End

6.1.1 River Crossing 1

The river flows in a northerly direction. One existing river crossing is located in the vicinity of Catchment 1. The river crossing is where the Preferred Collection Pipeline Route crosses the Klipspruit at an existing mine road crossing. The crossing consists of 8 box culverts (2 m width × 2 m height × 1.2 m bridge deck). Photographs of the bridge crossing are shown in Figure A1 to Figure A2, Appendix A.

6.1.2 River Crossing 2

The river flows in a northerly direction. One existing river crossing is located in the downstream vicinity of Catchment 2. The river crossing is where the Klipspruit flows underneath the R544 road. The crossing consists of 3 box culverts (16 m width × 2.45 m height × 1.2 m bridge deck). Photographs of the bridge crossing are shown in Figure A3 to Figure A5, Appendix A.

6.1.3 River Crossing 3

The river crossing was not visited due to limited access.

6.1.4 River Crossing 4

Three existing river crossing are located in the vicinity of Catchment 4:

- The most upstream river crossing is where the Brugspruit flows underneath the R104 road. The crossing consists of 4 pipe culverts (2.5 m diameter × 2.5 m bridge deck). Photographs of the bridge crossing are shown in Figure A6 to Figure A7, Appendix A.
- The middle river crossing is where the Brugspruit flows underneath the N4 highway. The crossing consists of 3 pipe culverts (2.5 m diameter × 11 m bridge deck). Photographs of the bridge crossing are shown in Figure A7 to Figure A8, Appendix A.
- The downstream river crossing is where the Brugspruit flows underneath a road in the KwaQuga Township. The crossing consists of 3 pipe culverts (2.5 m diameter × 2 m bridge deck). Photographs of the bridge crossing are shown in Figure A8 to Figure A9, Appendix A.

6.1.5 River Crossing 5

Two existing river crossing are located in the vicinity of Catchment 5:

- The most upstream river crossing is where a tributary of the Brugspruit flows underneath the R104 road. The crossing consists of 5 pipe culverts (1.75 m diameter × 3.25 m bridge deck). Photographs of the bridge crossing are shown in Figure A10 to Figure A12, Appendix A.
- The downstream river crossing is where a tributary of the Brugspruit flows underneath the N4 highway. The crossing consists of 3 pipe culverts (2.5 m diameter × 2.5 m bridge deck). Photographs of the bridge crossing are shown in Figure A11 to Figure A13, Appendix A.

6.1.6 River Crossing 6

Two existing river crossing are located in the vicinity of Catchment 6:

- The most upstream river crossing is where a tributary of the Brugspruit flows underneath the R104 road. The crossing consists of 3 pipe culverts (2.5 m diameter × 0.5 m bridge deck). Photographs of the bridge crossing are shown in Figure A14 to Figure A16, Appendix A.
- The downstream river crossing is where a tributary of the Brugspruit flows underneath the N4 highway. The crossing consists of 3 pipe culverts (2.5 m diameter × 1.0 m bridge deck). Photographs of the bridge crossing are shown in Figure A16 to Figure A18, Appendix A.

6.1.7 River Crossing 7

One existing river crossing is located in the vicinity of Catchment 7 at the EWRP. The river crossing is where the Naauwpoortspruit flows underneath the road adjacent to the EWRP. The crossing consists of 5 box culverts (2.5 m width × 2 m height × 0.5 m bridge deck). Photographs of the bridge crossing are shown in Figure A19 to Figure A20, Appendix A.

6.2 Flood peak calculations

The 1 in 50 year and the 1 in 100 year flood peaks were determined for input into the floodline determinations. A hydrological assessment of the relevant catchments was carried out and used in the estimation of the flood peaks. The flood peaks used to determine the floodlines were calculated assuming current levels of development. The catchment characteristics used in the analysis are summarised in Table 17 and the calculated flood peaks given in Table 18. The 1 in 50 and 1 in 100 year flood peaks used in the floodline calculations were calculated using the Rational Method.

Table 17: The Areas, Slopes, Hydraulic Lengths and Time of Concentrations for the Catchments (Figures 2) associated with the proposed pipeline / river crossings

Pipeline / river Crossing No.	Area (km^2)	Slope (m/m)	Hydraulic Length (m)	Time of Concentration (hrs)
1	33.22	0.0103	6600	2.046
2	92.85	0.0067	13000	3.343
3	14.23	0.0194	2400	0.845
4	22.25	0.0183	4000	1.193
5	15.03	0.0161	3900	1.310
6	28.23	0.0057	4700	2.039
7	53.01	0.0062	9000	2.897

Table 18: Computed flood peaks (m^3/s)

Catchment at Pipeline / River Crossing No.	1 in 50 Year Flood Peak (m^3/s)	1 in 100 Year Flood Peak (m^3/s)
1	120.2	156.7
2	181.2	241.2
3	95.1	123.2
4	112.1	145.6
5	75.9	98.6
6	114.7	154.6
7	127.8	165.5

6.3 Floodline Determinations

Survey data was obtained by GAA from the interpolated 5m contours from the 1:50000 topographical maps. All the river crossings along the pipeline route were modelled using the HEC-RAS model to determine the 1 in 50- and 1 in 100 year floodlines. The HEC-RAS model determines the flood levels for various peaks using standard Mannings-based hydraulic and energy balancing equations.

Floodlines for the relevant pipeline / river crossings were determined for the following reasons:

- To prevent impacts on the environment in terms of streamflow alteration and releasing of poor quality water into the environment.

- For the determination of preferential pipeline routing, as well as for the placing of infrastructure associated with pipeline / river crossings, such as plinths and pipe bridges. Pipelines will be located outside of or above the 1:100 year floodline to prevent pipeline damage during flooding and enable pipeline maintenance when required.

6.3.1 HEC-RAS Modelling

All pipeline / river crossings were modelled using the HEC-RAS software to determine the 1 in 50- and 1 in 100 year floodlines. The floodlines were determined for the following crossings:

- Crossing 1
- Crossing 2
- Crossing 3
- Crossing 4
- Crossing 5
- Crossing 6
- Crossing 7

The floodlines for Crossing 1 to Crossing 6 are plotted in Figure B1, Appendix B. The floodline for Crossing 7 is plotted in Figure B2, Appendix B.

Determination of the floodline for the Klipspruit/Brugspruit was performed on 5 m contour interval topography and thus does not have a high level of accuracy. The 5 m contours were generated from a 25 m grid and thus the outcome does not always give an elevation in the stream bed. This resulted in the coarse floodline determination, where the channel is not always well represented. The 1 in 50 and 1 in 100 year flood levels, velocities and flow areas are presented in Appendix C, Table C1 for the different river stations (chainages) from the HEC-RAS output. The results illustrate that there is a difference in the water surface elevations for the 1 in 50- and 1 in 100 year flows.

The floodline for the Naauwpoortspruit was determined with a 5 m contour interval and thus does not have a high level of accuracy. The 1 in 50- and 1 in 100 year flood levels, velocities and flow areas are presented in Appendix C, Table C2 for the different river stations (chainages) from the HEC-RAS output. The results illustrate that there is a difference in the water surface elevations for the 1 in 50- and 1 in 100 year flows. As a result, for purposes of clarity, the floodlines have been differentiated by lines with different colours in Figure B2 in Appendix B.

7.0 IMPACT ASSESSMENT

The following impacts have been identified for assessment:-

- The impact of removing the liming plant discharge on the Kromdraaispruit flow regime and water quality.
- The impact of removing the MS&S discharge on the flow and water quality on the Klipspruit / Brugspruit system.
- The impact of emergency discharges of up to 50Mℓ/d from the EWRP on the Naauwpoortspruit.
- The impact of operational mishap and maintenance of pipelines.

The above impacts are discussed in the sections below.

7.1 Impacts of reducing the discharge volume into the Kromdraaispruit

7.1.1 Impact Assessment

Reducing the amount of excess pre-treated mine water discharged into the Kromdraaispruit from the current 8 Mℓ/day to zero was assessed. The approach adopted was to use the time series of measured monthly flows and sulphate concentrations at the weir. Sulphate was chosen as the water quality variable to assess as it is a good indicator of the input from mining. Two cases were investigated. Case 1 is the reduction of the 8 Mℓ/d discharge to 3 Mℓ/d which represents the situation for the remaining life of the mine. Case 2 is the removal of the full discharge which represents the situation after closure of the mine. The monthly flows at the weir were reduced by 5 Mℓ/d for Case 1 and by 8 Mℓ/d for Case 2. The average monthly flow volumes were calculated for the two cases for comparison to the current situation. The sulphate load to the river was reduced and a revised set of sulphate concentrations calculated for the two cases.

The modelled monthly flow rates for the two cases together with the current flow volumes are given in Table 19 . The percentage reduction in flow is also given in the table. The results show that the removal of the discharge will result in a 40% to 70% reduction in flow for Case 1 and a 60% to 95% reduction for Case 2. The analysis results indicate that the reduction in flow is likely to be significant due to the removal of the liming plant discharge.

Table 19: Current and modelled reductions in flow rates at the Kromdraaispruit weir.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average Monthly Flow of Weir Data	0.22	0.20	0.21	0.19	0.20	0.36	0.33	0.37	0.37	0.37	0.20	0.19
Average Monthly Flow with Discharge Reduced by 5Mℓ/day to 3Mℓ/day (Case 1)	0.08 (64%)	0.06 (70%)	0.07 (67%)	0.06 (68%)	0.07 (65%)	0.20 (44%)	0.17 (48%)	0.21 (43%)	0.21 (43%)	0.21 (43%)	0.07 (65%)	0.05 (74%)
Average Monthly Flow with Discharge Reduced by 8Mℓ/day to 0Mℓ/day (Case 2)	0.02 (90%)	0.01 (95%)	0.04 (81%)	0.01 (95%)	0.02 (90%)	0.15 (58%)	0.13 (61%)	0.16 (57%)	0.16 (57%)	0.16 (57%)	0.01 (95%)	0.01 (95%)

The calculated sulphate concentrations for the two cases together with the measured sulphate concentrations at the weir are shown plotted in Figure 6. The analysis results show that the removal of the discharge will reduce the sulphate concentrations and improve the water quality in the Kromdraaispruit from a salinity perspective. However the available water quality data for the Kromdraaispruit shows that the conditions are acid in the spruit for at least 50% of the time while the liming plant discharge is acid for only 5% of the time. This implies that there are other sources of acid in the Kromdraaispruit which will no longer be masked by the discharge once it stops.

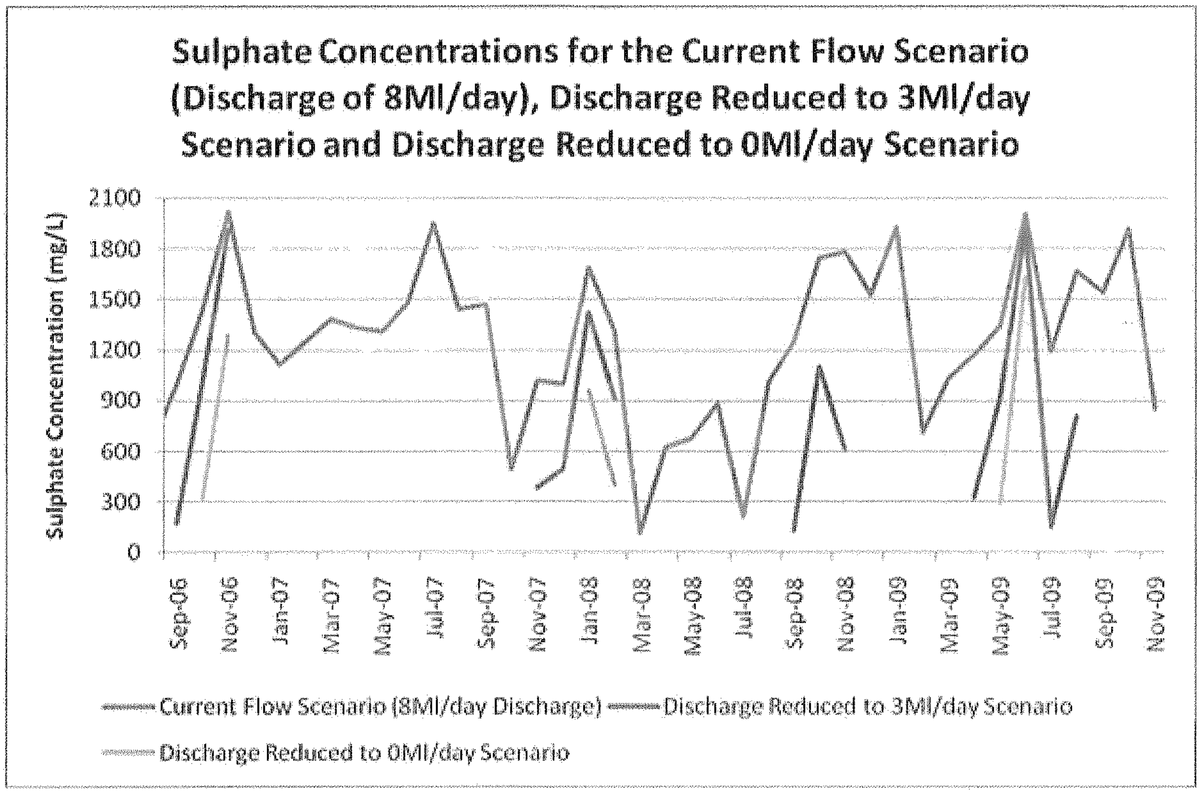


Figure 6: Plot of current and modelled sulphate concentrations in the Kromdraaispruit for Case 1 and Case 2

7.1.2 Impact Significance Rating

The main impacts of reducing the discharge of 8 Mℓ/d from the liming plant are:-

- Reduction in flow;
- Decreased or improved water quality.

The impact significance rating table is shown below in Table 24.

Table 20: Impact significance rating –Kromdraaispruit

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Removal of Liming Plant Discharge	The base flow of the Kromdraaispruit is dominated by the liming plant discharge. The impact assessment showed that the removal of the discharge completely significantly reduces the flow in the river which could impact on the wetland system.	3	5	2	6	60 Moderate (negative)
Removal of Liming Plant	The removal of the liming plant discharge will improve	4	4	2	6	60 Moderate

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Discharge	the salinity related aspects of water quality.					(positive)
Removal of Liming Plant Discharge	The acid conditions in the Kromdraaispruit are present 50% of the time. The liming plant discharge is only acid 5% of the time. There are therefore other acid sources present in the catchment. The removal of the liming plant discharge will not mask the other sources and acid conditions could prevail in the Kromdraaispruit	3	3	2	6	48 Moderate (negative)
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project if the impact is negative				
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.				
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.				

7.1.3 Mitigation

The mitigation measures that can be considered are:-

- If the impact of the reduction in flow is considered high on the wetland and the aquatic ecology of the Kromdraaispruit, a portion of the flow can be returned to the river after neutralisation as would occur during the operational phase when 3 Mℓ/d will be returned to the system. However this should only be considered if the wetland systems are considered to be of high importance.
- The removal of the limed discharge may result in acid conditions occurring more frequently in the Kromdraaispruit. This can be mitigated in the short term by liming the discharge at the Kromdraaispruit. This has been attempted in the past. A liming plant is still located at the weir. In the long term the other acid streams must be located, collected and neutralised before discharge or incorporated in the collection system for treatment at EWRP. This would be the task of the Regulators and the organisations responsible for the other sources to ensure that this happens.

7.2 Impacts of reducing the discharge volume into the Klipspruit/Brugspruit System

7.2.1 Impact Assessment

The collection of the decants from the defunct mines that are the responsibility of the DMR have not been included in this EIA although provision has been made in the design to collect the decants. The impact of collecting the decant from MS&S is therefore assessed. The current discharge from MS&S is estimated to be 1 600 m^3/d and the water quality profile is given in Table 21. The water quality profile shows that the decant is acid, high in heavy metals and saline. The RWQO for the salinity related variables, pH and the heavy metals exceed the RWQO. The impact of removing this water stream from the river system would be positive on the water quality.

The approach to assessing the impact on the flow regime and water quality in the Klipspruit was to apply the calibrated WQT salinity model to the Klipspruit catchment. The WQT models sulphate concentrations and flows. The model was calibrated using the flow and sulphate concentrations measured at the B1H004 flow gauge which includes the decant from MS&S. The model was then run without the MS&S decant and the change in flow and sulphate concentrations modelled. It has been assumed that the pumping system at MS&S coupled with the use of the evaporation dams will affectively remove the decant from the Klipspruit.

The predicted reduction in the flow is shown in Table 22. The results show that the impact on the flow regime is low with a reduction in the low flows of about 13% reducing to 2% for the higher flows. The percentiles of the current and modelled sulphate concentrations at B1H004 are shown in Table 23. The results show that the removal of the discharge will result in a lowering of the sulphate concentration. The reduction is still insufficient for the RWQO to be met. The decants from the other defunct mines will have to be removed in order for the RWQO to be met.

Table 21: Water quality profile of the MS&S decant

Water Quality Variable	Percentiles			RWQO
	5	50	95	
pH	2.73	2.80	2.97	6.0 – 9.0
Conductivity (mS/m)	225	237	251	120
Total alkalinity as $CaCO_3$(mg/l)	5	5	5	-
TDS (mg/l)	1630	1824	2085	820
Calcium (mg/l)	87	99	118	-
Sodium (mg/l)	91	96	114	250
Magnesium (mg/l)	45	56	64	-
Sulphate (mg/l)	1125	1210	1358	500
Chloride (mg/l)	123	131	134	320
Fluoride (mg/l)	0.2	0.2	0.2	1.7
Manganese (dissolved) (mg/l)	7.9	8.4	14.0	1.0
Iron (dissolved) (mg/l)	45	76	104	1.0
Aluminium (Dissolved) (mg/l)	54	71	82	0.2

Table 22: Percentiles of flow (million m^3/month) with and without the MS&S decant (without decant shown in brackets)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5th Percentile Flow (no MS&S decant)	0.20 (0.17)	0.52 (0.48)	0.36 (0.32)	0.74 (0.70)	0.48 (0.45)	0.24 (0.21)	0.43 (0.38)	0.29 (0.26)	0.51 (0.48)	0.48 (0.45)	0.42 (0.39)	0.22 (0.19)
50th Percentile Flow (no MS&S decant)	1.07 (1.01)	1.54 (1.48)	1.88 (1.82)	2.35 (2.29)	1.96 (1.90)	2.22 (2.16)	1.93 (1.87)	1.48 (1.42)	1.44 (1.38)	1.38 (1.32)	1.21 (1.06)	0.97 (0.91)
95th Percentile Flow (no MS&S decant)	3.59 (3.53)	3.83 (3.77)	6.67 (6.61)	9.68 (9.62)	8.65 (8.59)	8.80 (8.76)	6.44 (6.38)	4.63 (4.57)	3.65 (3.59)	3.11 (3.05)	2.85 (2.79)	2.40 (2.34)

Table 23: Impact at B1H004 of removing MS&S decant on sulphate concentrations

Sulphate concentrations at B1H004 (mg/l)

	MS&S included	MS&S excluded
5 percentile	79.7	62.5
Median	310.9	272.5
95 percentile	717.6	667.4
RWQO (mg/l) for B1H004		
500		

7.2.2 Impact Significance Rating

The main impacts of reducing the discharge of 1.6 Mℓ/d from MS&S are:-

- Reduction in flow;
- Decreased or improved water quality.

The impact significance rating table is shown below in Table 24.

Table 24: Impact significance rating – Klipspruit

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Removal of Ms&S decant	The base flow of the Klipspruit is dominated by the large discharges totalling 50 Mℓ/d from the Sewage works. The reduction in flow of an average of 1.6 Mℓ/d from MS&S made a small change in the river flow at B1H004 on the Klipspruit	4	4	2	3	30 Moderate (negative)
Removal of MS&S decant	The collection of the decant from MS&S removes an acid saline stream from the river system. This results in an improvement in the water quality	4	4	2	4	40 Moderate (positive)

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project if the impact is negative				
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.				
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.				

7.2.3 Mitigation

Mitigation is not required as the impacts on the system are low for the reduction of flow and positive for the improvement in water quality.

7.3 Naauwpoortspruit

7.3.1 Impact Assessment

There is currently no pre-treated mine water being discharged into the Naauwpoortspruit. The discharges into this river system will only occur as an emergency discharge from the EWRP to be made when the users cannot take the water. The emergency discharges will be water of a potable standard. As a result of this new flow regime during the emergency discharges, a large volume of water (50 Mℓ/d) will be discharged as a once-off release into the Naauwpoortspruit. Table 25 shows the minimum, maximum, 5th, 50th and 95th percentiles of the daily flows measured at B1H019 as well as the emergency discharge of 50 Mℓ/d.

The emergency discharge of 50 Mℓ/d is less than the 95th percentile of the measured flow at B1H019 and the emergency discharge is exceeded 418 times in the daily flow record at B1H019 which extends from March 1990 to April 2010. This is a large volume of water to add to a small stream like the Naauwpoortspruit. This large volume of water would be considerably more harmful to the stream should the discharge take place in months with relatively high stream flows; or occur within the periods of heavy rainfall, such as was experienced in the last two years.

Table 25: The minimum, maximum, 5th, 50th and 95th percentiles of the daily flows at B1H019 as well as the emergency discharge of 50 Mℓ

Statistic	Flow (m^3/s)
Min	0.001
Max	2.354
5th Percentile	0.015
50th Percentile	0.066
95th Percentile	0.647
Emergency Discharge (50Mℓ/day)	0.579

An operating rule is proposed so that releases are reduced as the flow in the river increases. The releases are based on the gauge plate reading and the associated discharge at the B1H019 weir on the

Naauwpoortspruit. The rule is summarised in Table 26. Table 26 relates the various discharges in the stream to the allowed discharges from the EWRP in m^3/s as well as Mℓ/d.

Table 26: Operating rules for the emergency discharge releases from the EWRP, gauge plate readings and their associated discharges for the Naauwpoortspruit at weir B1H019

Gauge plate depth (m)	Discharge at B1H019 (m^3/s)	Allowed discharge (m^3/s)	Total flow (m^3/s)	Allowed discharge (Mℓ/d)
0	0.000	0.579	0.579	50
0.05	0.066	0.579	0.645	50
0.1	0.189	0.579	0.768	50
0.15	0.349	0.579	0.928	50
0.2	0.539	0.579	1.118	50
0.25	0.757	0.579	1.336	50
0.3	0.999	0.579	1.578	50
0.35	1.260	0.579	1.839	50
0.4	1.550	0.579	2.129	50
0.41	1.610	0.521	2.131	45
0.42	1.670	0.463	2.133	40
0.43	1.730	0.405	2.135	35
0.44	1.790	0.347	2.137	30
0.45	1.850	0.289	2.139	25
0.46	1.920	0.231	2.151	20
0.47	1.970	0.174	2.144	15
0.48	2.030	0.116	2.146	10
0.49	2.080	0.058	2.138	5
0.5	2.130	0.000	2.130	0
0.55	2.340	0.000	2.340	0

The impact of the discharge on the instream water quality will be positive as the water will be treated to potable standards before discharge.

7.3.2 Impact Significance Rating

The main impacts of discharging 50 Mℓ/d of treated water would be:

- Flooding;
- Decreased or improved water quality and
- Erosion.

The impact significance rating table is shown below in Table 27.

Table 27: Impact significance rating - EWRP site

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Discharge of water from EWRP	As described previously discharge from the EWRP into the adjacent stream would have a **positive impact** on the water quality, due to the water quality being considerably better than that of the Naauwpoortspruit. The impact would be the same if there was a leak or spill from the KwaQuga distribution pipeline or the Witbank/eMalahleni distribution pipeline, as the water is of a similar quality.	2	1	2	6	30 Low (positive)
Discharge of water from EWRP	The impact of discharge on the erodibility of the discharge point as well as the downstream channel would be moderate.	2	1	1	6	24 Low (negative)
Discharge of water from EWRP	Impact of discharge on flooding of the lower reaches of the Naauwpoortspruit	2	1	2	8	40 Moderate (negative)
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project if the impact is negative				
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.				
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.				

7.3.3 Mitigation

The following mitigation is proposed:

- Discharge from the EWRP into the Naauwpoortspruit, should not be directly into the stream, but routed through a velocity reduction mechanism such as a temporary storage dam. The discharge point must also have erosion reduction structures such as gabion baskets or rocks;
- A monitoring programme will need to be implemented in relation to the discharge. This will include sampling of the typical water quality parameters as necessary, when discharge takes place;

- Discharge would need to follow the operating rules described above including:
  - EWRP should not be allowed to make the full discharge of 50 Mℓ/d into the stream unless the flow downstream at weir B1H019 is less than 1.55 m^3/s;
  - The total flow in the stream, which includes the natural flow and the discharge, should not exceed 2.16 m^3/s. This would protect the people, farms and industries downstream from flooding. The weir would therefore need to be monitored daily to facilitate this rule.

Table 28: Recommended Water Quality Sampling Parameters for the Water Quality Monitoring Programme

Recommended Water Quality Sampling Parameters	Units
Conductivity at 25˚C	mS/m
Total Dissolved Solids	mg/L
pH at 25°C	
Turbidity	NTU
Alkalinity as CaCO3	mg/L
Ammonia as N	mg/L
Calcium as Ca	mg/L
Chloride as Cl	mg/L
Fluoride as F	mg/L
Magnesium as Mg	mg/L
Nitrate and Nitrite as N	mg/L
Potassium as K	mg/L
Sodium as Na	mg/L
Sulphate as SO4	mg/L
Aluminium as Al	mg/L
Boron as B	mg/L
Iron as Fe	mg/L
Manganese as Mn	mg/L

7.4 Impacts of Collection and Distribution Pipelines

The impacts associated with the various pipelines are outlined in this section. The impact associated with each of the pipelines are similar so are discussed as a group rather than individually.

7.4.1 Bursts and Leaks

The collection pipelines will convey untreated mine water while the distribution pipelines will be delivering potable water to the water supply reservoirs. The collection pipelines are routed through mining areas, within existing mining / power line / railway line servitudes and along road reserves. The pipelines are buried so will not be vulnerable to vandalism or tampering. However there could still be leaks or bursts from the pipelines. The leaks will infiltrate into the soil and will be noticed as a wet patch or areas of lush vegetation. The leaks will also pollute the local subsurface water quality around the collection pipelines. For the distribution lines the water quality will not be impacted negatively.

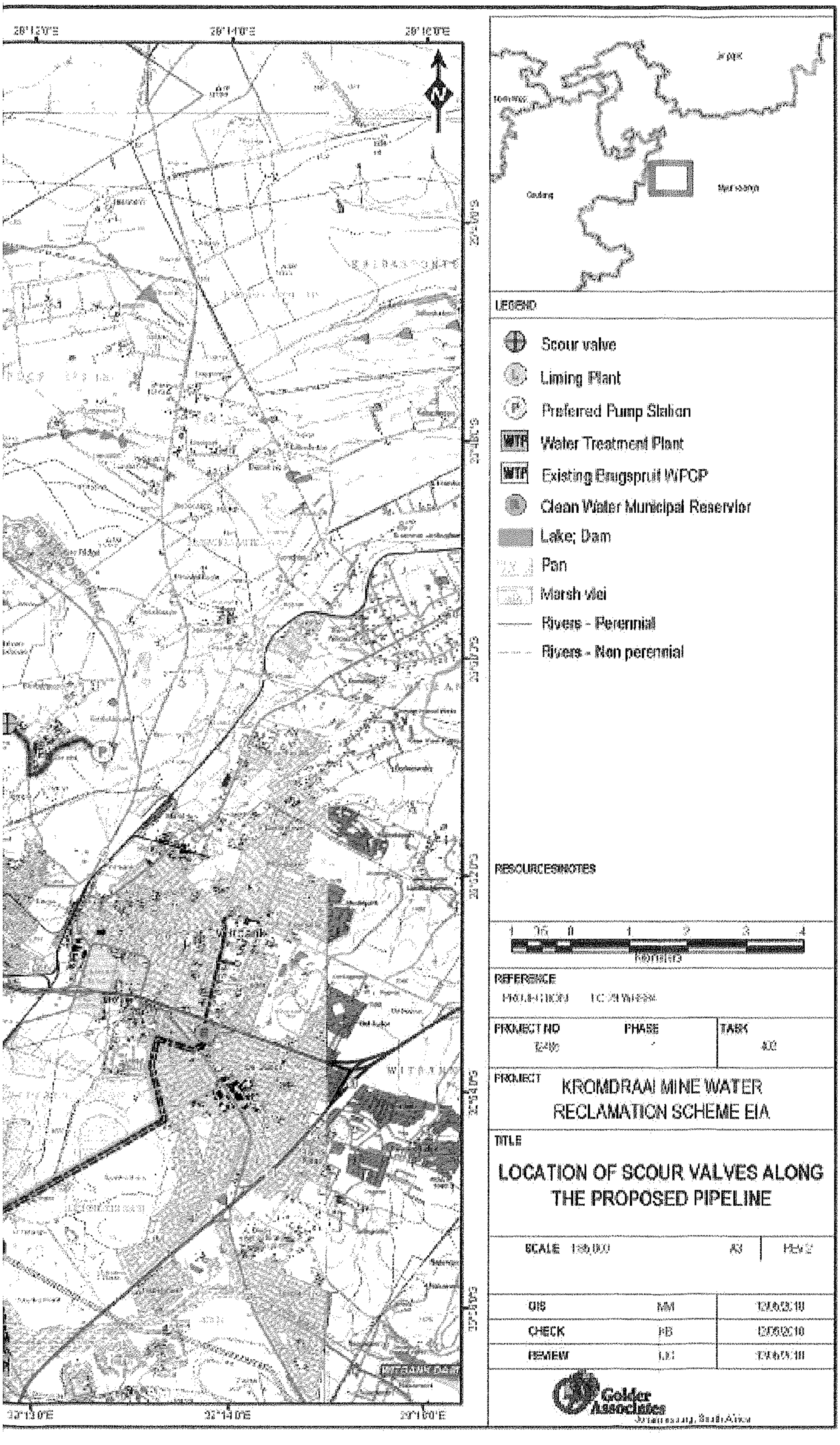
A burst will be seen on surface as a fountain of water. These bursts will result is local erosion and increase in flow in the local streams draining the area where the burst occurs. These bursts are quickly identified due to a drop in pressure in the system and a reduction in volume reporting to the destination. The water quality of the local streams will be significantly impacted on by a burst. Given the length of time that the burst will continue for the impact will be restricted to the local streams.

7.4.2 Scour Valves

Scour valves / bleed points will be located at low points along the pipeline. The locations of the scour valves are shown in Figure 7. The scour valves will be used to discharge the water contained in the pipeline at these low points during times of pipeline maintenance (routine and emergency). Should this water not be collected and contained during times of maintenance, but be discharged directly into the environment, the receiving surface water environment will be impacted on in terms of water quality for the collection pipelines. To eliminate the impact, the water in the pipelines will not the discharged to the environment but collected in tankers and transported to the EWRP for treatment. The only impact would be spills of water during the scouring process due to mismanagement.

7.4.3 River Crossings

The river crossings will all be buried in trenches so will not impact on the flows in the rivers. The trench backfill will be well compacted and the vegetation re-established to prevent erosion. Similarly the excavations will be protected during construction to prevent the ingress of runoff into trenches.


LEGEND
Scour valve
Liming Plant
Preferred Pump Station
Water Treatment Plant
Existing Brugspruit WPCP
Clean Water Municipal Reservior
Lake; Dam
Pan
Marsh vlei
Rivers - Perennial
Rivers - Non perennial
RESOURCES/NOTES
REFERENCE
PROJECT NO
PHASE
TASK
PROJECT
KROMDRAAI MINE WATER
RECLAMATION SCHEME EIA
TITLE
LOCATION OF SCOUR VALVES ALONG
THE PROPOSED PIPELINE
SCALE
A3
GIS
CHECK
REVIEW
Golder Associates

7.4.4 Impact Significance Rating

The impact significance rating for the pipelines are given in Table 29.

Table 29: Impact significance rating - pipelines

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Leaks along collection pipelines	The impact of the leaks will be to saturate the soil profiles around the pipeline. This will impact on the water quality of soil profile and local streams in which the seeage will day light	2	1	1	4	16 Low (negative)
Bursts along collection pipelines	A burst will cause local erosion and impact on the water quality of the immediate environment and local streams if the burst occurs at a river crossing	2	1	2	6	30 Moderate (negative)
Scour of pipelines	The scour of pipes is a planned activity and will be managed by collecting the scour water in tankers. The impact will be due to spills during the scouring process	3	1	1	6	30 Moderate (negative)
River crossings	Erosion of trenches during runoff events in the rivers	4	1	1	4	24 Low (negative)

SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project if the impact is negative.
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.

7.4.5 Mitigation Measures

The following mitigation measures are proposed:

- Leaks should be detected by the pipeline monitoring system and observations made during the routine maintenance pipeline inspections.
- The pipeline will have a pressure and volume monitoring system which will detect bursts. The burst must be repaired immediately as part of the pipeline maintenance schedule. Sufficient valves must be in place along the pipeline to isolate the burst as quickly as possible.
- Remediation protocols must be developed to remediate the area after a burst or where extensive leaks have occurred.
- When excavating, the excavated soil should be protected from stormwater runoff so that the soil does not end up in the river system.
- The protocols for scouring the collection pipelines must be developed to prevent spills from entering the river systems. If spills do occur, the remediation protocols must be applied.

8.0 CONCLUSIONS

The following conclusions can be made as a result of this specialist study:-

- The removal of the 8 Mℓ/d discharge from the Kromdraaispruit will impact significantly on the low flow regime in the spruit. The reduction in the flow could impact on the wetland system and aquatic ecology. Neutralised water could be released post closure to maintain the wetland system if the importance of the wetland system is regarded as high. The removal of the liming plant discharge improves the salinity related water quality of the spruit. However, there are other sources of acid water in the catchment which might aggravate the acid conditions in the river if the liming plant discharge is removed. This can be mitigated in the short-term by liming the discharge at the Kromdraaispruit. This has been attempted in the past. A liming plant is still located at the weir. In the long-term, Anglo should support an investigation to locate, collect and neutralise the acid streams, or to incorporate the acid streams in the collection system for treatment at the eMalahleni Mine Water Reclamation Plant.
- The impact on the Klipspruit flow regime of collecting the 1.6Mℓ/d MS&S decant is low. The reduction is only between 13% for the low flows and 2.5% for the average flows. The removal of the decant impacts positively on the water quality in the Klipspruit/Brugspruit system. The removal does not result in the RWQO for the Klipspruit being met due to the decants from the other defunct mines in the catchment. Consideration should be given to including these decants into the scheme in the future.
- The discharge of treated water from the EWRP to the Naauwpoortspruit under emergency conditions will improve the water quality of the stream. However the proposed release of 50 Mℓ/d is a significant flow when compared to the flows measured in the Naauwpoortspruit at the B1H019 weir. An operating rule was developed so that the discharge can take place and not cause flooding of the Naauwpoortspruit.
- The pipelines are buried so leaks from the collection pipelines will impact on the water quality of the soils and seepage from the soils will impact on the local streams. A leakage detection system and routing pipeline inspections should be undertaken to mitigate this impact.
- Bursts from the distribution and collection pipelines will cause local erosion. The water quality of the water conveyed in the collection pipelines will impact on the water quality of the local streams and areas around the burst. The water from the distribution lines is treated to potable quality so will not impact negatively on the water quality of the receiving streams. The pipe pressure monitoring system, routine pipe inspections and valves will be used to limit the number of bursts and the time that the burst flows. Remediation measures need to be developed to remediate the areas impacted on by a burst.

- The pipelines will be buried at the water courses. The excavations will have to be well backfilled and the vegetation re-established to prevent erosion.
- Protocols will have to be developed for scouring of the pipelines so that spills to the river systems are kept to a minimum.

