The average TDS value is well within the water quality guidelines for domestic use and irrigation.

In order to come to an informed conclusion, the following should be brought into the equation:

11.1 **INFORMATION UNACCOUNTED FOR**

The following aspects are not accounted for in the cumulative impact assessment:

- The dilution of the impact from point source discharges through storm water and rainfall events;
- The abstraction of water from the system for use;
- The sweetening effect of the discharged spring water that emanates from Van Eeden spring at West Wits mine on the Wonderfonteinspruit;
- Diffuse sources of pollution from land use activities (agriculture, mining waste disposal).
- The dolomitic eyes such as the Turffontein Eye and Gerhardminnebron Eye have an impact in terms of the water quality found in the system.
- Losses of water to the dolomitic compartments;
- Vegetation uptake;
- The mining process is dynamic and mines make daily changes to the water and salt balances. These are difficult to account for.
- Some of the mining houses are taking a large initiative with regards to the separation of clean and dirty water in order to release only clean water to the environment. The effect of this initiative is not evident in this assessment as the historical data is not included.

11.2 **ASPECTS OF IMPACT**

Aspects that have an impact on the cumulative impact assessment include:

- Monitoring data
 - Analytical data compared from the different dischargers are not analysed with the same methods at the same laboratory;
 - Some analysis are undertaken internally and it is not sure whether approved analytical methods are used;
 - Sampling methodologies may differ - this specifically refers the method used in taking the sample.
 - Grab sampling does not form a representative sample for field situation. Reporting in this fashion, has limited advantage and allows little or no interpretation of the functioning of the works on a continuous basis.
 - Flow is not measured at all the water care works, thus the total load contribution from the works cannot be calculated accurately.
- Equipment
 - Sampling equipment and flow measuring equipment may

- become faulty and are not frequently calibrated;
- Only the larger municipal water care works were found to have flow measuring equipment.
- Some of the municipal water care works are under capacitated.

11.3 *MANAGEMENT MEASURES*

In order to properly quantify and manage the impacts associated with cumulative impacts, the following management measures require consideration:

- Quantification of the impact associated with diffuse sources within the catchment area - these include tailings dams, waste rock dumps and irrigation practices;
- Standardisation of sampling methods and analytical procedures is required.
- The Kromdraai Catchment Area is unique with regards to the geological compartmentalisation, and the impacts of dewatering and re-water should be considered taking into account the changes within the catchment area and the discharges.
- In order to manage and quantify the cumulative impacts, monitoring should be undertaken more frequently and synchronised.

11.4 *ASSESSMENT OF THE KROMDRAAI CATCHMENT AREA*

From the above it is clear that to take an informed bearing on the Kromdraai Catchment area is no easy task.

Numerous tables of information seem to be incorrect or may even be adjusted as discharge versus TDS in some cases does not correlate. Further investigation may provide concrete evidence of additional discharge points not being monitored and thus not being brought into the equation.

The standard of DWAF monitoring equipment and regular calibration thereof is questionable and thus information received is incomplete and does not give a proper overview of the area. In some cases measuring and data capturing has been discontinued leaving a void in the information field.

It was further found that individual mines and municipalities do not follow a set monitoring programme i.e. set dates, times or even the method of assessment. Therefore the information flow is scattered and in most cases should not be compared with one another due to the lack of consistency.

Notwithstanding the above, and with reference to Tables 9.1, 9.2 and 9.3 it is clear that the average TDS discharged per volume is in excess of the acceptable drinking water standard and as such it is clear that point source discharges contribute in an accumulative context negatively to the overall fitness for use of the surface water resource.

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ANNEXURE A

PHOTOGRAPHS

Flip Human Water Care Works

Figure .1 *Flip Human Inlet Works*



Figure 2 *Flip Human Grit Removal*



Figure 3 Primary Settlers



Figure 4 Aerator Chambers and Digesters

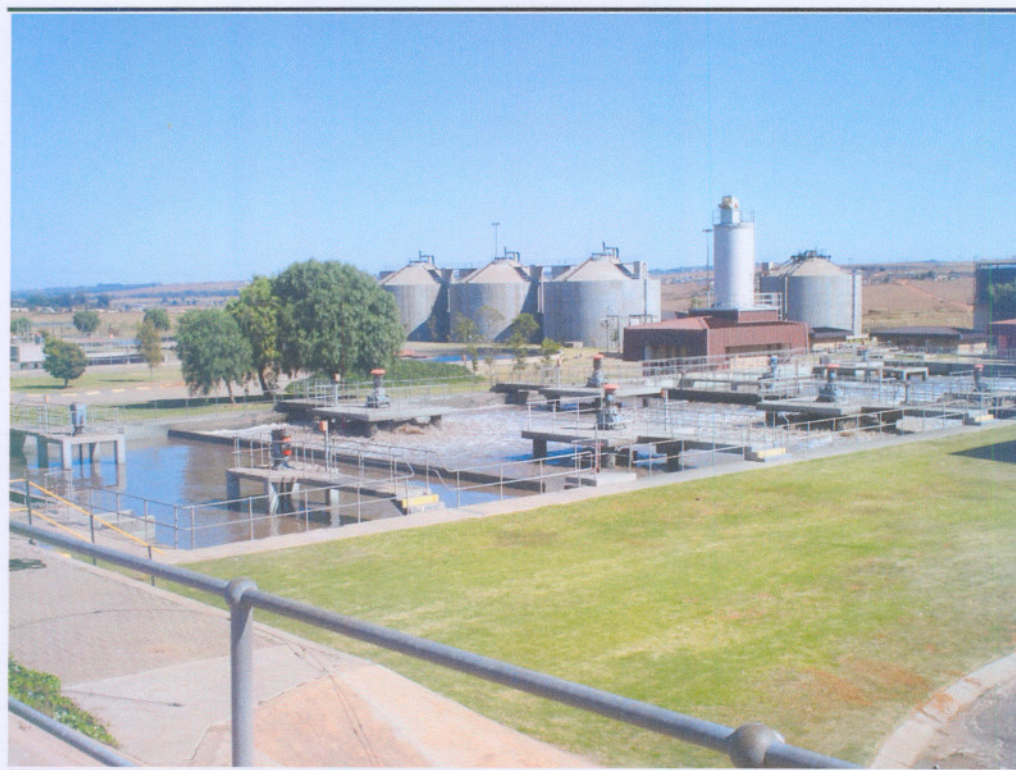


Figure 5

Final Clarifier



Wedela Water Care Works

Figure 6 *Wedela Works*



Figure 7 *Wedela Inlet Works*



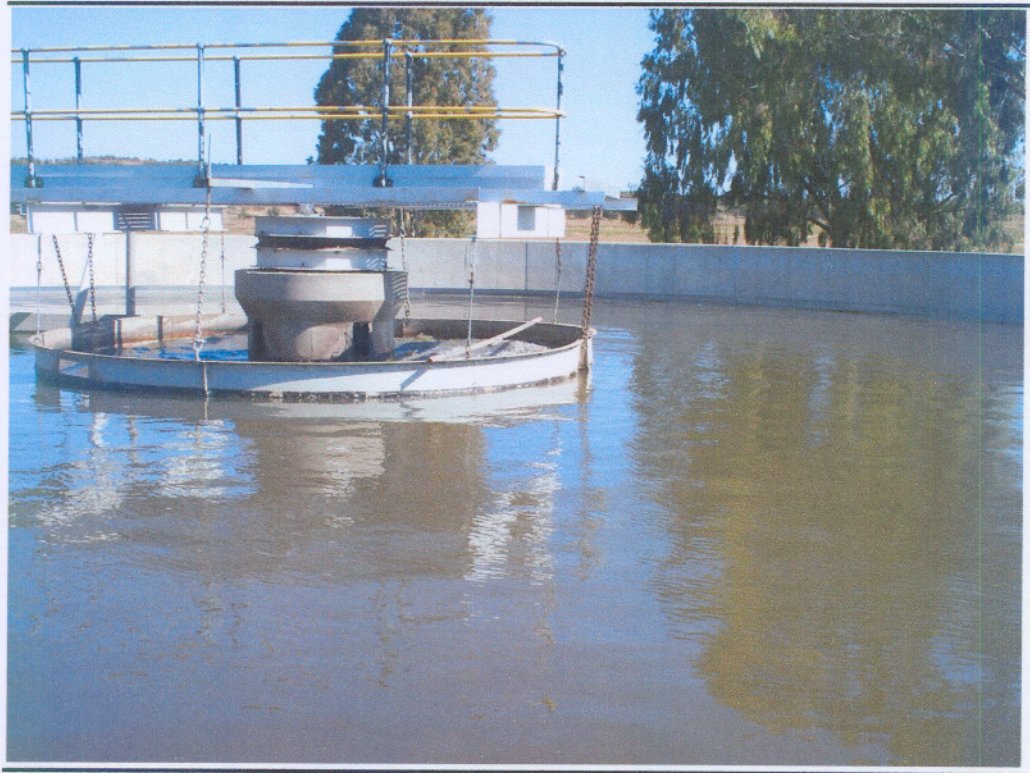
Figure 8 *Balancing Tank*



Figure 9 *Wedela Aeration Chamber*



Figure 10 *Wedela Secondary Settler*



Fochville Water Care Works

Figure 11 Fochville Grit Removal Channel and Aeration Chamber



Figure 12 Fochville Primary Settler (front) and storm water balancing dams(back)



Figure 13 Fochville Biofilters and Digester

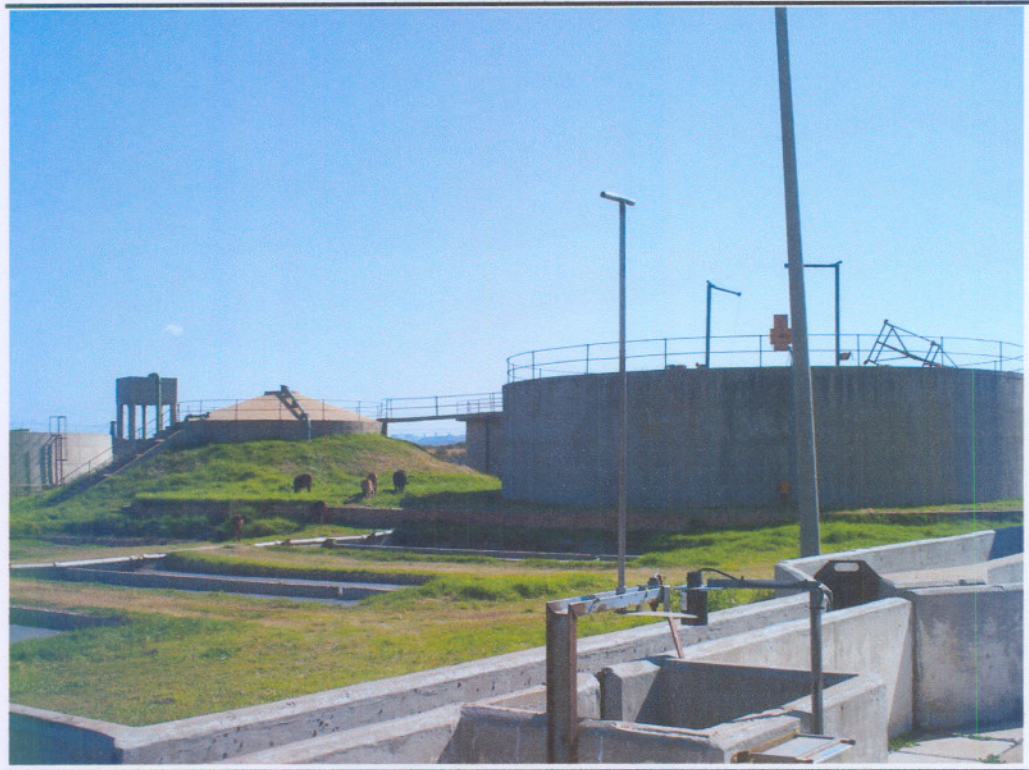


Figure 14 Fochville Works Sludge Drying Beds



Wolverdiend Water Care Works

Figure 15

Weloverdiend - Inlet Works



Figure 16 *Welverdiend - Secondary Treatment Zone*



Figure 17 *Welverdiend - Settlement Chamber*



Figure 18

Welverdiend Chlorination Channel and Discharge Point



Khutsong Water Care Works

Figure 19 *Khutsong - Grit Removal*



Figure 20 *Khutsong Aeration Chamber*

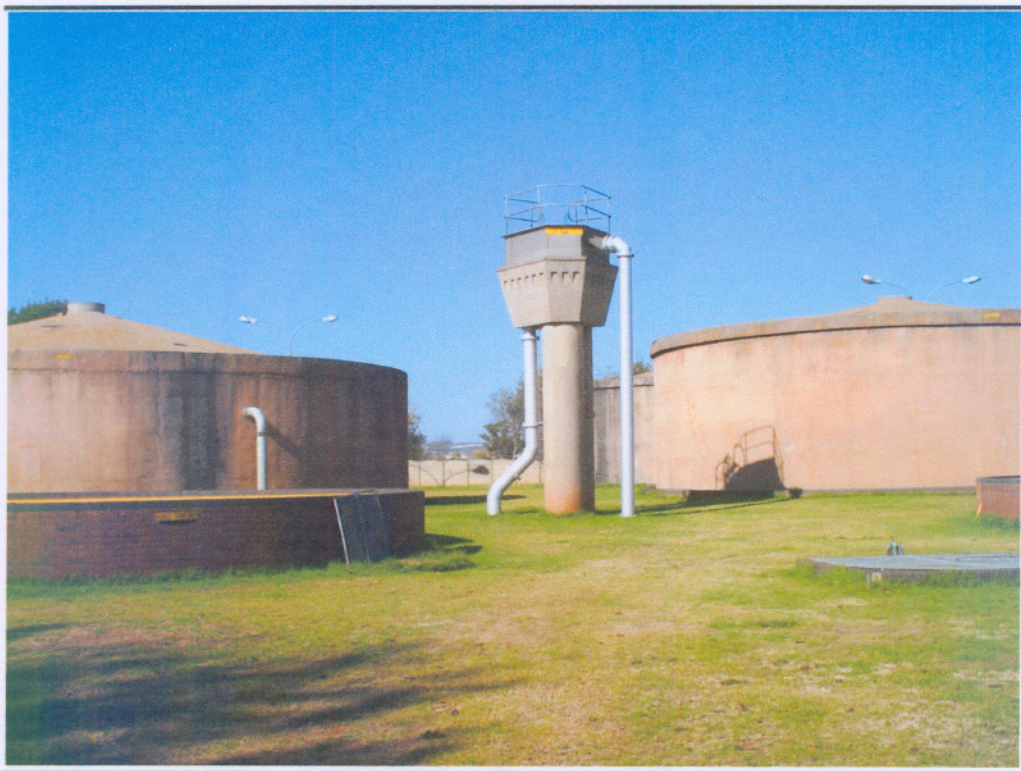


Oberholser Water Care Works

Figure 21 Oberholser Water Care Works Primary Settler



Figure 22 Oberholser - Biofilter System



ANNEXURE B
DWAF Gauging Stations
Flow and Quality Data

Site C2H025 Wonderfontein-@Spruit 7 @ Gemsbokfontein
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours

Year 1994
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	27526	27460	33001	16415	14574	15885	24346	19794	12326	4473	36021	9226	1
2	20151	25684	30434	16252	17318	15134	21508	19124	11815	5272	30135	7049	2
3	14539	40793	33746	16723	16020	19036	19890	17528	10257	4504	33719	6244	3
4	14751	54856	39397	15852	14525	21620	21036	17292	9006	7342	46594	4927	4
5	16166	55635	36215	13491	13377	20843	21956	18544	10070	11150	35588	3672	5
6	15046	55532	31428	11870	13374	20102	20633	18670	10631	9686	36034	21437	6
7	13069	48031	29123	13692	13522	18448	21956	17960	7519	10437	33513	33593	7
8	10120	41142	27032	15546	13516	17439	21860	18160	9941	11174	24099	16071	8
9	8849	41817	27516	17929	13246	18865	21927	17445	6947	9080	22883	28877	9
10	6648	42217	22475	20565	12877	19455	21617	16497	9246	8203	22527	30638	10
11	11030	42193	20158	21352	11215	18840	20456	14920	10171	8879	22243	23125	11
12	11892	40762	18093	20145	10883	20743	19461	15481	11318	789.7	19266	23178	12
13	13227	54905	17377	18284	10114	21394	19689	17142	10999	1092	30584	18969	13
14	12982	46525	22960	17498	10139	20165	20089	10396	8490	15654	19450	13956	14
15	10413	46647	22115	16479	10270	18615	19917	13449	8998	18184	15589	12197	15
16	19169	51256	18995	15700	12670	18633	19291	12557	8259	16672	15395	19322	16
17	32347	56602	18046	14342	13926	19665	20562	12596	8018	16106	12400	25421	17
18	30944	48925	17290	13730	14983	18668	19892	13896	5092	8494	8173	21354	18
19	13055	45578	18780	14928	14789	18606	16764	13711	6482	4518	12078	14708	19
20	19492	46022	18681	19733	14077	17658	15619	11173	6565	6256	29406	6935	20
21	21460	53113	18058	18575	14015	17046	14522	12137	6904	157.8	51201	5395	21
22	23869	46203	18976	9495	14439	17787	15274	11636	6514	572.9	47719	2945	22
23	33770	54301	18443	12366	14706	13358	16425	9509	5550	650.5	44195	4179	23
24	42704	57831	16648	13633	14951	14964	18767	9732	4907	422.3	35614	6737	24
25	48887	52205	22627	16367	15465	15268	19823	11094	7291	166.8	32375	1820	25
26	41066	37630	18563	17038	16381	15899	19915	12746	6857	1614	27982	9011	26
27	42572	36693	18174	17947	16483	18414	19975	13210	8834	612.7	[JM41307		27
28	55812	33845	17634	18521	15528	14305	18862	13470	5242	2444	[JM30651		28
29	51445		15386	19127	14887	24919	18091	14253	6271	34078	[JM27044		29
30	30371		17845	19196	16315	28218	19610	12646	1991	26877	[JM29710		30
31	27847		16449		16878		19785	12032		34159		35344	31
Mean	23910	45872	22634	16426	14047	18666	19662	14478	8084	9023	28646	17259	
Median	19492	46364	18976	16447	14439	18624	19892	13711	8139	7342	29771	16071	
Maximum	55812	57832	39398	21353	17318	28218	24347	19795	12327	34160	51202	41307	
Minimum	6648	25684	15386	9495	10114	13358	14522	9509	1991	157.8	8173	1820	
Total	741234	1284417	701684	492808	435477	560006	609533	448819	242525	279733	744798	535057	
Missing Days	0	0	0	0	0	0	0	0	0	4	0	0	

Summaries

Notes

All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 19601 M ... Missing Data
 Ann. Median 17318
 Annual Total 7076089
 Missing Days 4

Maximum Minimum
 Daily 57831 157.8

Site C2H025 Wonderfontein-@Spruit 7 @ Gemsbokfontein Year 1995
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	38230	20068	30005	58003	36746	22251	21545	20640	14156	21070	21542	24200	1
2	30553	14667	26130	50861	41429	22552	22216	20801	16245	3711	21001	19636	2
3	25322	12161	18215	48912	37848	22041	22098	20137	17142	2880	23818	20419	3
4	19309	10409	17715	45982	36827	22222	22126	19346	17236	2349	23392	19308	4
5	16185	10196	17376	42835	35227	22723	20810	20180	17221	7583	20656	27745	5
6	13080	8606	16123	39993	35402	21403	22719	15404	17379	3658	18065	47275	6
7	10416	6532	15441	36663	44708	22235	23847	15959	16933	6454	15700	34738	7
8	14113	6794	14566	33764	37755	22210	25307	12898	15025	4516	43993	43891	8
9	20354	5984	18468	33130	34367	21062	22090	14428	14263	5606	39226	40513	9
10	57296	6807	29693	35679	35028	20771	25721	15525	13487	692.3	29633	40933	10
11	58459	7234	23978	31462	33389	21245	25644	18175	12622	705.7	31167	39577	11
12	56625	6729	19279	28172	32142	22252	22738	18469	11750	1111	32800	A38195	12
13	52573	5479	16626	31377	30158	20632	18502	19703	11735	209.2	14404	36552	13
14	58875	3744	16427	26945	28996	21675	22956	18877	16106	140.6	69835	A33231	14
15	72853	3395	17484	23575	29177	21804	24310	18568	15162	126.5	90944	A31701	15
16	60115	1884	15740	22818	28560	18600	24875	19008	13121	114.4	45742	A30980	16
17	59206	1271	13738	22167	27458	23932	25297	19894	13201	102.4	13333	68848	17
18	59078	1020	11246	23023	23978	29761	23798	20249	13846	3374	29632	64913	18
19	58898	4050	9794	21612	25393	26216	22896	19111	14725	11733	44258	58514	19
20	58716	3239	9707	20433	25396	24052	21994	18633	15750	15974	34747	57619	20
21	58534	14005	9031	25641	22173	23905	22091	19494	15362	32205	28097	58847	21
22	58497	19707	11630	34132	21979	23132	21526	17711	14844	28142	37308	58757	22
23	55599	15424	28131	28280	21505	22366	19696	13823	14161	37478	38799	58152	23
24	48873	10907	37862	21015	21065	23172	18157	6383	13444	38988	36623	49066	24
25	47927	11779	41385	18196	19240	24091	17767	5666	10169	20243	29481	46526	25
26	38674	13350	56908	18329	19972	22490	20243	8274	8610	47382	24881	44232	26
27	32257	14317	57210	19148	20689	20997	21597	3131	9860	98730	24230	39202	27
28	27305	18090	57398	29496	21114	21874	21618	10370	15702	39073	22908	35004	28
29	23127		57311	30611	21624	22237	21703	15061	7723	15459	29498	30669	29
30	24361		57520	36102	21154	22625	20865	16098	11120	43442	34096	26644	30
31	28306		57761		21259		20405	13682		31617		23828	31

Mean 41410 9209 26771 31279 28766 22551 22166 15990 13937 16931 32327 A40313
 Median 47927 7920 18215 30053 28560 22244 22091 18175 14212 6454 29565 A39202
 Maximum 72853 20069 57761 58003 44709 29762 25722 20801 17380 98730 90944A 68849
 Minimum 10416 1020 9031 18196 19240 18600 17767 3131 7723 102.4 13333 A19308
 Total 1283732 257863 829912 938370 891776 676542 687174 495714 418117 524883 969824A 1249729

Summaries

Notes

All recorded data is continuous and reliable
 except where the following tags are used...

Annual Mean 25270 A A ... Above Rating
 Ann. Median 21874 A
 Annual Total 9223637A

Maximum Minimum
 Daily 98730 A 102.4 A

Site C2H069 Mooirivierloop @ Blaauwbank
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Year 2003
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	45935	40218	41443	27926	17850	29436	25019	26601	25084	12419	21597	21931	1
2	45552	38268	43278	E 26967	15846	29153	21482	28369	25046	11308	26936	19320	2
3	45091	35219	50150	E 26189	16140	26813	23129	32317	19972	10214	23447	18551	3
4	44631	32961	44937	E 27705	20803	24930	22569	28661	17230	11653	20227	18902	4
5	43847	29035	35090	E 28051	18964	27281	24945	22972	20964	19240	19083	16193	5
6	40860	28208	33514	35900	19100	25200	25148	27706	21535	13179	16418	14059	6
7	38432	26280	29796	27563	20269	28744	23496	26948	32901	9880	18700	18554	7
8	37168	23621	28404	25080	20522	26044	23095	27661	24882	8326	17432	14663	8
9	36692	24417	32843	26005	21261	24721	23107	26029	16662	7913	20752	12171	9
10	39107	24906	36241	28036	21434	23349	23700	34298	17173	7705	14748	11191	10
11	42314	23404	28531	24681	29787	24674	25192	27601	16051	8311	13821	10261	11
12	42630	21299	25539	21700	24283	28713	31503	30269	17779	12902	13668	9195	12
13	41582	20549	26035	26310	20711	27757	30540	25716	19594	13625	12557	7897	13
14	39047	19496	24310	24112	22255	24307	27391	22010	18689	9336	12408	10597	14
15	36212	19686	22465	24219	20492	23909	28573	23147	20301	7914	13348	10376	15
16	34638	19456	21728	23677	19938	22801	25757	30420	17221	7012	17430	12970	16
17	32218	19018	20290	23685	22599	23806	26251	38271	17266	6730	13797	11940	17
18	31986	19901	18756	24868	22563	24390	25593	31987	18808	8997	12682	9671	18
19	34470	25482	18074	22478	21484	27876	26855	23512	21908	23554	13592	8726	19
20	34473	30124	25945	21456	22744	29156	26887	24592	23981	15063	13990	9404	20
21	34556	32185	26878	19763	22790	24589	26383	23446	31422	16137	14857	11439	21
22	33201	33001	30086	20308	19974	24124	24942	20092	26750	16182	16894	9368	22
23	32910	35563	35627	[JM 20530	24232	24822	22429	21962	15409	26283	9056	23	
24	39329	39120	37020	[JM 20081	23247	25340	30852	21725	14948	22737	7770	24	
25	42726	36545	31390	[JM 25108	22935	25414	21108	24820	13279	23460	8362	25	
26	44035	36362	28706	[JM 19139	24240	28572	18623	20314	21453	23581	12335	26	
27	45294	36417	27704	[JM 18243	24677	25631	19300	18549	15513	23132	14777	27	
28	45592	37976	26834	17993	19290	23295	24937	21199	23199	203278	24105	12718	28
29	45655		25959	18857	20719	22496	26185	22206	17466	52900	24931	11253	29
30	45212		24924	17056	21338	25084	29958	22384	13210	27140	26993	10338	30
31	43435		30621		21265		27728	30247		20972		8568	31
Mean	39963	28883	30101E	24424	20888	25400	25812	26161	21083	20726	18787	12341	
Median	40861	28622	28532E	24682	20711	24676	25414	26029	20308	13179	18067	11253	
Maximum	45935	40219	50150E	35900	29787	29436	31504	38272	32902	203278	26994	21931	
Minimum	31986	19017	18074	E17055	15846	22496	21481	18623	13210	6730	12408	7770	
Total	1238845	808728	933132E	610595	647536	761992	800158	810986	632478	642504	563618	382569	
Missing Days	0	0	0	5	0	0	0	0	0	0	0	0	

Summaries

Notes

All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 24536 E E ... Estimated Data
 Ann. Median 23601 E M ... Missing Data
 Annual Total 8833141E
 Missing Days 5

Maximum Minimum

Daily 203278 E 6730 E

Site C2H069 Mooirivierloop @ Blaauwbank
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Year 2004
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	8492	27406	43238	31320	32246	22995	24285	14855	14914	10379	17511	16591	1
2	9807	22135	41082	35512	32434	20559	23782	14217	17790	10412	16329	11182	2
3	9983	20248	39178	32495	32399	14665	30723	11628	19136	11026	16415	8775	3
4	21868	17279	40818	34961	32308	16891	29704	11822	19519	9090	18890	9259	4
5	33364	18345	43528	35093	32680	16883	21177	11529	16557	10525	20725	10327	5
6	16188	18671	45482	34117	31641	15125	17364	15112	15000	11061	20738	13961	6
7	10497	21819	42033	33713	30779	15136	19650	13986	22876	8592	19268	19058	7
8	8355	28846	38557	35331	29312	16047	20050	15849	19714	14791	11168	26666	8
9	7908	21428	36453	35068	27575	14708	17847	17631	16300	12610	8887	26756	9
10	7721	16760	34740	35485	25498	15482	27779	16722	19192	14937	5234	27018	10
11	14618	15789	31757	30803	25406	17950	33131	10703	24837	12229	4737	19704	11
12	13614	17710	31416	28577	24675	16602	21841	10186	20664	12120	4160	32648	12
13	9975	15071	36541	29388	24226	24497	21638	10208	17041	17312	4921	19249	13
14	8756	19377	37209	32269	23854	18435	23616	9527	20975	18371	4145	21426	14
15	8240	24733	40131	31828	23873	14130	20179	13798	20604	16129	4079	20223	15
16	8481	23285	35000	24500	23459	18079	24297	10930	13105	18821	4418	23787	16
17	9659	21745	31509	26100	22617	21482	21560	11339	14251	19769	5570	19337	17
18	16949	23938	29810	26138	21559	20133	24680	15659	18112	15748	6004	23890	18
19	16807	24498	28992	26386	20983	20083	21211	11386	15604	16927	4462	25219	19
20	18405	27759	29179	36026	20974	23074	16433	12833	11021	17162	5415	21110	20
21	19507	25249	31335	38201	21295	20252	17448	11412	10916	18078	6824	21673	21
22	22070	35065	35053	39960	22021	17183	14510	13756	9619	16406	8153	21059	22
23	27175	33953	40110	41102	22440	18205	16047	11307	10661	16118	8481	21929	23
24	28683	34866	40526	37680	22202	17875	21421	10428	14728	18383	12652	23416	24
25	33169	39544	39258	34893	22180	15982	20579	9458	12690	17169	10112	26857	25
26	25016	43825	36546	34460	22114	19403	16100	10544	11457	17052	5503	25688	26
27	24765	44286	34010	33112	22131	19321	14323	13806	13324	21046	8765	27610	27
28	23706	47287	35385	32668	22077	16764	22104	16795	15252	20183	7280	27830	28
29	21542	48044	39337	32534	26473	17450	22474	19234	14274	18942	10223	24762	29
30	22556	33492	32705	27172	21284	16089	12139	11946	18864	13003	23947	30	30
31	21911	29169	21882	14357	14324	19841	23044	31					
Mean	17090	26861	36480	33081	25500	18222	21174	13004	16069	15487	9802	21419	
Median	16807	23938	36541	33413	23873	17913	21211	12139	15428	16406	8317	21929	
Maximum	33364	48044	45482	41103	32680	24497	33131	19234	24838	21047	20739	32648	
Minimum	7721	15071	28992	24500	20974	14130	14323	9458	9619	8592	4079	8775	
Total	529804	778974	1130889	992440	790500	546690	656413	403138	482095	480106	294086	664016	

