Appendix G7: Geohydrological Specialist Study

SRK Consulting (South Africa) Pty Ltd.

Elders Colliery Hydrogeology Report - Update

Project Number: Delh. 2018.027-9b

Δh WATER SYSTEMS MODELLING

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1. INTRODUCTION

1.1. Background

In 2019 Delta H (Delta-H Water System Modelling PTY Ltd) was appointed by SRK Consulting (South Africa) (Pty) Ltd (SRK) to update the Groundwater Specialist Study Report by JMA Consulting (2015) for Anglo Operations (Pty) Limited (AOPL) proposed Elders Colliery. The updated specialist study (Delta H 2019) considered changes in the box cut, mined seam (No. 4 seam only), mining schedule and surface infrastructure, entailing an overburden stockpile at the colliery. The mining schedule was subsequently updated to comprise underground mining of the No. 2 and No. 4 seam, necessitating a model update (Delta H 2020a). The current model update takes cognisance of the recent pumping tests within the proposed mining area (Delta H 2020b), which yielded lower conductivity values than previously envisaged and subsequently lower predicted inflow rates.
To achieve a stand-alone report, only the sections addressing the groundwater model calibration and predictive simulations were updated from the previous (Delta H 2020a) report and the other sections including the unchanged impact rating carried over.

1.2. Scope of Work

The scope of work as defined by the client comprised of an update of the numerical groundwater flow model (Delta H 2019) to account for the recent pumping test results within the proposed mining area (Delta H 2020b).

The updated 3D numerical groundwater model was used to:

- Estimate future mine inflows over life of mine (on an annual basis based on provided LoM plans), which represent the updated groundwater balance for the life of mine
- Investigate the impacts of the proposed mine workings on the surrounding aquifers.
- Evaluate the potential impacts of the mine residue deposit and ore stockpile on the receiving groundwater environment (considering no intervention) using an advective-dispersive transport model.
- Estimate the rate of mine inundation post closure and potentially associated decant rates and areas over a period of 100 years.
- Predict life of mine and post-closure migration of contaminant plumes emanating from the ore and overburden stockpiles.

The impact assessment of the proposed development on the groundwater environment is based on the outcomes of the numerical groundwater flow and transport model and differentiates impacts related to:

- a change in the groundwater quality,
- a change in the volume of groundwater in storage or entering groundwater storage (recharge), or
- a change in the groundwater flow regime.

Following the impact assessment itself, a monitoring programme to monitor the status of the groundwater resource is proposed. The monitoring programme outlines necessary sampling locations, frequencies and parameters.

1.3. Project Description

The Elders Colliery is a proposed underground coal mine located approximately 25 km north of the town of Bethal, on the R35 provincial road in the Mpumalanga Province. Anglo Operations (Pty) Limited (AOL) submitted an environmental authorisation application to the Mpumalanga Department of Mineral Resources (DMR) for the proposed project on 16 July 2015 and subsequently a Scoping Report and Environmental Management Programme (EMPr) was submitted. The environmental authorisation for the proposed Elders Colliery is pending. AOL proposed to make several changes to the proposed project and subsequently requires environmental authorisation.

Recently proposed changes involve a new mine plan, which now entails the underground mining of the No. 2 and No. 4 coal seam by means of bord and pillar mining methods, making use of continuous miners and shuttle cars. Further changes relate to the locations of the overburden and ROM stockpiles, with the latter designed as a bin and an emergency stockpile area that will be cleared within in 24 hours, should the need arise to use it. The ROM stockpile and emergency stockpile area are therefore not considered as potential pollution sources in the current model application.

1.4. Data Sources and Deficiencies

1.4.1. Data Sources

The following specialist reports, mine plans, water monitoring data and mine water balance information were considered for the purpose of this study (Table 1.1).

Table 1.1: Reports and data retrieved for the study.

Author/ Consultant	Title	Report No	Description
JMA (2006)	Geological and groundwater inputs for the Anglo Elders Project	JMA Project: 10314A	Hydrocensus, borehole and geochemical data for impact assessment of opencast and underground (bord and pillar) mining of No.2 and No.4 Coal Seams
JMA (2014)	Elders Colliery: Underground and Mini-pit Geohydrological Baseline Report.	JMA/20014/2012 Prj5624 EldersBaselineReportMarch2013	Impact assessment for underground (bord and pillar) and opencast (mini-pits) mining of No. 2 and No. 4 Coal Seams, relies mostly on 2006 data, updated hydrocensus
JMA (2015)	Groundwater Specialist Report, Anglo Operations Ltd – Elders project - No.2 & No.4 Seam Underground	JMA Project: JMA/10456 JMA Report: Prj5924 SRK Ref: 484436	Impact assessment of proposed underground (bord and pillar) mining of No.2 and No.4 Coal Seams, relies on 2006 and 2014 data
GEOSTRATUM Groundwater and Geochemistry Consult (2015)	Environmental geochemical Report – Geochemical testing of Coal Samples from the Elders Colliery	Report No. 1502002 Report Status: First Draft Report	ABA and kinetic leach tests on 6 coal samples
Australian Laboratory Services [ALS] (2012)	Acid Mine Drainage (AMD) Prediction from coal samples – A Shake Flask Kinetic Test	Australian Laboratory Services (ALS) Report No. 2	Kinetic shake flask testing of six coal samples
SRK Consulting (2015)	Anglo Operations Pty Ltd Elders Colliery Integrated Water and Waste Management Plan	JW212/15/D202 – Rev 1	IWWMP
Ukwazi, 2019	102ELD028-RS0003-000-C-ELDERS BLOCK PLAN (Bound).DWG	-	Surface Mine layout, including overburden stockpile, Pollution Control Dams and brine dam
Ukwazi, 2020	S2_1.dxf - S2_4.dxf, S4_1.dxf to S4_7.dxf, EldersPPP_v1.pptx	-	Updated Life of Mine plan
Ukwazi, 2020	102ELD029-RS0022-000-E-ELDERS BLOCK PLAN.DWG		Updated box cut and surface infrastructure layout
Anglo American, 2019	eld_topo_bhwe_thk_1m.dxf	-	Basal horizon of weathering, Elders Colliery
Anglo American, 2019	eld_s4_totrf_cnt_5m.dxf and eld_s4_totfl_cnt_5m.dxf	-	Roof and floor of No 4 Seam, Elders Colliery
Anglo American, 2019	s2faults_0316.dxf and s4faults_0316.dxf, aeromag_interp_2005.dxf		Delineated faults and sills, Elders Colliery
JMA / SRK	Wetlands_updated_07092015_Cape.shp	-	Map of delineated wetlands

1.4.2. Deficiencies

Knowledge gaps identified during the data review process relate to the following:

- Hydraulic conductivity values only available from slug tests performed at shallow depth (i.e. not the targeted seams). However, this is a common approach and the model predictions should accordingly be updated once early mine inflow data become available.
- Dolerite dykes/sills conductivities based on literature values only – common approach.

2. GEOGRAPHICAL SETTING

2.1. TOPOGRAPHY AND DRAINAGE

The Elder Colliery is located on various farm portions from Kleinfontein 49 IS, Boschkrans 53 IS, Elandsfotine 75 IS, Middelkraal 50 IS, Halfgewonnen 190 IS, Vlakfonein 76 IS and Geluk 226 IS, located in Mpumalanga Province. The project area is approximately 18 km north from Bethal and 24 km east of Kriel, with the R23 running north to south through the project area, illustrated in Figure 2.1. The project area falls within qquaternary catchment B11A (with a small portion into B11B) of the Olifants Water Management Area. The topographical feature ranges from approximately 1700 metres above mean sea level (m AMSL) to 1550 m AMSL towards the Olifants and Viskuile Rivers. The major Olifants and Viskuile Rivers, together with some smaller tributaries; all flow towards the north-west.

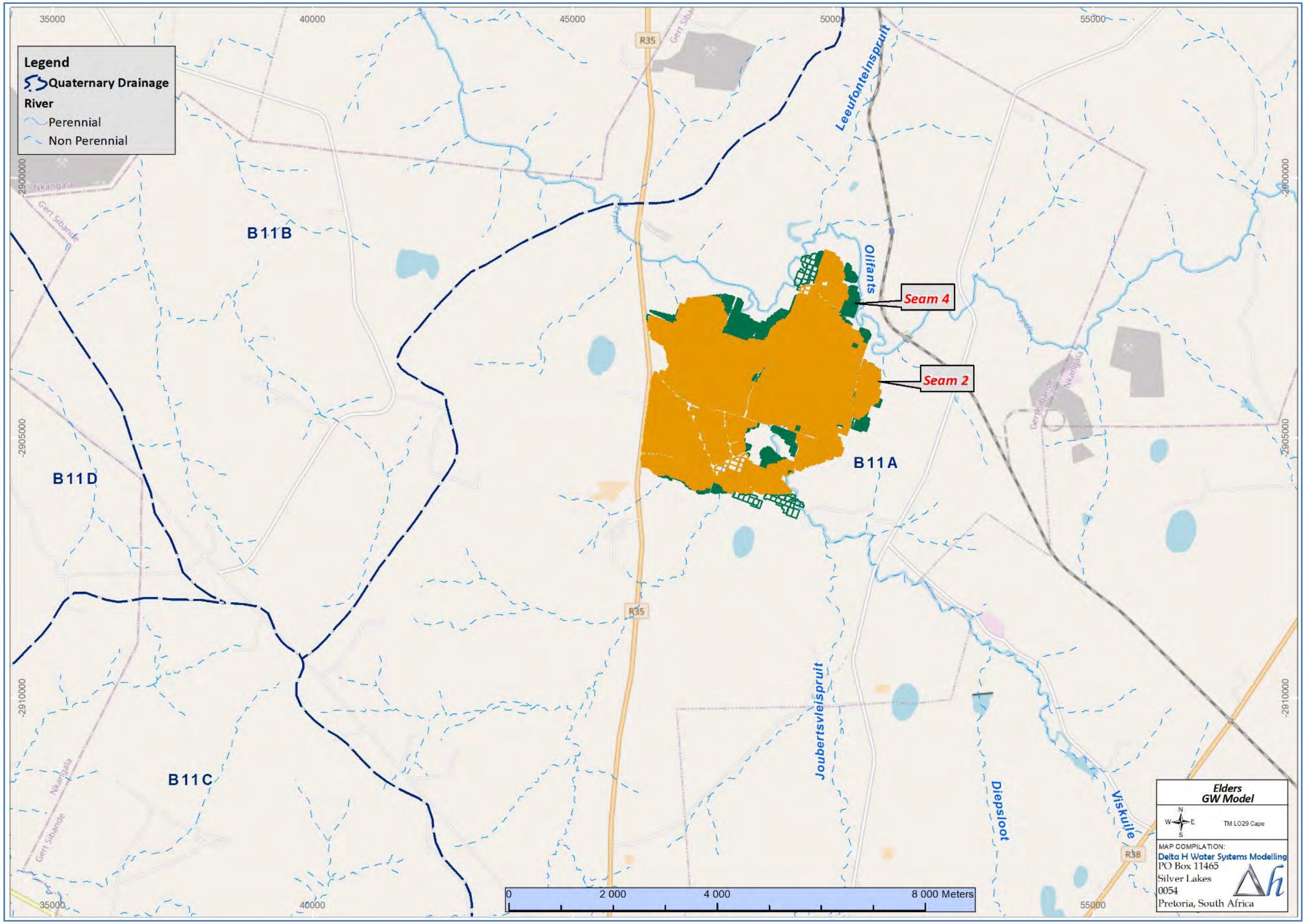

Figure 2.1: Locality map of the project area.

2.2. CLIMATE

The area is characterised by an undulating topography and typical Highveld climate, with rainfall predominantly in the warm summer month and cold dry winters. JMA (2015) collated and analysed a comprehensive rainfall data set for the area using the combined rainfall record of the 0478292W Langsloot (1914 to 1992) and 0478303 Secunda (1984 to 2008) stations (Table 2.1). JMA (2015) present also Mean Annual Runoff (MAR) values for catchments in the wider project area from the WR90 database, with a MAR of 39 mm for quaternary catchment B11A into which most of the Elders project area falls.

Table 2.1: Average Monthly Rainfall depths for SAWS station 0478292W/ 0478303 and Evaporation Depths from WR90 (JMA 2015).

Month	Average rainfall (mm)	Average evaporation (mm)
October	77.2	139.7
November	112.1	133.4
December	121.9	148.7
January	129.9	147.8
February	90.5	129.1
March	82.0	127.4
April	38.0	98.0
May	19.9	81.6
June	9.6	64.7
July	6.8	69.2
August	8.9	89.4
September	21.8	115.9
Annual Total	**718.6**	**1344.9**

A summary of readily available hydrological data for the catchments of interest is provided in Table 2.2, with the proposed mine falling primarily into quaternary catchment B11A and to a minor portion B11B.

Table 2.2: Summary of information for the quaternary catchments the Elders model area (GRAII; DWAF 1996).

Quaternary catchment	Mean Annual Precipitation (mm/a)	Mean Annual Runoff (mm/a)	Mean Annual Baseflow (mm/a)	Mean Annual Recharge		Mean Annual Recharge after Vegter (1995)	
				mm/a	% of MAP	mm/a	% of MAP
B11A	699	38.94	12.86	41.73	5.97	32.26	4.61
B11B	687	36.20	11.90	50.97	7.42	38.80	5.65
B11C	673	33.18	12.47	34.36	5.11	32.00	4.75
B11D	671	30.08	11.78	38.83	5.79	32.12	4.79

3. METHODOLOGY

3.1. Desk Study

The desktop study relied on a review of readily available data in the form of

- hydrogeological specialist reports (see Table 1.1),
- site layout as provided by the client,
- results from the continuous monitoring program at Elders Colliery,
- data from the national Groundwater Archive and Groundwater Resource Assessment Phase II, maintained by the Department of Water Affairs and Sanitation,
- published regional geological and hydrogeological maps.

The desktop study focussed on the establishment of a sound conceptual hydrogeological model as detailed in chapter 6.5.

3.2. Hydrocensus

A groundwater hydrocensus of the Elders Colliery project area was undertaken from the 18th of February to the 22nd of February 2019. The hydrocensus took cognisance of the 2002 and 2012 hydrocensus completed by JMA Consulting (Pty) Ltd. A total of 50 boreholes were located and verified in the field, largely within the proximity of the proposed underground mining area. The spatial distribution of the boreholes is shown in Figure 3.1, while the identified borehole coordinates, status and uses including groundwater levels are shown in Table 3.1. The ESW boreholes in Table 3.1 are generally in a poor condition, mainly because of their age and neglect.

Ten water samples were analysed for major and trace elements to provide an evaluation of the ambient groundwater quality. Additional photos of the boreholes (and headworks) is provided in Appendix A. Twenty-six groundwater level measurements could be obtained during the hydrocensus. The water levels measured during the 2019 hydrocensus in the area ranged between 0.6 metre below ground level (mbgl) and 35.2 mbgl, with an arithmetic average of around 8.4 mbgl.

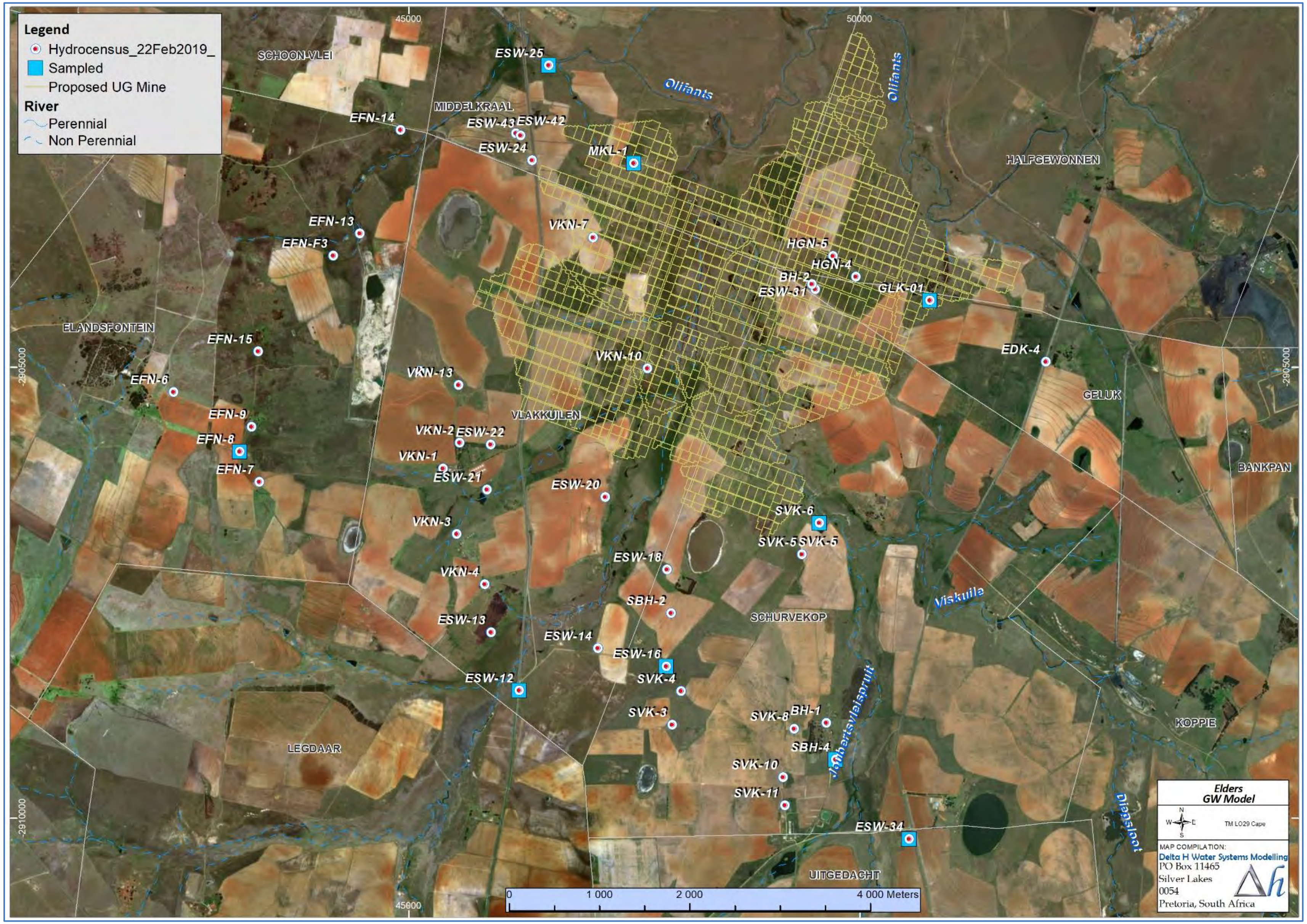

Figure 3.1: Hydrocensus (2019) boreholes, Elders Colliery.