The overall impact of the proposed scheme is positive. The salt load discharged to the river systems will be reduced by the proposed scheme. This will lead to an improvement in the water quality in the Klipspruit and Wilge River Systems. The water quality in the Olifants River is under threat from a number of sources. This has been recognised by DWA in the Integrated Water Resource Management Plan where the removal of salt load from the river system is a stated objective. This scheme complies with this objective and will contribute to the improvement of the water quality situation in the catchment.

9.0 REFERENCES

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APPENDIX A

Site Visit Photographs

APPENDIX A

Site Visit Photographs

Figure A1: Upstream view along the Klipspruit at River Crossing 1

Figure A2: Downstream view along the Klipspruit at River Crossing 1

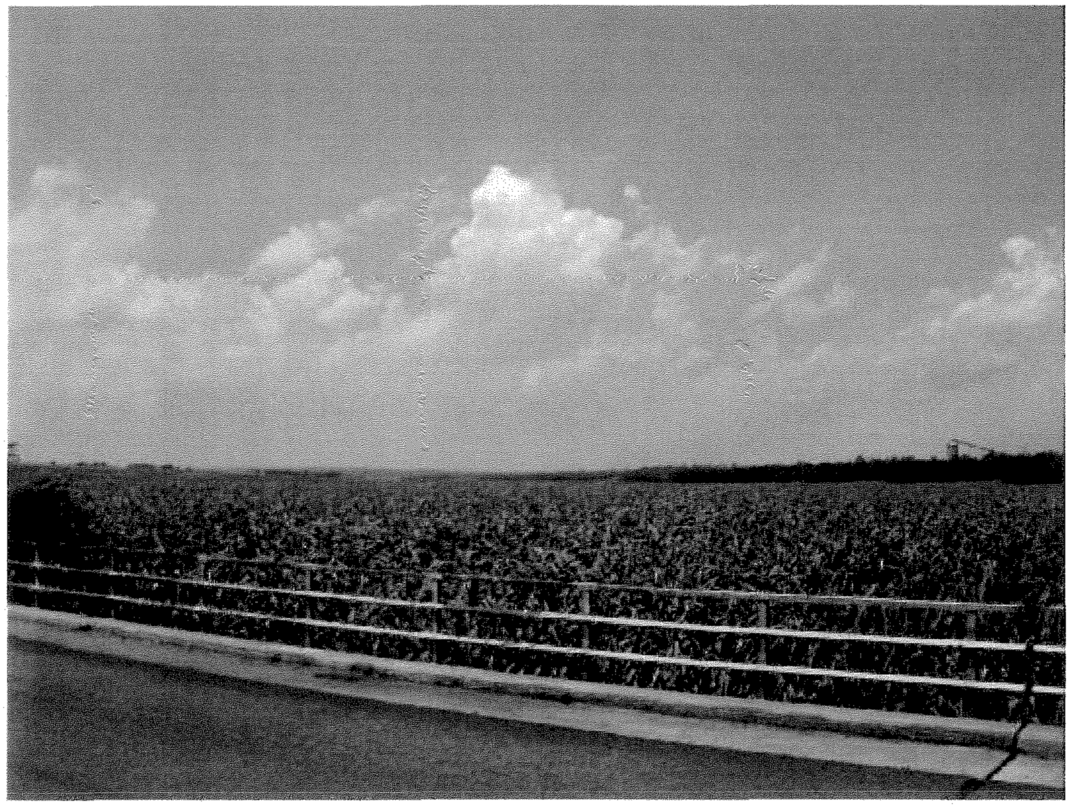

Figure A3: Upstream view along the Klipspruit downstream of River Crossing 2 at R544

Figure A4: Downstream view along the Klipspruit downstream of River Crossing 2 at R544

Figure A5: Downstream view along the Klipspruit downstream of River Crossing 2 at R544

Figure A6: Upstream view from R104 along a tributary of the Brugspruit at River Crossing 4

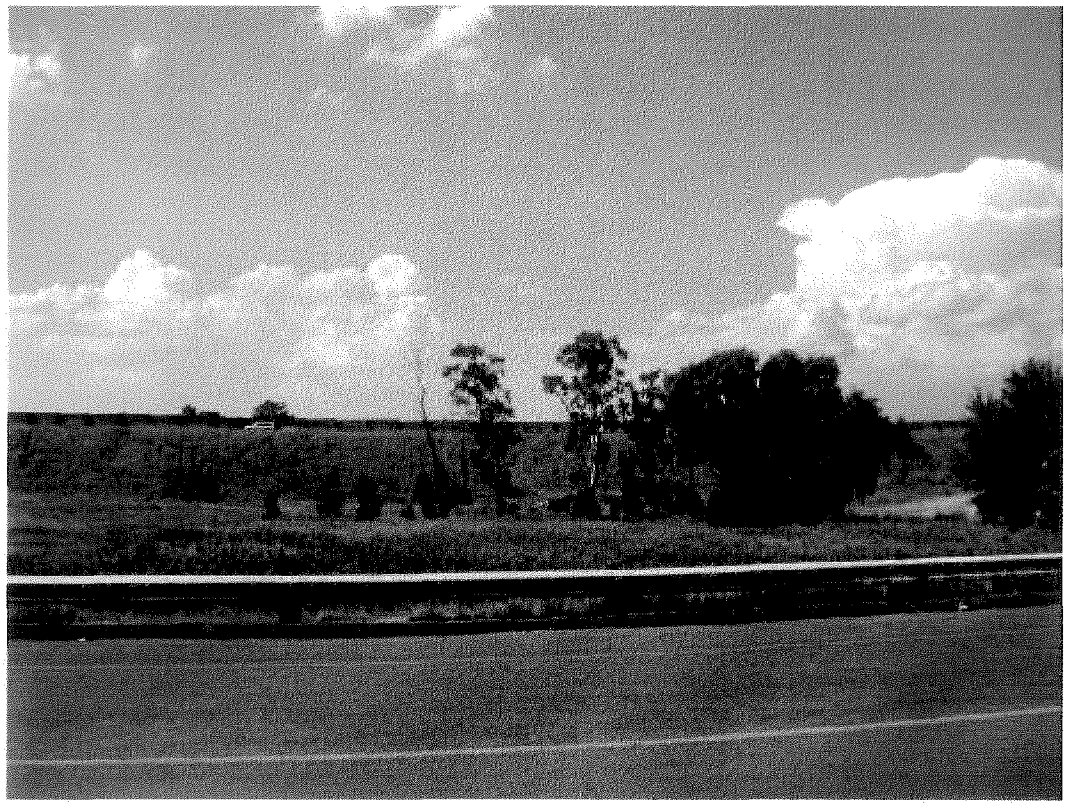

Figure A7: Downstream view from R104 along a tributary of the Brugspruit at River Crossing 4 towards the N4 highway

Figure A8: Downstream view towards N4 highway of the Brugspruit at River Crossing 4

Figure A9: Downstream view from bridge in KwaQuga Township along the Brugspruit at River Crossing 4

Figure A10: Upstream view from R104 along a tributary (Schoongezightspruit) of the Brugspruit at River Crossing 5

Figure A11: Upstream view from N4 highway towards R104 along a tributary of the Brugspruit at River Crossing 5

Figure A12: Downstream view from R104 towards N4 highway along a tributary of the Brugspruit at River Crossing 5

Figure A13: Downstream view from N4 highway towards the Brugspruit at River Crossing 5

Figure A14: Upstream view from R104 along a tributary of the Brugspruit at River Crossing 6

Figure A15: Upstream view from R104 of culverts along a tributary of the Brugspruit at River Crossing 6

Figure A16: Upstream view from N4 highway of culverts along a tributary of the Brugspruit at River Crossing 6

Figure A17: Downstream view from R104 along a tributary of the Brugspruit at River Crossing 6

Figure A18: Downstream view from N4 highway along a tributary of the Brugspruit at River Crossing 6

Figure A19: Upstream view from small road at EWRP along the Naauwpoortspruit at River Crossing 7

Figure A20: Downstream view from small road at EWRP along the Naauwpoortspruit at River Crossing 7

APPENDIX B

Floodlines

APPENDIX C

HEC-RAS Results

Table C1: Hec-Ras Output for the Klipspruit and Brugspruit

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
				(m3/s)	(m)	(m)	(m/s)	(m)
River4	reach1	1410	1 in 50 years	55	1515	1515.67	1.74	60.11
River4	reach1	1410	1 in 100 years	65	1515	1515.72	1.88	61.99
River4	reach1	1283	1 in 50 years	55	1513.32	1513.61	1.66	119.4
River4	reach1	1283	1 in 100 years	65	1513.32	1513.65	1.74	120.87
River4	reach1	1245	1 in 50 years	55	1512.82	1513.24	0.99	141.43
River4	reach1	1245	1 in 100 years	65	1512.82	1513.29	1.05	143.4
River4	reach1	1103	1 in 50 years	55	1510.94	1511.61	2.11	64.82
River4	reach1	1103	1 in 100 years	65	1510.94	1511.67	2.2	66.35
River4	reach1	939	1 in 50 years	55	1508.77	1509.31	1.22	96.22
River4	reach1	939	1 in 100 years	65	1508.77	1509.36	1.3	98.44
River4	reach1	769	1 in 50 years	55	1506.52	1507.38	2.34	49.03
River4	reach1	769	1 in 100 years	65	1506.52	1507.46	2.41	53.27
River4	reach1	587	1 in 50 years	55	1504.12	1504.66	1.05	110.23
River4	reach1	587	1 in 100 years	65	1504.12	1504.77	1.01	115.33
River4	reach1	430	1 in 50 years	55	1501.59	1504.69	0.19	185.77
River4	reach1	430	1 in 100 years	65	1501.59	1504.79	0.21	191.66
River4	reach1	420		Culvert				
River4	reach1	396	1 in 50 years	55	1501.59	1503.74	0.36	129.53
River4	reach1	396	1 in 100 years	65	1501.59	1504.14	0.32	154.56
River4	reach1	365	1 in 50 years	55	1500.41	1503.75	0.06	282.46
River4	reach1	365	1 in 100	65	1500.41	1504.14	0.07	282.46

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			years					
River4	reach1	340		Culvert				
River4	reach1	307	1 in 50 years	55	1500.41	1500.66	1.51	157.23
River4	reach1	307	1 in 100 years	65	1500.41	1500.69	1.59	159.72
River3	Reach1	2100	1 in 50 years	95	1460.49	1461.9	1.1	88.18
River3	Reach1	2100	1 in 100 years	123	1460.49	1462.05	1.24	92.33
River3	Reach1	1800	1 in 50 years	95	1460	1460.39	1.92	133.06
River3	Reach1	1800	1 in 100 years	123	1460	1460.46	2.08	135.23
River3	Reach1	1500	1 in 50 years	95	1455	1455.89	1.08	118.88
River3	Reach1	1500	1 in 100 years	123	1455	1456.01	1.19	124.01
River3	Reach1	1200	1 in 50 years	95	1453.35	1454.25	1.86	111.25
River3	Reach1	1200	1 in 100 years	123	1453.35	1454.35	2	122.49
River3	Reach1	900	1 in 50 years	95	1450	1450.57	1.71	107.66
River3	Reach1	900	1 in 100 years	123	1450	1450.65	1.91	110.4
River3	Reach1	600	1 in 50 years	95	1445	1445.68	2.44	66.2
River3	Reach1	600	1 in 100 years	123	1445	1445.8	2.63	69.26
River3	Reach1	300	1 in 50 years	95	1440	1441.34	1.27	87.67
River3	Reach1	300	1 in 100 years	123	1440	1441.49	1.39	93.21
River2	Reach1	2207	1 in 50 years	112	1480	1482.38	0.3	194.41
River2	Reach1	2207	1 in 100 years	146	1480	1485.5	0.13	287.08
River2	Reach1	1890	1 in 50 years	112	1476.99	1482.38	0.15	219.16

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
River2	Reach1	1890	1 in 100 years	146	1476.99	1485.5	0.09	296.5
River2	Reach1	1870		Culvert				
River2	Reach1	1855	1 in 50 years	112	1476.57	1482.04	0.14	231.4
River2	Reach1	1855	1 in 100 years	146	1476.57	1485.49	0.08	317.57
River2	Reach1	1845	1 in 50 years	112	1476.57	1482.04	0.14	231.38
River2	Reach1	1845	1 in 100 years	146	1476.57	1485.49	0.08	317.57
River2	Reach1	1701	1 in 50 years	112	1475.2	1482.04	0.08	314.44
River2	Reach1	1701	1 in 100 years	146	1475.2	1485.49	0.05	403.9
River2	Reach1	1670		Culvert				
River2	Reach1	1650	1 in 50 years	112	1474.56	1476.79	0.86	145.45
River2	Reach1	1650	1 in 100 years	146	1474.56	1476.98	0.93	151.53
River2	Reach1	1634	1 in 50 years	112	1474.56	1475.84	2.55	74.27
River2	Reach1	1634	1 in 100 years	146	1474.56	1475.98	2.73	82.02
River2	Reach1	1307	1 in 50 years	112	1471.46	1473.17	0.56	142.27
River2	Reach1	1307	1 in 100 years	146	1471.46	1473.26	0.69	144.56
River2	Reach1	1050	1 in 50 years	112	1468.62	1473.18	0.09	372.01
River2	Reach1	1050	1 in 100 years	146	1468.62	1473.27	0.11	374.99
River2	Reach1	1020		Culvert				
River2	Reach1	1007	1 in 50 years	112	1468.62	1468.99	1.4	218.87
River2	Reach1	1007	1 in 100 years	146	1468.62	1469.07	1.52	221.6

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
River2	Reach1	707	1 in 50 years	112	1465.77	1466.48	1.3	135.18
River2	Reach1	707	1 in 100 years	146	1465.77	1466.58	1.45	139.05
River2	Reach1	407	1 in 50 years	112	1462.92	1463.75	2.11	132.93
River2	Reach1	407	1 in 100 years	146	1462.92	1463.85	2.25	147.28
River1	Reach1	900	1 in 50 years	76	1485	1486.26	0.49	141.31
River1	Reach1	900	1 in 100 years	99	1485	1486.33	0.6	143.18
River1	Reach1	600	1 in 50 years	76	1482.21	1486.26	0.16	191.86
River1	Reach1	600	1 in 100 years	99	1482.21	1486.33	0.21	194.14
River1	Reach1	470	1 in 50 years	76	1481.05	1486.26	0.06	396.2
River1	Reach1	470	1 in 100 years	99	1481.05	1486.33	0.07	397.57
River1	Reach1	420		Culvert				
River1	Reach1	415	1 in 50 years	76	1481.05	1485.46	0.07	344.29
River1	Reach1	415	1 in 100 years	99	1481.05	1485.57	0.09	349.34
River1	Reach1	411	1 in 50 years	76	1480.45	1485.46	0.06	389.23
River1	Reach1	411	1 in 100 years	99	1480.45	1485.57	0.08	394.45
River1	Reach1	400		Culvert				
River1	Reach1	362	1 in 50 years	76	1480	1480.26	1.59	185.66
River1	Reach1	362	1 in 100 years	99	1480	1480.31	1.73	187.8
Klipspruit	Reach1	2700	1 in 50 years	120	1450	1450.97	1.06	140.45
Klipspruit	Reach1	2700	1 in 100 years	157	1450	1451.11	1.18	146.92
Klipspruit	Reach1	2400	1 in 50 years	120	1448.05	1449.09	2.39	89.36

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Klipspruit	Reach1	2400	1 in 100 years	157	1448.05	1449.21	2.56	95.87
Klipspruit	Reach1	2100	1 in 50 years	120	1446.11	1446.75	0.92	211.92
Klipspruit	Reach1	2100	1 in 100 years	157	1446.11	1446.85	1.04	214.79
Klipspruit	Reach1	1800	1 in 50 years	120	1444.16	1444.51	1.83	194.37
Klipspruit	Reach1	1800	1 in 100 years	157	1444.16	1444.58	1.99	197.2
Klipspruit	Reach1	1500	1 in 50 years	120	1442.21	1443.54	0.45	239.28
Klipspruit	Reach1	1500	1 in 100 years	157	1442.21	1443.77	0.48	251.76
Klipspruit	Reach1	1250	1 in 50 years	120	1440.27	1443.51	0.32	171.12
Klipspruit	Reach1	1250	1 in 100 years	157	1440.27	1443.74	0.38	178.14
Klipspruit	Reach1	1225		Culvert				
Klipspruit	Reach1	1200	1 in 50 years	120	1440.27	1441.18	2.38	91.94
Klipspruit	Reach1	1200	1 in 100 years	157	1440.27	1441.3	2.55	97.78
Klipspruit	Reach1	900	1 in 50 years	120	1438.32	1439	0.95	235.2
Klipspruit	Reach1	900	1 in 100 years	157	1438.32	1439.09	1.06	245.38
Klipspruit	Reach1	600	1 in 50 years	120	1436.38	1436.67	1.67	253.85
Klipspruit	Reach1	600	1 in 100 years	157	1436.38	1436.73	1.82	257.44
Klipspruit	Reach1	388	1 in 50 years	120	1435	1436.13	0.29	419.35
Klipspruit	Reach1	388	1 in 100 years	157	1435	1436.32	0.32	434.02
Brugspruit	reach1	16332	1 in 50 years	55	1505	1505.31	0.96	189.89
Brugspruit	reach1	16332	1 in 100 years	65	1505	1505.29	1.24	188.89
Brugspruit	reach1	16185	1 in 50 years	55	1502.83	1503.1	1.36	200.97

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach1	16185	1 in 100 years	65	1502.83	1503.18	1.13	204.31
Brugspruit	reach1	16090	1 in 50 years	55	1501.75	1502.96	0.57	117.5
Brugspruit	reach1	16090	1 in 100 years	65	1501.75	1503.03	0.63	123.05
Brugspruit	reach1	16068	1 in 50 years	55	1501.1	1502.89	0.32	162.6
Brugspruit	reach1	16068	1 in 100 years	65	1501.1	1502.95	0.36	167.46
Brugspruit	reach1	16050		Culvert				
Brugspruit	reach1	16045	1 in 50 years	55	1501.1	1501.58	1.98	74.67
Brugspruit	reach1	16045	1 in 100 years	65	1501.1	1501.63	2.06	77.96
Brugspruit	reach2	15648	1 in 50 years	115	1495	1495.87	2.08	125.74
Brugspruit	reach2	15648	1 in 100 years	155	1495	1495.97	2.33	138.23
Brugspruit	reach2	15578	1 in 50 years	115	1494.44	1494.78	1.77	204.68
Brugspruit	reach2	15578	1 in 100 years	155	1494.44	1494.85	1.95	208.1
Brugspruit	reach2	15427	1 in 50 years	115	1493.25	1493.91	0.83	228.92
Brugspruit	reach2	15427	1 in 100 years	155	1493.25	1494.03	0.93	235.54
Brugspruit	reach2	15256	1 in 50 years	115	1491.89	1493.02	2.02	86
Brugspruit	reach2	15256	1 in 100 years	155	1491.89	1493.2	2.15	245.98
Brugspruit	reach2	15106	1 in 50 years	115	1490.7	1491.25	1.93	118.86
Brugspruit	reach2	15106	1 in 100 years	155	1490.7	1491.32	2.27	120.62
Brugspruit	reach2	14893	1 in 50 years	115	1489.01	1489.64	1.12	174.76
Brugspruit	reach2	14893	1 in 100 years	155	1489.01	1489.82	1.16	181.85
Brugspruit	reach2	14683	1 in 50 years	115	1487.34	1488.79	1.55	64.47

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach2	14683	1 in 100 years	155	1487.34	1488.97	1.78	67.76
Brugspruit	reach2	14653	1 in 50 years	115	1487.1	1488.38	2.68	66.06
Brugspruit	reach2	14653	1 in 100 years	155	1487.1	1488.55	2.89	71.82
Brugspruit	reach2	14293	1 in 50 years	115	1484.24	1484.96	1.12	152.65
Brugspruit	reach2	14293	1 in 100 years	155	1484.24	1485.11	1.23	156.48
Brugspruit	reach2	13993	1 in 50 years	115	1481.86	1482.62	2.33	73.87
Brugspruit	reach2	13993	1 in 100 years	155	1481.86	1482.75	2.65	76.64
Brugspruit	reach2	13759	1 in 50 years	115	1480	1480.73	1.32	129.07
Brugspruit	reach2	13759	1 in 100 years	155	1480	1480.87	1.48	132.26
Brugspruit	reach3	13093	1 in 50 years	172	1475.24	1476.7	2.02	126.01
Brugspruit	reach3	13093	1 in 100 years	229	1475.24	1476.86	2.18	140.57
Brugspruit	reach3	12793	1 in 50 years	172	1473.53	1474.25	1.89	140.24
Brugspruit	reach3	12793	1 in 100 years	229	1473.53	1474.37	2.12	144.54
Brugspruit	reach3	12493	1 in 50 years	172	1471.82	1472.66	1.14	196.68
Brugspruit	reach3	12493	1 in 100 years	229	1471.82	1472.82	1.26	202.76
Brugspruit	reach3	12193	1 in 50 years	172	1470.12	1470.72	1.88	163
Brugspruit	reach3	12193	1 in 100 years	229	1470.12	1470.8	2.17	165.91
Brugspruit	reach3	11893	1 in 50 years	172	1468.41	1469.1	0.96	268.45
Brugspruit	reach3	11893	1 in 100 years	229	1468.41	1469.25	1.05	272.77
Brugspruit	reach3	11593	1 in 50 years	172	1466.7	1467.98	1.61	144.39
Brugspruit	reach3	11593	1 in 100 years	229	1466.7	1468.12	1.77	149.41

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach3	11294	1 in 50 years	172	1465	1465.41	1.98	218.26
Brugspruit	reach3	11294	1 in 100 years	229	1465	1465.5	2.17	221.62
Brugspruit	reach4	10800	1 in 50 years	181	1460	1460.76	1.08	229.79
Brugspruit	reach4	10800	1 in 100 years	241	1460	1460.9	1.21	232.92
Brugspruit	reach4	10500	1 in 50 years	181	1458.65	1459.34	1.39	199.92
Brugspruit	reach4	10500	1 in 100 years	241	1458.65	1459.47	1.55	203.51
Brugspruit	reach4	10200	1 in 50 years	181	1457.31	1458.16	1.05	218.05
Brugspruit	reach4	10200	1 in 100 years	241	1457.31	1458.32	1.16	223.5
Brugspruit	reach4	9900	1 in 50 years	181	1455.96	1456.8	1.69	138.83
Brugspruit	reach4	9900	1 in 100 years	241	1455.96	1456.94	1.89	142.62
Brugspruit	reach4	9600	1 in 50 years	181	1454.61	1455.44	1.13	210.73
Brugspruit	reach4	9600	1 in 100 years	241	1454.61	1455.58	1.26	216.36
Brugspruit	reach4	9300	1 in 50 years	181	1453.26	1453.97	1.5	183.54
Brugspruit	reach4	9300	1 in 100 years	241	1453.26	1454.1	1.67	188.37
Brugspruit	reach4	9000	1 in 50 years	181	1451.92	1452.76	1.03	225.63
Brugspruit	reach4	9000	1 in 100 years	241	1451.92	1452.91	1.15	231.45
Brugspruit	reach4	8700	1 in 50 years	181	1450.57	1451.5	1.65	182.84
Brugspruit	reach4	8700	1 in 100 years	241	1450.57	1451.62	1.82	198.87
Brugspruit	reach4	8400	1 in 50 years	181	1449.22	1449.85	1.19	254.9
Brugspruit	reach4	8400	1 in 100 years	241	1449.22	1449.97	1.32	259.11
Brugspruit	reach4	8100	1 in 50 years	181	1447.87	1448.49	1.02	298.24

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach4	8100	1 in 100 years	241	1447.87	1448.59	1.15	301.9
Brugspruit	reach4	7800	1 in 50 years	181	1446.53	1447.07	1.1	313.7
Brugspruit	reach4	7800	1 in 100 years	241	1446.53	1447.18	1.22	318.36
Brugspruit	reach4	7500	1 in 50 years	181	1445.18	1445.64	0.86	459.9
Brugspruit	reach4	7500	1 in 100 years	241	1445.18	1445.71	0.99	461.17
Brugspruit	reach4	7200	1 in 50 years	181	1443.83	1444.27	0.9	460.55
Brugspruit	reach4	7200	1 in 100 years	241	1443.83	1444.37	0.98	463.93
Brugspruit	reach4	6900	1 in 50 years	181	1442.48	1442.95	0.85	463.65
Brugspruit	reach4	6900	1 in 100 years	241	1442.48	1443.02	0.99	465.9
Brugspruit	reach4	6600	1 in 50 years	181	1441.14	1441.74	1.01	310.89
Brugspruit	reach4	6600	1 in 100 years	241	1441.14	1441.92	1.03	318.93
Brugspruit	reach4	6348	1 in 50 years	181	1440	1441.33	0.81	189.53
Brugspruit	reach4	6348	1 in 100 years	241	1440	1441.52	0.94	195.07
Brugspruit	reach5	5942	1 in 50 years	193	1440	1440.86	0.79	296.28
Brugspruit	reach5	5942	1 in 100 years	256	1440	1441.03	0.87	299.97
Brugspruit	reach5	5700	1 in 50 years	193	1439.43	1440.4	1.02	207.86
Brugspruit	reach5	5700	1 in 100 years	256	1439.43	1440.55	1.16	211.62
Brugspruit	reach5	5400	1 in 50 years	193	1438.72	1439.41	1.24	237.64
Brugspruit	reach5	5400	1 in 100 years	256	1438.72	1439.54	1.37	242.27
Brugspruit	reach5	5100	1 in 50 years	193	1438.01	1438.88	0.63	374.09
Brugspruit	reach5	5100	1 in 100 years	256	1438.01	1439.05	0.69	382.33

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach5	4800	1 in 50 years	193	1437.3	1438.46	0.98	212.76
Brugspruit	reach5	4800	1 in 100 years	256	1437.3	1438.64	1.07	221.04
Brugspruit	reach5	4500	1 in 50 years	193	1436.6	1437.86	1.17	172.22
Brugspruit	reach5	4500	1 in 100 years	256	1436.6	1438.02	1.33	181.78
Brugspruit	reach5	4200	1 in 50 years	193	1435.89	1436.57	1.8	177.25
Brugspruit	reach5	4200	1 in 100 years	256	1435.89	1436.74	1.86	187.02
Brugspruit	reach5	3900	1 in 50 years	193	1435.18	1436.27	0.53	361.52
Brugspruit	reach5	3900	1 in 100 years	256	1435.18	1436.46	0.59	369.85
Brugspruit	reach5	3827	1 in 50 years	193	1435.01	1436.25	0.41	412.71
Brugspruit	reach5	3827	1 in 100 years	256	1435.01	1436.43	0.46	421.31
Brugspruit	reach6	3241	1 in 50 years	304	1435	1435.94	0.64	528.09
Brugspruit	reach6	3241	1 in 100 years	397	1435	1436.13	0.69	537.08
Brugspruit	reach6	3000	1 in 50 years	304	1434.61	1435.76	0.62	452.56
Brugspruit	reach6	3000	1 in 100 years	397	1434.61	1435.96	0.69	461.5
Brugspruit	reach6	2700	1 in 50 years	304	1434.13	1435.4	1.13	245.43
Brugspruit	reach6	2700	1 in 100 years	397	1434.13	1435.6	1.25	254.93
Brugspruit	reach6	2400	1 in 50 years	304	1433.65	1434.84	1.08	271.76
Brugspruit	reach6	2400	1 in 100 years	397	1433.65	1435.05	1.18	283.36
Brugspruit	reach6	2100	1 in 50 years	304	1433.17	1434.51	0.77	338.91
Brugspruit	reach6	2100	1 in 100 years	397	1433.17	1434.73	0.84	351.72
Brugspruit	reach6	1800	1 in 50 years	304	1432.69	1433.96	1.56	179.66

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Brugspruit	reach6	1800	1 in 100 years	397	1432.69	1434.17	1.71	187.74
Brugspruit	reach6	1500	1 in 50 years	304	1432.21	1433.36	0.93	305.04
Brugspruit	reach6	1500	1 in 100 years	397	1432.21	1433.8	0.86	319.04
Brugspruit	reach6	1200	1 in 50 years	304	1431.73	1432.98	0.87	313.59
Brugspruit	reach6	1200	1 in 100 years	397	1431.73	1433.64	0.7	346.68
Brugspruit	reach6	900	1 in 50 years	304	1431.25	1432.79	0.63	364.35
Brugspruit	reach6	900	1 in 100 years	397	1431.25	1433.57	0.51	414.04
Brugspruit	reach6	600	1 in 50 years	304	1430.77	1432.75	0.34	526.9
Brugspruit	reach6	600	1 in 100 years	397	1430.77	1433.55	0.3	554.57
Brugspruit	reach6	300	1 in 50 years	304	1430.29	1432.73	0.29	459
Brugspruit	reach6	300	1 in 100 years	397	1430.29	1433.54	0.27	466.99
Brugspruit	reach6	166	1 in 50 years	304	1430.05	1432.72	0.28	407.07
Brugspruit	reach6	166	1 in 100 years	397	1430.05	1433.54	0.28	417.76
Brugspruit	reach6	156		Culvert				
Brugspruit	reach6	146	1 in 50 years	304	1430.05	1430.8	1.18	381.53
Brugspruit	reach6	146	1 in 100 years	397	1430.05	1430.91	1.31	382.99
Brugspruit	reach6	122	1 in 50 years	304	1430.01	1430.6	1.56	363.2
Brugspruit	reach6	122	1 in 100 years	397	1430.01	1430.69	1.72	374.03

Table C2: Hec-Ras Output for the Naauwpoortspruit

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
				(m3/s)	(m)	(m)	(m/s)	(m)
River1	reach1	1001	1 in 50 year	30	1538.09	1538.66	0.94	115.62
River1	reach1	1001	1 in 100 year	37	1538.09	1538.7	1.03	124.4
River1	reach1	882	1 in 50 year	30	1537.12	1537.58	2.08	90.76
River1	reach1	882	1 in 100 year	37	1537.12	1537.62	2.19	98.68
Naauwpoortspruit	reach1	3644	1 in 50 year	90	1545	1545.41	0.88	282.27
Naauwpoortspruit	reach1	3644	1 in 100 year	119	1545	1545.49	0.97	291.64
Naauwpoortspruit	reach1	3444	1 in 50 year	90	1544.1	1544.83	1.11	307.62
Naauwpoortspruit	reach1	3444	1 in 100 year	119	1544.1	1544.9	1.21	324.39
Naauwpoortspruit	reach1	3270	1 in 50 year	90	1543.32	1543.89	1.52	199.72
Naauwpoortspruit	reach1	3270	1 in 100 year	119	1543.32	1543.97	1.58	229.41
Naauwpoortspruit	reach1	3042	1 in 50 year	90	1542.29	1542.71	0.89	267.42
Naauwpoortspruit	reach1	3042	1 in 100 year	119	1542.29	1542.77	1.01	272.71
Naauwpoortspruit	reach1	2841	1 in 50 year	90	1541.39	1541.61	1.13	369.71
Naauwpoortspruit	reach1	2841	1 in 100 year	119	1541.39	1541.66	1.21	373.79
Naauwpoortspruit	reach1	2649	1 in 50 year	90	1540.52	1540.85	0.62	463.87
Naauwpoortspruit	reach1	2649	1 in 100 year	119	1540.52	1540.9	0.71	468.94
Naauwpoortspruit	reach1	2452	1 in 50 year	90	1539.64	1539.8	1.28	448.43
Naauwpoortspruit	reach1	2452	1 in 100 year	119	1539.64	1539.84	1.36	452.49
Naauwpoortspruit	reach1	2254	1 in 50 year	90	1538.75	1539.11	0.52	507.85
Naauwpoortspruit	reach1	2254	1 in 100 year	119	1538.75	1539.16	0.6	514.91
Naauwpoortspruit	reach1	2044	1 in 50 year	90	1537.8	1538.4	1.77	210.65
Naauwpoortspruit	reach1	2044	1 in 100 year	119	1537.8	1538.53	1.64	256.44
Naauwpoortspruit	reach1	1848	1 in 50 year	90	1536.92	1537.6	1.08	165.18
Naauwpoortspruit	reach1	1848	1 in 100 year	119	1536.92	1537.63	1.35	168.11

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
Naauwpoortspruit	reach1	1659	1 in 50 year	90	1536.07	1537.63	0.15	547.25
Naauwpoortspruit	reach1	1659	1 in 100 year	119	1536.07	1537.68	0.19	554.62
Naauwpoortspruit	reach1	1465	1 in 50 year	90	1535.19	1537.63	0.06	824.8
Naauwpoortspruit	reach1	1465	1 in 100 year	119	1535.19	1537.68	0.08	834.13
Naauwpoortspruit	reach2	958	1 in 50 year	128	1535	1537.63	0.09	774.4
Naauwpoortspruit	reach2	958	1 in 100 year	166	1535	1537.67	0.11	779.64
Naauwpoortspruit	reach2	767	1 in 50 year	128	1534.99	1537.63	0.09	781.14
Naauwpoortspruit	reach2	767	1 in 100 year	166	1534.99	1537.67	0.11	786.91
Naauwpoortspruit	reach2	596	1 in 50 year	128	1534.98	1537.63	0.08	803.88
Naauwpoortspruit	reach2	596	1 in 100 year	166	1534.98	1537.67	0.1	809.12
Naauwpoortspruit	reach2	461	1 in 50 year	128	1534.98	1537.62	0.07	903.26
Naauwpoortspruit	reach2	461	1 in 100 year	166	1534.98	1537.67	0.09	907.32
Naauwpoortspruit	reach2	450		Culvert				
Naauwpoortspruit	reach2	441	1 in 50 year	128	1534.97	1535.46	0.4	703.01
Naauwpoortspruit	reach2	441	1 in 100 year	166	1534.97	1535.52	0.46	709.31
Naauwpoortspruit	reach2	241	1 in 50 year	128	1534.96	1535.14	0.9	805.09
Naauwpoortspruit	reach2	241	1 in 100 year	166	1534.96	1535.17	1	807.7

APPENDIX D

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Golder Associates

October 2010

SURFACE WATER SPECIALIST STUDY

eMalahleni Water Reclamation Plant: treated water discharge impact assessment

Submitted to:
Anglo American Thermal Coal (Pty) Ltd

REPORT

Report Number. 12485-9939-12

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Executive Summary

Anglo American Thermal Coal (AATC), on behalf of the mines in the Witbank mining area, proposes to expand the collection of mine affected water, treat this water and distribute it as potable and industrial water to augment local water supplies. The treated water will be supplied, under commercial terms, to a water services authority (WSA) and industrial users.

The proposed expansion project will consist of:

- Conveyance of an additional 25 Ml/day of mine affected water from existing mine shafts in the Witbank area to the existing eMalahleni Water Reclamation Plant (EWRP) via existing and new water pipelines;
- Conveyance of potable water from the EWRP to a bulk storage facility, such as the existing KwaGuqa municipal reservoir and the eMalahleni/Witbank municipal reservoir; and
- Increase in the existing EWRP capacity from 25 Mℓ/day to 50 Mℓ/day that will allow for the reclamation of mine water from other sources, such as the Navigation Section of Landau Colliery

Under certain abnormal conditions in the event that the water users are unable to accept the treated water, discharge of the treated water to the Naauwpoortspruit, may be required. This report documents the findings of the component of the surface water specialist study with regard to the discharge of 50 Mℓ of treated water from the EWRP into the Naauwpoortspruit under abnormal conditions.

Data analysis on the current flows in the Naauwpoortspruit (recorded at B1H019) indicates that the quantity of water that would be released (a maximum of 50 Mlℓ/d) is less than the 95th percentile at this site. The proposed treated water discharge is exceeded 418 out of 7337 times of the daily flow recorded at B1H019 which extends from March 1990 to April 2010. This large volume of water would be considerably more harmful to the stream should the discharge take place in months with relatively high stream flows; or occur within the periods of heavy rainfall, such as experienced over the last two years.