Summaries

Notes

All recorded data is continuous and reliable

Annual Mean 21172
 Ann. Median 20066
 Annual Total 7749154

Maximum Minimum
 Daily 48044 4079

Site C2H069 Mooirivierloop @ Blaauwbank
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Year 2005
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	23461	37584	23362	16699	26289	14759	13018	13284	11884	[]	[]	[]	1
2	22068	35896	23928	15389	23658	11980	12288	15296	11391	[]	[]	[]	2
3	20946	36667	18128	20068	21940	12478	12764	16080	10072	[]	[]	[]	3
4	21765	36026	24901	21205	23560	13767	13110	12665	12711	[]	[]	[]	4
5	19666	36963	24112	24140	23442	14944	11959	12533	14173	[]	[]	[]	5
6	17619	38040	16813	23236	22011	13751	11632	15736	11197	[]	[]	[]	6
7	16909	36992	15558	23044	23764	16525	11307	16866	10103	[]	[]	[]	7
8	15873	35250	16343	24376	21675	11871	14627	14458	9894	[]	[]	[]	8
9	18081	34364	20636	22213	22141	13529	14705	13905	10602	[]	[]	[]	9
10	22324	25219	20009	21603	18644	15291	15986	16843	10975	[]	[]	[]	10
11	21358	15614	15175	22936	18345	14444	10820	16845	12145	[]	[]	[]	11
12	21654	18144	12932	20729	18967	15552	15196	13916	10293	[]	[]	[]	12
13	24513	21347	13732	19353	16578	15253	11117	16592	9454	[]	[]	[]	13
14	31847	20951	11394	19884	16960	13368	11426	14144	9226	[]	[]	[]	14
15	29413	24648	12163	21741	19354	13812	15226	14709	10758	Q []	[]	[]	15
16	33725	23001	20644	22936	19264	13929	14542	14670	10536	Q []	[]	[]	16
17	27812	20047	18118	22039	17386	13908	12415	14361	11571	Q []	[]	[]	17
18	26967	19391	19336	20313	17079	19761	12146	13016	11503	Q []	[]	[]	18
19	32238	15276	20122	21164	16947	18393	11584	13986	12966	Q []	[]	[]	19
20	29961	23602	18221	22894	17695	18957	11599	12997	12533	Q []	[]	[]	20
21	51553	29048	17517	E23106	18942	15016	11662	12823	11566	Q []	[]	[]	21
22	60411	32764	18678	E21470	19731	13882	10708	12575	13473	Q []	[]	[]	22
23	63022	31234	18422	20428	18974	12851	10462	11249	11092	Q []	[]	[]	23
24	60243	33538	18800	24419	13743	12512	13076	12528	9936	Q []	[]	[]	24
25	56618	27789	21016	22650	14970	13606	12752	10002	9907	Q []	[]	[]	25
26	48846	27591	22287	22424	16954	16677	14299	10713	10289	Q []	[]	[]	26
27	43887	29842	21976	24820	13116	16849	14122	11083	8023	Q []	[]	[]	27
28	42577	24923	19727	24500	16871	15506	12409	14669	8711	Q []	[]	[]	28
29	38537		18812	24732	15798	18263	13393	16263	[]	[]	[]	[]	29
30	36823		16585	25738	14598	13225	14344	13100	[]	[]	[]	[]	30
31	36823		17444		14488		14483	14857	[]	[]	[]	[]	31
Mean	32824	28277	18610E	22009	18835	14822	12877	13961	10964Q	[]	[]	[]	
Median	29413	28419	18678E	22319	18645	14187	12753	13987	10867Q	[]	[]	[]	
Maximum	63023	38041	24901E	25738	26290	19761	15986	16867	14174Q	[]	[]	[]	
Minimum	15873	15276	11394	E15389	13116	11871	10462	10002	8023	Q []	[]	[]	
Total	1017557	791766	576907E	660263	583898	444671	399193	432779	306996Q	[]	[]	[]	
Missing Days	0	0	0	0	0	0	0	2	31	30	31		

Summaries

Notes

All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 19239 E E ... Estimated Data
 Ann. Median 16849 E M ... Missing Data
 Annual Total 5214031E Q ... Data Not Audited
 Missing Days 94

Maximum Minimum
 Daily 63022 E 8023 E

Site C2H025 Wonderfontein-@Spruit 7 @ Gemsbokfontein Year 1994
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	27526	27460	33001	16415	14574	15885	24346	19794	12326	4473	36021	9226	1
2	20151	25684	30434	16252	17318	15134	21508	19124	11815	5272	30135	7049	2
3	14539	40793	33746	16723	16020	19036	19890	17528	10257	4504	33719	6244	3
4	14751	54856	39397	15852	14525	21620	21036	17292	9006	7342	46594	4927	4
5	16166	55635	36215	13491	13377	20843	21956	18544	10070	11150	35588	3672	5
6	15046	55532	31428	11870	13374	20102	20633	18670	10631	9686	36034	21437	6
7	13069	48031	29123	13692	13522	18448	21956	17960	7519	10437	33513	33593	7
8	10120	41142	27032	15546	13516	17439	21860	18160	9941	11174	24099	16071	8
9	8849	41817	27516	17929	13246	18865	21927	17445	6947	9080	22883	28877	9
10	6648	42217	22475	20565	12877	19455	21617	16497	9246	8203	22527	30638	10
11	11030	42193	20158	21352	11215	18840	20456	14920	10171	8879	22243	23125	11
12	11892	40762	18093	20145	10883	20743	19461	15481	11318	789.7	19266	23178	12
13	13227	54905	17377	18284	10114	21394	19689	17142	10999	1092	30584	18969	13
14	12982	46525	22960	17498	10139	20165	20089	10396	8490	15654	19450	13956	14
15	10413	46647	22115	16479	10270	18615	19917	13449	8998	18184	15589	12197	15
16	19169	51256	18995	15700	12670	18633	19291	12557	8259	16672	15395	19322	16
17	32347	56602	18046	14342	13926	19665	20562	12596	8018	16106	12400	25421	17
18	30944	48925	17290	13730	14983	18668	19892	13896	5092	8494	8173	21354	18
19	13055	45578	18780	14928	14789	18606	16764	13711	6482	4518	12078	14708	19
20	19492	46022	18681	19733	14077	17658	15619	11173	6565	6256	29406	6935	20
21	21460	53113	18058	18575	14015	17046	14522	12137	6904	157.8	51201	5395	21
22	23869	46203	18976	9495	14439	17787	15274	11636	6514	572.9	47719	2945	22
23	33770	54301	18443	12366	14706	13358	16425	9509	5550	650.5	44195	4179	23
24	42704	57831	16648	13633	14951	14964	18767	9732	4907	422.3	35614	6737	24
25	48887	52205	22627	16367	15465	15268	19823	11094	7291	166.8	32375	1820	25
26	41066	37630	18563	17038	16381	15899	19915	12746	6857	1614	27982	9011	26
27	42572	36693	18174	17947	16483	18414	19975	13210	8834	612.7	[]M41307		27
28	55812	33845	17634	18521	15528	14305	18862	13470	5242	2444	[]M30651		28
29	51445		15386	19127	14887	24919	18091	14253	6271	34078	[]M27044		29
30	30371		17845	19196	16315	28218	19610	12646	1991	26877	[]M29710		30
31	27847		16449		16878		19785	12032		34159		35344	31

Mean 23910 45872 22634 16426 14047 18666 19662 14478 8084 9023 28646 17259
 Median 19492 46364 18976 16447 14439 18624 19892 13711 8139 7342 29771 16071
 Maximum 55812 57832 39398 21353 17318 28218 24347 19795 12327 34160 51202 41307
 Minimum 6648 25684 15386 9495 10114 13358 14522 9509 1991 157.8 8173 1820
 Total 741234 1284417 701684 492808 435477 560006 609533 448819 242525 279733 744798 535057
 Missing Days 0 0 0 0 0 0 0 0 0 0 4 0

Summaries

Notes

All recorded data is continuous and reliable
 except where the following tags are used...

Annual Mean 19601 M ... Missing Data
 Ann. Median 17318
 Annual Total 7076089
 Missing Days 4

Maximum Minimum
 Daily 57831 157.8

Site C2H025 Wonderfontein-@Spruit 7 @ Gemsbokfontein Year 1995
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	38230	20068	30005	58003	36746	22251	21545	20640	14156	21070	21542	24200	1
2	30553	14667	26130	50861	41429	22552	22216	20801	16245	3711	21001	19636	2
3	25322	12161	18215	48912	37848	22041	22098	20137	17142	2880	23818	20419	3
4	19309	10409	17715	45982	36827	22222	22126	19346	17236	2349	23392	19308	4
5	16185	10196	17376	42835	35227	22723	20810	20180	17221	7583	20656	27745	5
6	13080	8606	16123	39993	35402	21403	22719	15404	17379	3658	18065	47275	6
7	10416	6532	15441	36663	44708	22235	23847	15959	16933	6454	15700	34738	7
8	14113	6794	14566	33764	37755	22210	25307	12898	15025	4516	43993	43891	8
9	20354	5984	18468	33130	34367	21062	22090	14428	14263	5606	39226	40513	9
10	57296	6807	29693	35679	35028	20771	25721	15525	13487	692.3	29633	40933	10
11	58459	7234	23978	31462	33389	21245	25644	18175	12622	705.7	31167	39577	11
12	56625	6729	19279	28172	32142	22252	22738	18469	11750	1111	32800	A38195	12
13	52573	5479	16626	31377	30158	20632	18502	19703	11735	209.2	14404	36552	13
14	58875	3744	16427	26945	28996	21675	22956	18877	16106	140.6	69835	A33231	14
15	72853	3395	17484	23575	29177	21804	24310	18568	15162	126.5	90944	A31701	15
16	60115	1884	15740	22818	28560	18600	24875	19008	13121	114.4	45742	A30980	16
17	59206	1271	13738	22167	27458	23932	25297	19894	13201	102.4	13333	68848	17
18	59078	1020	11246	23023	23978	29761	23798	20249	13846	3374	29632	64913	18
19	58898	4050	9794	21612	25393	26216	22896	19111	14725	11733	44258	58514	19
20	58716	3239	9707	20433	25396	24052	21994	18633	15750	15974	34747	57619	20
21	58534	14005	9031	25641	22173	23905	22091	19494	15362	32205	28097	58847	21
22	58497	19707	11630	34132	21979	23132	21526	17711	14844	28142	37308	58757	22
23	55599	15424	28131	28280	21505	22366	19696	13823	14161	37478	38799	58152	23
24	48873	10907	37862	21015	21065	23172	18157	6383	13444	38988	36623	49066	24
25	47927	11779	41385	18196	19240	24091	17767	5666	10169	20243	29481	46526	25
26	38674	13350	56908	18329	19972	22490	20243	8274	8610	47382	24881	44232	26
27	32257	14317	57210	19148	20689	20997	21597	3131	9860	98730	24230	39202	27
28	27305	18090	57398	29496	21114	21874	21618	10370	15702	39073	22908	35004	28
29	23127	57311	30611	21624	22237	21703	15061	7723	15459	29498	30669	29	29
30	24361	57520	36102	21154	22625	20865	16098	11120	43442	34096	26644	30	30
31	28306	57761	21259	20405	13682	31617	23828	31					

Mean 41410 9209 26771 31279 28766 22551 22166 15990 13937 16931 32327 A40313
 Median 47927 7920 18215 30053 28560 22244 22091 18175 14212 6454 29565 A39202
 Maximum 72853 20069 57761 58003 44709 29762 25722 20801 17380 98730 90944A 68849
 Minimum 10416 1020 9031 18196 19240 18600 17767 3131 7723 102.4 13333 A19308
 Total 1283732 257863 829912 938370 891776 676542 687174 495714 418117 524883 969824A 1249729

Summaries ----- Notes -----

All recorded data is continuous and reliable
 except where the following tags are used...

