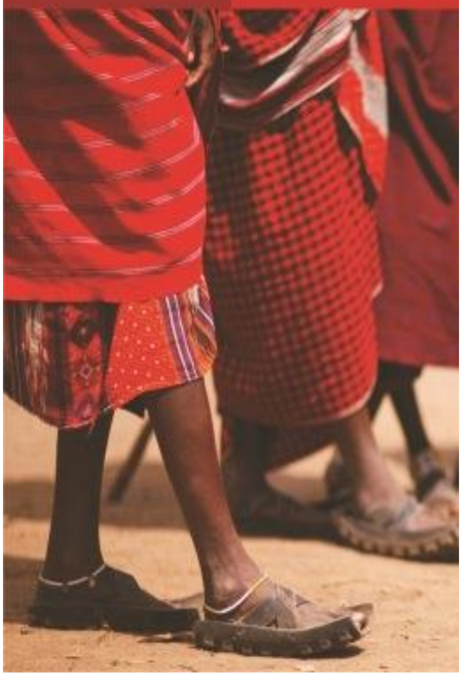

DIGBY WELLS
ENVIRONMENTAL

Environmental Authorisation for the BECSA Klipspruit Extension: Weltevreden

Surface Water Report

Project Number:

BHP2690

Prepared for:

BHP Billiton Energy Coal South Africa Proprietry Limited (BECSA)

January 2015

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Report Type:	Surface Water Report
Project Name:	Environmental Authorisation for the BECSA Klipspruit Extension: Weltevreden
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EXECUTIVE SUMMARY

Digby Wells Environmental (Digby Wells) has been appointed by BHP Billiton Energy Coal South Africa (Pty) Limited (BECSA) as the Environmental Assessment Practitioner (EAP) to conduct the Environmental Impact Assessment (EIA) and associated specialist studies for the proposed opencast development at Klipspruit Extension (KPSX) Weltevreden opencast coal mine. The KPSX: Weltevreden Project will extend the KPS LoM by at least another twenty (20) years. This report details the findings of the surface water assessment.

The Weltevreden project area is located in the Olifants Water Management Area 4 (WMA 4), with the proposed Project's footprint falling in quaternary catchments B11F and B20G. The majority of the study area falls within the quaternary catchment B20G, drained by the Saalklapspruit, a tributary of the Wilge River. The south-western portion of the site falls within the B11F catchment, which is bisected by the Olifants River.

The catchment is largely rural with grasslands and cultivated lands making up most of the land cover. The design rainfall for a 1:50 year of 129 mm was determined for the project site. The peak flows determined for the sub-catchments range from 28 to 208 m^3/s and 39 to 245 m^3/s for 1:50 and 1:100 flood events respectively.

The predominant uses of the surface water resources within the KPSX: Weltevreden catchments are agricultural, mining and power generation. The WARMS database of registered users identified that irrigation uses approximately 1,385,884 m^3/year whilst mining use 74,855 m^3/year.

Ten surface water sites were sampled during the July 2014 sampling run. The water quality results indicated already impacted surface water streams, and potentially from existing mining operations. The elevated parameters are TDS, Alkalinity, SO_4, Ca, Mg, Na, Mn and EC, which exceed the Interim WQO of the Wilge catchment. The water quality was worse in 2009 compared to the July 2014 results. The water quality interpretations are summarized as follows:

<u>Saalklapspruit system:</u>

- For sites Wel SW1, Wel SW2, Wel SW13, for the period of 2009: Site Wel SW1 had elevated levels of Cl, Alkalinity, SO_4, Na, Al and Fe. Site SW1 is close to existing mine works and thus the water quality could potentially be influenced negatively by contaminants from the mining operations;
- Site Wel SW7, a downstream point from the existing Klipspruit mining area, shows clean water during the 2014 sample run. However, in 2009 the water quality was of poor quality, with elevated TDS, Alk, SO_4, Ca, Mg, Na, Mn and EC, exceeding the Wilge IWQO;
- Site Wel SW8, most downstream point on the Saalklapspruit, shows elevated parameters of concern during the 2014 and 2009 sampling runs. These include Cl,

Alk, Na, K and Mn. Additional parameters which were above the IWQO in 2009 include SO_4, EC and Al. Site Wel SW08 is downstream of the Phola Sewage Treatment Works (STW) discharge point, which can possibly explain the poor water quality;

- Wel SW6 indicated high Na, Mg, Al and F concentrations during the 2009 sample run; exceeding the IWQO. There were no other activities in the area except the agricultural activities. These elements can be related to geology and the use of fertilizers; and
- Wel SW11 and Wel SW12 were sampled on tributaries to the Saalklapspruit which showed clean water during the 2014 sample run. These tributaries drain areas which have had no history of mining.

Grootspruit System:

- Wel SW14, located on a tributary of the Grootspruit presented clean water; and
- For sites Wel SW3, Wel SW5, Wel SW4, Upstream point on the Grootspruit: Site SW3 was dry in 2014, but in 2009 the results indicated clean water with only Al exceeding the IWQO. For the mid-Grootspruit sampling site (SW5), located within sand mining area, the water was clean both in 2009 and 2014. However, SW4, the most downstream point, indicated the most contamination. This site is located downstream of other mines, west and southwest of Clewer town, Anker's Elandsfontein Colliery, Highveld Steel, as well as an Anglo operation South of Clewer. There is elevated TDS, Cl, SO_4, Ca, Mg, Na and EC in both sampling events. There were records of a low pH in 2009.

Tweefonteinspruit System:

- Site Wel SW9, in the upper Tweefonteinspruit, upstream of Coalville town and south of a mined out area, had a poor water quality with levels exceeding the IRWQO for TDS, Cl, SO_4, Ca, Mg, Na, EC, Alk, K and Mn. The dirty water could be attributed to residual impacts from the mined out area upstream.

The impacts of existing activities on the surface water quality are evident in the two streams draining on the site; the Grootspruit and the Saalklapspruit. With the development of mining in these upstream catchments of the Wilge River, more pollution emanating from the proposed additional mining activities could add onto pollutants stream in the catchments if no mitigation measures are taken. Several impacts were determined and these include:

- The clearing of land in preparation for the construction of infrastructure and opencast mining pits will have negative impacts on the surface water quality. The contamination of water can result from soil erosion or from storm flow coming into contact with the overburden material, should the overburden be carbonaceous and/or pyritic;
- The water quantity can be affected as there will be a reduction of potential clean runoff water reporting to the catchment when dirty areas isolation is implemented;

- The opencast pits and ROM stockpiles will potentially result in contamination of surface water runoff from carbonaceous material in the overburden and ROM, as well as from accidental spillages of pit dewatering;
- The proposed mining through the non-perennial tributaries to the Saalklapspruit and the Grootspruit will result in destruction of these river sections. The downstream river regime could potentially alter in terms of flow. Construction within the floodplains should be avoided;
- Additional water use needs for mining will add strain onto the water demand of the catchment; and
- Water quality deterioration could result from spillages of fuels and other hydrocarbon containing materials like lubricants, chemicals from blasting material, as well as hazardous substances stored and used on site.

The cumulative impacts can result from carbonaceous material washed down into the downstream water resources. These could result in further increases in TDS, Alkalinity, SO_4, Ca, Mg, Na, Mn and EC.

The identified potential impacts however can be controlled by implementation of mitigation measures and ensuring zero discharge for dirty water. The following are some measures that can be implemented:

- Ensure that spillage control kits are available during transport and on storage sites in case of any accidental leakage or spillages, which can then be cleared immediately;
- The temporary storage of fuel, lubricants and explosives must be in a hard park, roofed and bunded facility. This will prevent contamination of soils and the possibility of contamination of the surface water catchment on site after storm water runoff;
- Surface water clean and dirty water channels should be constructed to divert runoff to appropriate storage dams (dirty water should be directed to the PCD) to avoid eroded soils entering the clean water catchment dam on site. This protects the downstream water uses whilst also preventing runoff from reporting downstream;
- Conveyors transporting the coal should be stable and covered on the top to avoid flushing of the coal by rain into the natural environment;
- Haul road speed limits should be adhered to prevent spillages from speeding trucks, and the trucks should be covered so that no material spills out onto the roads;
- Monitoring of vegetation establishment should be done so that areas where there is poor growth could be re-vegetated;
- Monitoring should be implemented in the streams to identify residual impacts on water quality from decant or spillages. Once the contamination is managed, the post closure rehabilitation and monitoring will further enhance positive impacts on water quality (removal of erosion source), as well as the restoration of storm water flow to the catchment after mining; and

- Post closure monitoring should continue for an additional 3 years to capture post closure residual impacts.

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Al	Aluminium
Alk	Total Alkalinity as $CaCO_3$
BECSA	BHP Billiton Energy Coal South Africa (Pty) Limited
BPG	Best Practice Guidelines
Ca	Calcium as
Cl	Chloride
Digby Wells	Digby Wells Environmental
DRE	Design Rainfall Estimation
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
Fe	Iron
F	Fluoride
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water and Waste Management Plan
Interim RWQO	Interim Resource Water Quality Objectives
KPSX	Klipspruit Extension
K	Potassium
MAE	Mean Annual Evaporation
MAR	Mean Annual Runoff
MAP	Mean Annual Precipitation
NE	Not Evaluated

NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
Mn	Manganese
Mg	Magnesium
N	Free and Saline Ammonia
Na	Sodium
$N0_3$	Nitrate
pH	pH-Value at 25°C
SWMP	Storm Water Management Plan
SO_4	Sulfate
TDS	Total Dissolved Solids (TDS)
WRC	Water Research Commission

1 Introduction

Digby Wells Environmental (Digby Wells) has been appointed by BHP Billiton Energy Coal South Africa Proprietary Limited (BECSA) as the Environmental Assessment Practitioner (EAP) to conduct the Environmental Impact Assessment (EIA) and associated specialist studies for the proposed opencast development at Klipspruit Extension (KPSX) Weltevreden Project. The KPSX: Weltevreden Project will extend the KPS Life of Mine (LoM) by at least another twenty (20) years. This report details the surface water assessment completed for the proposed Project area.

1.1 Legislation

The specialist surface water assessment complies with South African legislation for environmental authorisations, most specifically the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

In accordance with Section 21 and Section 49 of the NWA, an application for a Water Use Licence Application (WULA) will be submitted to the Department of Water and Sanitation (DWS) for the various water uses at KPSX: Weltevreden. An Integrated Water and Waste Management Plan (IWWMP) will be developed to manage the water resources and waste streams produced during the mining operations.

Other water related legislation and guidelines are also applied namely the DWS Best Practice Guidelines (BPGs) (2006) and the Regulations to the NWA, the Regulations 704 of 1999.

2 Terms of Reference

The surface water assessment detailed in this report is based on the following terms of reference:

- A site visit for the collection of water samples for determination of the baseline surface water quality. The baseline surface water quality will be benchmarked against standards defined for the Wilge River Catchment; based on preliminary standards from the DWS, 2009;
- A river hydrology assessment;
- A detailed surface water impacts identification and rating based on the project description, and proposed mitigation measures over the Life of Mine (LoM);
- Develop a surface water management plan for implementation throughout the life of the Project (subject to annual audit and review/revision). The management plan is to indicate the period of implementation and the responsible personnel;
- A recommended surface water monitoring programme indicating the variables to be analysed, frequency of analyses, data management and reporting; and

- A conceptual Storm Water Management Plan (SWMP) as prescribed by the Best Practice Guideline (BPG) G1: Storm Water Management (DWA, 2006) prepared for the proposed infrastructure.

3 Methodology

The surface water assessment was carried out in three phases namely:

- A desktop study to characterize the site, identify water sampling points and to conduct hydrological characterization, site characterisation, catchment and water use description. The catchment attributes namely Mean Annual Runoff (MAR), Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) were obtained from the Water Research Commission (WRC) Report K5/1491 (WRC, 2005). Extreme event rainfall depths were determined from the South African Weather Services (SAWS) rainfall information database using data from 3 sites within a 20 kilometre (km) radius. A 24 hour design rainfall depth model was run on the Design Rainfall Estimation (DRE) in South Africa software (Smithers and Schulze, 2003), for the 1:50 and 1:100 year return periods;
- A site visit to assess the site characteristics and collect surface water quality samples. Upstream and downstream surface water quality locations were sampled ; and
- Report compilation including the following:
  - Water quality baseline status benchmarked against the Wilge River catchment Interim Resource Water Quality Objectives (I RWQO) set out by the Department of Water and Sanitation (DWS);
  - Potential impacts identification, rating pre- and post-mitigation for a list of anticipated project activities;
  - Recommendation of mitigation measures to minimise or reduce impacts on the surface water quantity and quality;
  - Development of a surface water quality monitoring programme indicating monitoring points, frequency of monitoring, database management and reporting; and
  - Documentation of the Storm Water Management Plan (SWMP) and the hydrologic modelling performed for the study area.

There are several reports available that have been utilized in the compilation of this report, including:

- Weltevreden Surface Water Quality Report (Jaco – K Consulting, 2009);
- New Largo and Weltevreden Feasibility Study, Aquatics Report (Oryx Environmental, 2004); and

- Aquatic Ecological Assessment of the Riverine Resources in the Vicinity of the Proposed Weltevreden Colliery Development (Scientific Aquatic Services, 2009).

4 Study Area

The KPSX: Weltevreden Project area is located north of Ogies on both sides of the N12 highway, in the Mpumalanga Province (Figure 4-1). The Project area includes the farms Grootpan 7 IS, Hartebeestlaagte 325 JS, Tweefontein 328 JS, Weltevreden 324 JS and Wildebeestfonein 327 JS. The dominant land use in the greater study region is a combination of coal mining and agriculture. The project area summary is detailed in Table 4-1.

Table 4-1: Summary of the project site areas

Project Area Summary	
Infrastructure area in hectares	2,661.8
Project area in hectares	7,353.9
% area Infrastructure	36%

The proposed infrastructure will have linear structures such as haul roads and conveyors which will cross streams. There are 14 stream crossings as shown in Figure 4-2.

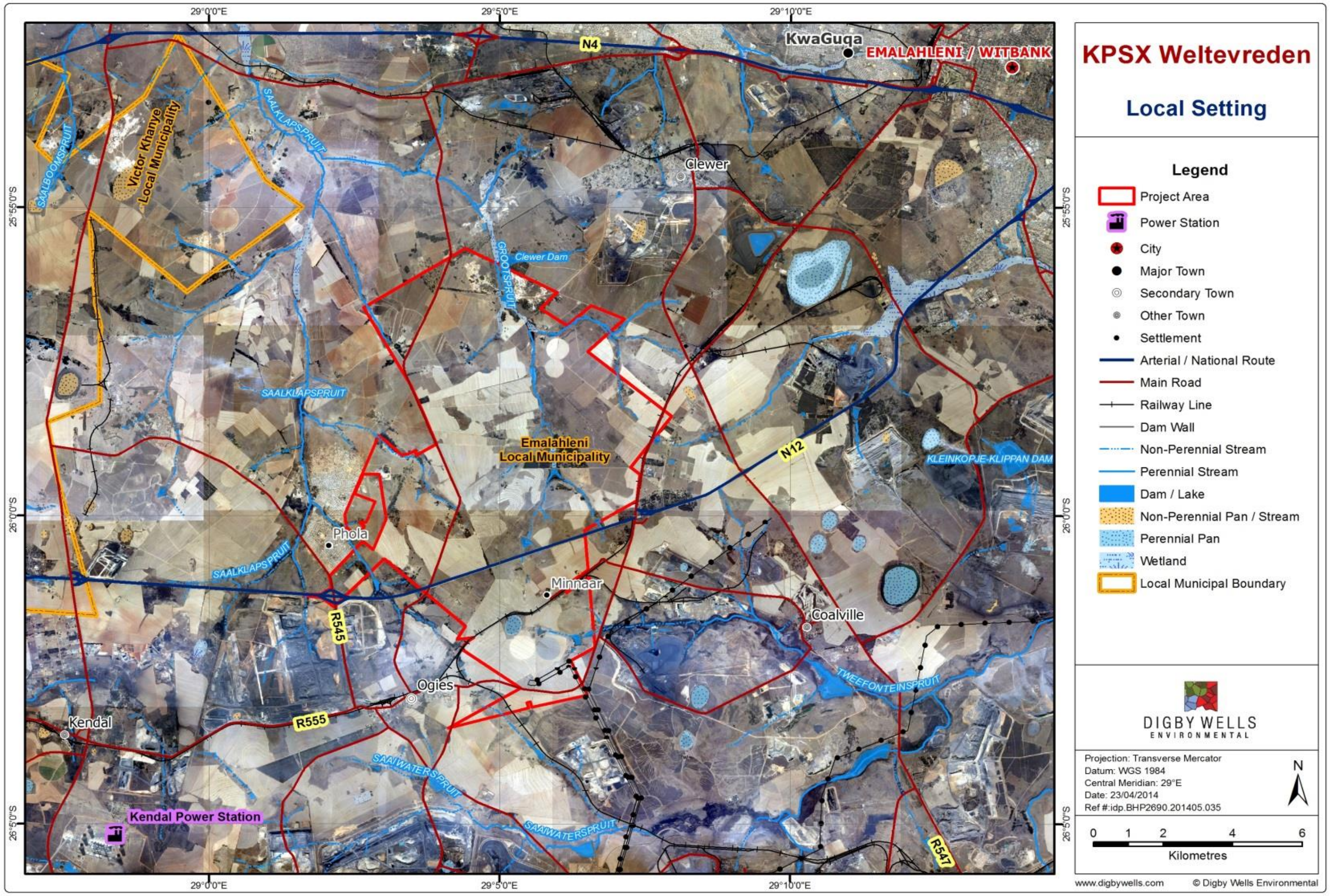

Figure 4-1: Local setting

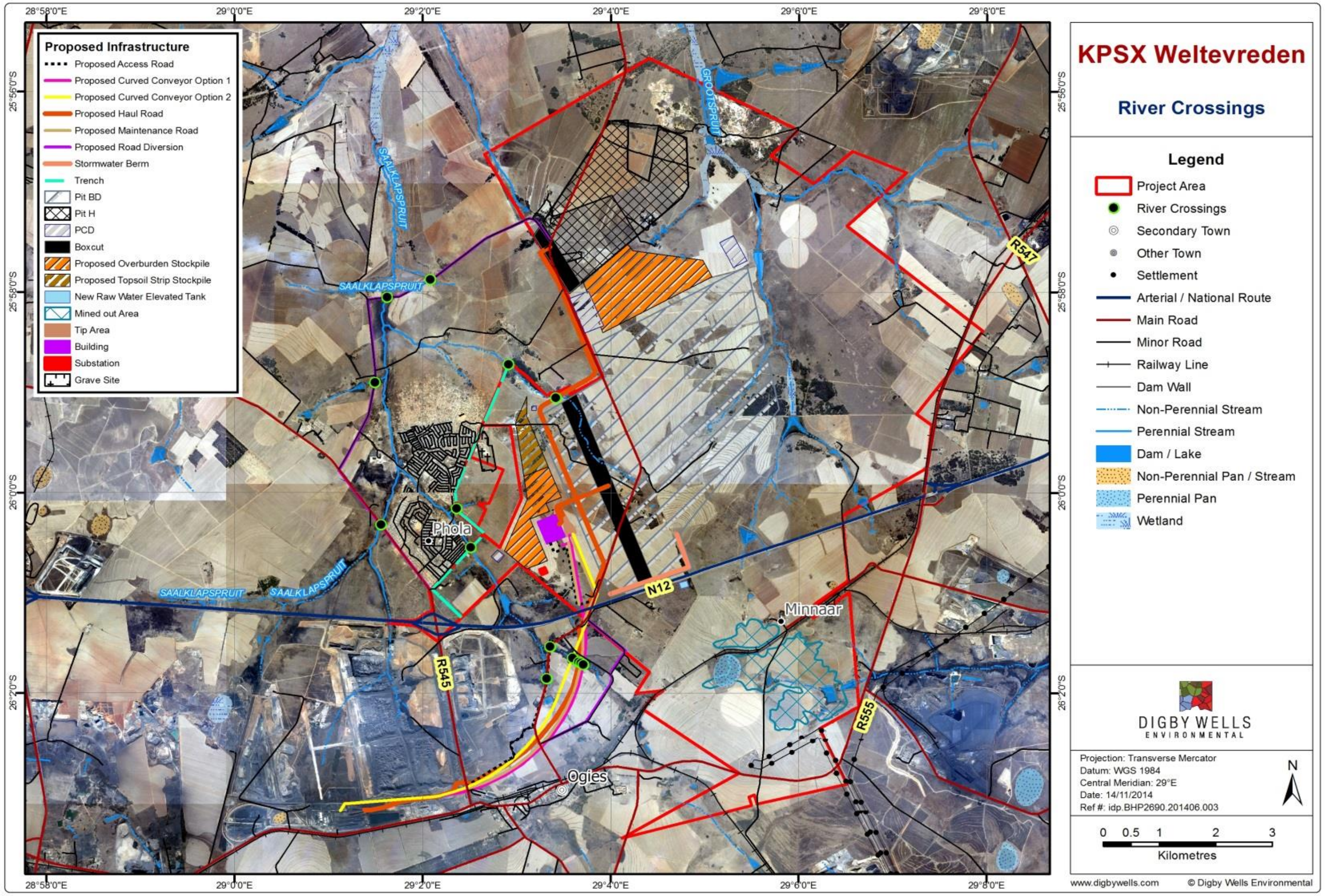

Figure 4-2: Location of the 14 river/stream crossing points

4.1 Site Climate and Meteorological Overview

Detailed meteorological data is presented in Digby Wells' air quality specialist report (2015) and based on modelled meteorological data for the period January 2011 to December 2013. The data was obtained for a point in the proposed KPSX: Weltevreden opencast site (25.991436° S, 29.099525° E).