Water quality data at monitoring site WP 46 on the Naauwpoorspruit was obtained from AATC (Kromdraai). It is clear from the results that the Naauwpoortspruit is already highly polluted.

The proposed discharge will be routed into the Naauwpoortspruit adjacent to the EWRP site. This stream flows into the Witbank Dam. The water quality of the treated discharge water, which is assumed to be similar to the current water quality exiting the EWRP, and the Resource Water Quality Objectives (RWQO) as well as the South African National Standards (SANS) 241 (Ed. 2005) Class I for drinking water, would therefore have a positive impact on the Naauwpoortspruit.

In summary, the main potential impacts of discharge of 50 Mℓ/d of treated water under abnormal conditions would be flooding and erosion in terms of the quantity of water being discharged and improved water quality in the Naauwpoortspruit in terms of quality of water being discharged.

In respect of this the following mitigation is proposed:

- A flood protection berm should be built along the EWRP to stop flood water inundating the plant should a discharge take place when the flow in the Naauwpoortspruit is high or if heavy rainfalls occur soon after a discharge;
- Discharge from the EWRP into the Naauwpoortspruit, should not be directly into the stream, but routed through a velocity reduction mechanism such as a temporary storage dam. The discharge point must also have erosion reduction structures such as gabion baskets or rocks;
- A monitoring programme will need to be implemented in relation to the discharge which will include sampling of the typical water quality parameters as necessary, when discharge takes place;

- Discharge would need to follow the operating rules described including:
  - Partial discharge (< 50 Mℓ) into the stream unless the flow downstream at weir B1H019 is less than 1.55 m^3/s; and
  - Total flow in the stream, which includes the natural flow and the discharge, should not exceed 2.16 m^3/s. This would protect the people, farms and industries downstream from flooding. The weir would therefore need to be monitored daily to facilitate this rule.

Table of Contents

1.0 INTRODUCTION 1

2.0 STUDY APPROACH 3

3.0 HYDROLOGY 3

3.1 Flow 3

3.1.1 Current Naauwpoortspruit flow data 3

3.1.2 Impact assessment 3

4.0 BASELINE WATER QUALITY 4

4.1.1 Water quality impact assessment 6

5.0 IMPACT SIGNIFICANCE RATING 7

6.0 OPERATING RULES 8

6.1 Mitigation 10

7.0 CONCLUSIONS 10

8.0 REFERENCES 10

TABLES

Table 1: Current flow records expected flows with discharge included at B1H019 weir 3

Table 2: In-stream water quality data at monitoring point WP46 for the Naauwpoortspruit 4

Table 3: Final product water qualities from the eMalahleni Water Reclamation Plant 6

Table 4: Impact significance rating - WRP site 7

Table 5: Operating rules for the emergency discharge releases from the EWRP, gauge plate readings and their associated discharges for the Naauwpoortspruit at weir B1H019 8

FIGURES

Figure 1: Study area for the eMalahleni Mine Water Reclamation Project 2

Figure 2: Flow measurement stations 5

Figure 3: Rating curve for the Naauwpoortspruit at weir B1H019 9

APPENDICES

APPENDIX A
Document Limitations

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1.0 INTRODUCTION

Anglo American Thermal Coal (AATC), on behalf of the mines in the Witbank mining area, proposes to expand the collection of mine affected water, treat this water and distribute it as potable and industrial water to augment local water supplies. The treated water will be supplied, under commercial terms, to a water services authority (WSA) and industrial users.

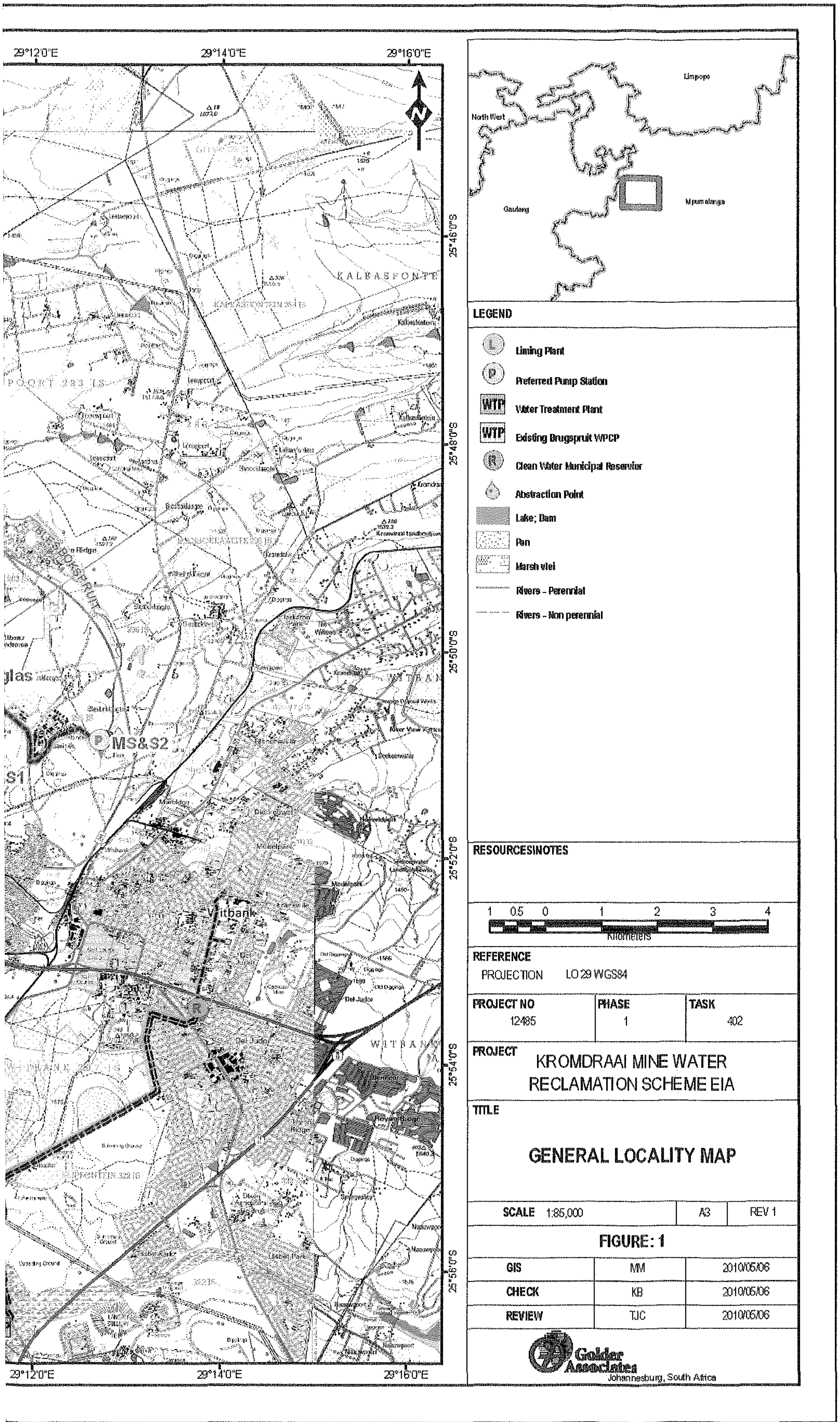
The proposed expansion project will consist of:

- Conveyance of an additional 25 Ml/day of mine affected water from existing mine shafts in the Witbank area to the existing eMalahleni Water Reclamation Plant (EWRP) via existing and new water pipelines. The various pipeline routes in the proposed study area are illustrated in Figure 1;
- Conveyance of potable water from the EWRP to a bulk storage facility, such as the existing KwaGuqa municipal reservoir and the eMalahleni/Witbank municipal reservoir; and
- Increase in the existing EWRP capacity from 25 Mℓ/day to 50 Mℓ/day that will allow for the reclamation of mine water from other sources, such as the Navigation Section of Landau Colliery

In order to obtain Environmental Authorisation for the proposed project, AATC is required to conduct an Environmental Impact Assessment (EIA) in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA). Golder Associates Africa (Pty) Ltd (GAA), an independent company, is conducting the EIA and is compiling the Environmental Management Plan (EMP) to support the EIA application. As part of the EIA a surface water specialist study is required, a component of which is to assess the impacts of discharge of treated water from the plant to the Naauwpoortspruit under conditions when the water users are unable to accept the water.

This report documents the findings of the component of the surface water specialist study with regard to the discharge of 50 Mℓ of treated water from the EWRP into the Naauwpoortspruit under abnormal conditions. The following aspects have been addressed as part of the study:

- Impact of the discharge of 50 Mℓ of treated water from the EWRP on the hydrology of the Naauwpoortspruit;
- Impact of the discharge of 50 Mℓ of treated water from the EWRP on the point of discharge into the Naauwpoortspruit; and
- Outlining the operating rules which the discharge into the Naauwpoortspruit must follow.



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29°14'0"E
29°16'0"E
25°46'0"S
25°48'0"S
25°50'0"S
25°52'0"S
25°54'0"S
25°56'0"S
N
KALBASFONTEIN
MS&S2
S1
Witbank
Limpopo
North West
Gauteng
Mpumalanga
LEGEND
Liming Plant
Preferred Pump Station
Water Treatment Plant
Existing Brugspruit WPCP
Clean Water Municipal Reservior
Abstraction Point
Lake; Dam
Pan
Marsh vlei
Rivers - Perennial
Rivers - Non perennial
RESOURCES/NOTES
1 0.5 0 1 2 3 4
Kilometers
REFERENCE
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PROJECT NO 12485
PHASE 1
TASK 402
PROJECT
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GENERAL LOCALITY MAP
SCALE 1:85,000
A3
REV 1
FIGURE: 1
GIS MM 2010/05/06
CHECK KB 2010/05/06
REVIEW TJC 2010/05/06
Golder Associates
Johannesburg, South Africa

2.0 STUDY APPROACH

The approach adopted in the study can be summarised as follows:

- Site visits were conducted;
- Hydrological data to support the EIA was analysed; and
- Water quality assessments were performed on the affected river.

3.0 HYDROLOGY

3.1 Flow

The various sites where flow readings are taken by the Department of Water Affairs (DWA) are shown in Figure 2 and flow readings for B1H019 weir were obtained from the DWA Water Management System (WMS).

The Mean Annual Runoff (MAR) data for the Naauwpoortspruit was gathered using the Surface Water Resources of South Africa 1990 reports (WRC,1990) as well as weir data. Data for this quaternary catchment was used to calculate the runoff for the individual catchment, by area weighting.

The Naauwpoortspruit was assessed in terms of the historical data as well as the anticipated impacts of the discharge from the EWRP.

3.1.1 Current Naauwpoortspruit flow data

The daily river flows for the Naauwpoortspruit catchment were obtained from the DWA website at a weir approximately 7 km downstream of the EWRP, weir B1H019. Observed flow data at B1H019 weir extends from April 1990 to August 2009. The minimum, maximum, 5th, 50th and 95th percentiles of the flows at B1H019 are shown in Table 1, as well as flow with proposed discharge included.

Table 1: Current flow records expected flows with discharge included at B1H019 weir

Statistic	Flow (m^3/s)
Min	0.001
Max	2.354
5th Percentile	0.015
50th Percentile	0.066
95th Percentile	0.647
Discharge (50Ml/day)	0.579

3.1.2 Impact assessment

There is currently no pre-treated mine water being discharged into the Naauwpoortspruit and any discharge from the EWRP into this river system will only occur in the event that the water users are unable to accept the treated water. The discharge will be water of potable standard. Table 1 indicates that the flow with the proposed discharge of 50 Mℓ/day is less than the 95th percentile. The proposed treated water discharge is exceeded 418 out of 7337 times of the daily flow recorded at B1H019 which extends from March 1990 to April 2010. This large volume of water would be considerably more harmful to the stream should the discharge take place in months with relatively high stream flows; or occur within the periods of heavy rainfall, such as was experienced in the last two years.

4.0 BASELINE WATER QUALITY

The water quality data was obtained from AATC (Kromdraai). In stream water quality was assessed in terms of the historical data. The water quality presented in Table 2 is representative of the current river flows in the Nauuwpoortspruit. The closest water quality monitoring point, in the Naauwpoortspruit, to the proposed discharge point is WP 46.

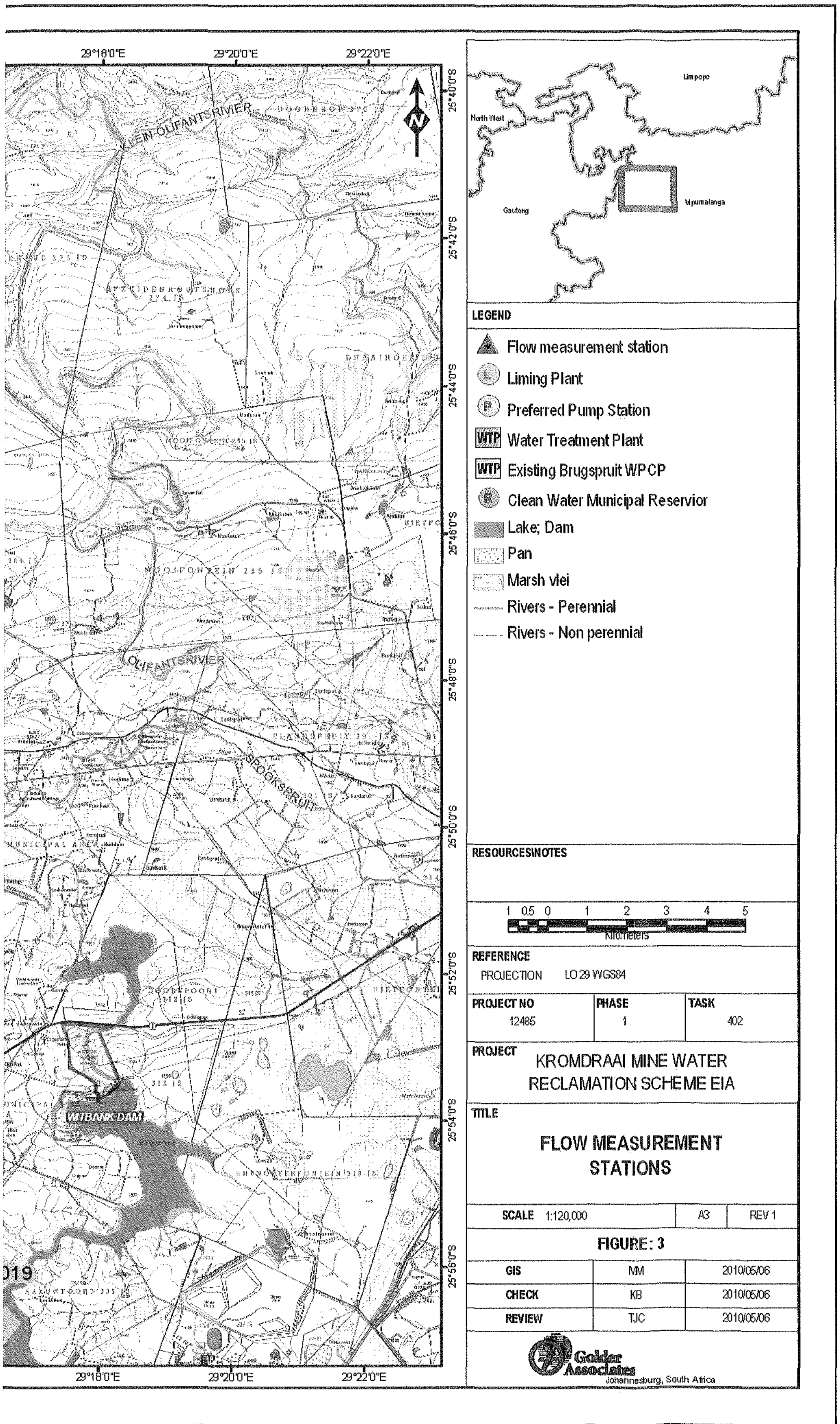
This point is located upstream of the N12 on the Naauwpoortspruit. The available data set begins in April 1990 and ends in August 2009 but the data is inconsistent, with periods where monitoring was not undertaken. The 5th, 50th and the 95th percentiles of the data set are presented in Table 2 and compared against the Resource Water Quality Objectives (RWQO) and SANS 241 standards for drinking water.

Table 2: In-stream water quality data at monitoring point WP46 for the Naauwpoortspruit

	Units	5th Percentile	50th Percentile	95th Percentile	RWQO	SANS 241 Ed.6, 2005. Class I
pH		3.6	6.3	9	6.5 - 9.0	5 - 9.5
EC	mS/m	5.5	247	566	70	<150
TDS	mg/ℓ	38.5	1726.9	3963.6	476	<1000
PAcid		2	32	140	-	-
MALK	mg $CaCO_3$/ℓ	2	17.25	220.4	-	-
Ca	mg/ℓ	24	422	667	150	<150
Mg	mg/ℓ	8.6	178	288	70	<70
Na	mg/ℓ	3.4	45.74	202	70	<200
K	mg/ℓ	1.3	9	31	50	<50
SO_4	mg/ℓ	15.3	253	264	200	<400
Cl	mg/ℓ	1	14	122	25	<200
F	mg/ℓ				1	<1.0
Fe	mg/ℓ	0.1	0.37	4.1	1	<0.2
Mn	mg/ℓ	0.1	6.3	15.3	0.50	<0.1
Al	mg/ℓ	0.1	0.68	6	0.1	<0.3
N	mg/ℓ N				6	<10
Temp	˚C	2.6	22.195	25.5	-	-
SS	mg/ℓ	2.5	29	245	-	-

Note: Shaded areas highlight parameters which exceed the RWQOs or SAND 241 standards

It is clear from the results that the Naauwpoortspruit is already highly polluted.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KLEIN-OLIFANTSRIVIER
OLIFANTSRIVIER
SPOOKSPRUIT
WITBANK DAM
N
Limpopo
North West
Gauteng
Mpumalanga
LEGEND
Flow measurement station
Liming Plant
Preferred Pump Station
WTP Water Treatment Plant
WTP Existing Brugspruit WPCP
Clean Water Municipal Reservior
Lake; Dam
Pan
Marsh vlei
Rivers - Perennial
Rivers - Non perennial
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REV 1
FIGURE: 3
GIS MM 2010/05/06
CHECK KB 2010/05/06
REVIEW TJC 2010/05/06
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4.1.1 Water quality impact assessment

The proposed discharge will be routed into the Naauwpoortspruit adjacent to the EWRP site. This stream flows into the Witbank Dam. The water quality of the treated discharge water, which is assumed to be similar to the current water quality exiting the EWRP, and the Resource Water Quality Objectives (RWQO) as well as the South African National Standards (SANS) 241 (Ed. 2005) Class I is shown in Table 3.

Table 3: Final product water qualities from the eMalahleni Water Reclamation Plant

Parameter	Units	5th Percentile	50th Percentile	95th Percentile	SANS 241 (Ed. 2005) Class I	RWQOs
pH		5.72	7.02	7.38	5 - 9.5	6.5 - 9.0
Conductivity	(mS/m)	17.71	20.15	51.18	150	70
Turbidity	NTU	0.45	1.45	2.85	1	-
Alkalinity	(mg/l)	8.00	13.00	33.60	-	-
Acidity	(mg/l $CaCO_3$/l)	3.53	6.55	11.49	-	-
Total Hardness	(mg/l $CaCO_3$/l)	21.67	30.22	96.42	-	-
Ca Hardness	(mg/l $CaCO_3$/l)	19.66	27.22	89.51	-	-
Mg Hardness	(mg/l $CaCO_3$/l)	1.37	3.77	9.29	-	-
Na	(mg/l)	17.68	20.30	52.48	200	70
Ca	(mg/l)	8.56	10.90	35.84	150	150
Mg	(mg/l)	0.36	0.82	2.06	70	70
K	(mg/l)	3.91	4.56	12.08	50	50
Zn	(mg/l)	0.02	0.04	0.26	5	-
Mn	(mg/l)	0.01	0.02	0.07	0.1	0.5
Al	(mg/l)	0.01	0.02	0.05	0.300	0.1
Fe	(mg/l)	0.05	0.05	<0.1	0.200	1
Ba	(mg/l)	0.01	0.02	0.07	-	-
Sb	(mg/l)	<0.005	<0.005	<0.005	0.010	-
As	(mg/l)	<0.01	<0.01	<0.01	0.015	-
Cd	(mg/l)	<0.003	<0.003	<0.003	0.005	-
Cr	(mg/l)	<0.01	<0.01	<0.01	0.100	-
Co	(mg/l)	<0.01	<0.01	<0.01	0.500	-
Cu	(mg/l)	<0.01	<0.01	0.03	1	-
Pb	(mg/l)	0.01	0.01	0.01	0.050	-
Hg	(mg/l)	<0.01	<0.01	<0.01	0.002	-
Ni	(mg/l)	0.01	0.01	0.01	0.150	-
Se	(mg/l)	<0.01	<0.01	<0.01	0.020	-
V	(mg/l)	<0.01	<0.01	<0.01	0.200	-
Cl	(mg/l)	11.25	16.00	28	200	25
SO_4	(mg/l)	31.60	44.10	113	400	200
Nitrates & Nitrites as N	(mg/l)	2.53	3.60	8.7	10	6
F	(mg/l)	<0.20	<0.20	<0.20	1	1
Ammonia as N	(mg/l)	0.1	0.1	0.98	1	0.02

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TDS	(mg/l)	86.00	120.00	296.40	1000	476
TSS	(mg/l)	0.80	2.80	8.96	-	-
Phenols	(mg/l)	<0.005	<0.005	<0.005	0.010	-

Note: Shaded areas highlight parameters which exceed the SANS (Ed. 2005) Class I Standard or the RWQOs for the catchment.

The water quality results set out in Table 3 indicate slightly elevated levels of turbidity, iron, and ammonia when compared against SANS 241 standards for potable water; and nitrate and ammonia when compared against the RWQOs for the catchment. However, when compared against the current water quality of the Naauwpoortspruit (Table 2), the water quality of the proposed discharge would considerably improve that of the Naauwpoortspruit. In terms of water quality therefore, the impacts from the discharge would be positive.

5.0 IMPACT SIGNIFICANCE RATING

The main impacts of discharge of discharge of 50 Ml of treated water would be:

- Flooding;
- Decreased or improved water quality and
- Erosion.

The impact significance rating table is shown below in Table 4.

Table 4: Impact significance rating - WRP site

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
Flooding of EWRP site by the Naauwpoortspruit	Flooding of the EWRP site may occur should discharge take place when flow in the Naauwpoortspruit is high; or if heavy rainfalls occur soon after the discharge,	2	1	2	10	26 (low negative)
Discharge of water from EWRP	As described previously discharge from the EWRP into the adjacent stream would have a **positive impact** on the water quality, due to the water quality being considerably better than that of the Naauwpoortspruit. The impact would be the same if there was a leak or spill from the KwaQuga distribution pipeline or the Witbank/eMalahleni distribution pipeline, as the water is of a similar quality.	0	1	1	1	0 (positive)
Discharge of water from EWRP	The impact of discharge on the erodibility of the discharge point as well as the downstream channel would be moderate,	4	1	2	8	44 (moderate negative)

Activity	Potential Impact	Occurrence		Severity		
		Probability	Duration	Scale	Magnitude	Total SP
	particularly if this discharge were to occur during a time when large rainfall events had occurred or were to occur shortly thereafter.					
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.				
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.				
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.				

6.0 OPERATING RULES

The full rundown of the operating rules used in conjunction with the gauge plate reading and the associated discharge at the weir along the Naauwpoortspruit (B1H019) are shown in Table 5. Table 5 relates the various discharges in the stream to the allowed discharges from the EWRP in m^3/s as well as Mℓ. The relationship between the gauge plate reading and the associated discharge at the weir along the Naauwpoortspruit (B1H019) is shown in the rating curve in Figure 3.

Table 5: Operating rules for the emergency discharge releases from the EWRP, gauge plate readings and their associated discharges for the Naauwpoortspruit at weir B1H019

Gauge plate depth (m)	Discharge (m^3/s)	Allowed discharge (m^3/s)	Total flow (m^3/s)	Allowed discharge (Mℓ)
0	0.000	0.579	0.579	50
0.05	0.066	0.579	0.645	50
0.1	0.189	0.579	0.768	50
0.15	0.349	0.579	0.928	50
0.2	0.539	0.579	1.118	50
0.25	0.757	0.579	1.336	50
0.3	0.999	0.579	1.578	50
0.35	1.260	0.579	1.839	50
0.4	1.550	0.579	2.129	50
0.41	1.610	0.521	2.131	45
0.42	1.670	0.463	2.133	40
0.43	1.730	0.405	2.135	35

Gauge plate depth (m)	Discharge (m^3/s)	Allowed discharge (m^3/s)	Total flow (m^3/s)	Allowed discharge (Mℓ)
0.44	1.790	0.347	2.137	30
0.45	1.850	0.289	2.139	25
0.46	1.920	0.231	2.151	20
0.47	1.970	0.174	2.144	15
0.48	2.030	0.116	2.146	10
0.49	2.080	0.058	2.138	5
0.5	2.130	0.000	2.130	0
0.55	2.340	0.000	2.340	0

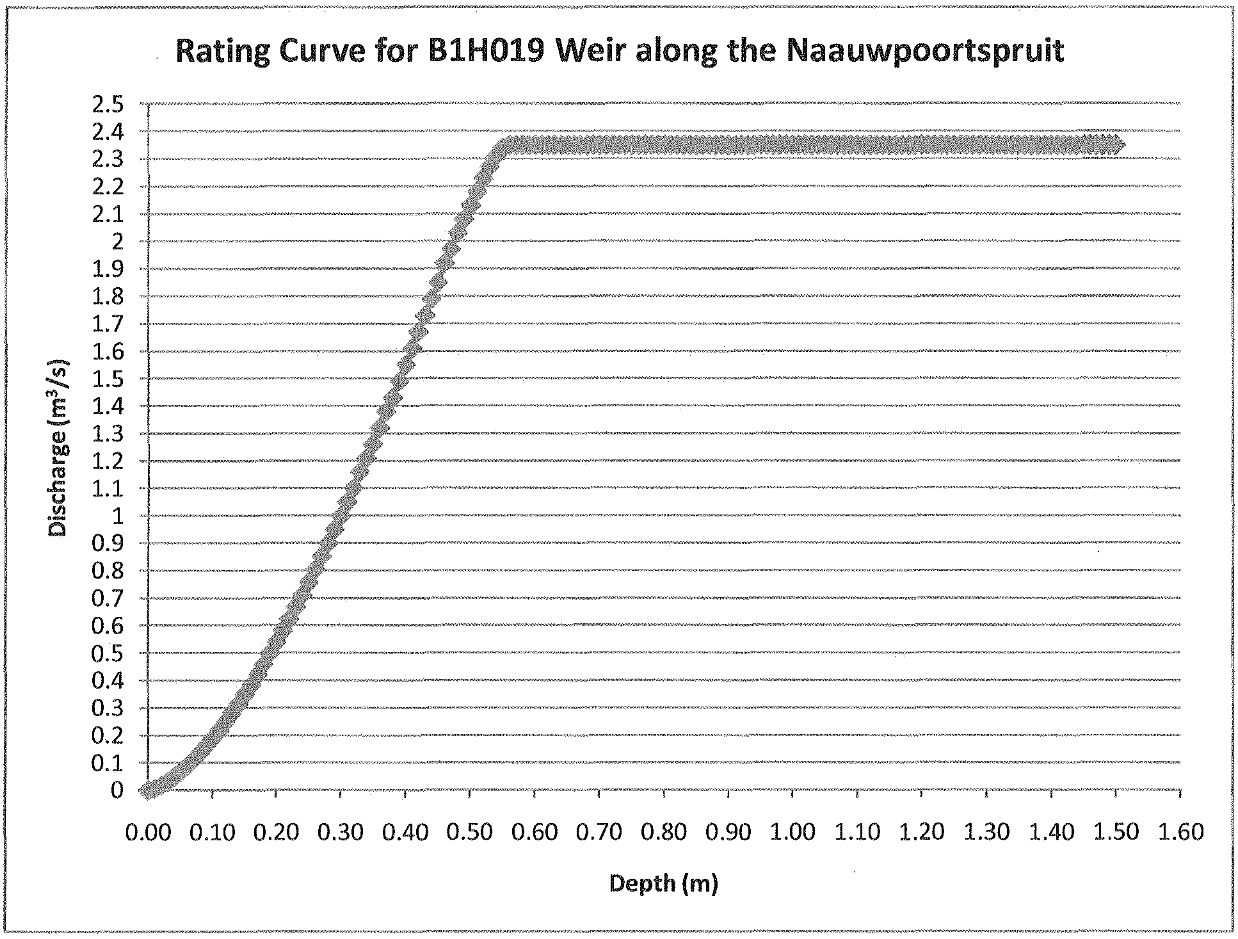

Figure 3: Rating curve for the Naauwpoortspruit at weir B1H019

6.1 Mitigation

The following mitigation is proposed:

- A flood protection berm should be built along the EWRP to stop flood water inundating the plant should a discharge take place when the flow in the Naauwpoortspruit is high or if heavy rainfalls occur soon after a discharge;
- Discharge from the EWRP into the Naauwpoortspruit, should not be directly into the stream, but routed through a velocity reduction mechanism such as a temporary storage dam. The discharge point must also have erosion reduction structures such as gabion baskets or rocks;
- A monitoring programme will need to be implemented in relation to the discharge. This will include sampling of the typical water quality parameters as necessary, when discharge takes place;
- Discharge would need to follow the operating rules described above including:
  - EWRP should not be allowed to make the full discharge of 50 Mℓ into the stream unless the flow downstream at weir B1H019 is less than 1.55 m^3/s;
  - The total flow in the stream, which includes the natural flow and the discharge, should not exceed 2.16 m^3/s. This would protect the people, farms and industries downstream from flooding. The weir would therefore need to be monitored daily to facilitate this rule.

7.0 CONCLUSIONS

In conclusion, the most important possible impacts of discharge of 50 Mℓ/d of treated water under unusual conditions would be flooding and erosion in terms of the quantity of water being discharged and enhanced water quality in the Naauwpoortspruit in terms of quality of water being discharged.

In respect of this the subsequent mitigation is proposed:

- A flood protection berm should be built beside the EWRP to prevent flood water inundating the plant should a discharge take place when the flow in the Naauwpoortspruit is high or if heavy rainfalls take place shortly after a discharge;
- Discharge from the EWRP into the Naauwpoortspruit, should not be directly into the stream, but routed through a velocity reduction system such as a temporary storage dam. The discharge point should also have erosion reduction structures such as gabion baskets or rocks;
- A monitoring programme should to be implemented in relation to the discharge which will incorporate sampling of the typical water quality parameters as necessary, when discharge takes place;
- Discharge would have to follow the operating rules expressed including:
  - Partial discharge (< 50 Mℓ) into the stream except when the flow downstream at weir B1H019 is less than 1.55 m^3/s; and
  - Total flow in the stream, which consists of the natural flow and the discharge, should not exceed 2.16 m^3/s. This would protect the people, farms and industries downstream from flooding. The weir would thus need to be monitored daily to facilitate this rule.

8.0 REFERENCES

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APPENDIX A

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Comments, Suggestions and Questions Raised	Commentator	Organisation	Date	Source	Response
You mentioned the suburb of Jacaroo Park in your presentation. We have learnt that water quality is of great concern in this area. They seem to receive water from the current water reclamation plant. Can you comment on this?	Mr Philix Mnisi	Transnet	23 August 2010	Public meeting, Del Amor, Witbank	The water quality from the existing water reclamation plant is better than the general accepted standard. Over the three years of operation, Anglo has produced better quality than required in the SANS guidelines for class 1 water. Anglo cannot comment on the water quality from the municipality's system. The treated mine water that is delivered into the municipal water supply is mixed with other sources of municipal water. Unfortunately, there are a number of other older (defunct) mines that are not part of the mine water reclamation scheme, and may be causing water quality issues in the area. Anglo American Thermal Coal has conducted engineering assessments to incorporate mine water from these defunct mines into the scheme, but the properties do not belong to Anglo. Anglo American Thermal Coal will continue to engage with the Department of Mineral Resources regarding this issue.
Historically, water quality in the Witbank area has been poor. I would like to know whether the addition of the treated mine water has contributed to the deterioration of water quality in the area?	Mr Philix Mnisi	Transnet	23 August 2010	Public meeting, Del Amor, Witbank	No comment can be made on the water quality in the municipal (distribution) system. Water quality records for the water reclamation plant indicate that the treated water distributed to the municipality is of very high quality.

Comments, Suggestions and Questions Raised	Commentator	Organisation	Date	Source	Response
Could it be clarified where the water gets contaminated, is it before it is mixed with the municipal water or between the municipality and the consumer?	Mr Roark Rawheath	Samancor Chrome	23 August 2010	Public meeting, Del Amor, Witbank	The water from the reclamation plant only makes up 20 % of the total municipal water reserve. Water quality records for the water reclamation plant show that the treated water distributed to the municipality is of very high quality. If water contamination is taking place between the municipality and the consumer, this should be taken up with the municipality.
The municipality supplies 80 % of drinking water to the public, and the water reclamation plant supplies 20% of the water. Reservoir B is pivotal to the municipality because they can distribute to the other reservoirs.	Mr Eric Parker	Town Planner, Emalahleni	23 August 2010	Public meeting, Del Amor, Witbank	For years the municipality has been struggling with its own water treatment plant and also with water quality from the dams feeding into the system. A lot of hidden dirt is present in the water and this affects the taste and colour of the water. Fortunately, pathogens in the water have not affected animals drinking from the dams. The municipality has upgraded the treatment plant a number of times in the past couple of years, but are struggling to keep up with the demand for water, and the treatment plant is running over capacity. This is another reason why the municipality is very happy to get good quality water supply from the water reclamation scheme.

APPENDIX F

Specialist Reports: Soil, Land Use and Land Capability

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Report No: RG/2009/12/02/1
Date: October 2010

REPORT

eMalahleni Mine Water Reclamation Expansion Project

Soil, Land Capability and Land Use Assessment

Requested By
Golder Associates Africa (Pty) Ltd

Compiled By
Rehab Green Monitoring Consultants CC
Environmental and Rehabilitation Monitoring Consultant cc
P.I. Steenekamp (Cert.Sci.Nat.)