Table 3.1: Summary of hydrocensus boreholes (bold BH IDs indicate sampled boreholes).

BH	Long_WGS	Lat_WGS	GW level (mbgl)	Comment	Parent Farm
BH-1	29.49667	-26.29163	0	Wind pump. Borehole in use for domestic purposes.	SCHURVEKOP
BH-2	29.49522	-26.24825	35.2	Monitoring borehole, well is in good condition. No markings could be observed.	GELUK
EDK-4	29.52087	-26.25541	9.96	General condition of the borehole is good. Allen key bolt was replaced and thread lubricated.	
EFN-13	29.44468	-26.24283	3.54	-	ELANDSFONTEIN
EFN-14	29.44915	-26.23246	4.94	Overall condition good. Bee infested.	
EFN-15	29.43346	-26.25468	3.31	Open hole not in use.	
EFN-6	29.42410	-26.25876	14.81	Wind pump not in use	
EFN-7	29.43364	-26.26773	-	Destroyed	
EFN-8*	29.43145	-26.26470	4.95	Open hole, not used.	
EFN-9	29.43276	-26.26220	6.87	Wind pump. Borehole is in use and pumps into a 5000l JOJO tank for domestic use.	
EFN-F3	29.44175	-26.24506	-	Spring	
ESW-12*	29.46254	-26.28849	2.54	General condition of the borehole is good. Allen key bolt was replaced and thread lubricated.	VLAKKUILEN
ESW-13	29.45942	-26.28270	5.07	General condition of the borehole is good. Allen key bolt was replaced and thread lubricated.	
ESW-14	29.47126	-26.28423	-	Open hole, not used.	
ESW-16*	29.47888	-26.28602	3.06	General condition of the borehole is good. accept for casing. Allen key bolt was replaced and thread lubricated. Bolt size is 8mm.	SCHURVEKOP
ESW-18	29.47892	-26.27635	-	Bee infested	
ESW-20	29.47201	-26.26912	8.17	General condition of the borehole is good. Allen key bolt was replaced and thread lubricated.	VLAKKUILEN
ESW-21	29.45892	-26.26843	-	General condition of the borehole is in a reasonable condition. Bee hives inside the borehole. Could not measure water level.	
ESW-22	29.45928	-26.26391	4.56	Borehole is in a reasonable condition. Allen key bolt was replaced and lubricated. Bolt size is 8mm	
ESW-25*	29.46559	-26.22593	0	Artesian hole	MIDDELKRAAL
ESW-31	29.49487	-26.24775	13.12	Borehole in good condition. Borehole is fenced off.	GELUK
ESW-34*	29.50588	-26.30322	13.26	Borehole damaged, casing bent.	UITGEDACHT
ESW-42	29.46197	-26.23277	t.b.d.	Borehole with 75mm ID casing (located in bean crops)	MIDDELKRAAL
ESW-43	29.46248	-26.23299	t.b.d.	Borehole with 75mm ID casing (located in bean crops)	
HGN-4	29.49976	-26.24700	4.39	Borehole is open and not in use.	HALFGEWONNEN
HGN-5	29.49718	-26.24493	-	No access	
MKL-1*	29.47506	-26.23572	0.6	Open hole not in use. Situated at old homestead.	MIDDELKRAAL
RP-1	29.38531	-26.28984	-	Hand pump and is used for domestic purposes.	RENSBURGSHOOP
SBH-2	29.47937	-26.28071	2.8	Overall borehole condition is good accept for marker pole. Borehole was drilled in 2017.	SCHURVEKOP
SBH-4*	29.49770	-26.29527	3.21	Monitoring borehole. Overall condition is very good. Borehole drilled in 2017. More details in spreadsheet.	SCHURVEKOP
SVK-10	29.49188	-26.29709	-		
SVK-11	29.49208	-26.29991	-	Borehole equipped with a hand pump Borehole water is used for domestic purposes.	
SVK-3	29.47955	-26.29185	-	Wind pump. No access for meter to measure water level. Borehole used for cattle drinking water.	

BH	Long_WGS	Lat_WGS	GW level (mbgl)	Comment	Parent Farm
SVK-4	29.48053	-26.28850	8.32	Wind pump. Water used for cattle	
SVK-5	29.49388	-26.27478	-	Borehole is equipped with a windmill. Not in use. Base plate closed no access.	
SVK-8	29.49309	-26.29222	-	Maize field	
VKN-1	29.45401	-26.26631	15.54	Borehole is used for domestic purposes. Hole is equipped with a 0.56kw submersible pump.	VLAKKUILEN
VKN-10	29.47667	-26.25623	1.89	Newly renovated wind pump. Water used for cattle.	
VKN-12	29.45138	-26.25658	16.91	Borehole is equipped with a new wind pump. Water is used for cattle.	
VKN-13	29.45570	-26.25798	-	Open hole, not in use blocked at 1.0m	
VKN-2	29.45585	-26.26372	-	Destroyed	
VKN-3	29.45556	-26.27286	24.69	This borehole supplies drinking water to a village close by. Hole is equipped with a submersible pump	
VKN-4	29.45871	-26.27787	0	Borehole is equipped with a windmill. Borehole is not in use. Located next to an abandoned village.	
VKN-7	29.47059	-26.24318	0	Destroyed	
SVK-6*	29.49578	-26.27161	5.49	Borehole is open and not in use. The pipe in the borehole has no use.	SCHURVEKOP
SVK-5	29.49388	-26.27478	0	Wind pump\cattle water	SCHURVEKOP
KT-02	29.36526	-26.32362	0	Blocked	KRAALSTAD
HB0-04*	29.38364	-26.32659	1.25	Borehole is open and is not in use.	KRAALSTAD
ESW-24	29.46379	-26.23547	0	Overall condition good. Bee infested.	MIDDELKRAAL
GLK-01*	29.50796	-26.24933	0	Newly renovated wind pump. Water used for cattle.	GELUK

3.3. GEOPHYSICAL SURVEY AND RESULTS

The objective of the geophysical surveys was to investigate the sub-surface for geological anomalies and deep weathering zones, which could potentially act as preferential flow paths and to optimize the selection of drilling sites for water supply boreholes. Available Skytem data with inferred dykes, faults, and other anomalies together with topographic and geological maps were used to provide guidance for the ground geophysical traverse locations, which entailed Magnetic Method, Earth Resistivity Tomography and Electromagnetic Method (see Delta H 2020b).

3.4. DRILLING AND SITING OF BOREHOLES

Seven (7) new boreholes were sited using ground geophysics and drilled as part of this study. While Table 3.2 provides a summary of the boreholes, the reader is referred to Delta H (2020b) for a more detailed description of the boreholes.

Table 3.2: Summary of newly drilled boreholes.

BH ID	Long	Lat	Station	Water Intersection (drillers note)	Depth [m]	Casing height [m]	Water level [m]	OD:pvc [mm]
EGW-BH1	29.47760	-26.23530	7/275	Seepage (no strike)	42.78	0.22	5.8	90
EGW-BH2	29.47110	-26.24270	6/755	Water (strike 27)	49.1	0.33	6.23	140
EGW-BH3	29.47170	-26.24230	6/830	Little Water (strike 48)	50.8	0.48	3.81	90
EGW-BH4	29.46800	-26.24510	6/340	Water (strike 24)	43.59	0.44	7.01	140
EGW-BH5	29.48120	-26.23390	7/675	Water	48.37	0.58	6.4	140
EGW-BH6	29.47310	-26.24130	6/1005	Significant water (strike 30)	48.3	0.27	1.85	140
EGW-BH7	29.47480	-26.23190	8/155	No-strike	43.58	1.3	5.37	90

Furthermore, approximate positions (to be refined by ground geophysical investigations) for new monitoring boreholes are proposed in chapter 8.1.

3.5. AQUIFER TESTING

The seven (7) newly drilled boreholes (Table 3.2) were tested to determine the site specific aquifer parameters. Four (4) boreholes were pump tested whereas the remaining three (3) boreholes were slug tested due to low yields (Delta H 2020b). Additional hydraulic conductivity values of the aquifers are also available from previous hydrogeological studies for the site (JMA 2006, 2015).

3.6. SAMPLING AND CHEMICAL ANALYSIS

In addition to earlier water analysis (see chapter 4.6), ten groundwater water samples were taken during the 2019 hydrocensus and analysed by an accredited laboratory for major and trace elements to provide an evaluation of the ambient groundwater quality. The recent hydrocensus results are also discussed in chapter 4.6.

3.7. GROUNDWATER RECHARGE CALCULATIONS

The main source of recharge into the shallow primary aquifers is direct rainfall recharge that infiltrates the aquifer through the overlying unsaturated zone. Recharge of the deep Karoo aquifer is limited to vertical seepage from the shallow Karoo aquifer through permeable fracture systems that cut through dolerite sill or Karoo sandstones and link the two aquifers hydraulically. Due to the heterogeneous nature of fracture systems, the hydraulic interaction is highly variable. The percentage of the mean annual precipitation (MAP) of around 670 mm for the area of interest recharging the regional undisturbed shallow weathered Karoo aquifer was estimated in GRAII (DWAF 2006) to range from 4.6 % to 7.4 % of MAP or 32 to 51 mm/a for the catchments of interest (Table 2.2).
JMA (2015) estimated recharge rates of 4% of MAP for areas below the No.4 coal seam covered by natural vegetation, of 13% for areas below the delineated surface water bodies and 8% for areas within 100 m from surface water bodies for their calculation of the mine water balance. While the recharge rates for delineated surface water bodies, which

include wetlands, are certainly too high for wetlands (which evapotranspirate water), the natural vegetation recharge rate appears reasonable based on experience from other mines in the area.

The following recharge rate estimations were used in the current study:

- a regional recharge rate of 4% of MAP or 29 mm/a
- a recharge rate of 2.7% of MAP or 20 mm/a for wetlands
- a recharge rate of 5% of MAP or 36 mm/a for the overburden stockpile during LoM
- a seepage rate of 12 mm/a for the lined Pollution Control and Brine Dams during LoM, which is considered a conservative overestimation of seepage rates for lined facilities (see chapter 6.4.3).

3.8. GROUNDWATER MODELLING

A three-dimensional numerical (finite-element) groundwater flow and transport model was developed for Elders Colliery. A numerical model is a mathematical approximation of the real word aquifer system, and there are always errors associated with groundwater models due to uncertainty in the data, potential alternative conceptual models in describing the real world system or the capability of numerical methods to describe natural physical processes. However, numerical groundwater models are considered the best tools available to quantify / estimate groundwater and contaminant transport, and the results can be used in management decisions. The chosen software code, model set-up, assumptions and results are described in detail in chapter 6.

4. PREVAILING GROUNDWATER CONDITIONS

4.1. GEOLOGY

4.1.1. Regional Geology

The project area is predominantly underlain by litho-stratigraphic units from the Karoo Supergroup (Figure 4.3), overlain along major river courses by quaternary, alluvial deposits. The Karoo Supergroup formed during the Late Carboniferous to Middle Jurassic eras from plant assemblages, thick glacial deposits and extensive flood basalts with their associated dolerite sills and dykes. Extensive coal deposits establish the economic importance of the Karoo Supergroup. The project area is characterised by the Main Karoo Basin which is underlain by the stable Kaapvaal Craton floor. The Main Karoo Basin consists of a number of sub-groups, i.e. Dwyka, Ecca, Beaufo, Drakensburg and Lebombo Groups. These sub-groups are further divided into formations. One such formation, the Vryheid Formation, forms part of the Ecca Group, and characterise the geology and geomorphology of the project area. There are no exposures of Pre-Karoo rocks in the project area as outcrops are limited to Karoo dolerite and the Ecca Group. The Vryheid Formation is mainly from deltaic origin, consisting of upwards coarsening sedimentary material such as dark-grey, muddy siltstone, sandstone, dark siltstone and mudstone units, with interbedded coal units of variable thicknesses at depths.
The dolerite intrusions present within the project area are younger than the lithologies of the Ecca Group and intruded into and through these sedimentary lithological units. The dolerite intrusions typically occur as sills or dykes and are often responsible for the devolatization of the coal adjacent to these intrusions. Typically, dolerite sills crop out on surface, occur very close to the surface or have been entirely removed through erosion in places. These sills are usually fine crystalline, although it can occur in varying degrees of texture starting from fine crystalline and grading to a medium crystalline texture.

4.1.1. Local Geology

Based on geological logs from exploration boreholes, Anglo Operations (Pty) Limited developed a detailed geological model for the site, describing the depth of soft overburden, base of weathering and coal seams as well as structural information (dykes, faults). The information was used to develop the conceptual as well as numerical model, i.e. the model layers align with the provided geological model (Figure 6.2 and Table 6.1).

Figure 4.1 shows a generalised geological profile for Elders Colliery, while Figure 4.2 shows the bowl shaped No. 4 coal seam floor contours, which essentially reflects the topography of the proposed 4 and 2 seam underground workings.

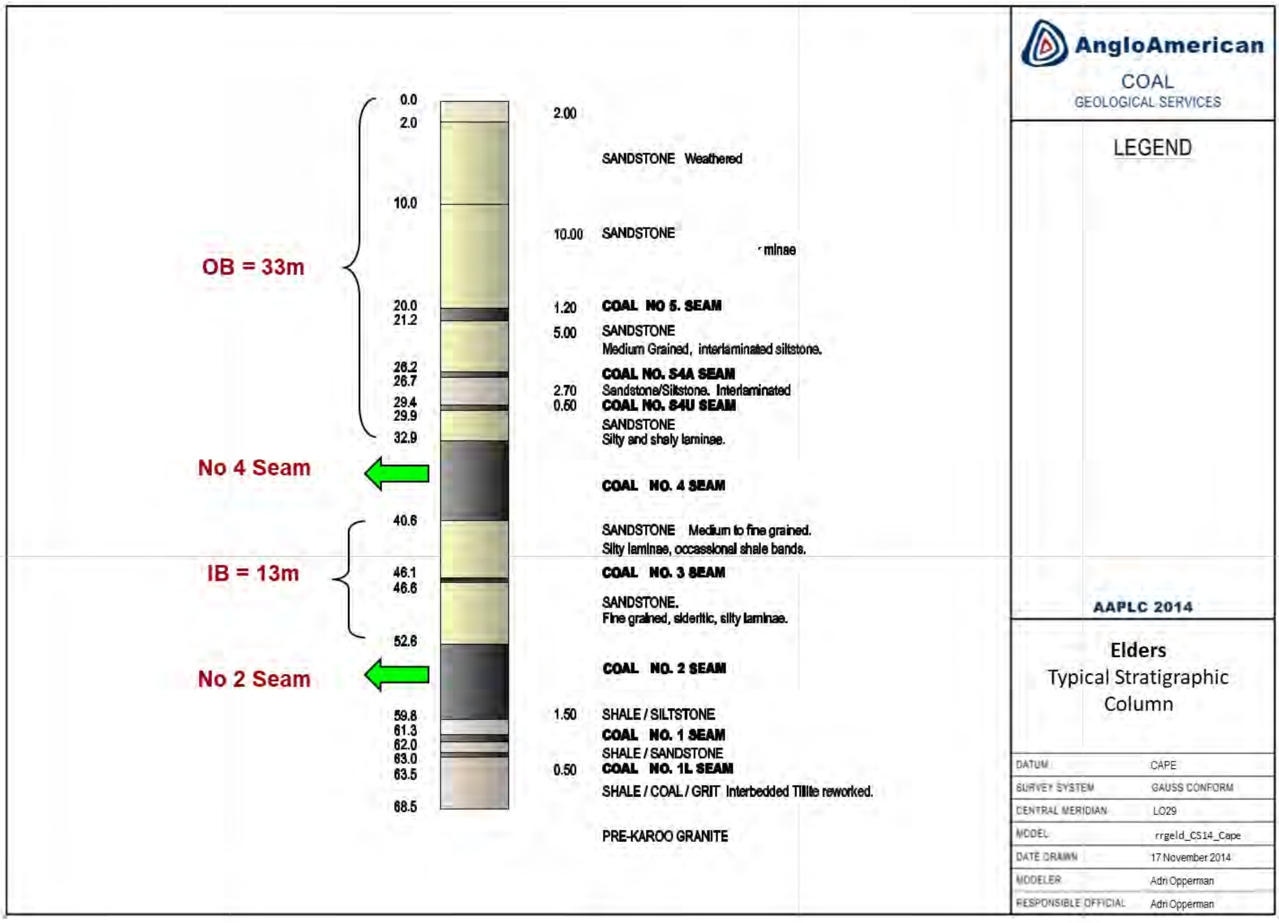

Figure 4.1: Generalised geological profile for Elders Colliery (client data, file name: Elders_Attachment_10_StratColumn.pptx).