4.1.1 Precipitation/ Rainfall

As shown in Table 4-2, the three year (2011-2013) annual total rainfall maximum and average for the KPSX Weltevreden site is 1,064.9 mm and 795.3 mm respectively. The highest total monthly precipitation (228.1 mm) was observed in December. The rate decreases down to 4.1 mm in June. The average rainfall is higher than the determined mean annual precipitation for the quaternary catchments in which the Weltevreden site is located.

Table 4-2: Average Monthly Precipitation derived from the KPSX: Weltevreden modelled data (2011-2013)

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Total Monthly Rainfall (Max).	153.7	115.1	70.9	70.6	20.8	4.1	13.0	17.3	53.1	178.3	140.2	228.1	1,064.9
Average Total Monthly Rainfall	151.4	80.4	20.8	45.0	10.4	2.7	6.5	13.0	29.8	105.7	119.5	210.1	795.3

4.1.2 Evaporation

The South African Weather Service is no longer collecting measurements of evaporation, hence historical data are relied upon to assess this parameter. The nearest station from which data could be retrieved was the Bethal station which is approximately 60 km from Orgies. As shown in Table 4-3, the annual maximum, minimum and mean monthly evaporation rates for the Bethal area, for the period 1963-1987 are 213 mm, 90 mm and 144 mm, respectively. The highest monthly maximum evaporation (264 mm) occurred in December. The rate decreases to 8 mm in July. The monthly minimum evaporation ranges between 8 mm (July) and 156 mm in December. The mean annual evaporation for the Bethal station is 1,721 mm.

Table 4-3: Maximum, minimum and mean monthly evaporation rates for the Bethal (Symon's Pan) S-Pan evaporation station for 1963-1987 periods (South African Weather Service)

Evaporation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Max.	228	202	196	145	176	178	212	200	257	259	241	264	213
Monthly Min.	93	68	60	76	71	61	8	89	118	140	140	156	90
Monthly Mean	173	147	139	110	100	89	102	135	171	181	179	195	144

With the assumption that the evaporation trends have maintained more or less the same order of magnitude over the months of the year, the area indicates a water strained area, with evaporation in most months higher that the precipitation.

4.2 Site Catchment Description

The Weltevreden project area is located in the Olifants Water Management Area 4 (WMA 4), with the proposed Project's footprint falling in quaternary catchments B11F and B20G. The majority of the study area falls within quaternary catchment B20G, a tributary of the Wilge River. The south-western portion of the site falls within the B11F catchment, which is bisected by the Olifants River. The quaternary catchments are represented in Figure 4-3.

The project is located in the Upper Olifants River catchment and there are a large number of defunct mines scattered over the Wilge, Middelburg Dam and Witbank Dam catchments. The DWS report (DWAF, 2009) has reiterated on the deteriorating water quality, where Total Dissolved Solids (TDS) and sulfate concentrations in the Witbank, Middelburg and Loskop Dams have been increasing since 1970. Owing to the impacts, it is imperative that the DWS developed water management strategies. Hence the development of the Integrated Water Resource Management Plan for the Upper and Middle Olifants Catchment in 2009 (DWAF, 2009) which was responsible for setting up the Resource Water Quality Objectives (RWQO) used in this assessment.

The project area lies in the greater Wilge River Catchment, which is upstream of the Loskop Dam Catchment (Figure 4-4). The confluences of the Klein Olifants, Spookspruit, Klipspruit and Wilge Rivers with the Olifants River are between Witbank and Loskop Dams.

The catchment is largely rural with grasslands and bare cultivated lands making up most of the land cover. A small portion of the site is covered in dams and towns. A sand mining operation is located in the catchment in the north-eastern part of the project area, towards the town of Clewer.

The topography of the proposed KPSX Weltevreden Project area and surrounds is undulating with numerous ridges and valleys. The topographical model indicates that the elevation of the project area decreases from 1,612 metres above mean sea level (m amsl) in the south to 1,482 m amsl in the north. The majority of the project area has gentle slopes of less than 4°. Isolated slopes of between 4° and 11.3° occur along the sides of the ridges and river valleys. There is a ridge running in an east-west direction in the southern part of the project area.

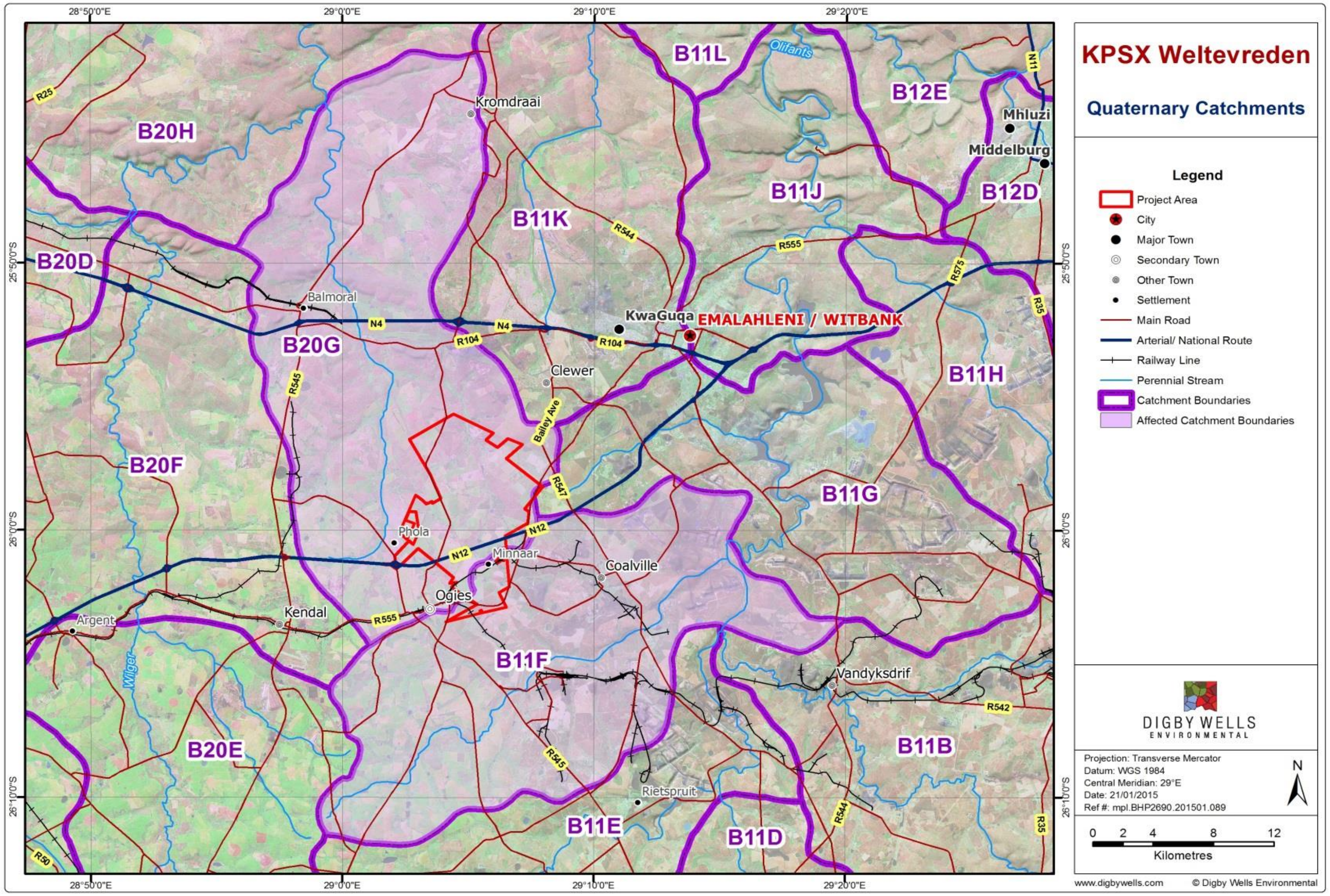

Figure 4-3: Quaternary catchments

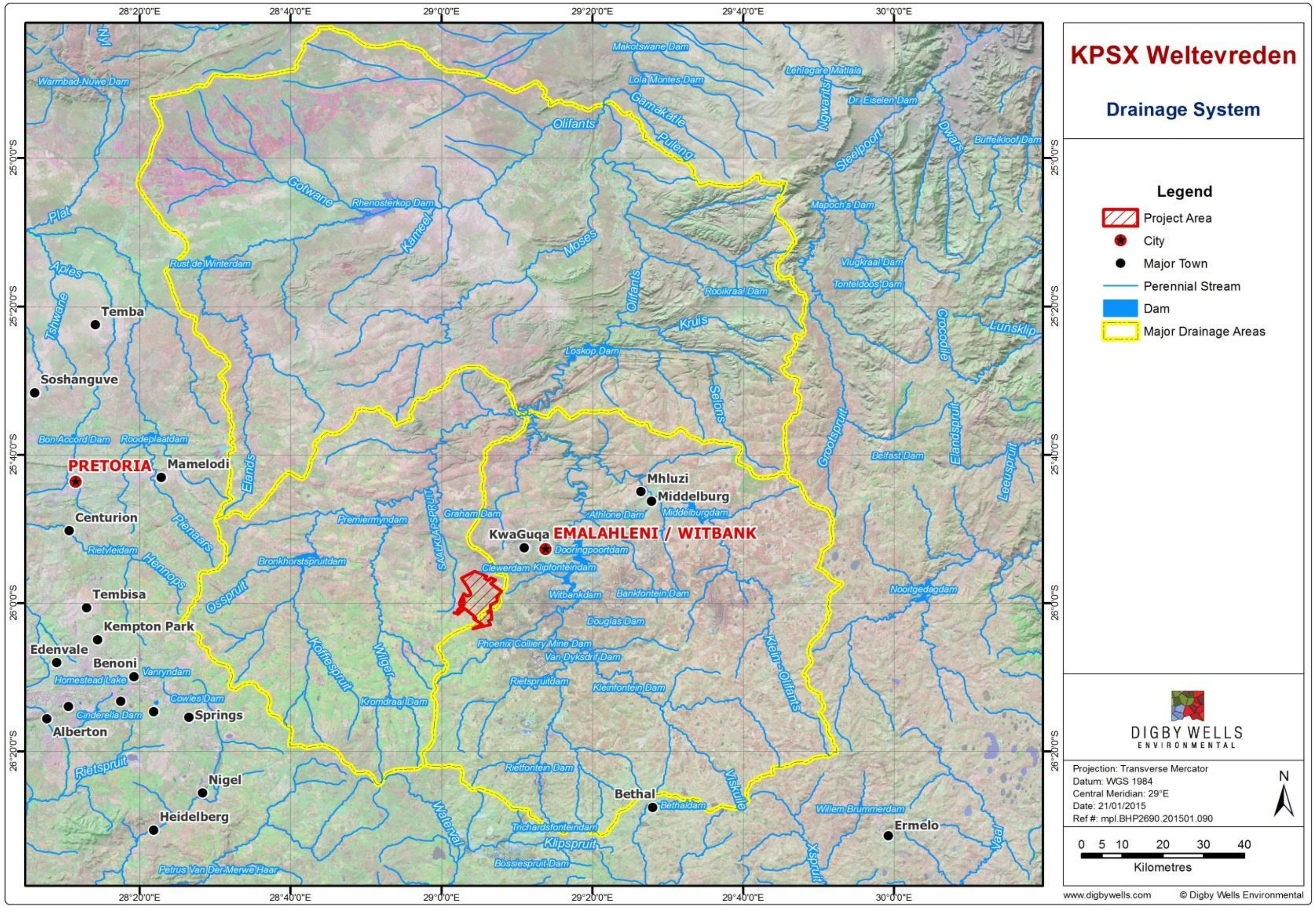

Figure 4-4: Location of the major catchment drainage areas of the study area

4.3 Quaternary Catchments Characteristics

The attributes of the affected quaternary catchments, namely the Mean Annual Runoff (MAR), Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) are summarised in Table 4-4. Quaternary catchments B11F and B20G indicate that the percentage of MAP that contributes to MAR in the catchments are 6.7% and 6.6% respectively.

Table 4-4: Predominant Quaternary Catchments for KPSX: Weltevreden

Quaternary Catchment	Catchment Area (km^2)	Rainfall Zone	MAP (mm)	MAR (mm)	MAR $m^3 x 10^6$	Evaporation Zone	MAE (mm)
B11F	338.0	B1A	692	46.4	15.69	4A	1599
B20G	519.4	B2C	669	44.0	22.87	4A	1689

The Project site occupies 8.63 km^2 of quaternary catchment B11F, constituting 2.55%. The MAR from KPSX: Weltevreden is estimated to contribute 0.26% to the Witbank Dam.

A portion (64.9 km^2) of the Project site falls within quaternary catchment B20G, constituting 12.5% of the quaternary catchment and 0.5% of the Loskop Dam catchment. The MAR for Loskop Dam is 397 million m^3.

4.4 Drainage Systems

KPSX: Weltevreden is characterised by several streams in the upper reaches of the Olifants River system. Table 4-5 indicates the details of associated drainage networks in the two quaternary catchments where the Project is located.

Table 4-5: Predominant Quaternary Catchment Characteristics for KPSX: Weltevreden

Quaternary Catchment	Water Resources / River Systems
B20G	■ The site is drained by two stream systems, namely the Saalklapspruit and Grootspruit; ■ The Grootspruit is characterised by several floodplains, wetlands and several farm dams; ■ The streams drain northwards; and ■ There are several unnamed tributaries of these main streams that also drain the Project site.
B11F	■ The portion of Project site is drained in a westerly direction by the upper sections of the Tweefonteinspruit; ■ A perennial pan is located on the catchment divide; and

Quaternary Catchment	Water Resources / River Systems
	■ Several farms dams are located on the upper Tweefonteinspruit.

The receiving surface water body in the event of contamination from the proposed mine is the Loskop Dam and its associated downstream users. The water quality remains of paramount importance for the survival of the aquatic environment. In the southern portion of the site, the water drains into the Witbank Dam. The water authority is the DWS, Mpumalanga Region.

4.4.1 Catchment Delineation

The catchment delineation was carried out on the available Digital Elevation Model (DEM) data. The Figure 4-5 illustrates the demarcation of the delineated subcatchment within the project area.

The subcatchments upstream of the infrastructure have also been delineated and these are useful for the development of the storm water berms upstream of the project area to protect the catchment to the south.

The subcatchments 1, 5, 6, 7, 8 and 10 form part of the Grootspruit catchment draining most of the Project site. The Grootspruit is a perennial stream and drains through KPSX: Weltevreden. The northern section of the Project site is subject to mining activities; sand mining on the eastern bank of the Grootspruit and topsoil mining on the western bank. The rest of the subcatchments are described in the Table 4-6.

Table 4-6: The delineated sub-catchment descriptions

Subcatchment	River Catchment Description
Sub 1	A catchment on the upper Grootspruit covered in grasslands and cultivated land.
Sub 2	A catchment for the upper Tweefonteinspruit which drain the south eastern boundary of KPSX: Weltevreden. The land is mostly cultivated land. Immediately upstream of the Tweefonteinspruit is Grootpan; a perennial pan between the town of Ogies and the settlement of Minnaar, located on the catchment divide B11F and B20G.
Sub 3	A catchment for the Ogiesfontein, a tributary of the Saalklapspruit tributary catchment flowing through Phola settlement.
Sub 4	A catchment for an unnamed tributary of the Saalklapspruit, north of Phola settlement.

Subcatchment	River Catchment Description
Sub 5	A catchment of the tributary pf the Grootspruit, characterized by grasslands.
Sub 6	A catchment fora tributary of the Grootspruit draining the NE of the project boundary.
Sub 7	A catchment for the mid-section of the Grootspruit covered in grassland and cultivated land.
Sub 8	A catchment for a tributary of the Grootspruit draining through mostly cultivated land.
Sub 9	A catchment for a tributary of the Saalklapspruit, draining the northwest boundary of the project boundary. This catchment is mostly grasslands with scattered cultivated land.
Sub 10	A catchment for the lower Grootspruit section within the project area. This catchment is highly disturbed by sand mining activities and dammed water. The sand mining was operational at time of site visit. This section of the Grootspruit if described as a wetland.

The 1:50 and the 1:100 peak flows were estimated using the rational runoff modelling method for catchments below 15 km^2 and the alternative rational for the bigger catchments for all the 10 sub-catchments delineated.

Where: The rainfall runoff model to determine the peak flow is obtained from the following relationship:

$$Q = \frac{CIA}{3.6}$$

Where:

Q = peak flow (m^3/s)

C = runoff coefficient (dimensionless)

I = average rainfall intensity over the catchment (mm/hour)

A = effective runoff area of the catchment (km^2)

3.6 = conversion factor

The 1:50 and 1:100 flood peak flows for the delineated upstream catchments and the catchment characteristics for the catchments are detailed in Table 4-7.

The sub-catchments' 1:50 year flood peak flows should be directed by berms separating clean and dirty areas as required by the Regulations of 2006 (BPG G1: Storm water management).

Table 4-7: The estimated 1:50 and 1:100 year peak flood flows

Subcatchment	Quaternary catchment	River Catchment	Area (km^2)	Longest stream (km)	dH (10-85 difference) (m)	Average slope	C	Tc (hrs)	50 year (m^3/s)	100 year (m^3/s)
Sub 1	B20G	Grootspruit	17.593	4.608	29	0.00841	0.313	1.35	105	127
Sub 2	B11F	Tweefonteinspruit	10.276	3.391	34	0.01333	0.426	0.89	83	111
Sub 3	B20G	Saalklapspruit	26.391	6.906	67	0.01776	0.465	1.59	208	245
Sub 4	B20G	Saalklapspruit	11.223	5.707	50	0.0117	0.318	1.40	45	62
Sub 5	B20G	Grootspruit	5.461	3.731	36	0.01297	0.308	0.97	28	39
Sub 6	B20G	Grootspruit	17.060	7.024	65	0.01238	0.308	1.61	88	107
Sub 7	B20G	Grootspruit	6.763	2.469	12	0.0064	0.308	0.94	37	51
Sub 8	B20G	Grootspruit	7.173	3.908	48	0.016	0.308	0.95	37	51
Sub 9	B20G	Saalklapspruit	9.196	5.505	44	0.01173	0.308	1.27	39	53
Sub 10	B20G	Grootspruit	16.515	4.461	31	0.00919	0.308	1.28	98	119

Note: Tc is the time of concentration: the time it takes for water to travel from furthest point of the catchment to the catchment outlet

10:85 Height difference (m): difference in elevation height at 10% and 85% of the length of the longest water course to determine average slope.

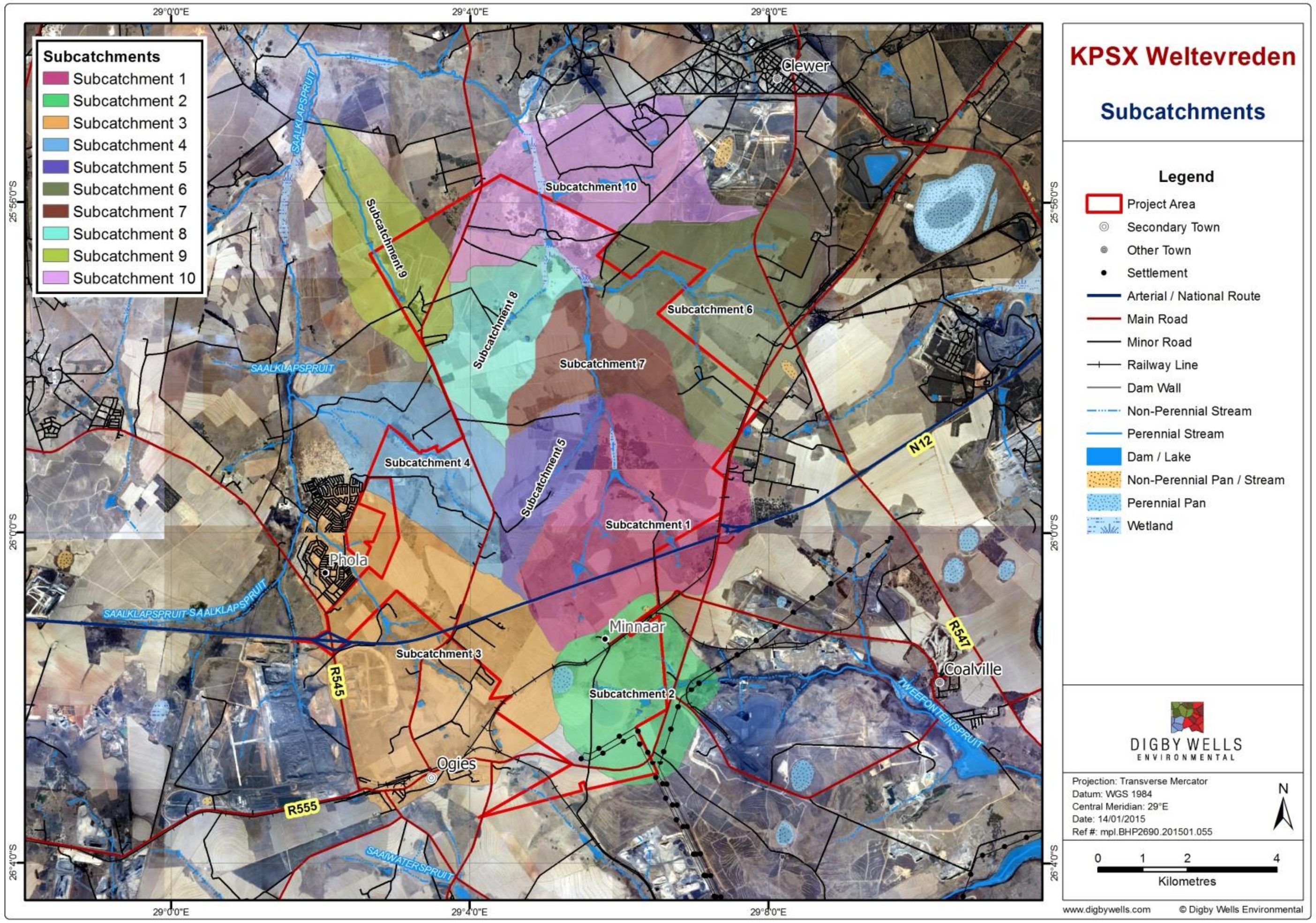

Figure 4-5: Subcatchments

4.4.2 Evaluation of Streamflow

There are no streamflow measuring stations on the Grootspruit, Saalklapspruit or Tweefonteinspruit. The nearest streamflow measuring station is located in quaternary catchment B11G. This point was not used.