Annual Mean 25270 A A ... Above Rating
 Ann. Median 21874 A
 Annual Total 9223637A

Maximum Minimum
 Daily 98730 A 102.4 A

Site C2H006 Mooi River @ Klerkskraal
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Year 1964
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day	
1	16734	18003	21857	23349	20854	24325	27388	26136	26136	21153	19074	21746	26142	1
2	16606	18003	21423	26195	21459	24614	27090	26136	26136	21337	19741	24539	26204	2
3	16478	18003	20553	24695	22014	24904	26794	26136	26136	21522	19696	24688	26714	3
4	16350	18003	19694	22837	22118	25195	26498	26136	26136	21707	19522	28997	24115	4
5	16239	18003	18848	21985	22118	25487	26214	26136	26136	21893	19348	28742	22674	5
6	16397	18003	18014	22564	22118	25781	26136	26136	26136	22046	19175	26803	23901	6
7	16652	18003	17192	23129	22118	26062	26136	26136	26136	21639	19002	24911	28031	7
8	16908	18003	16411	23697	22118	26136	26136	26136	26136	21038	18830	22021	26675	8
9	17165	17936	16196	24270	22118	26136	26136	26136	26122	20442	18575	20452	36255	9
10	17423	16770	16196	24848	22104	26136	26136	26136	25900	19851	19184	21196	32427	10
11	17682	20628	16196	25429	21861	26136	26136	26136	25610	19266	19616	21949	26522	11
12	17933	21362	16196	25926	21537	26136	26136	26149	25320	18688	20154	22709	23337	12
13	18003	20377	16196	25284	21215	26136	26371	25032	18141	22952	23475	20473	13	
14	18003	20092	16196	23575	20894	26106	26667	24745	18003	25009	24250	19868	14	
15	18003	19990	16208	20492	20574	25578	26965	24459	18003	25794	24851	19868	15	
16	18003	19870	16487	19437	20256	24992	27264	24167	18003	25794	23775	19868	16	
17	18003	19445	16876	18402	19983	25767	27564	23742	18003	25795	22304	19868	17	
18	18003	18915	17267	17384	20528	27269	27865	23263	18003	27518	20861	19868	18	
19	18003	18389	17662	16444	21393	28559	28141	22787	18003	28694	19448	19868	19	
20	18003	17868	18059	16404	22268	28574	27988	22314	17993	37175	18069	19868	20	
21	18003	17352	18459	16661	23154	28322	27683	21843	17800	33001	16721	19868	21	
22	18003	16840	18816	16920	24048	28230	27379	21375	17538	40793	15514	19868	22	
23	18003	16368	18597	17179	24953	28230	27077	20933	17277	53167	15200	19868	23	
24	18003	16793	18201	17440	25842	28230	26775	20824	17017	39098	15077	19868	24	
25	18003	17619	17807	17701	25926	28230	26474	20824	16758	29676	14954	19868	25	
26	18003	18457	17416	17984	25631	28230	26195	20824	16501	25395	14831	19868	26	
27	18003	19307	17028	18495	25336	28230	26136	20824	16293	28075	14709	19868	27	
28	18003	20171	16643	19076	25043	28215	26136	20824	16798	35093	14587	19868	28	
29	18003	21046	16287	19663	24750	27986	26136	20824	17547	31733	14663	27010	29	
30	18003		16289	20256	24459	27688	26136	20831	18305	27905	17696	91318	30	
31	18003		16400		24190		26136	20969		24238		59959	31	

Mean	17568	18607	17602	20924	22677	26720	26711	23659	18886	26414	20658	26444
Median	18003	18003	17192	20374	22118	26136	26474	24167	18003	25395	21471	20473
Maximum	18003	21362	21857	26195	25926	28574	28141	26136	22046	53167	28997	91318
Minimum	16239	16368	16196	16404	19983	24325	26136	20824	16293	18575	14587	19868
Total	544620	539617	545670	627719	702983	801615	828038	733443	566566	818820	619739	819770

Summaries

Notes

All recorded data is continuous and reliable

Annual Mean 22263
 Ann. Median 21042
 Annual Total 8148599

	Maximum	Minimum
Daily	91317	14587

Site C2H006 Mooi River @ Klerkskraal Year 1965
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	31367	31262	19065	18181	18323	19630	20285	22118	20250	20147	19646	19868	1
2	24012	29545	18010	18704	18072	19495	20147	22118	20387	20008	19375	19868	2
3	21623	32150	16973	19232	18003	19361	20008	22118	20525	19900	19105	19868	3
4	20322	32000	15955	22048	18003	19227	19886	22118	20662	19983	18837	19868	4
5	20905	45784	14956	29171	18003	19093	19868	22118	20785	20100	18569	19781	5
6	21494	150097	13978	28953	18003	18985	19868	22118	20711	20217	18303	18699	6
7	22088	111986	13047	28734	18003	19385	19868	22118	20575	20335	18052	17356	7
8	41012	68042	12769	28517	18003	19982	19868	22093	20440	20539	17960	16044	8
9	38382	57214	12769	27898	18003	20586	19868	21830	20305	24120	17910	14764	9
10	39628	46070	12769	20083	18003	21195	19868	21509	20170	24628	17860	13518	10
11	85187	35021	12769	16002	18003	21809	19868	21189	20035	24988	17810	12310	11
12	53763	51248	12769	16370	18003	22429	19868	20871	19905	24843	17760	11291	12
13	37111	36971	12769	16579	18003	22958	19868	20555	19868	24698	18957	11157	13
14	29427	31136	12769	18329	18003	22679	19868	20240	19868	24554	21002	11157	14
15	42382	28897	12769	21340	18003	22215	19868	19957	19868	24409	19868	11157	15
16	62174	30403	12769	21611	18010	21755	19868	20128	19868	24265	19868	11157	16
17	52606	29189	12769	21883	18177	21297	19868	20450	19868	24112	19868	11157	17
18	131015	26839	12769	21041	18409	20842	19868	20773	19868	23855	19868	11157	18
19	125332	24556	12769	19868	18642	20391	22037	21098	19873	23570	19868	11157	19
20	79983	22339	12769	19868	18876	19975	23875	21424	19973	23287	19868	11157	20
21	59887	20312	12801	19868	19112	19981	21282	21752	20110	23004	19868	11157	21
22	59342	19868	13180	19868	19348	20118	20690	22032	20248	22723	19868	11157	22
23	54044	19868	13658	19868	19585	20255	21132	21833	20386	22442	19868	11157	23
24	40502	19868	14142	19868	19811	20392	21577	21512	20524	22159	19868	11157	24
25	35319	19868	14633	19853	19868	20529	22006	21194	20662	21844	19868	11157	25
26	33102	19868	15128	19644	19868	20667	22118	20876	20785	21521	19868	11177	26
27	34616	19868	15628	19378	19868	20787	22118	20560	20707	21199	19868	11364	27
28	34531	19834	16133	19112	19868	20703	22118	20246	20566	20879	19868	11590	28
29	32630		16639	18848	19868	20563	22118	19952	20426	20560	19868	11817	29
30	30766		17148	18585	19863	20424	22118	19976	20286	20242	19868	12046	30
31	30608		17662		19766		22118	20112		19929		12276	31
Mean	45973	38575	14346	20977	18689	20590	20767	21193	20283	22228	19301	13502	
Median	37111	29974	13180	19868	18177	20477	20008	21194	20295	22159	19868	11364	
Maximum	131015	150097	19065	29171	19868	22958	23875	22118	20785	24988	21002	19868	
Minimum	20322	19834	12769	16002	18003	18985	19868	19952	19868	19900	17760	11157	
Total	1425159	1080101	444738	629301	579367	617709	643780	656989	608499	689058	579028	418548	

Summaries

Notes

All recorded data is continuous and reliable

Annual Mean 22937
 Ann. Median 19973
 Annual Total 8372277

Maximum Minimum
 Daily 150097 11157

Site C2H006 Mooi River @ Klerkskraal
 VarFrom 100.00 Water Level in Metres
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Year 1966
 Table Type Total

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	12508	13062	34501	21511	30412	29086	30372	[JM [JM [JM [JM [JM	1				
2	12724	13230	32418	37722	31118	29390	30372	[JM [JM [JM [JM [JM	2				
3	12769	13399	30378	38134	32067	29695	30372	[JM [JM [JM [JM [JM	3				
4	12769	21008	28379	36608	33025	30001	30372	[JM [JM [JM [JM [JM	4				
5	12769	76599	26423	35978	33992	30308	30372	[JM [JM [JM [JM [JM	5				
6	12769	96605	24596	35352	34970	30618	30372	[JM [JM [JM [JM [JM	6				
7	12769	1162190A	24261	34728	35956	30929	30372	[JM [JM [JM [JM [JM	7				
8	12769	1624929A	26184	34109	36839	31241	30372	[JM [JM [JM [JM [JM	8				
9	12761	1130224A	30239	33493	36516	31554	30372	[JM [JM [JM [JM [JM	9				
10	12590	691410	34341	32881	35864	31868	30372	[JM [JM [JM [JM [JM	10				
11	12358	374589	36453	32273	35216	32183	30372	[JM [JM [JM [JM [JM	11				
12	12127	352467	37838	31669	34572	32468	30372	[JM [JM [JM [JM [JM	12				
13	11897	226311	38985	31068	33932	32302	30372	[JM [JM [JM [JM [JM	13				
14	11669	130856	37513	30504	33295	31988	30372	[JM [JM [JM [JM [JM	14				
15	11441	82291	35371	30372	32681	31674	30372	[JM [JM [JM [JM [JM	15				
16	11236	61355	33270	30372	32296	31362	30372	[JM [JM [JM [JM [JM	16				
17	11504	49565	31212	30372	31983	31050	30403	[JM [JM [JM [JM [JM	17				
18	11975	40005	29196	30372	31670	30739	30956	[JM [JM [JM [JM [JM	18				
19	12451	36543	27220	30372	31359	30445	31699	[JM [JM [JM [JM [JM	19				
20	12933	36296	25383	30372	31048	30372	32447	[JM [JM [JM [JM [JM	20				
21	13421	39151	24422	30372	30738	30372	33082	[JM [JM [JM [JM [JM	21				
22	13916	35776	23668	30372	30430	30372	32463	[JM [JM [JM [JM [JM	22				
23	14347	40828	22921	30372	30120	30372	31511	[JM [JM [JM [JM [JM	23				
24	14228	54635	22180	30372	29811	30372	[JM [JM [JM [JM [JM	24					
25	13991	48468	21447	30372	29503	30372	[JM [JM [JM [JM [JM	25					
26	13755	43837	20721	30372	29196	30372	[JM [JM [JM [JM [JM	26					
27	13521	39418	20051	30372	28890	30372	[JM [JM [JM [JM [JM	27					
28	13289	36627	20112	30372	28585	30372	[JM [JM [JM [JM [JM	28					
29	13058		20414	30372	28314	30372	[JM [JM [JM [JM [JM	29					
30	12840		20717	30372	28481	30372	[JM [JM [JM [JM [JM	30					
31	12894		21022		28783		[JM [JM [JM [JM [JM	31					
Mean	12776	234703A	27801	31733	31989	30766	30805	[JM [JM [JM [JM [JM					
Median	12769	49016A	26423	30372	31670	30372	30372	[JM [JM [JM [JM [JM					
Maximum	14347	1624929A	38985	38134	36839	32468	33082	[JM [JM [JM [JM [JM					
Minimum	11236	13062A	20051	21511	28314	29086	30372	[JM [JM [JM [JM [JM					
Total	396048	6571671A	861837	951980	991662	922992	708510	[JM [JM [JM [JM [JM					
Missing Days	0	0	0	0	0	0	8	31	30	31	30	31	

Summaries

Notes

All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 55905 A A ... Above Rating
 Ann. Median 30371 A M ... Missing Data
 Annual Total 11404700A
 Missing Days 161

Maximum Minimum
 Daily 1624929A 11235 A

Site C2H085 Mooi River @ Hoogekraal Year 2003
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	214748	[]M	[]M 57670	50964	92364	E 99703	122754	61308	30957	65154	21505		1
2	177531	[]M	[]M 50728	60543	81164	E []M 75936	60575	22111	39024	19754			2
3	136119	[]M	[]M 30289	57839	63198	[]M 45083	37965	21170	29499	22848			3
4	107582	[]M 101109	29866	E 54884	52947	[]M 29831	24599	10469	28030	16208			4
5	73820	[]M 62691	30314	E 40409	60911	[]M 22135	30929	12465	25607	14988			5
6	39098	[]M 32975	27529	E 33076	104385	[]M 32104	40315	21695	37333	15655			6
7	32964	[]M 18519	[]M 56924	125805	E []M 31610	52835	9521	41623	15209				7
8	47834	[]M 15145	E []M 58271	150693	E 105646	101606	109884	12825	39182	16962			8
9	51840	[]M 17252	E []M 66339	180650	E 169332	144884	115483	11114	21904	35442			9
10	90595	[]M 25067	E []M 71221	203506	227593	E 172777	90254	9894	15591	36074			10
11	176531	20069	15302	[]M 70425	178949	277161	E 155908	64244	15248	4666	13034		11
12	174770	18022	9728	[]M 68442	150767	218984	E 148301	50019	15710	9209	9252		12
13	126491	14913	10644	[]M 71302	147999	133851	E 141198	49827	14880	19973	6480		13
14	118939	8057	9689	E []M 80274	149044	E 96626	E 128720	39735	8844	44714	4232		14
15	127203	9187	6197	E 35565	58799	135886	E 83239	106791	35334	6348	102564	3532	15
16	103757	11672	10534	E 27110	44422	E 117519	E 85926	115404	36299	8310	152331	4309	16
17	69960	[]M 12360	E 38233	31758	E 102514	E 83806	115667	41860	8473	95405	3464		17
18	53822	[]M 21184	58491	32145	E 118836	87056	114169	36346	9244	68412	1511		18
19	50689	[]M 23626	39308	41462	E 168945	86951	113573	42532	5834	58103	1119		19
20	42751	[]M []M 29863	43455	181684	78156	119440	52110	7036	64532	694.1			20
21	71542	[]M []M 37160	62618	171298	E 60736	108164	62566	23754	89672	10.0			21
22	44779	[]M []M 59852	79397	157195	E 56734	91520	57765	52956	79869	0.9			22
23	29925	[]M []M 63505	79088	130911	E 66298	95451	31115	58805	75744	0.0			23
24	34018	[]M []M 69356	83930	124116	62399	88338	30756	51251	80839	0.0			24
25	67423	[]M 58930	74622	78723	153215	77589	71138	25888	40457	65516	222.7		25
26	115139	E []M 76349	73125	67549	156486	124582	56724	25044	21571	42107	4587		26
27	[]M []M 87289	61587	65435	141214	E 153795	92726	23027	23268	47344	3579			27
28	[]M []M 100332	55039	67869	131263	E 134733	105564	29351	17015	42470	17447			28
29	[]M 107154	55313	66567	E 121568	E 137417	84128	48853	27143	31616	36128			29
30	[]M 107524	E 41410	71356	E 104348	E 159913	72928	39059	95022	26688	27819			30
31	[]M 76535	E 83982	E 143790	65617		85577		13725	31				31

Mean 91534E 13654 43746E 47543E 61274E 131980E 120481E 95813 48196 24483 51491 11800
 Median 72681 E 13293 23626 E 46069 E 65435 E 133574 E 99703 E 101606 41087 15710 42288 9252
 Maximum 214749E 20069 107525E 74622E 83983E 203507E 277161E 172778 115483 95022 152331 36129
 Minimum 29925 E 8057 6197 E 27110 E 31758 E 52947 E 56734 E 22135 23027 5834 4665 0.00
 Total 2379884E 81923 1006147E 1045945E 1899481E 3959392E 3012024E 2970205 1445869 758979 1544734 365800
 Missing Days 5 22 8 8 0 0 6 0 0 0 0 0

Summaries ----- Notes -----
 ----- All recorded data is continuous and reliable
 except where the following tags are used...
 Annual Mean 64779 E E ... Estimated Data
 Ann. Median 56019 E M ... Missing Data
 Annual Total 20470403E
 Missing Days 49
 Maximum Minimum
 Daily 277161 E 0.00E