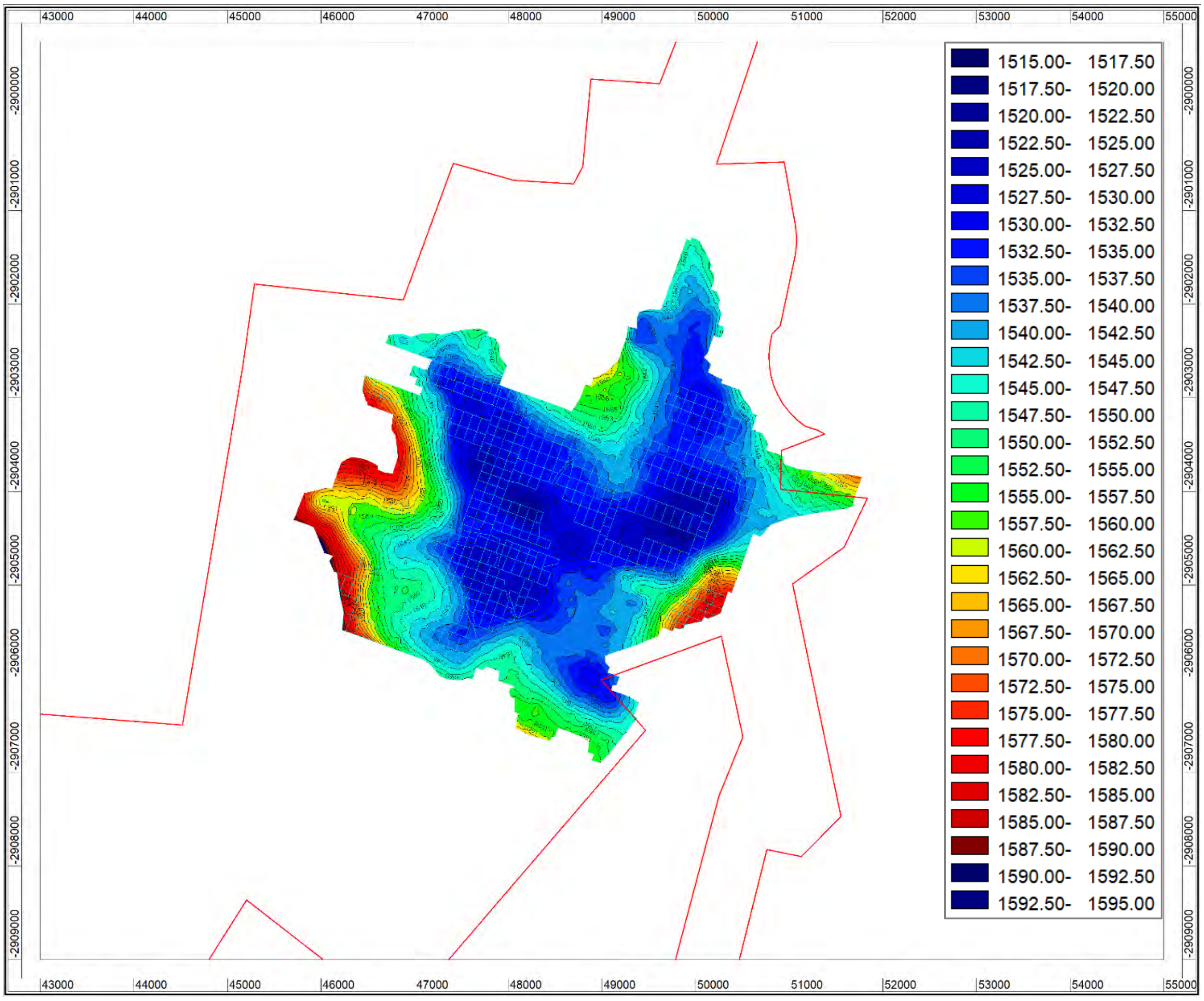

Figure 4.2: No. 4 Seam floor elevations at Elders Colliery.

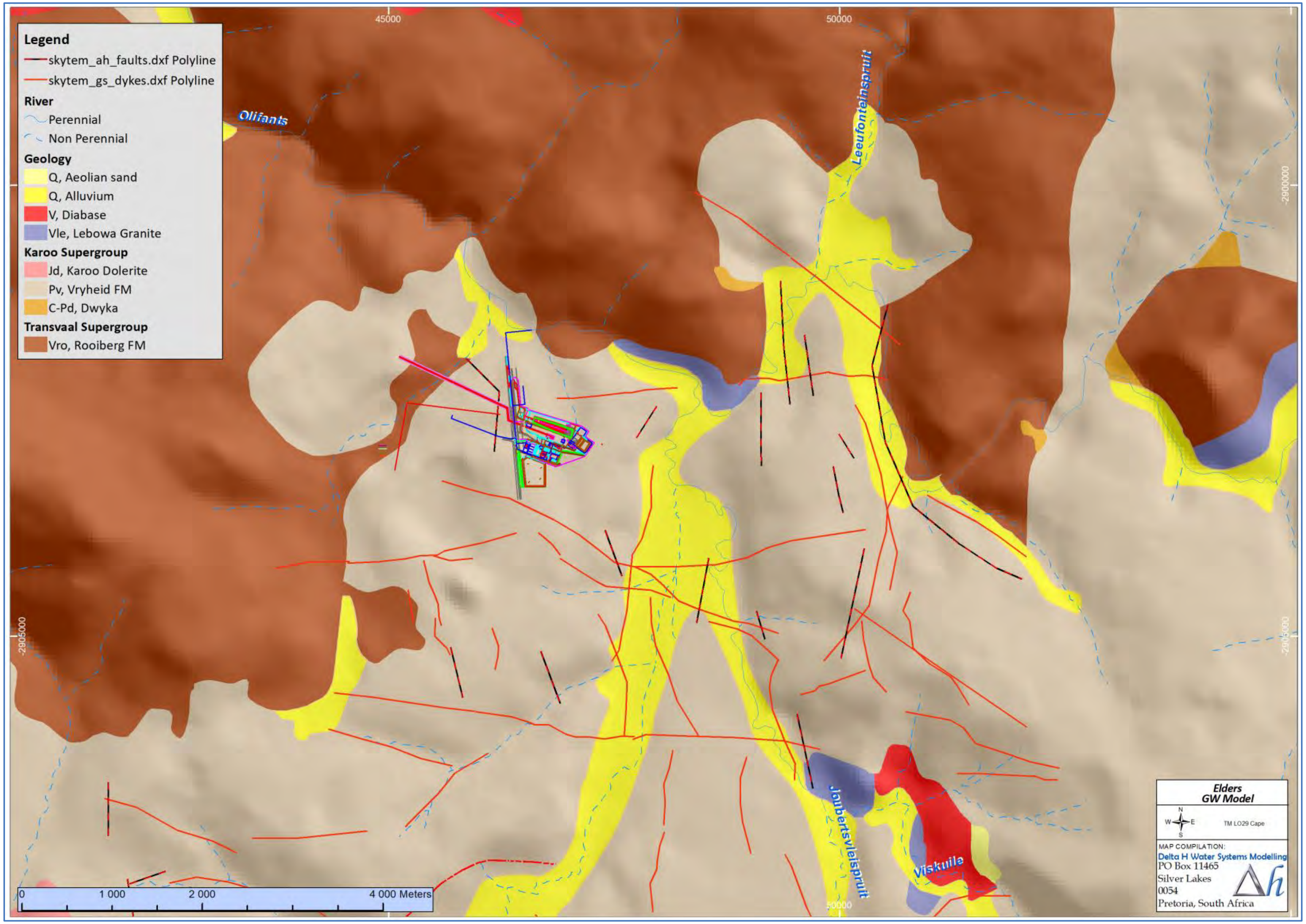

Figure 4.3: Regional geological setting of Elders Colliery.

4.2. ACID GENERATION CAPACITY

4.2.1. Previous Assessments

JMA (2006) retrieved geochemical samples from nine hydrogeological boreholes (ESW-4, -9, -13, -24, -25, -27, -29, -34 and EDK-4) to determine the geochemical characteristics of the different lithological units at EldersColliery. Acid Base Accounting (ABA) results are available for 29 samples (Table 4.1), XRD results for 12 over- and interburden (Table 4.2) as well as 14 coal samples (Table 4.3). Particle size analyses as required for kinetic geochemical models are available for the clastic sedimentary units and coal seam (Table 4.4). Except for a few (1 Rhyolite, 1 sand, 2 sandstone and 1 siltstone) samples, the tested over-/interburden and coal samples are generally classified potentially acid generating.

Table 4.1: ABA results for the Elders Colliery samples (after JMA 2006, sample type reclassified).

No.	Lithological description	Paste pH	Oxidized pH	Total S (%)	AP (kg/t)	NP (kg/t)	NNP (kg/t)	NPR	Type
1	Carbonaceous Siltstone	7.65	7.52	0.183	5.72	48.75	43.03	8.52	NAG
2	No. 5 coal seam	7.4	3.73	0.348	10.88	8.75	-2.13	0.8	PAG
3	Sandstone	7.34	2.35	1.739	54.34	11	-43.34	0.2	PAG
4	No. 5 coal seam	6.33	1.35	0.215	6.72	0	-6.72	0	PAG
5	Carbonaceous Siltstone	3.89	1.95	0.897	28.03	0	-28.03	0	PAG
6	Carbonaceous Siltstone	7.59	7.45	2.332	72.88	55.5	-17.38	0.76	PAG
7	No. 4 coal seam	7.52	7.07	0.974	30.44	11.5	-18.94	0.38	PAG
8	Sandstone	8.09	2.63	0.492	15.38	5.75	-9.63	0.37	PAG
9	Carbonaceous Siltstone	7.43	3.25	0.653	20.41	2.75	-17.66	0.13	PAG
10	No. 4 coal seam	7.83	7.29	0.985	30.78	3.25	-27.53	0.11	PAG
11	Sandstone	8.12	3.25	1.325	41.41	14.25	-27.16	0.34	PAG
12	No. 2 coal seam	7.44	3.81	0.623	19.47	12.75	-6.72	0.65	PAG
13	No. 4 coal seam	6.6	4.55	0.041	1.28	1.25	-0.03	0.98	PAG
14	No. 4 coal seam	7.52	3.2	0.355	11.09	4.25	-6.84	0.38	PAG
15	Sandstone	8	2.7	0.233	7.28	3.75	-3.53	0.52	PAG
16	No. 2 coal seam	7.26	3.6	0.548	17.13	9	-8.13	0.53	PAG
17	No. 4 coal seam	8	7.19	1.239	38.72	34.25	-4.47	0.88	PAG
18	Sandstone	8.93	6.76	0.323	10.09	12	1.91	1.19	PAG
19	No. 2 coal seam	8.19	5.81	1.275	39.84	17.75	-22.09	0.45	PAG
20	Sand and clay	8.2	7.37	0.001	0.03	0	-0.03	0	Uncertain
21	No. 4 coal seam	6.75	1.51	0.085	2.66	0	-2.66	0	PAG
22	No. 4 coal seam	7.55	3.45	0.199	6.22	5	-1.22	0.8	PAG
23	Rhyolite	9.66	8.66	0.015	0.47	6.25	5.78	13.33	NAG
24	Sandstone	8.24	8.43	0.009	0.28	10	9.72	35.56	NAG
25	No. 5 coal seam	7.78	2.8	1.281	40.03	3.5	-36.53	0.09	PAG
26	Sandstone	9.12	3.67	0.066	2.06	2.5	0.44	1.21	Uncertain
27	Sandstone	8.85	8.76	0.001	0.03	43.5	43.47	1392	NAG
28	No. 5 coal seam	7.78	7.4	1.145	35.78	9	-26.78	0.25	PAG
29	Carbonaceous Shale	7.93	3.06	1.481	46.28	4.75	-41.53	0.1	PAG

Table 4.2: XRD analysis of clastic and clastic carbonaceous samples, Elders Colliery (JMA 2006).

Unit	Dolomite/ Ankerite	Siderite	Calcite	K-Feldspar	Cpx	Plagioclas e	Hematite	Pyrite	Anatase	Quartz	Chlorite	Mica	Kaolinite	Smectite	Il/Sm Interstrati
ESW13, 8-10m, Carbonaceous Siltstone	5	6	5	4	-	2	-	1	-	24	-	14	37	-	3
ESW24, 18-25m, Carbonaceous Siltstone	7	-	8	9	-	-	-	1	-	20	-	-	55	-	-
ESW24, 28-29m, Carbonaceous Siltstone	-	-	4	16	-	-	-	trace	-	53	-	-	27	-	-
ESW25, 8-16m, Carbonaceous Siltstone	2	-	1	8	3	3	-	1	1	56	-	-	22	5	-
EDK4, 21-22m, Carbonaceous Shale	-	3	3	1	-	4	-	3	1	32	-	7	39	-	7
ESW13, 15-17m, Sandstone	1	-	2	11	-	-	-	trace	1	41	-	4	39	-	2
ESW25, 7-8m, Sandstone	-	-	1	2	-	2	-	-	-	81	-	2	8	4	-
ESW25, 19-27m, Sandstone	-	-	-	3	-	-	-	-	-	91	-	-	6	-	-
ESW29, 11-17m, Sandstone	-	-	-	16	-	19	-	-	-	52	9	4	-	-	-
ESW4, 16-17m, Sandstone	5	1	2	7	-	6	-	1	-	52	-	8	15	-	3
ESW34, 17-18m, Sandstone	-	1	1	11	-	4	-	-	1	71	-	-	11	-	-
ESW9, 6-10m, Sandstone	-	-	1	1	-	3	-	1	1	49	-	10	31	-	3

Table 4.3: XRD analysis of coal samples, Elders Colliery (JMA 2006).

BH	Seam	Dolomite/ Ankerite	Siderite	Calcite	K-Feldspar	Cpx	Plagioclase	Hematite	Pyrite	Goethite	Anatase	Alunite	Quartz	Chlorite	Mica	Kaolinite	Smectite	Il/Sm Inter-stratificatio
ESW13, 10-15m	5	5	1	3	4	-	-	-	1	-	-	-	28	-	5	52	-	2
ESW24, 14-18m	5	-	8	-	4	-	-	-	-	-	-	-	31	-	9	48	-	-
ESW9, 5-6m	5	-	-	1	11	-	-	-	-	-	1	-	58	-	4	21	-	4
EDK4, 20-21m	5	12	2	22	7	3	-	1	-	-	-	17	-	5	25	-	4	-
ESW24, 29-30m	4	-	1	2	2	-	-	-	-	-	1	-	42	-	3	47	-	2
ESW25, 18-19m	4	-	-	5	-	-	-	-	-	-	-	22	18	-	-	55	-	-
ESW29, 5-6m	4	-	-	-	4	-	-	-	-	-	-	-	77	-	-	18	-	-
ESW29, 7-10m	4	-	-	-	-	-	-	-	-	-	-	-	23	-	-	66	-	-
ESW4, 13-15m	4	-	8	-	4	-	7	-	1	-	-	-	28	-	9	26	18	-
ESW27, 17-24m	4	-	-	10	6	-	-	-	1	-	-	-	29	-	-	46	-	8
ESW34, 14-15m	4	-	-	3	12	-	18	-	-	13	-	-	21	-	16	18	-	-
ESW29, 2-4m	2	-	-	2	2	-	-	-	1	-	1	-	11	-	-	83	-	-
ESW4, 11-13m	2	-	21	9	8	-	7	-	1	-	1	-	16	-	11	16	10	-
ESW27, 5-7m	2	23	-	-	2	-	2	-	3	-	3	-	19	-	3	9	3	22

Table 4.4: Particle size analysis of sedimentary units, Elders Colliery (JMA 2006).

Grain size interval (mm)		Grain type (Wentworth size class)	Clastic sedimentary units		Coal seams	
			g	wt-%	g	wt-%
4.75	10	Gravel (Granule-Pebble)	102.7	1.21	131.36	1.81
2.8	4.75	Gravel (Granule-Pebble)	65.7	2.08	63.47	2.35
2	2.8	Gravel (Granule)	45.05	3.48	45.04	4.07
1.7	2	Very coarse sand	19.74	4.07	19.95	4.81
0.5	1.7	Coarse and very coarse sand	106.89	5.51	103.18	6.22
0.3	0.5	Medium sand	47.72	14.75	43.15	15.6
0.15	0.3	Fine to medium sand	54.37	22.41	48.31	23.29
0.075	0.15	Very fine to fine sand	33.85	27.9	25.69	24.77
0	0.075	Clay and fine coarse silt	22.55	18.59	17.72	17.08
		Total	498.57	100	497.86	100

Leach tests were performed on 18 samples with significant total sulphur content, but the tested lithological units were not specified (JMA 2006). The leach tests were performed after treating the samples with various concentrations of H_2O_2 to simulate different degrees of oxidation. The leach test results show increased dissolved solids and sulphate concentrations as the pH decreases with increasing oxidation of the samples, essentially pyrite oxidation controlled by available oxygen.

A geochemical model was developed in Geochemist Workbench to predict the likely water quality as a function of oxygen supply to the interlinked (backfilled) box-cut and underground mine voids. The ABA, leach test and geochemical model results were then used to estimate ranges of likely water qualities for the site (Table 4.5).

Table 4.5: Estimated Water Qualities at Different Mining Phases (JMA 2006).

Parameter	Operational Phase (up to 17 years)	Post Closure (closure to full flooding)
pH	7.8 to 5.5 (or pH < 3)*	5.5
TDS (mg/l)	200 to 4 500	4 500 to 6 500
Ca (mg/l)	24 to 950	950 to 750 **
Mg (mg/l)	12 to 250	250
Na (mg/l)	23 to 250	250 to 800
K (mg/l)	6 to 30	30 to 80
SO4 (mg/l)	6 to 1 600	1 600 to 4 500
Total. Alkalinity (mg/l)	200 (to 5)*	5
Al (mg/l)	< 1 to 5	<5
Fe (mg/l)	<1 to 10	<10

* Local Patches around carbonaceous material ** Concentration decrease due to precipitation

Shake Flask Kinetic leach testing of 6 coal (2 and 4 Seam) samples (S2T, S2L, S2S, S4T, S4L and S4S) was done by ALS (2012) over a period of 30 days at a liquid to solid ration of 3:1. While the leachate of all coal samples was neutral to alkaline (pH within 7.0–9.0), conductivities and sulphate concentrations gradually increased over the test period to up to 2 700 µS/cm and 1 700 mg/l respectively. ALS (2012) predicted accordingly sulphate loads of between 2 333 and 5 667 g to be released from the coal seam materials, i.e. neutral but high sulphate leachate from the coal seams.
Additional ABA, NAG, leach and kinetic leach (22 weeks) tests were done by Geostratum (2015) on 6 coal samples (No. 4 and No. 2 seams). The ABA results (Table 4.6) show that all coal samples have an uncertain or low to medium potential for acid generation, but will generate a medium to high salt load.