However, during site visit flow measurements were taken using a flow meter to obtain the general velocity of the streams at locations. On average, maximum flows of 0.2 to 0.5 m/s were recorded whilst average flows were 0.1 to 0.3 m/s. There was flow on the Saalklapspruit, whilst upstream the Grootspruit was dry. Secondary sources of water, for example one identified as fountain in one farm contribute to the baseflow that was recorded in the dry season (during site visit)

The sites are detailed in Table 4-8 (refer to Figure 4-8 for the sites locations).

Table 4-8: Field visit flow meter measurements results

Site	Latitude	Longitude	Max flow (m/s)	Average reading (m/s)
WELSW04	-25.90878000	29.06541300	0.4	0.2
WELSW08	-25.96757300	29.02698200	0.2	0.1
WELSW11	-25.97636000	29.04383400	0.3	0.2
WELSW13	-26.01562000	29.04631800	0.5	0.3

4.4.3 Design Rainfall

The closest stations to KPSX: Weltevreden are displayed in Table 4-9. This data was utilised to calculate the 24 hour design rainfall depth (Table 4-10), using Design Rainfall Estimation (DRE) in South Africa software (Smithers and Schulze, 2003).

Table 4-9: Summary of the rainfall station in proximity to KPSX: Weltevreden

Station Name	SAWS Number	Distance (km)	Record Length (years)	Latitude (°S)	Longitude (°E)	MAP (mm)	Altitude (m)
Ogies (POL)	0478093_W	8.0	92	-26.050000	29.050000	719	1743
Waterpan	0515270_W	7.4	42	-26.000000	29.150000	695	1605
Clydesdale	0515266_W	9.0	36	-25.933333	29.150000	768	1606
Clewer (SAR)	0515234_W	10.5	54	-25.900000	29.133333	724	1525

Table 4-10: Calculated 24 Hour Design Rainfall Depth

Design rainfall return period (years)	1:2	1:5	1:10	1:20	1:50	1:100	1:200
24 Hour design peak rainfall (mm)	59.2	79.4	93.8	109	129	145	163

Rainfall of 129 mm in a period of 24 hours is expected as the 1:50 peak rainfall. When compared to the modelled monthly rainfalls, the 24 hour rain exceeds the monthly rainfalls for most months, except the months of January and December. This implies that in general with normal rainfall there would be capacity for this extreme rainfall event should it occur, as long as the storage dams are designed to cater for the design rainfall. However, in the months of January and December, the storage facilities need to be monitored to ensure that it is adequate if an extreme design rainfall is experienced.

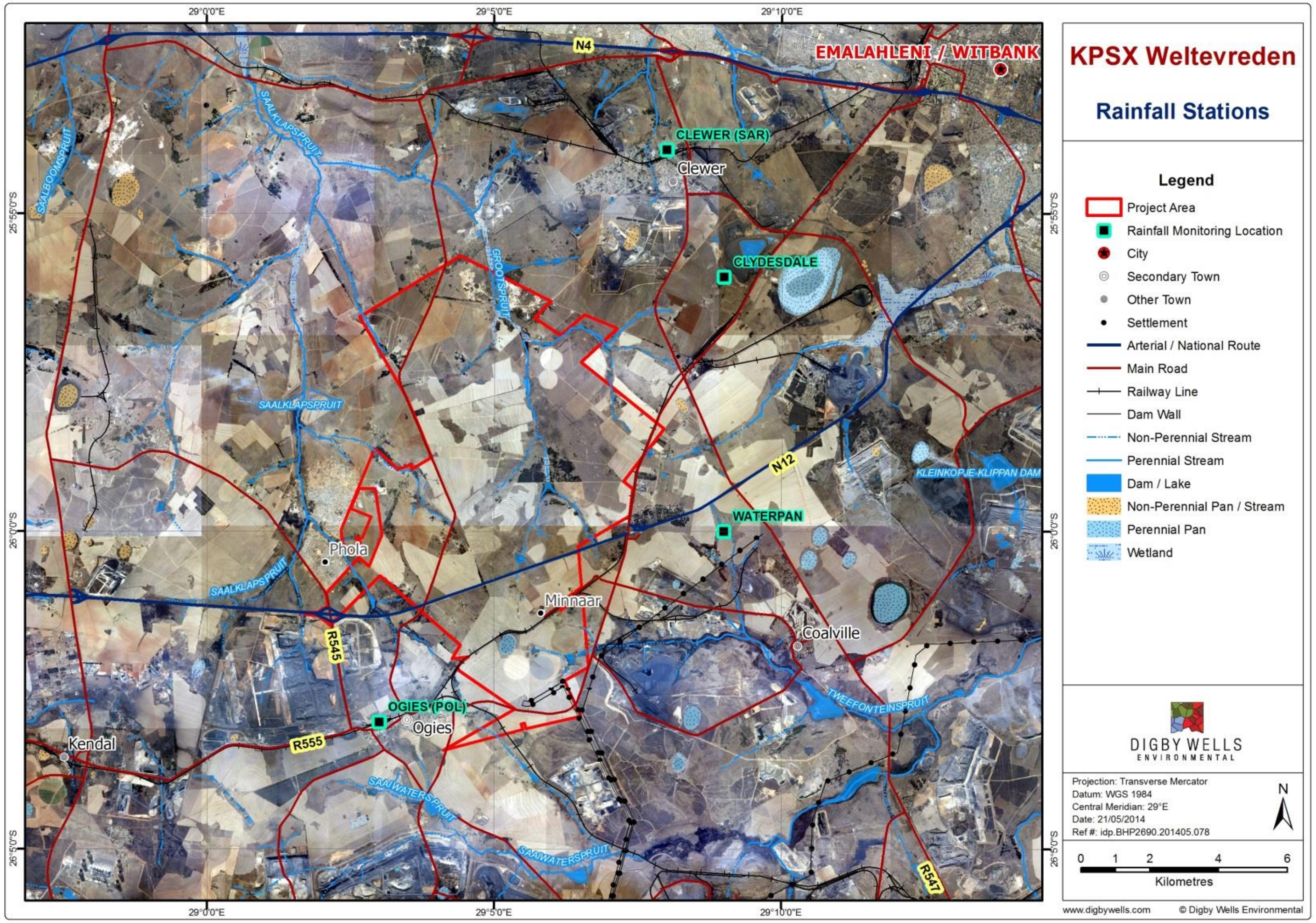

Figure 4-6: Location of rainfall stations used in the DRE

4.5 Surface Water Use

On a more regional scale, the Wilge River catchment is more rural in nature with the main activity being agriculture around the towns of Bronkhorstspruit and Delmas (DWAF, 2009). The coal mining, previously concentrated in the Middelburg and Witbank Dam catchments is expanding into the Wilge River Catchment. Irrigation agriculture is practiced throughout the project area with the largest irrigation areas located downstream of Loskop Dam.

The predominant users of the surface water resources within the KPSX: Weltevreden catchments are agricultural, mining and power generation.

The WARMS Water User Registration Management Systems (WARMS) database was used to characterise the water uses and users. According to the DWS water use database (WARMS), the main use of water in quaternary catchment B20G is agricultural irrigation and a small portion for mining. The water uses and users have been summarised in Table 4-11.

Table 4-11: Summary of the WARMS registered and active water users

Registered water use	No of registered users	Volumes used (m^3/year)	Sources of water used
Irrigation	34	1,385,884	River/ stream, dam and wetlands
Mining	2	74,855	River/ stream

4.6 Surface Water Quality

Water quality data was benchmarked against the Interim RWQO for the Wilge River Catchment. The Wilge Interim Resource Water quality objectives (IRWQO) as detailed in Table 4-12

Table 4-12: Wilge River IRWQO

Parameter	Wilge Catchment IRWQO
Total Dissolved Solids	450
Nitrate NO_3 as N	6
Chlorides as Cl	20
Total Alkalinity as $CaCO_3$	85
Sulphate as SO_4	120
Calcium as Ca	80
Magnesium as Mg	20
Sodium as Na	20
Potassium as K	10
Iron as Fe	1
Manganese as Mn	0.18

Conductivity at 25° C in mS/m	70
pH-Value at 25° C in pH units	6.5-8.4
Aluminium as Al	0.02
Fluoride as F	0.5

NB: All parameters are in mg/l unless specified

4.6.1 DWS Water Quality Monitoring Database

Water quality data has been collected over the years by the Department of Water and Sanitation (DWS), under the Water Management System (WMS), and a water quality database is kept. Eight sites were identified within region B, close to the project site. These sites are listed in Table 4-13 and the locations are shown in Figure 4-7.

Table 4-13: Resource water quality data for region B close to the Weltevreden site (DWS, 2014)[1]

Water Quality	Description and Type	First date	Last date	med EC	Latitude	Longitude
B20 189556	Phola STW Prinshof Final Discharge from Waste Water Treatment Works	2009/03/24	2012/02/28	79	-25.99389	29.02722
B20 189465	Prinshof Us Phola STW Discharge on Saalklapspruit-Saalboomspruit:	2010/01/19	2012/02/28	61	-25.99583	29.02917
B20 189464	Roodepoortjie ds Phola STW on Saalklapspruit-Saalboomspruit	2009/03/24	2014/08/20	63	-25.96778	29.02694
B20 188545	Doornrug at R104 Bridge D/S of Highveld Steel on Saalklapspruit	2005/08/31	2012/08/14	67	-25.88114	29.01131
B20 188544	Doornrug downstream of Highveld Steel on Tributary of Grootspruit	2005/08/31	2012/03/28	143	-25.89742	29.06506
B20 188542	Elandsfontein 309 JS upstream of Elandsfontein Colliery on Grootspruit	2005/08/31	2012/02/27	17	-25.91961	29.0785
B20 188541	Hartebeestlaagte 325 JS downstream of Elandsfontein Colliery on Grootspruit	2005/08/30	2014/08/21	126	-25.90894	29.06533
B20 88768	Grootspruit on Hartbeeslaagte	1991/10/19	1992/01/21	7	-25.93917	29.08333
B11 189428	Tweefontein upstream of Tweefontein United Collieries on Tributary of Tweefonteinspruit	2009/04/23	2012/03/12	325	- 26.02444	29.15556

[1] Extracted from http://www.dwa.gov.za/iwqs/wms/data/C_reg_WMS_nobor.htm

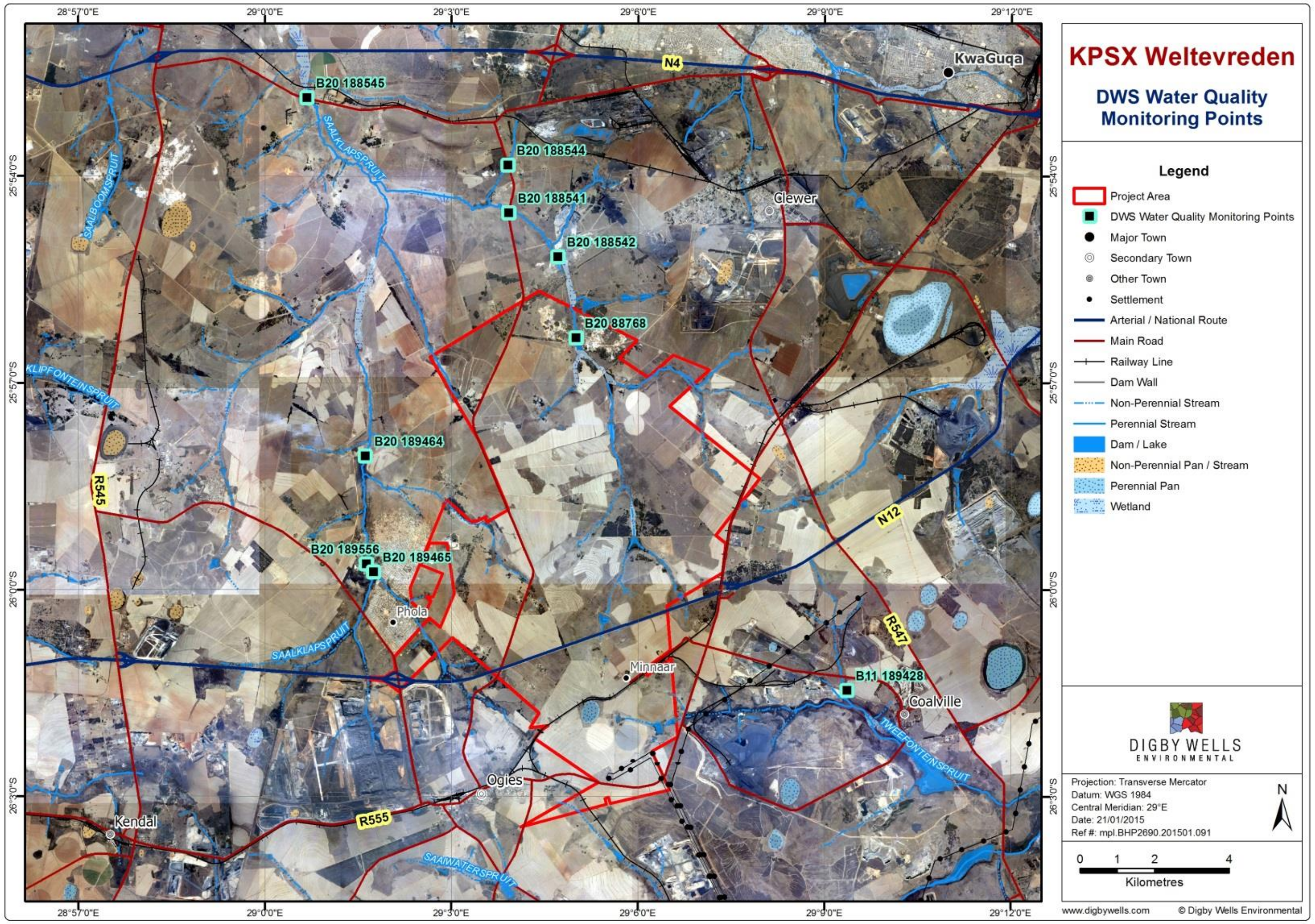

Figure 4-7: DWS water quality monitoring sites in the project vicinity

4.6.2 Historical Water Quality Database

Historical water quality monitoring data has been made available by the client for the surface water assessment. Collected water samples were analysed at Regen Waters Laboratory in Witbank and a surface water quality report was compiled by JKC (2009).

Water samples at eight (8) locations were collected on the following dates:

- 31 July 2009;
- 25 August 2009;
- 23 September 2009;
- 22 October 2009; and
- 25 November 2009.

The locations (in Transverse Mercator Projection, WGS1984, and 29E) of the sampling sites have been detailed in Table 4-14. These sites have been maintained for the updated water quality data discussed in Section 4.6.3.

Table 4-14: Summary of the surface monitoring locations (JKC, 2009)

Monitoring Location	Latitude	Longitude
Wel SW1	-26.02577500	29.05575200
Wel SW2	-26.02722200	29.06050000
Wel SW3	-25.98071100	29.09804800
Wel SW4	-25.90878000	29.06541300
Wel SW5	-25.93929600	29.08413800
Wel SW6	-25.96458300	29.03475000
Wel SW7	-26.00546300	29.02590100
Wel SW8	-25.96757300	29.02698200

Water quality data was benchmarked against the Interim RWQO for the Wilge River Catchment.

4.6.3 August 2014 Sampling

Digby Wells conducted a site visit on 28 to 31 July 2014 to collect surface water samples from the existing surface water stations, as well as from additional sites. Only 10 of the 14 sites identified for sampling were sampled as indicated in the Figure 4-8 and Table 4-15.

Table 4-15: The list of sampling sites and locations

Sampling Location	Latitude	Longitude	Comment
Wel SW1	-26.025775	29.055752	Sampled
Wel SW2	-26.027222	29.0605	Not sampled as it was close to Wel SW1
Wel SW3	-25.980711	29.098048	Not sampled as the site was dry
Wel SW4	-25.90878	29.065413	Sampled
Wel SW5	-25.939296	29.084138	Sampled
Wel SW6	-25.964583	29.03475	Not sampled, too close to Wel SW8
Wel SW7	-26.005463	29.025901	Sampled
Wel SW8	-25.967573	29.026982	Sampled
Wel SW9	-26.031298	29.111296	Sampled
Wel SW10	-26.058155	29.087963	Not sampled was dry
Wel SW11	-25.97636	29.043834	Sampled
Wel SW12	-25.950329	29.049746	Sampled
Wel SW13	-26.01562	29.046318	Sampled
Wel SW14	-25.95048	29.097253	Sampled

The 10 sampled sites are described in Table 4-17.

The water samples collected as grab samples during the site visit were submitted to Aquatico Laboratory, a South African National Accreditation System (SANAS) accredited laboratory for analysis. The variables analysed in the laboratory are listed in Table 4-16. The water quality results were benchmarked against the Interim RWQO.

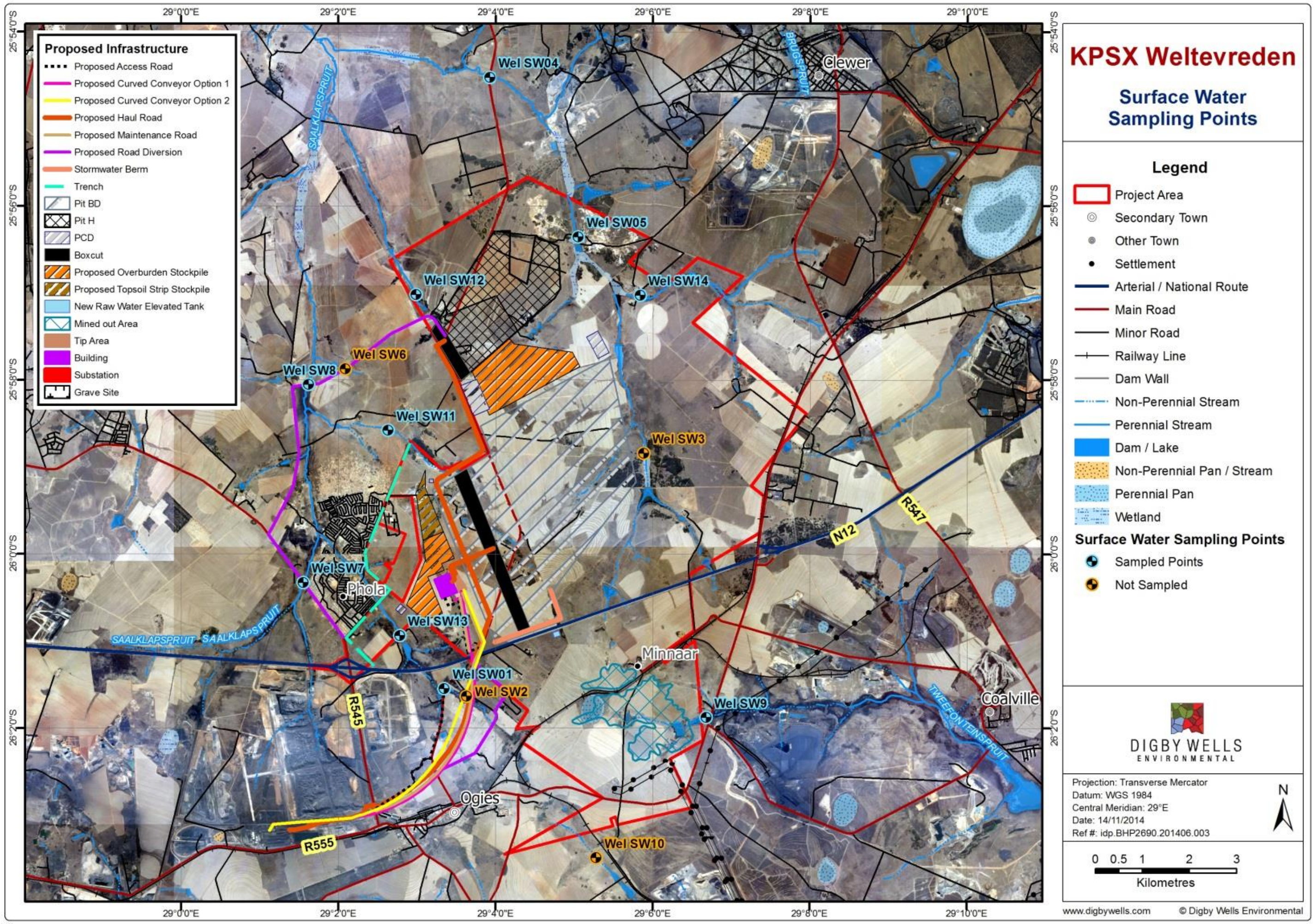

Figure 4-8: Surface water sampling sites indicating all new and old sites (Note: The orange sites were not sampled in 2014)

Table 4-16: Summary of the parameters/ variables analysed

Total Dissolved Solids (TDS)	Potassium as K
Sulfate as SO_4	Chlorides as Cl
Sodium as Na	Iron as Fe
Magnesium as Mg	Manganese as Mn
Nitrate NO_3 as N	Electrical Conductivity (EC)
Fluoride as F	Total Alkalinity as $CaCO_3$ (Alk)
Calcium as Ca	pH-Value at 25°C
Free and Saline Ammonia as N	Aluminium as Al

*The units of measurement are mg/L except pH and EC measured in pH units and mS/m respectively.