CONTENTS

		Page
I.	**EXECUTIVE SUMMARY**	5
1.	**INTRODUCTION**	**8**
1.1	**Project background**	**8**
1.2	**Study aims and objectives**	**9**
2.	**STUDY APPROACH**	**9**
3.	**METHODOLOGY**	**11**
3.1	**Field preparation**	**11**
3.2	**Soil classification**	**11**
3.3	**Soil sampling and analyses**	**12**
3.4	**Land capability and agricultural potential classification**	**12**
3.5	**Land use mapping**	**12**
3.6	**Map compilations**	**12**
3.7	**Impact assessment**	**13**
4.	**SURVEY RESULTS**	**15**
4.1	**Soil**	**15**
4.1.1	Soils along the collection pipeline route	15
4.1.1.1	Well-drained soils	15
4.1.1.2	Disturbed soils	15
4.1.1.3	Imperfectly and poorly-drained soils (Hydromorphic soils)	16
4.1.1.4	Soils at the footprint of semi-permanent infrastructure	16
4.1.2	Soils along the proposed mutual collection and distribution pipeline route	20
4.1.3	Soils along the proposed distribution pipeline route	22
4.1.4	Soils along the proposed route refinements	24
4.2	**Land capability and agricultural potential classification**	**27**
4.2.1	Arable	27
4.2.2	Grazing	27
4.2.3	Wetland	27
4.2.4	Wilderness	27
4.3	**Land use**	**31**
4.3.1	Land use along the collection, mutual collection/distribution and distribution route	31

4.3.2 Land uses along the proposed route refinements 31

5. IMPACT ASSESSMENT 34

5.1 Construction phase 34

5.2 Operational phase 34

5.3 Decommissioning phase 35

6. MITIGATION MEASURES 35

6.1 Construction phase 35

6.2 Operational phase 36

6.3 Decommissioning phase 36

7. CONCLUSION AND RECOMMENDATIONS 37

8. ASSUMPTIONS 37

REFERENCES

TABLES:

Table 1	Significance assessment	13
Table 2	Impact ranking	13
Table 3	Significance evaluation	14
Table 4	Soil legend - Collection pipeline route	18
Table 5	Soil legend - Mutual collection and distribution pipeline route	21
Table 6	Soil legend - Distribution pipeline route	23
Table 7	Soil legend - Route refinements along the collection pipeline route	25
Table 8	Soil legend - Route refinements along the mutual collection and distribution pipeline route	25
Table 9	Soil legend - Route refinements along the distribution pipeline route	26
Table 10	Land capability of soils along the collection, mutual collection and Distribution and distribution pipeline route	28
Table 11	Land capability of soils along the 3 proposed route refinement sections	28
Table 12	Land uses along the collection, mutual collection/distribution and distribution route	31
Table 13	Land uses along the 3 proposed route refinements	31
Table 14	Impact assessment during construction phase	34
Table 15	Impact assessment during operational phase	34
Table 16	Impact assessment during the decommissioning phase	35

FIGURES:

Figure 1	eMalahleni Water reclamation expansion project area	8
Figure 2	The proposed eMalahleni water reclamation expansion project components	10
Figure 3	Soils along the proposed collection pipeline route	19
Figure 4	Soils along the proposed mutual collection and distribution pipeline route	20
Figure 5	Soils along the proposed distribution pipeline route	22
Figure 6	Soils along proposed route refinements of the collections, distribution and mutual collection and distribution pipeline routes	24
Figure 7	Land capability along the proposed collection, mutual collection and	

	distribution and distribution pipeline route	29
Figure 8	Land capability of soils along the 3 proposed route refinement sections	30
Figure 9	Land use along the collection, mutual collection/distribution and distribution pipeline route	32
Figure 10	Land use along the 3 proposed route refinement sections	33

I. EXECUTIVE SUMMARY

The eMalaleni Mine Water Reclamation Expansion Project (EMWREP) aims to supply additional potable water to the Witbank Municipality in order to provide in the constant growing water demand of the Witbank Municipal area. Low quality mine water will be collected at various mining areas such as Kromdraai, Exelcior, Middelburg Steam, Station and Navigation collieries and conveyed via a collection pipeline network to the existing water treatment plant at Navigation Colliery. Treated water will be conveyed via a new distribution pipeline to the KwaGuqa reservoir and via an existing pipeline to the Witbank reservoir.

The report describes the soil types, the land capability and land uses along the proposed routes. The approach is to describe the soils along the collection and distribution pipeline routes separately. However, the proposed route south of the N4 towards the water treatment plant accommodates both the collection and distribution pipeline which will be buried in the same trench. The main impact on soils will thus be a single trench for both the collection and distribution pipeline. The soils were therefore described as 3 sections according to the pipeline type as follows:

- Soils along the proposed collection pipeline route, Figure 3 (Kromdraai colliery to the N4 – 48657 m).
- Soils along the mutual collection and distribution pipeline route, Figure 4 (N4 to the water treatment plant – 10580 m).
- Soils along the distribution route, Figure 5 (along the northern side of the N4 to the Kwaguqa reservoir – 5904 m).

The aim is further to describe the soils along the proposed route refinements (3 sections) of the collection and distribution pipeline separately. However, the second proposed route refinement south of the N4 towards the water treatment plant accommodates both the collection and distribution pipeline. The soils along the 3 route refinements sections were therefore divided as follows.

- Refinements along the collection pipeline route, Figure 6 (north of the N4 – 2694 m).
- Refinements along mutual collection and distribution pipeline route, Figure 6 (South of N4 to the east 1614 m).
- Refinements along distribution pipeline route, Figure 6 (south of N4 to the west – 6265 m).

The field survey was conducted during January 2010. Soils along the proposed pipeline routes were assessed by means of hand auger observations at intervals varying between 150 to 600 meters.

Collection pipeline route

Soil and land capability

Well to moderately drained, sandy loam soils of the Hutton, Clovelly and Avalon forms classified as arable land capability and moderate to high agricultural potential comprises approximately 51% of the route.

Grey, leached, sandy soil of the fernwood, Longlands and Katspruit forms classified as wetland with low agricultural potential comprises approximately 6% of the route.

Disturbed areas such as currently mined land, excavated areas, eroded areas, rehabilitated areas and semi-permanent infrastructure such as rail and road intersections dominated by the Witbank soil form comprises approximately 43% of the route.

Land use

Approximately 50% of the route occurs within mine property where no specific utilization takes place and the land use was described as "Vacant – mine property". Approximately 40% of the route is infrequently grazed by local farmers and the land use was described as "Vacant – Informal grazing". The remainder of the route consists of small land uses such as roads, rail road, a dam, residential and road edges etc.

Mutual collection and distribution pipeline route

Soil and land capability

Well to moderately drained, sandy loam soils of the Clovelly and Avalon forms classified as arable land capability and moderate to high agricultural potential comprises approximately 63 % of the route.

Grey, leached, sandy soil of the Longlands form classified as wetland with low agricultural potential comprises approximately 19% of the route.

Disturbed areas such as excavated areas, diggings, trenches, eroded areas and semi-permanent infrastructure such as rail and road intersections dominated by the Witbank soil form comprises approximately 18% of the route.

Land use

Approximately 40% of the route occurs within mine property where no specific utilization takes place and the land use was described as "Vacant – mine property". Approximately 30% of the route is infrequently grazed by local farmers and the land use was described as "Vacant – Informal grazing" and approximately 20% of the route runs on the boundary between a maize field and tree plantation. The remainder of the route consists of small land uses such as roads, rail road, mining infrastructure etc.

Distribution pipeline route

Soil and land capability

Well to moderately drained, sandy loam soils of the Hutton and Clovelly forms classified as arable land capability and moderate to high agricultural potential comprises approximately 77% of the route.

Grey, leached, sandy soil of the Longlands form classified as wetland with low agricultural potential comprises approximately 13% of the route.

Disturbed areas such as excavated areas, trenches, eroded areas and semi-permanent infrastructure such as rail and road intersections dominated by the Witbank soil form comprises approximately 10% of the route.

Land use

Approximately 55% of the route occurs between the N4 highway and a residential area and practically no reasonable land use are possible and the land use was described as "Vacant – residential/road edge". Approximately 40% of the route is infrequently grazed by local farmers and the land use was described as "Vacant – Informal grazing". The remainder of the route consists of small land uses such as roads, rail road etc.

General conclusion

In general the impact by buried pipelines on soil, land capability, land use is fairly low. Pipelines occupy small areas of land and the impact is of short term nature and can be fairly well mitigated. Almost all current land uses can continue after the trenches are closed.

The project will have a massive positive impact on the environment in terms of soil and water resources. Extremely severe soil and water pollution by decanting low quality mine water was observed during the field assessment. By lowering the underground mine water levels, decanting will decrease land less soil and surface water recourses will be contaminated.

Considering the low impact on soils, land capability and land use as well as the massive positive impact on the environment in terms of soil and water resources and subsequent impacts on fauna and flora the project should definitely continue.

Collection points and associated pipelines that will have a direct impact on the current decanting just north of eMalahleni should be constructed first.

1. INTRODUCTION

1.1 Project background

Anglo American Thermal Coal is undertaking a feasibility study to collect mine affected water at several mines in the Witbank area to be treated to potable standards at an existing water treatment plant. The project refer to as the eMalaleni Mine Water Reclamation Expansion Project (EMWREP) aims to supply additional potable water to the Witbank Municipality in order to provide in the constant growing water demand of the Witbank Municipal area.

The water collection points, the collection and distribution pipeline network, the water treatment plant and water reservoirs encompass the larger EMWREP area. The project area is situated to the west of Witbank and stretches from Kromdraai opencast approximately 15 km north of the N4 highway to the eMalahleni Water Treatment Plant at Navigation Colliery approximately 7 km south of the N4 highway (Figure 1).

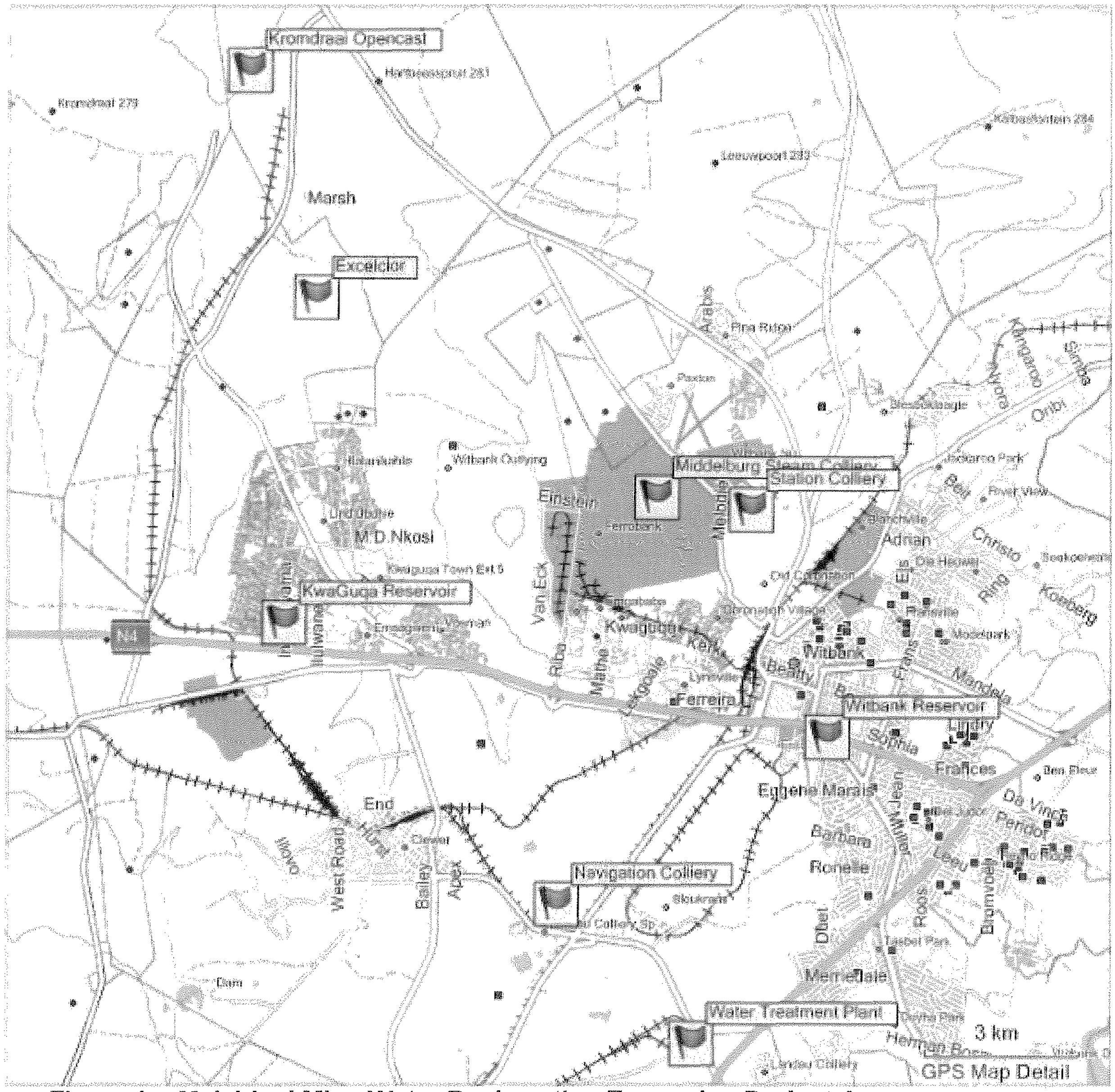

Figure 1: eMalahleni Mine Water Reclamation Expansion Project Area

The proposed project consists of the following.

- The conveyance of mine affected water from various collection points at Kromdraai, Exelcior, Middelburg Steam and Station collieries to the water treatment plant at Navigation Colliery via new water collection pipelines.
- The expansion of the existing eMalahleni Water Treatment Plant at Navigation colliery where mine affected water will be treated to potable standards. The expansion is covered by the plant's existing EIA. The expansions will double the current capacity of the plant.
- The conveyance of potable water from the eMalahleni Water Treatment Plant via a new distribution pipeline to the KwaGuqa Reservoir and via an existing pipeline to the Witbank Reservoir.
- The disposal of waste generated during the water treatment process onto existing disposal facilities at Navigation Colliery.

1.2 Study aims and objectives

The study provides input to the EIA as required in terms of the Minerals and Petroleum Resources Development Act (2002).The Act requires that pollution and/or degradation of the environment is to be avoided, or where either aspect cannot be avoided, is to be minimized and remedied. Further objectives are:

- To address issues that have been raised during the Scoping Phase;
- Address alternatives to the proposed activity in a comparative manner;
- Address all identified impacts and determine the significance of each impact; and
- Formulate mitigation measures.

2. STUDY APPROACH

The key component (Figure 2) associated with the proposed EMWREP that could have an effect on soil, land capability and land use is the pipeline that needs to be buried. The trenches to be will be the main unavoidable impact unless the pipeline will be constructed above ground.

The aim is to describe the soils along the collection and distribution pipeline routes separately. However, the proposed route south of the N4 towards the water treatment plant accommodates both the collection and distribution pipeline which will be buried in the same trench. The main impact on soils will thus be a single trench for both the collection and distribution pipeline. The soils were therefore described as 3 sections according to the pipeline type as follows:

- Soils along the proposed collection pipeline route, Figure 3 (Kromdraai colliery to the N4 – 48657 m).
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- Soils along the distribution route, Figure 5 (along the northern side of the N4 to the Kwaguqa reservoir – 5904 m).

The aim is further to describe the soils along the proposed route refinements (3 sections) of the collection and distribution pipeline separately. However, the second proposed route refinement south of the N4 towards the water treatment plant accommodates both the collection and distribution pipeline. The soils along the 3 route refinements sections were therefore divided as follows.

- Refinements along the collection pipeline route, Figure 6 (north of the N4 – 2694 m).
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- Refinements along distribution pipeline route, Figure 6 (south of N4 to the west – 6265 m).

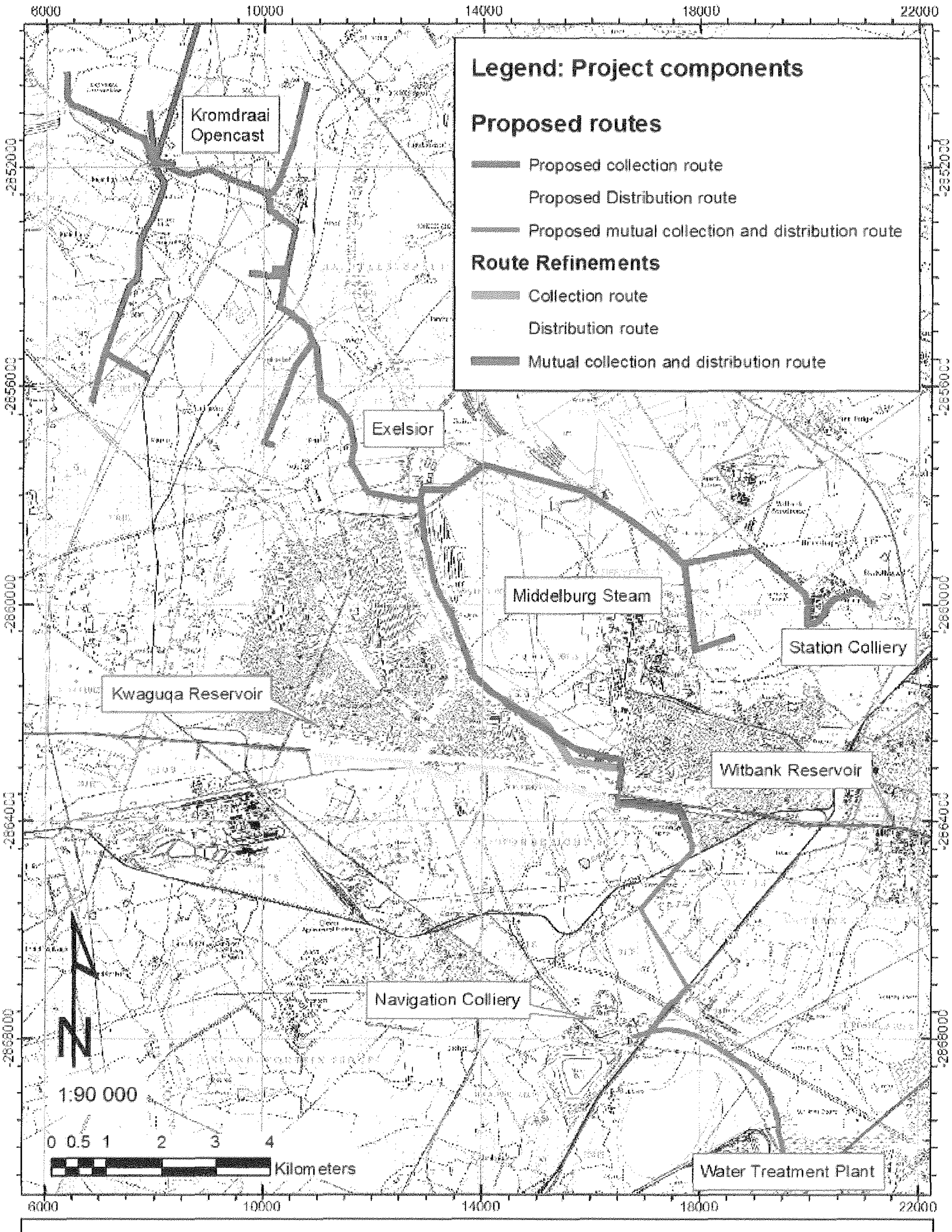


Figure 2: The Proposed eMalahleni Mine Water Reclamation Expansion Project Components

3. METHODOLOGY

3.1 Field preparation

In order to do accurate surveying all available data was processed with the aid of advanced Geographic Information System (GIS) software (ArcGIS 9.3.1). The shapefile containing the geographic location of the proposed pipeline route was superimposed on a Google Earth image as well as 1:50 000 scale topographic data. Observation points were generated at 150 m intervals along the proposed route. The coordinates of the observation points were calculated and loaded on a Geographic Positioning System (GPS) to accurately locate the position of the pipeline in the field. Large scale field maps (1:7000 scale) showing the proposed pipeline route and observation points on both aerial and topographic background data were printed.

3.2 Soil classification

The field survey was conducted during January 2010. Soils along the proposed pipeline routes were assessed at intervals varying between 150 to 600 meters.

The soils were investigated by making observations with the use of a bucket type auger to a maximum depth of 1500 mm or to the depth of refusal. At each observation point the South African Taxonomic Soil Classification System (Soil Classification Working Group, 2nd edition 1991) was used to describe and classify the soil. The classification system categories soil types in an upper soil Form level which are subdivided in a number of lower Family levels. Each soil Form (higher level) is defined by a unique vertical sequence of soil horizons with specific defined properties. The soil Families (lower level) are a subdivision of the soil Form (higher level) differentiated on the basis of specific characteristics.

In this way, standardised soil identification and communication is allowed by use of soil Form names and family numbers or names e.g. Hutton 2100 or Hutton Hayfield. The soil Form and soil Family together are refer to as soil types in this report. At each auger observation point the following procedure was followed to note soil properties and classify soils accordingly:

i) Identify applicable diagnostic horizons by noting the physical properties such as:

- Effective depth (depth of soil suitable for root development);
- Colour (in accordance with Munsell colour chart);
- Texture (refers to the particle size distribution);
- Structure (aggregation of soil particles into structural units);
- Mottling (alterations due to continued exposure to wetness);
- Concretions (cohesion of minerals into hard fragments) and
- Leaching (removal of soluble constituents by percolating water).

ii) Determine according to above properties the appropriate soil Form and soil Family

The soil Form are indicted by the name and the Family by its appropriate number e.g. Hutton 2100. The soil Form and Family were then symbolized e.g. Hu and referred to as soil type Hu. The soil Form and Family were often further categorized based on effective soil depth and a numerical number was add to the symbol e.g. Hu1. For example where the Hutton 2100 soil Form and Family occurs at an effective depth of 900-1200 mm it was symbolized and referred to as soil type Hu1 and where this soil Form and Family occurs at an effective depth of 600-900 mm it was symbolized and referred to as soil type Hu2 (see Soil Legend, Table 4).

3.3 Soil sampling and analyses

No soil sampling was done.

3.4 Land capability and agricultural potential classification

The land capability and agricultural potential of soils was solely based on soil physical properties and other local influences such as close to urban or industrial areas or narrow strips between road and residential area which could made agricultural activities impractical was excluded. This implies that the agricultural potential of a specific section could be classified as high according to soil properties although cultivation of the area could be impractical due to local influences.

Land capability was assessed according to the definitions of the Chamber of Mines of South Africa and Coaltech Research Association (Guidelines for the Rehabilitation of Mined land. 2007, Johannesburg). Soils types were classified accordingly into 4 categories namely arable, grazing, wetland and wilderness.

The practical field procedure for the identification and delineation of wetlands and riparian areas (Department of Water Affair and Forestry, 2005) were used as guideline to delineate wetland zones. Wetland zones namely temporary, seasonal and permanent was delineated based on soils Form, soil wetness, terrain unit and vegetation indicators.

The agricultural potential of soils was based on soil properties noted during auger observations namely effective soil depth, texture, soil wetness and disturbances.

Well-drained soils with an effective depth less than 600 mm were classified as low agricultural potential, 600-900 mm moderate and deeper than 900 mm high agricultural potential. All mined and disturbed areas were classified as low agricultural potential. Rehabilitated soils with a topsoil depth less than 600 mm on top the spoil material were classified as low potential and deeper than 600 mm as moderate potential. Leached, grey soils showing evidence of periodic or permanent percolating water tables were classified as low agricultural potential.

3.5 Land use mapping

The localities and extents of land use practices were surveyed during the time of the soil assessment as shown on the land use map Figures 9 and 10.

3.6 Map compilations

Maps were compiled on aerial photo background. The maps were generated in a projected coordinate system using the longitude of origin (LO) coordinate system based on the 29° East meridian, WGS 1984 spheroid and Hartebeesthoek 1994 Datum.

The soil, land capability and land use data is shown on 8 maps, Figures 3-10.

3.7 Impact Assessment

This assessment evaluates the effects of the proposed project on the soil environment. Each potential impact was assessed according to the following criteria:

- **Magnitude** is a measure of the degree of change in a measurement or analysis which is classified as minor/negligible, low, moderate, high or very high.

- **Scale/Geographic extent** refers to the area that could be affected by the impact and is classified as none, site only, local, regional, national, or international.

- **Duration** refers to the length of time over which an environmental impact may occur: i.e. Immediate (less than 1 year), short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.

- **Probability of occurrence** is a description of the probability of the impact actually occurring as improbable (less than 5 % chance), low probability (5 % to 40 % chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60 % to 90 % chance) or definite (impact will definitely occur).

- **Direction** of an impact may be positive, neutral or negative with respect to the particular impact.

- **Reversibility** is an indicator of the potential for recovery of the endpoint from the impact.

- **Frequency** describes how often the impact may occur within a given time period and is classified as low, medium or high frequency. Seasonal considerations should be discussed where these are important in the evaluation of the impact.

The significance of the identified impacts was determined using the approach outlined below. This incorporates two aspects for assessing the potential significance of impacts (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998), namely occurrence and severity, which are further sub-divided as follows:

Table 1: Significance assessment

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Magnitude (severity) of impact	Scale / extent of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Table 2: Impact ranking

Probability	Duration
5 - Definite/don't know (100% change)	5 - Permanent
4 - Highly probable (60-90% change)	4 - Long-term (> 15 years)
3 - Medium probability (40-60% change)	3 - Medium-term (8-15 years)
2 - Low probability (5-40% change)	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 – Improbable (< 5% change)	1 – Immediate
0 - None	

SCALE	MAGNITUDE
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (probability + duration + scale) x magnitude

The maximum value is 150 significance points (SP). The impact significance was then rated as follows:

Table 3: Significance evaluation

Significance Points	**Significance Rating**	**Decision making**
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.

4. SURVEY RESULTS

4.1 Soil

The soil Form and Family classified at each observation point was symbolized and manually grouped into sections displaying similar soil properties and shown as soil types on the soil maps Figures 3-6.

4.1.1 Soils along the collection pipeline route

The dominant soil types along the collection pipeline route are shown in Figure 3 and the soil properties are summarised in the soils legend, Table 4 in terms of the dominant and subdominant soil forms and families, average effective soil depth, a broad description of the dominant soil form, the agricultural potential, the land capability, the length of the section, the number of sections and the percentage comprised by each section.

The soils are broadly discussed in 4 categories namely well-drained soils, disturbed soils, imperfectly to poorly-drained soils and soils at the footprint of semi-permanent infrastructure.

4.1.1.1 Well-drained soils

Well-drained soils with little or no disturbance were dominated by red and yellow-brown loamy sand to sandy loam soils. The dominant soil types were symbolized as Hu1, Cv1, Cv2, Cv3 and Av1.

Soil type Hu1 is dominated by the Hutton 2100 soil Form and Family and consists of deep, red, sandy loam arable soils with high agricultural potential comprising 10.65% or 5178m of the route (9 sections).

Soil types Cv1, Cv2 and Cv3 is dominated by the Clovelly 2100 and 1100 soil Form and Families and consists of shallow to deep, yellow-brown, loamy sand to sandy loam soils differentiated based on effective soil depth. Soil types Cv1 consists of deep arable soils with moderate to high agricultural potential comprising 18.47% or 8986 m of the route (8 sections). Soil types Cv2 consists of moderately deep arable soils with moderate agricultural potential comprising 17.85% or 8687 m of the route (13 sections). Soil types Cv3 consists of shallow soils rated as grazing potential comprising 3.437% or 1671 m of the route (3 sections).

Soil type Av1 is dominated by the Avalon 1100 soil Form and Family and consists of moderately deep, yellow-brown loamy sand to sandy loam arable soils with moderate agricultural potential comprising 0.85% or 4148m of the route (1 section).

4.1.1.2 Disturbed soils

Disturbed soils were described in 3 broad categories based on type of disturbances and symbolised as Wb-R, ML and Dist.

Soil type Wb-R consists of rehabilitated land which was previously mined by opencast methods. The spoil material (waste rock and discard material) were levelled, covered with stored topsoil and seeded with a grass mixture. Soil type Wb-R is dominated by the Witbank 1000 soil Form and Family and consists of shallow to moderately deep, yellow-brown and red, loamy sand soils underlain by coaliferous material. The post-mining land capability of these soils were predominantly classified as grazing with moderate to low agricultural potential and comprises 8.81% or 4290 m of the route (6 sections).

Soil type ML consists of currently mined areas (no topsoil) or areas mainly disturbed by mining related activities which could be rehabilitated to some extent. Some areas are still occupied by mining infrastructure such as roads, loading zones etc. These sections are dominated by the Witbank 1000 soil Form and Family and consist of shallow, disturbed, yellow-brown, loamy sand soils of which the current land capability was classified as wilderness with low agricultural potential comprising 15.07% or 7337 m of the route (10 sections). Sporadic occurrences of undisturbed soils do occur (soil types Cv and Hu).

Soil type Dist consists of areas mainly disturbed by various smaller, non-mining related activities although some could be mined areas. In these sections the natural soil horizon sequences of the A- and B-horizons are disturbed although the topsoil are mostly not completely removed such as diggings, eroded areas, footprints of demolished infrastructure and partly excavated areas. These sections are dominated by the Witbank 1000 soil Form and Family and consist of shallow, disturbed, yellow-brown, loamy sand soils of which the current land capability was classified as wilderness with low agricultural potential comprising 18.41% or 8959 m of the route (19 sections). Sporadic occurrences of undisturbed soils do occur (soil types Cv and Hu).

4.1.1.3 Imperfectly and poorly-drained soils (Hydromorphic soils)

Imperfectly drained soils were dominated by grey, leached, sandy soils symbolized as soil types Fw and Lo.

Soil type Fw is dominated by the Fernwood 1110 soil Form and Family and consists of deep, grey, sandy soils underlain by weathered rock. The grey colour is evidence of removal of soluble constituents and minerals by percolating groundwater. The land capability was classified as temporary wetland with low agricultural potential comprising 2.67% or 1304m of the route (4 sections).

Soil type Lo is dominated by the Longlands 1000 soil Form and Family and consists of shallow, grey, sandy soils underlain by soft plinthite. The grey colour is evidence of removal of soluble constituents and minerals by percolating groundwater and the plinthic horizon is the result of periodic fluctuating water tables. The land capability was classified as seasonal wetland with low agricultural potential comprising 2.44% or 1189 m of the route (4 sections).

Poorly-drained soils are dominated by the grey saturated soils underlain by clay symbolized as soil type Ka.

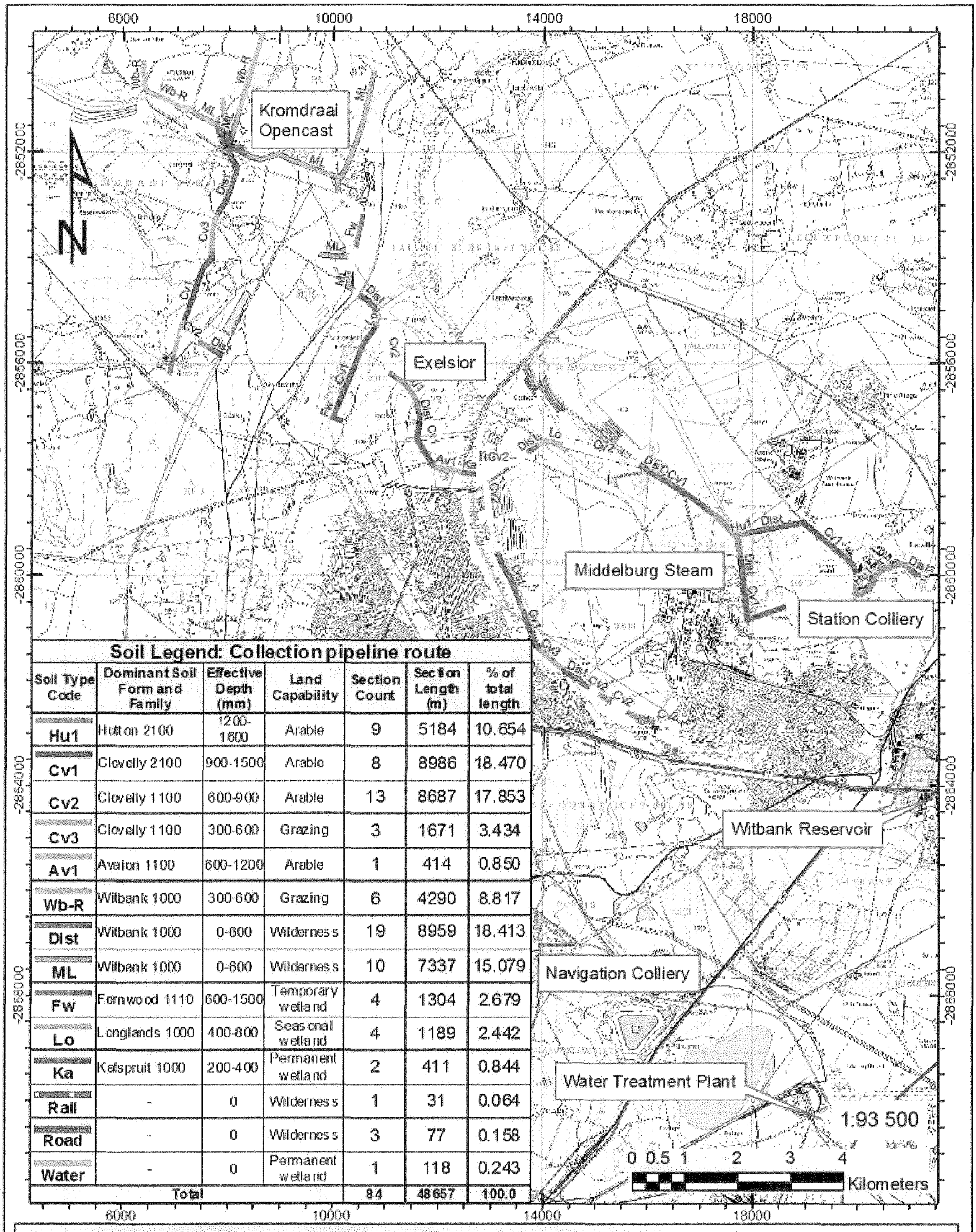
Soil type Ka is dominated by the Katspruit 1000 soil Form and Family and consists of shallow, grey, clay loam soils underlain by gleyed clay. The grey, gleyed clay layer is evidence of long term to permanent saturated soil conditions. The land capability was classified as permanent wetland with low agricultural potential comprising 0.24% or 118 m of the route (1 section).

4.1.1.4 Soils at the footprint of semi-permanent infrastructure

Soils at the footprint of semi-permanent infrastructure such as roads, rail roads and dams were not assessed. Soils underneath such structures had already been impacted on and could have been removed or partly removed and covered with gravel and tar layers. Roads, rail roads and dams were symbolized as Road, Rail and Water respectively. Road crossings comprise 0.15% or 77 m of the route (3 sections). Rail road crossings comprise 0.06% or 31 m of the route (1 section) and water 0.24% or 118 m (1section).