Table 4.6: ABA and NAG pH results for the Elders Colliery samples (from Geostratum 2015).

BH ID.	Depth (m).	Seam No.	Paste pH	NAG pH	Total S (%)	Sulphide S (%)	AP (kg/t)	NP (kg/t)	NNP (kg/t)	NPR	Type
ESW45	47-54	4	6.91	5.56	1.09	0.89	27.81	43.29	15.48	1.56	Uncertain
ESW45	73-78	2	7.26	4.36	0.88	0.81	25.31	16.51	-8.80	0.65	PAG
ESW46	66-73	4	6.98	5.79	1.19	1.09	34.06	48.47	14.41	1.42	Uncertain
ESW46	89-97	2	7.20	5.61	1.09	0.93	29.06	39.50	10.44	1.36	Uncertain
ESW47	78-85	4	7.20	5.71	1.30	1.12	35.00	46.67	11.67	1.33	Uncertain
ESW47	110-114	2	7.36	5.16	0.81	0.78	24.38	25.50	1.12	1.05	Uncertain

Static distilled water leach test at a liquid to solid ratio of 1:20 (according to ASTM D3987) showed circum-neutral pH values around 7.8 and no elevated major ions or metal concentrations leached from the samples (Geostratum 2015). Kinetic leach tests (according to ASTM D5744-07) were performed on one No.2 and one No. 4 coal seam sample over 20 weeks at a liquid to solid ratio of 1:2. Neutral to alkaline pH values between 6.3 and 8.2 were observed throughout the period, with elevated sulphate concentrations in the first two leachates attributed to dissolution gypsum (Geostratum 2015). Elevated fluoride concentrations were observed in the leachate from No. 2 seam sample as well as nickel and to a lesser degree barium, lead and selenium in leachate from both coal samples. Based on the kinetic test results, Geostratum (2015) suggested a neutral drainage from the coal seam.

4.2.2. Recent Assessment of Overburden

Delta-H (2020c) retrieved six fresh overburden material samples from two newly drilled boreholes to represent the lithology intersected by the proposed box cut and therefore of the overburden stockpile for static and kinetic geochemical testing. Based on static Acid Base Accounting and Net Acid Generation test results (Table 4.7), two samples from borehole E1 (E1_Carb Sandstone (18-20m) and E1_Sandstone (25-26m)) were classified as non-acid generating, one coal sample (E3_Coal (23m)) as inconclusive and potentially acid generating conditions if preferentially exposed and three samples (E3_Carb Sandstone (14-22m), E3_Carb Sandstone (52-52m) and E1_Carb Sandstone (28-30m)) as potentially long term acid generating. The results are in general agreement with the earlier assessment by JMA (2006), which also classified most tested carbonaceous siltstones and sandstones as potentially acid generating, and only selected samples as non-acid generating.

Table 4.7: ABA and NAG pH results for the Elders Colliery overburden samples (Delta-H 2020).

Sample ID	SULPHUR SPECIATION			NET ACID GENERATION		ACID BASE ACCOUNTING					
	Total S (%)	SO_4 (%)	S^{2-} (%)	NAG (pH)	NAG (kg H_2SO_4/t)	Paste pH	AP (kg/t)	Sulphide AP (calc) (kg/t)	NP (kg/t)	NNP (kg/t)	NPR
E3_Carb Sandstone (14-22m)	0.38	0.22	0.15	5.5	1.18	7.1	12.00	4.69	4.47	-7.3	0.38
E3_Coal (23m)	1.6	0.74	0.86	4.5	35.00	7.4	50.00	26.88	28.00	-22.0	0.55
E3_Carb Sandstone (52-53m)	2.19	0.24	1.94	4.5	14.00	6.1	68.00	60.63	7.33	-61.0	0.11
E1_Carb Sandstone (18-20m)	0.17	0.14	0.03	7.7	<0.01	7.6	5.21	0.94	8.49	3.3	1.63
E1_Sandstone (25-26m)	0.22	0.12	0.1	7.7	<0.01	7.8	6.86	3.13	19.00	12.0	2.76
E1_Carb Sandstone (28-30m)	2.7	0.47	2.24	4.5	13	6.8	84.00	70.00	30.00	-55.0	0.35
Duplicate	2.7	0.47	2.24	4.5	13	6.9	84.00	70.00	29.00	-55.0	0.34

Kinetic testing of a composited (mixture of non-acid generating and acid generating materials) E1 borehole sample showed that the composited material contained enough Neutralisation Potential to buffer potential acidity generated by the carbonaceous sandstone. Kinetic test results for a composited E3 borehole sample, a mixture of materials which have been initially classified as predominantly long-term acid generating or inconclusive, suggested a medium term neutral leachate quality, but acidic leachate conditions could potentially prevail in the long term due to limited Neutralisation Potential of the composite sample.

A geochemical model of the overburden stockpile, considering water and diffusive oxygen ingress as reactants in the oxidation of pyrite bearing material, was developed in PHREEQC. Various scenarios for the mineralogical composition of the stockpile (based on average composition of borehole E1, E3 and E1 and E3 combined) were simulated and sulphate concentrations in the seepage at the bottom of the dump (assumed height 25m) before interaction with the underlying aquifer estimated. Increasing over the first 45 years, sulphate concentrations stabilised for most scenarios at around 4 200 mg/l, controlled by gypsum equilibrium. With simulated sulphate concentrations consistently around 1 000 mg/l at the end of life of mine (30 years), the model results were in good agreement with predictions by JMA (2006, Table 4.5). The expected pH values of the leachate remained for all simulated scenarios circum-neutral.

4.3. HYDROGEOLOGY

4.3.1. Unsaturated zone

Based on the 2002, 2012 (JMA) and recent 2019 hydrocensus results, the thickness of the unsaturated zone ranges from 0.7 m to 35.2 m, with an arithmetic average of around 10.1 m. The groundwater model considers flow and transport processes within the unsaturated zone, with a capillary pressure-saturation relationship (after van Genuchten) typically of a loamy sand assigned to the weathered aquifer and of a coarse sand assigned to the fractured Karoo rocks and dolerites.

4.3.2. Saturated zone

Based on the conceptual hydrogeological understanding of the site, the following hydro-stratigraphic zones are differentiated within the model area:

1. **Shallow alluvial and weathered Karoo aquifer**
2. **Fractured Karoo aquifer**
3. **Dolerite intrusions**
4. **Artificial mine aquifer**

Weathered Karoo aquifer

The weathered zone of the Karoo sediments hosts the unconfined or semi-confined shallow weathered Karoo aquifer or hydro-stratigraphic zone. The weathered zone is typically around 15m thick and water levels within this aquifer are often shallow (few meters below ground level). Due to direct rainfall recharge and dynamic groundwater flow through the unconfined aquifer in weathered sediments, the water quality is generally good, but in the absence of an overlying confining layer also vulnerable to pollution. Localised perched aquifers may occur on clay layers or lenses, but are due to their localised nature of no further interest in the context of the current study. Water intersections in the weathered aquifer are mostly above or at the interface to fresh bedrock (sandstone or sills), where less permeable layers of weathering products and capillary forces limit the vertical percolation of water and promote lateral water movement. Groundwater daylights as springs where the flow path is obstructed by less permeable dolerite sills (contact springs) or where the surface topography cuts into the groundwater level at e.g. drainage lines (free draining springs).

Fractured Karoo aquifer

The fractured Karoo aquifer consists of the various lithologies of siltstone, shale, sandstone and the coal seams. Groundwater flow is governed by secondary porosities like faults, fractures, joints, bedding planes or other geological contacts (including coal seams), while the rock matrix itself is considered impermeable. Geological structures are generally better developed in competent rocks like sandstone, which subsequently show better water yields than the less competent silt- or mudstones and shales. Not all secondary structures are water bearing due to e.g. compressional forces by the neo-tectonic stress field overburden closing the apertures. The fractured Karoo aquifer is considered a semi-confined aquifer, depending on the prevailing sedimentary succession.

Fractured Karoo aquifers have typically a low hydraulic conductivity (<0.001 m/d), but are known to be highly heterogeneous with yields ranging from 0.5 to 2 L/s. Higher yields are typically associated with higher hydraulic conductivities along shallow coal seams and at contact zones with intrusive rocks. Depending on the residence time of the water in the aquifer, groundwater quality can be poor.

Dolerite intrusions

The Karoo rocks in the project area were intruded by dolerite sills or dykes, with their contact zones with the host rock providing preferential flow paths, while the dolerite itself is rather impermeable or semi-permeable (hydraulic conductivity of approximately 1E-8 m/s). This setting promotes groundwater ponding and flow along, but not across the sills and dykes.

Artificial mine aquifer

Artificial Karoo aquifers will be created by the future underground (bord and pillar) mining of the No. 4 coal seam with an average extraction factor of 68% and an average stoping height of around 3m (pers. comm., C. Els, Lead mining engineer, Ukwazi). The underground mining will create artificial high porosity and conductivity networks within the No. 4 coal seam of the fractured Karoo aquifer.

4.3.3. Hydraulic conductivity

JMA Consulting (Pty) Ltd drilled during their 2002 Elders Colliery groundwater studies 40 hydrogeological boreholes (4 deeper EDK boreholes ranging from 45 to 90 mbgl and 36 shallow boreholes to generally 30 mbgl, which were augmented in 2005 by two additional shallow (30 mbgl) boreholes (JMA 2006). Geological logs, blow yields, water levels (2002) and hydraulic conductivity values determined by slug tests are available for most of the boreholes (Table 4.8). Only nine water levels are available for the deeper boreholes. Blow yields range from 0 to 6 l/s, with an average of 0.98 L/s for 17 boreholes with blow yields larger zero. Hydraulic conductivity values based on slug tests performed on 43 shallow boreholes (ESW boreholes) and 4 deep boreholes (EDK boreholes) are summarised in Table 4.9, along with measured porosities and calculated storativities. The arithmetic averages were subsequently used as initial hydraulic conductivities of the shallow weathered and deep fractured aquifers for the model calibration.

Table 4.8: Summary of hydrogeological boreholes at Elders Colliery (JMA 2006, hydraulic conductivity outliers indicated in grey).

Site ID	No	Y	X	Z (mamsl)	Collar height (m)	Depth (m)	Depth of water strike (m)	Est. Blow Yield (l/s)	Water level (mbgl)	Water level (mamsl)	Water level (mbgl)	Water level (mamsl)	K (m/d)
									Aug 2002		2012		
2629AD10001	EDK-1	-38464.16	2907899.5	1658	0.51	90	14-15, 25.5-26	0.02, 0.02	5.84	1652.16	4.94	1653.06	0.004
2629AD10002	EDK-2	-43325.52	2906999.77	1643.5	0.47	48			6.3	1637.2	4.02	1639.48	0.002
2629AD10003	EDK-3	-49697.69	2908773.17	1607	0.55	45	19-20	1.5	10.15	1596.85			0
2629BC10004	EDK-4	-52055.19	2904961.3	1633	0.59	58	20-21	5	10.67	1622.33			0.19
2629AD00001	ESW-1	-39881.2	2907982.45	1676	0.7	30	21-22	0.4	10.3	1665.7	0.9	1675.1	0.254
2629AD00002	ESW-2	-36295.76	2909642.57	1607	0.4	30	23-26	3.5	13.1	1593.9			160.36
2629AD00003	ESW-3	-35372.75	2911545.57	1603	0.53	30	16-17	0.02	5.72	1597.28			0.027
2629AD00004	ESW-4	-36372.15	2913012.97	1600	0.47	30			9.24	1590.76			0.003
2629AD00005	ESW-5	-36286.62	2913248.71	1578	0.71	30	7-8, 10-11	0.02, 0.05	3.9	1574.1			0
2629AD00006	ESW-6	-40510.9	2913572.6	1598	0.53	30	14-19	0.2	7.98	1590.02			0.215
2629AD00007	ESW-7	-40608.65	2907251.3	1662	0.57	30	10-26,	0.4	3.2	1658.8	2.49	1659.51	0.02
2629AD00008	ESW-8	-43466.92	2907707.07	1621	0.55	30			2.26	1618.74			0.01
2629AD00009	ESW-9	-43938.62	2908224.94	1607	0.49	30			1.8	1605.2			0.02
2629AD00010	ESW-10	-43926.57	2908537.33	1611	0.47	30			6.59	1604.41			0.004
2629AD00011	ESW-11	-44958.21	2908568.57	1597	0.47	30	20-30	1.3	1.25	1595.75			1.204
2629AD00012	ESW-12	-46226.99	2908481.1	1592	0.62	30			3.67	1588.33			0.024
2629AD00013	ESW-13	-45894.28	2907949.23	1597	0.39	30			7.27	1589.73			0.009
2629AD00014	ESW-14	-47056.31	2908119.59	1594	0.64	30			3.08	1590.92	3.01	1590.99	0.01
2629AD00015	ESW-15	-47037.65	2909127.71	1610	0.35	30			3.58	1606.42			0.042
2629AD00016	ESW-16	-47855.68	2908305.33	1601	0.43	30			3.48	1597.52			0.02
2629AD00017	ESW-17	-48894.96	2907112.69	1586.5	0.43	30	14-15, 18-19	0.5, 4.5	5.58	1580.92			0.033
2629AD00018	ESW-18	-47845.61	2907248.36	1592	0.61	30	5-6,	0.3	3.71	1588.29			0.167
2629AD00019	ESW-19	-47773.57	2906468.14	1584	0.57	30	21-23	0.5	4.66	1579.34			0.194
2629AD00020	ESW-20	-47207.29	2906435.04	1588	0.61	30			7.98	1580.02	7.2	1580.8	0.007
2629AD00021	ESW-21	-45877.92	2906365.99	1605.5	0.66	31	12-14	0.5	3.69	1601.81			0.06
2629AD00022	ESW-22	-45913.69	2905858.71	1621	0.89	30	18-19	0.1	5.95	1615.05			0.017
2629AB00023	ESW-23	-44878.99	2904342.81	1619	0.69	30	11-12	0.8	3.7	1615.3			0.125
2629AB00024	ESW-24	-46366.53	2902708.38	1605	0.68	30			4.73	1600.27			0.003
2629AB00025	ESW-25	-46523	2901670.85	1572	0.67	30	6-7	6	1.24	1570.76	-0.02	1572.02	0.908
2629AB00026	ESW-26	-48160.5	2902082.32	1575	0.31	30			0	1575			0.011
2629AB00027	ESW-27	-49168.67	2902116.02	1575.5	0.53	30	15-16	2.5	0	1575.5	0.23	1575.27	0.094
2629AB00028	ESW-28	-49564.54	2901291.05	1579	0.48	30	10-11	2.5	3.7	1575.3			0.218
2629BA00029	ESW-29	-50511.31	2902222.01	1581	0.32	30	2-7	0.01	3.2	1577.8	3.28	1577.72	0.02

Site ID	No	Y	X	Z (mamsl)	Collar height (m)	Depth (m)	Depth of water strike (m)	Est. Blow Yield (l/s)	Water level (mbgl)	Water level (mamsl)	Water level (mbgl)	Water level (mamsl)	K (m/d)
									Aug 2002		2012		
2629BA00030	ESW-30	-50763.82	2903064.99	1584	0.54	30	17-18	0.3	2.89	1581.11	2.64	1581.36	0.14
2629AB00031	ESW-31	-49434.96	2904083.55	1606	0.47	30	23-24	0.14	11.2	1594.8			0
2629AD00032	ESW-32	-49089	2905754.04	1578	0.67	30	6-10	0.25	3.2	1574.8			0.033
2629AD00033	ESW-33	-49035	2910463	1603	0.49	30			8.3	1594.7			0.003
2629BC00034	ESW-34	-50541.16	2910230.51	1605	0.72	30			11.44	1593.56			
2629BC00035	ESW-35	-53589.42	2906495.36	1642.25	0.51	30			6.79	1635.46			
2629BA00036	ESW-36	-52641.24	2903096.86	1610	0.54	30			9.32	1600.68	7.26	1602.74	
2629BA00037	ESW-37	-50247.72	2899819.08	1581.1	0.76	30			1.89	1579.2	2.62	1578.48	0.017
2629BA00038	ESW-38	-50201.43	2900416.05	1579.5	0.73	30	8.5-19.5	0.1	2.87	1576.6			0.08
											Mar-2015		
2629BA00039	ESW39	-45287.58	2904438.45	1613.28	0.43	74					3.72	1575.78	
2629BA00040	ESW40	-45268.37	2905076.54	1627.65	0.54	72					4.54	1608.74	
2629BA00041	ESW41	-45849.96	2905314.57	1627.27	0.54	62					3.22	1624.43	
2629BA00042	ESW42	-45682.81	2903135.82	1598.25		74		3					
2629BA00043	ESW43	-46464.33	2902811.77	1599.45		79		3					
2629AB00044	ESW44	-45921.72	2902541.72	1584.34	0.36	58					2.30	1597.15	
2629AB00045	ESW45	-49946.93	2902715.04	1589.94	0.57	100					10.94	1573.4	
2629AB00046	ESW46	-49823.72	2903833.56	1606.84	0.27	108					20.93	1569.01	
2629AB00047	ESW47	-49555.52	2904729.95	1612.53		114					32.22	1574.62	

Table 4.9: Hydraulic conductivity values for the Elders Colliery hydrogeological boreholes (from JMA 2015).