Table 4-17: Water quality sampling sites and site observations and photos for the sampled locations

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW01	2014/07/28	River with average flow velocity of 0.3m/s. The area was characterised by pine trees and located next to a dirt road. The site is on the upper Saalklapspruit.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW04	2014/07/30	A site on the Grootspruit with an average flow of 0.2 m/s. The water looked clear, but the field measurements for pH (6.21), EC (80.7 mS/m) and TDS (551 mg/L) exceeded the IWQO for the Wilge River. This site is downstream from other mines such as the Anker Coal: Elandsfontein Colliery. The channel was shallow, approximately 20 cm deep and more than 3 m wide.	
Wel SW05	2014/07/30	The site is located downstream from a dam in the Grootspruit. The sample was collected from a dam spillway. This site is in the vicinity of sand mining operations, north of the project site. The bridge was flowing through the spillway.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW07	2014/07/29	On the Saalklapspruit, near Phola. General waste was identified in the river namely, rubble material, scrap metal, plastics and paper blown by wind or possibly dumped there. Some sections of the river were clear whilst green algal growth was evident near the bridge.	
Wel SW08	2014/07/29	On the Saalklapspruit, with an average flow of 0.1 m/s. The site is on a blocked bridge, resulting in the water flowing over the road. The water had a pungent smell, and green algae were evident on the stream bed downstream.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW09	2014/07/31	Wetland area, associated with a mined out underground mine just south of the perennial pan, to the southeast of the project site, at the most upstream point of the Tweefonteinspruit. There was a small channel with orange to red looking water draining from the wetland. The field tested water quality was high in EC (102 mS/m) and TDS (691 mg/L), exceeding the Interim RWQO.	
Wel SW11	2014/07/29	A tributary to the Saalklapspruit, the site located just outside project boundary on a downstream location. The flow rate was 0.2 m/s. They were cow prints indicating that the site is used for livestock watering. In the opposite direction, there was dumped litter. The rest of the land cover around the site were grasslands.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW12	2014/07/29	The area appeared like a channelled wetland with low flows. This site was surrounded by grasslands. The water appeared clear. The site is located on a tributary to the Saalklapspruit.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW13	2014/07/29	The site is located in the Upper Saalklapspruit and there was evidence of livestock prints. The site is downstream of WELSW01 whilst upstream of Phola. The water appeared clear. The field pH was slightly lower than the IWQO, at 6.3 at a temperature of 11.9◦C.	

Sample ID:	Date Sampled	Site Visit Observation	Photo
Wel SW14	2014/07/31	Site located on a tributary to the Grootspruit. The water was clear and there was evidence pointing to the use of the river sections, and dams downstream of site for stock watering and irrigation.	

Some dry sites were observed. Wel SW3 was previously sampled in 2009, yet was observed to be dry on 30 July 2014. Figure 4-9 and Figure 4-10 show the photos taken from a couple of the dry sites – Wel SW3 and Wel SW10. At the site Wel SW3, te river bed was not well defined, upstream of this point water is impounded in several farm dams whilst downstream of site Wel SW10 is a dam, used for livestock watering

Figure 4-9: The dry Wel SW3 site

Figure 4-10 : Dry stream at site Wel SW10

4.6.4 Water Quality Data Analysis

4.6.4.1 DWS Monitoring

The water quality results were benchmarked against the Interim RWQO as shown in Table 4-18.

Most of the water quality data for the various sites had data gaps, except for the parameters pH, EC and SO_4. The sites which had the most consistent records and included most of the parameters were sites B20 188545, B20 188541 and B20 88768.

The data obtained from the DWS water quality records indicated the following:

- On the Saalklapspruit as site B20 189465 upstream of B20 189556 which is located at the final discharge point for the Phola Sewerage treatment works (STW) of Prinshof, the parameters of concern, exceeding the Interim RWQO at both sites are Cl, Alk, SO_4, Na, NH_4 and PO_4.
  - Site B20 189464 Roodepoortjie, downstream of the Phola STW on the Saalklapspruit-Saalboomspruit has similar water quality as site B20 189465.
  - Site B20 189556 also has elevated TDS, Mg and K.
  - The nutrient loads recorded at these sites can be attributed to the waste water treatment plant, agricultural impacts and waste from the residential area of Phola;
- Along the Grootspruit, the two upstream sites B20 88768 and B20 188542, indicate relatively clean water with NH_4 being the only parameter of concern for both sites and alkalinity for B20 188542.
  - Point B20 188541 on the farm Hartebeestlaagte 325 JS, downstream from the Elandsfontein Colliery on the Grootspruit, indicates potential mining related impacts due to elevated levels of TDS, Cl, SO_4, Ca, Mg, Na, K, EC, NH_4 and low pH;
- B20 188544 is a sampling point on a tributary to the Grootspruit, downstream of Highveld Steel and only has records for pH, EC and SO_4. The pH and EC exceeded the Interim RWQO;
- The most downstream point (B20 188545), located on the R104 Bridge downstream of Highveld Steel on Saalklapspruit, and has all records for the recording period. It presented elevated TDS, Cl, SO_4, Mg, Na, EC, NH_4 and PO_4. This site indicates poor water quality, indicating that the upstream impacts have been transferred downstream; and
- The site B11 189428, on the tributary of the Tweefonteinspruit, upstream from Tweefontein United Collieries, indicates the poorest water quality of all sites around the Weltevreden site. The water quality data presents the highest concentrations of most parameters of concern namely TDS, Alk, SO_4, Ca, Mg, EC and F. These

impacts are potentially associated with coal mining immediately upstream from the site.

Table 4-18: DWS Water Management System (WMS) water quality database benchmarked with the Brummerspruit Catchment WQO

Wilge Catchment IRWQO			Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Conductivity at 25° C in mS/m	pH-Value at 25° C	Free and Saline Ammonia as N	Fluoride as F	PO4_P_Diss_Water
sample ID	**First date**	**Last date**	450	6	20	85	120	80	20	20	10	70	6.5-8.4	0.007	0.5	0.05
B20 88768	1991/10/19	1992/01/21	45.75	0.03125	2.325	18.3875	7.325	3.9	2.4375	4.6125	1.5475	7.975	8.1775	0.02563	0.13375	0.008
B20 188541	2005/08/30	2014/08/21	807.352	0.04	43.8748	9.22336	702.112	244.116	79.2116	55.6745	13.4452	134.282	5.4835	0.02	0.28164	0.006
B20 188542	2005/08/31	2012/02/27	272.734	0.0325	8.913	135.119	37.2244	15.6695	7.7855	8.134	2.5925	18.8921	6.96154	0.0605	0.3085	0.0095
B20 188544	2005/08/31	2012/03/28					367.514					142.522	7.52278			
B20 188545	2005/08/31	2012/08/14	566.409	0.578	23.6507	66.7929	268.485	73.8621	30.0577	29.814	6.64291	70.5923	7.22266	0.0495	0.36765	0.0765
B20 189464	2009/03/24	2014/08/20	346.309	2.53767	22.528	68.744	129.501	36.709	18.924	24.461	7.231	67.6606	6.89515	0.025	0.272	1.151815
B20 189465	2010/01/19	2012/02/28	413.947	2.70267	27.143	112.175	133.666	36.391	18.551	36.013	8.234	64.1048	7.08514	9.772	0.299	0.724714
B20 189556	2009/03/24	2012/02/28	566.562	4.81414	49.594	121.033	136.52	47.997	20.404	68.633	13.0435	85.96	7.12804	9.2065	0.436	5.099368
B11 189428	2009/04/23	2012/03/12	2382.55	0.025	13.9985	205.88	867.265	312.425	341.421	27.342	9.7755	366.252	6.90333	0.37	0.4515	0.005

4.6.4.2 Historical and 2014 Sampling

The water quality results are illustrated in Table 4-20 and benchmarked against the Interim RWQO for the Wilge River catchment, in the Olifants water management area. The results are interpreted in a table specific to the available streams (Table 4-19).

Time series graphs were plotted for the 2009 period for both the salts and the metal elements of concern and appended in Appendix A.

Table 4-19: Water quality data interpretation

River System	Sampling Sites	Baseline Water Quality Interpretation
Saalklapspruit	Wel SW1, Wel SW2, Wel SW13	SW13 and SW1 upstream of Phola indicated clean water for the 2014 sample run. However, in 2009, SW1 had elevated levels of Cl, Alkalinity, SO_4, Na, Al and Fe. Site SW1 is close to existing mine works, thus the water quality could be influenced by contaminants from the mining operations to the left bank. SW2 is considered as clean water.
	Wel SW7	Site SW7, a downstream point from the existing Klipspruit mining area, shows clean water during the 2014 sample run. However, in 2009 the water quality was very poor, with elevated TDS, Alk, SO_4, Ca, Mg, Na, Mn and EC exceeding the IWQO. These are parameters that could be related to mining that took place upstream from this site.
	Wel SW11	Another tributary to the Saalklapspruit with clean water during the 2014 sample run.
	Wel SW8	Site SW8, most downstream point on the Saalklapspruit, shows parameters of concern similar for the 2014 and 2009 sampling runs. These parameters include Cl, Alk, Na, K, Mn, with additional parameters which were above the IWQO only in 2009 being SO_4, EC and Al. The parameters shown in 2014, are not indicated upstream of this point on this river at Wel SW11 and Wel SW7. This could potentially be impacts arising from the Phola Sewage Treatment Works (STW) discharge point, just upstream. This could imply that there is some input from Phola and activities on the tributary draining into Saalklapspruit; just before this point that were

River System	Sampling Sites	Baseline Water Quality Interpretation
		recorded in 2009. SO_4 and Al levels were elevated.
	Wel SW6	High Na, Mg, Al and F were recorded in 2009, exceeding the IWQO. There were no other activities in the area except the agricultural activities. These elements can be related to geology.
	Wel SW12	A tributary of the Saalklapspruit with clean water.
Grootspruit	Wel SW14	A tributary of the Grootspruit with clean water.
	Wel SW3, Wel SW5, Wel SW4,	Upstream point on the Grootspruit - SW3 was dry in 2014, but in 2009 the results indicated clean water with only Al exceeding the IWQO. In the mid Grootspruit sampling site - SW5 located within sand mining area was clean in 2009 and 2014. However, SW4, the most downstream point indicates the highest level of contamination. This site is located downstream from other mines, west and southwest of Clewer town, Anker's Elandsfontein Colliery, Highveld Steel, as well as Anglo operations south of Clewer. There were elevated TDS, Cl, SO_4, Ca, Mg, Na and EC in both sampling years. There were records of a low pH in 2009.
Tweefonteinspruit	Wel SW9	This site is on the Upper Tweefonteinspruit, upstream of Coalville town and south of a mined out area. It presented a poor water quality with levels exceeding the IRWQO for TDS, Cl, SO_4, Ca, Mg, Na, EC, Alk, K and Mn. The dirty water could be attributed to residual impacts of the mined out underground mining area immediately upstream, which could result as decant at downslope location..

Table 4-20: Water quality results for the 2009 and 2014 sample run benchmarked against the Wilge catchment Interim RWQO

Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al	Fluoride as F
Wilge Catchment IRWQO		450	6	20	85	120	80	20	20	10	1	0.18	70	6.5-8.4	0.02	0.5
Wel SW1	2009/06/30	358	0.12	62.0	56	130.0	27.3	15.1	52.3	7.51	0.04	0.01	54.7	7.23	0.08	0.20
Wel SW1	2009/07/31	334	0.17	54.0	74	111.0	28.2	17.3	53.7	5.69	1.68	0.01	49.9	7.66	1.59	0.35
Wel SW1	2009/08/25	358	0.26	58.0	93	110.0	26.6	17.0	55.0	7.07	0.34	0.07	54.7	7.82	2.64	0.33
Wel SW1	2009/09/23	374	0.10	62.0	91	119.0	30.1	18.7	58.9	7.41	0.36	0.02	59.5	8.56	0.42	0.35
Wel SW1	2009/10/22	448	0.19	73.0	96	159.0	34.7	20.3	68.2	8.83	0.48	0.07	69.0	8.67	0.75	0.59
Wel SW2	2009/06/30	96	1.70	14.0	19	24.3	6.7	3.3	12.9	3.05	0.16	0.01	13.9	7.26	0.16	0.20
Wel SW2	2009/07/31	78	2.50	13.0	15	16.2	3.5	2.1	12.6	2.20	0.84	0.01	9.9	6.99	0.98	0.20
Wel SW2	2009/08/25	74	3.00	12.0	12	18.3	2.3	1.4	11.5	2.33	1.71	0.01	10.6	7.27	1.85	0.20
Wel SW2	2009/09/23	62	1.59	12.0	13	12.3	2.8	1.6	11.8	1.77	0.93	0.01	9.5	7.12	0.12	0.20
Wel SW2	2009/10/22	68	1.10	11.0	15	19.3	2.4	1.3	11.3	1.46	2.12	0.02	9.4	7.63	1.40	0.20
Wel SW3	2009/06/30	114	0.21	13.0	45	25.0	9.0	5.9	13.8	3.62	0.28	0.01	17.1	7.23	0.05	0.36
Wel SW3	2009/07/31	120	0.23	15.0	46	32.1	9.8	6.7	15.8	3.90	0.93	0.01	17.3	7.46	0.41	0.36
Wel SW3	2009/08/25	124	0.24	13.0	51	27.7	9.4	6.5	15.4	4.90	0.43	0.01	19.0	7.45	0.11	0.31
Wel SW3	2009/09/23	118	0.10	15.0	54	23.2	10.4	6.9	15.4	3.69	0.01	0.01	18.9	7.36	0.01	0.35
Wel SW3	2009/10/22	126	0.26	15.0	55	26.1	10.5	7.1	15.7	3.91	0.58	0.20	19.7	7.98	0.10	0.37
Wel SW4	2009/06/30	856	1.30	28.0	13	544.0	141.0	47.8	25.4	7.75	0.01	1.89	108.0	6.75	0.01	0.20
Wel SW4	2009/07/31	1134	0.85	42.0	5	714.0	199.0	67.6	37.5	9.00	0.01	6.50	140.2	5.06	1.03	0.20
Wel SW4	2009/08/25	1224	0.60	35.0	5	802.0	193.0	68.6	42.9	9.56	0.01	5.45	150.0	4.68	1.29	0.20
Wel SW4	2009/09/23	1398	0.10	36.0	5	903.0	238.0	78.2	44.5	9.62	0.03	10.80	173.0	4.24	2.42	0.20
Wel SW4	2009/10/22	1208	0.23	32.0	5	795.0	194.0	67.9	45.7	6.11	0.01	7.36	152.0	5.53	0.52	0.20
Wel SW5	2009/06/30	84	0.38	18.0	17	21.8	6.5	3.5	10.9	3.28	0.33	0.06	14.5	7.27	0.02	0.20

Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al	Fluoride as F
Wilge Catchment IRWQO		450	6	20	85	120	80	20	20	10	1	0.18	70	6.5-8.4	0.02	0.5
Wel SW5	2009/08/25	78	0.36	14.0	22	20.1	5.7	3.8	10.7	3.00	0.82	0.09	13.1	7.27	0.01	0.20
Wel SW5	2009/09/23	90	0.42	16.0	32	15.2	7.3	3.9	11.0	3.22	1.43	0.20	13.8	7.27	0.07	0.20
Wel SW5	2009/10/22	108	0.29	15.0	36	25.2	7.9	4.1	10.4	3.57	5.03	0.43	14.8	7.49	0.09	0.24
Wel SW6	2009/06/30	220	0.10	14.0	140	29.7	23.5	14.7	22.3	6.71	0.80	0.01	33.5	7.69	0.08	0.76
Wel SW6	2009/07/31	258	0.19	16.0	190	23.0	35.6	21.7	26.5	4.39	0.67	0.01	40.5	8.16	0.05	0.54
Wel SW6	2009/08/25	284	0.28	16.0	210	20.3	33.6	21.0	28.2	5.36	1.03	0.01	42.2	7.99	0.01	0.52
Wel SW6	2009/09/23	356	0.10	21.0	302	7.6	47.4	28.5	30.5	5.25	0.23	0.01	54.5	7.73	0.01	0.68
Wel SW6	2009/10/22	328	0.10	16.0	256	17.8	39.9	25.2	28.9	4.50	0.90	0.66	50.2	7.74	0.08	0.77
Wel SW7	2009/07/31	596	0.34	10.0	65	348.0	90.3	51.0	17.9	5.78	0.03	0.01	78.6	7.54	0.03	0.24
Wel SW7	2009/08/25	1274	1.90	9.0	199	738.0	184.0	110.0	24.2	10.70	0.02	0.33	155.0	7.88	0.01	0.28
Wel SW7	2009/09/23	1408	3.78	13.0	211	752.0	184.0	109.0	27.5	9.28	0.01	0.83	162.0	7.47	0.01	0.30
Wel SW7	2009/10/22	458	0.83	20.0	175	154.0	52.4	30.0	32.6	6.41	0.10	1.52	67.0	7.56	0.01	0.35
Wel SW8	2009/07/31	322	0.39	22.0	80	143.0	37.1	20.5	25.6	5.36	0.21	0.14	47.8	7.63	0.10	0.20
Wel SW8	2009/08/25	544	0.46	20.0	109	282.0	68.4	38.6	27.5	7.06	0.23	0.22	80.2	7.48	0.01	0.20
Wel SW8	2009/09/23	454	0.80	31.0	131	176.0	50.9	28.5	37.1	7.95	0.11	0.03	71.0	7.46	0.01	0.20
Wel SW8	2009/10/22	332	0.18	35.0	122	102.0	30.2	15.7	45.1	8.69	1.47	0.50	61.1	7.59	0.04	0.28
Wel SW1	2014/07/28	38	2.29	5.5	9	4.3	2.0	1.4	6.9	2.06	0.00	0.00	7.0	7.30	0.00	0.15
Wel SW13	2014/07/29	79	0.81	11.0	18	26.9	7.2	3.9	11.6	2.88	0.00	0.00	13.3	7.31	0.00	0.21
Wel SW07	2014/07/29	115	0.59	10.6	19	54.9	12.9	7.4	12.0	2.66	0.00	0.00	18.9	7.37	0.00	0.19
Wel SW08	2014/07/29	313	0.34	37.7	150	73.4	26.9	13.2	41.6	13.20	0.00	0.24	54.9	7.82	0.00	0.32
Wel SW12	2014/07/29	30	0.66	6.4	9	4.4	3.1	1.0	5.0	1.65	0.00	0.00	4.3	7.25	0.00	0.14
Wel SW11	2014/07/29	45	0.73	10.0	13	7.4	2.9	2.5	8.2	2.34	0.00	0.00	7.1	7.12	0.05	0.12

Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al	Fluoride as F
Wilge Catchment IRWQO		450	6	20	85	120	80	20	20	10	1	0.18	70	6.5-8.4	0.02	0.5
Wel SW04	2014/07/30	876	0.22	37.8	21	582.0	138.0	50.2	44.9	9.12	0.00	0.17	104.0	6.98	0.00	0.16
Wel SW05	2014/07/30	66	0.55	10.8	21	17.7	7.1	4.2	8.1	3.10	0.00	0.00	11.3	7.52	0.00	0.20
Wel SW14	2014/07/31	56	0.27	8.9	17	17.0	5.9	3.4	7.3	1.65	0.00	0.00	9.2	7.12	0.00	0.18
Wel SW09	2014/07/31	1083	0.26	94.1	91	621.0	128.0	84.3	84.8	14.10	0.00	0.30	135.0	7.65	0.00	0.23

5 Environmental Impact Assessment

The activities list, associated with the KPSX: Weltevreden Project is included in Table 5-1.