Site C2H085 Mooi River @ Hoogekraal Year 2004
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	5611	5327	489196	325080	175436	142517	179881	153549	110639	32023	134234	51772	1
2	1961	6640	535020	296053	158457	147568	219723	138120	113054	43266	75700	74046	2
3	2394	8161	360415	254142	149386	169107	276315	148860	121458	42753	56121	60027	3
4	154	3106	264370	229570	155581	179389	245494	163924	130503	40556	37855	34930	4
5	3616	61	224308	236169	171492	189750	238541	164271	137182	27761	29462	22813	5
6	3210	0	1765555	242439	172751	180910	225460	152793	153830	26205	27875	34794	6
7	4640	0	6052492	255651	162192	208244	227816	150317	173013	19313	27609	70790	7
8	552	0	[JM 257470	154138	224526	232274	132577	171597	17758	22233	91282	8	
9	7402	484	[JM 240546	154782	206258	231840	127534	134757	19722	25343	89819	9	
10	5926	14666	[JM 223567	144182	178685	230253	122247	110367	12499	29319	59517	10	
11	2798	6035	[JM 217833	134228	161373	227113	137822	90996	25092	20847	88985	11	
12	81	4670	[JM 213143	145750	149561	222679	160125	98364	29598	15138	60316	12	
13	0	9009	[JM 206556	146847	144534	220611	154288	82391	34918	4716	30416	13	
14	0	8560	[JM 203528	143650	141254	226071	148885	62712	30603	2181	24459	14	
15	0	57768	[JM 192416	148851	150845	225752	133461	49278	31257	3158	16994	15	
16	0	112464	356303	180974	149860	175503	205565	125834	53340	41077	912	10991	16
17	0	138770	492378	172965	160822	186962	195176	146108	57316	33411	3049	10342	17
18	0	160790	478154	161336	179806	179780	180632	161179	58132	32250	7559	14988	18
19	0	84181	464499	156138	182031	166786	171258	138697	58979	19585	1703	24916	19
20	1055	56379	429975	177542	175393	156965	179795	114982	49751	21512	1001	72831	20
21	2697	69547	379036	226634	164621	151767	199928	109269	39683	20407	1401	64392	21
22	29540	65353	323620	340807	153470	151572	199255	106763	43497	15594	796	69956	22
23	54423	47693	282825	379013	128976	176213	186775	85250	27989	11925	298	111051	23
24	39812	89061	277810	308661	124029	182097	184964	68362	30935	13434	318	103644	24
25	58949	204070	383712	269775	132236	176662	182841	74820	37360	20686	2480	257065	25
26	54433	312323	555612	266610	146797	174977	176586	80550	37507	15453	6328	490628	26
27	36667	334463	499161	268516	145020	158666	158496	86291	38313	12037	4471	343779	27
28	24563	264829	380789	287669	133217	145769	173002	127925	33032	16836	3430	220285	28
29	19102	279779	357282	249312	118365	140230	183261	142650	36913	310101	15236	166542	29
30	14411	363457	203127	123326	163900	175730	135711	27674	654535	22984	114315	30	
31	6586	359794	140238	173637	115535	325594	75117	31					
Mean	12277	80834	698946	241441	150836	168746	205056	129313	79019	64444	19459	95542	
Median	3209	47693	380788	238357	149385	167946	199927	135710	58555	26205	6943	69956	
Maximum	58949	334463	6052492	379013	182031	224526	276315	164271	173013	654535	134234	490628	
Minimum	0.0	0.0	224307	156137	118365	140230	158496	68361	27674	11924	298.3	10342	
Total	380583	2344190	16075764	7243242	4675930	5062372	6356726	4008700	2370562	1997760	583756	2961801	
Missing Days	0	0	8	0	0	0	0	0	0	0	0	0	

Summaries

Notes

All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 151009 M ... Missing Data
 Ann. Median 132406
 Annual Total 54061386
 Missing Days 8

Maximum Minimum
 Daily 6052492 0.00

Site C2H085 Mooi River @ Hoogekraal Year 2005
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	64189	213746	82922	480915Q	522309Q	159929Q	[JM	133835Q	[JM	[JM	[JM	[JM	1
2	38666	221419	95553	425483Q	472136Q	158720Q	175143Q	124545Q	[JM	[JM	[JM	[JM	2
3	23339	188070	110028	335898Q	399647Q	145882Q	171012Q	[JM	[JM	[JM	[JM	[JM	3
4	14508	129164	77708	268858Q	362690Q	129245Q	161328Q	[JM	[JM	[JM	[JM	[JM	4
5	10893	108073	64945	239307Q	353392Q	128154Q	147051Q	[JM	[JM	[JM	[JM	[JM	5
6	4048	61857	70579	250014Q	326443Q	147146Q	174231Q	[JM	[JM	[JM	[JM	[JM	6
7	935	68854	60874	262030Q	287884Q	155647Q	199954Q	[JM	[JM	[JM	[JM	[JM	7
8	309	61389	46540	271623Q	258742Q	139082Q	191481Q	[JM	[JM	[JM	[JM	[JM	8
9	321	84740	44054	261113Q	242391Q	143937Q	187089Q	[JM	[JM	[JM	[JM	[JM	9
10	430	102059	43358	259968Q	237035Q	151308Q	170553Q	[JM	[JM	[JM	[JM	[JM	10
11	7225	64315	35256	260458Q	239323Q	163334Q	155235Q	[JM	[JM	[JM	[JM	[JM	11
12	58461	48346	29201	251532Q	226718Q	161398Q	140225Q	[JM	[JM	[JM	[JM	[JM	12
13	38950	37551	46492	242887Q	217589Q	180945Q	166782Q	[JM	[JM	[JM	[JM	[JM	13
14	68613	41965	35273	242714Q	198223Q	209151Q	182556Q	[JM	[JM	[JM	[JM	[JM	14
15	123284	32774	36641	232609Q	176084Q	[JM	186097Q	[JM	[JM	[JM	[JM	[JM	15
16	181554	50671	57342	232378Q	186109Q	[JM	173061Q	[JM	[JM	[JM	[JM	[JM	16
17	219853	47418	97014	207115Q	195406Q	[JM	158010Q	[JM	[JM	[JM	[JM	[JM	17
18	165924	48768	112193	260883Q	194892Q	[JM	151484Q	[JM	[JM	[JM	[JM	[JM	18
19	230176	49877	142203	274448Q	194228Q	[JM	135012Q	[JM	[JM	[JM	[JM	[JM	19
20	307870	64379	98181	272018Q	193554Q	[JM	138623Q	[JM	[JM	[JM	[JM	[JM	20
21	747697	78270	58102	279006Q	188439Q	[JM	150293Q	[JM	[JM	[JM	[JM	[JM	21
22	7195734	148381	61209	272349Q	167138Q	[JM	153318Q	[JM	[JM	[JM	[JM	[JM	22
23	5625969	138332	99191	266571Q	175359Q	[JM	148085Q	[JM	[JM	[JM	[JM	[JM	23
24	4545355	181059	144002	268964Q	180117Q	[JM	146842Q	[JM	[JM	[JM	[JM	[JM	24
25	1575917	165967	207659	288358Q	178898Q	[JM	149889Q	[JM	[JM	[JM	[JM	[JM	25
26	922152	145000	231172	323318Q	164188Q	[JM	140074Q	[JM	[JM	[JM	[JM	[JM	26
27	1003222	129665	313923	341459Q	162142Q	[JM	141686Q	[JM	[JM	[JM	[JM	[JM	27
28	663088	110658	461222	331324Q	154379Q	[JM	147611Q	[JM	[JM	[JM	[JM	[JM	28
29	466223		475326	353355Q	140031Q	[JM	148907Q	[JM	[JM	[JM	[JM	[JM	29
30	319705		445298	470891Q	146841Q	[JM	145163Q	[JM	[JM	[JM	[JM	[JM	30
31	240440		473180Q		157305Q		136824Q	[JM	[JM	[JM	[JM	[JM	31
Mean	802098	100813	140537Q	290928Q	235472Q	155277Q	159121Q	129190Q	[JM	[JM	[JM	[JM	
Median	165924	81505	82922Q	268911Q	194892Q	153477Q	152401Q	129190Q	[JM	[JM	[JM	[JM	
Maximum	7195734	221419	475326Q	480915Q	522309Q	209151Q	199954Q	133835Q	[JM	[JM	[JM	[JM	
Minimum	308.8	32774	29200	Q207115	Q140030	Q128153	Q135012	Q124544	Q	[JM	[JM	[JM	[JM
Total	24865048	2822766	4356639Q	8727848Q	7299633Q	2173876Q	4773618Q	258380Q	[JM	[JM	[JM	[JM	
Missing Days	0	0	0	0	0	16	1	29	30	31	30	31	

Summaries ----- Notes -----

All recorded data is continuous and reliable
 except where the following tags are used...

Annual Mean 280598 Q M ... Missing Data
 Ann. Median 162142 Q Q ... Data Not Audited
 Annual Total 55277808Q
 Missing Days 168

Maximum Minimum
 Daily 7195734Q 308.7 Q

Site C2H110 Left Principal Canal From Boskop Dam @ Naauwpoort Year 2003
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	173422	73408	237940	167844	186598	119409	213999	137420	61779	232389	204303	195232	1
2	173422	112459	238184	184682	153197	120282	204816	92665	62166	232356	197640	202111	2
3	157038	130365	238429	184666	96569	121064	187547	160187	62655	191452	201203	210640	3
4	123823	130961	238757	145968	164841	121268	152577	189021	91069	121113	203005	210803	4
5	177079	154104	239965	91475	190863	121373	101727	189271	174052	200115	203891	194878	5
6	205632	192417	241413	149360	190544	157322	166127	189294	201481	231749	205198	159523	6
7	205150	172371	206782	171297	190592	203774	212643	189283	200908	231305	199749	195552	7
8	204609	141766	138283	207894	190769	203204	226276	174801	207814	230969	200866	208979	8
9	204052	185660	216873	224931	151572	202634	225509	150395	211173	231206	199318	208701	9
10	157778	217598	246117	224670	93587	202152	224707	150808	210760	189750	201194	204994	10
11	84386	226123	245186	172297	130112	202037	186469	151222	210342	119439	245649	206122	11
12	172835	238479	245027	92997	141853	201963	121655	151606	183163	203923	230227	207536	12
13	201306	251646	245027	198245	141335	159667	193864	151680	138353	237698	228080	206435	13
14	201919	226741	245027	229627	141345	97927	220926	151671	205264	237834	220308	204772	14
15	201532	185324	245027	226287	141480	97831	216887	151662	233151	230884	204949	202884	15
16	201024	216218	245027	226593	141616	160539	214672	151654	232508	218879	202653	227345	16
17	178916	225991	245027	185613	141752	183917	215240	179644	231939	210755	195170	227787	17
18	144724	226202	245053	128666	189438	184506	185322	193652	230913	213017	198945	225891	18
19	182631	226051	245251	128310	205068	184289	132758	202020	200110	219892	202172	219988	19
20	204767	225843	205199	127955	205043	152543	162511	201819	134031	221923	193163	219003	20
21	208176	162908	129952	208561	204797	102405	174379	201571	198208	221813	151937	219747	21
22	208882	78901	129916	235473	204518	161902	173548	163809	222776	221702	105932	219460	22
23	209642	79400	191687	234799	160648	187880	173666	96723	234008	224855	108732	218082	23
24	166285	79901	213544	234059	94702	187636	173889	177518	252227	214154	94727	218863	24
25	93604	80350	213935	176233	165337	187792	142116	208621	251434	192966	101481	218842	25
26	163149	80339	213527	85679	190438	188029	89085	208226	241268	207898	111127	218468	26
27	198201	80201	213006	86049	194704	152625	143245	208240	223765	213839	115692	218156	27
28	199056	167894	180777	158265	202415	101226	164983	208153	229829	212765	130753	218075	28
29	199708		131974	186881	202756	162285	164768	153606	232594	211527	137078	217917	29
30	200304		140607	186797	169776	198696	164529	60498	232284	208290	178664	217674	30
31	152485		148932		118537		163997	61210	207444		217712	31	

Mean 179211 163201 211660 175406 164413 160939 177240 163160 193401 211094 179127 211038
 Median 198201 170133 237940 184674 165337 162094 173889 163809 210551 214154 199533 217674
 Maximum 209642 251646 246117 235473 205068 203774 226276 208621 252227 237834 245649 227787
 Minimum 84386 73408 129916 85679 93587 97831 89085 60498 61779 119439 94727 159523
 Total 5555538 4569620 6561453 5262173 5096802 4828179 5494436 5057950 5802023 6543900 5373804 6542172

Summaries ----- Notes -----
 ----- All recorded data is continuous and reliable

Annual Mean 182707
 Ann. Median 197639
 Annual Total 66688050

Maximum Minimum
 Daily 252227 60497

Site C2H110 Left Principal Canal From Boskop Dam @ Naauwpoort Year 2004
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	217472	206780	110620	112412	84017	88575	144903	131381	61406	193364	202933	213332	1
2	217326	206830	110629	93769	109105	112912	123171	149353	61400	154945	202932	213882	2
3	217263	206041	111210	93769	121330	134114	90030	149195	86531	197092	202397	170474	3
4	217193	206045	102227	93771	121868	137773	105388	149219	127827	211397	200449	87006	4
5	216812	206099	95170	94018	122932	142963	112430	149330	182353	205974	172326	87608	5
6	215800	206333	95762	93882	124611	153997	112515	113643	205100	197434	126213	88141	6
7	215865	205705	96469	93764	105962	158637	112496	60280	205059	192292	136144	88800	7
8	216255	204995	96825	83909	71155	158658	112503	60267	204885	180898	139450	88977	8
9	216155	204612	96944	73080	82581	158867	97740	95036	204949	182762	139955	84056	9
10	214951	204196	95746	73084	88023	158870	75837	109074	172827	193087	139625	79233	10
11	212371	204055	98186	73130	88072	128244	108630	109046	113927	199873	139557	79307	11
12	212240	204118	98431	73095	98333	80948	122412	109109	171778	202713	156762	79690	12
13	212277	204217	99494	85512	112573	140462	122509	97301	207747	202641	184696	80031	13
14	218396	204164	100142	93658	112735	169092	122547	75760	231370	206945	195659	124969	14
15	232279	203309	100161	93753	112919	169156	122588	135335	231221	216983	215086	214786	15
16	245518	201828	100076	93749	149641	169187	104818	161021	231148	216142	229766	214914	16
17	244521	200955	100026	93764	166483	169114	73747	173966	197642	214146	229569	209918	17
18	243918	200542	100034	113940	166000	137320	117016	194273	133139	214361	229257	199393	18
19	243755	200738	100068	109690	166014	75254	135398	194181	191763	214358	226023	199422	19
20	217815	201146	100093	106097	166167	143257	135351	161711	213613	214358	226742	181874	20
21	208108	201275	100345	112094	133510	174684	135273	110180	213637	209618	227323	135108	21
22	208105	201057	113732	113005	82662	174681	135304	163315	213623	209685	224526	105440	22
23	208433	169750	119243	86504	121999	174642	110605	185644	187376	208701	221087	105636	23
24	208470	113247	119249	95348	140293	174677	72677	180681	140766	209018	215490	85584	24
25	207179	96391	119243	123659	140619	141059	122343	172907	140967	208405	214591	69228	25
26	205880	103100	107144	122897	140753	88132	151414	173616	193855	206425	214270	69165	26
27	206652	111453	85873	124874	145039	126854	163161	128459	213467	209246	211931	154046	27
28	206913	110564	112841	127175	128451	144860	163041	61135	213575	211024	211792	157673	28
29	207355	110849	122260	127918	88898	144839	163073	61337	213591	176233	212573	121538	29
30	206936		120712	109734	88958	144864	134370	61375	213463	102692	212639	103948	30
31	206524		85648		88736		86543	61396		175618		72993	31

Mean 217056 182772 103697 99502 118401 142556 119027 127049 179333 198014 195392 127941
 Median 215800 203309 100093 93827 121330 144850 122343 131381 201263 206425 211861 105440
 Maximum 245518 206830 122260 127918 166483 174684 163161 194273 231370 216983 229766 214914
 Minimum 205880 96391 85648 73080 71155 75254 72677 60267 61400 102692 126213 69165
 Total 6728735 5300394 3214603 2985053 3670437 4276692 3689834 3938527 5380004 6138430 5861763 3966173

Summaries ----- Notes -----
 ----- All recorded data is continuous and reliable

Annual Mean 150684
 Ann. Median 143109
 Annual Total 55150647

Maximum Minimum
 Daily 245517 60267

Site C2H110 Left Principal Canal From Boskop Dam @ Naauwpoort Year 2005
 VarFrom 100.00 Water Level in Metres Table Type Total
 VarTo 150.00 Stream Discharge Volume in Cubic Metres
 Figures are for period starting 0 hours.