Description of Statistical Analyses	Hydraulic Conductivity k (m/day)	Porosity (%)	Storativities (%)*
Shallow Weathered Zone Aquifer (ESW-Group)			
Min	0.0010		
Max	117.16		
Arithmetic Mean	3.561	8.9	4.45
Geometric Mean	0.033		
Harmonic Mean	0.006		
Proposed value	**0.025**		
Deep Fractured Karoo Aquifer (EDK-Group)			
Min	0.001		
Max	0.190		
Arithmetic Mean	0.049	4.9	0.49
Geometric Mean	0.006		
Harmonic Mean	0.002		
Proposed value	**0.004**		

*Methodology not provided, but appears to be based on arbitrary fractions (5 and 10%) of porosities.

Recent pumping and slug tests by Delta H (2020b) focussed on the upper weathered and fractured Karoo aquifer (up to 50 m below ground level) within the mining area itself. Determined transmissivity and conductivity values are provided in Table 4.10 and Table 4.11. While borehole EGW-BH5 is considered an outlier (next to a wetland, which appears to provide localised recharge to the borehole), the determined values (median conductivity of 8E-07 m/s or 0.07 m/d) fall essentially between the conductivity values suggested by JMA (2015) for the upper and deeper aquifer. This appears plausible as the recent tests focussed exactly on the upper fractured and weathered aquifer, providing conductivity estimates for the transition zone of the shallow weathered and upper fractured aquifers.

Table 4.10: Summary of the aquifer parameters (transmissivity values in m^2/day) based on the pump tests.

BH ID	Aquifer properties (Pump Test)				
	Cooper-Jacob (late)	Papadopulos-Cooper	Theis (Step Test)	Agarwal (Recovery)	FC Sheet
	T-value	*T-value*	*T-value*	*T-value*	*S-value*
EGW-BH2	3.135	2.778	3.90	4.569	6.83E-04
EGW-BH4	0.3282	0.01	2.18	1.889	6.83E-04
EGW-BH5	50.52	52.65	106.40	164.1	7.06E-04
EGW-BH6	2.62	5.1	3.74	7.98	6.80E-04

Table 4.11: Summary of the aquifer parameters (hydraulic conductivity values in m/day) based on the slug tests.

BH ID	Slug input	Aquifer properties (Slug Test)			
		Bouwer-Rice		KGS Model	
		K-value	*Yo-value*	*K-value*	*Ss-value*
EGW-BH1	In	0.0034	0.099	0.04	2.00E-03
	Out	0.007	0.027	0.15	1.30E-05
EGW-BH3	In	0.016	0.033	no fit	no fit
	Out	0.0002	0.11	no fit	no fit
EGW-BH7	In	0.0002	0.09	no fit	no fit
	Out	0.21	0.29	no fit	no fit

4.4. GROUNDWATER LEVELS

Groundwater levels were collated from the 2002, 2012 (Table 4.8 and Table 4.12, both by JMA) and the current 2019 (Table 3.1) hydrocensus in the Elders area, with the most recent water levels used if several entries existed.

Table 4.12: Summary of geohydrological boreholes of external water users, Elders Colliery (JMA 2006, 2014).

Site ID	No	Y	X	Est. Yield (l/s)	Use	Water level (mbgl)	Water level (mamsl)	Water level (mbgl)	Water level (mamsl)
						May-Aug 2002		2012	
2629AD20001	VKN-1	-45380.3	2906121.61	1	Y	16.05	1604.95		
2629AD20002	VKN-2	-45565.12	2905835.32	0.8	Y	7.01	1617.99		
2629AD20003	VKN-3	-45532.58	2906847.81	1	Y	33.25	1575.75		
2629AD20004	VKN-4	-45845.27	2907403.97	0.5	Y	Closed			
2629AD20005	VKN-5	-45066.69	2907533.07	0.5	Y	4.12	1627.88		
2629AD20006	VKN-6	-45732.73	2904202.88	0.5	Y	Closed			
2629AD20007	VKN-7	-47010.92	2903568.21	1	Y	6.99	1601.01		
2629AB20008	VKN-8	-47330.15	2903706.75	0.5	Y	Closed			
2629AD20009	VKN-9	-47065.54	2904484.63	0.3	Y	Closed			
2629AD20010	VKN-10	-47648.07	2905013.01	?	Y	2.18	1572.82		
2629AD20011	VKN-11	-46808.95	2908298.17		N				
2629AD20012	VKN-12	-45121.33	2905042.73	?	N	2.15	1619.85		
2629AD20013	VKN-13	-45552.37	2905199.34		N				
2629AD30001	SVK-1	-47904.97	2907403.69	?	N				
2629AD30002	SVK-2	-49411	2905387.44	?	N	5.09	1595.11		
2629AD30003	SVK-3	-47886.2	2908964.64	1	Y	Closed			
2629AD30004	SVK-4	-47985.46	2908592.76	2	Y	11.94	1596.06		
2629AD30005	SVK-5	-49359.6	2907074.57	1	Y	Closed			
2629AD30006	SVK-6	-49550.74	2906724.1	0.5	Y	Closed			
2629AD30007	SVK-7	-50000	2906000		Y				
2629AD30008	SVK-8	-49273.32	2909006.42		N				
2629AD30009	SVK-9	-47542.67	2909765.49	?	N	3.75	1615.25		
2629AD30010	SVK-10	-49150.42	2909545.5	0.5	Y	5.04	1602.96		
2629AD30011	SVK-11	-49169.2	2909858	0.5	Y	21.6	1587.4		
2629AD30012	SVK-12	-49910.34	2909572.79	0.3	Y	31.07	1558.93		
2629AD30013	SVK-13	-49866.51	2909542.7	1	Y	Closed			
2629AD30014	SVK-14	-49859.994	2909405.95	0.5	N	18.28	1575.72	1.92	1592.08
2629AD30015	SVK-15	-49881.213	2909601.04	1	Y	27.87	1567.13	2.53	1592.47
2629BC30016	SVK-16	-50005.85	2909410.29	1	Y	18.66	1574.34		
2629AD30017	SVK-17	-49814.46	2909315.38	2.2	Y	20.71	1573.29		
2629AD30018	SVK-18	-49671.13	2909187.42	0.5	Y	Closed			
2629AD30019	SVK-19	-49755.13	2908901.91	0.5	Y	Closed			
2629AD30020	SVK-20	-49780.29	2908852.15	15	N	9.85	1584.15		
2629BC30021	SVK-21	-51002.7	2909888.37	0.3	N	Blocked			
2629BC30022	SVK-22	-51504.83	2909689.84	1	Y	Closed			
2629BC30023	SVK-23	-51473.07	2906882.29	?	N	Closed			
2629AD30024	SVK-P1	-49948.8	2906598.22	0.5	N	1.78	1574.22		
2629AD30025	SVK-F1	-51580.94	2906386.38	0.03	Y	0	1618.5		
2629AD30026	SVK-F2	-49382.37	2905819.41	0.02	Y	0	1584		
2629AD40001	MKL-1	-47495.573	2902739.74	?	N	0	1591	0.65	1590.35
2629AD40002	MKL-2	-49257.48	2899780.93	0.6	Y	Closed			
2629AD40003	MKL-3	-49252.17	2899338.87	1.5	Y	1.74	1620.26		
2629AD40004	MKL-4	-48205.64	2898543.91	0.5	N	0.35	1620.65		
2629AD40005	MKL-5	-48102.509	2900472.99	0.2	N	2.8	1613.2	3.23	1612.77
2629AD40006	MKL-6	-48864.42	2900117.35	0.2	N	Closed			
2629AD40007	MKL-7	-49152	2899922.34	0.2	N	0.67	1621.83		
2629AD40008	MKL-8	-46827.73	2902833.02	0.5	N	2.04	1600.96		

Site ID	No	Y	X	Est. Yield (l/s)	Use	Water level (mbgl)	Water level (mamsl)	Water level (mbgl)	Water level (mamsl)
						May-Aug 2002		2012	
2629AD40009	MKL-F1	-48923.86	2900785.63	0.02	N	0	1581		
2629AD40010	MKL-F2	-46362.81	2901794.36	0.02	Y	0	1579		
2629BA50001	HGN-1	-51657.5	2898959.36	0.2	N	0.46	1639.04		
2629BA50002	HGN-2	-52783.64	2902972.25	0.5	Y	4.86	1599.14		
2629BA50003	HGN-3	-52605.78	2902969.31	0.5	Y	Closed			
2629AD50004	HGN-4	-49958.768	2903998.676	0.5	Y	Closed		5.06	1603.44
2629AD50005	HGN-5	-49666.96	2903772.01	0.5	Y	32.2	1574.8		
2629BA50006	HGN-F1	-52433.99	2902952	0.05	N	0	1601		
2629BA50007	HGN-F2	-51690.22	2899027.07	0.02	Y	0	1640		
2629BA50008	HGN-F3	-52031.38	2902183.71	0.1	Y	0	1592		
2629BA60001	GLK-1	-50795.12	2904255	?	N	Dry			
2629BC60002	GLK-2	-51908.23	2904486.53	0.5	Y	Closed			
2629BC60003	GLK-3	-52264.02	2904955.5	0.5	Y	Closed			
2629BC60004	GLK-4	-52264.25	2904898.99	0.5	Y	Closed			
2629BC60005	GLK-5	-53570	2906130	0	N				
2629BC60006	GLK-6	-53011.73	2905101.46		Y	Closed			
2629AD70001	UGT-1	-49265.17	2910356.92	2.5	N	3.09	1598.41		
2629AD70002	UGT-2	-49173.43	2910322.22	0.4	Y	6.53	1594.97		
2629AD70003	UGT-3	-49376.8	2910416.06	0.6	Y	15.65	1578.35		
2629AD80001	EFN-1	-41198.16	2905943		Y	16.02	1628.98		
2629AD80002	EFN-2	-42285.49	2907032		Y	27.23	1629.77		
2629AD80003	EFN-3	-40647.36	2908281		Y				
2629AD80004	EFN-4	-42054.32	2905012.46	2.5	N	Blocked			
2629AD80005	EFN-5	-42045.08	2905396.86	0.5	N	Closed			
2629AD80006	EFN-6	-42395.14	2905275.03	0.3	N	12.79	1665.21		
2629AD80007	EFN-7	-43344.88	2906271.95	0.5	N	4.2	1652.8		
2629AD80008	EFN-8	-43127.23	2905935.53	0.3	Y	Closed			
2629AD80009	EFN-9	-43259.02	2905659	0.1	Y	Closed			
2629AD80010	EFN-10	-43449.6	2905431.41	0.15	Y	Closed			
2629AD80011	EFN-11	-44756.83	2904997.15	1	Y	Closed			
2629AB80012	EFN-12	-44665.19	2904339.86	0.8	N	0.93	1611.07		
2629AB80013	EFN-13	-44457.2	2903517.09		N	3.58	1603.42		
2629AB80014	EFN-14	-44907.81	2902369.77	0.15	N	Closed			
2629AD80015	EFN-15	-43331.74	2904826.11		N	Closed			
2629AD80016	EFN-16	-42006.38	2905006.76	0.3	Y	10.02	1649.98		
2629AD80017	EFN-17	-43835.54	2906810.93	2.5	N	4.34	1650.66		
2629AD80018	EFN-F1	-43084.19	2906860.47	0.03	Y	0.03	1646.97		
2629AD80019	EFN-F2	-41854.54	2905312.04	0.5	Y	0.3	1656.7		
2629AB80020	EFN-F3	-44163.6	2903763.14	0.02	Y	0	1617		
2629AB80021	EFN-F4	-43166.72	2903680.01	0.05	Y	0	1651		
2629AB90001	SVI-1	-44749.179	2901430.451	3.25	Y	6.58	1603.42	6.93	1603.07
2629AB90002	SVI-2	-44556.89	2901838.99	0.3	Y	Closed			
2629AB90003	SVI-F1	-44530.51	2901957.44	0	N	Dry			
2629AD11001	HB01	-39534.17	2910737.81		N				
2629AD11002	HB02	-40112.01	2911815.35		N	6.62	1628.38		
2629AD11003	HB03	-38335.87	2912742.79		N				
2629AD11004	HB04	-38330.723	2912777.795		Y	2.83	1617.17	2.92	1617.08
2629AD12001	LR01	-44643.78	2907934.88		N	7.95	1624.05		
2629AD12002	LR02	-44399.54	2907506.39		N	6.16	1635.85		
2629AD12003	LR03	-43916.868	2908438.303		Y			0.83	1608.17
2629AD12004	LR04	-41214.97	2908504.02		N	14.24	1650.76		
2629AD12005	LR05	-41678.27	2908547.61	0.5	Y				
2629AD12006	LR06	-41963.32	2912419.5	0.5	Y	3	1647		
2629AD12007	LR07	-46228.53	2910002.24	0.2	Y				
2629AD12008	LR08	-45889.45	2909870.3		N				

Site ID	No	Y	X	Est. Yield (l/s)	Use	Water level (mbgl)	Water level (mamsl)	Water level (mbgl)	Water level (mamsl)
						May-Aug 2002		2012	
2629AD12009	LR09	-45711.25	2909428.73		N	3.86	1596.14		
2629AD13001	RP01	-38486.8	2909005.23		Y				
2629AD13002	RP02	-41140.35	2911549.37		N	6.31	1643.69		
2629AD13003	RP03	-39395.97	2908572.57		Y	8.65	1673.35		
2629AD13004	RP04	-39773.55	2909208.55		N				
2629AD13005	RP05	-40370	2909142.82		N				
2629AD13006	RP06	-40505.31	2911536.28		Y	14.61	1630.39		
2629AD14001	KT01	-36992.21	2912304.58	0.5	Y				
2629AD14002	KT02	-36496.57	2912442.76		N				
2629AD14003	KT03	-36476.61	2912440.49		N				
2629AD14004	KT04	-36345.53	2912539.83		Y				
2629AD14005	KT05	-36494.18	2912580.13		N	5.95	1613.05		
2629AD14006	KT06	-38601.71	2913659.81		Y	10.31	1594.7		
2629AD14007	KT07	-38577.81	2913638.69	1	Y	5.76	1599.24		
2629AD14008	KT08	-38626.16	2913494.81		Y				
2629AD14009	KT_F01	-38491.63	2913744.79		Y	0	1600		
2629AD14010	KT_F02	-35866.95	2913011.55		Y	0	1610		
2629AD15001	BKS-1	-38163.15	2905976.43		N	Closed			
2629AD15002	BKS-2	-39130.33	2905922.82		N	Blocked			
2629AD15003	VFN-1	-36011.18	2907119.13		N	1.63	1634.87		
2629AD15004	VFN-2	-35393.06	2907049.84		N	5.39	1631.61		
2629AD15005	VFN-3	-35098.34	2907803.51	0.3	Y	Closed			
2629AD15006	RBP-1	-37053.82	2907187.44		N	7.1	1634.4		
2629AD15007	RBP-2	-38305.493	2907140.89	1	Y	Closed		12.15	1628.35
2629AD15008	RBP-3	-38154.358	2907245.588		N	6.66	1635.34	7.85	1634.15

Based on the 104 collated data, the groundwater levels are generally shallow and range from just 0.68 mbgl (or 0 mbgl for springs) to 35.2 mbgl; with a regional average of of 10.1 mbgl. Using the measured groundwater table elevations, Delta H established the correlation between surface topography and elevation of the groundwater level within the shallow aquifer (Figure 4.4) for the wider area of interest. Based on the regional results, a very good correlation between the measured water levels and surface topography is obvious (R^2 = 0.98, i.e. approximately 98 % of observed water level variations can be explained by variations in surface elevation) and it can be assumed that the water table within the shallow weathered aquifer mimics the surface topography at the regional scale. The few obvious outliers from the regression line in Figure 4.4 are probably due to groundwater abstractions preceding water level measurements.

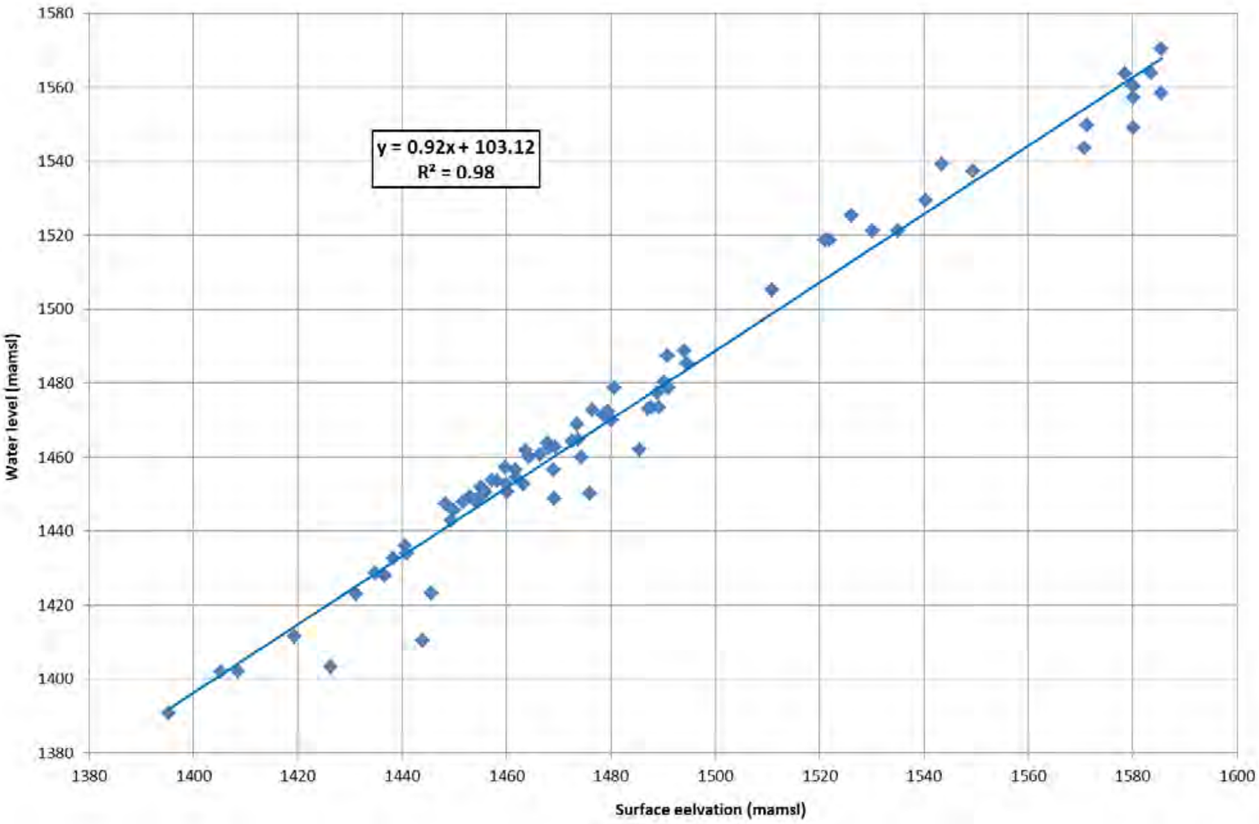

Figure 4.4: Groundwater elevation versus surface elevation in the wider Elders Colliery project area (JMA 2006, 2014 and Delta H 2019).