Table 5-1: Project Activities

Activity No.	Activity
Construction Phase	
1	The recruitment, procurement and employment of construction workers, engineers and contractors.
2	The transportation of construction material to the Project site via national, provincial and local roads.
3	Storage of fuel, lubricant and explosives in temporary facilities for the duration of the construction phase. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed accordingly.
4	Site clearance and topsoil removal prior to the commencement of physical construction activities, as well as the open pit mining. This activity refers to the conversion of undeveloped, vacant land into industrial use.
5	Construction of surface infrastructure will take place, including the offices and fuel bay, haul roads, PCDs, coal tip and conveyor belt, pipelines and clean water canals and a high mast radio communication tower.
6	The construction of stockpiles, including topsoil, overburden and discard and emergency coal stockpiles.
7	The establishment of the initial boxcut and access ramps to the open pit mining areas.
Operational Phase	
8	Limited employment of skilled and unskilled labour will be required for the operation of the mine and support infrastructure.
9	Storage of fuel in diesel tanks, as well as lubricant and explosives in facilities for the duration of Project. These substances are classified as hazardous in terms of the Hazardous Substances Act, 1973 (Act No. 15 of 1973) and will be managed

Activity No.	Activity
	accordingly.
10	Drilling and blasting of the overburden rock for easy removal by excavators and dump trucks.
11	Coal removal by truck and shovel methods from the exposed coal seams. The coal is removed with shovels and transported to the plant by conveyor belt by trucks.
12	Vehicular activity on the proposed haul roads. Mining equipment will utilise the haul roads to access open pit areas, as well as to transport coal from the opencast pit to the plant and conveyor belt. The haul road will consist of wetland and stream crossings.
13	Mine water, or dirty water that is located within the opencast pits will need to be diverted by channels and berms to the PCDs to prevent clean water resources from being contaminated. Pipelines will pump the dirty water from the KPSX: Weltevreden PCDs to the KPS PCD.
14	Use of conveyor belts to transport the coal to the stockpiles at the KPS plant.
15	The PCDs will store all dirty water that has come into contact with the opencast pit, overburden stockpiles or emergency coal stockpile.
16	Operation and maintenance of the stockpiles, including topsoil, overburden and discard and ROM coal stockpiles.
17	Waste and sewage generation and disposal. All domestic, industrial and hazardous waste is produced during the mining process. Waste includes cans, plastics, used tyres and oil which must be disposed of in an appropriate manner by a contractor at a licensed waste disposal site. Sewage produced from the office buildings and ablutions will be treated at a sewage plant, septic tank or French drain system.
18	Concurrent replacement of overburden and topsoil and the re-vegetation of mined out strips. The mined strip will be backfilled with the overburden and compacted. Subsequently, the topsoil will be placed on top of the overburden and the area will be vegetated.
Decommissioning Phase	

Activity No.	Activity
19	Retrenchment of mine employees and staff will take place following the cessation of the mining operations and coal beneficiation activities.
20	Demolition of infrastructure will take place and includes the PCDs, haul roads, coal tip and conveyor belts, pipelines, high mast radio communication tower, fuel bay and mine offices and workshop.
21	Removal of fuel, lubricant and explosives will be required following the cessation of the mining activities to ensure that there is no health and safety risk to the environment and to people.
22	Final replacement of overburden and topsoil and the establishment of vegetation on the final open cast void. Overburden will be backfilled into the final void and compacted. Subsequently, topsoil will placed and the area vegetated.
23	Waste handling of scrap metal and used oil as a result of the Decommissioning Phase will be undertaken.
Post-closure Phase	
24	Post-closure monitoring and rehabilitation will determine the level of success of the rehabilitation, as well as to identify any additional measures that have to be undertaken to ensure that the mining area is restored to an adequate state. Monitoring will include surface water, groundwater, soil fertility and erosion, natural vegetation and alien invasive species and dust generation from the coal discard dumps.

5.1 Impact Rating Methodology

The methodology utilised to assess the significance of impacts is discussed in detail below. The significance rating formula is as follows:

Significance = Consequence x Probability

Where

Consequence = Type of Impact x (Intensity + Spatial Scale + Duration)

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact = ***+1*** *(Positive Impact) or* ***-1*** *(Negative Impact)*

The weight assigned to the various parameters for positive and negative impacts is provided for in the formula and is presented in Table 5-2. The probability consequence matrix for impacts is displayed in Table 5-3, with the impact significance rating described in Table 5-4.

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Table 5-2: Surface water impact assessment parameter ratings

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	*Positive Impacts (Type of Impact = +1)*			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	International The effect will occur across international borders.	Permanent: No Mitigation The impact will remain long after the life of the Project.	Certain/ Definite. There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	National Will affect the entire country.	Beyond Project Life The impact will remain for some time after the life of a Project.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to	On-going and widespread positive benefits to local communities which	Province/ Region Will affect the entire province	Project Life The impact will cease after the operational life span of the	Likely The impact may occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts (Type of Impact = -1)	*Positive Impacts (Type of Impact = +1)*			
	rehabilitate. Very serious widespread social impacts. Irreparable damage to highly valued items.	improves livelihoods, as well as a positive improvement to the receiving environment.	or region.	Project.	
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense social benefits to some people. Average to intense environmental enhancements.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	Local Extending across the site and to nearby settlements.	Medium term 1-5 years.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.

Rating	Intensity		Spatial scale	Duration	Probability
	Negative Impacts ***(Type of Impact = -1)***	***Positive Impacts*** ***(Type of Impact = +1)***			
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 5-3: Probability consequence matrix for impacts

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Consequence																																						

Table 5-4: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which may be sufficient by itself to justify implementation of the Project. The impact may result in permanent positive change.	**Major (positive)**
73 to 108	A beneficial impact which may help to justify the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment.	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the Project. These impacts will usually result in positive medium to long-term effect on the social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural environment.	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the social and/or natural environment.	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the Project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the social and/or natural environment.	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the Project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe effects.	Moderate (negative)

Score	Description	Rating
-109 to -147	A very serious negative impact which may be sufficient by itself to prevent implementation of the Project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects.	Major (negative)

Surface water quality and quantity are at risk to potential impacts associated with the opencast mining and infrastructure at KPSX: Weltevreden. These potential impacts are discussed in more detail below.

5.2 Construction Phase

Construction activities will begin with recruitment and other admin processes, transportation of material to site and storage of these. The physical construction activities will entail vegetation removal and surface infrastructure until the establishment of the initial boxcut. These initial activities will cover an area approximately 10% of the project site. The initial construction impact will therefore be assumed to be less significant.

For Activity 1 there are no surface water qualities or quantity impacts identified as most of it is administrative. Activity 1 has there not been assessed.

The identified impacts for the construction phase are detailed below.

5.2.1 Water Quality

The potential water quality impacts are explained in the tables below for the various activities.

Activity No. 2 & 3	
Criteria	**Details / Discussion**
Description of impact	■ The potential impact will arise from potential spillages during transport of construction material, hazardous substances and hydrocarbon containing fuels and lubricants. These can be mobilised to surface water resources, resulting in water contamination.
Mitigation required	■ Ensure that spillage control kits are available during transport and on storage sites in case of any accidental leakages of spillages, which can then be cleared immediately. ■ The temporary storage facilities of fuel, lubricants and explosives must be a hard park, roofed and bunded facility. This will prevent contamination of soils and the possibility of contamination of the surface water resources on site when storm

	water runoff deposit the contaminated soils into the dam.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-4	4	-48
Post-Mitigation	5	2	-2	2	-18

Activity No. 4					
Criteria	**Details / Discussion**				
Description of impact	■ Removal of vegetation and/or topsoil during excavation exposes the soil, leaving it prone to erosion which causes siltation of the surrounding surface water resources.				
Mitigation required	■ Removal of topsoil should be done systematically, only clearing the necessary areas at a time. ■ Clean and dirty surface water channels should be constructed to divert runoff separately to appropriate storage dams (dirty water to the PCD to avoid eroded soils entering the clean water catchment dam on site).				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	4	3	-2	5	-45
Post-Mitigation	4	2	-2	4	-32

Activity No. 5, 6 and 7	
Criteria	**Details / Discussion**
Description of impact	■ The construction of infrastructure exposes the surface water to the following impacts: ▪ Poorly designed and constructed pollution control dams and other water management facilities pose a threat to the surface water quality if leakage of contaminated water reports to the surrounding water bodies. ▪ The stockpiles will pose a source of sediment material that can be washed off to the streams and rivers.

Mitigation required	■ Dirty water channels that divert the water to the pollution dams should be constructed surrounding the stockpile areas and initial box cuts to avoid runoff reporting to the clean water catchment dam on site. ■ The topsoil stockpiles should be vegetated as soon as possible to prevent erosion, which might cause siltation of the water resources.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-3	3	-33
Post-Mitigation	5	2	-2	2	-18

5.2.2 Water Quantity

Activity No. 4					
Criteria	**Details / Discussion**				
Description of impact	■ Initial removal of topsoil involves potential contamination of surface water resources. Polluted surface water resources have reduced availability for downstream water users.				
Mitigation required	■ Clean and dirty surface water channels should be constructed to divert runoff to the appropriate storage dams (dirty water to the PCD to avoid eroded soils entering the clean water catchment dam on site). This preserves the downstream water uses whilst also preventing runoff from reporting downstream.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	3	-3	4	-36
Post-Mitigation	3	2	-2	3	-21

Activity No. 5, 6 & 7	
Criteria	**Details / Discussion**
Description of impact	■ Infrastructure development might disrupt the surface water flow patterns that could cause erosion due to the increased runoff velocity.
Mitigation required	■ The design, construction, operation and maintenance of water management facilities should be well executed and in line with GN 704 requirements for capacity. This could result in prevention of dirty water from negatively impacting

	on the receiving environment. ■ Mitigation can only manage the situation from consequences of hydrology phenomena like floods without necessarily returning the captured dirty water to the catchment.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-2	6	-60
Post-Mitigation	5	2	-1	3	-24

5.3 Operational Phase

The operational phase will entail the operation of the constructed infrastructure, the mining and ore transport process, as well as the storage and use of hazardous and hydrocarbon material. It will be at this stage that more areas will become disturbed. The activities that will have water quality and quantity impacts are detailed below.

Activity 8 is not anticipated to have direct water quality impacts and was not assessed.

5.3.1 Water Quality

Activity No. 9					
Criteria	**Details / Discussion**				
Description of impact	■ The potential impact will arise from the mobilization of leaked/spilled contaminants (hazardous and hydrocarbon containing material) from surface to the surrounding surface water resources. The leakages could have arisen from the use of the fuels, lubricants or from the storage facilities. This could have an impact on the quality of water.				
Mitigation required	■ Ensure that spillage control kits to contain the spillages of the contaminants from point of spillage are available on-site; and ■ The temporary storage facilities for fuel, lubricants and explosives must be a hard park, roofed and bunded facility. This will prevent contamination of soils and the possibility of contamination of the surface water catchment on site when storm water runoff deposits the contaminated soils into the dam.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	4	-4	4	-52
Post-Mitigation	5	2	-2	3	-27

Activity No. 10 &11					
Criteria	**Details / Discussion**				
Description of impact	■ The nitrates and carbonaceous material will be in contact with pit water, contaminate the water in the pit and can potentially contaminate the streams if they discharge into the natural environment. The impacts arise from: ▪ Blasting that release ammonium nitrates from the explosive residues. ▪ Exposure of runoff to carbonaceous material from coal removal.				
Mitigation required	■ All water being pumped from the pit should be stored in the pollution control dams (PCD's) for proper management of dirty water.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-4	4	-48
Post-Mitigation	5	1	-3	2	-18

Activity No. 12,14,16	
Criteria	**Details / Discussion**
Description of impact	■ Potential water quality contamination could result from the activities including: ▪ Spillages of oil and diesel from the trucks transporting the coal may cause water pollution if storm water runoff reports to the streams. ▪ Potential contamination of wetland and streams from carbonaceous material on the ROM, or spillages from the conveyor. ▪ Flushing of chemicals from the coal being transported via conveyor belts can contaminate the water in Saalklapspruit at the conveyor crossing (at Wel SW2 site) and at haul road crossings.
Mitigation required	■ Conveyors transporting the coal should be stable and covered on top to avoid flushing of the coal by rain. ■ Haul road speed limits should be adhered to prevent spillages from speeding trucks, and the trucks should be covered so that no material spills out onto the roads. ■ The haul trucks should also have controlled loads. ■ The stockpiles should be controlled so that they are not overloaded beyond their capacity. When the haul trucks are loading the stockpile, their movement should

	be well regulated reducing spillages and consequently increasing the dirty area footprint outside the dirty areas. Such areas should be operated within the bounds of the berms and dirty area cut-off trenches.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-3	4	-44
Post-Mitigation	5	2	-3	2	-20

Activity No. 13,15					
Criteria	**Details / Discussion**				
Description of impact	■ A potential pit dewatering pipeline burst could result in dirty pit water contaminating the surface water runoff. ■ PCDs can also have a negative impact if they are not well lined, if they crack and seep water or overflow in the event of extreme rainfall to the surface and underground.				
Mitigation required	■ The dewatering berms and pipelines need to be well sized based on the determined dewatering rates; ■ The design, construction, maintenance and operation of the PCD that form part of a dirty water system to have a minimum freeboard of 0.8 metres above full supply level and should be able to contain a 1:50 year recurrence, 24-hour storm event; and ■ Maintenance of structures is essential to ensure efficient operation and identification of potential issues before they arise.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	6	4	-4	4	-56
Post-Mitigation	6	3	-2	3	-33

Activity No. 17	
Criteria	**Details / Discussion**
Description of impact	■ Temporary storage of waste material before collection for disposal may result in leakages which could potentially contaminate water resource or a wetland. ■ Sewage treatment plant system failure may result in overflows or leakages into

	the surface water bodies on site.				
Mitigation required	■ Ensure that there is no discharge or leakage on the sewage treatment plant, septic tank or French drain system by monitoring and maintenance of the system. ■ Measures should be in place to reduce system blockages through usage control and educating employees on the best ways to use the system. ■ The temporary storage facilities waste materials must be a hard park, roofed and bunded facility. This will prevent contamination of soils and the possibility of contamination of the surface water catchment on site when storm water runoff deposits the contaminated soils into the dam.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-3	4	-44
Post-Mitigation	5	2	-2	2	-18

Activity No. 18					
Criteria	**Details / Discussion**				
Description of impact	■ This will have a positive impact on the quality of water as re-vegetation of the mined out strips will prevent soil erosion into the streams.				
Enhancement required	■ Monitoring of vegetation establishment should be done so that areas where there is poor growth could be re-vegetated. Once the vegetation has been monitored, it is important that the bare patches are filled up with more vegetation. This ensures that the entire surface under rehabilitation is covered from elements of erosion. ■ Monitoring of water quality should continue downstream so that impacts are detected and more vegetation can be added. The dirty water can be collected for further treatment in a sustainable way.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Enhancement	7	3	3	6	78
Post-Enhancement	7	3	4	6	84

5.3.2 Water Quantity

Activity No. 8,10,11,12					
Criteria	**Details / Discussion**				
Description of impact	■ Increase of demand on raw water for use by employees, as well as for the mining operations and dust suppression.				
Mitigation required	■ Water conservation should be implemented to ensure raw water demand is managed, from the mining and general use by staff during the LoM. ■ Strategies for water reuse for industrial purposes will save on the required raw water for the mining and drilling processes, i.e. using PCD water for dust suppression.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	5	3	-3	5	-55
Post-Mitigation	5	2	-2	3	-27

Activity No. 10,11,13,15					
Criteria	**Details / Discussion**				
Description of impact	■ At the pit entry/exit points, runoff is likely to flow towards the pit and that changes the surface water flow or drainage patterns thereby affecting the catchment yield on the streams. ■ Rainwater falling on the open portions of the pit, un-rehabilitated spoils, as well as the overburden dumps will be collected as dirty water and be re-used. This will reduce the runoff that reports to the downstream clean catchments. ■ The storage of dirty water in the PCDs reduces the water available for use downstream users.				
Mitigation required	■ Clean and dirty surface water channels should be constructed to divert clean runoff away from the site and dirty water to appropriate storage dams. ■ All the water being pumped from the pit should be stored in the pollution control dams (PCD's) for re-use on the mine to prevent unnecessary wastage of water and the need for extra water from the catchment.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*

Pre-Mitigation	6	3	-3	5	-60
Post-Mitigation	5	3	-2	4	-30

Activity No. 10,11					
Criteria	**Details / Discussion**				
Description of impact	■ When open pit mining at Pit BD commences, some streams will be mined through. This may result in a total destruction of some upstream sections of non-perennial tributaries to the Saalklapspruit and the Grootspruit.				
Mitigation required	■ Mining of streams should be avoided where possible. In addition to this, mining within floodlines of major streams and within 100 m of streams should be avoided. ■ The mine plan should therefore be altered so that streams are not mined out because once streams are mined out, they will not be returned to their pre mining status.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	7	3	-5	7	-105
Post-Mitigation	no mitigation				

Activity No. 18					
Criteria	**Details / Discussion**				
Description of impact	■ A positive impact on the quantity of water will take place as the pre-mining drainage pattern will be restored as far is practical.				
Enhancement required	■ Monitoring of vegetation establishment should be done so that areas where there is poor growth could be re-vegetated. As the vegetation is monitored, it is important that the bare patches are filled up with more vegetation. This ensures that the entire surface under rehabilitation is covered from elements of erosion. ■ Monitoring of water quality should continue downstream so that when impacts are detected, more vegetation can be added and the dirty water can be collected for further treatment in a sustainable way.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*

Pre-Enhancement	7	3	3	6	78
Post-Enhancement	7	3	3	6	78

5.4 Decommissioning

The decommissioning phase entails the close out of the mine and removal of infrastructure, retrenchment of staff and the replacement of soil and overburden in an attempt to restore the site to its original pre-mining state.

Activity 19 will not have impact on water quality or quantity except reducing the raw water required at the mine for use and is rated below.

5.4.1 Water Quality

Activity No. 20, 21 and 23					
Criteria	**Details / Discussion**				
Description of impact	■ The potential impact will arise during demolition of infrastructure, where mobilization of contaminants such as fuels containing hydrocarbons, waste, explosives, PCD material to the surface water resources resulting in the contamination of those resources.				
Mitigation required	■ Accredited contractors must be used for disposal and transport of demolition material. ■ Ensure that spillage control kits to contain the contaminants from point of spillage are available on-site.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	3	3	-5	4	-44
Post-Mitigation	2	4	-2	2	-16

Activity No. 22	
Criteria	**Details / Discussion**
Description of impact	■ This will have a positive impact on the quality of water as re-vegetation of the area will prevent soil erosion discharging into the streams.

Enhancement required	■ The backfilled areas should be vegetated as soon as possible to prevent dust and siltation of the water bodies. ■ Undertake surface inspection to ensure a surface profile that allows for good drainage. ■ Where rehabilitation (grass seeding of topsoil cover) is not effective, the associated soil erosion should be mitigated by installing silt traps. ■ To complement the rehabilitation process, water quality monitoring should be implemented until 3 years post closure, so as to capture any negative residual impacts that could surface years later.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Enhancement	4	3	3	5	50
Post-Enhancement	4	3	3	6	60

5.4.2 Water Quantity

Activity No. 19					
Criteria	**Details / Discussion**				
Description of impact	■ A positive impact on the quantity of water will result when there are no more raw water requirements after mine closure. As such, more water is available for other downstream uses.				
Enhancement required	■ The water quality of the water passing through the site should be clean and the post mining water treatment should ensure that the remaining infrastructure is self-sustaining without further need for raw water.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Enhancement	6	4	5	5	75
Post-Enhancement	6	4	5	5	75

Activity No. 22	
Criteria	**Details / Discussion**

Description of impact	▪ A positive impact on the quantity of water will take place as the pre mining drainage pattern will be restored in the catchment.				
Enhancement required	▪ Monitoring of the surface profile to ensure that it allows for a free surface drainage of water. This will ensure that any areas where water ponds can be detected. It will be imperative that areas of water ponding and disrupted flow are reworked to avoid ponding.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Enhancement	4	3	3	5	50
Post-Enhancement	4	3	3	5	50

5.5 Post Closure

Post closure activities will include rehabilitation and monitoring to determine the success of the rehabilitation. There will be no major impacts anticipated that will directly impact the surface water resources as rehabilitation is already carried out in the decommissioning phase. In this phase monitoring should continue, for residual surface water impacts as well as identification of patchy rehabilitation work areas and ensuring that these are attended to.

5.5.1 Water Quality

Activity No. 24	
Criteria	**Details / Discussion**
Description of impact	▪ Possible water quality impacts may arise when decant occurs from either backfilled pits of from remaining discard dumps. Water pollution could result in contamination the surrounding water bodies.
Mitigation required	▪ Water quality monitoring should continue to enable the detection of decant when it occurs, so immediate mitigation measures can be implemented. ▪ Ensure that monitoring is in place for at least 2 to 3 years post closure, after rehabilitation and that all the land remains free draining post closure, post rehabilitation. ▪ If post closure impacts are identified, methods of withholding and treating the water should be further investigated depending on parameters of concern. ▪ Decant studies should be carried out to identify decant points and when decant water is observed, it should be collected and treated before release.

Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Mitigation	7	5	-7	6	-114
Post-Mitigation	3	3	-2	3	-24

5.5.2 Water Quantity

Activity No. 24					
Criteria	**Details / Discussion**				
Description of impact	■ A positive impact on the quantity of water as the stream flows are restored to the catchment.				
Enhancement required	■ Monitoring of vegetation establishment should be done so that areas where there is poor growth could be re-vegetated. ■ Monitoring of the surface profile to ensure that it allows free surface drainage of water.				
Parameters	*Duration*	*Spatial*	*Intensity*	*Probability*	*Significant rating*
Pre-Enhancement	4	3	3	5	50
Post-Enhancement	4	3	3	5	50

6 Cumulative Impacts

The current water quality indicates existing contamination, potentially from upstream mines on the Grootspruit and some water quality impacts are already evident on the Saalklapspruit in the most upstream points. These can be attributed to the impacts of the mining operations at the existing Klipspruit South Mining area. There are other mines in the upstream catchments of the Wilge and these have contributed to the deterioration of water quality. With the development of mining in these upstream catchments of the Wilge, pollution is expected to further accumulate.

The cumulative impacts can result from carbonaceous material washed into the downstream water resources. These could result in further increases in TDS, Alkalinity, SO_4, Ca, Mg, Na, Mn and EC.

This however can be controlled by implementation of mitigation measures and ensuring zero discharge for dirty water.

The water use needs will add onto the water demand of the catchment thus water demand and supply management will be important.

7 Summary of Significant Impacts

7.1 Construction Phase

The clearing of land in preparation for the construction of infrastructure and opencast mining will have negative impacts associated with water quality and quantity. Potential contamination of water may occur due to contact with the overburden material, should the overburden be carbonaceous and/or pyritic. The reduction of potential clean runoff water reporting to the catchment will have impacts on water quantity.

7.2 Operational Phase

The opencast pits and ROM stockpiles will potentially contaminate surface water runoff with carbonaceous material from the overburden and ROM, as well as from accidental spillages and pit dewatering. Precipitation falling in the open pits, un-rehabilitated spoils and overburden dumps will be collected as dirty water and re-used in the Plant operations. This will reduce the runoff that is generated and which could contribute to the downstream clean catchments.

The proposed mining through the non-perennial tributaries to the Saalklapspruit and the Grootspruit will result in destruction of these river sections and thus the downstream river regime, which potentially may alter the flow. Construction within the floodplains should be avoided.

7.3 Decommissioning Phase

Precipitation falling on un-rehabilitated areas and any remaining overburden dumps or stockpiles is subject to contamination from carbonaceous material. Such an impact will have negative impacts on the water quality.

7.4 Post Closure

Surface water monitoring should identify residual impacts on water quality from decant. Once decant is managed, the post closure rehabilitation and monitoring will further enhance positive impacts on quality (removal of erosion source), as well as the restoration of storm water flow to the catchment after mining.

The identified impacts are summarised in the Table 7-1.

Table 7-1: Summary of surface water impact assessment

Activity	Impact	Pre-mitigation:						Post-mitigation:					
		Duration	Extent	Intensity	Conse-quence	Proba-bility	Signifi-cance	Duration	Extent	Intensity	Conse-quence	Proba-bility	Signifi-cance
2,3	Hydrocarbons mobilised to surface waters resulting in water contamination	Project Life	Local	Moderately high - negative	Moderately detrimental	Probable	Minor - negative	Project Life	Limited	Low - negative	Slightly detrimental	Improbable	Negligible - negative
4	Water Quality deterioration from erosion	Long term	Local	Low - negative	Slightly detrimental	Likely	Minor - negative	Long term	Limited	Low - negative	Slightly detrimental	Probable	Negligible - negative
5,6,7	Introduction to potential impacts sources such as stockpiles resulting in siltation source and PCDs etc contamination source.	Project Life	Local	Moderate - negative	Moderately detrimental	Unlikely	Negligible - negative	Project Life	Limited	Low - negative	Slightly detrimental	Improbable	Negligible - negative
4	Water pollution from spillages reducing the water use potential	Medium term	Local	Moderate - negative	Slightly detrimental	Probable	Minor - negative	Medium term	Limited	Low - negative	Slightly detrimental	Unlikely	Negligible - negative
5,6,7	Reduced and impeded stream flows to downstream users	Project Life	Local	Low - negative	Moderately detrimental	Highly probable	Minor - negative	Project Life	Limited	Very low - negative	Slightly detrimental	Unlikely	Negligible - negative
9	Hydrocarbon contamination on surface water	Project Life	Municipal Area	Moderately high - negative	Moderately detrimental	Probable	Minor - negative	Project Life	Limited	Low - negative	Slightly detrimental	Unlikely	Negligible - negative
10,11	Water quality contamination from blasting material residues and carbonaceous material if the water in contact t with these is released to environment	Project Life	Local	Moderately high - negative	Moderately detrimental	Probable	Minor - negative	Project Life	Very limited	Moderate - negative	Slightly detrimental	Improbable	Negligible - negative
12,14,16	Water pollution from sediments and	Project Life	Local	Moderate - negative	Moderately detrimental	Probable	Minor - negative	Project Life	Limited	Moderate - negative	Moderately detrimental	Improbable	Negligible - negative
13,15	Surface water contamination from PCDs and pipe burst	Beyond project life	Municipal Area	Moderately high - negative	Highly detrimental	Probable	Minor - negative	Beyond project life	Local	Low - negative	Moderately detrimental	Unlikely	Negligible - negative
17	Surface water contamination from waste and sewage disposal	Project Life	Local	Moderate - negative	Moderately detrimental	Probable	Minor - negative	Project Life	Limited	Low - negative	Slightly detrimental	Improbable	Negligible - negative
18	Reduced dirty catchment area thus reducing pollution potential	Permanent	Local	Moderate - positive	Moderately beneficial	Highly probable	Moderate - positive	Permanent	Local	Moderately high - positive	Highly beneficial	Highly probable	Moderate - positive
10,11,13, 15	Changed hydrological regime from mine dewatering and Reduced clean water catchment for runoff	Beyond project life	Local	Moderate - negative	Moderately detrimental	Likely	Minor - negative	Project Life	Local	Low - negative	Moderately detrimental	Unlikely	Negligible - negative

Activity	Impact	Pre-mitigation:						Post-mitigation:					
		Duration	Extent	Intensity	Conse-quence	Proba-bility	Signifi-cance	Duration	Extent	Intensity	Conse-quence	Proba-bility	Signifi-cance
10,11	Destruction of streams sections by O/C mining	Permanent	Local	Moderately high - negative	Highly detrimental	Certain	Moderate - negative	#N/A	#N/A	Negligible	Negligible	#N/A	0
18	Increased water uses water quantity for downstream water users	Permanent	Local	Moderate - positive	Moderately beneficial	Highly probable	Moderate - positive	Permanent	Local	Moderate - positive	Moderately beneficial	Highly probable	Moderate - positive
8,10,11	increased water uses water quantity for downstream water users	Project Life	Municipal Area	High - negative	Highly detrimental	Probable	Minor - negative	Project Life	Very limited	Moderate - negative	Slightly detrimental	Unlikely	Negligible - negative
20,21,23	Hydrocarbon contamination on surface water during demolition	Medium term	Local	High - negative	Moderately detrimental	Probable	Minor - negative	Short term	Municipal Area	Low - negative	Slightly detrimental	Improbable	Negligible - negative
22	Reduced sources of erosion material / siltation	Long term	Local	Moderate - positive	Moderately beneficial	Likely	Minor - positive	Long term	Local	Moderate - positive	Moderately beneficial	Highly probable	Minor - positive
22	Restoration of stream flows	Long term	Local	Moderate - positive	Moderately beneficial	Likely	Minor - positive	Long term	Local	Moderate - positive	Moderately beneficial	Likely	Minor - positive
24	Water quality deterioration from decant	Permanent	Province/ Region	Extremely high - negative	Extremely detrimental	Highly probable	Major - negative	Medium term	Municipal Area	Low - negative	Slightly detrimental	Unlikely	Negligible - negative
19	As such more water is available for other downstream uses	Beyond project life	Municipal Area	High - positive	Highly beneficial	Likely	Moderate - positive	Beyond project life	Municipal Area	High - positive	Highly beneficial	Likely	As such more water is available for other downstream uses
24	Restoration of stream flows	Beyond project life	Province/ Region	Moderately high - negative	Highly detrimental	Probable	Minor - negative	Beyond project life	Local	Low - negative	Moderately detrimental	Unlikely	Restroration of stream flows

8 Surface Water Monitoring Plan

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented.

A monitoring program is used as an early detection tool for surface water quality and is used to determine when mitigation must be implemented. Monitoring should be implemented throughout the life of mine. The impacts on water quality will be determined by benchmarking the monitoring data against the WIlge Interim RWQO.

The surface water monitoring plan is detailed below.

Table 8-1. Surface water monitoring plan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Ensure that monitoring is implemented to cover all mining activity areas and detect impact. Water quality monitoring is implemented at all sites. All parameters Al, hydrocarbons.,SO_4, PO_4, Fe, Mn, Ca, Mg, NO_3, NH_3, F, Cl, pH, EC, TDS, SS; Na, K and metals	-Monthly during construction. - Reduce to quarterly on rehabilitated areas. - This can further be reduced to biannually (wet and dry season). -Monitoring needs to carry on three years after the project has ceased, as is standard practice to detect residual impacts.	Specialist Environmental Quality
Water quantity	Flow monitoring should be carried out in channels and pipelines and at facilities on site. Monitoring water levels in dams and channels. Records of Pit dewatering	-Instantaneous where automatic flow meters are in place for real time measurements. -Where there are no automatic flowmeters weekly monitoring needs to be done. -In operational areas, daily records need to be kept	Specialist Environmental Quality
Physical structures and SWMP performance	Personnel should have a walk around facilities to determine the facilities conditions and pick out any anomalies such as leaks or overflows and system malfunctions. Dams are inspected for silting and blockages of inflows, pipelines for hydraulic integrity; monitor The overlal SWMP performance should be detailed.	Continuous process and yearly formal report	Specialist Environmental Quality
Meteorological	Measure rainfall	Real time system if in	Sampler

Monitoring Element	Comment	Frequency	Responsibility
data		place	
Rehabilitation	Perform and monitor continuous rehabilitation sites	Continuous	Specialist Environmental Quality

9 Conclusions and Recommendation

The KPSX: Weltevreden Project area is located in the Olifants Water Management Area 4 (WMA 4), with the proposed Project's footprint falling in quaternary catchments B11F and B20G. The majority of the study area falls within the quaternary catchment B20G, and is drained by Saalklapspruit, a tributary of the Wilge River. The south-western portion of the site falls within the B11F catchment, which is bisected by the Olifants River.

The catchment is largely rural with grasslands and bare and cultivated lands making up most of the land cover. The design rainfall for a 1:50 year of 129mm was determined for the project site. The peak flows determined for the sub-catchments range from 28 to 208 m^3/s and 39 to 245 m^3/s for 1:50 and 1:100 flood events respectively.

The predominant users of the surface water resources within the KPSX: Weltevreden catchments are agricultural, mining and power generation. The WARMS database of registered users identified that irrigation uses approximately 1,385,884 m^3/year, whilst mining is 74,855 m^3/year.

Ten sites were sampled as part of the water quality assessment. The water quality results indicated an already impacted surface water streams from existing mining operations. The parameters identified are TDS, Alk, SO_4, Ca, Mg, Na, Mn and EC, which exceed the Interim WQO of the Wilge catchment. The water quality was worse in 2009 compared to the one sample run undertaken during July 2014.

Impacts from existing activities are evident in the two streams draining on the site, the Grootspruit and the Saalklapspruit.

With the development of mining in these upstream catchments of the Wilge, more pollution is expected. Several impacts were determined and these include:

- The clearing of land in preparation for the construction of infrastructure and opencast mining pits will have negative impacts associated with water quality. Contamination of water can result from soil erosion or from the potential contamination of water due to contact with the overburden material, should the overburden be carbonaceous and/or pyritic;
- The water quantity can be affected as there will be a reduction of the potential clean runoff water reporting to the catchment. This will have impacts on water quantity when dirty areas isolation is implemented;

- The opencast pits and ROM stockpiles will potentially contaminate surface water runoff from carbonaceous material, as well as from accidental spillages of pit water;
- The proposed mining through the non-perennial tributaries to the Saalklapspruit and the Grootspruit will result in the destruction of these river sections, thus the downstream river regime which potentially alters the flow. Construction within the floodplains should be avoided;
- After rehabilitation, precipitation falling on un-rehabilitated areas and any remaining overburden dumps or stockpiles is subject to contamination from carbonaceous material. Such an impact will have negative impacts on the water quality;
- Additional water use needs will add to the water demand of the catchment; and
- Water quality deterioration could result from spillages of fuels and other hydrocarbon containing materials like lubricants, chemicals from blasting material, as well as hazardous substances stored and used on site.

The cumulative impacts can result from carbonaceous material washed down into the downstream water resources. These could result in further increases in TDS, Alkalinity, SO_4, Ca, Mg, Na, Mn and EC.

The identified potential impacts however can be controlled by implementation of mitigation measures and ensuring zero discharge for dirty water. The following are some measures that can be implemented:

- Ensure that spillage control kits are available during transport and on storage sites in case of any accidental leakages of spillages, which can then be cleared immediately;
- The temporary storage of fuel, lubricants and explosives must be in a hard park, roofed and bunded facility. This will prevent contamination of soils and the possibility of contamination of the surface water catchment when storm water runoff moves through the area;
- Clean and dirty surface water channels should be constructed to divert runoff to appropriate storage dams (dirty water to the PCD to avoid eroded soils entering the clean water catchment dam on site). This only preserves the downstream water uses whilst also preventing runoff from reporting downstream;
- Conveyors transporting the coal should be stable and covered on the top to avoid flushing of the coal by rain into the natural environment;
- Haul road speed limits should be adhered to prevent spillages from trucks, and the trucks should be covered so that no material spills onto the roads; and
- Monitoring of vegetation establishment should be done so that areas where there is poor growth should be re-vegetated.

The monitoring should identify residual impacts on water quality from decant. Once the decant is managed, the post closure rehabilitation and monitoring will further enhance positive impacts on quality (removal of erosion source), as well as the restoration of storm water flow to the catchment after mining. Post-closure monitoring can be continued for an additional 3 years to capture post closure residual impacts.

10 Water Management Plan

10.1 Conceptual Storm Water Management Plan (SWMP)

The SWMP intends to protect the storm water and other surrounding water resources from impacts by mining process.

10.1.1 Storm Water Management Principles

There are four primary principles that need to be applied in the development and implementation of a SWMP:

- Clean water must be kept clean and be routed to a natural watercourse by a system separate from the dirty water system while preventing or minimising the risk of spillage of clean water into dirty water systems;
- Dirty water must be collected and contained in a system separate from the clean water system and the risk of spillage or seepage into clean water systems must be minimised;
- The SWMP must be sustainable over the life cycle of the mine and over different hydrological cycles and must incorporate principles of risk management; and
- The statutory requirements of various regulatory agencies and the interests of stakeholders must be considered and incorporated.

10.1.2 Objectives of the SWMP

The SWMP will achieve the following objectives:

- Ensure that dirty water is collected into dirty water facilities for reuse within the mining operations and clean water is kept out of the dirty area;
- Ensure that all storm water structures are designed to keep dirty and clean water separate and can contain the water and will not spill into one another in at least a 1:50 year storm event;
- To illustrate the flow of storm water on site to ensure clean water is kept clean and dirty water is collected;
- To describe the operational and management practices and monitoring plan which could be used to control pollution and detect impacts of mining activities; and
- To provide other elements including a facility inspection schedule, site compliance evaluation program, and record-keeping and reporting programs that will enable the KPSX: Weltevreden Mine to comply with the intent of the plan.

10.1.3 Legal

The compilation of a SWMP is guided by the principles and requirements stipulated in the following main documents:

- Department of Water and Sanitation's (DWS) Best Practice Guidelines (BPG) G1: Storm Water Management; and
- National Water Act (Act No.36 of 1998) regulations on water use for mining and related activities aimed at the protection of water resources Government Notice Regulations (GNR) no 704 (1999).

10.2 Conceptual Storm Water Management Plan (SWMP)

The proposed mining layout is across the direction of drainage. As such the alternatives for clean water management are the construction of clean water berms and drainage trenches around the pits, pollution Control dams (PCDs) and stockpiles.

Clean water will be diverted around the mine workings and discharged into the unnamed tributary of the Saalklapspruit, southeast of the site. Some of the clean water will be diverted towards the Grootspruit. The development of the pit should leave enough room for the construction of suitable management structures.

A conceptual SWMP is summarized in a layout plan Figure 10-1 with an annotation of the demarcation of clean and dirty areas; the location of the storm water infrastructure; and location of key monitoring points.

10.2.1 Site Water Management and Operational Control

The proposed KPSX Project will be a new mine, constructed for open cast mining. It will provide operational control over its infrastructure such as overburden stockpiles, open pit, pollution control dam (PCD), topsoil stockpiles, tip area, conveyors, haul roads, trenches and berms.

Several pieces of infrastructure will be constructed and will be used to undertake the following water management activities:

- Mine water, or dirty water that has come into contact with the opencast pit, overburden stockpiles or emergency coal stockpile will be channelled to the PCDs on the KPSX Weltevreden site. This dirty water will then be channelled to the PCDs at the main Klipspruit South facilities for handling;
- The PCDs will store all dirty water that has come into contact with the opencast pit, overburden stockpiles or tip area; and
- The construction of berms and channels will be carried out to ensure that clean water stays out of the site and is diverted to the natural drainage systems.

10.2.2 Technical Situation Analysis

The clean water and dirty water catchments were delineated by taking into account the proposed infrastructure and based on the hydrology with guidance from the DWA BPG G1.

The Weltevreden site has been classified into dirty, moderately dirty and clean areas as illustrated in Table 10-1. This is the basis for the clean and dirty area delineation as shown Figure 10-2.

The buildings are usually part of clean systems, however in this case they are classified in a dirty area, as they are isolated clear areas within dirty areas.

Table 10-1: Weltevreden Colliery site area classifications for the SWMP

Area Classification	Surface Infrastructure	Comment
Dirty	Tip Area	Suspended and dissolved carbonaceous contaminants
	Proposed Overburden Stockpile	Suspended solids and potential contaminants
	Boxcut and Pit	Suspended solids and potential contaminants
	Conveyor belts	Suspended solids and potential contaminants form coal
	PCDs	Dissolved contaminants
Moderately dirty	Proposed Topsoil Strip Stockpile	SS solids
	Building	Only sewer to consider
	Mined out Area	Potential dissolved contaminants and decant
	Haul roads	Small coal particles
Clean	New Raw Water Elevated Tank	Clean water no issue except spillages of clean water
	Grave Site	A social issue
	Substation	A safety issue

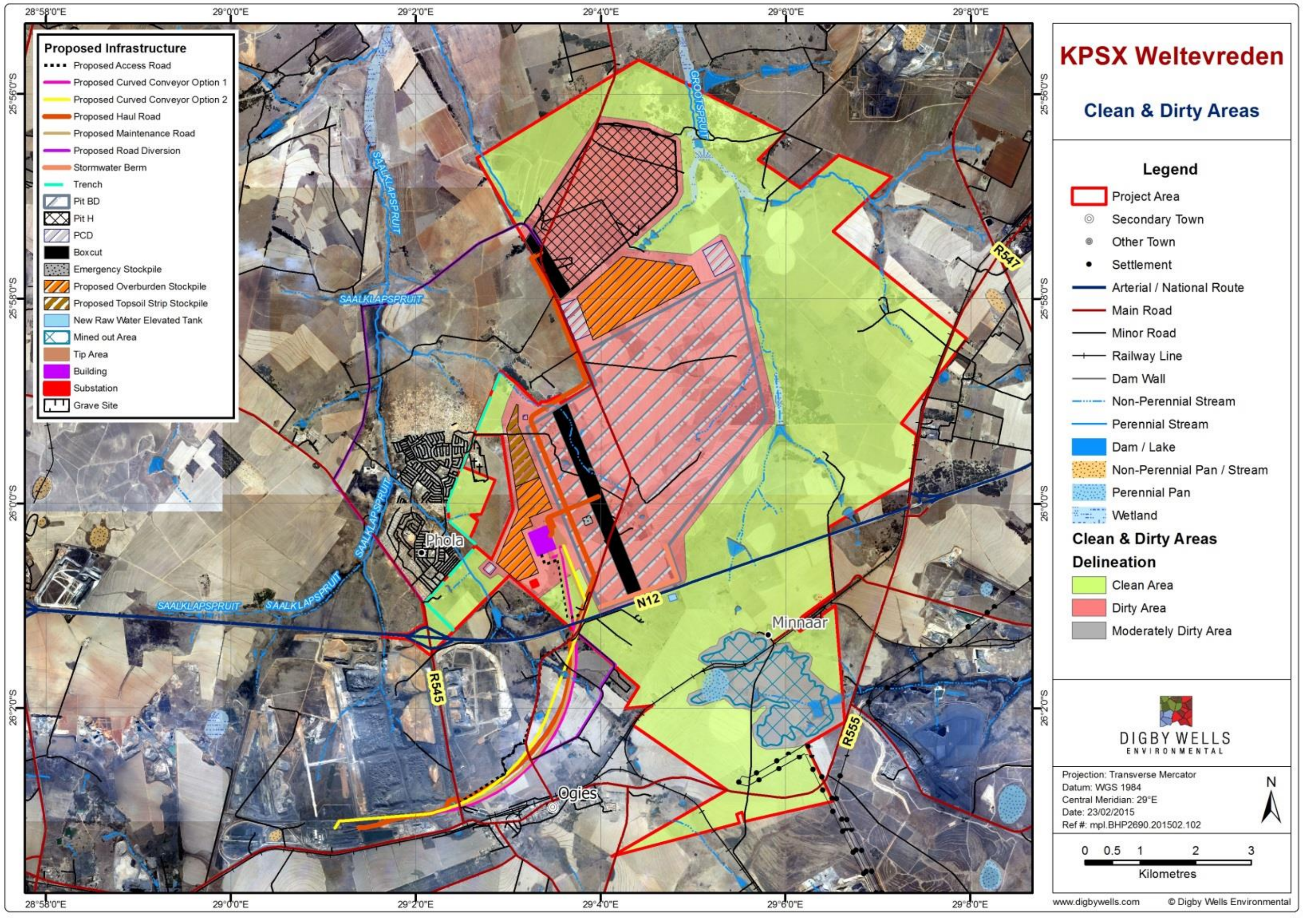

Figure 10-1: Clean and dirty area delineation within the Weltevreden project boundary

10.2.3 Potential Impacts on Storm Water

The mining process can result in potential impacts on the storm water if suitable management measures are not implemented.