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Day
1	73128	149983	202219	143959	125574	143155	133175	[]M []M []M []M []M	1				
2	134542	150329	202611	83380	140194	143701	84170	[]M []M []M []M []M	2				
3	164783	155502	201442	148781	140345	132403	153495	[]M []M []M []M []M	3				
4	184784	136842	164741	177247	140627	98066	174154	[]M []M []M []M []M	4				
5	206079	77698	98148	176563	140704	99458	176782	[]M []M []M []M []M	5				
6	210947	169089	167173	176195	125779	100064	182232	[]M []M []M []M []M	6				
7	197555	207434	204631	174262	98583	101950	189136	[]M []M []M []M []M	7				
8	176078	206850	219453	148061	134685	102387	149169	[]M []M []M []M []M	8				
9	213022	206720	215673	98164	153598	102254	92003	[]M []M []M []M []M	9				
10	226639	206449	213125	151732	153681	101853	157346	[]M []M []M []M []M	10				
11	225921	182819	175466	175001	153663	101434	181475	[]M []M []M []M []M	11				
12	225374	143372	107127	175029	153393	142751	169115	[]M []M []M []M []M	12				
13	225882	174547	178404	175637	134720	155091	189015	[]M []M []M []M []M	13				
14	167539	210482	210961	175954	87530	152727	188138	[]M []M []M []M []M	14				
15	105036	211287	211838	160539	121091	153191	153666	[]M []M []M []M []M	15				
16	127293	210932	212045	116344	140007	153825	87273	[]M []M []M []M []M	16				
17	140975	203560	212389	148736	134661	134829	155583	[]M []M []M []M []M	17				
18	138554	173818	176231	164591	139884	95574	181418	[]M []M []M []M []M	18				
19	146422	95681	97680	165015	157683	142497	180085	[]M []M []M []M []M	19				
20	96107	175148	98310	165150	138299	161741	178378	[]M []M []M []M []M	20				
21	96605	208540	127712	165254	137930	158073	176970	[]M []M []M []M []M	21				
22	97072	206717	140635	137436	141549	155480	152762	[]M []M []M []M []M	22				
23	97208	205260	141149	80464	143612	156228	94652	[]M []M []M []M []M	23				
24	97354	204714	124787	124759	143573	137800	155439	[]M []M []M []M []M	24				
25	117398	161626	92454	146930	143222	105269	176749	[]M []M []M []M []M	25				
26	148797	89319	92547	146946	143289	149965	174691	[]M []M []M []M []M	26				
27	149034	167639	92809	146786	143137	166298	175254	[]M []M []M []M []M	27				
28	149213	202239	92719	146786	143168	164158	177319	[]M []M []M []M []M	28				
29	149444	120094	129578	143289	164440	142545	[]M []M []M []M []M	29					
30	149740	172498	98849	143089	158046	87602	[]M []M []M []M []M	30					
31	149920	171731	143063	159431	[]M []M []M	[]M []M []M	[]M []M []M	31					
Mean	154466	174807	159316	147471	138181	134490	155781	[]M []M []M []M []M					
Median	149213	178984	171731	148759	140704	142953	169115	[]M []M []M []M []M					
Maximum	226639	211287	219453	177247	157683	166298	189136	[]M []M []M []M []M					
Minimum	73128	77698	92454	80464	87530	95574	84170	[]M []M []M []M []M					
Total	4788441	4894599	4938801	4424128	4283622	4034709	4829225	[]M []M []M []M []M					
Missing Days	0	0	0	0	0	0	0	31	30	31	30	31	

Summaries

Notes

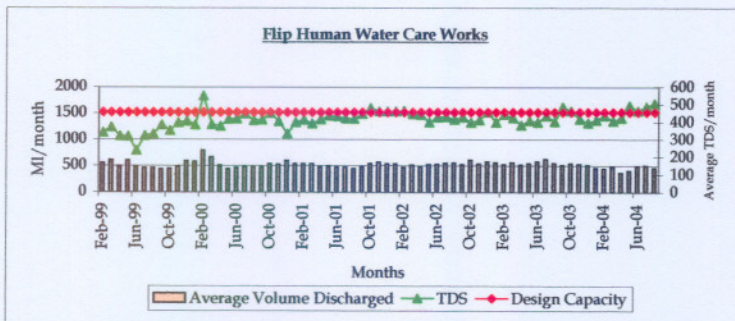
All recorded data is continuous and reliable except where the following tags are used...

Annual Mean 151856 M ... Missing Data
 Ann. Median 150156
 Annual Total 32193525
 Missing Days 153

Maximum Minimum
 Daily 226639 73127

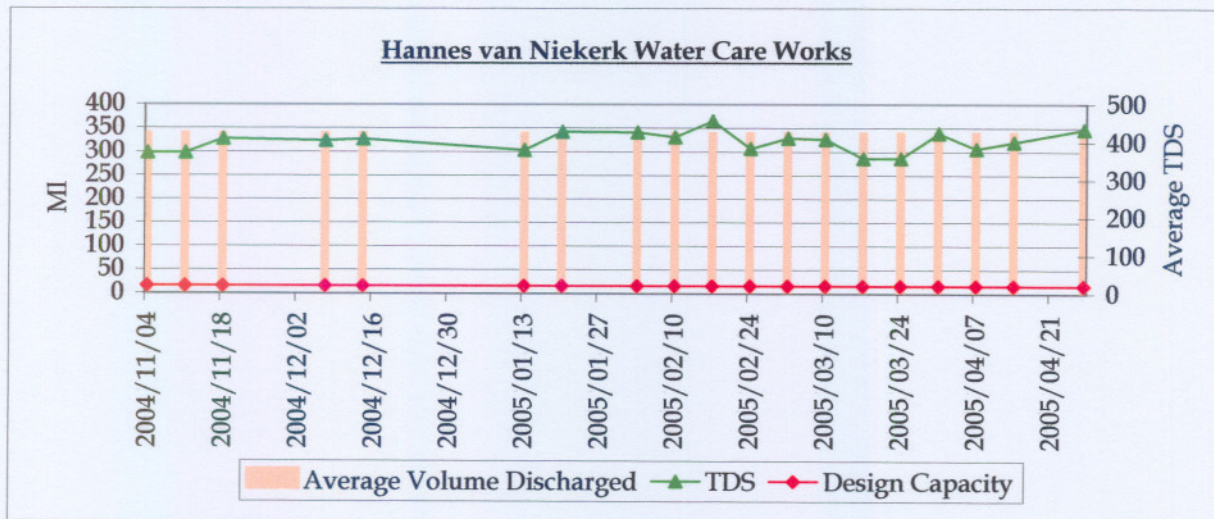
Flip Human Water Care Works

Time Period	TDS	Design Capacity (MI/month)	Average Volume Discharged (MI)
Feb-99	342	1525	552.745
Mar-99	373	1525	606.977
Apr-99	321	1525	493.244
May-99	319	1525	602.632
Jun-99	238	1525	478.851
Jul-99	323	1525	460.526
Aug-99	333	1525	456.604
Sep-99	385	1525	433.633
Oct-99	352	1525	445.3
Nov-99	397	1525	479.949
Dec-99	407	1525	590.494
Jan-00	385	1525	576.105
Feb-00	551	1525	786.371
Mar-00	386	1525	660.061
Apr-00	378	1525	503.205
May-00	417	1525	442.189
Jun-00	420	1525	465.407
Jul-00	449	1525	483.413
Aug-00	410	1525	476.872
Sep-00	414	1525	478.332
Oct-00	452	1525	538.287
Nov-00	405	1525	524.33
Dec-00	335	1525	596.577
Jan-01	399	1525	538.195
Feb-01	413	1525	533.322
Mar-01	392	1525	535.014
Apr-01	415	1525	481.99
May-01	438	1525	496.963
Jun-01	433	1525	475.918
Jul-01	421	1525	470.536
Aug-01	420	1525	446.413
Sep-01	448	1525	484.43
Oct-01	482	1525	543.503
Nov-01	462	1525	565.521
Dec-01	463	1525	537.924
Jan-02	463	1525	533.923
Feb-02	467	1525	468.152
Mar-02	447	1525	514.44
Apr-02	442	1525	490.17
May-02	399	1525	522.714
Jun-02	428	1525	532.143
Jul-02	430	1525	546.136
Aug-02	415	1525	553.542
Sep-02	429	1525	524.416
Oct-02	397	1525	607.273
Nov-02	412	1525	536.626
Dec-02	457	1525	576.919
Jan-03	399	1525	561.01
Feb-03	444	1525	523.909
Mar-03	424	1525	558.99
Apr-03	384	1525	519.176
May-03	408	1525	543.946
Jun-03	399	1525	576.209
Jul-03	435	1525	625.714
Aug-03	403	1525	549.785
Sep-03	488	1525	511.071
Oct-03	464	1525	541.067
Nov-03	418	1525	530.897
Dec-03	396	1525	512.474
Jan-04	412	1525	458.393
Feb-04	438	1525	447.995
Mar-04	407	1525	477.938
Apr-04	422	1525	369.708
May-04	495	1525	404.41
Jun-04	464	1525	491.329
Jul-04	488	1525	497.918
Aug-04	508	1525	457.112
Average for the Period	416	1525	519.51



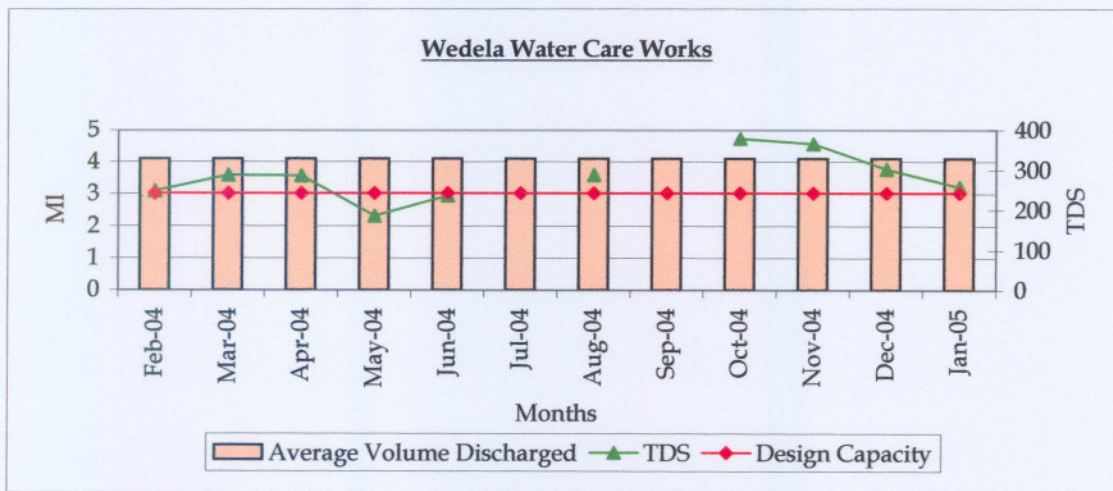
Hannes van Niekerk Water Care Works

Time Period	TDS	Design Capacity (MI/day)	Average Volume Discharged (MI/month)
Nov-04	373	16.5	335.5
Nov-04	373	16.5	335.5
Nov-04	410	16.5	335.5
Dec-04	405	16.5	335.5
Dec-04	409	16.5	335.5
Jan-05	380	16.5	335.5
Jan-05	428	16.5	335.5
Feb-05	427	16.5	335.5
Feb-05	414	16.5	335.5
Feb-05	457	16.5	335.5
Feb-05	384	16.5	335.5
Mar-05	412	16.5	335.5
Mar-05	408	16.5	335.5
Mar-05	358	16.5	335.5
Mar-05	358	16.5	335.5
Mar-05	424	16.5	335.5
Apr-05	383	16.5	335.5
Apr-05	401	16.5	335.5
Apr-05	434	16.5	335.5
Average for the Period	402	16.5	335.5