The observed, correlation is used to improve the interpolation of initial water levels for the numerical model in data scarce environments by applying a co-kriging algorithm based on the known topography (Bayesian interpolation). The Bayesian interpolation method uses correlated data to improve the spatial interpolation of the unknown variable, in this case the groundwater levels based on known surface elevations. As a Universal Kriging algorithm, it relies on a mathematical description of the change (or variance) of a variable with distance, i.e. to what extent neighbouring observations are spatially correlated. Such correlation is expressed in a semi-variogram, as depicted in the empirical semi-variogram for the wider Elders Colliery model area below (Figure 4.5) with the fitted Bayesian model used for the interpolation. The semi-variogram model is then used in combination with the knowledge of the surface elevation and its correlation to the groundwater elevation as a qualified guess to improve the spatial interpolation of water levels.

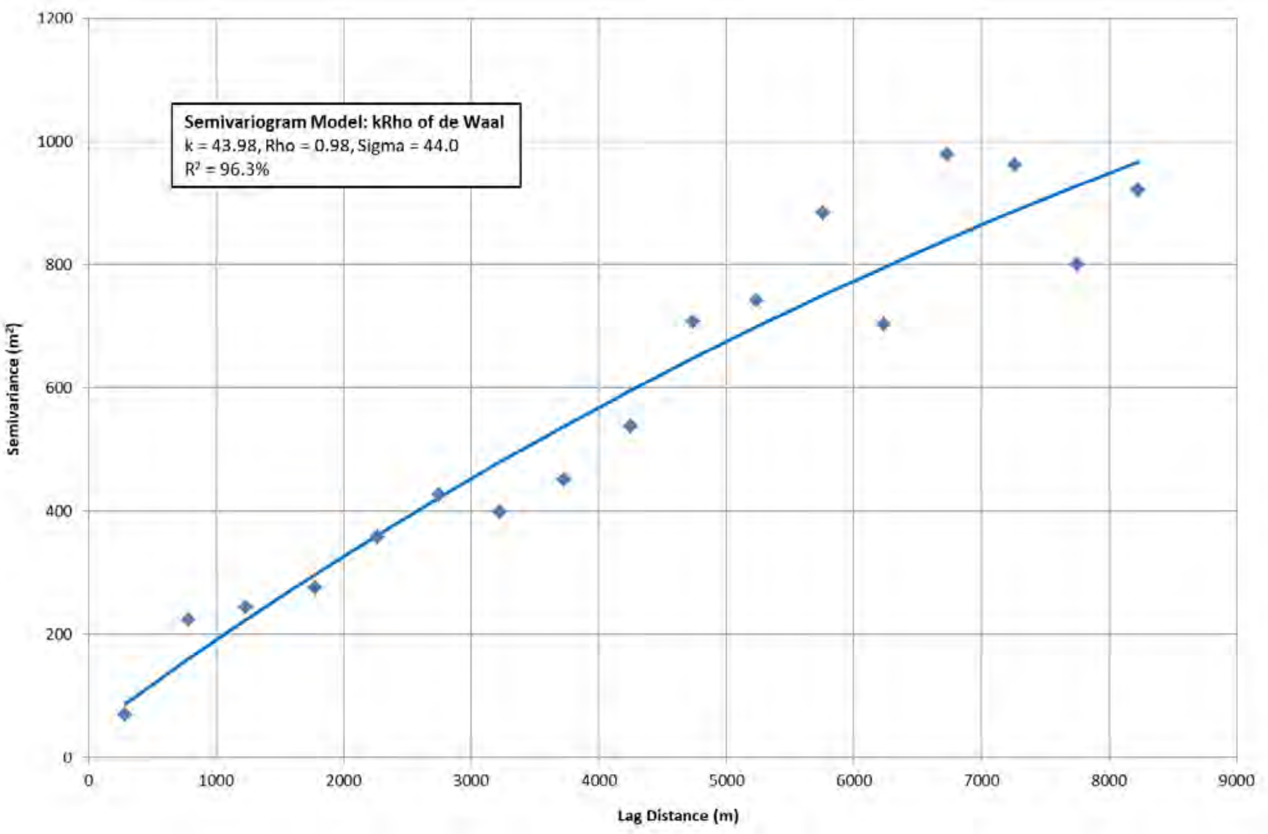

Figure 4.5: Empirical semi-variogram and fitted Bayesian model.

The interpolated (unconfined) groundwater piezometric map for the shallow weathered aquifer in the Elders project area using Bayesian interpolation (with the model parameters given above) is shown in Figure 4.6 and was subsequently used as initial heads for the Elders Colliery model (steady-state) calibration. It must be noted that initial heads only facilitate the mathematical convergence of a steady-state model, but do not change the outcome of the model i.e. the calculated steady-state heads.

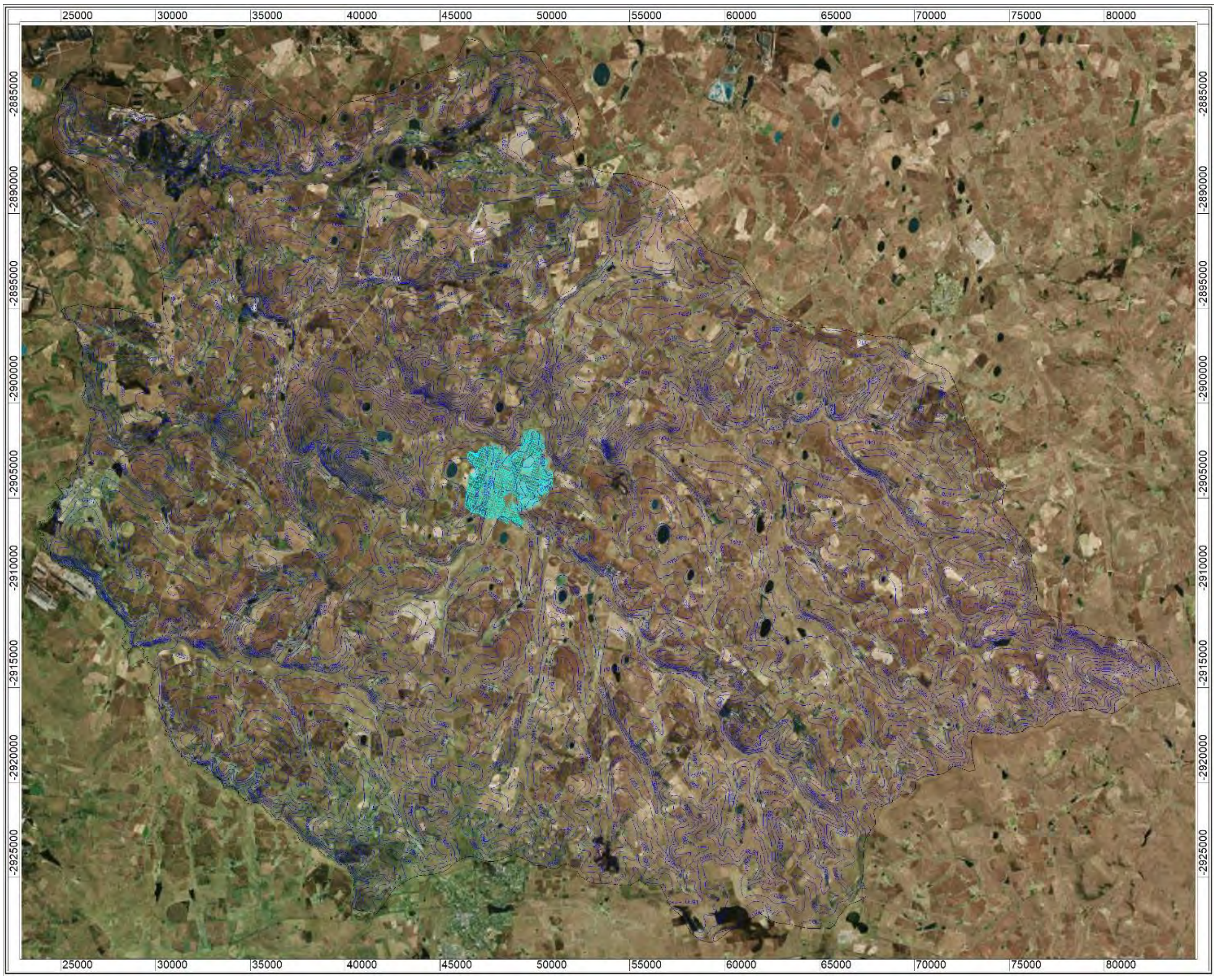

Figure 4.6: Bayesian interpolated groundwater levels within the weathered Karoo aquifer for the Elders project area (proposed underground mine layout indicated in light blue).

4.5. GROUNDWATER POTENTIAL CONTAMINANTS

Based on the site specific geochemical studies (chapter 4.2) and experience from active collieries, the main potential impacts on the ambient groundwater quality associated with the proposed underground mining of the No. 4 and 2 coal seams are acidic contact water with elevated salt and metal concentrations, i.e. acid rock drainage.
Acid rock drainage conditions are likely to be associated with coal exposed in the underground mine voids (included abstracted groundwater in contact with the coal) and the overburden stockpile, as most tested over-/interburden and coal samples were classified potentially acid generating (JMA 2006, Table 4.1).

The elevated salt concentrations due to the oxidation of sulphide bearing minerals are dominated by sulphate, whereas metals of concern potentially mobilised under acidic conditions are iron and manganese (Table 4.5) and to a lesser degree barium and nickel.

4.6. GROUNDWATER QUALITY

4.6.1. Earlier water quality results

Most boreholes sampled by JMA in 2002/03 (with 8 additional analysis for 2012) show a good drinking water quality with a few exceedances of NH_3 (2 boreholes), NO_3 (1 borehole), F (2 boreholes) and Fe (2 boreholes) limits. The Piper diagram (Figure 4.7), a graphical visualisation of major cation and anion ratios, characterises the regional groundwater type as a Ca-Mg-HCO_3 or Na-HCO_3 facies, with several samples trending towards Na-Cl facies. The bicarbonate dominance is most samples is a result CO_2 equilibration of rainwater with the atmosphere and percolating rainwater with the further CO_2 enriched soil atmosphere as a result of the decay of plant humus, litter and other organic substrates. Water seeps through the soil and vadose zone, also rich in carbon dioxide from weathering of carbonate minerals, which in turn dissolves as bicarbonate into the water. The bicarbonate enriched water signature indicates potential fresher, recently recharged groundwater. The mixed cation signatures (calcium/magnesium versus sodium) can be attributed to cation exchange reaction that occurs during the evolution of groundwater within the soil and rock matrix.

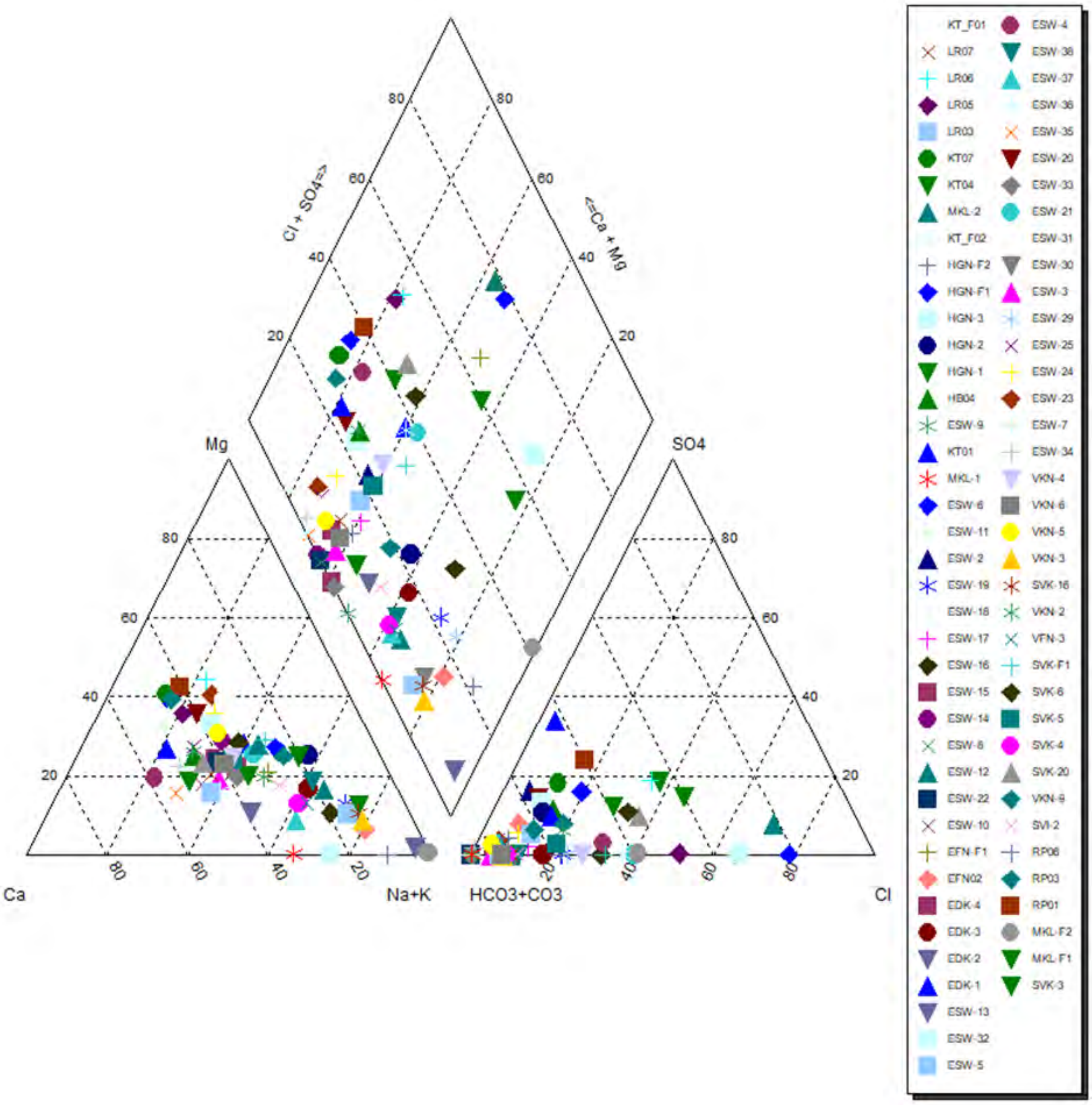

Figure 4.7: Piper diagram for the groundwater quality at Elders (after JMA, 2015).

Some groundwater samples, i.e. MKL-2, HGN-F1, HGN-3 and EFN-F1, are clearly dominated by chloride anions instead of bicarbonate anions. These sodium-chloride waters indicate highly mineralised, deeper, and less mobile water which is not part of the active hydrogeological cycle. The depositional environment of the Karoo Supergroup was driven by sea water interaction and deposition with sodium and chloride enrichment of deposited minerals. The same enrichment is observed in groundwater interacting with these minerals. The mixed groundwater signatures between bicarbonate and chloride anion respectively calcium/magnesium and sodium cation dominance indicate the evolution and/or mixing of groundwater within the natural aquifer system from freshly recharged shallow groundwater to deeper mineralised groundwater.

4.6.2. 2019 Hydrocensus water quality results

A total of ten (10) groundwater samples were collected during the hydrocensus to determine the current baseline water quality at Elders Colliery. A list of the water samples collected during the hydrocensus is given in Table 3.1 and the major ionic composition shown in Figure 4.8.