10.2.3.1 Water Quality

The most significant impacts identified during the surface water assessment at KPSX, Weltevreden relate to water quality impacts such as hydrocarbon contamination and contamination from blasting material residues and carbonaceous material that come into contact with surface water resources.

Other impacts on storm water relate to the development of infrastructure which in the long run poses water quality impacts such as stockpiles becoming sources of sediment and PCDs being sources of dirty water leachate to the streams through seepage.

Positive impacts can arise at the end of mining during the decommissioning and post closure stage. These include the return of storm water runoff to the catchment once the site is rehabilitated and well vegetated and compacted. Vegetation would also reduce the soil erosion potential of the surface.

Post mining potential decant is the major impact that will need to be well managed. Possible water quality impacts may arise when decant occurs from either backfilled pits of from remaining overburden dumps. Leachate seeping from the mine could result in contamination the surrounding water bodies. Backfilling of pits with the waste material could also have negative implications on water quality as the water would have been in contact with material causing water quality deterioration.

10.2.3.2 Water Quantity

In terms of the surface water quantity and flow patterns the following were the impacts identified during the surface water assessment and with a high significance rating.

Infrastructure development might disrupt the surface water flow patterns that could cause erosion due to the increased runoff velocity; therefore the construction of these should comply with GNR704 to reduce potential impacts.

Flooding of PCDs if they are not adequately constructed can result in dirty water flowing to the streams.

When open pit mining at Pit BD commences, some non-perennial streams will be mined through. This may result in the elimination of upstream sections of a non-perennial tributary to the Saalklapspruit and the entire tributary to the Grootspruit. This would alter the flow in the main streams during rainy seasons as the tributaries normally had flow after heavy storm events. This would lead to reduced stream flows.

A positive impact on the quantity of water will take place as the pre mining drainage pattern will be restored in the catchment as much as is possible.

10.2.4 Storm Water Management

The general topography on the proposed site varies from areas several high level ground which form most of the subcatchments divides. The high lying areas results in several natural drainage lines and streams towards either the Grootspruit of the Saalklapspruit, where some of the areas will be mined out. This results in water flowing east and north in catchments of the Grootspruit, whilst in the Saalklapsruit sub-catchment flow is either to the south, the south west or the north west.

The general topography of the site is the basis for the recommendation for placement of berms and an evaluation of the proposed PCD sites. This ensures minimal pumping whilst utilising gravity. The catchment delineation carried out during the Surface Water specialist study also acts as a basis for placement of berms to ensure that dirty water from upstream in catchments is not allowed to flow downstream to clean catchment, but it is intercepted.

There is a clean catchment to the northeast of the site, on the other side of the Grootspruit and upstream on the Grootspruit to the South of the site, adjacent to the N12. Clean and dirty water will have to be separated with berms and trenches around the eastern perimeter of the workings. There has been no consideration of storing the clean catchment runoff water in storm water dams, as the volumes anticipated from upstream of the infrastructure will be minimal. This is due to very small upstream catchments and as such, the clean water should freely join the natural system.

The area upstream of the Saalklapspruit to the east of Phola, will be a dirty area, which will need the storm water to be directed around to drain freely to the stream around the settlement of Phola. The clean water will then be discharged back to the overland flow draining northwards into a tributary of the Saalklapspruit.

Dirty area water run-off will be prevented from flowing towards the natural streams by berms and cut-off trenches. This is motivated because the open pit and other infrastructure are upstream of the streams and in some cases there is very limited space between the infrastructure and the streams.

The following are the recommendations for the SWMP, as also depicted in Figure 10-2

Table 10-2: SWMP

Area/ infrastructure	Recommended SWMP strategies
Stockpiles	A clean water diversion berm should be constructed around the overburden stockpiles and top soil stockpiles. This will prevent clean water from flowing into the stockpiles and then to the tributaries of the Saalklapspruit via Phola.
Proposed Haul road	A berm should be placed on the downstream site of the haul road especially near the stream. Between the PCD and the haul road near pit H, it appears to be flat ground. To protect the haul road from flooding, the PCD should have elevated edges in the

Area/ infrastructure	Recommended SWMP strategies
	form of berm. Culverts should be available to convey water below the haul road at certain points.
Trip Area	The tip area associated with pit BD should also be serviced by drains which can be V-drains carrying dirty water towards the PCD, downstream near Phola. The surface can be slightly manipulated so that the flow is towards the south of the buildings. This can then be serviced by a trench which can be linked to a southern cut-off trench towards the PCD on the west of the stockpiles. The same drain can drain through the buildings collecting storm water.
The building area	This area can be serviced by shallow storm drains to ensure free drainage, and these should be linked to the trenches draining the south of the stockpiles to the PCD servicing the stockpiles area. The area between the building and the stockpiles could potentially be a blind hydrological flow area where water can pond. As such it's important that the surface is modified along the buildings and tip area so that it can slope towards the south where the cut-off trench will be located.
PCDs	4 PCDs are proposed for the Weltevreden site, to store dirty water from drainage or from pit dewatering. The PCDs should be able to cater for a 1:50 year storm event directly flowing on the stockpiles and open pits, in addition to pit dewatering. Most of the PCDs are located on low ground, hence water will flow by gravity to them. One PCD to the southwest of Pit H is located on flat ground. This could be supplied by pumps and pipes from the pit dewatering. The PCD on low ground, on the east, should be constructed before the stockpile between pits BD and H as water will flow in that direction. Another PCD is proposed to be shifted on lower ground if it is to service seepage from the stockpiles, to a position just at the end of the topsoil stockpile. The dirty water captured for storage in PCDs, should be retained to augment the supply of water for dust suppression.
Water diversion around the open pits	To limit the amount of clean storm water ingress into the open pit, a diversion bund is created around the perimeter of the open pits. This will also act as a safety feature thus preventing accidental access to the pit. Where the bund crosses the access ramps, the side slopes should be flattened more, to pose as a speed hump, allowing access to the pit yet preventing storm water ingress. The recommended side slopes for the berms is 1:1.5.

In the project site, there are little upstream river sections that will be mined, due to the location of the infrastructure areas close to the watershed. The recommendations for diversion of the small non perennial stream sections were not part of this scope.

Based on the Life of Mine (LoM) plan, backfilling will be stating from the mined areas, hence west to east on the pits. The placement of the final PCD in the west will be there for the entire life of mine.

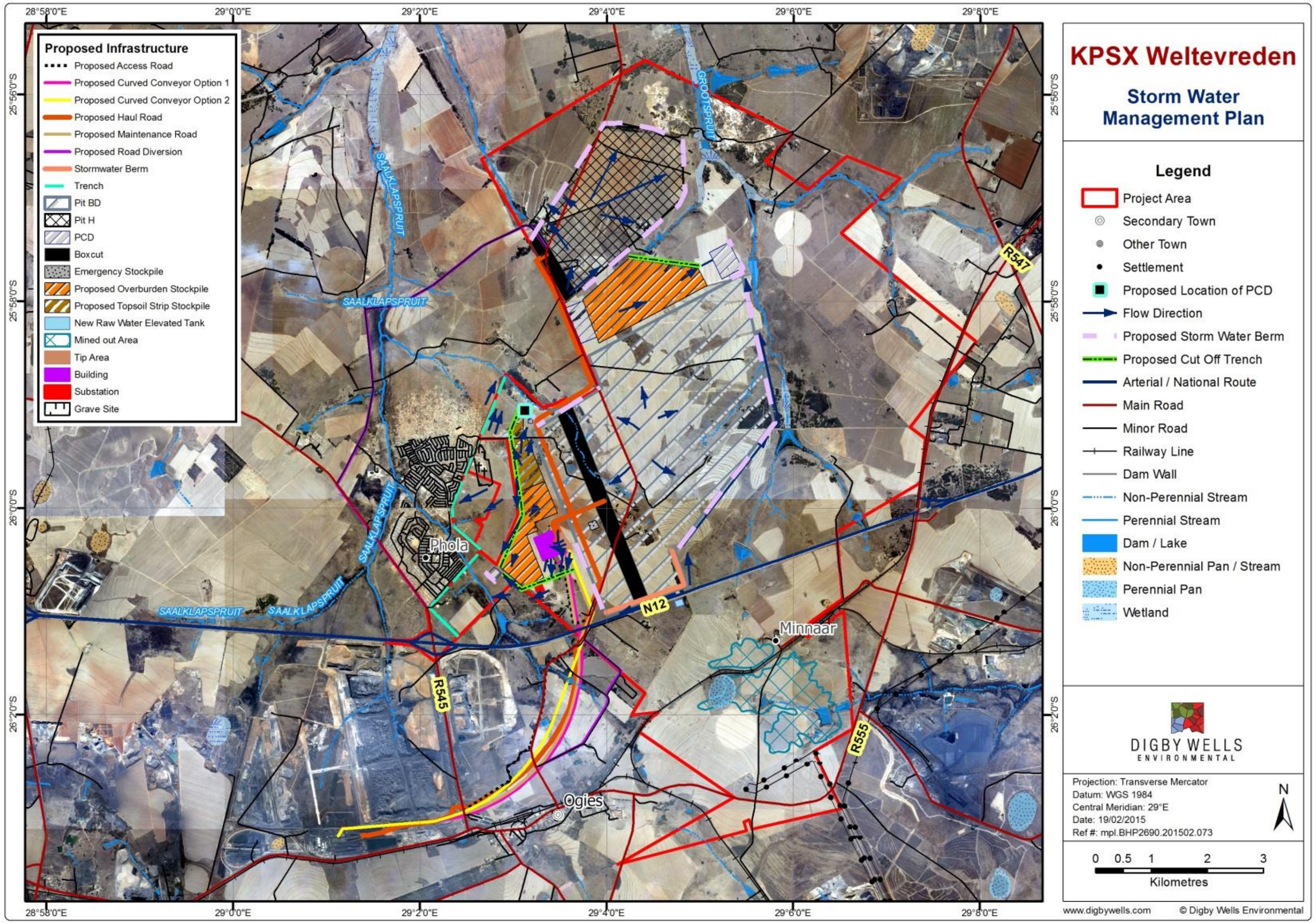

Figure 10-2: Proposed Storm water management measures for KPSX Weltevreden- overall development plan

10.3 Storm Water Operational Management

In the development, operation and management of the SWMP, operating procedures and rules should be kept in mind.

The clean and dirty water conveyance structures should in line with the GNR 704, thus should be able to accommodate flow volumes that emanate from a 1:50 year flood event. This implies the berms should prevent the runoff volumes from entering the mining site.

The PCD that will be constructed on site will serve as a dirty water dam. Water from the rest of the dirty area and from the pits is directed to the PCD facility. This water can be reused in the mining process as long as its quality permits. The dams should be designed to hold the dewatering volumes, as well as maintain a freeboard of at least 0.8 m based on best practise guidelines and as required by legislation.

Should any discharge at the mine occur it should be in line with the Wilge Interim Resource Water quality objectives (IRWQO) as detailed in Table 4-12.

Table 10-3: Wilge River IRWQO

Parameter	Wilge Catchment IRWQO
Total Dissolved Solids	450
Nitrate NO_3 as N	6
Chlorides as Cl	20
Total Alkalinity as $CaCO_3$	85
Sulphate as SO_4	120
Calcium as Ca	80
Magnesium as Mg	20
Sodium as Na	20
Potassium as K	10
Iron as Fe	1
Manganese as Mn	0.18
Conductivity at 25° C in mS/m	70
pH-Value at 25° C in pH units	6.5-8.4
Aluminium as Al	0.02
Fluoride as F	0.5

NB: All parameters are in mg/l unless specified

Day to day environmental and water management and storm water controls by Weltevreden Colliery will be combined and will involve a sequence of management practices at the site which include:

10.3.1 Erosion and Sediment control

As part of the dirty water drainage system, eroded sediment material, silt and sand mobilised in the dirty areas will flow and join the dirty system into the PCDs. Regular inspection, maintenance and cleaning are required for the PCD.

Part of the storm water will either inadvertently or by design drain to the streams. Therefore the potential for impacts to the streams form storm water diversions could exist. It is necessary to minimize these impacts through Best Management Practices (BMPs) and SWMPs. Given the small catchments upstream that will be directed towards the stream it is anticipated that impacts on the wetlands caused by storm water control measures will be small.

10.3.2 Storm Water Monitoring

In line with water management, a monitoring plan should be implemented to continuously check the quality of the storm water in order to implement mitigation measured should any impacts be detected. The details of the water quality monitoring sites are detailed in Table 10-4.

The sampling should be undertaken quarterly and ensure that the parameters analysed are a full ICP analysis and the major chemical constituents dictated by the Water Use Licence (WUL).

The monitoring of the facilities should be done regularly and also complemented by a SWMP assessment. The SWMP should be modified for efficient performance of facilities, to control overflows, erosion, blockages and pollution should the Assessment identify any gaps.

Table 10-4: Proposed surface water monitoring locations

Sampling Location	Latitude	Longitude
Wel SW1	-26.025775	29.055752
Wel SW2	-26.027222	29.0605
Wel SW3	-25.980711	29.098048
Wel SW4	-25.90878	29.065413
Wel SW5	-25.939296	29.084138
Wel SW6	-25.964583	29.03475
Wel SW7	-26.005463	29.025901
Wel SW8	-25.967573	29.026982
Wel SW9	-26.031298	29.111296
Wel SW10	-26.058155	29.087963
Wel SW11	-25.97636	29.043834
Wel SW12	-25.950329	29.049746
Wel SW13	-26.01562	29.046318

Sampling Location	Latitude	Longitude
Wel SW14	-25.95048	29.097253

10.3.3 Responsibilities

The following people would be useful in overseeing implementation of the SWMP, managing storm water, evaluating success of the plan, and directing changes to the SWMP and activities within the mine as needed. Such individuals include:

- Mine manager: Onsite coordination of all mining activities and implementation of the SWMP;
- Environmental Officer: Responsible for monitoring, site inspections, record-keeping, and reporting. Completes an analysis of monitoring data and recommends new measures if required; and
- Engineers: Responsible for implementing storm water pollution prevention maintenance program, oversees good housekeeping practices and construction of structural measures.

10.3.4 Emergency

In the event of an emergency, an emergency response plan may be consulted. This plan will be drawn up and placed around the site where it will be easily viewed. The plan will contain evacuation routes and a list of emergency numbers. It is advisable that the emergency response plan is tested and regularly reviewed in order to identify any weaknesses.

Emergencies should be investigated comprehensively to identify their magnitude (volume, quantity /discharge rate and quality), impacts on downstream receiving water bodies, as well as circumstances which caused them.

The potential emergencies that could occur are described below.

10.3.4.1 Hydrocarbon Spillage

In the event of a hydrocarbon spillage such as diesel, petrol and oil, procedures must be put into place to ensure that there are minimal impacts to the surrounding environment. Hydrocarbon emergency spill clean-up material should be purchased. The proposed procedure to follow could include:

- In the event of a small spillage, the area will be isolated and cleaned up;
- The spillages contained within bunded areas will be collected, the area will be cleaned and the collected water will be sent through a water/oil separator;
- In the event of a large spillage, adequate emergency equipment for spill containment or collection such as additional supplies of booms and absorbent materials will be

available and if required, a specialised clean-up contractor will be called in to decontaminate the area; and

- The most affected sites (for example diesel bay and weigh bridges) can be cleaned once to twice a year (particularly before the on-set of the rainfall season).

10.3.4.2 Flooding

Although flooding is unlikely, the possibility exists for flooding should a severe thunderstorm strike the area. This could result in a large volume of water flowing on site, filling the drains and creating an overflow of mud into the storm water system. Therefore, procedures must be put in place to ensure that there is a quick response to this event and damage is kept to a minimum.

During the operation of the PCDs, they must be kept at minimum levels in order to accommodate defined runoff events by storing dirty water without overflow in the event of extreme events.

The proposed procedures to be follow during flooding include:

- A contractor could be used in the clean-up process;
- Design of the contaminated storm water channels could be such that the initial contaminated flow is collected and the rest of the dilute flow is released off-site. Accredited engineers should be used to develop infrastructure according to engineering standards;
- Cover material to close out the holding bays should be available on-site to cover raw materials in cases of a major storm, when there is excess material available on site; and
- Project managers must be trained on the actions to implement in cases of floods in order to ensure that damage and storm water impacts are kept to a minimum.

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Appendix A: Water Quality Lab Results

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Digby Wells & Associates
Address: 359 Pretoria Ave, Fern Isle, Section 5, Ferndale, Randburg
Report no: 19675
Project: Digby Wells & Associates

Date of certificate: 11 August 2014
Date accepted: 05 August 2014
Date completed: 11 August 2014
Revision: 0

	Lab no:			179813	179814	179815	179816	179817	179818	179819
	Date sampled:			28-Jul-14	29-Jul-14	29-Jul-14	29-Jul-14	29-Jul-14	29-Jul-14	30-Jul-14
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			WELSW01	WELSW13	WELSW07	WELSW08	WELSW12	WELSW11	WELSW04
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	7.30	7.31	7.37	7.82	7.25	7.12	6.98
A	Electrical conductivity (EC)	mS/m	ALM 20	7.04	13.3	18.9	54.9	4.25	7.14	104
A	Total dissolved solids (TDS)	mg/l	ALM 26	38	79	115	313	30	45	876
A	Total alkalinity	mg $CaCO_3$/l	ALM 01	9.09	18.4	19.3	150	8.82	13.1	21.1
A	Chloride (Cl)	mg/l	ALM 02	5.53	11.0	10.6	37.7	6.42	9.96	37.8
A	Sulphate (SO_4)	mg/l	ALM 03	4.28	26.9	54.9	73.4	4.40	7.40	582
A	Nitrate (NO_3) as N	mg/l	ALM 06	2.29	0.807	0.588	0.344	0.659	0.733	0.218
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.051	0.072	0.102	10.7	0.164	0.133	0.060
A	Orthophosphate (PO_4) asP	mg/l	ALM 04	<0.008	<0.008	<0.008	1.29	<0.008	<0.008	<0.008
A	Fluoride (F)	mg/l	ALM 08	0.148	0.208	0.186	0.320	0.141	0.119	0.164
A	Calcium (Ca)	mg/l	ALM 30	1.99	7.24	12.9	26.9	3.06	2.86	138
A	Magnesium (Mg)	mg/l	ALM 30	1.44	3.90	7.42	13.2	1.02	2.45	50.2
A	Sodium (Na)	mg/l	ALM 30	6.90	11.6	12.0	41.6	5.01	8.17	44.9
A	Potassium (K)	mg/l	ALM 30	2.06	2.88	2.66	13.2	1.65	2.34	9.12
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	0.051	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.001	<0.001	0.240	<0.001	<0.001	0.171
A	Total chromium (Cr)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Copper (Cu)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Nickel (Ni)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	<0.002
A	Cobalt (Co)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Cadmium (Cd)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	Turbidity	NTU	ALM 21	1.30	14.9	3.96	2.61	4.47	30.7	0.412
A	Total hardness	mg $CaCO_3$/l	ALM 26	11	34	63	122	12	17	551
N	Suspended solids (SS)	mg/l	ALM 25	<1	<1	<1	3	6	17	3

A = Accredited N = Non accredited O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine
The results relates only to the test item tested.
Results reported against the limit of detection.
Results marked 'Not SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory.
Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation.