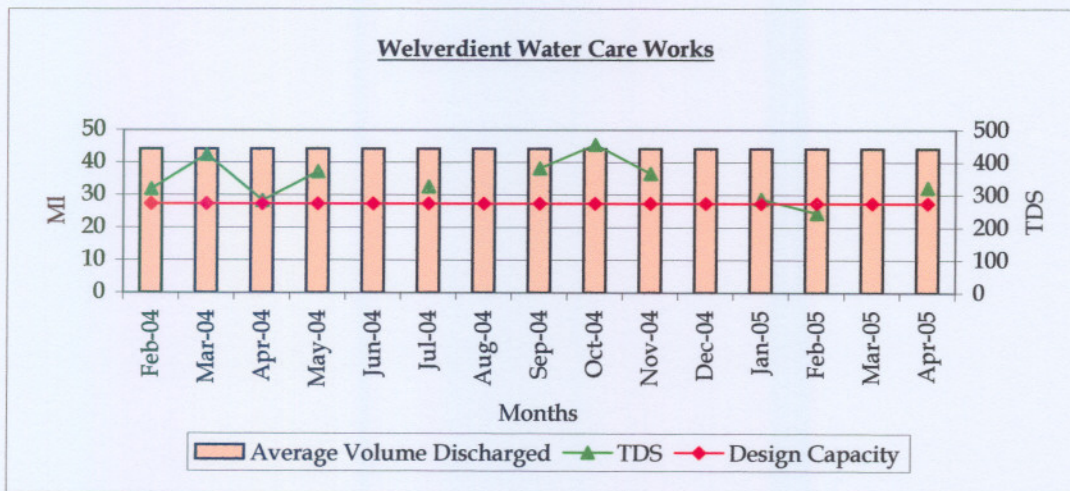
Wedela Water Care Works

Time Period	TDS	Design Capacity (MI)	Average Volume Discharged (MI)
Feb-04	248	3.03	4.1
Mar-04	288	3.03	4.1
Apr-04	286	3.03	4.1
May-04	186	3.03	4.1
Jun-04	236	3.03	4.1
Jul-04		3.03	4.1
Aug-04	288	3.03	4.1
Sep-04		3.03	4.1
Oct-04	379	3.03	4.1
Nov-04	365	3.03	4.1
Dec-04	302	3.03	4.1
Jan-05	258	3.03	4.1
Average for the Period	284	3.0	4.1



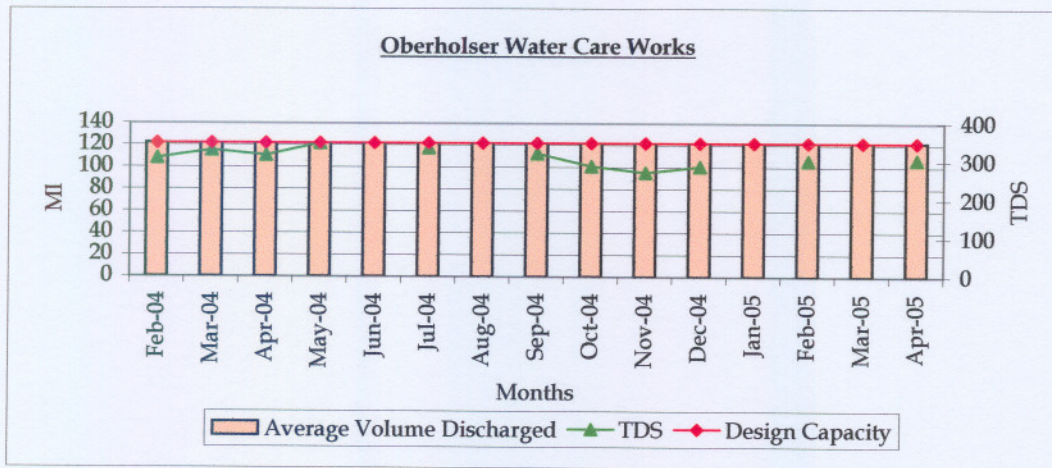
Welverdient Water Care Works

Time Period	TDS	Design Capacity (MI)	Average Volume Discharged (MI)
Feb-04	320	27.45	44.225
Mar-04	425	27.45	44.225
Apr-04	284	27.45	44.225
May-04	373	27.45	44.225
Jun-04		27.45	44.225
Jul-04	327	27.45	44.225
Aug-04		27.45	44.225
Sep-04	383	27.45	44.225
Oct-04	455	27.45	44.225
Nov-04	366	27.45	44.225
Dec-04		27.45	44.225
Jan-05	288	27.45	44.225
Feb-05	244	27.45	44.225
Mar-05		27.45	44.225
Apr-05	323	27.45	44.225
Average for the Period	344	27.5	44.2



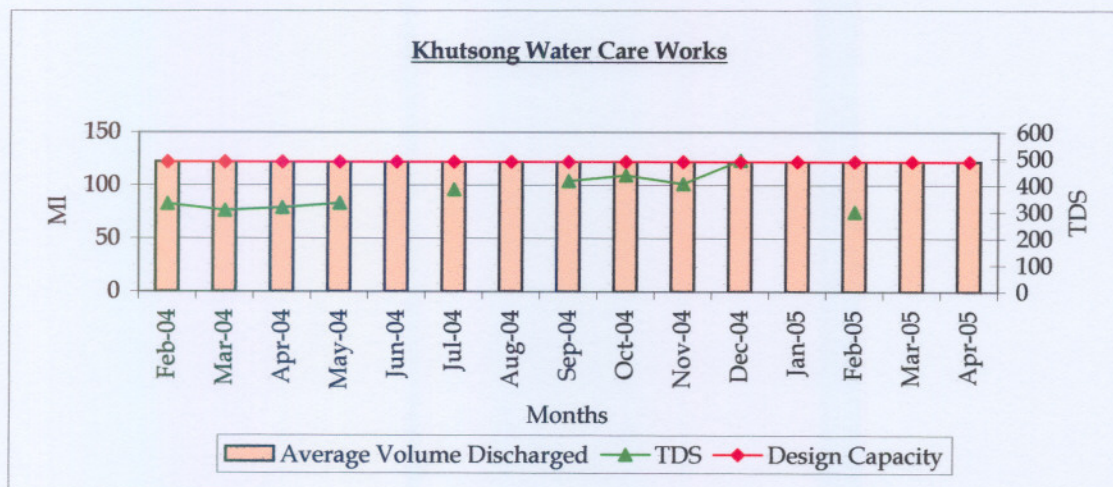
Oberholser Water Care Works

Time Period	TDS	Design Capacity (MI)	Average Volume Discharged (MI)
Feb-04	309	122	122
Mar-04	330	122	122
Apr-04	317	122	122
May-04	348	122	122
Jun-04		122	122
Jul-04	336	122	122
Aug-04		122	122
Sep-04	322	122	122
Oct-04	289	122	122
Nov-04	272	122	122
Dec-04	288	122	122
Jan-05		122	122
Feb-05	303	122	122
Mar-05		122	122
Apr-05	305	122	122
Average for the Period	311	122.0	122.0



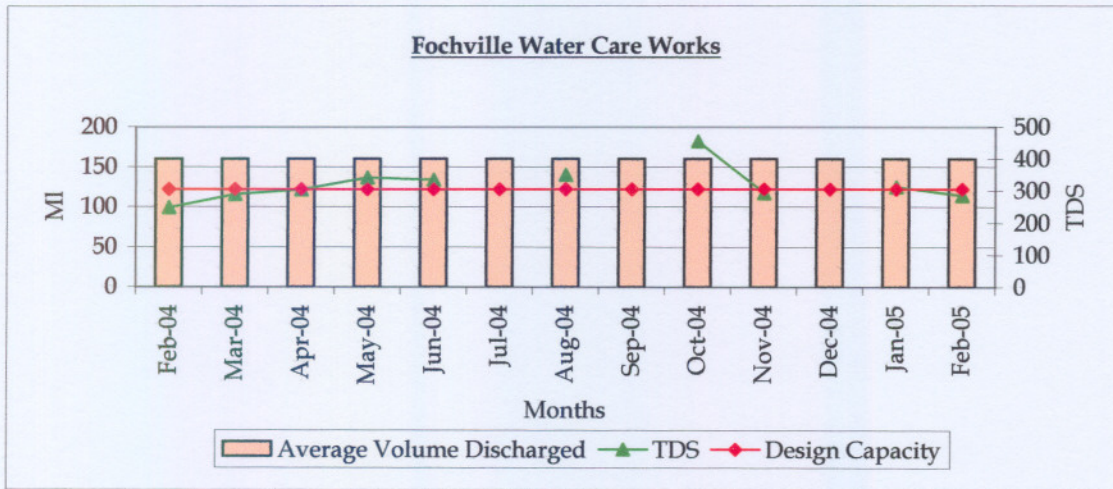
Khutsong Water Care Works

Time Period	TDS	Design Capacity (MI)	Average Volume Discharged (MI)
Feb-04	331	122	122
Mar-04	306	122	122
Apr-04	317	122	122
May-04	333	122	122
Jun-04		122	122
Jul-04	384	122	122
Aug-04		122	122
Sep-04	416	122	122
Oct-04	437	122	122
Nov-04	406	122	122
Dec-04	495	122	122
Jan-05		122	122
Feb-05	300	122	122
Mar-05		122	122
Apr-05	322	122	122
Average for the Period	368	122.0	122.0



Fochville Water Care Works

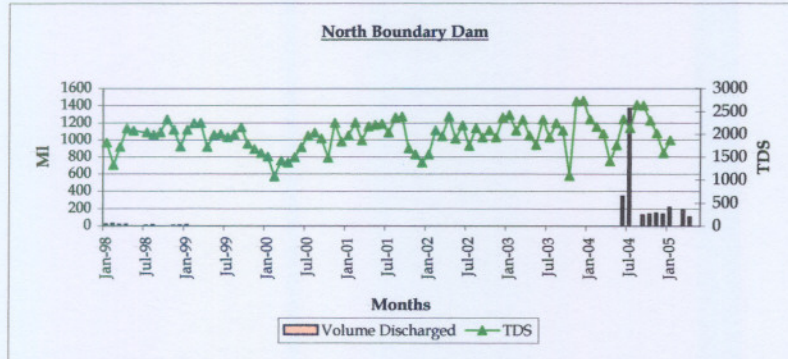
Time Period	TDS	Design Capacity (MI)	Average Volume Discharged (MI)
Feb-04	248	122	160.125
Mar-04	290	122	160.125
Apr-04	304	122	160.125
May-04	342	122	160.125
Jun-04	335	122	160.125
Jul-04		122	160.125
Aug-04	351	122	160.125
Sep-04		122	160.125
Oct-04	456	122	160.125
Nov-04	293	122	160.125
Dec-04		122	160.125
Jan-05	312	122	160.125
Feb-05	286	122	160.125
Average for the Period	322	122	160



AngloGold Ashanti - North Boundary Dam

Time Period	TDS	Average Volume Discharged (MI)
Jan-98	1822	18.859
Feb-98	1327	23.965
Mar-98	1727	16
Apr-98	2133	13.2
May-98	2086	0
Jul-98	2047	2.448
Aug-98	1992	11.47
Sep-98	2050	0.712
Oct-98	2333	0.2
Nov-98	2102	4.5
Dec-98	1734	7.5
Jan-99	2101	11.706
Feb-99	2251	
Mar-99	2256	
Apr-99	1725	
May-99	1992	
Jun-99	2013	
Jul-99	1940	
Aug-99	2000	
Sep-99	2160	
Oct-99	1790	
Nov-99	1675	
Dec-99	1586	
Jan-00	1507	
Feb-00	1079	
Mar-00	1421	
Apr-00	1382	
May-00	1494	
Jun-00	1719	
Jul-00	1974	
Aug-00	2044	
Sep-00	1910	
Oct-00	1484	
Nov-00	2253	
Dec-00	1844	
Jan-01	1981	
Feb-01	2262	
Mar-01	1870	
Apr-01	2178	
May-01	2214	
Jun-01	2233	
Jul-01	2038	
Aug-01	2374	
Sep-01	2393	
Oct-01	1693	
Nov-01	1556	
Dec-01	1378	
Jan-02	1558	
Feb-02	2092	
Mar-02	1962	
Apr-02	2393	
May-02	1901	
Jun-02	2202	
Jul-02	1747	
Aug-02	2139	
Sep-02	1932	
Oct-02	2091	
Nov-02	1931	
Dec-02	2370	
Jan-03	2427	
Feb-03	2081	
Mar-03	2323	
Apr-03	1969	
May-03	1767	
Jun-03	2321	
Jul-03	1932	
Aug-03	2250	
Sep-03	2081	
Oct-03	1089	
Nov-03	2726	
Dec-03	2740	
Jan-04	2330	
Feb-04	2163	
Mar-04	2015	
Apr-04	1410	
May-04	1759	
Jun-04	2331	345
Jul-04	2140	1366

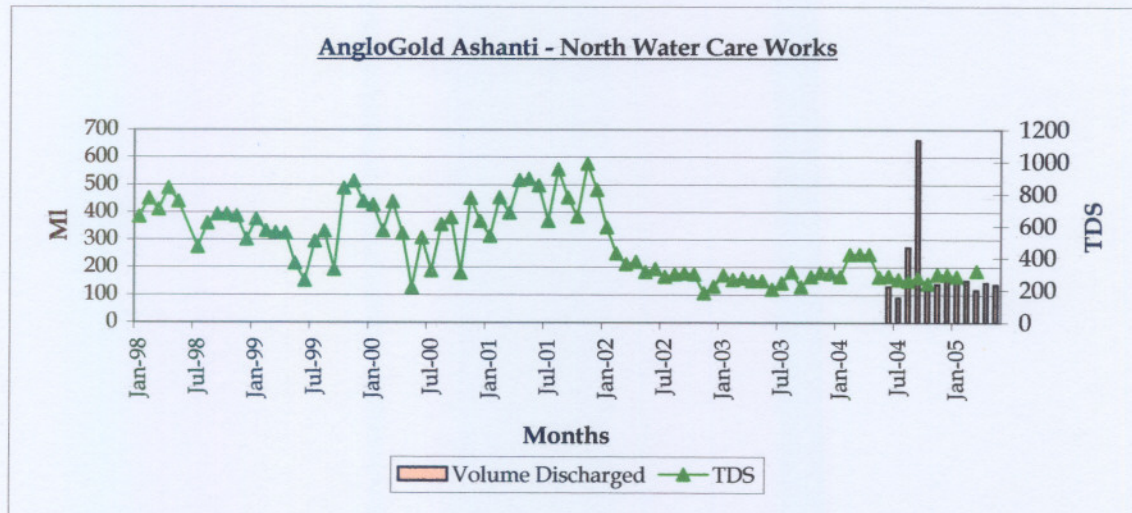
Aug-04	2645	
Sep-04	2632	129
Oct-04	2301	141
Nov-04	2024	150
Dec-04	1583	140
Jan-05	1868	216.211
Feb-05		
Mar-05		187.244
Apr-05		105.186
May-05		
Average for the Period	1980	137