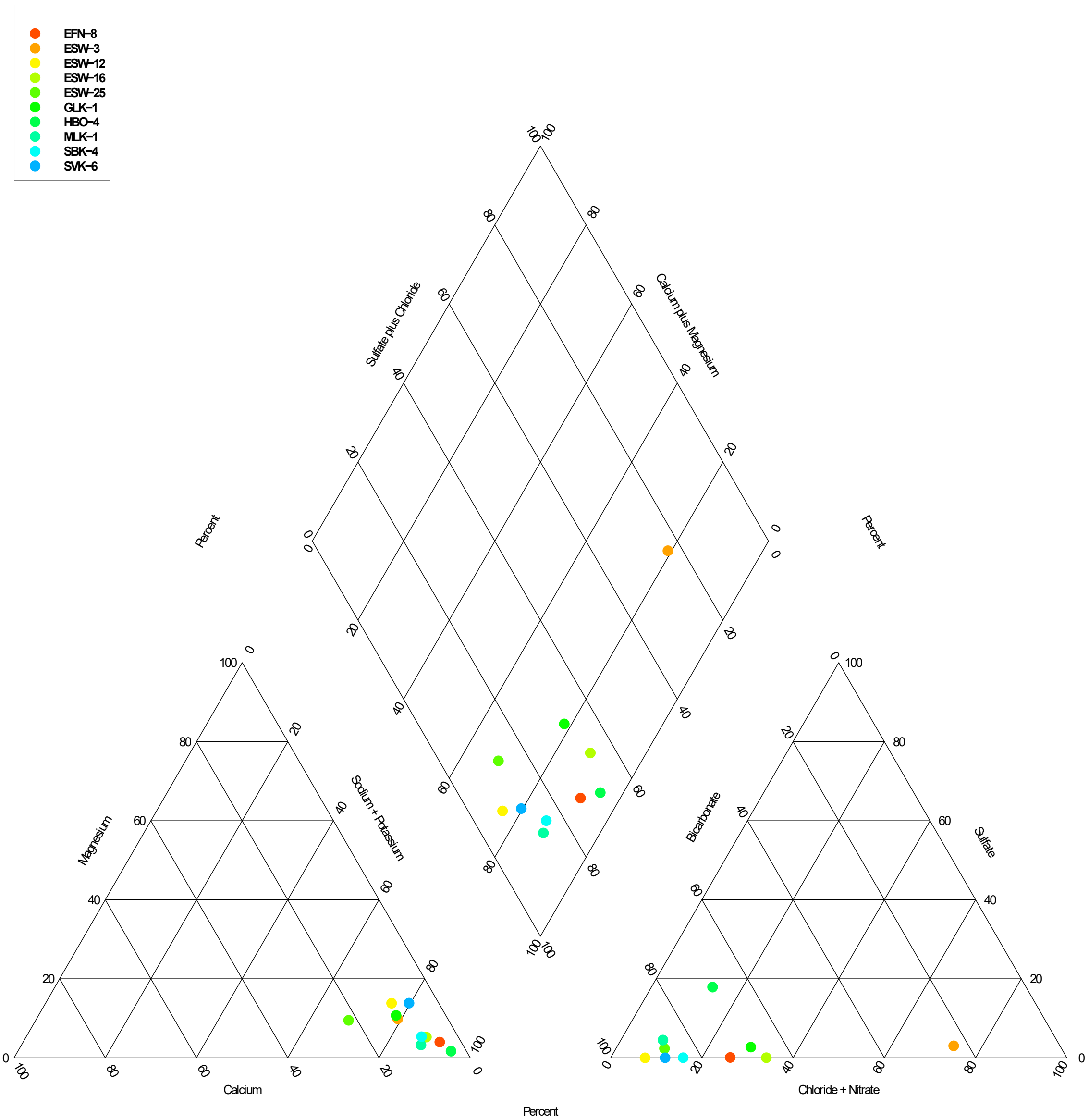

Figure 4.8: Piper diagram for groundwater hydrocensus samples at Elders Colliery (samples with SO_4 and NO_3 as N concentrations below limit of detection are visualised as an order of magnitude smaller than the detection limit concentration).

Similar to the earlier results, the majority of groundwater samples collected during the hydrocensus show a dominant Na-HCO_3 (sodium- bicarbonate) water facies, indicating freshly recharged groundwater which had limited time to equilibrate with the aquifer material along its flow path. Dominant bicarbonate anion signatures are as before attributed to CO_2 equilibration with the atmosphere (rainwater) and vadose zone. Sample ESW-3, characterised by a Na+K-Cl+NO_3 (chloride + nitrate) water facies, represents highly mineralised, stagnant groundwater that equilibrated with sodium and chloride rich sediments of the Karoo Supergroup.

The water quality results are compared in Table 4.13 to the stipulated limits as set out in the SANS 241-1:2015 for Drinking Water and the more stringent South Africa Water Quality Guidelines (SAWQG) for domestic use. The original laboratory results are included in the Appendix.

The TDS, Ca, Cl and NO_3 as N concentrations exceed in borehole ESW-3, and TDS and Na concentrations in borehole ESW-12 the DWA SAWQG for domestic use. The iron concentration in borehole ESW-16 exceeds both, the DWA SAWQG for domestic use target values and SANS 241-1 (2015) drinking water limits, while iron concentrations in boreholes HBO4, MLK-1 and SBK-4 exceed only the DWA SAWQG for domestic use target values. The elevated iron concentrations at these boreholes are not expected to be geogenic, but potentially from the rusted steel casing of the boreholes itself. All tested samples exceed turbidity value based on the SANS 241-1 (2015) drinking water standards.

Table 4.13: Groundwater quality from the hydrocensus results compared to relevant standards (exceedances are presented in red and parameters below limit of detection are excluded from the table, included in the appendix).

Borehole ID			EFN-8	ESW-3	ESW-12	ESW-16	ESW-25	GLK-1	HBO-4	MLK-1	SBK-4	SVK-6
Parameters	SAWQG Target Values	SANS 241:2015	56179	56180	56181	56182	56183	56184	56185	56186	56187	56188
pH Value @ 25°C	6.0-9.0	5-9.7	6.1	6.5	7.6	7.4	6.7	9.3	7.0	6.8	7.4	8.0
Conductivity mS/m @ 25°C	0-70	170.0	4.9	73.8	79.1	34.7	26.8	41.2	12.5	9.6	28.1	40.4
Total Dissolved Solids	0-450	1200.0	66.0	498.0	476.0	206.0	162.0	270.0	86.0	90.0	198.0	198.0
Calcium, Ca	0-32	-	2	47	24	12	26	21	8	6	16	12
Magnesium, Mg	0-30	-	1	26	20	5	7	13	3	1	7	16
Sodium, Na	0-100	200	5	28	122	46	15	42	1	9	26	39
Potassium, K	0-50	-	1.7	15.7	3.5	5.5	3.4	5.7	11.6	2.5	7.7	5.8
Total Alkalinity as $CaCO_3$	-	-	16.0	80.0	400.0	112.0	116.0	156.0	40.0	40.0	120.0	184.0
Bicarbonate, HCO_3	-	-	19.5	97.6	486.2	136.3	141.5	159.2	48.7	48.8	146.0	222.3
Carbonate, CO_3	-	-	0.0	0.0	0.9	0.2	0.0	14.7	0.0	0.0	0.2	1.0
Chloride, Cl	0-100	-	4.0	106.0	23.0	41.0	10.0	40.0	4.0	3.0	16.0	17.0
Sulphate, SO4	0-200	-	<2	10.0	<2	<2	3.0	5.0	10.0	2.0	<2	<2
Nitrate as N	0-6	11.0	<0.1	29.0	0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	0.2
Fluoride, F	0-1	1.5	<0.2	<0.2	0.5	0.2	0.4	0.2	0.4	<0.2	<0.2	0.4
Free and Saline Ammonia as NH_4	-	-	0.3	1.2	0.3	0.3	0.2	<0.1	1.6	1.1	0.4	3.3
Turbidity in N.T.U		1	7.2	12.0	100.0	47.0	39.0	2.0	40.0	121.0	37.0	9.8
Iron, Fe	0-0.1	2.0	0.047	< 0.025	< 0.025	3.48	0.056	< 0.025	1.66	0.481	0.188	< 0.025
Manganese, Mn	0.4	0.4	0.085	0.165	0.177	0.182	0.079	< 0.025	0.084	0.184	0.172	0.061
Zinc, Zn	5	5.0	0.065	2.87	0.019	0.030	0.029	0.040	0.091	0.039	0.029	0.035
Lead, Pb	-	0.01	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Cobalt, Co	-	0.5	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Copper, Cu	0-1	0.4	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Chromium, Cr	0.05	-	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Boron, B	2.4	-	< 0.010	< 0.010	0.043	< 0.010	0.021	0.020	0.010	< 0.010	< 0.010	0.198
Ortho Phosphate as P	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silicon, Si	-	-	14.3	19.2	7.5	7.6	12.8	8.7	7.7	15.6	6.1	1.0
Barium, Ba	-	1	0.03	0.50	0.32	0.20	0.36	0.18	0.02	0.04	0.14	0.07
Nickel, Ni	-	0.07	< 0.010	< 0.010	< 0.010	0.015	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010

5. AQUIFER CHARACTERISATION

5.1. GROUNDWATER VULNERABILITY

Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Aquifer vulnerability is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by a contaminant load imposed from surface. Figure 5.1 shows the national groundwater vulnerability ratings underlying the project area, indicating the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. The method is based on the DRASTIC method which includes the following parameters: Depth to water table; Recharge (net); Aquifer media; Soil media; Topography; Impact of the vadose (unsaturated) zone; conductivity (hydraulic).
Based on the national results (Figure 5.1), the aquifer underlying the project area has a medium vulnerability rating.

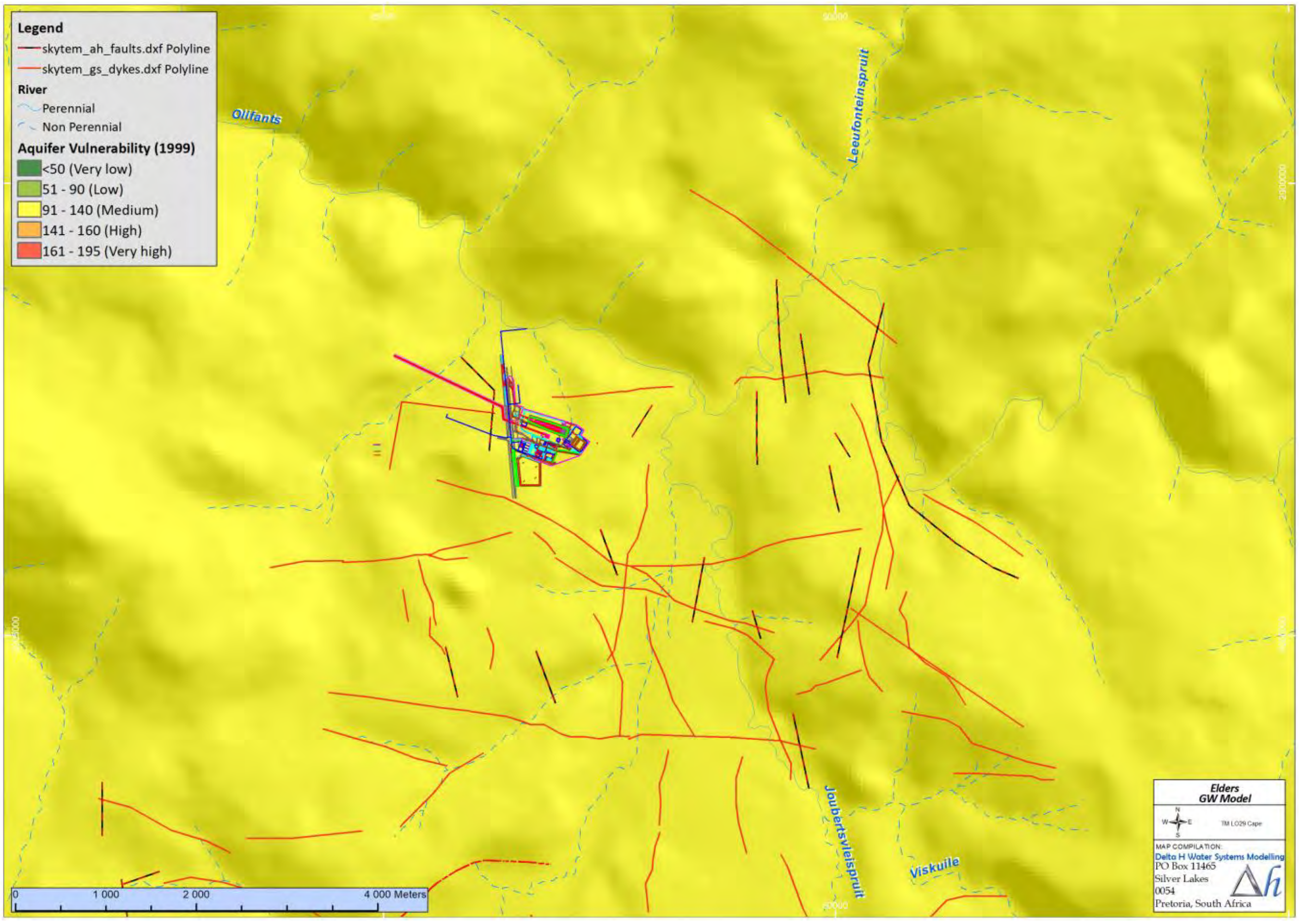

Figure 5.1: Groundwater vulnerability map for the Elders project area.

5.2. AQUIFER CLASSIFICATION

According to the Hydrogeological Map (1:500 000) series, the regional hydrogeology is characterized as an 'intergranular and fractured aquifer' with a typical potential yield of 0.1 to 0.5 litres per second, (Figure 5.2). A micro-fractured matrix in the fractured Karoo aquifers provides the storage capacity with limited groundwater movements, while secondary features such as fractures / faults and bedding planes enhance the groundwater flow. The intergranular aquifer is associated with the river alluvial and quaternary sand deposits.

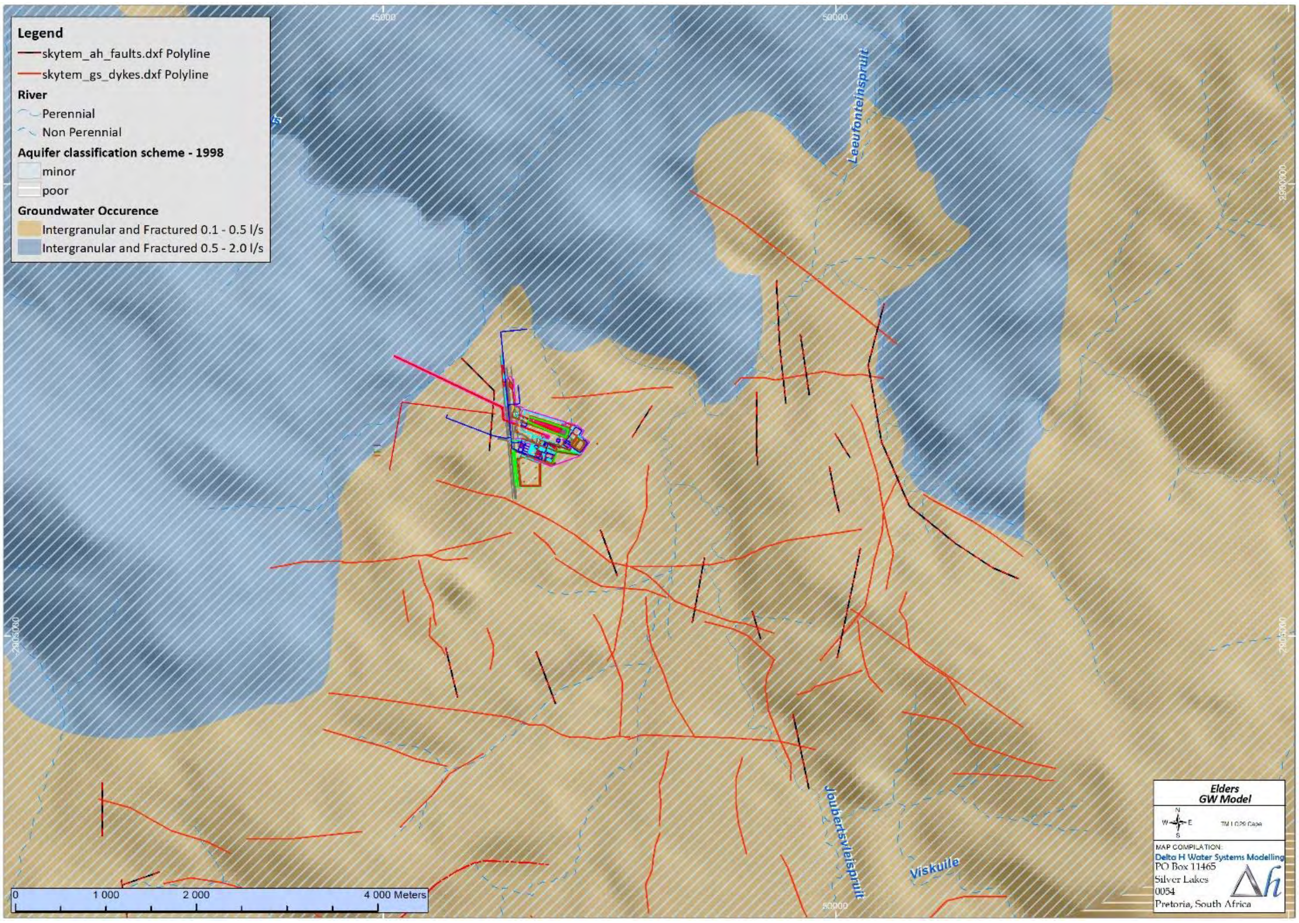

Figure 5.2: Aquifer classification map for the Elders project area.

Based on the aquifer classification map (Parsons and Conrad, 1998), the aquifer system underlying the site is regarded a mainly "poor aquifer" to "minor aquifer" (Figure 5.2). A summary of the classification scheme is provided in Table 5.1. In this classification system, it is important to note that the concepts of Minor and Poor Aquifers are relative and that yield is not quantified. Within any specific area, all classes of aquifers should therefore, in theory, be present.

Table 5.1: Aquifer classification scheme after Parsons and Conrad (1998).

Aquifer	Description
Sole source aquifer	An aquifer used to supply 50% or more of urban domestic water for a given area, for which there are no reasonably available alternative sources, should this aquifer be impacted upon or depleted.
Major aquifer region	High-yielding aquifer of acceptable quality water.
Minor aquifer region	Moderately yielding aquifer of acceptable quality or high yielding aquifer of poor quality water.
Poor aquifer region	Insignificantly yielding aquifer of good quality or moderately yielding aquifer of poor quality, or aquifer that will never be utilised for water supply and that will not contaminate other aquifers.
Special aquifer region	An aquifer designated as such by the Minister of Water

5.3. AQUIFER PROTECTION CLASSIFICATION

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required (Parsons 1995). The point scoring system and classification of the Elders project area are presented in Table 5.2.

Table 5.2: Groundwater Quality Management (GQM) Classification System.

Aquifer System Management Classification		
Class	Points	**Project area**
Sole Source Aquifer System: Major Aquifer System: Minor Aquifer System: Non-Aquifer System: Special Aquifer System:	6 4 2 0 0 – 6	**2**
Aquifer Vulnerability Classification		
Class	Points	**Project area**
High: Medium: Low:	3 2 1	**2**

The recommended level of groundwater protection based on the Groundwater Quality Management Classification is calculated as follows: GQM Index = Aquifer System Management x Aquifer Vulnerability = 2 x 2 = 4

A Groundwater Quality Management Index of 4 was estimated for the project area from the ratings for the Aquifer System Management Classification (Table 5.2). According to this estimate, a medium-level of groundwater protection (Table 5.3) is required for the intergranular and fractured aquifer. Reasonable groundwater protection measures are recommended to ensure that no cumulative pollution affects the aquifer, even in the long term. DWSs water quality management objectives are to protect human health and the environment. Therefore, the significance of this aquifer classification is that if any potential risk exists, measures must be taken to limit the risk to the environment, which in this case is the protection of the underlying aquifer.