Test Report

Client: Digby Wells & Associates
Address: 359 Pretoria Ave, Fern Isle, Section 5, Ferndale, Randburg
Report no: 19675
Project: Digby Wells & Associates

Date of certificate: 11 August 2014
Date accepted: 05 August 2014
Date completed: 11 August 2014
Revision: 0

				179820	179821	179822
Lab no:				179820	179821	179822
Date sampled:				30-Jul-14	31-Jul-14	31-Jul-14
Sample type:				Water	Water	Water
Locality description:				WE;SW05	WELSW14	WELSW09
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	7.52	7.12	7.65
A	Electrical conductivity (EC)	mS/m	ALM 20	11.3	9.15	135
A	Total dissolved solids (TDS)	mg/l	ALM 26	66	56	1083
A	Total alkalinity	mg $CaCO_3$/l	ALM 01	20.6	17.2	91.2
A	Chloride (Cl)	mg/l	ALM 02	10.8	8.85	94.1
A	Sulphate (SO_4)	mg/l	ALM 03	17.7	17.0	621
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.554	0.271	0.263
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.098	0.071	0.067
A	Orthophosphate (PO_4) asP	mg/l	ALM 04	<0.008	<0.008	<0.008
A	Fluoride (F)	mg/l	ALM 08	0.201	0.184	0.230
A	Calcium (Ca)	mg/l	ALM 30	7.06	5.88	128
A	Magnesium (Mg)	mg/l	ALM 30	4.16	3.41	84.3
A	Sodium (Na)	mg/l	ALM 30	8.07	7.26	84.8
A	Potassium (K)	mg/l	ALM 30	3.10	1.65	14.1
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	0.295
A	Total chromium (Cr)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Copper (Cu)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Nickel (Ni)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Cobalt (Co)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Cadmium (Cd)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
A	Turbidity	NTU	ALM 21	1.50	1.04	6.17
A	Total hardness	mg $CaCO_3$/l	ALM 26	35	29	666
N	Suspended solids (SS)	mg/l	ALM 25	<1	<1	9

A = Accredited N = Non accredited O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine
The results relates only to the test item tested.
Results reported against the limit of detection.
Results marked 'Not SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory.
Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation.

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Appendix B: Water Quality Graphs

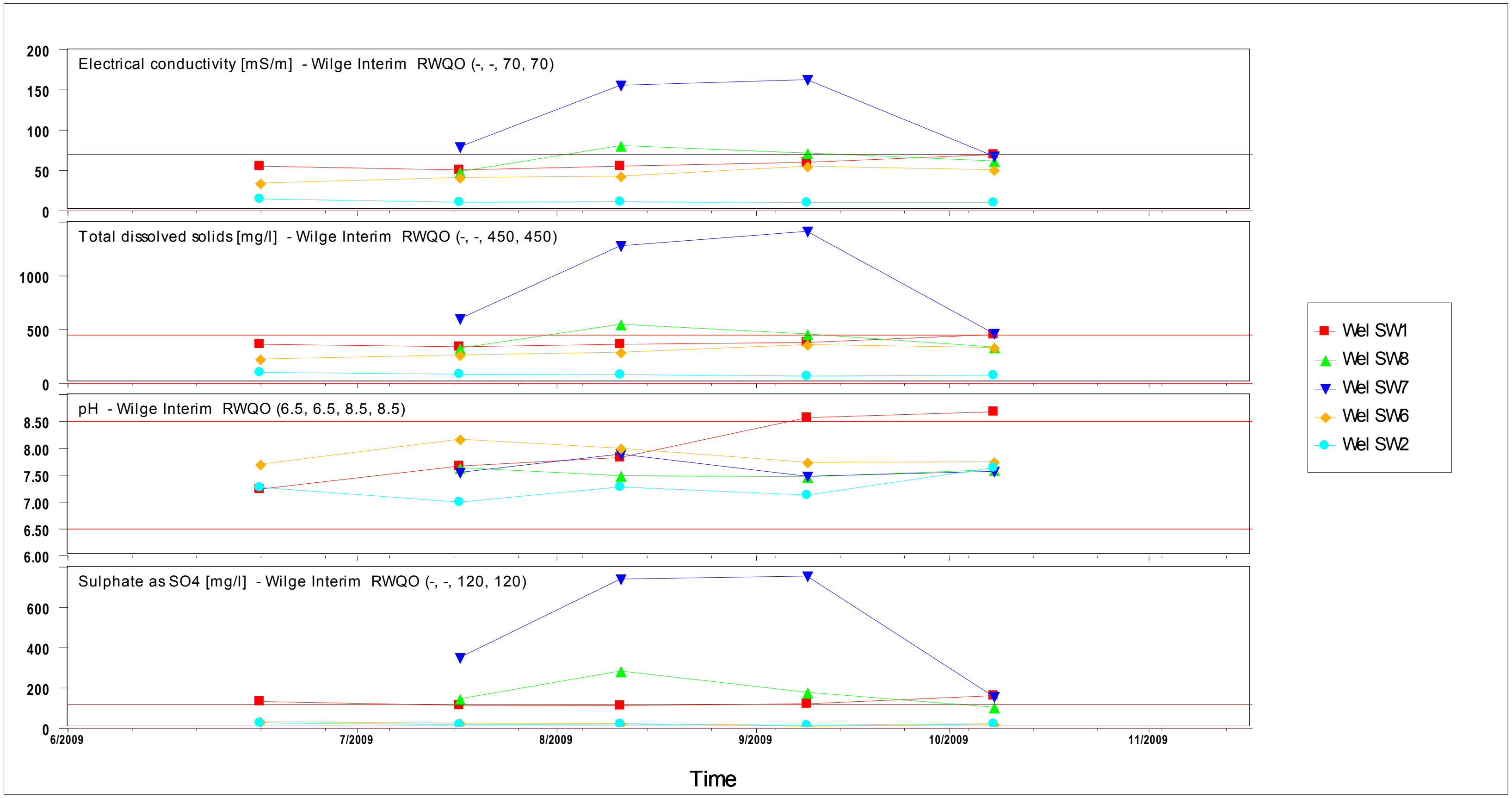

Figure 1: SO_4, pH, TDS and EC for the Saalklapspruit

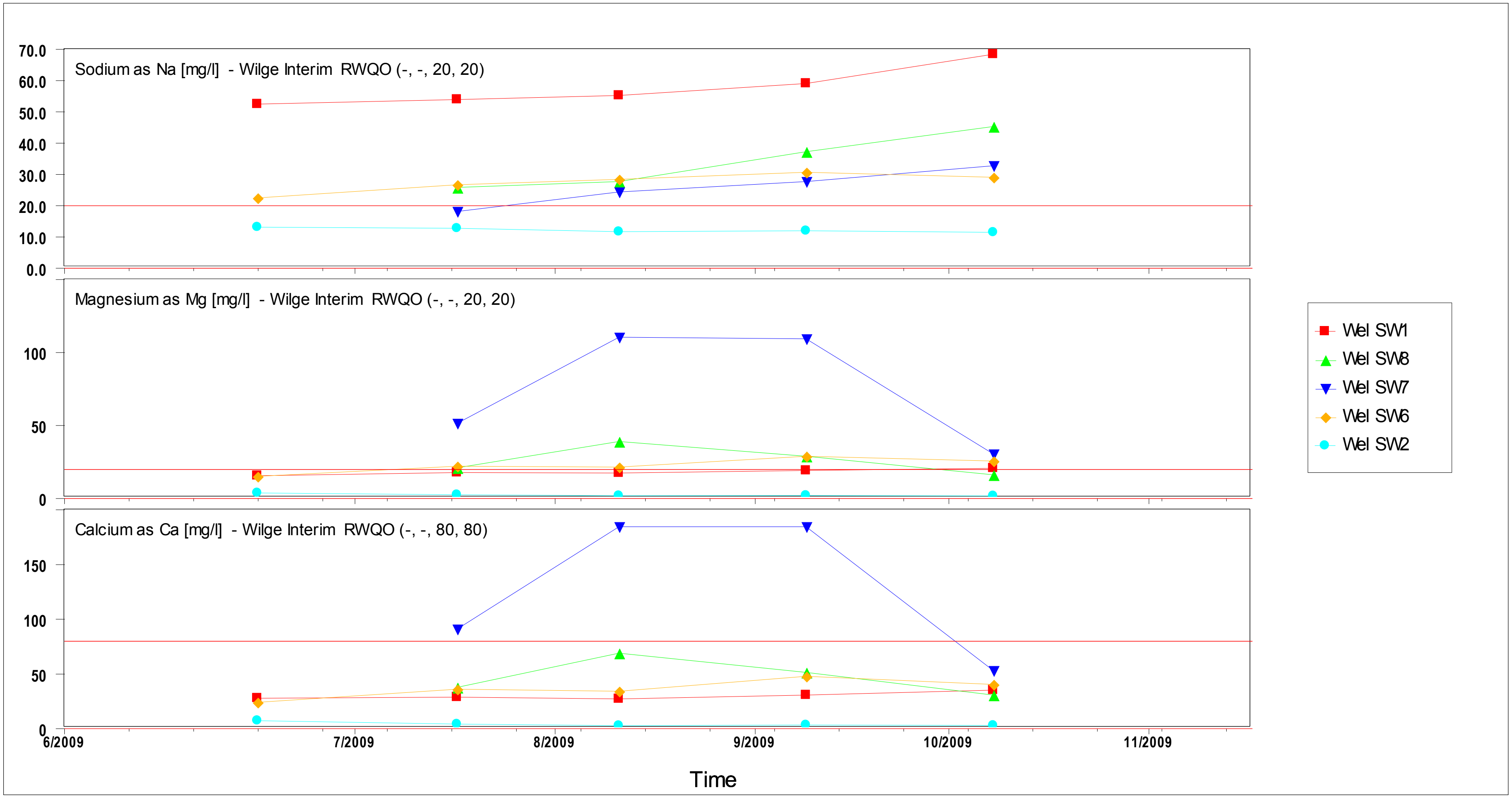

Figure 2: Ca, Mg for the Grootspruit River system

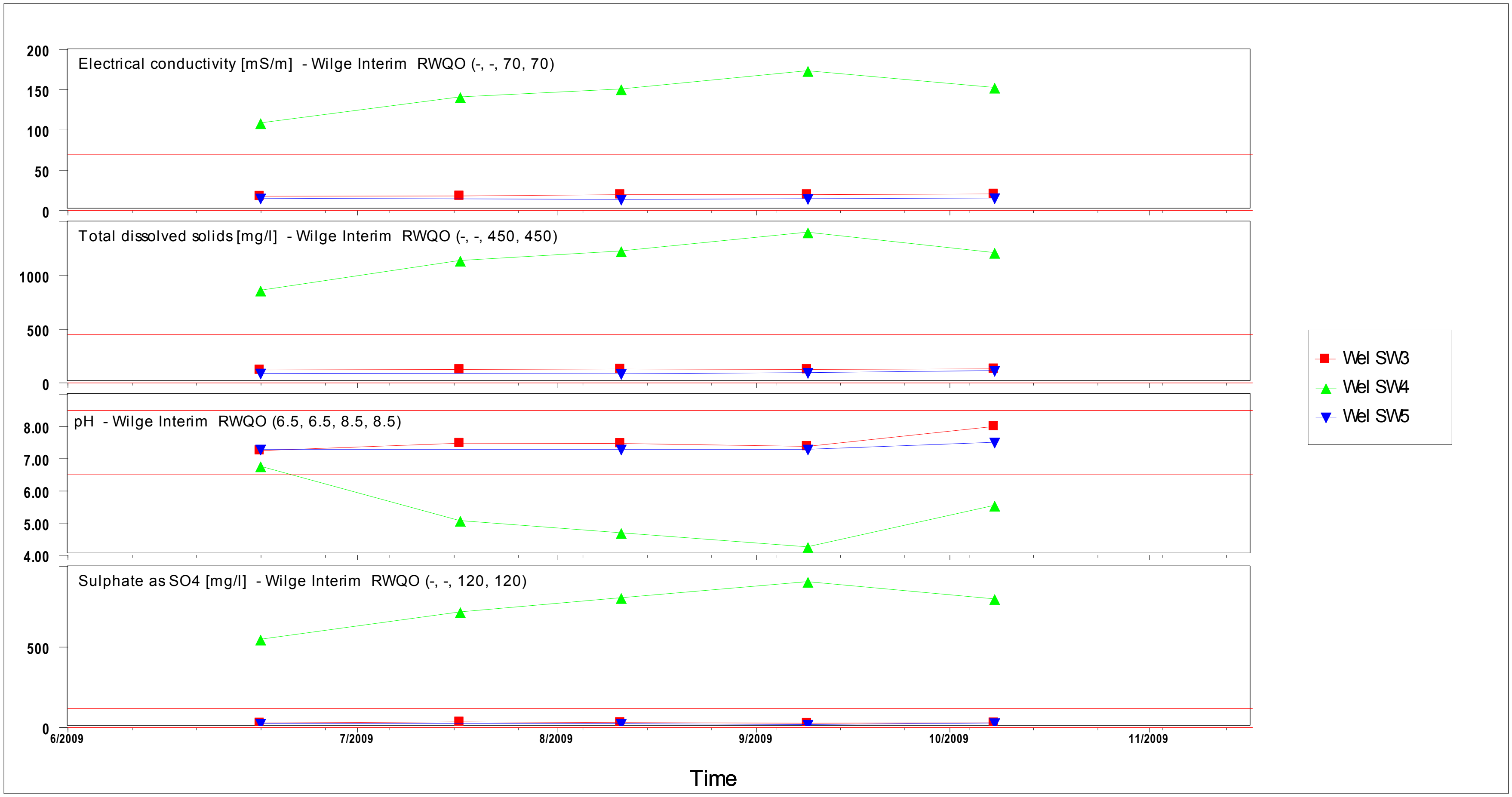

Figure 3: SO4, pH, TDS and EC for the Grootspruit

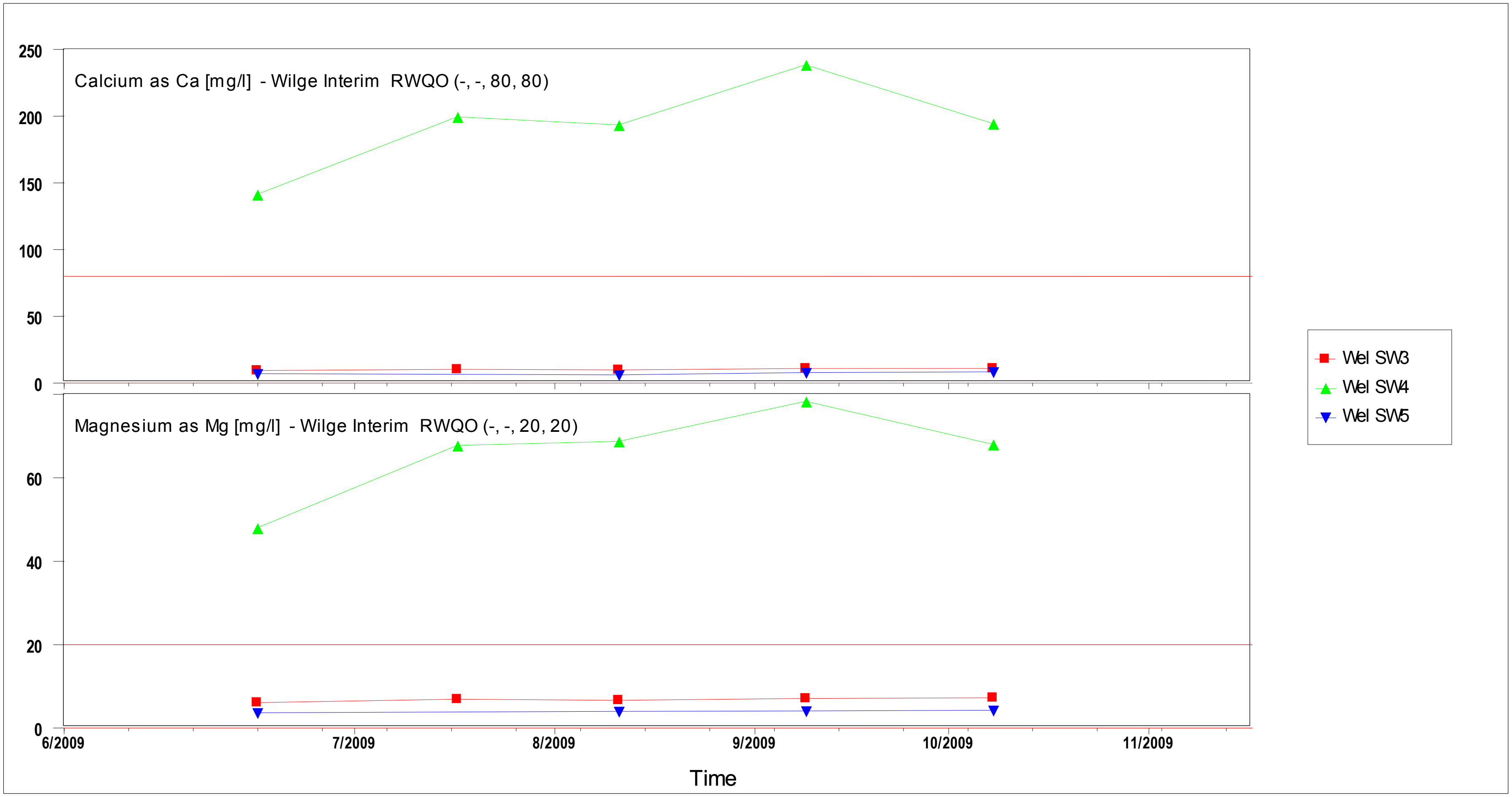

Figure 4: Ca, Mg for the Grootspruit River system

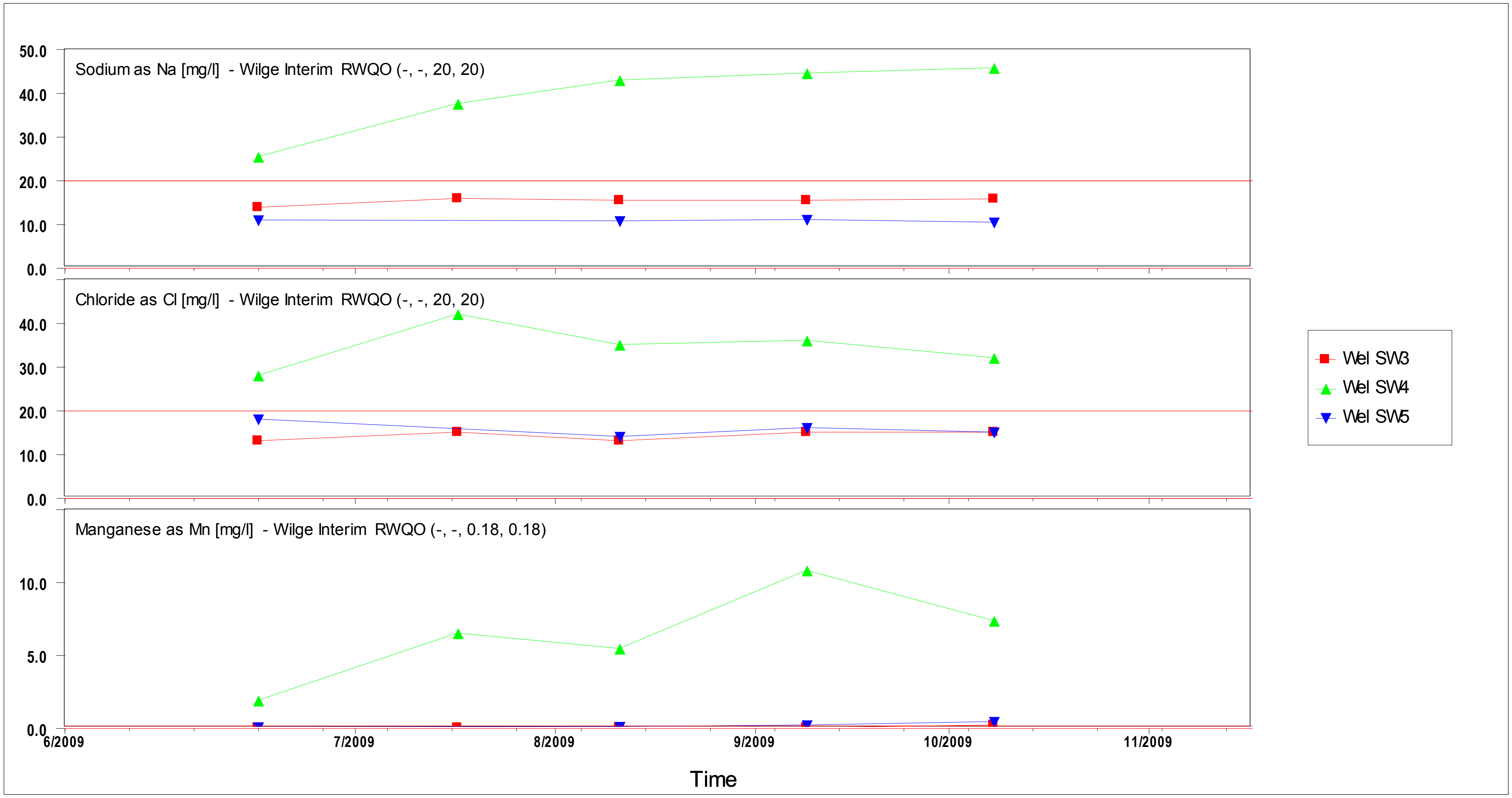

Figure 5: Na, Cl, Mn for the Grootspruit River system