Table 4: Soil legend – Collection pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Hu1	Hutton 2100	Clovelly 1100	1200-1600	Deep, reddish brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	High	9	5184	10.654
Cv1	Clovelly 2100	Avalon 1100, Glencoe 1100, Hutton 2100	900-1500	Deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate to high	8	8986	18.470
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	13	8687	17.853
Cv3	Clovelly 1100	Clovelly 1100, Hutton 1100	300-600	Shallow, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Grazing	Low	3	1671	3.434
Av1	Avalon 1100	Clovelly 1100, Glencoe 1100	600-1200	Moderately deep, moderately drained, yellow brown, loamy sand to sandy loam soils underlain by soft plinthite.	Arable	Moderate	1	414	0.850
Wb-R	Witbank 1000	-	300-600	Rehabilitated land; Shallow to moderately deep, mainly yellow brown and red, loamy sand soils underlain by coalliferous spoil material.	Grazing	Moderate to low	6	4290	8.817
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	19	8959	18.413
ML	Witbank 1000	-	0-600	Mined land with no topsoil or areas where topsoil are disturbed mainly by mining activities and could be rehabilitated to some extent (levelled only).	Wilderness	Low	10	7337	15.079
Fw	Fernwood 1110	Longlands 1000	600-1500	Seepage zone on lower midslope - Moderately deep to deep, imperfectly drianed, grey, leached soils.	Temporary wetland	Low	4	1304	2.679
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	4	1189	2.442
Ka	Katspruit 1000	Kroonstad 1000, Longlands 1000	200-400	Saturated zones in valley bottom - Shallow, grey soils underlain by gleyed clay.	Permanent wetland	Low	2	411	0.844
Rail	-	-	0	Rail road crossings - areas occupied by gravel and stone layers - soils not assessed	Wilderness	Low to none	1	31	0.064
Road	-	-	0	Road crossings - areas occupied by gravel and tar layers - soils not assessed	Wilderness	Low to none	3	77	0.158
Water	-	-	0	Dams - areas occupied by surface water - soils not assessed	Permanent wetland	Low to none	1	118	0.243
						Total	**84**	**486587**	**100.0**



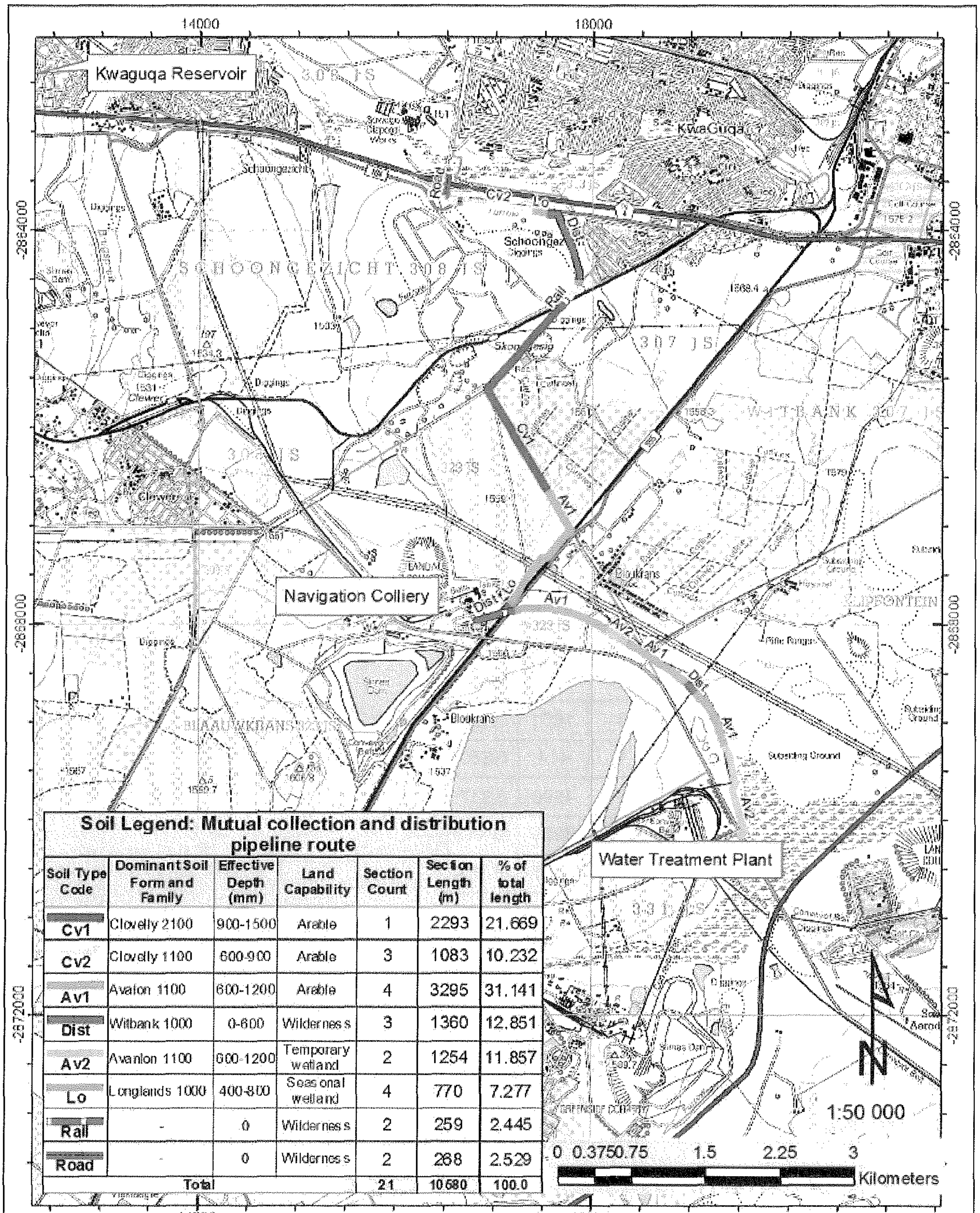
Soil Legend: Collection pipeline route

Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Section Count	Section Length (m)	% of total length
Hu1	Hutton 2100	1200-1600	Arable	9	5184	10.654
Cv1	Clovelly 2100	900-1500	Arable	8	8986	18.470
Cv2	Clovelly 1100	600-900	Arable	13	8687	17.853
Cv3	Clovelly 1100	300-600	Grazing	3	1671	3.434
Av1	Avalon 1100	600-1200	Arable	1	414	0.850
Wb-R	Witbank 1000	300-600	Grazing	6	4290	8.817
Dist	Witbank 1000	0-600	Wilderness	19	8959	18.413
ML	Witbank 1000	0-600	Wilderness	10	7337	15.079
Fw	Fernwood 1110	600-1500	Temporary wetland	4	1304	2.679
Lo	Longlands 1000	400-800	Seasonal wetland	4	1189	2.442
Ka	Katspruit 1000	200-400	Permanent wetland	2	411	0.844
Rail	-	0	Wilderness	1	31	0.064
Road	-	0	Wilderness	3	77	0.158
Water	-	0	Permanent wetland	1	118	0.243
Total				84	48657	100.0

Figure 3: Soils along the proposed collection pipeline route
(Excludes the mutual route section where the collection and distribution pipeline runs together)

4.1.2 Soils along the proposed mutual collection and distribution pipeline route

The dominant soil types along the mutual collection and distribution pipeline route are shown in Figure 4 and the soil properties are summarised in the soils legend, Table 5 in terms of the dominant and subdominant soil forms and families, average effective soil depth, a broad description of the dominant soil form, the agricultural potential, the land capability, the length of the section, the number of sections and the percentage comprised by each section.



Soil Legend: Mutual collection and distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Section Count	Section Length (m)	% of total length
Cv1	Clovelly 2100	900-1500	Arable	1	2293	21.669
Cv2	Clovelly 1100	600-900	Arable	3	1083	10.232
Av1	Avalon 1100	600-1200	Arable	4	3295	31.141
Dist	Witbank 1000	0-600	Wilderness	3	1360	12.851
Av2	Avanlon 1100	600-1200	Temporary wetland	2	1254	11.857
Lo	Longlands 1000	400-800	Seasonal wetland	4	770	7.277
Rail	-	0	Wilderness	2	259	2.445
Road	-	0	Wilderness	2	268	2.529
Total				21	10580	100.0

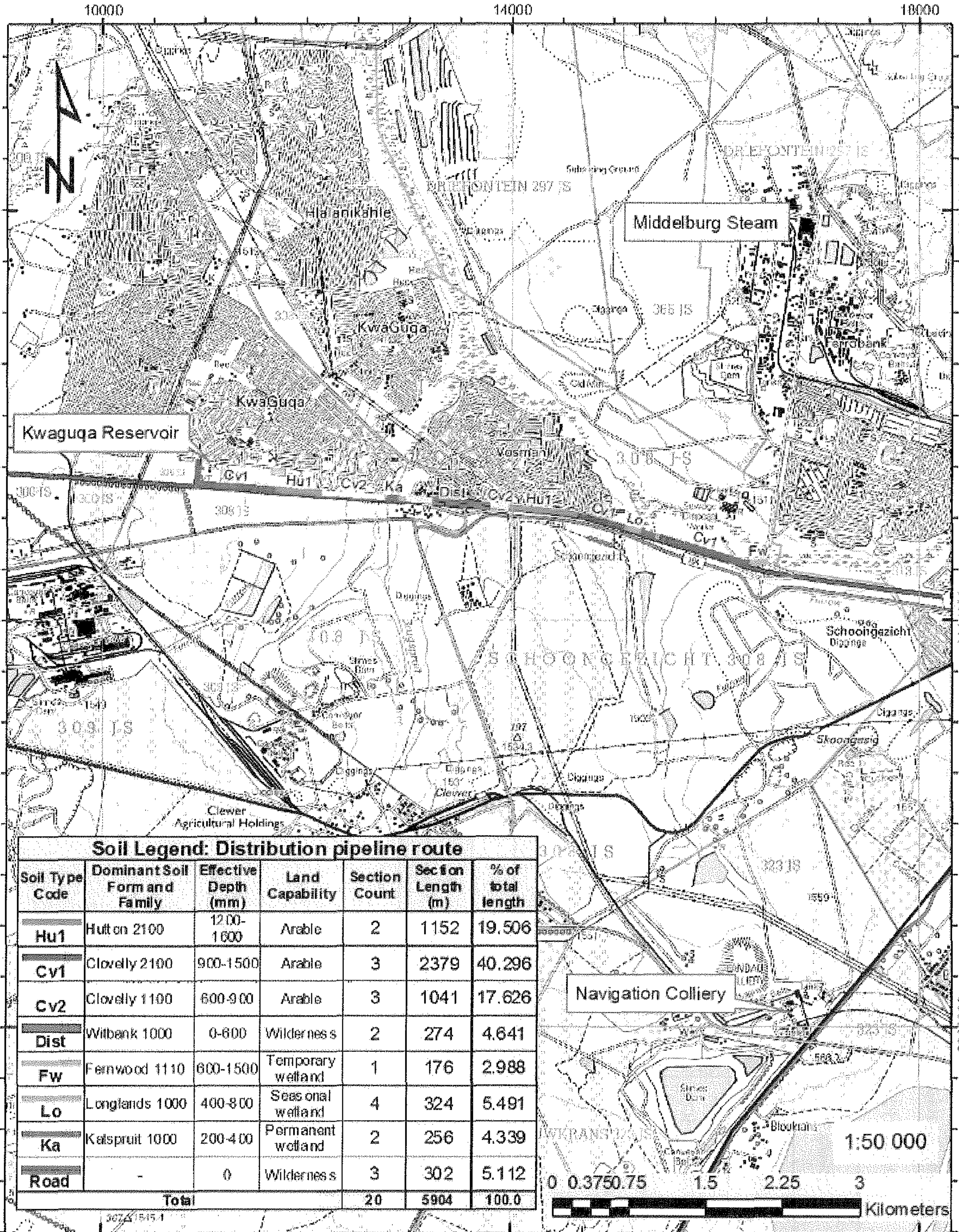
Figure 4: Soils along the proposed mutual collection and distribution pipeline route

Table 5: Soil legend – Mutual collection and distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Cv1	Clovelly 2100	Avalon 1100, Glencoe 1100, Hutton 2100	900-1500	Deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate to high	1	2293	21.669
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	3	1083	10.232
Av1	Avalon 1100	Clovelly 1100, Glencoe 1100	600-1200	Moderately deep, moderately drained, yellow brown, loamy sand to sandy loam soils underlain by soft plinthite.	Arable	Moderate	4	3295	31.141
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	3	1360	12.851
Av2	Avalon 1100	Fernwood 1110, Glencoe 1100, Longlands 1000	600-1200	Moderately deep to deep , imperfectly drained yellow brown, loamy sand soils, underlain by soft plinthite subject to wetness which might be human induced	Temporary wetland	Low	2	1254	11.857
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	4	770	7.277
Rail	-	-	0	Rail road crossings - areas occupied by gravel and stone layers - soils not assessed	Wilderness	Low to none	2	259	2.445
Road	-	-	0	Road crossings - areas occupied by gravel and tar layers - soils not assessed	Wilderness	Low to none	2	268	2.529
						Total	**21**	**105820**	**100.001.0**

4.1.3 Soils along the proposed distribution pipeline route

The dominant soil types along the distribution pipeline route are shown in Figure 5 and the soil properties are summarised in the soils legend, Table 6 in terms of the dominant and subdominant soil forms and families, average effective soil depth, a broad description of the dominant soil form, the agricultural potential, the land capability, the length of the section, the number of sections and the percentage comprised by each section.



Soil Legend: Distribution pipeline route						
Soil Type Code	**Dominant Soil Form and Family**	**Effective Depth (mm)**	**Land Capability**	**Section Count**	**Section Length (m)**	**% of total length**
Hu1	Hutton 2100	1200-1600	Arable	2	1152	19.506
Cv1	Clovelly 2100	900-1500	Arable	3	2379	40.296
Cv2	Clovelly 1100	600-900	Arable	3	1041	17.626
Dist	Witbank 1000	0-600	Wilderness	2	274	4.641
Fw	Fernwood 1110	600-1500	Temporary wetland	1	176	2.988
Lo	Longlands 1000	400-800	Seasonal wetland	4	324	5.491
Ka	Katspruit 1000	200-400	Permanent wetland	2	256	4.339
Road	-	0	Wilderness	3	302	5.112
Total				20	5904	100.0

Figure 5: Soils along the proposed distribution pipeline route

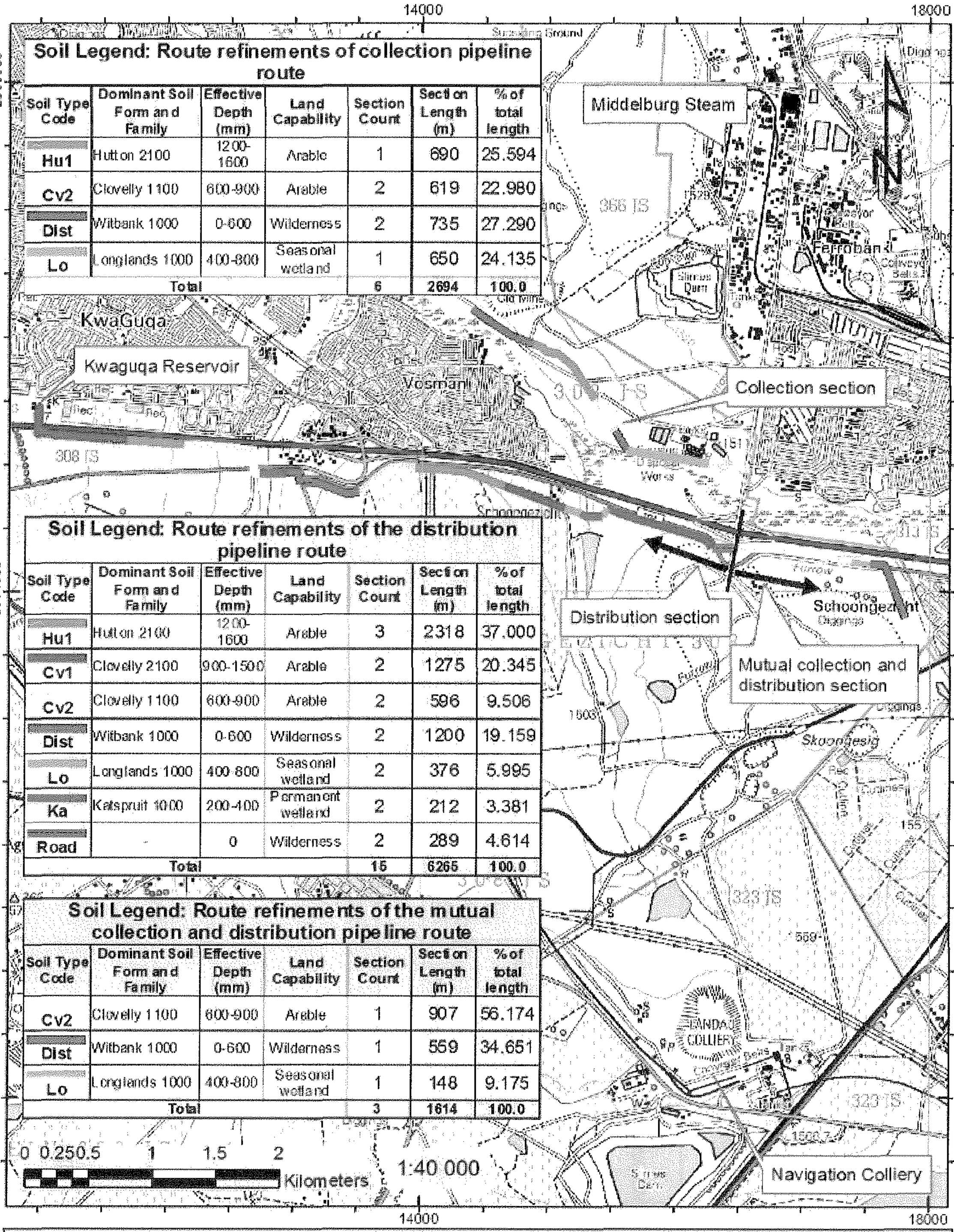
(Excludes the mutual section where the collection and distribution pipeline runs together)

Table 6: Soil legend – Distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Hu1	Hutton 2100	Clovelly 1100	1200-1600	Deep, reddish brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	High	2	1152	19.506
Cv1	Clovelly 2100	Avalon 1100, Glencoe 1100, Hutton 2100	900-1500	Deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate to high	3	2379	40.296
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	3	1041	17.626
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	2	274	4.641
Fw	Fernwood 1110	Longlands 1000	600-1500	Seepage zone on lower midslope - Moderately deep to deep, imperfectly drianed, grey, leached soils.	Temporary wetland	Low	1	176	2.988
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	4	324	5.491
Ka	Katspruit 1000	Kroonstad 1000, Longlands 1000	200-400	Saturated zones in valley bottom - Shallow, grey soils underlain by gleyed clay.	Permanent wetland	Low	2	256	4.339
Road	-	-	0	Road crossings - areas occupied by gravel and tar layers - soils not assessed	Wilderness	Low to none	3	302	5.112
						Total	**20**	**5904**	**100.0**

4.1.4 Soils along the proposed route refinements

The dominant soil types along the 3 route refinements sections are shown in Figure 6 and the soil properties are summarised in the soils legends, Tables 7, 8 and 9 in terms of the dominant and subdominant soil forms and families, average effective soil depth, a broad description of the dominant soil form, the agricultural potential, the land capability, the length of the section, the number of sections and the percentage comprised by each section.



Soil Legend: Route refinements of collection pipeline route

Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Section Count	Section Length (m)	% of total length
Hu1	Hutton 2100	1200-1600	Arable	1	690	25.594
Cv2	Clovelly 1100	600-900	Arable	2	619	22.980
Dist	Witbank 1000	0-600	Wilderness	2	735	27.290
Lo	Longlands 1000	400-800	Seasonal wetland	1	650	24.135
Total				6	2694	100.0

Soil Legend: Route refinements of the distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Section Count	Section Length (m)	% of total length
Hu1	Hutton 2100	1200-1600	Arable	3	2318	37.000
Cv1	Clovelly 2100	900-1500	Arable	2	1275	20.345
Cv2	Clovelly 1100	600-900	Arable	2	596	9.506
Dist	Witbank 1000	0-600	Wilderness	2	1200	19.159
Lo	Longlands 1000	400-800	Seasonal wetland	2	376	5.995
Ka	Katspruit 1000	200-400	Permanent wetland	2	212	3.381
Road	-	0	Wilderness	2	289	4.614
Total				15	6265	100.0

Soil Legend: Route refinements of the mutual collection and distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Section Count	Section Length (m)	% of total length
Cv2	Clovelly 1100	600-900	Arable	1	907	56.174
Dist	Witbank 1000	0-600	Wilderness	1	559	34.651
Lo	Longlands 1000	400-800	Seasonal wetland	1	148	9.175
Total				3	1614	100.0

Figure 6: Soils along proposed route refinements of the collection, distribution and mutual collection and distribution pipeline routes

Table 7: Soil legend – Route refinements along the collection pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Hu1	Hutton 2100	Clovelly 1100	1200-1600	Deep, reddish brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	High	1	690	25.594
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	2	619	22.980
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	2	735	27.290
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	1	650	24.135
						Total	**6**	**2694**	**100.0**

Table 8: Soil legend – Route refinements along the mutual collection and distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	1	907	56.174
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	1	559	34.651
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	1	148	9.175
						Total	**3**	**1614**	**100.0**

26

Table 9: Soil legend – Route refinements along the distribution pipeline route

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
Hu1	Hutton 2100	Clovelly 1100	1200-1600	Deep, reddish brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	High	3	2318	37.000
Cv1	Clovelly 2100	Avalon 1100, Glencoe 1100, Hutton 2100	900-1500	Deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate to high	2	1275	20.345
Cv2	Clovelly 1100	Avalon 1100, Glencoe 1100, Hutton 2100	600-900	Moderately deep, yellow brown, well-drained, sandy loam soils, underlain by weathered or hard rock.	Arable	Moderate	2	596	9.506
Dist	Witbank 1000	Clovelly 1100, Hutton 1100, Avalon 1100	0-600	Areas where soils are disturbed mainly by non-mining related activities such as loading zones, trenches, diggings, partly excavated areas, eroded areas and footprints of demolished infrastructure.	Wilderness	Low	2	1200	19.159
Lo	Longlands 1000	Fernwood 1110, Wasbank 1000, Kroonstad	400-800	Seepage zone on lower footslope - Moderately deep, grey, leached soils underlain by soft plinthite	Seasonal wetland	Low	2	376	5.995
Ka	Katspruit 1000	Kroonstad 1000, Longlands 1000	200-400	Saturated zones in valley bottom - Shallow, grey soils underlain by gleyed clay.	Permanent wetland	Low	2	212	3.381
Road	-	-	0	Road crossings - areas occupied by gravel and tar layers - soils not assessed	Wilderness	Low to none	2	289	4.614
						Total	**15**	**62665**	**100.0**

4.2 Land capability and agricultural potential classification

The land capability and agricultural potential of soils was classified according to guidelines specified in section 3.5.

The land capability and agricultural potential of each soil type per route section e.g. collection route, mutual collection and distribution route, distribution route as well as the 3 route refinement sections are already given in the soil legends, Tables 4-9. The land capability of the 3 route sections mentioned above was therefore combined and shown in Figure 7 and summarised in Table 10. The land capability of the 3 route refinements was combined in Figure 8 and summarised in Table 11.

The land capability and agricultural potential per soil types were classified as follows:

4.2.1 Arable

Soil type Hu1, consisting of deep (>1200 mm), well-drained, sandy loam soils was classified as arable soils with high agricultural potential. Soil type Cv1 consisting of deep (900-1500 mm), well-drained, sandy loam soils was classified as arable soils with moderate to high agricultural potential. Soil type Cv2 consisting of moderately deep (600-900 mm), well-drained, sandy loam soils was classified as arable soils with moderate agricultural potential. Soil type Av1 consisting of moderately deep (600-900 mm), moderately-drained, sandy loam soils was classified as arable soils with moderate agricultural potential.

4.2.2 Grazing

Soil type Cv3 consisting of shallow (300-600 mm), well-drained, sandy loam soils was classified as grazing land capability with low agricultural potential. Soil type Wb-R consisting of rehabilitated land with shallow (300-700 mm), well-drained, loamy sand soils was classified as grazing land capability with moderate to low agricultural potential.

4.2.3 Wetland

Soil types Fw, and Av2 consisting of deep, imperfectly-drained, sandy soils on lower midslopes was classified as temporary wetland zones with low agricultural potential. Soil type Lo, consisting of moderately deep, imperfectly-drained, sandy soils on footslopes and valley bottoms was classified as seasonal wetland zones with low agricultural potential. Soil type Ka, consisting of shallow, poorly-drained, clay loam soils in valley bottoms was classified as permanent wetland zones with low agricultural potential.

4.2.4 Wilderness

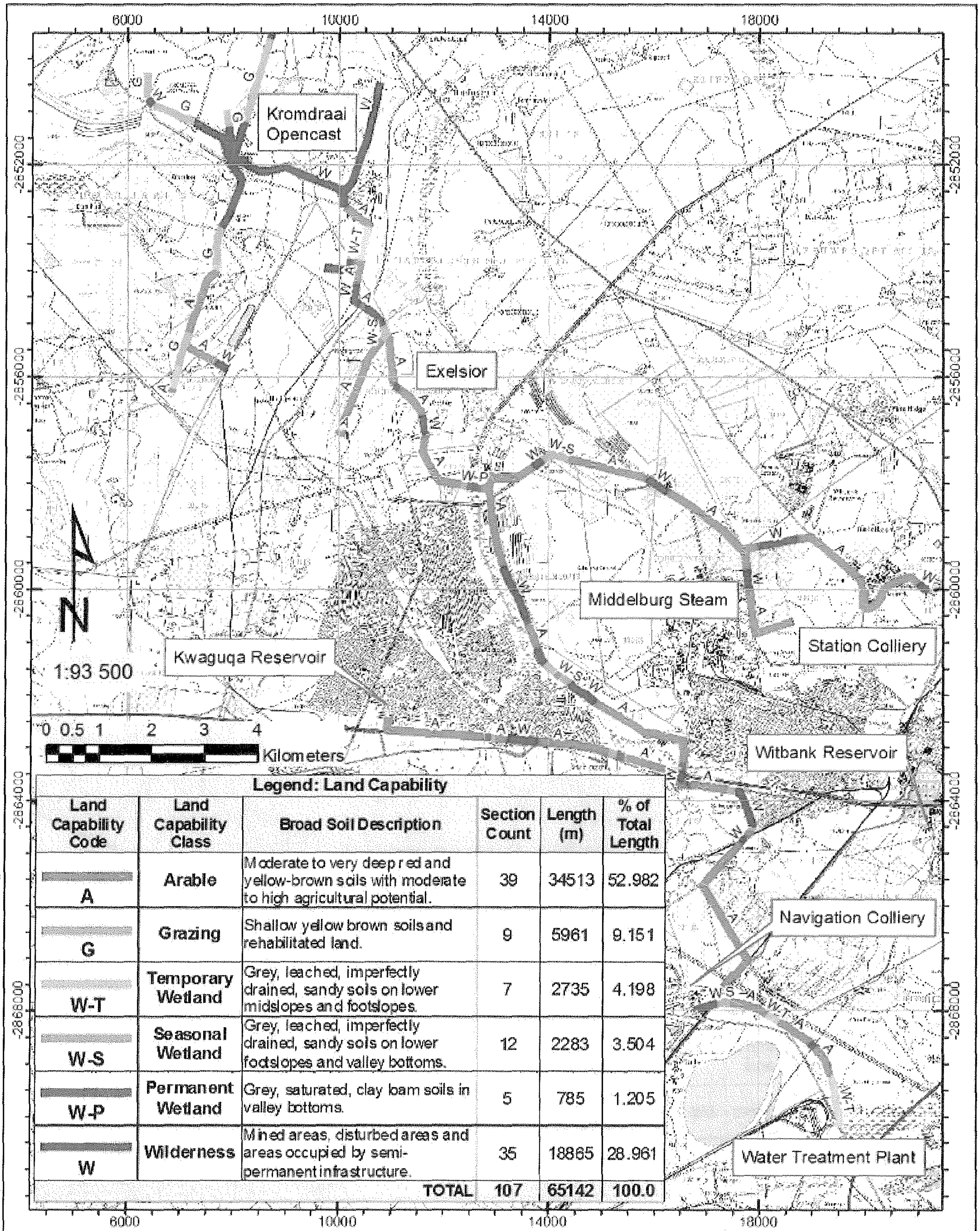
Soil types Dist and ML consisting of mining related and other disturbed areas such as mined areas, excavated or partly excavated areas, diggings, trenches, eroded areas and footprints of demolished infrastructure were classified as Wilderness. The footprint or area occupied by existing semi-permanent infrastructure symbolised as Road, Rail and Water were also classified as wilderness.

Table 10: Land capability of soils along the collection, mutual collection and distribution and distribution pipeline route

Land Capability Code	Land Capability Class	*Soil Types	Broad Soil Description	Section Count	Length (m)	% of Total Length
A	**Arable**	Hu1, Cv1, Cv2, Av1	Moderate to very deep red and yellow-brown soils with moderate to high agricultural potential.	39	34513	52.982
G	**Grazing**	Cv3, Wb-R	Shallow yellow brown soils and rehabilitated land.	9	5961	9.151
W-T	**Temporary Wetland**	Fw, Av2	Grey, leached, imperfectly drained, sandy soils on lower midslopes and footslopes.	7	2735	4.198
W-S	**Seasonal Wetland**	Lo	Grey, leached, imperfectly drained, sandy soils on lower footslopes and valley bottoms.	12	2283	3.504
W-P	**Permanent Wetland**	Ka, Water	Grey, saturated, clay loam soils in valley bottoms.	5	785	1.205
W	**Wilderness**	Dist, ML, Road, Rail	Mined areas, disturbed areas and areas occupied by semi-permanent infrastructure.	35	18865	28.961
*See soil map, Figures 3-6			**Total**	**107**	**651421**	**100.001**

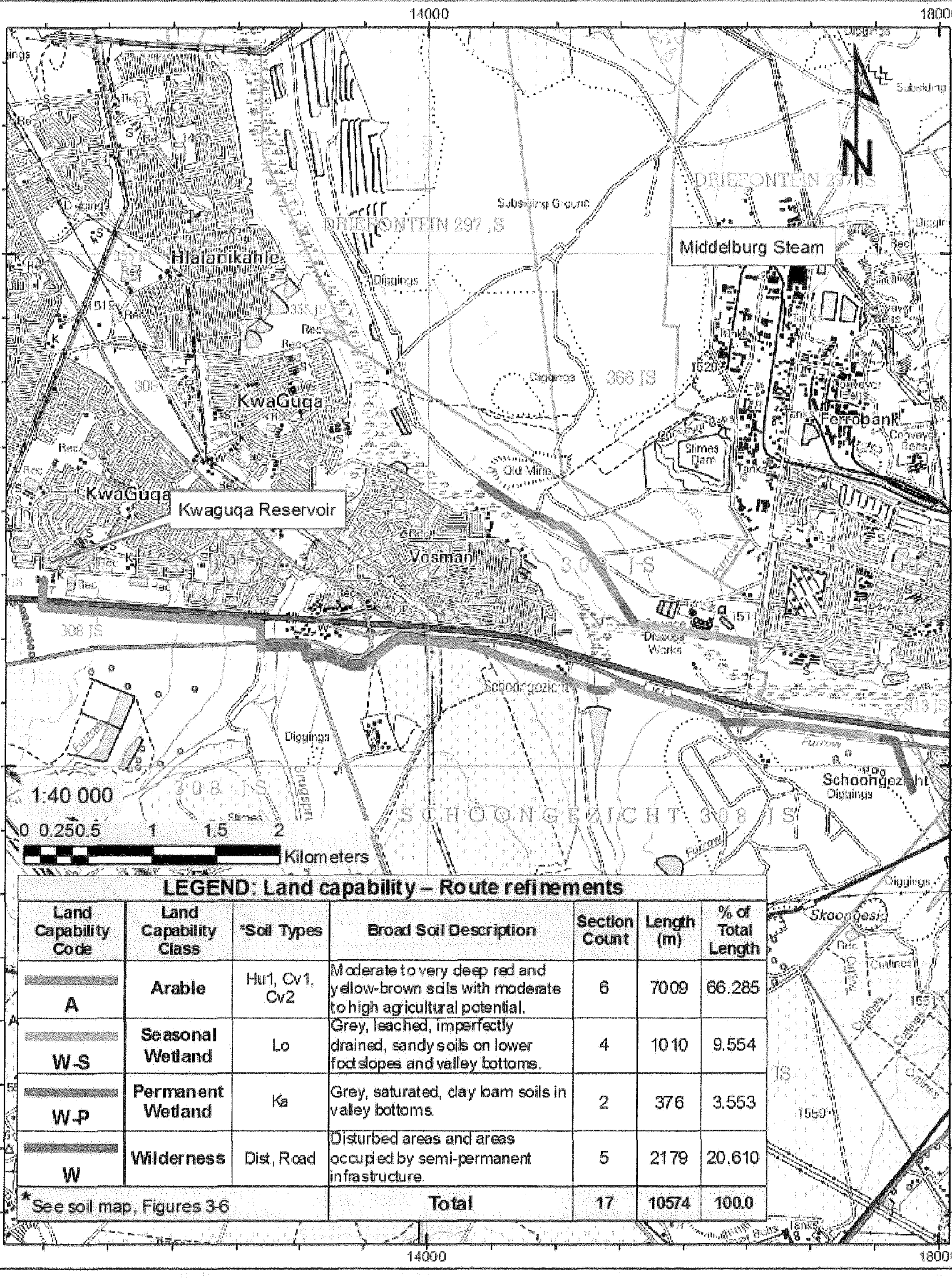
Table 11: Land capability of soils along the 3 proposed route refinement sections

LEGEND: Land capability – Route refinements						
Land Capability Code	**Land Capability Class**	***Soil Types**	**Broad Soil Description**	**Section Count**	**Length (m)**	**% of Total Length**
A	**Arable**	Hu1, Cv1, Cv2	Moderate to very deep red and yellow-brown soils with moderate to high agricultural potential.	6	7009	66.285
W-S	**Seasonal Wetland**	Lo	Grey, leached, imperfectly drained, sandy soils on lower footslopes and valley bottoms.	4	1010	9.554
W-P	**Permanent Wetland**	Ka	Grey, saturated, clay loam soils in valley bottoms.	2	376	3.553
W	**Wilderness**	Dist, Road	Disturbed areas and areas occupied by semi-permanent infrastructure.	5	2179	20.610
*See soil map, Figures 3-6			**Total**	**17**	**10574**	**100.002**



Legend: Land Capability					
Land Capability Code	Land Capability Class	Broad Soil Description	Section Count	Length (m)	% of Total Length
A	Arable	Moderate to very deep red and yellow-brown soils with moderate to high agricultural potential.	39	34513	52.982
G	Grazing	Shallow yellow brown soils and rehabilitated land.	9	5961	9.151
W-T	Temporary Wetland	Grey, leached, imperfectly drained, sandy soils on lower midslopes and footslopes.	7	2735	4.198
W-S	Seasonal Wetland	Grey, leached, imperfectly drained, sandy soils on lower footslopes and valley bottoms.	12	2283	3.504
W-P	Permanent Wetland	Grey, saturated, clay loam soils in valley bottoms.	5	785	1.205
W	Wilderness	Mined areas, disturbed areas and areas occupied by semi-permanent infrastructure.	35	18865	28.961
		TOTAL	107	65142	100.0

Figure 7: Land Capability along the proposed collection, mutual collection and distribution and distribution pipeline route



LEGEND: Land capability – Route refinements						
Land Capability Code	Land Capability Class	*Soil Types	Broad Soil Description	Section Count	Length (m)	% of Total Length
A	Arable	Hu1, Cv1, Cv2	Moderate to very deep red and yellow-brown soils with moderate to high agricultural potential.	6	7009	66.285
W-S	Seasonal Wetland	Lo	Grey, leached, imperfectly drained, sandy soils on lower footslopes and valley bottoms.	4	1010	9.554
W-P	Permanent Wetland	Ka	Grey, saturated, clay loam soils in valley bottoms.	2	376	3.553
W	Wilderness	Dist, Road	Disturbed areas and areas occupied by semi-permanent infrastructure.	5	2179	20.610
*See soil map, Figures 3-6			Total	17	10574	100.0

Figure 8: Land Capability of soils along the 3 proposed route refinement sections

4.3 Land Use

4.3.1 Land uses along the collection, mutual collection/distribution and distribution route

The current land uses along the proposed route are fairly insignificant and summarized in Table 12 and shown on Figure 9. The majority of the route, symbolized as **V-M** (45.5%) are situated within vacant mine property which are fenced off or barricaded by trenches and no specific land uses is taking place. Sections symbolized as **V-G** are areas that could be vacant or grazed from time to time by local farmers. Sections symbolizes as **ML** are currently mine land and **MI** are areas partly occupied by mining infrastructure. Sections of the route along the edge of maize fields and patches of bluegum trees are symbolized as **M** and **BT** respectively. Sections in-between roads and residential areas are probably not utilized at all and are symbolized as **V-R**. A section along the edge of the sewage disposal works was symbolized as **SDW**. Road and rail road crossings were symbolized as **R** and **RR** respectively. A section of the route crossing a local dam was symbolized a **D**.