AngloGold Ashanti - North Water Care Works

Time Period	TDS	Average Volume Discharged (MI)
Jan-98	659	
Feb-98	774	
Mar-98	705	
Apr-98	839	
May-98	756	
Jul-98	470	
Aug-98	618	
Sep-98	675	
Oct-98	675	
Nov-98	664	
Dec-98	518	
Jan-99	647	
Feb-99	571	
Mar-99	559	
Apr-99	558	
May-99	370	
Jun-99	261	
Jul-99	507	
Aug-99	570	
Sep-99	330	
Oct-99	839	
Nov-99	881	
Dec-99	756	
Jan-00	735	
Feb-00	572	
Mar-00	755	
Apr-00	556	
May-00	216	
Jun-00	529	
Jul-00	322	
Aug-00	611	
Sep-00	654	
Oct-00	309	
Nov-00	775	
Dec-00	633	
Jan-01	538	
Feb-01	780	
Mar-01	684	
Apr-01	888	
May-01	896	
Jun-01	855	
Jul-01	632	
Aug-01	955	
Sep-01	779	
Oct-01	660	
Nov-01	990	
Dec-01	827	
Jan-02	593	
Feb-02	431	
Mar-02	363	
Apr-02	380	
May-02	314	
Jun-02	333	

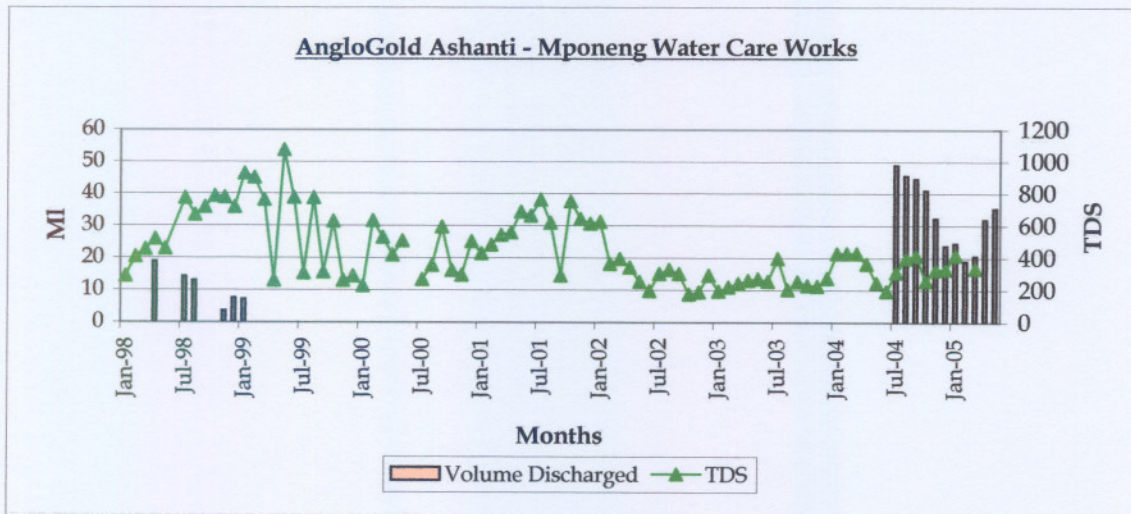
Jul-02	284	
Aug-02	301	
Sep-02	307	
Oct-02	301	
Nov-02	182	
Dec-02	223	
Jan-03	294	
Feb-03	265	
Mar-03	274	
Apr-03	259	
May-03	259	
Jun-03	207	
Jul-03	246	
Aug-03	314	
Sep-03	221	
Oct-03	285	
Nov-03	311	
Dec-03	305	
Jan-04	285	
Feb-04	424	
Mar-04	424	
Apr-04	424	
May-04	282	
Jun-04	289	129
Jul-04	268	89
Aug-04	259	271
Sep-04	279	661
Oct-04	241	129
Nov-04	299	139
Dec-04	297	159
Jan-05	285	158.4
Feb-05		151.792
Mar-05	320	116.918
Apr-05		142.904
May-05		136.116
Average for the Period	496	217



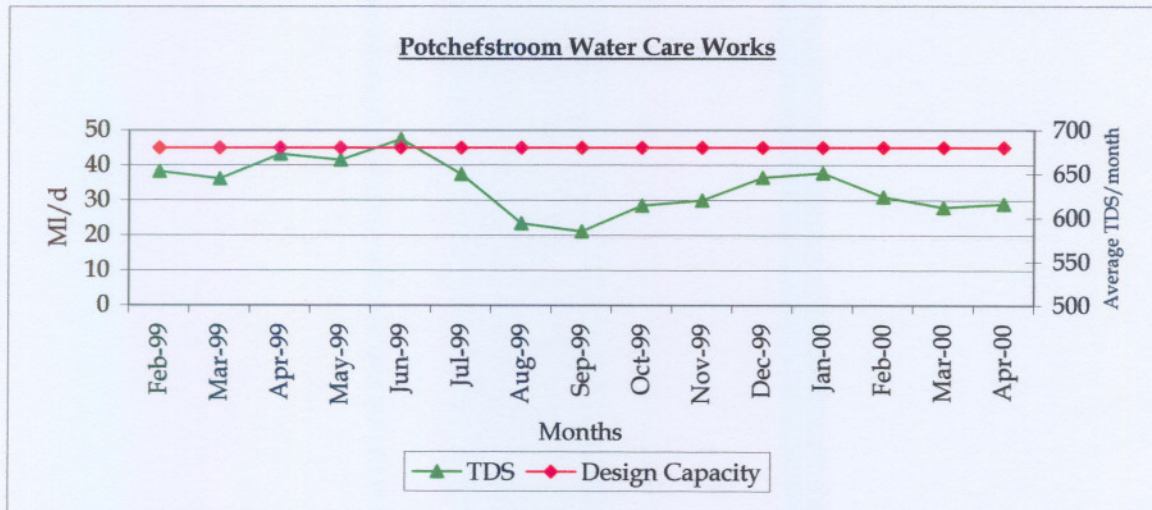
AngloGold Ashanti - Mponeng Water Care Works

Time Period	TDS	Average Volume Discharged (Ml)
Jan-98	290	0
Feb-98	409	0
Mar-98	454	0
Apr-98	519	18.828
May-98	458	0
Jul-98	775	14.128
Aug-98	668	12.913
Sep-98	719	0
Oct-98	786	0
Nov-98	779	3.579
Dec-98	718	7.518
Jan-99	928	7.121
Feb-99	903	
Mar-99	764	
Apr-99	262	
May-99	1077	
Jun-99	778	
Jul-99	306	
Aug-99	776	
Sep-99	312	
Oct-99	629	
Nov-99	261	
Dec-99	289	
Jan-00	228	
Feb-00	633	
Mar-00	529	
Apr-00	420	
May-00	508	
Jun-00		
Jul-00	267	
Aug-00	357	
Sep-00	594	
Oct-00	325	
Nov-00	295	
Dec-00	504	
Jan-01	429	
Feb-01	482	
Mar-01	543	
Apr-01	558	
May-01	689	
Jun-01	662	
Jul-01	764	
Aug-01	619	
Sep-01	292	
Oct-01	754	
Nov-01	644	
Dec-01	613	
Jan-02	625	
Feb-02	364	
Mar-02	396	
Apr-02	342	
May-02	253	
Jun-02	196	

Jul-02	303	
Aug-02	329	
Sep-02	303	
Oct-02	175	
Nov-02	189	
Dec-02	294	
Jan-03	195	
Feb-03	221	
Mar-03	242	
Apr-03	262	
May-03	271	
Jun-03	255	
Jul-03	398	
Aug-03	204	
Sep-03	254	
Oct-03	231	
Nov-03	227	
Dec-03	275	
Jan-04	429	
Feb-04	429	
Mar-04	429	
Apr-04	364	
May-04	246	
Jun-04	195	
Jul-04	310	49
Aug-04	399	46
Sep-04	416	45
Oct-04	257	41
Nov-04	326	32
Dec-04	330	24
Jan-05	418	25
Feb-05		19
Mar-05	337	21
Apr-05		32
May-05		35
Average for the Period	445	17

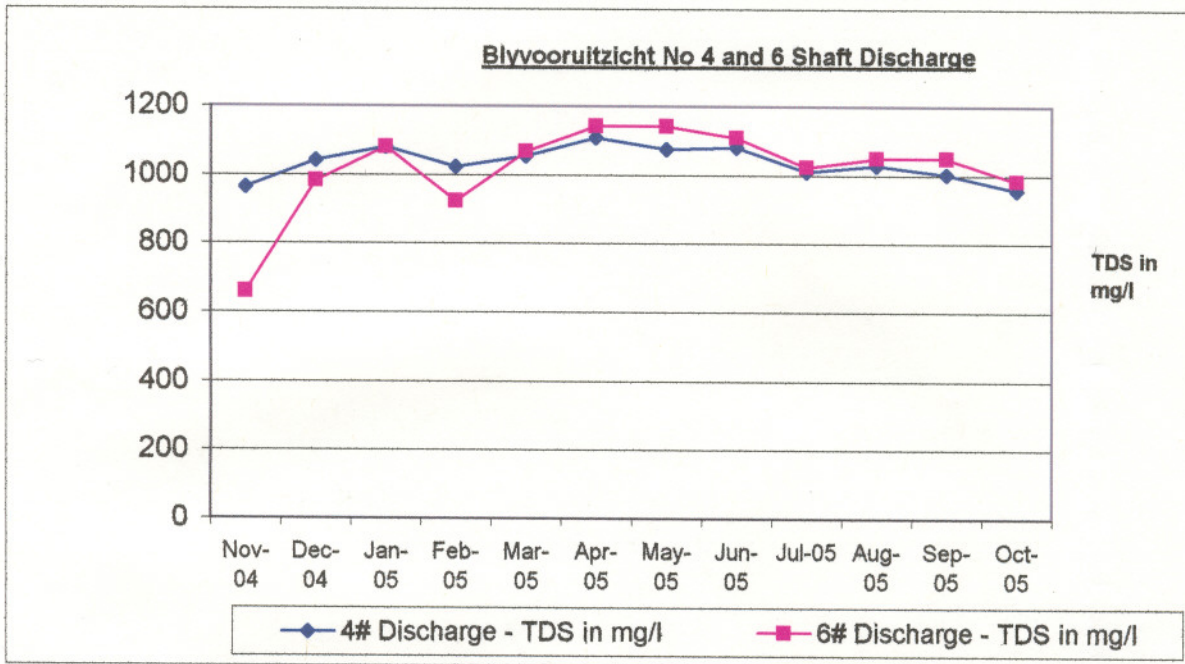


Time Period	TDS	Design Capacity (MI/day)	Average Volume Discharged (MI/month)
24-29 March 2005	653	45	30
29-4 April 2005	644.8	45	30
4-11 April 2005	672.8	45	30
12-18 April 2005	666	45	30
19-25 April 2005	690	45	30
26-2 May 2005	650	45	30
4-10 May 2005	594	45	30
11-16 May 2005	585	45	30
17-23 May 2005	614	45	30
24-30 May 2005	619.7	45	30
31-6 June 2005	646	45	30
7-13 June 2005	650.8	45	30
14-20 June 2005	624	45	30
21-27 June 2005	612	45	30
28-4 July 2005	616	45	30
Average for the Period	635.9	45	30



TDS Values for discharges from Blyvooruitzicht Gold Mine

Time Period	4# Discharge - TDS in mg/l	6# Discharge - TDS in mg/l	Discharge Volume (MI per day)	No.2 Sewage TDS	Design Capacity (MI per day)	Di
Nov-04	964	660	5.7	429	4	
Dec-04	1043	983	5.7	297	4	
Jan-05	1082	1082	5.7	422	4	
Feb-05	1023	924	5.7	297	4	
Mar-05	1056	1069	5.7	469	4	
Apr-05	1109	1142	5.7	370	4	
May-05	1076	1142	5.7	462	4	
Jun-05	1082	1109	5.7	660	4	
Jul-05	1010	1023	5.7	475	4	
Aug-05	1030	1049	5.7	469	4	
Sep-05	1003	1049	5.7	541	4	
Oct-05	957	983	5.7	475	4	
Average for the Period	1036.25	1017.92		447.17		

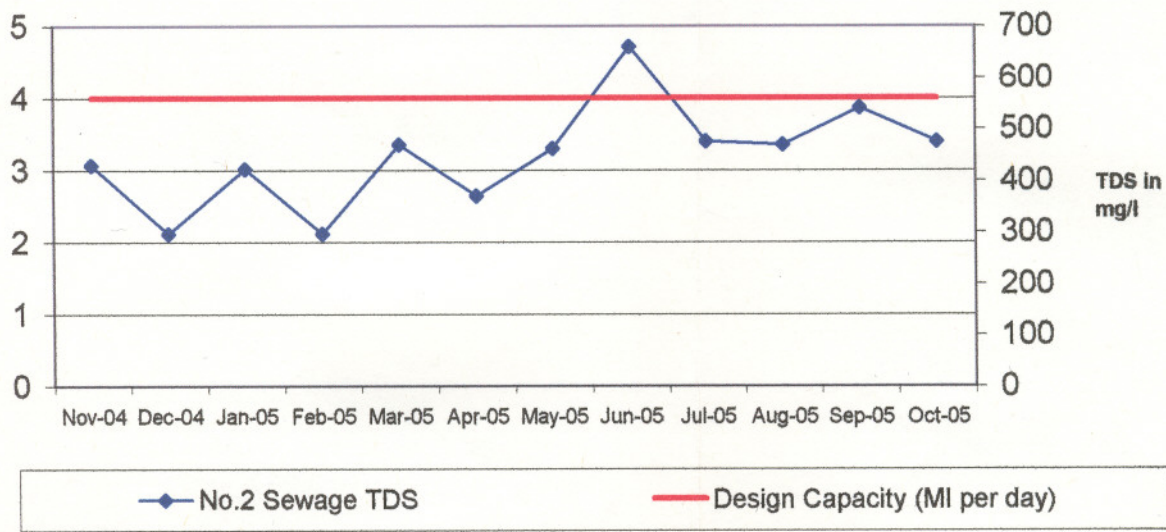


1036.25
1017.92
1027.085

2.
MI 1.
0.

Charge Volume (MI per day)	No.5 Sewage TDS	Design Capacity (MI per day)	Discharge Volume (MI per day)
5.576	409	2.5	1.12
5.576	277	2.5	1.12
5.576	232	2.5	1.12
5.576	570	2.5	1.12
5.576	732	2.5	1.12
5.576	746	2.5	1.12
5.576	752	2.5	1.12
5.576	772	2.5	1.12
5.576	799	2.5	1.12
5.576	739	2.5	1.12
5.576	726	2.5	1.12
5.576	733	2.5	1.12
	623.92		

Blyvooruitzicht No 2 Sewage Works Discharge



Blyvooruitzicht No 5 Shaft Water Care Works