Table 12: Land uses along the collection, mutual collection/distribution and distribution route

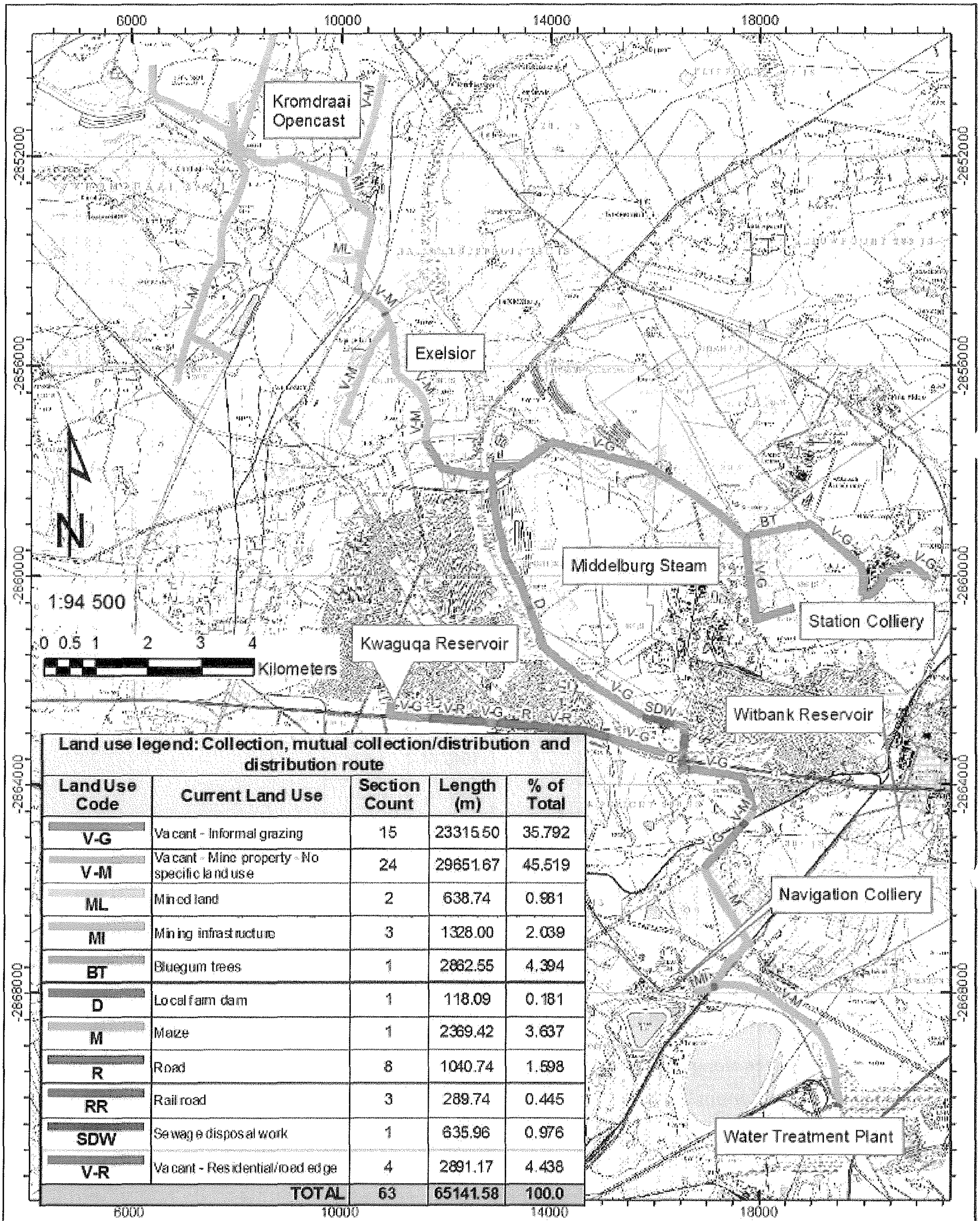
Land Use Code	Current Land Use	Section Count	Length (m)	% of Total
V-G	Vacant - Informal grazing	15	23315.50	35.792
V-M	Vacant - Mine property - No specific land use	24	29651.67	45.519
ML	Mined land	2	638.74	0.981
MI	Mining infrastructure	3	1328.00	2.039
BT	Bluegum trees	1	2862.55	4.394
D	Local farm dam	1	118.09	0.181
M	Maize	1	2369.42	3.637
R	Road	8	1040.74	1.598
RR	Rail road	3	289.74	0.445
SDW	Sewage disposal work	1	635.96	0.976
V-R	Vacant - Residential/road edge	4	2891.17	4.438
	TOTAL	63	65141.58	100.0

4.3.2 Land uses along the proposed route refinements

Land uses along the proposed route refinements is given in Table 13 and shown in Figure 10.

Table 13: Land uses along the 3 proposed route refinements

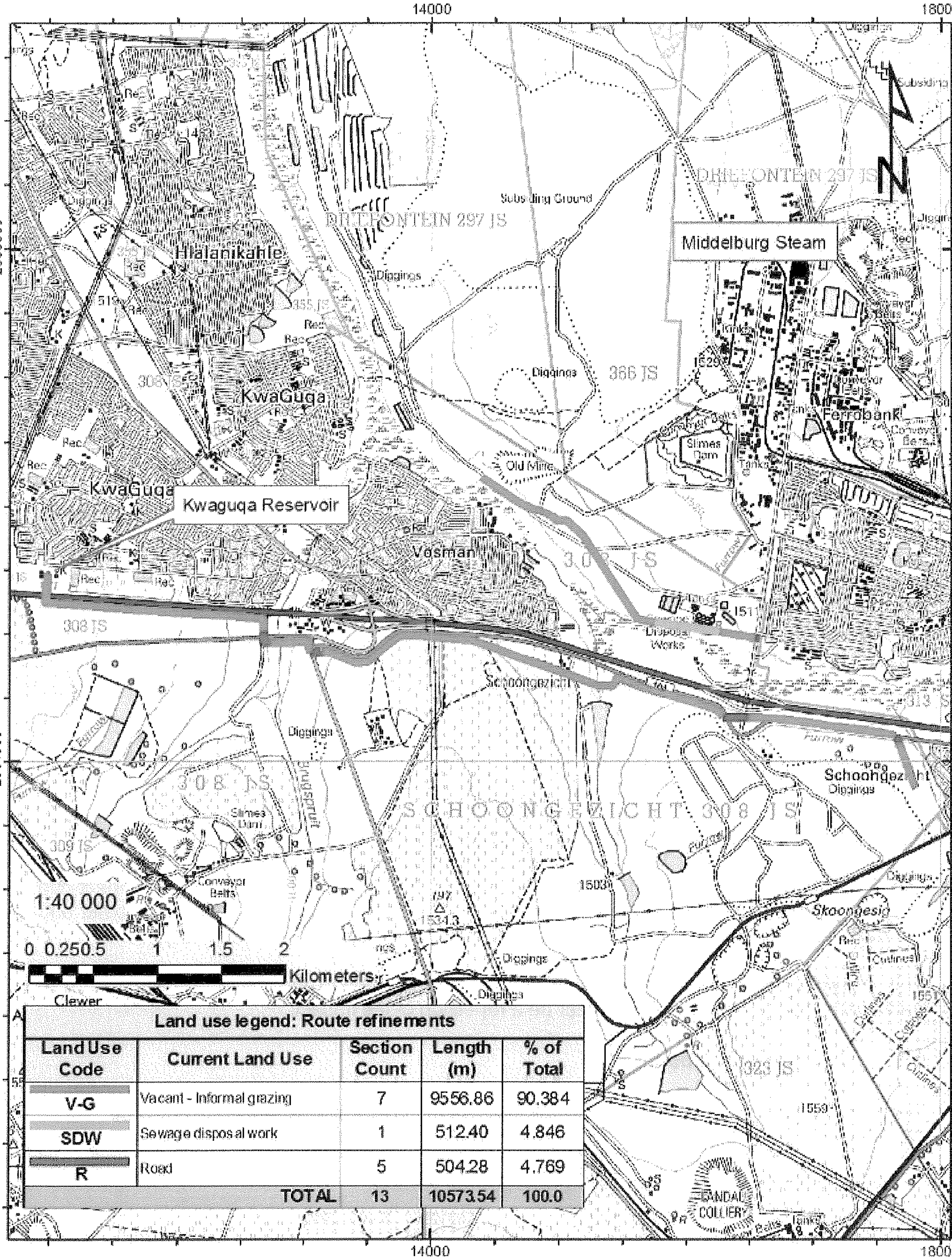
Land Use Code	Current Land Use	Section Count	Length (m)	% of Total
V-G	Vacant - Informal grazing	7	9556.86	90.384
SDW	Sewage disposal work	1	512.40	4.846
R	Road	5	504.28	4.769
	TOTAL	13	10573.54	100.0



Land use legend: Collection, mutual collection/distribution and distribution route

Land Use Code	Current Land Use	Section Count	Length (m)	% of Total
V-G	Vacant - Informal grazing	15	23315.50	35.792
V-M	Vacant - Mine property - No specific land use	24	29651.67	45.519
ML	Mined land	2	638.74	0.981
MI	Mining infrastructure	3	1328.00	2.039
BT	Bluegum trees	1	2862.55	4.394
D	Local farm dam	1	118.09	0.181
M	Maize	1	2369.42	3.637
R	Road	8	1040.74	1.598
RR	Rail road	3	289.74	0.445
SDW	Sewage disposal work	1	635.96	0.976
V-R	Vacant - Residential/road edge	4	2891.17	4.438
	TOTAL	**63**	**65141.58**	**100.0**

Figure 9: Land use along the proposed collection, mutual collection/distribution and distribution pipeline route



Land Use Code	Current Land Use	Section Count	Length (m)	% of Total
Land use legend: Route refinements				
V-G	Vacant - Informal grazing	7	9556.86	90.384
SDW	Sewage disposal work	1	512.40	4.846
R	Road	5	504.28	4.769
	TOTAL	**13**	**10573.54**	**100.0**

Figure 10: Land use along the 3 proposed route refinement sections

5. IMPACT ASSESSMENT

5.1 Construction phase

During the construction phase trenches will be dug, the pipe will be laid and the trenches will be closed after a while. This will cause the natural functioning of the soil in terms of a growth medium and habitat for fauna and flora to cease as long as the trenches are open. If the trenches are deeper than 1.5 m the subsoil or underlying rock material will be penetrated at shallow sections which creates the possibility of topsoil and subsoil to be mixed. The topsoil on rehabilitated sections is shallow and trenches will definitely penetrates the low quality spoil (coaliferous) material. Mixing this material with the topsoil during backfill of the trenches will cause coal related salt pollution to the topsoil.

Table 14: Impact assessment during construction phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Digging of trenches – disturbance of natural soil profile and horizon sequences	Soil	8	2	1	5	64	Moderate
Mixing of topsoil with subsoil or rocky material during backfill of trenches	Soil	6	4	1	4	54	Moderate
Soil pollution with coal related salts - Mixing of topsoil with low quality spoil material during backfill of trenches on rehabilitated land	Soil	8	4	1	4	72	Moderate
Compaction by mechanical equipment	Soil	2	2	1	4	20	Low
Possible oil and fuel spillages by mechanical equipment	Soil	6	2	1	2	24	Low

The significance rating of the trenches and topsoil which will probably be mixed with subsoil or spoil material is moderate. The direction of the impact is negative and the frequency is once off although the impact will remain to some extent after rehabilitation took place. The impact can however be fairly well mitigated. The topsoil and subsoil can be place apart from each other and backfilled in the same sequence. The compaction can be remediated mechanically.

The impact will however not be reversed or alleviated during the decommissioning phase (reclamation of pipeline) but it will rather be a repetition of the impact.

5.2 Operational phase

The impact of the pipeline itself during the operational phase will be none. Leakages or bursts can however cause soil erosion and pollution by low quality mine water.

Table 15: Impact assessment during operational phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Soil pollution - Possible spillages of low quality water due to leakages or bursts	Soil	4	1	1	4	24	Low
Erosion caused by serious bursts or leakages	Soil	4	1	1	4	24	Low

The significance rating of soil contamination by low quality water is low. The direction of the impact is negative and the frequency is once off. The impact can however hardly be reversed or mitigated. Low quality water which drained into the soil profile cannot be removed or reclaimed. The mitigation will rather be constant monitoring and rapid identification and repairing of any leakages.

5.3 Decommissioning phase

Whether the pipeline will definitely be reclaimed during the decommissioning phase is probably not sure. However it will imply dinging of trenches to reclaim the pipeline, possible mixing of topsoil, subsoil and spoil material, possible spillage of oil and fuel and compaction of soils. The impact will thus not reverse or alleviated during the decommissioning phase (reclamation of pipeline) but it will rather be a repetition of the impact.

Table 16: Impact assessment during the decommissioning phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Digging of trenches – disturbance of natural soil profile and horizon sequences	Soil	8	2	1	5	64	Moderate
Mixing of topsoil with subsoil or rocky material during backfill of trenches	Soil	6	4	1	4	54	Moderate
Soil pollution with coal related salts - Mixing of topsoil with low quality spoil material during backfill of trenches on rehabilitated land	Soil	8	4	1	4	72	Moderate
Compaction by mechanical equipment	Soil	2	2	1	4	20	Low
Possible oil and fuel spillages by mechanical equipment	Soil	6	2	1	2	24	Low

The direction of the impact is negative and the frequency is once off although the impact will remain until rehabilitation takes place. It is however unknown whether the pipeline will be removed or remain for continuing use or be left in the ground.

6. MITIGATION MEASURES

6.1 Construction phase

The digging of trenches is unavoidable unless the pipeline is to be constructed above surface which will have the least impact on soils. Inspections and evaluation of the health of the pipeline as well as maintenance and repairs will also be much easier. However approximately 10 km of existing trenches occurs within 10-30 m of the current proposed route. Most of these trenches currently serve the purpose of barricading mining areas, industrial areas and dangerous zones. These trenches can be made deeper and filled back to the current level to maintain the current purpose which will result in minimal impact on soils.

At shallow sections the topsoil should be placed further from the trench and weathered rock, gravely, stony or rocky material should be placed separately (closer to the trench) in order to backfill subsoil material first without mixing with topsoil.

The above method should be applied to rehabilitated land as well. The impact of mixing coaliferous spoil material with topsoil is severe and should be avoided to all costs. It is therefore rather recommended that the spoil material should by no means be penetrated and trenches should be dug only to the depth of the spoil material. After the trench are backfilled soil can then be graded from both sides on top of the closed trench to create a berm of 300 to 500 mm high in order to provide more protection to the pipeline and which can simultaneously serve as a method to demarcate the pipeline.

Soil compaction by heavy mechanical equipment can be alleviated by ripping actions after the trenches were closed as part of the rehabilitation procedure.

Contamination due to oil and fuel spillages should be contained by strict guideline to contractors in terms of the mechanical condition of equipment used, the maintenances of equipment as well as the reporting and cleaning up procedures of spillages.

6.2 Operational phase

Small and big leakages will probably occur on any newly constructed pipeline especially if some sections might consist of reclaimed pipes. Smaller leakages on such a pipeline below the soil surface might take even weeks before it might be visible on the surface which could lead to enormous spillages. It is therefore recommended that the pipeline should be operational and all leakages repaired before backfill of the trenches takes place. Inspections should take place on a daily basis during the early operational phase until all leakages and malfunction of any related parts are sorted out. All leakages should be reported and recorded and problematic sections should be identified. Scheduled monitoring should take place afterwards based on the stability of the whole pipeline system.

The trenches should be closed shortly after the pipeline has been declared leakage free. Rehabilitation of the closed trenches should take place in spring or early summer. Soils should be loosen and leveled with a ripping and disc action and seeded with 2 or 3 annual species. No natural species which does not occur in the area should be used. The annual species will stabilize the soil in the first year while natural species establish themselves. Intensive fertilizing is not required because it is a narrow strip which can recover fairly rapidly. Lime can be applied at 1ton per ha after the ripping action and can be worked into the upper 100-150 mm of soil with the disc action. A fertilizer mixture such as 2:3:2(22) can be applied directly after seeding which should take place shortly after good rains. A second application of 100kg 232(22) can be applied after 6 weeks (after good rains).

Erosion should be monitor and stabilized as soon as possible wherever it occurs.

6.3 Decommissioning phase

The reclamation of the buried pipeline will repeat all impacts which took place during the construction phase as well as possible soil pollution all along the pipeline by low quality water which remained in the system. The system should be flushed with clean water before reclamation commences. It is however strongly recommended that should the aim is to reclaim the pipeline it should be constructed above ground.

Mitigation measures of the construction phase should be applied where applicable.

7. CONCLUSION AND RECOMMENDATIONS

In terms of soils, land capability and land use both the collection and distribution pipeline route is well planned and positioned very strategically. Following mitigation procedures as described, the impact on soils and land capability can be minimal. Almost the entire route is vacant land and no current land uses will be impacted negatively. The majority of the proposed routes are along or close to current roads which lessen impacts on soils, fauna and flora especially during the construction phase.

In general the impact by pipelines on soil, land capability, land use is fairly low. Pipelines occupy small areas of land and the impact is very site specific. Although above ground pipelines are a constant obstruction, it can be removed fairly easy and cost effectively with little permanent adverse impacts. Buried pipelines have more severe initial impacts on soils and land capability but current land uses can continue afterwards.

The impact of pipelines which are constructed on road shoulders or in road, rail road or power line servitudes are very low because it occupies land which will probably never be utilized effectively especially in terms of agricultural purposes.

Recommendations are provided as mitigation measures in section 6

The project will have a massive positive impact on the environment in terms of soil and water resources. Extremely severe soil and water pollution by decanting of low quality mine water was observed during the field assessment. By lowering the underground mine water levels, decanting will decrease land less soil and surface water recourses will be contaminated.

Considering the fairly low impact on soils, land capability and land use as well as the massive positive impact on the environment in terms of soil and water resources and subsequent impacts on fauna and flora the project should definitely continue.

Collection points and associated pipelines that will have a direct impact on the current decanting just north of eMalahleni should be constructed first.

8. ASSUMPTIONS

A 100 m buffer zone could not be surveyed due to the tight timeframes of the project. The route as indicated by the original shapefile received from Golder was surveyed and an approximate 30m zone was covered. Numerous changes were made to the route as indicated by an updated shapefile later received after the fieldwork was done. Some of these changes fall outside the surveyed 30 m buffer zone and information had to be interpolated to accommodate changes. The shapefile indicating the 3 route refinements was also receive after fieldwork was done and soil data was interpolated to accommodate the route refinements.

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Date: October 2010

REPORT

Soil, Land Capability and Land Use Assessment of the proposed extension route of the existing distribution pipeline

Addendum to the eMalahleni Mine Water Reclamation Expansion Project Report

Requested By
Golder Associates Africa (Pty) Ltd

Compiled By
Rehab Green Monitoring Consultants CC
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CONTENTS

		Page
I.	EXECUTIVE SUMMARY	4
1.	INTRODUCTION	5
1.1	Project background	5
2	STUDY AIMS AND OBJECTIVES	6
3.	METHODOLOGY	6
3.1	Field preparation	6
3.2	Soil classification	6
3.3	Soil sampling and analyses	7
3.4	Land capability and agricultural potential classification	7
3.5	Land use mapping	7
3.6	Map compilations	7
3.7	Impact assessment	8
4.	SURVEY RESULTS	10
4.1	Soil	10
4.1.1	Soils along the proposed extension of the distribution pipeline route	10
4.2	Land capability and agricultural potential classification	12
4.3	Land use	12
5.	IMPACT ASSESSMENT	12
5.1	Construction phase	12
5.2	Operational phase	13
5.3	Decommissioning phase	13
6.	MITIGATION MEASURES	13
6.1	Construction phase	13
6.2	Operational phase	14
6.3	Decommissioning phase	14
7.	CONCLUSION AND RECOMMENDATIONS	14

REFERENCES

TABLES:

Table 1	Significance assessment	8
Table 2	Impact ranking	8
Table 3	Significance evaluation	9
Table 4	Soil legend - distribution pipeline extension	10
Table 5	Impact assessment during construction phase	12
Table 6	Impact assessment during operational phase	13
Table 7	Impact assessment during the decommissioning phase	13

FIGURES:

Figure 1	Location of reservoir B, D and A	5
Figure 2	Soils along the proposed distribution pipeline extension route stretching from reservoir B to reservoir A via reservoir D	11

I. EXECUTIVE SUMMARY

This report is an addendum to the eMahleni Mine Water Reclamation soils report (Rehab Green cc, Report No RG/2009/12/02/1, July 2010) to accommodate an additional route distribution pipeline.

The distribution pipeline runs from Witbank Reservoir (Reservoir B) just south of the N4 highway to Reservoir A via Reservoir D. The new distribution pipeline will be extended north from Reservoir B, crossing under the highway through an existing culvert, running on the western side of Woltemade Street within the existing Municipal servitude up to Christiaan de Wet Street. From there, it will turn in a north westerly direction, following Christiaan de Wet until it reaches Nicol Street. At the intersection, it will cross Christiaan de Wet Street and then Nicol Street and run on the northern side of Nicol Street until it is adjacent to Reservoir A. From there, it will cross Nicol Street once again and head towards the tie-in point to the Reservoir. The new section (from Reservoir B to Reservoir A) is 2.623 km in length and is located in the Witbank CBD within existing road reserves (Figure 1).

The report describes the soil types, the land capability and land uses along the proposed route. The field survey was conducted during April 2010. Soils along the proposed pipeline routes were assessed by means of hand auger observations at intervals varying between 150 to 600 meters.

Soil and land capability and land use

The total route consists of yellow brown, well-drained, sandy loam soils of the Witbank form of which the upper part of the soil profile is disturbed due to road construction, residential and industrial development. The soils were classified as wilderness land capability with low to no agricultural potential.

General conclusion

In general the impact by buried pipelines on soil, land capability, land use is very low especially in urban areas where soils cannot be utilized for agricultural or other purposes. Pipelines occupy small areas of land and the impact is of short term nature and can be fairly well mitigated. All current land uses can continue after the trenches are closed.

The project will have a massive positive impact on the environment in terms of soil and water resources. Extremely severe soil and water pollution by decanting low quality mine water was observed during the field assessment on the collection pipeline route. By lowering the underground mine water levels, decanting will decrease land less soil and surface water recourses will be contaminated.

Considering the low impact on soils, land capability and land use as well as the massive positive impact on the environment in terms of soil and water resources and subsequent impacts on fauna and flora the project should definitely continue.

Collection points and associated pipelines that will have a direct impact on the current decanting just north of eMalahleni should be constructed first.

1. INTRODUCTION

1.1 Project background

This report is an addendum to the eMahleni Mine Water Reclamation soils report (Rehab Green cc, Report No RG/2009/12/02/1, July 2010) to accommodate an additional route distribution pipeline.

The distribution pipeline runs from Witbank Reservoir (Reservoir B) just south of the N4 highway to Reservoir A via Reservoir D. The new distribution pipeline will be extended north from Reservoir B, crossing under the highway through an existing culvert, running on the western side of Woltemade Street within the existing Municipal servitude up to Christiaan de Wet Street. From there, it will turn in a north westerly direction, following Christiaan de Wet until it reaches Nicol Street. At the intersection, it will cross Christiaan de Wet Street and then Nicol Street and run on the northern side of Nicol Street until it is adjacent to Reservoir A. From there, it will cross Nicol Street once again and head towards the tie-in point to the Reservoir. The new section (from Reservoir B to Reservoir A) is 2.623 km in length and is located in the Witbank CBD within existing road reserves (Figure 1).

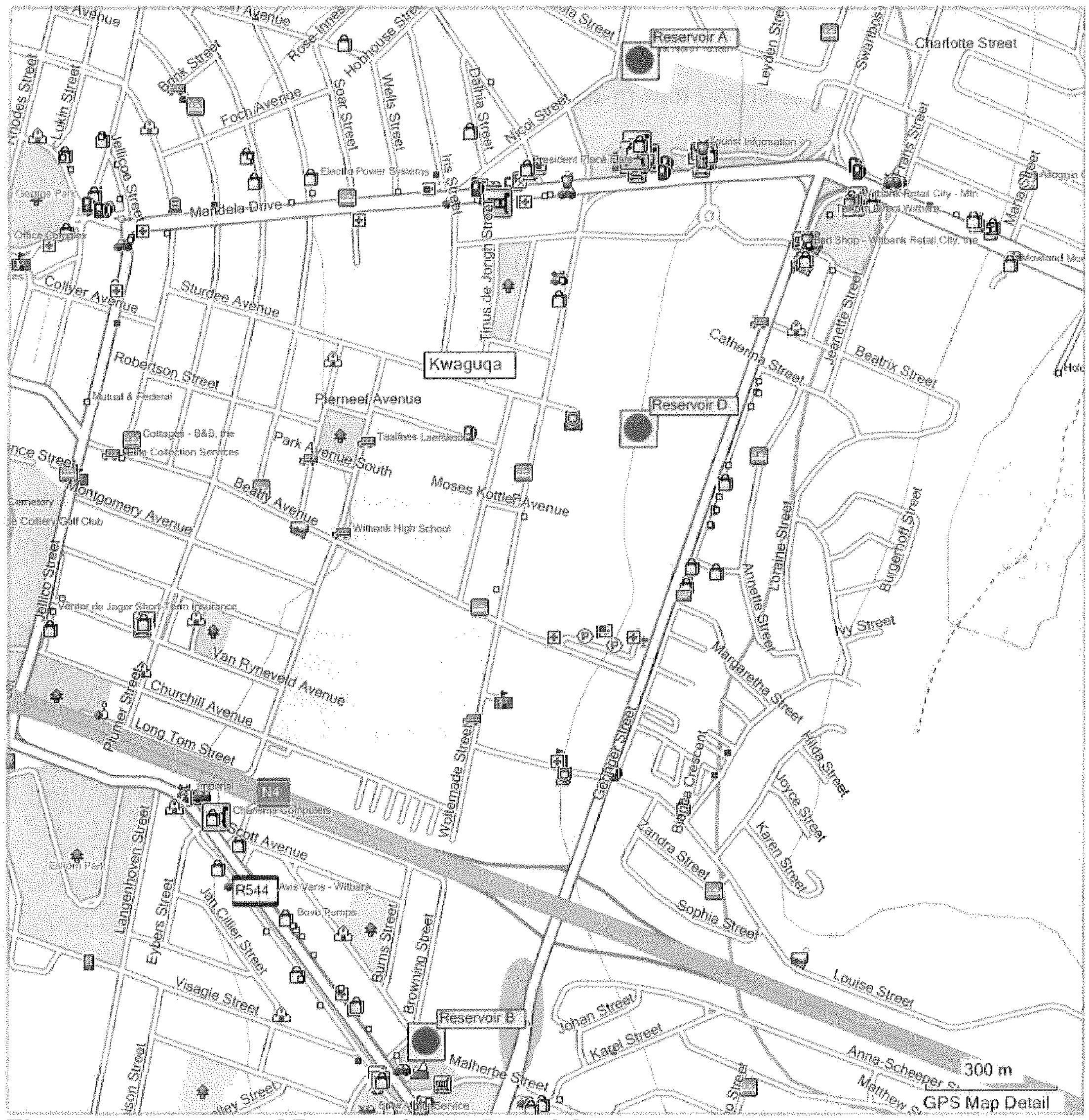


Figure 1: Location of Reservoirs B, D and A

2. STUDY AIMS AND OBJECTIVES

The study provides input to the EIA as required in terms of the Minerals and Petroleum Resources Development Act (2002).The Act requires that pollution and/or degradation of the environment is to be avoided, or where either aspect cannot be avoided, is to be minimized and remedied. Further objectives are:

- Address all identified impacts and determine the significance of each impact; and
- Formulate mitigation measures.

3. METHODOLOGY

3.1 Field preparation

In order to do accurate surveying all available data was processed with the aid of advanced Geographic Information System (GIS) software (ArcGIS 9.3.1). The shapefile containing the geographic location of the proposed pipeline route was superimposed on a Google Earth image as well as 1:50 000 scale topographic data. Observation points were generated at 150 m intervals along the proposed route. The coordinates of the observation points were calculated and loaded on a Geographic Positioning System (GPS) to accurately locate the position of the pipeline in the field. Large scale field maps (1:5000 scale) showing the proposed pipeline route and observation points on both aerial and topographic background data were printed.

3.2 Soil classification

The field survey was conducted during April 2010. Soils along the proposed pipeline routes were assessed at intervals varying between 150 to 600 meters.

The soils were investigated by making observations with the use of a bucket type auger to a maximum depth of 1500 mm or to the depth of refusal. At each observation point the South African Taxonomic Soil Classification System (Soil Classification Working Group, 2nd edition 1991) was used to describe and classify the soil. The classification system categories soil types in an upper soil Form level which are subdivided in a number of lower Family levels. Each soil Form (higher level) is defined by a unique vertical sequence of soil horizons with specific defined properties. The soil Families (lower level) are a subdivision of the soil Form (higher level) differentiated on the basis of specific characteristics.

In this way, standardised soil identification and communication is allowed by use of soil Form names and family numbers or names e.g. Hutton 2100 or Hutton Hayfield. The soil Form and soil Family together are refer to as soil types in this report. At each auger observation point the following procedure was followed to note soil properties and classify soils accordingly:

i) Identify applicable diagnostic horizons by noting the physical properties such as:

- Effective depth (depth of soil suitable for root development);
- Colour (in accordance with Munsell colour chart);
- Texture (refers to the particle size distribution);
- Structure (aggregation of soil particles into structural units);
- Mottling (alterations due to continued exposure to wetness);
- Concretions (cohesion of minerals into hard fragments) and
- Leaching (removal of soluble constituents by percolating water).

ii) Determine according to above properties the appropriate soil Form and soil Family

The soil Form are indicted by the name and the Family by its appropriate number e.g. Hutton 2100. The soil Form and Family were then symbolized e.g. Hu and referred to as soil type Hu. The soil Form and Family were often further categorized based on effective soil depth and a numerical number was add to the symbol e.g. Hu1. For example where the Hutton 2100 soil Form and Family occurs at an effective depth of 900-1200 mm it was symbolized and referred to as soil type Hu1 and where this soil Form and Family occurs at an effective depth of 600-900 mm it was symbolized and referred to as soil type Hu2 (see Soil Legend, Table 4).

3.3 Soil sampling and analyses

No soil sampling was done.

3.4 Land capability and agricultural potential classification

The land capability and agricultural potential of soils was solely based on soil physical properties and other local influences such as close to urban or industrial areas or narrow strips between road and residential area which could made agricultural activities impractical was excluded. This implies that the agricultural potential of a specific section could be classified as high according to soil properties although cultivation of the area could be impractical due to local influences.

Land capability was assessed according to the definitions of the Chamber of Mines of South Africa and Coaltech Research Association (Guidelines for the Rehabilitation of Mined land. 2007, Johannesburg). Soils types were classified accordingly into 3 categories namely arable, grazing and wilderness.

The practical field procedure for the identification and delineation of wetlands and riparian areas (Department of Water Affair and Forestry, 2005) were used as guideline to delineate wetland zones. Wetland zones namely temporary, seasonal and permanent was delineated based on soils Form, soil wetness, terrain unit and vegetation indicators.

The agricultural potential of soils was based on soil properties noted during auger observations namely effective soil depth, texture, soil wetness and disturbances.

Well-drained soils with an effective depth less than 600 mm were classified as low agricultural potential, 600-900 mm moderate and deeper than 900 mm high agricultural potential. All mined and disturbed areas were classified as low agricultural potential. Rehabilitated soils with a topsoil depth less than 600 mm on top the spoil material were classified as low potential and deeper than 600 mm as moderate potential. Leached, grey soils showing evidence of periodic or permanent percolating water tables were classified as low agricultural potential.

3.5 Land use mapping

The localities and extents of land use practices were surveyed during the time of the soil assessment.

3.6 Map compilations

Maps were compiled on aerial photo background. The maps were generated in a projected coordinate system using the longitude of origin (LO) coordinate system based on the 29° East meridian, WGS 1984 spheroid and Hartebeesthoek 1994 Datum.

3.7 Impact Assessment

This assessment evaluates the effects of the proposed project on the soil environment. Each potential impact was assessed according to the following criteria:

- **Magnitude** is a measure of the degree of change in a measurement or analysis which is classified as minor/negligible, low, moderate, high or very high.

- **Scale/Geographic extent** refers to the area that could be affected by the impact and is classified as none, site only, local, regional, national, or international.

- **Duration** refers to the length of time over which an environmental impact may occur: i.e. Immediate (less than 1 year), short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.

- **Probability of occurrence** is a description of the probability of the impact actually occurring as improbable (less than 5 % chance), low probability (5 % to 40 % chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60 % to 90 % chance) or definite (impact will definitely occur).

- **Direction** of an impact may be positive, neutral or negative with respect to the particular impact.

- **Reversibility** is an indicator of the potential for recovery of the endpoint from the impact.

- **Frequency** describes how often the impact may occur within a given time period and is classified as low, medium or high frequency. Seasonal considerations should be discussed where these are important in the evaluation of the impact.

The significance of the identified impacts was determined using the approach outlined below. This incorporates two aspects for assessing the potential significance of impacts (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998), namely occurrence and severity, which are further sub-divided as follows:

Table 1: Significance assessment

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Magnitude (severity) of impact	Scale / extent of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Table 2: Impact ranking

Probability	Duration
5 - Definite/don't know (100% change)	5 - Permanent
4 - Highly probable (60-90% change)	4 - Long-term (> 15 years)
3 - Medium probability (40-60% change)	3 - Medium-term (8-15 years)
2 - Low probability (5-40% change)	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 – Improbable (< 5% change)	1 – Immediate
0 - None	
SCALE	MAGNITUDE
5 - International	10 - Very high/don't know
4 - National	8 - High

3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (probability + duration + scale) x magnitude

The maximum value is 150 significance points (SP). The impact significance was then rated as follows:

Table 3: Significance evaluation

Significance Points	Significance Rating	Decision making
SP >75	Indicates **high** environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates **moderate** environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates **low** environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.

4. SURVEY RESULTS

4.1 Soil

The soil Form and Family classified at each observation point was symbolized and manually grouped into sections displaying similar soil properties and shown as soil types on the soil map Figure 2.

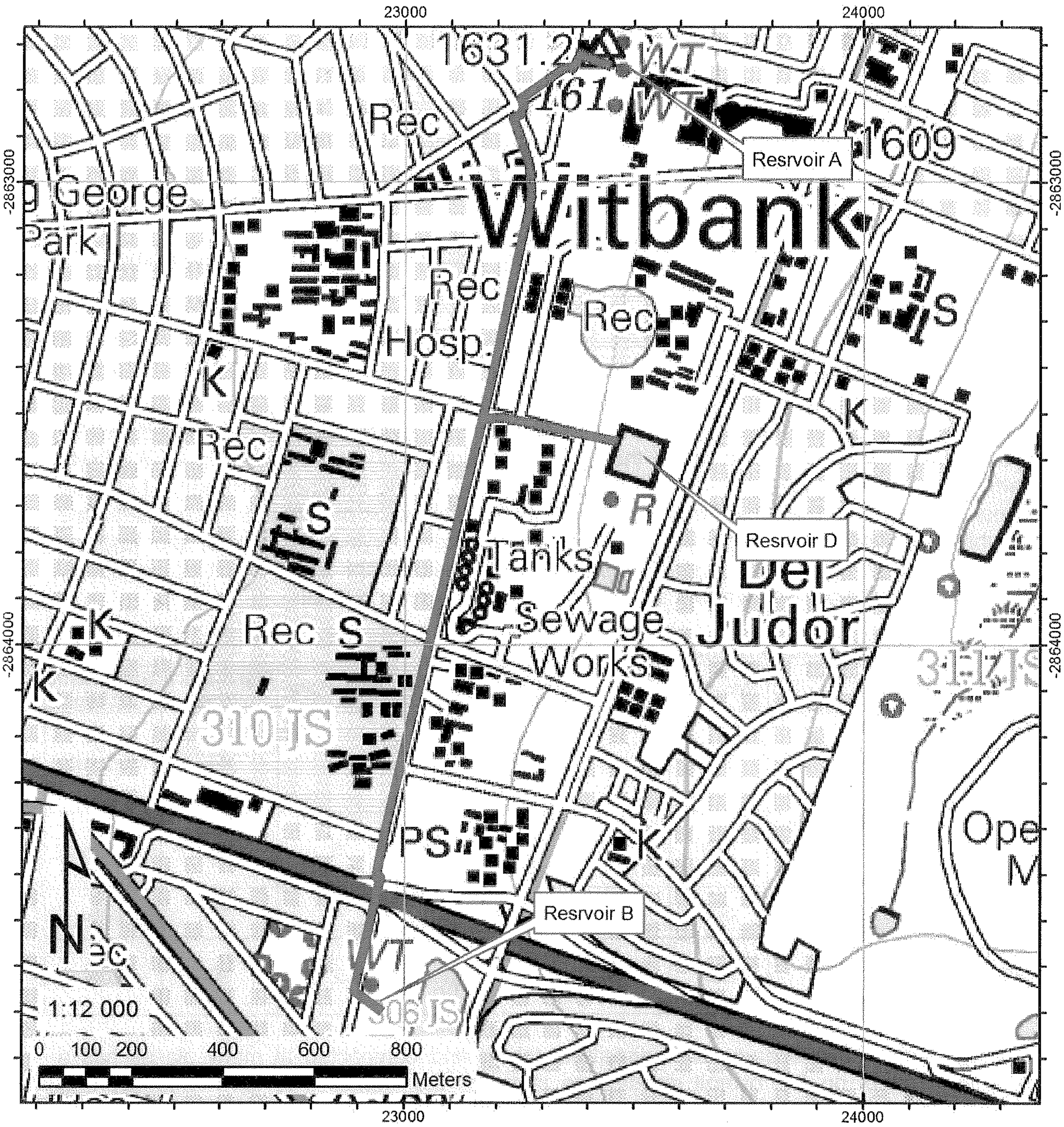
4.1.1 Soils along the proposed extension of the existing distribution pipeline

The dominant soil types along the proposed route for the extension of the existing distribution pipeline are shown in Figure 2 and the soil properties are summarised in the soils legend, Table 4 in terms of the dominant and subdominant soil forms and families, average effective soil depth, a broad description of the dominant soil form, the agricultural potential, the land capability, the length of the section, the number of sections and the percentage comprised by each section.

Soil type **W** dominated by the Witbank soil Form consists mainly of soils previously disturbed during road construction, residential or industrial development. In these soils the natural soil horizon sequences of the A- and B-horizons are disturbed although the topsoil are mostly not completely removed and in many cases the original surface is covered with gravely imported soil material. The total proposed route is dominated by the Witbank 1000 soil Form and Family and consists of shallow to moderately deep, disturbed, yellow brown and reddish brown loamy sand soils of which the current land capability was classified as wilderness with low agricultural potential. Sporadic occurrences of undisturbed soils do occur (soil types Clovelly, Hutton and Avalon).

Table 4: Soil legend – distribution pipeline extension

Soil Type Code	Dominant Soil Form and Family	Subdominant Soil Form and Family	Effective Depth (mm)	Summarized Description of Dominant Soil Form	Land Capability	Agricultural Potential	Section Count	Section Length (m)	Percentage of total length
W	Witbank 1000	Clovelly 1100 Hutton 1100 Avalon 1100	500-1000	Mainly well-drained, yellow brown, sandy loam soils of which the upper part of the soil profile are disturbed due to road construction, residential of industrial development	Wilderness	Low-none	1	2623	100.0
						Total	**1**	**2623**	**100.0**



Soil Legend: Distribution pipeline route							
Soil Type Code	Dominant Soil Form and Family	Effective Depth (mm)	Land Capability	Soil description	Section Count	Section Length (m)	% of total length
W	Witbank 1000	500-1000	Wilderness	Mainly well-drained, yellow brown, sandy loam soils of which the upper part of the soil profile are disturbed due to road construction, residential of industrial development	1	2623	100.0
				Total	1	2623	100.0

Figure 2: Soils along the proposed distribution pipeline extension route stretching from reservoir B to reservoir A via reservoir D

4.2 Land capability and agricultural potential along the proposed extension of the existing distribution pipeline

The land capability and agricultural potential of soil types along the proposed route are given in the soil legend, Table 4. Due to continuous disturbances in soil type **W** and the high density of infrastructure along the route the agricultural potential was classified as low to none.

4.3 Land Use

The land use along the proposed route is high density residential and industrial development.

5. IMPACT ASSESSMENT

5.1 Construction phase

During the construction phase trenches will be dug, the pipe will be laid and the trenches will be closed after a while. This will cause the natural functioning of the soil in terms of a growth medium and habitat for fauna and flora to cease as long as the trenches are open. At shallow sections of the route the subsoil or underlying rock material will be penetrated which creates the possibility of topsoil and subsoil to be mixed. However, varying soil colors and textures frequently found along road edges during the soil assessment are evident of previously disturbances and mixing of different soil types and road building material.

Table 5: Impact assessment during construction phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Digging of trenches – disturbance of natural soil profile and horizon sequences	Soil	6	2	1	5	48	Moderate
Mixing of topsoil with subsoil or rocky material during backfill of trenches	Soil	6	4	1	5	60	Moderate
Compaction by mechanical equipment	Soil	2	4	1	4	18	Low
Possible oil and fuel spillages by mechanical equipment	Soil	6	2	1	2	30	Low

The soils which have already been disturbed, mixed and compacted at many places has a decreasing effect on the overall significance rating of the impact. The land capability and agricultural potential which hardly exists due to permanent infrastructure further reduces the impact. The direction of the impact is negative and the frequency is once off although the impact will remain to some extent after rehabilitation took place. The impact can however be fairly well mitigated. The topsoil and subsoil can be place apart from each other and backfilled in the same sequence. The compaction can be remediated mechanically where grass had to be established.

The impact will however not be reversed or alleviated during the decommissioning phase (reclamation of pipeline) but it will rather be a repetition of the impact.

5.2 Operational phase

The impact of the pipeline itself during the operational phase will be none. Leakages or bursts can however cause soil erosion and disturbance of the soil profile will be unavoidable during reparation of the pipeline.

Table 6: Impact assessment during operational phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Erosion caused by serious bursts or leakages	Soil	2	1	1	2	8	Low
Disturbance and mixing of soil and subsoil during reparation of leakages	Soil	2	1	1	2	8	Low

Mitigation will be frequent monitoring and rapid repairing of any leakages and to contain areas to be disturbed during reparations as far as possible.

5.3 Decommissioning phase

Whether the pipeline will be reclaimed during the decommissioning phase is probably not sure. However, it will imply dinging of trenches and damaging of existing infrastructure, possible mixing of topsoil and subsoil, possible spillages of oil and fuel as well as compaction of soils. The impact will thus not be reversed or alleviated during the decommissioning phase (reclamation of pipeline) but it will rather be a repetition of the impact.

Table 7: Impact assessment during the decommissioning phase

Impact	Receptor	Magnitude	Duration	Scale	Probability	Significance Score	Significance Rating
Digging of trenches – disturbance of natural soil profile and horizon sequences	Soil	8	2	1	5	64	Moderate
Mixing of topsoil with subsoil or rocky material during backfill of trenches	Soil	6	4	1	4	54	Moderate
Compaction by mechanical equipment	Soil	2	2	1	4	20	Low
Possible oil and fuel spillages by mechanical equipment	Soil	6	2	1	2	24	Low

6. MITIGATION MEASURES

6.1 Construction phase

The digging of trenches is unavoidable unless the pipeline is to be constructed above ground which is probably not practical in urban areas although it would have the least impact on soils.

At shallow sections the topsoil should be placed further from the trench and weathered rock, gravely, stony or rocky material should be placed separately (closer to the trench) in order to backfill subsoil material first without mixing with topsoil.

Contamination due to oil and fuel spillages should be contained by strict guideline and rules to contractors in terms of the mechanical condition of equipment used, the maintenance of equipment as well as the reporting and cleaning up procedures of spillages.

6.2 Operational phase

Leakages might occur on any newly constructed pipeline especially at coupling points. Smaller leakages on such a pipeline below the soil surface might take even weeks before it might be visible on the surface which could lead to enormous spillages. It is therefore recommended that the pipeline should be operational and all leakages repaired before backfill of the trenches takes place. Inspections should take place on a daily basis during the early operational phase until all leakages and malfunction of any related parts are sorted out. All leakages should be reported and recorded and problematic sections should be identified. Scheduled monitoring should take place afterwards.

The original surface condition should be reestablished during the rehabilitation process e.g. paving, sidewalks, grass etc.

6.3 Decommissioning phase

The reclamation of the buried pipeline will repeat all impacts which took place during the construction phase. Mitigation measures of the construction phase should be applied where applicable.

7. CONCLUSION AND RECOMMENDATIONS

The proposed pipeline route is well planned and the impact on soils and land capability will be minimal due to the current developed status of the area. Impacts on the current land uses will be temporary. The majority of the proposed route is along roads which lessen impacts on soils, fauna and flora especially during the construction phase.

In general the impact by pipelines on soil, land capability, land use is fairly low. Pipelines occupy small areas of land and the impact is very site specific. The impact of pipelines which are constructed on road shoulders or in road, rail road or power line servitudes are much lower because it occupies land which can mostly not be utilized effectively especially in terms of agricultural purposes.

Collection points and associated pipelines that will have a direct impact on the current decanting just north of eMalahleni should be constructed first.

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REHAB GREEN CC

APPENDIX G

Specialist Reports: Surface Water

October 2010

CELEBRATING 50 YEARS in 2010

SURFACE WATER SPECIALIST STUDY

eMalahleni Mine Water Reclamation Plant Expansion EIA

Submitted to:
Anglo American Thermal Coal (Pty) Ltd

REPORT

Report Number. 12485-9459-5

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EXECUTIVE SUMMARY

The proposed scheme consists of the following components:-

- A system of pipelines collecting the excess mine water from the operational Kromdraai, Excelsior and Navigation Sections of Landau Colliery and the defunct Middelburg Steam and Station (MS&S) Colliery. The collection system has been sized to include the other defunct mines under the management of the Department of Mineral Resources (DMR) which are currently decanting into the Klipspruit River System, although these are not part of the current scheme proposed in this EIA.

- The water collected in the collection system is pumped to the existing eMalahleni Water Reclamation Plant (EWRP) where it will be treated for potable use. The EWRP is to be doubled in capacity from 25 Mℓ/d to 50 Mℓ/d. The expansion of the plant is to take place on the existing plant foot print which was covered in the EIA for the first phase of the scheme.

- The potable water is conveyed to the municipal water supply reservoirs in Witbank and KwaGuqa for domestic use.

The scheme falls in the upper Olifants catchment in the Klipspruit, Kromdraaispruit and Naauwpoortspruit catchments. The Kromdraaispruit has a history of acid conditions due to discharges from the Kromdraai Colliery liming plant, seeps and decants from other defunct mines in the catchment such as the Blackstone Colliery adjacent to Kromdraai. Kromdraai is discharging about 8 Mℓ/d of neutralised mine water into the spruit. This discharge forms the bulk of the base flow in the river. As a result of the seeps and discharge, wetland systems have developed in the spruit. The Klipspruit is a highly impacted catchment with a long history of water quality problems. The current water quality in the catchment is impacted by acid seeps and decants from defunct mines some of which belong to the DMR. The flow in the Klipspruit is impacted on by discharges (totalling 40 Mℓ/d) from the Klipspruit and Ferrobank sewage treatment plants. As a result there is a significant base flow in the river. The MS&S Colliery decants about 1.6 Mℓ/d into the Klipspruit River System. The EWRP is located on the banks of the Naauwpoortspruit. There is a possibility that treated water will be discharged to the Naauwpoortspruit in emergency conditions when the potable water users cannot take the water or if the Local Municipality do not agree to take the extra 25 Mℓ/d.

This report documents the findings of the surface water specialist study which was conducted to support the EIA. The following aspects have been addressed as part of the study:

- The excess neutralised mine water at Kromdraai is currently discharged into the Kromdraaispruit. The proposal is to collect this water and pump it to the EWRP for treatment. The flow in the Kromdraaispruit will therefore reduce. The magnitude of the flow reduction in the Kromdraaispruit will be determined.

- The neutralised mine water from Kromdraai is saline. This discharge therefore impacts on the water quality of the Kromdraaispruit. The removal of the saline discharge will therefore change the water quality profile of the Kromdraaispruit. This change will be assessed in this specialist study.

- The decants from the defunct Transvaal and Delagoa Bay Colliery are collected and conveyed to the Brugspruit Water Pollution Control Plant (WPCP). The acid streams are neutralised at the WPCP and discharged to the Brugspruit / Klipspruit. The discharge from MS&S also reports to the Brugspruit / Klipspruit system. These discharges are to be collected as part of the scheme and pumped to the EWRP for treatment. The impact on the flow regime of the Brugspruit / Klipspruit of removing the discharges will be assessed.

- The impact of removing the decant from the MS&S on the water quality of the Brugspruit / Klipspruit system will be assessed.

- Impacts of pipeline routing with regard to storm water runoff, erosion, spills and leaks as well as scour valve discharges.

The study conclusions can be summarised as follows:-

- The removal of the 8 Mℓ/d discharge from the Kromdraaispruit will impact significantly on the low flow regime in the spruit. The removal of the liming plant discharge improves the salinity related water quality of the spruit. However, there are other sources of acid water in the catchment which might aggravate the acid conditions in the river if the liming plant discharge is removed. This can be mitigated in the short-term by liming the discharge at the Kromdraaispruit. This has been attempted in the past. A liming plant is still located at the weir. In the long-term, Anglo should support an investigation to locate, collect and neutralise the acid streams, or to incorporate the acid streams in the collection system for treatment at the eMalahleni Mine Water Reclamation Plant.
- The impact on the flow regime of the Klipspruit due to collecting the 1.6 Mℓ/d MS&S decant is low. The reduction is only between 13% for the low flows and 2.5% for the average flows. The collection of the decant impacts positively on the water quality in the Klipspruit/Brugspruit system. The collection does not result in the RWQO for the Klipspruit being met due to the decants from the other defunct mines in the catchment. Consideration should be given to including these decants into the scheme in the future.
- The discharge of treated water from the EWRP to the Naauwpoortspruit under emergency conditions will improve the water quality of the stream. However the proposed release of 50 Mℓ/d is a significant flow when compared to the flows measured in the Naauwpoortspruit at the B1H019 weir. An operating rule was developed so that the discharge can take place and not cause flooding of the Naauwpoortspruit.
- The pipelines are buried so leaks from the collection pipelines will impact on the water quality of the soils and seepage from the soils will impact on the local streams. A leakage detection system and routing pipeline inspections should be undertaken to mitigate this impact.
- Bursts from the distribution and collection pipelines will cause local erosion. The water quality of the water conveyed in the collection pipelines will impact on the water quality of the local streams and areas around the burst. The water from the distribution lines is treated to potable quality so will not impact negatively on the water quality of the receiving streams. The pipe pressure monitoring system, routine pipe inspections and valves will be used to limit the number of bursts and the time that the burst flows. Remediation measures need to be developed to remediate the areas impacted on by a burst.
- The pipelines will be buried at the water courses. The excavations will have to be well backfilled and the vegetation re-established to prevent erosion.
- Protocols will have to be developed for scouring of the pipelines so that spills to the river systems are kept to a minimum.

The overall impact of the proposed scheme is positive. The salt load discharged to the river systems will be reduced by the proposed scheme. This will lead to an improvement in the water quality in the Klipspruit and Wilge River Systems. The water quality in the Olifants River is under threat from a number of sources. This has been recognised by DWA in the Integrated Water Resource Management Plan where the removal of salt load from the river system is a stated objective. This scheme complies with this objective and will contribute to the improvement of the water quality situation in the catchment.

Table of Contents

1.0 INTRODUCTION **1**

2.0 PROJECT DESCRIPTION **1**

2.1 Project Components 1

2.1.1 Mine Water Sources 2

2.1.2 Mine Water Collection 2

2.1.2.1 Kromdraai and Excelsior 2

2.1.2.2 Middleburg Steam and Station 3

2.1.2.3 Navigation 4

2.1.3 Upgrade of the Capacity of the Existing EWRP 5

2.1.4 Treated Water Distribution 5

2.1.5 Waste 6

3.0 STUDY APPROACH AND METHODS **8**

4.0 SITE DESCRIPTION **8**

4.1 Introduction 8

4.2 Description of Klipspruit/Brugspruit system 8

4.3 Description of Kromdraaispruit 9

4.4 Description of Naauwpoortspruit 10

5.0 BASELINE ASSESSMENT **11**

5.1 Rainfall 11

5.2 Streamflow 11

5.2.1 Kromdraaispruit 11

5.2.2 Klipspruit 12

5.2.3 Naauwpoortspruit 13

5.3 Water Quality 15

5.3.1 Kromdraaispruit 17

5.3.2 Klipspruit/Brugspruit 19

5.3.3 Naauwpoortspruit 21

6.0 FLOODLINE DETERMINATION **21**

6.1 Observations made during the site visit 21

6.1.1 River Crossing 1 23

6.1.2 River Crossing 2 23

6.1.3 River Crossing 3 23

6.1.4 River Crossing 4 23

6.1.5 River Crossing 5 23

6.1.6 River Crossing 6 23

6.1.7 River Crossing 7 24

6.2 Flood peak calculations 24

6.3 Floodline Determinations 24

6.3.1 HEC-RAS Modelling 25

7.0 IMPACT ASSESSMENT 25

7.1 Impacts of reducing the discharge volume into the Kromdraaispruit 26

7.1.1 Impact Assessment 26

7.1.2 Impact Significance Rating 27

7.1.3 Mitigation 28

7.2 Impacts of reducing the discharge volume into the Klipspruit/Brugspruit System 29

7.2.1 Impact Assessment 29

7.2.2 Impact Significance Rating 30

7.2.3 Mitigation 31

7.3 Naauwpoortspruit 31

7.3.1 Impact Assessment 31

7.3.2 Impact Significance Rating 32

7.3.3 Mitigation 33

7.4 Impacts of Collection and Distribution Pipelines 34

7.4.1 Bursts and Leaks 34

7.4.2 Scour Valves 35

7.4.3 River Crossings 35

7.4.4 Impact Significance Rating 37

7.4.5 Mitigation Measures 38

8.0 CONCLUSIONS 38

9.0 REFERENCES 39

TABLES

Table 1: Existing and proposed additional mine water sources included in the Mine Water Reclamation Scheme 2

Table 2: Main waste streams generated at the EWRP 6

Table 3: Interim and acceptable water quality guidelines set for the Klipspruit catchment given in the WQMP............9

Table 4: Interim RWQO set in IWRMP for Management Unit 21 (Kromdraaispruit)............10

Table 5: Interim RWQO set in IWRMP for Management Unit 6 (Naauwpoortspruit)............10

Table 6: Rainfall Station used in the study............11

Table 7: 24 Hour Storm Rainfall Depths (mm) for SAWS Station 0515196_W (Clewer)............11

Table 8: Monthly flow volumes (million m^3) measured at WP32 along the Kromdraaispruit............11

Table 9: Catchment Area, Quaternary Catchment B20G unit MAR............12

Table 10: Current average monthly flows (million m^3) for the naturalised Kromdraaispruit flow............12

Table 11: Monthly flow volumes (million m^3) measured at WP25 along the Schoongezichtspruit............12

Table 12: The minimum and maximum daily flow rates as well as the 5, 50 and 95 percentile flow rates for the Zaaihoek weir (B1H004)............13

Table 13: Minimum, maximum, 5^{th}, 50^{th} and 95^{th} percentiles of daily flows measured at B1H019 weir............13

Table 14: In-stream water quality data for Kromdraaispruit............18

Table 15: In-stream water quality data for the Klipspruit/Brugspruit............20

Table 16: Water Quality Data at B1H019 along the Naauwpoortspruit............21

Table 17: The Areas, Slopes, Hydraulic Lengths and Time of Concentrations for the Catchments (Figures 2) associated with the proposed pipeline / river crossings............24

Table 18: Computed flood peaks (m^3/s)............24

Table 19: Current and modelled reductions in flow rates at the Kromdraaispruit weir............26

Table 20: Impact significance rating –Kromdraaispruit............27

Table 21: Water quality profile of the MS&S decant............29

Table 22: Percentiles of flow (million m^3/month) with and without the MS&S decant (without decant shown in brackets)............30

Table 23: Impact at B1H004 of removing MS&S decant on sulphate concentrations............30

Table 24: Impact significance rating – Klipspruit............30

Table 25: The minimum, maximum, 5^{th}, 50^{th} and 95^{th} percentiles of the daily flows at B1H019 as well as the emergency discharge of 50 Mℓ............31

Table 26: Operating rules for the emergency discharge releases from the EWRP, gauge plate readings and their associated discharges for the Naauwpoortspruit at weir B1H019............32

Table 27: Impact significance rating - EWRP site............33

Table 28: Recommended Water Quality Sampling Parameters for the Water Quality Monitoring Programme............34

Table 29: Impact significance rating - pipelines............37

Table C1: Hec-Ras Output for the Klipspruit and Brugspruit............55

Table C2: Hec-Ras Output for the Naauwpoortspruit............66

FIGURES

Figure 1: Study area for the eMalahleni Mine Water Reclamation Project 7

Figure 2: Flow measurement stations 14

Figure 3: Daily Flow record along Klipspruit at B1H004 (Zaaihoek) 15

Figure 4: Water Quality Monitoring Site Locations 16

Figure 5: eMalahleni Mine Water Reclamation Project showing the pipeline route, pipeline / river crossings and their associated catchments 22

Figure 6: Plot of current and modelled sulphate concentrations in the Kromdraaispruit for Case 1 and Case 2 27

Figure 7: Location of Scour Valves along the Proposed Pipeline Routes 36

Figure A1: Upstream view along the Klipspruit at River Crossing 1 41

Figure A2: Downstream view along the Klipspruit at River Crossing 1 41

Figure A3: Upstream view along the Klipspruit downstream of River Crossing 2 at R544 42

Figure A4: Downstream view along the Klipspruit downstream of River Crossing 2 at R544 42

Figure A5: Downstream view along the Klipspruit downstream of River Crossing 2 at R544 43

Figure A6: Upstream view from R104 along a tributary of the Brugspruit at River Crossing 4 43

Figure A7: Downstream view from R104 along a tributary of the Brugspruit at River Crossing 4 towards the N4 highway 44

Figure A8: Downstream view towards N4 highway of the Brugspruit at River Crossing 4 44

Figure A9: Downstream view from bridge in KwaQuga Township along the Brugspruit at River Crossing 4 45

Figure A10: Upstream view from R104 along a tributary (Schoongezightspruit) of the Brugspruit at River Crossing 5 45

Figure A11: Upstream view from N4 highway towards R104 along a tributary of the Brugspruit at River Crossing 5 46

Figure A12: Downstream view from R104 towards N4 highway along a tributary of the Brugspruit at River Crossing 5 46

Figure A13: Downstream view from N4 highway towards the Brugspruit at River Crossing 5 47

Figure A14: Upstream view from R104 along a tributary of the Brugspruit at River Crossing 6 47

Figure A15: Upstream view from R104 of culverts along a tributary of the Brugspruit at River Crossing 6 48

Figure A16: Upstream view from N4 highway of culverts along a tributary of the Brugspruit at River Crossing 6 48

Figure A17: Downstream view from R104 along a tributary of the Brugspruit at River Crossing 6 49

Figure A18: Downstream view from N4 highway along a tributary of the Brugspruit at River Crossing 6 49

Figure A19: Upstream view from small road at EWRP along the Naauwpoortspruit at River Crossing 7 50

Figure A20: Downstream view from small road at EWRP along the Naauwpoortspruit at River Crossing 7 50

APPENDICES

APPENDIX A
Site Visit Photographs

APPENDIX B
Floodlines

APPENDIX C

HEC-RAS Results

APPENDIX D
Document Limitations

1.0 INTRODUCTION

Anglo American Thermal Coal (AATC), on behalf of the mines in the Witbank mining area, proposes to expand the collection of mine affected water, treat this water and distribute it as potable and industrial water to augment local water supplies. The treated water will be supplied, under commercial terms, to a water services authority (WSA) and industrial users.

The proposed expansion project will consist of:

- Conveyance of an additional 25 Mℓ/day of mine affected water from existing mine shafts in the Witbank area to the existing eMalahleni Water Reclamation Plant (EWRP) via existing and new water pipelines. The various pipeline routes in the proposed study area are illustrated in Figure 1:
- Conveyance of potable water from the EWRP to a bulk storage facility, such as the existing KwaGuqa municipal reservoir and the eMalahleni/Witbank municipal reservoir; and
- Increase in the existing EWRP capacity from 25 Mℓ/day to 50 Mℓ/day that will allow for the reclamation of mine water from other sources, such as the Navigation Section of Landau Colliery.

In order to obtain Environmental Authorisation for the proposed project, Anglo is required to conduct an Environmental Impact Assessment (EIA) in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA). Golder Associates Africa (Pty) Ltd (GAA), an independent company, is conducting the EIA and is compiling the Environmental Management Plan (EMP) to support the EIA application. As part of the EIA, a surface water specialist study is required, a component of which is to assess the impacts of discharge of treated water from the EWRP to the Naauwpoortspruit under conditions when the water users are unable to accept the water.

This report documents the findings of the surface water specialist study which was conducted to support the EIA. The following aspects have been addressed as part of the study:

- The excess neutralised mine water at the Kromdraai Colliery is currently discharged into the Kromdraaispruit. The proposal is to collect this water and pump it to the EWRP for treatment. The flow in the Kromdraaispruit will therefore reduce. The magnitude of the flow reduction in the Kromdraaispruit will be determined.
- The neutralised mine water from Kromdraai Colliery is saline. This discharge therefore impacts on the water quality of the Kromdraaispruit. The removal of the saline discharge will therefore change the water quality profile of the Kromdraaispruit. This change will be assessed in this specialist study.
- The excess mine water from the defunct Middelburg Steam and Station (MS&S) also reports to the Brugspruit / Klipspruit system. These discharges are to be collected as part of the scheme and pumped to the EWRP for treatment. The impact on the flow regime of the Brugspruit / Klipspruit of removing the discharges will be assessed.
- The impact of collecting the decant from the MS&S on the water quality of the Brugspruit / Klipspruit system will be assessed.
- Impacts of pipeline routing with regard to storm water runoff, erosion, spills and leaks as well as scour valve discharges.

2.0 PROJECT DESCRIPTION

2.1 Project Components

The various project components (Sections 2.1.1 to 2.1.5) associated with the proposed expansion project are shown in Figure 1:

2.1.1 Mine Water Sources

Currently (Phase 1 – Existing mine water sources), the Mine Water Reclamation Scheme collects 25 Mℓ/day from the Kleinkopje, Navigation, Greenside and South Witbank Collieries (Table 1). The proposed project (Phase 2) will entail the collection of an additional 20 Mℓ/day from Landau Colliery (Excelsior, Kromdraai and Navigation Sections) and the Middleburg Steam and Station Collieries. The additional 5 Mℓ/day will be sourced from other mines in the area; this is still under investigation (Table 1).

Table 1: Existing and proposed additional mine water sources included in the Mine Water Reclamation Scheme

Phase 1 Existing mine water sources	**Kleinkopje Colliery**	**Navigation Colliery**	**Greenside Colliery**	**South Witbank Colliery**	**Total**
	13 Mℓ/day	2.5 Mℓ/day	6.0 Mℓ/day	3.5 Mℓ/day	25 Mℓ/day
Phase 2 Additional mine water sources	**Kromdraai and Excelsior Sections of Landau Colliery**	**Navigation Section of Landau Colliery**	**Middelburg Steam and Station Collieries**	**Other mine water sources (still under investigation)**	
	5 -10 Mℓ/day	8 Mℓ/day	2.0 Mℓ/day	5 -10 Mℓ/day	20 Mℓ/day – 30 Mℓ/day

Additional mine water sources for inclusion into the scheme could include the following:

- Non-Anglo Mines (ownerless)
- Defunct Old Douglas1, 2, and 3 Collieries; and
- Defunct Transvaal and Delagoa Bay Colliery (T&DB).

The inclusion of the above-mentioned mine water sources into the scheme may, however, complicate and delay the proposed expansion project from a technical and regulatory perspective. It is, however, important to note that the project team has considered the possibility of including these mine water sources into the scheme during the design of the project components; the collection pipelines have been designed to have sufficient capacity to accommodate these additional sources, if required. These water sources may therefore be included into the scheme at a later stage, subject to independent environmental assessment and licensing/permitting at that stage.

2.1.2 Mine Water Collection

2.1.2.1 Kromdraai and Excelsior

Currently, at the Kromdraai and Excelsior Sections, excess mine water is pumped from various abstraction and decant points and conveyed to a Liming Plant located at Kromdraai. Here, the mine water is neutralised, and the treated water is either used by the mines as process water or is discharged to the Kromdraaispruit. Currently, 8 Mℓ/day of neutralised water is discharged from the Liming Plant into the Kromdraaispruit. As part of the expansion project, during the life of the mine, it is proposed that excess mine water be pumped to a holding (balancing) pond located at the existing Kromdraai Liming Plant. From here, the water will be pumped (via a pipeline and pump station) to the existing EWRP (located at Greenside Colliery) via the Brugspruit WPCP. Once the Kromdraai and Excelsior Sections of Landau Colliery have closed, and the Liming Plant has been decommissioned, the excess mine water will be pumped to a mine void located at

Central and South Pit 1, and from there, pumped to the EWRP via the same pipeline and pump system as described above.

The Kromdraai and Excelsior collection sub-system will consist of the following components:

- Mine water will continue to be abstracted from the various points indicated on Figure 1 via new and existing borehole pumps and pumps in sumps on surface.

- Conveyance of the abstracted water to a holding / balancing facility located at Kromdraai.
  During the life of the mine, the abstracted water will be transported via new and existing pipelines to the existing Liming Plant at Kromdraai and stored in a new storage/balancing pond, prior to being pumped to the EWRP. This pond will have a storage capacity of 25 000 m^3. Excess mine water over and above the volume that will be conveyed to the EWRP will be neutralised and used by the mine or discharged into the Kromdraaispruit. Upon implementation of the proposed project, during the life of the mine, 3 – 4 Mℓ/day may still need to be discharged.
  Subsequent to mine closure, and the decommissioning of the Liming Plant, the abstracted water will be conveyed via new and existing pipelines to a mine void (with a storage capacity of 8.3 million m^3) in the vicinity of Central and South Pit 1, prior to being pumped to the EWRP. Discharges of neutralised water from the Liming Plant to the Kromdraaispruit will therefore cease.

- Conveyance of the water from the holding / balancing facility at Kromdraai to the EWRP via the Brugspruit WPCP.

- A new end-suction pump station located at the Liming Plant will be used to pump the water from the storage/balancing pond at the existing Kromdraai Liming Plant to the Brugspruit WPCP. At the Brugspruit WPCP, the water will be routed through a new concrete sump (capacity of approximately 1 000 m^3), and pumped via a new submersible pump to the EWRP. Upon mine closure, a new submersible pump will be used to pump the water from the mine void to Brugspruit WPCP.

  The mine water collection pipeline extending from the abstraction points to the EWRP will be an HDPE pipeline with a diameter ranging from 100 – 500 mm, covering a distance of approximately 50 km. The entire pipeline will be buried, where possible. Roads / railway lines and watercourses will be crossed by the proposed pipeline. The location of the river crossings are shown in Figure 5. Pipelines will be laid across roads and railway lines by pipe jacking or excavation trenches; trenches will be excavated to lay pipes in watercourses. During construction of the pipeline, a servitude (right of way) width of 10 – 20 m will be required, whereas a servitude (right of way) width of 3 – 10 m will be required during the operation of the pipeline. These widths will, however, vary along the length of the pipeline, due to availability of space, any sensitive landscapes, etc. Scour valves will be placed at the lowest points along the length of the pipeline to ensure that the pipe can be drained, in case of failure or for maintenance purposes. As the scour valves will be located at the lowest points along the pipeline, any settled solids will be easily removed. Scour valves are normally situated inside an enclosed chamber to ensure that maintenance can be done. Water discharged from the scour valves will be contained and not released into the environment. Air valves will be placed on the apex (highest) points along the pipeline, relative to the hydraulic gradient. The main purposes of the air valves will be to ensure that, at start-up/commissioning of the pipeline, air bubbles in the pipeline can be released, and that pressure spikes are stabilised out during operation. Air valves will be situated inside an enclosed chamber to ensure that maintenance can be done (as with scour valves).

2.1.2.2 Middleburg Steam and Station

Currently, at the defunct Middleburg Steam and Station Collieries, excess mine water is decanting on surface; the decant reports to a number of evaporation dams located adjacent to the Blesbokspruit. As part of the expansion project, it is proposed that the mine water be pumped at volumes which limit decanting on surface, and be conveyed to the scheme's existing EWRP via the Brugspruit WPCP.

The Middleburg Steam and Station collection sub-system will consist of the following components:

- Abstraction of excess mine water from 2 points ,namely MS&S 1 and MS&S 2 (refer to Figure 1). It is proposed that the water be pumped from underground at MS&S 1 via new borehole pumps, and via new submersible pumps at MS&S 2. Any excess water that cannot be managed by pumping during extremely wet periods will be stored in the evaporation ponds for later introduction into the pump and pipe system.

- Conveyance of abstracted water from MS&S 1 and MS&S 2 to the EWRP via the Brugspruit WPCP. At the Brugspruit Works, the water will be routed to the new concrete sump (refer to Section 2.1.2.1 above), and pumped via the new submersible pump to the EWRP.

- Collection pipeline

  The mine water collection pipeline extending from MS&S 1 and MS&S 2 to the Brugspruit WPCP will be an HDPE pipeline with a diameter of 100 – 200 mm, and will cover a distance of about 18 km. The entire pipeline will be buried, where possible. Roads / railway lines and watercourses will be crossed by the proposed pipeline – refer to Figure 5 for an indication of the location of these crossings. Roads and railway lines will be crossed by pipe jacking or excavation trenches, whereas watercourses will be crossed by means of excavation trenches. During construction of the pipeline, a servitude (right of way) width of 10 – 20 m will be required, whereas a servitude (right of way) width of 3 – 10 m will be required during the operation of the pipeline. These widths will, however, vary along the length of the pipeline, due to availability of space, any sensitive landscapes, etc. As with the Kromdraai and Excelsior collection pipeline, scour valves will be placed on the lowest points along the length of the pipeline, and air valves will be placed on the apex (highest) points along the pipeline. It is important to note that the same section of the Kromdraai and Excelsior collection pipeline which extends from the concrete sump at the Brugspruit Works to the EWRP will be used for the Middleburg Steam and Station collection sub-system. This section of the pipeline has thus been designed to accommodate the mine water sources from both the Kromdraai and Excelsior sections of Landau Colliery, and Middleburg Steam and Station Collieries.

2.1.2.3 Navigation

Future mining at the Navigation Section of Landau Colliery, Will require the management of excess mine water. As part of the expansion project, it is proposed that this excess mine water be collected and conveyed to the existing EWRP. The Navigation collection sub-system will consist of the following components:

- Abstraction of excess mine water from three boreholes (two existing boreholes and one new borehole) located on site via submersible pumps (2 duty and 1 standby pump).

- Collection pipeline

  The abstracted water will be conveyed to the EWRP via a new HDPE pipeline (with a diameter of 300 – 500 mm) located within an existing pipeline servitude which runs from Navigation to the scheme's existing EWRP (as mentioned above, Navigation currently supplies mine water to the EWRP). The pipeline will cover a distance of approximately 4 km. The entire pipeline will be buried, where possible. Roads / railway lines and watercourses will be crossed by the proposed pipeline – refer to Figure 5 for an indication of the location of these crossings. Roads and railway lines will be crossed by pipe jacking or excavation trenches, whereas watercourses will be crossed by means of excavation trenches. During construction of the pipeline, a servitude (right of way) width of 10 – 20 m will be required, whereas a servitude (right of way) width of 3 – 10 m will be required during the operation of the pipeline. These widths will, however, vary along the length of the pipeline, due to availability of space, any sensitive landscapes, etc. No scour valves or air valves will be placed along the length of the pipeline. Should the contents of the pipeline need to be discharged (e.g. for maintenance purposes), the water will be released at the end of the pipeline at the EWRP.

2.1.3 Upgrade of the Capacity of the Existing EWRP

The existing EWRP at Greenside Colliery currently has a capacity to treat 25 Mℓ/day of mine water, and has a footprint of 8 hectares (ha). The EWRP footprint was originally designed to accommodate a future expansion (double-up). To accommodate the proposed additional excess mine water, it is proposed that the existing EWRP be upgraded to treat 50 Mℓ/day of mine water. Components for the upgrade include the addition of reverse osmosis components, additional chemical storage, etc. This can be accommodated without expanding the existing footprint of the Plant. Prior to treatment, the additional water sources will be temporarily stored in the existing mine water storage dams located at the EWRP.

The current water treatment process is based on a number of steps, including:

- Neutralisation and metals removal;
- Desalination;
- Reverse Osmosis; and
- Disinfection (using chlorine).

The same treatment process will be used to treat the additional mine water sources. Treated water will be temporarily stored in the existing potable water storage reservoirs located at the EWRP.

2.1.4 Treated Water Distribution

Currently, water treated to potable standards at the EWRP is distributed to the municipal water reservoir, referred to as the Witbank Reservoir, via a distribution pipeline. In addition, some treated water is distributed to the mines for their use. The expansion project will ensure an additional supply of 20 Mℓ/day to the municipality. It is proposed that 5 Mℓ/day be distributed to the Witbank Reservoir via the existing distribution pipeline or via a new pipeline located within the existing distribution pipeline servitude, which was permitted as part of Phase 1 of the scheme. 15 Mℓ/day will then be distributed to the KwaQuqa Reservoir via a new distribution pipeline or via a duplicate pipeline into the Witbank Reservoirs. It is proposed that 5 Mℓ/day be pre-treated (neutralised) to industrial water quality standards to be supplied to Greenside Colliery and the Phola Coal Beneficiation Plant located south west of the EWRP for use as process water. Pre-treated (neutralised) water will be conveyed to Greenside Colliery and the Phola Coal Beneficiation Plant via existing mine pipelines. In the unforeseen event that the treated water cannot be distributed to the various end users, it will be discharged into the Noupoortspruit adjacent to the EWRP. The distribution system will consist of the following elements:

- Pump stations

  As part of the expansion project, it is proposed that the existing pump station at the EWRP be upgraded to accommodate the additional 5 Mℓ/day to be distributed to the Witbank Reservoir. Also, a new pump station (2 duty pumps, and 2 standby pump) will be constructed at the EWRP site to cater for the 15 Mℓ/day to be distributed to the KwaQuqa Reservoir.

- Distribution pipelines

  Should a new distribution pipeline be constructed to convey treated water to the Witbank Reservoir, the pipeline will be an HDPE pipeline with a diameter of ± 630 mm, and will cover a distance of roughly 9 km. The new distribution pipeline transporting the treated water to the KwaQuqa Reservoir will also be an HDPE pipeline, will have a diameter ranging between 400 – 630 mm, and will cover a distance of ± 16 km.

- New inlet infrastructure to the Witbank and KwaQuqa Reservoirs will be required.
- The existing Witbank and KwaQuqa Reservoirs will be used to store the treated water prior to distribution to the public.

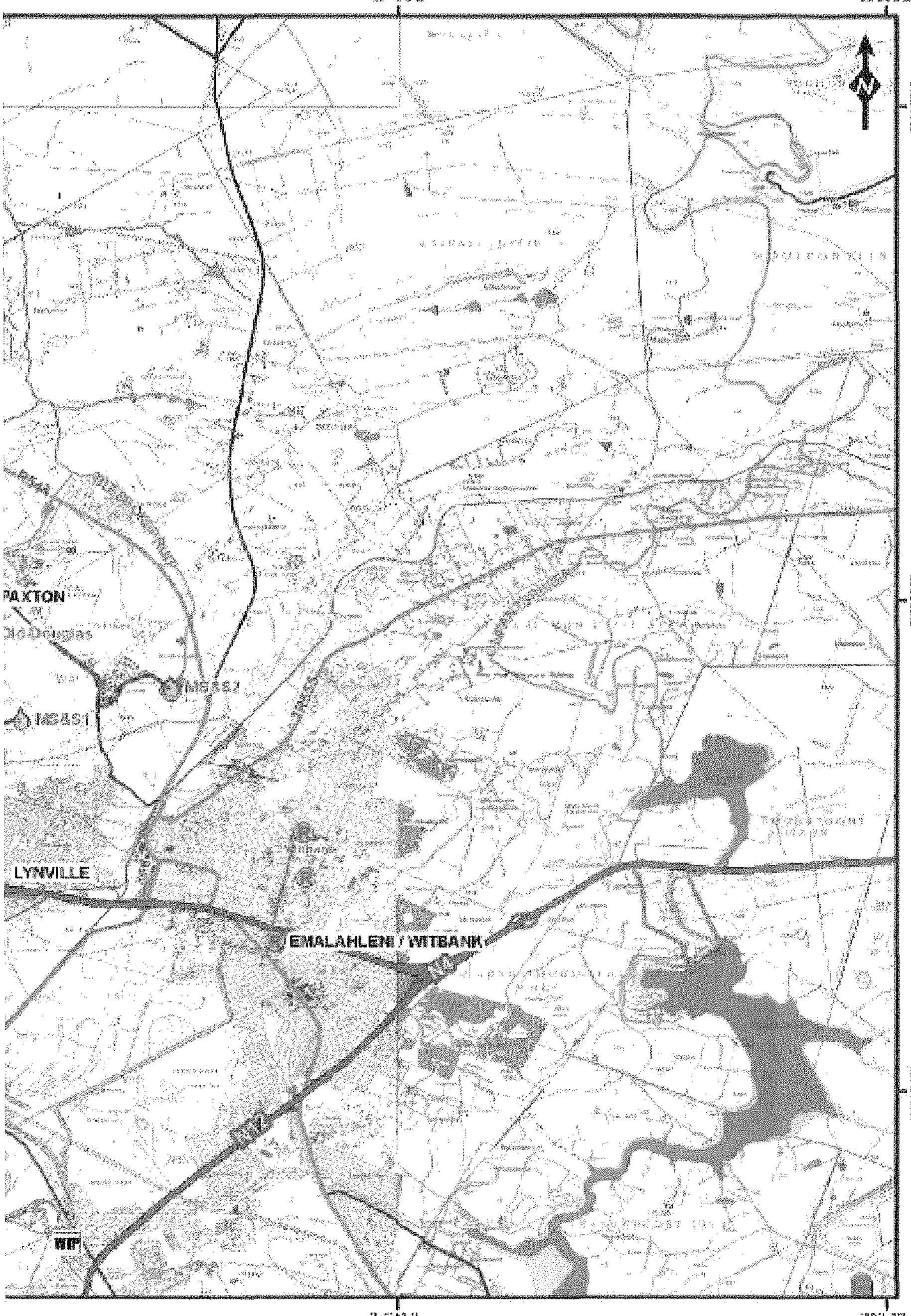
2.1.5 Waste

Two main waste streams, namely gypsum sludge and brine, are currently generated at the EWRP and are disposed of separately (see Table 2).

Table 2: Main waste streams generated at the EWRP

Waste type	Description
Gypsum sludge	Gypsum sludge is formed when lime is added to the mine water and metals such as calcium, iron, and manganese precipitate. The gypsum is dewatered to produce a gypsum cake. As part of the existing project, the Department of Water Affairs approved the disposal of the gypsum with the Blaauwkrans coal discard at Navigation Yellow Buoy Dam.
Brine	Brine, which is a liquid salty concentrate, is generated from the Reverse Osmosis Plant and contains similar elements as the gypsum sludge, but is not dewatered. A brine waste facility was built at the EWRP site to accommodate the liquid brine waste. The brine waste is prevented from reaching the environment through a system of controls: a double liner, a leachate collection layer and an under-drainage system below the double liner.

The additional brine will continue to be disposed of into the existing brine pond located at the EWRP site. When this facility reaches full capacity, the brine will then be disposed of at a new brine pond to be constructed at that time at the Blaauwkrans Mine Residue Disposal (MRD) site at Navigation. Two future brine ponds at Blaauwkrans were already permitted as part of Phase 1 of the scheme. In terms of the additional gypsum sludge volumes, it is proposed that the gypsum sludge continue to be disposed of at Yellow Buoy Dam. When this facility reaches full capacity (anticipated to be reached June / July 2014), the gypsum sludge will then be disposed of at a new facility to be constructed at that time at the Blaauwkrans MRD site at Navigation. Two future modules for disposal of gypsum cake at Blaauwkrans were already permitted as part of Phase 1 of the scheme. Anglo is currently investigating the re-use of gypsum sludge in building products and other by-products.



NOTES
...pocadastral Maps
...onal Surveys and Mapping

GCS WGS 1984

PROJECT
KROMDRAAI MINE WATER RECLAMATION SCHEME EIA

TITLE
LOCALITY MAP

Golder Associates
Johannesburg, South Africa

3.0 STUDY APPROACH AND METHODS

The approach adopted in the study can be summarised as follows:

- Site visits were conducted to measure the bridges where pipeline crossings are proposed and to collect flow information on the streams. During the site visit, photos were taken of the water courses and estimates were made of the channel roughness for use in determining the flood lines;
- A baseline assessment using the available hydrology and water quality information was undertaken. The data available from the Department of Water Affairs (DWA) and Anglo's monitoring programs were used for the baseline assessment;
- Flood lines were determined for the Klipspruit/Brugspruit system and for the Naauwpoortspruit at the EWRP.
- The available flow and water quality data were used together with hydrological models to assess the impacts on the flow regimes and the water quality of removing the discharges from the Kromdraaispruit and the Klipspruit/Brugspruit System.

4.0 SITE DESCRIPTION

4.1 Introduction

The study area is shown in Figure 1. The study area includes the upper reaches of the Kromdraaispruit and the Klipspruit/Brugspruit System. The proposed pipelines cross the Klipspruit and a number of tributaries of the Klipspruit and Brugspruit river system. The locations of the pipeline river crossings are shown in Figure 5. The Kromdraaispruit is unaffected by pipeline crossings but will be impacted by the removal of the current discharge from the spruit.

4.2 Description of Klipspruit/Brugspruit system

The Klipspruit catchment falls in Management Units 16, 17 and 18. The confluence of the Klipspruit with the Olifants River is downstream of Witbank Dam and upstream of Loskop Dam.

The Klipspruit catchment is highly impacted. The natural flow pattern is impacted on by sewage treatment plant discharges from the Klipspruit (10 Mℓ/d) and Ferrobank (40 Mℓ/d) works as well as discharges from the Brugspruit WPCP. From 1997 to 2008, neutralised acid mine water from BHP Billiton's South Witbank Colliery was discharged to the Brugspruit. In 2008 the water was collected and sent to the EWRP for treatment. There are also a number of defunct mines in the catchment. These mines were mined in the early 1900s. The majority of these mines are under the management of the Department of Mineral Resources. Anglo is responsible for the defunct Middelburg Steam and Station Colliery which falls in this catchment.

The Brugspruit WPCP was commissioned in 1997 by DWA to treat the acid decants from the defunct T&DB abandoned mine. Since commissioning, the WPCP and collection system has fallen into disrepair. The collection system has become blocked and no longer functions effectively. The WPCP has also been vandalised and is no longer functioning. This has resulted in the acid decants from the workings reporting untreated to the Brugspruit River. In 2009 DWA embarked on a program to refurbish the system. The refurbishment is still underway.

The water quality is impacted on by these discharges as well as runoff from the urban areas, stock grazing of the wetland vegetation and domestic use such as clothes washing in the river. The water quality in the Klipspruit catchment has been of concern for some time. DWA prepared a Water Quality Management Plan (WQMP) for the Klipspruit Catchment in 1992/93. It was proposed to implement a three-phased approach for the restoration of acceptable water quality in the local streams:

Phase 1 involved more intensive enforcement of pollution prevention and source-based pollution control at the different operating mines and industrial facilities. This phase was completed in late 1992.

Phase 2 involved the collection and treatment of acid mine drainage from the old defunct mines. Treatment simply entailed lime neutralisation and metals removal.

Phase 3 involved the re-mining and/or rehabilitation of all the old mining operations to reduce the amount of polluted mine water generated.

The WQMP developed for the Klipspruit Catchment in 1992/93 identified water quality requirements for a number of different users in the catchment. Consideration was given to potable use, irrigation, livestock watering and the natural aquatic environment. Water quality guidelines were set for a number of water quality variables at two levels:

Interim water quality guidelines were set to be achieved after implementation of Phase II of the WQMP, involving the collection and neutralisation of acid mine drainage. This is the current implementation stage that has been achieved in the catchment.

Acceptable water quality guidelines were set to be achieved after implementation of Phase III of the WQMP, involving re-mining and rehabilitation of the old mine workings.

The Interim water quality guidelines presented in the WQMP were adopted as the Interim RWQO for the Klipspruit catchment in the Integrated Water Resource Management Plan (IWRMP) for the Upper and Middle Olifants catchments developed by DWA.

Table 3: Interim and acceptable water quality guidelines set for the Klipspruit catchment given in the WQMP

Water Quality Variable	WQMP Guidelines (1992/93)	
	Interim	Acceptable
pH	6.0 – 9.0	6.5 – 8.5
Conductivity (mS/m)	120	100
Total alkalinity as $CaCO_3$(mg/l)	-	-
TDS (mg/l)	820	680
Calcium (mg/l)	-	-
Sodium (mg/l)	250	150
Magnesium (mg/l)	-	-
Sulphate (mg/l)	500	250
Chloride (mg/l)	320	100
Fluoride (mg/l)	1.7	1.0
Manganese (dissolved) (mg/l)	1.0	0.2
Iron (dissolved) (mg/l)	1.0	0.3
Aluminium (Dissolved) (mg/l)	0.2	0.1

4.3 Description of Kromdraaispruit

The Kromdraaispruit falls in Management Unit 21. The Kromdraaispruit is a tributary of the Saalklapspruit which in turn is a tributary of the Wilge River. The confluence of the Wilge River with the Olifants River is immediately upstream of Loskop Dam. There are a number of defunct mines in the Kromdraaispruit catchment as well as sections of Anglo's Kromdraai Mine. The seeps from the defunct mines as well as the discharge of neutralised mine water from the Kromdraai liming plant into the Kromdraaispruit has resulted in the development of wetland systems in the spruit.

The natural flow regime in the catchment is therefore impacted by the discharge from the Kromdraai liming plant. In addition the water quality will also be impacted by the discharge. Although the discharged water is neutral, the discharge is saline which impacts on the water quality in the Kromdraaispruit.

Interim RWQO have been set for Management Unit 21 as part of the IWRMP. The RWQO are listed in Table 4.

Table 4: Interim RWQO set in IWRMP for Management Unit 21 (Kromdraaispruit)

Water Quality Variable	Interim RWQO
pH	6.5 – 8.4
Conductivity (mS/m)	70
Total alkalinity as $CaCO_3$(mg/l)	85
TDS (mg/l)	450
Calcium (mg/l)	80
Sodium (mg/l)	20
Magnesium (mg/l)	20
Sulphate (mg/l)	120
Chloride (mg/l)	20
Fluoride (mg/l)	0.5
Manganese (dissolved) (mg/l)	0.18
Iron (dissolved) (mg/l)	1.0
Aluminium (Dissolved) (mg/l)	0.02

4.4 Description of Naauwpoortspruit

The Naauwpoortspruit falls in Management Unit 6 of the Witbank Dam Catchment. The Naauwpoortspruit flows into the Witbank Dam which has been constructed on the Olifants River. The Naauwpoortspruit is highly impacted with collieries and urban areas. The Greenside Colliery section of Kleinkopje Colliery and Landau are located in the upper reaches of the catchment. The Naauwpoort WWTW is located at the lower end of the catchment. The discharge from the WWTW is discharged into the river downstream of the DWA gauge B1H019.

Interim RWQO have been set for Management Unit 6 as part of the IWRMP. The RWQO are listed in Table 5.

Table 5: Interim RWQO set in IWRMP for Management Unit 6 (Naauwpoortspruit)

Water Quality Variable	Interim RWQO
pH	6.5 – 9
Dissolved Oxygen (% sat)	70
Boron (mg/l)	0.5
Potassium (mg/l)	50
SAR ($meql^{0.5}$)	1.5
Ammonia as NH_3 (mgN/l)	0.007
Sulphate (mg/l)	380
Fluoride (mg/l)	1.0
Manganese (dissolved)	0.4

Water Quality Variable	Interim RWQO
(mg/l)	
Iron (dissolved) (mg/l)	1.0
Aluminium (Dissolved) (mg/l)	0.02

5.0 BASELINE ASSESSMENT

5.1 Rainfall

The Rainfall Depths were extracted from the closest weather station obtained from the Design Rainfall Estimation Program (details in Table 6). Station 0515196_W (Clewer) was selected due to the record length and the limited patching of the record.

Table 6: Rainfall Station used in the study

Station Name	Station No.	Latitude (°)(')	Longitude (°)(')	Altitude (m)	Record (Years)	MAP (mm)
Clewer (SAR)	0515196_W	25°54'	29°08'	1 525	54	724

The 24 hour storm rainfall data for the 1:2, 1:5, 1:10, 1:20, 1:50, 1:100 and 1:200-year recurrence intervals at the SAWS Station 0515196_W (Clewer (SAR)) was abstracted from the database. The depths are presented in Table 7 below.

Table 7: 24 Hour Storm Rainfall Depths (mm) for SAWS Station 0515196_W (Clewer)

Return Period (years)	1:2	1:5	1:10	1:20	1:50	1:100	1:200
Rainfall Depth (mm)	52.1	66.6	76.3	85.6	97.5	106.5	115.4

5.2 Streamflow

5.2.1 Kromdraaispruit

A low flow V Notch weir (WP32) has been installed at the lower end of the Kromdraaispruit above the R555 road. The location of the site is shown in Figure 2. The catchment area at the weir is 61.2km^2. The Kromdraai mine staff read the gauge at the weir daily. The mine provided monthly volumes measured at the weir for the period of 2002 until 2009. These flows include the seeps and Kromdraai Liming Plant discharge. The minimum, average and maximum monthly volumes recorded in each month are given in Table 8.

Table 8: Monthly flow volumes (million m^3) measured at WP32 along the Kromdraaispruit

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum Monthly Flow	0.010	0.075	0.075	0.013	0.028	0.022	0.043	0.025	0.073	0.061	0.005	0.005
Average Monthly Flow	0.228	0.209	0.213	0.194	0.202	0.365	0.334	0.371	0.377	0.376	0.205	0.191
Maximum Monthly Flow	0.395	0.406	0.496	0.388	0.420	1.350	1.423	1.575	1.635	1.642	0.332	0.349

An indication of the magnitude of the natural flows that can be expected in the Kromdraaispruit were determined from the quaternary flows given in WRC (1990) for quaternary subcatchment B20G. The details of the quaternary catchment are given in Table 9. The naturalised flows were factored by the ratio of the catchment areas to give flows that are representative of the natural conditions. The monthly naturalized flows are given in Table 10. The difference between the weir measurements and the natural flows represents the contributions from other sources in the catchment.

Table 9: Catchment Area, Quaternary Catchment B20G unit MAR

Catchment	Area (km^2)	MAR (mm)	Streamflow (m^3)
Kromdraaispruit	61.2	44	2692800

The naturalized flows for the low flow winter period from May to September are lower than the flows measured by the mine at the weir. In the summer months the average naturalized flows are higher than the measured weir flows due to capacity of the weir and the frequency of flow readings.

The discharge from the liming plant has been variable over the 2002 to 2009 period. The discharge was not measured but data on the inflows to the plant indicated that the discharge was about 8 Mℓ/d (0.24 m^3/month) on average. This discharge is of a similar magnitude to the average and maximum monthly flows measured at the weir. This indicates that the flow is dominated by the discharge.

Table 10: Current average monthly naturalised flows (million m^3) for the Kromdraaispruit

Scenario	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Kromdraaispruit (no discharge from Liming Plant)	0.138	0.282	0.266	0.439	0.456	0.345	0.232	0.172	0.122	0.095	0.078	0.069

5.2.2 Klipspruit

The following sources of flow information are available in the Klipspruit catchment: -

- The measured monthly flow data collated from daily flow records measured on the Schoongezichtspruit (WP25) for the period 2000 to 2009;
- The flow records measured on the Klipspruit at DWA flow gauge B1H004 over the period 1959 to 2010.

The locations of the monitoring points are shown on Figure 2. The minimum, average and maximum monthly flows measured at WP25 are given in Table 11.

Table 11: Monthly flow volumes (million m^3) measured at WP25 along the Schoongezichtspruit

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum Monthly Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average Monthly Flow	0.042	0.057	0.041	0.069	0.044	0.058	0.041	0.043	0.044	0.04	0.093	0.028
Maximum Monthly Flow	0.171	0.279	0.173	0.358	0.197	0.235	0.116	0.140	0.163	0.1678	0.738	0.105

The minimum and maximum daily flow rates as well as the 5, 50 and 95 percentile flow rates for the Zaaihoek weir (B1H004) are listed in Table 12. The daily flows are shown plotted in Figure 3.

Table 12: The minimum and maximum daily flow rates (m^3/s) as well as the 5, 50 and 95 percentile flow rates for the Zaaihoek weir (B1H004)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Minimum Monthly Flow	0.070	0.290	0.124	0.377	0.243	0.090	0.036	0.025	0.024	0.025	0.031	0.024
5th Percentile Flow	0.201	0.520	0.364	0.738	0.478	0.237	0.432	0.287	0.506	0.481	0.417	0.217
50th Percentile Flow	1.075	1.540	1.885	2.350	1.965	2.225	1.930	1.480	1.445	1.380	1.215	0.967
95th Percentile Flow	3.588	3.826	6.670	9.678	8.650	8.799	6.443	4.633	3.648	3.113	2.847	2.40[illegible]
Maximum Monthly Flow	3.760	5.960	7.560	12.40	23.90	17.20	12.10	7.380	5.800	4.610	3.960	3.190

The available flow records highlight the following:-

- The flows in the Schoongezichtspruit are low as would be expected for the upper reaches of the catchment. There are periods where the flows in the spruit are essentially zero.
- The measured flows at the Zaaihoek weir show a very strong baseflow due to the sewage treatment plant discharges which total 0.58 m^3/s.

5.2.3 Naauwpoortspruit

The daily river flows for the Naauwpoortspruit catchment were obtained from the DWA website for the B1H019 weir located about 7 km downstream of the EWRP. The data set extends from April 1990 to August 2009. The minimum, maximum, 5th, 50th and 95th percentiles of the flows measured at B1H019 are shown in Table 13.

Table 13: Minimum, maximum, 5th, 50th and 95th percentiles of daily flows measured at B1H019 weir

Statistic	Flow (m^3/s)
Min	0.001
Max	2.354*
5th Percentile	0.015
50th Percentile	0.066
95th Percentile	0.647

* Capacity of weir

The flows measured at the weir vary significantly. The river does not have a high base flow as there are limited point source discharges in the catchment.

5.3.3 Naauwpoortspruit

The water quality data for the Naauwpoortspruit was obtained from Anglo. The closest water quality monitoring point along the Naauwpoortspruit to the emergency pre-treated mine water discharge point from the EWRP is at WP 46. This point is located upstream of the N12 on the Naauwpoortspruit. The available data set begins in April 1990 and ends in August 2009 but the data set is inconsistent with missing values. The 5th, 50th and the 95th percentiles of the data set are presented in Table 16 and compared against the Resource Water Quality Objectives (RWQO).

Table 16: Water Quality Data at B1H019 along the Naauwpoortspruit

Parameter	Units	5th Percentile	50th Percentile	95th Percentile	RWQO's
SODIUM	mg/L	15	28	59	115
POTASSIUM	mg/L	1.1	5	9.09	50
CALCIUM	mg/L	29	59	185.9	150
MAGNESIUM	mg/L	15	32	92	80
pH		5.9	7.9	8.3	6.5 – 8.4
CONDUCTIVITY	mS/m	37.2	66.3	165	90
CHLORIDE	mg/L	6.1	19	39	50
SULPHATE	mg/L	75	223	864	380
TALKALINITY	mg/l CaCO3	24	76	123.9	-
FLUORIDE	mg/L	0.3	0.4	0.6	1.0
PO4 as P	mg/L	0.003	0.013	0.037	0.05
$NH_4(N)$	mg/L	0.02	0.02	0.11	0.007
$NO_3(N)$	mg/L	0.02	0.04	0.23	6
SILICA	mg/L	1.21	3.1	5.99	-
TKN	mg/L	0.095	0.365	1.572	-
TP as P	mg/L	0.012	0.026	0.138	0.25
TDS	mg/L	257	466	1255	650
SAR		0.50	0.75	0.96	1.5

6.0 FLOODLINE DETERMINATION

6.1 Observations made during the site visit

A site visit to the relevant river crossings within the study area was undertaken to collect the information required to model the floodlines with the HEC-RAS model. The site visit was undertaken by Kevin Bursey and Angelina Jordanova of GAA on 07 January 2010 to determine the following inputs required by the model:

- "Roughness" of the watercourse and the area adjacent to it. The site visit established the Mannings' n to be between 0.03 and 0.045;
- Hydraulic controls (culverts); and
- The river widths, the bank heights and the road deck heights.

The site visit allowed for photographic identification and measurements of the flow controls. The location of the river crossings and their associated catchments are shown in Figure 5.

5.3.2 Klipspruit/Brugspruit

The water quality data for the Klipspruit/Brugspruit was obtained from the Anglo Brugspruit database. The data set available was for March 1990 to October 2009. The 5th, 50th and the 95th percentiles of the data set are presented in Table 15 and compared against the Resource Water Quality Objectives (RWQO). The location of the monitoring sites is shown in Figure 4.

The results given in Table 15 show the following:-

- The river system is acidic most of the time. The sources of acid are decants and seeps from the defunct mines in the upper reaches of the catchment.
- Due to the acidic conditions in the river, the dissolved heavy metal concentrations exceed the RWQO. The concentrations pose a threat to the aquatic life. In fact high aluminium concentrations have been identified as a reason for the fish kills in Loskop Dam.
- The salinity related water quality variables sulphate, TDS, calcium and magnesium exceed the RWQO.
- The Klipspruit / Brugspruit System is in a poor condition and threatens the water quality of the Olifants River and Loskop Dam.

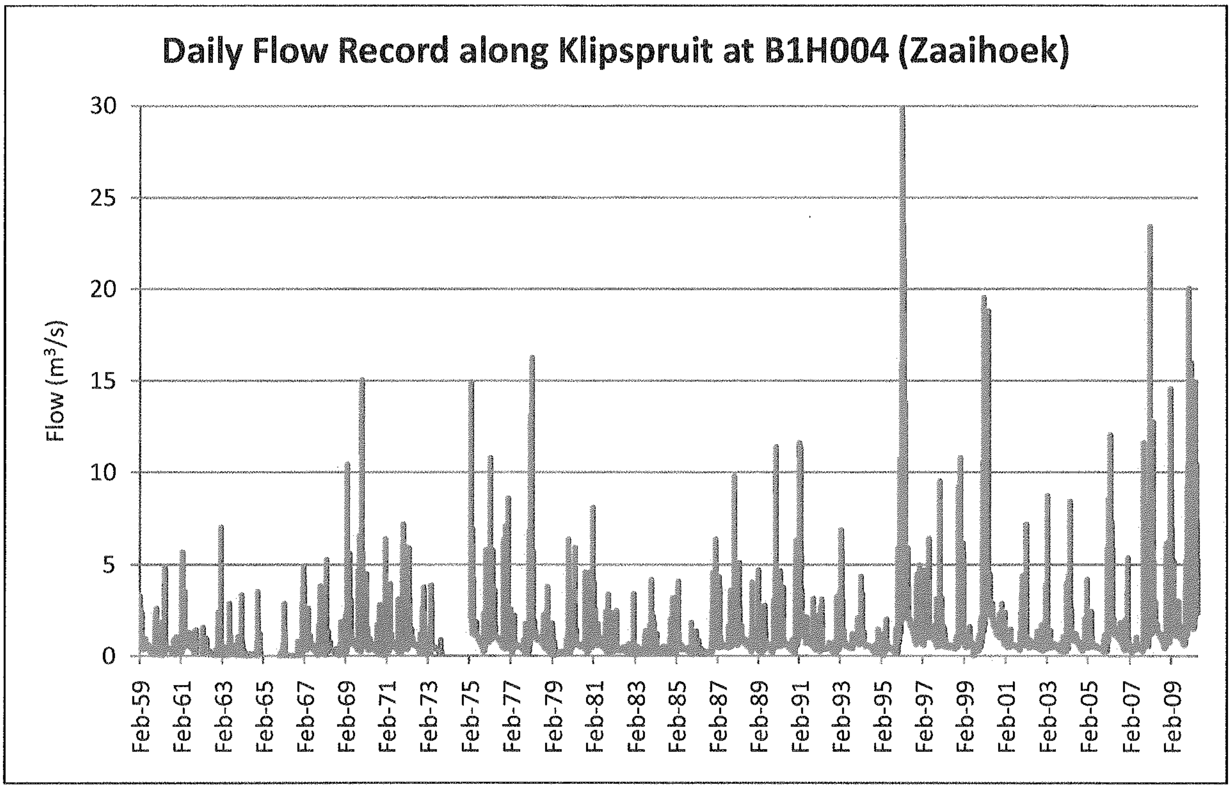


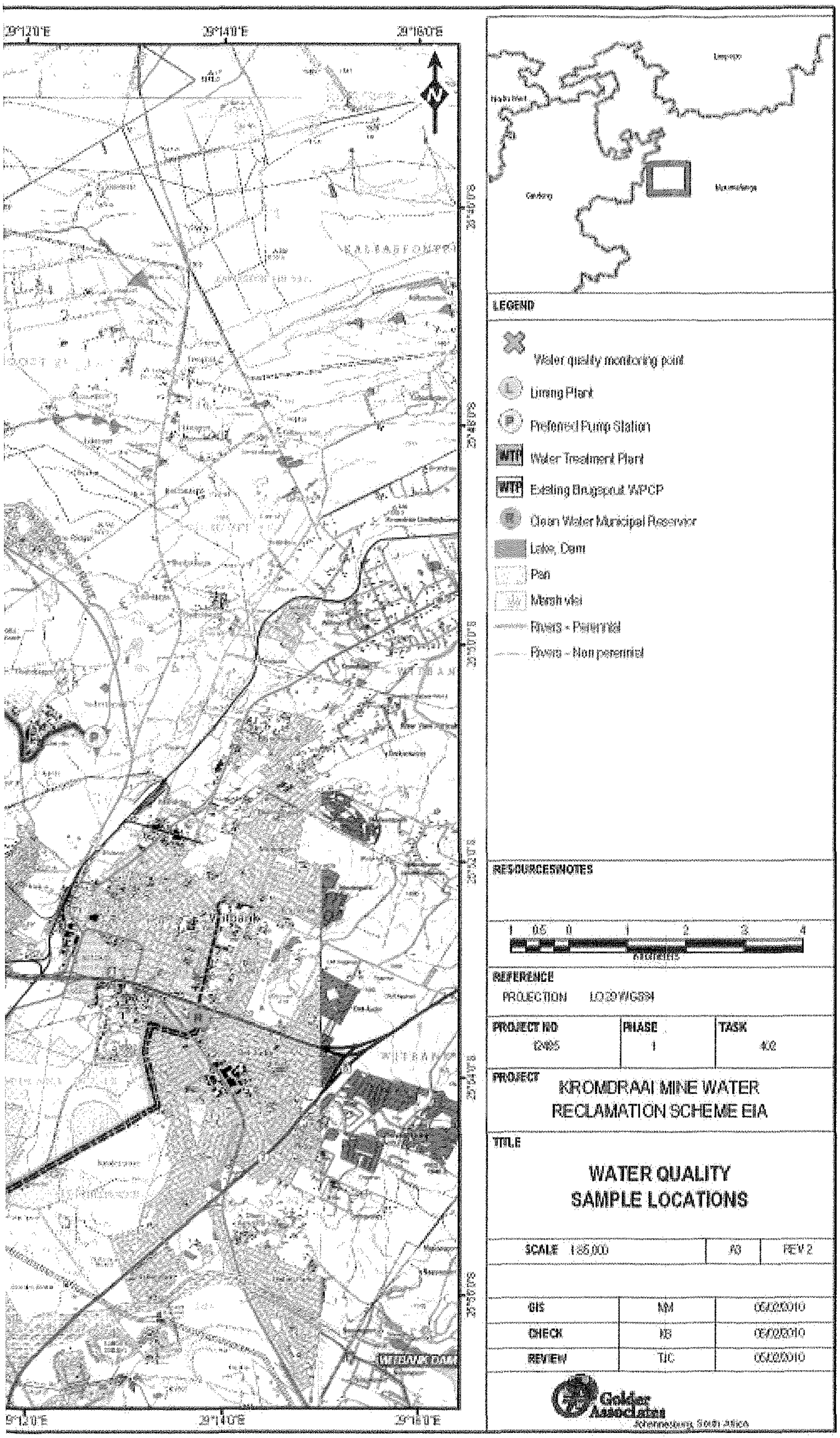
Figure 3: Daily Flow record on the Klipspruit at B1H004 (Zaaihoek)

5.3 Water Quality

The water quality data was obtained from the following sources:

- Department of Water Affairs (DWA)
- Anglo (Kromdraai)

The water qualities were assessed in terms of the *status quo* as well as the anticipated impacts of discharging water into the Kromdraaispruit, Klipspruit and Naauwpoortspruit. The water qualities presented below are representative of the current river flows found in the various catchments. The water quality monitoring site locations are shown in Figure 4.


29°12'0"E
29°14'0"E
29°16'0"E
WITBANK DAM
LEGEND
Water quality monitoring point
Liming Plant
Preferred Pump Station
WTP Water Treatment Plant
WTP Existing Brugspruit WPCP
Clean Water Municipal Reservoir
Lake, Dam
Pan
Marsh vlei
Rivers - Perennial
Rivers - Non perennial
RESOURCES/NOTES
1 0.5 0 1 2 3 4
Kilometres
REFERENCE
PROJECTION LO29 WGS84
PROJECT NO 12495
PHASE 1
TASK 402
PROJECT
KROMDRAAI MINE WATER
RECLAMATION SCHEME EIA
TITLE
WATER QUALITY
SAMPLE LOCATIONS
SCALE 1:85,000
A3
REV 2
GIS NM 05/02/2010
CHECK KB 05/02/2010
REVIEW TJC 05/02/2010
Golder Associates
Johannesburg, South Africa

5.3.1 Kromdraaispruit

The water quality data for the Kromdraaispruit was obtained from the Anglo Kromdraai database. The data set available was for the period from March 1990 to October 2009. The 5th, 50th and the 95th percentiles of the data set are presented in Table 14 and compared against the Resource Water Quality Objectives (RWQO) for the Kromdraaispruit. WP 32 is located at the weir along the Kromdraaispruit, WP 53 is located at the Graham Dam outlet along the Kromdraaispruit, WP 54 measures the quality of the discharges from the liming plant.

The comparison of the measured water quality data at WP32 to the RWQO's highlights that there are extended periods when the water in the Kromdraaispruit is slightly acid with associated high aluminium and manganese concentrations. The TDS, sulphate and calcium concentrations also exceed the RWQO's for the spruit. The discharge from the Graham Dam (WP53) is also acidic for 5% of the time. The liming plant produces an effluent which is acidic 5% of the time and periods of high pH (>9.0) for 5% of time due to over liming. In summary the available data indicates that there must be sources of acidic water other than the liming plant discharge to cause the acid conditions in the Kromdraaispruit at WP32 for more than 50% of the time.