Table 5.3: GQM index for the Elders project area.

Index	Level of Protection	Project area
<1 1 - 3 3 - 6 6 - 10 >10	Limited Low Level Medium Level High Level Strictly Non-Degradation	**4**

6. GROUNDWATER MODELLING

6.1. SOFTWARE MODEL CHOICE

The software code chosen for the numerical finite-element modelling work was the 3D groundwater flow model SPRING, developed by the delta h Ingenieurgesellschaft mbH, Germany (König, 2011). The program, formerly known as SICK 100, was first published in 1970, and since then has undergone a number of revisions. The current saturated and unsaturated program module SPRING-SITRA is based on the well-known SUTRA model (Voss, 1984). SPRING is widely accepted by environmental scientists and associated professionals. SPRING uses the finite-element approximation to solve the groundwater flow equation. This means that the model area or domain is represented by a number of nodes and elements. Hydraulic properties are assigned to these nodes and elements and an equation is developed for each node, based on the surrounding nodes. A series of iterations are then run to solve the resulting matrix problem utilising a pre-conditioning conjugate gradient (PCG) matrix solver for the current model. The model is said to have "converged" when errors reduce to within an acceptable range. SPRING is able to simulate steady and non-steady flow, in aquifers of irregular dimensions.

SPRING solves the stationary flow equation independent of the density for variable saturated media as a function of the pressure according to:

$$-\nabla\left(K_{ij}\nabla h\right) = -\nabla\left(K_{perm}\frac{\rho g}{\mu}\nabla h\right) = q = -\nabla\left[\frac{K_{perm}\cdot k_{rel}}{\mu}(\rho g\nabla z + \nabla p)\right]$$

∇	$\left(\frac{\partial}{\partial x},\frac{\partial}{\partial y},\frac{\partial}{\partial z}\right)$
q	Darcy flow
K_{ij}	Hydraulic conductivity tensor
ρg	Density $\cdot$ gravity
K_{perm}	Permeability
μ	Dynamic viscosity
k_{rel}	Relative permeability
p	Pressure

The relative hydraulic conductivity is hereby calculated as a function of water saturation, which in turn is a function of the saturation:

$$k_{rel}(S_r) = (S_e)^l\left[1-\left(1-(S_e)^{\frac{1}{m}}\right)^m\right]^2$$

$$S_e = \frac{S_r(p)-S_{res}}{S_s-S_{res}} = \left[1+\left(\frac{p_c}{p_e}\right)^n\right]^{\frac{1-n}{n}}$$

$S_r(p)$	Relative saturation dependent on pressure
S_e	Effective saturation
l	Unknown parameter, determined by van Genuchten to 0.5
m	equal to $1-(1/\mathrm{n})$
n	Pore size index
S_{res}	Residual saturation
S_s	Maximum saturation
p_c	Capillary pressure
p_e	Water entry pressure

Solving these equations for the relative saturation as a function of the capillary pressure $S_r(p_c)$ results in the capillary pressure- saturation function according to the Van Genuchten (1980) model as used in SPRING:

$$S_r(p_c) = S_{res} + (S_s - S_{res}) \cdot \left[1 + \left(\frac{p_c}{p_e}\right)^n\right]^{\frac{1-n}{n}}$$

The water entry pressure is a soil specific parameter and defined as the inverse of a = $1/p_e$ in the saturation parameters.

The density independent, instationary flow equation for variable saturated media as a function of the capillary pressure is given as follows:

$$\rho\left(S_r(p_c)S_{sp} + \theta\frac{\partial S_r(p_c)}{\partial p}\right)\frac{\partial p}{\partial t} + \theta S_r(p_c)\frac{\partial \rho}{\partial t} - \nabla\left[\rho\frac{K_{perm}k_{rel}}{\mu}(\nabla p + \rho g \nabla z)\right] = q$$

The specific pressure dependent storage coefficient S_{sp} is hereby given as

$$S_{sp} = \alpha(1-\theta) + \beta\theta$$

α Compressibility of porous media matrix
β Compressibility of fluid (water)
θ Aquifer porosity

The transport equation for a solute in variably saturated aquifers is given as follows:

$$\theta S_r(p_c)\frac{\partial c}{\partial t} + \theta S_r(p_c)v\nabla c - \nabla\big(\theta S_r(p_c)\big(D_m\bar{\bar{1}} + D_d\big)\nabla c\big) = qc^* + R_i$$

qc^* Volumetric source/sink term with concentration $c*$
D_m Molecular diffusion
$\bar{\bar{1}}$ Unit matrix
D_d Hydrodynamic dispersion
R_i Reactive transport processes (sorption, decay, etc.)

The software is therefore capable to derive quantitative results for groundwater flow and transport problems in the saturated and unsaturated zones of an aquifer.

Stability criteria

In order to simulate the solute transport accurately and to comply with applicable numerical stability criteria (Courant Criteria), the time step width has to be adapted for the predictive scenarios.

$$C_r = \left|\frac{v\Delta t}{L}\right| \leq 1$$

The geometry of the mesh can have an undesirable effect (numerical dispersion) on the simulated spreading of solutes, if the elements are too large in relation to the dispersion length. The mesh was therefore designed to comply with the Peclet criteria:

$$L < 2\alpha_l$$

v Flow velocity
Δt Discrete time step
L Longest dimension of an element in the direction of flow
α_l Longitudinal dispersion coefficient

A measure of this ratio is the Peclet number P_e, which should be less than 2 so that the proportion of the non-hyperbolic part of the transport equation dominates:

$$P_e = \left|\frac{v\Delta l}{D}\right| < 2$$

It describes the ratio of the advective part to the dispersion part (D) with respect to a characteristic length (side length of the elements, Δl). The lower the Peclet number, the less iterations are necessary to achieve a pre-defined maximum value of the residuals. Once this dimensionless number exceeds the value of 10, it is no longer guaranteed that the solution converges. An optimal discretization in space results for a Peclet number lower 2.

6.2. MODEL SET-UP AND BOUNDARIES

The model domain covers a surface area of 1 705 km^2 and overlaps the B11A, B, C and D quaternary catchments. The boundaries of the model follow in the south and west the boundaries of quaternary catchment B11A, in the north the boundary of quaternary catchment B11B and in the east the perennial Steenbokspruit and for sa short section a topographical high. The topographic highs (catchment boundaries) are sufficiently far removed from the proposed Elders Colliery underground workings and are therefore considered to define also local groundwater divides or natural flow and transport boundaries. The chosen approach ensures a dependable water balance for the model with rainfall recharge instead of assigned (and uncertain) flows being the driver of groundwater flow.

6.3. GEOMETRIC STRUCTURE OF THE MODEL

The finite-element model was set-up as a three-dimensional groundwater flow model. The model domain was discretised into multiple layers in accordance with the developed conceptual model. The final 3D numerical model area of 1 705 km^2 is spatially discretised into 98 161 nodes on tent node layers, which make up nine element layers comprising of 110 300 elements (triangles and quadrangles) per layer. While the model layers generally correlate with the various hydrogeological units underlying the project area, the horizontal element size (side length) varies from 10 to 50 m within the mining areas to a maximum side length of 150 m further away from the area of interest and expected steep head or concentration gradients.

A summary of the layer arrangement is provided in Table 6.1. In accordance with the developed conceptual model, the uppermost two element layers represent the weathered Karoo aquifer, whereas the next two element layers represent the fractured Karoo aquifer above the No 4 coal seam, i.e. overburden. The split into two model layers for the aquifer units was solely done to ensure numerical stability and an accurate calculation of unsaturated flow processes. Element layer V and VII represent the No. 4 and No. 2 Coal seams respectively and are only present within the area covered by the provided geological model and not throughout the model domain.

The surface elevation (i.e. node layer 1) is based on a regional (50m x 50m) digital Elevation Model (DEM), with surface elevations within Elders based on the DEM provided by the client. The bottom of the weathered zone is within the mine lease area based on the weathering elevation as provided by the client (file name: eld_topo_bhwe_thk_1m.dxf) and regionally off-set by 15 metres from the surface elevation. The zone of weathering was split for numerical accuracy into two model layers.

To ensure numerical stability and accuracy, the fractured Karoo overburden to the No. 4 coal seam was vertically discretised into 2 element layers by splitting its thickness to the roof of the coal seam. The roof and floor elevations of the No.4 and No. 2 coal seams, i.e. the thickness of element layers V and VII, were based on the grid provided by the client (file names: eld_s4_totrf_cnt_5m.dxf, eld_s4_totfl_cnt_5m.dxf, eld_s2_totrf_cnt_5m.dxf and eld_s2_totfl_cnt_5m.dxf). The deepest model layers IIX and IX represent the fractured Karoo aquifer below the No. 2 coal seam and were regionally off-set by 75 and 150m meters from surface, respectively (or split in two layers of even thickness underneath the coal seam). The depth of 150 mbgl is the lowest depth of active groundwater flow.

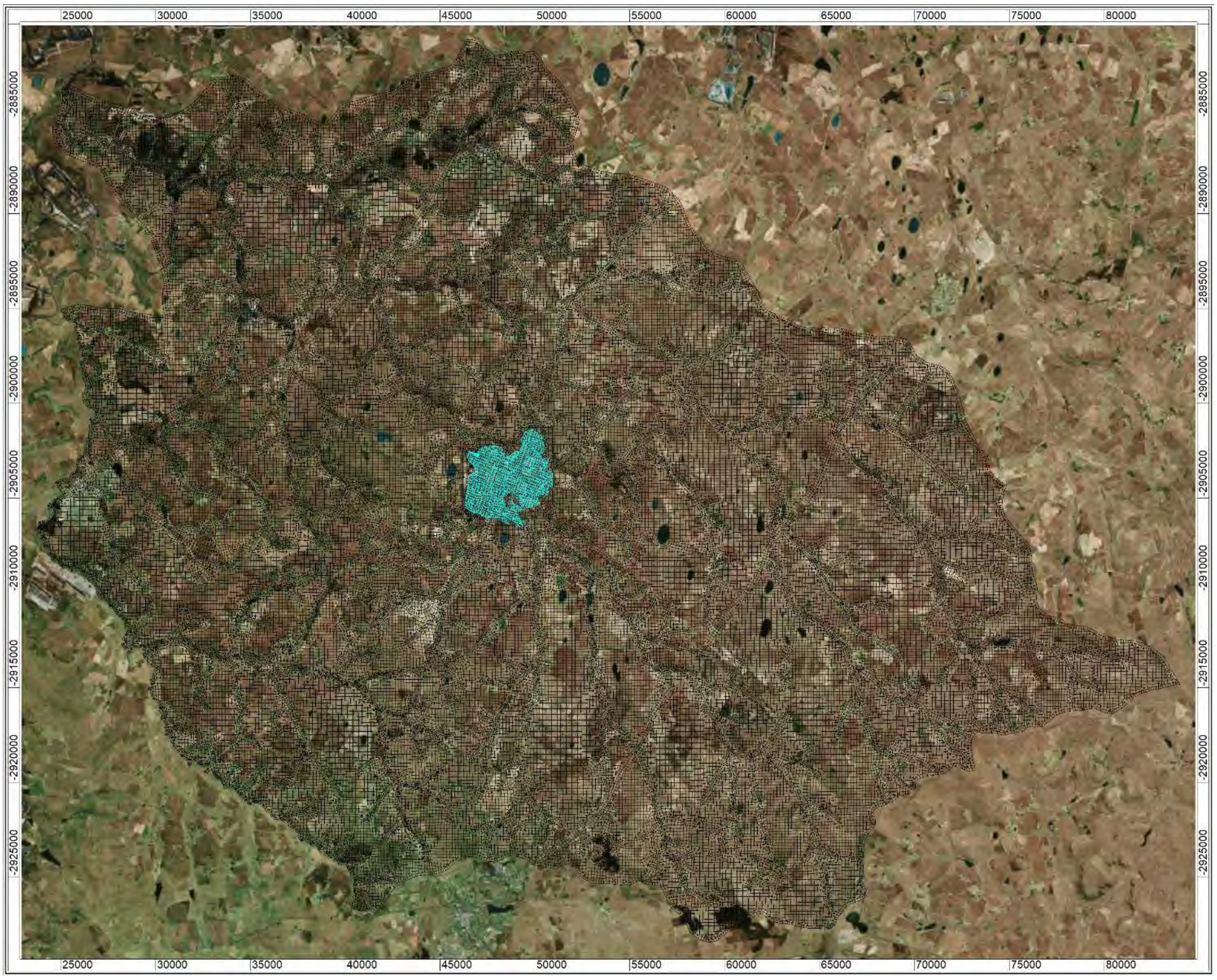

Figure 6.1: Finite element mesh of the Elders Colliery groundwater model (proposed underground mine layout indicated in bright blue).

Table 6.1: Layer arrangement for the Elders Colliery groundwater model.

Node layer	Element layer	Aquifer / Mining feature	Data used for interpolation
1	I, top	Surface elevation	DEM
2	I, bottom	Weathered aquifer	½ depth of weathering
3	II, bottom		Base of weathering, eld_topo_bhwe_thk_1m.dxf
4	III, bottom	Fractured Karoo aquifer	½ depth of overburden
5	IV, bottom		Roof of No 4 Coal Seam, eld_s4_totrf_cnt_5m.dxf
6	V, bottom	No 4 Coal Seam	Floor of No. 4 Coal seam, eld_s4_totfl_cnt_5m.dxf
7	VI, bottom	Fractured Karoo aquifer	Roof of No 2 Coal Seam, eld_s2_totrf_cnt_5m.dxf
8	VII, bottom	No 2 Coal Seam	Floor of No. 2 Coal seam, eld_s2_totfl_cnt_5m.dxf
9	IIX, bottom	Fractured Karoo aquifer	½ depth to bottom of active flow system
10	IX, bottom		Regional DEM -150 m, bottom of active flow system

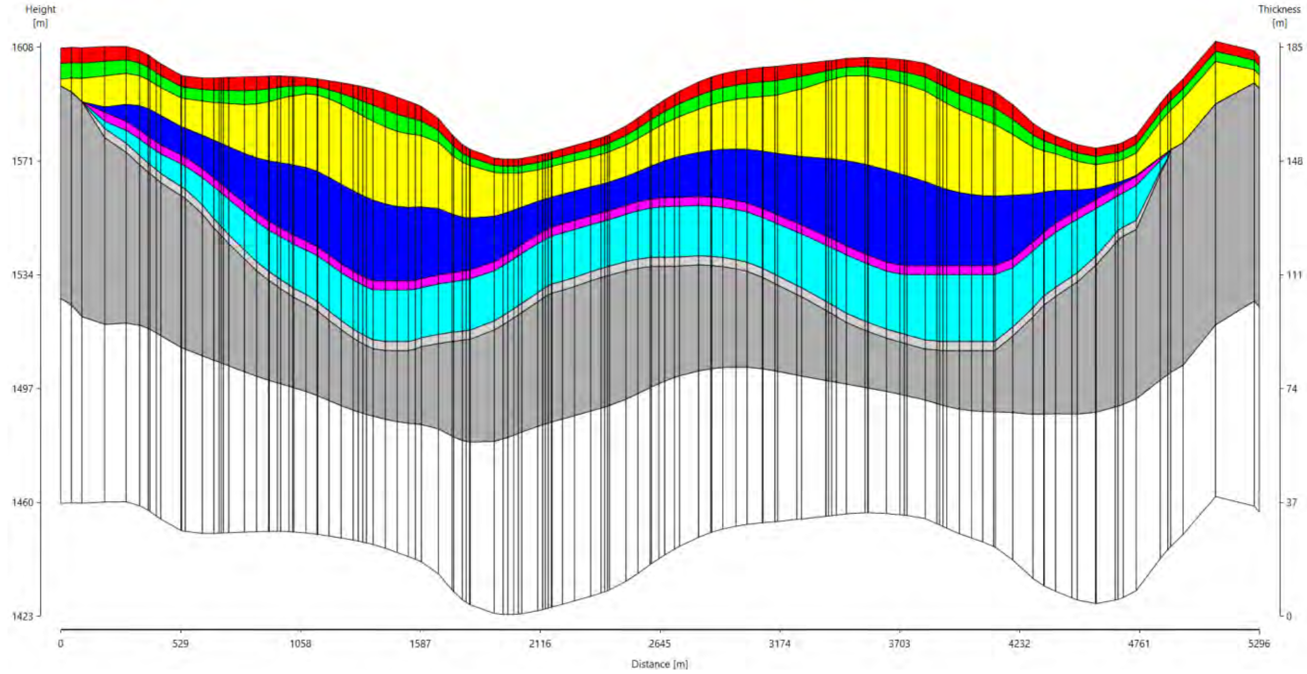

Figure 6.2: Example of the vertical grid layout across the mining area (E-W cross section, colours indicate numerical model layers only).

6.4. GROUNDWATER SOURCES AND SINKS

6.4.1. Groundwater recharge

The groundwater recharge and seepage rates as given chapter 3.7 were assigned to the top layer of the Elders Colliery groundwater model as aerial seepage rates (2nd type/Neumann or specified flux boundary condition). The recharge rates were considered fixed for the calibration of the model.

6.4.2. River courses

Water leaves the model domains via a number of non-perennial and perennial rivers. All non-perennial rivers or drainage lines were generally classified within the model domain as continuously gaining rivers (i.e. groundwater is only allowed to discharge into them) and therefore described within the model using SPRING's 'river package', with no exfiltration of surface water allowed. The chosen approach ensures no water losses from rivers into the model domain, while simulating potential leakage of groundwater into surface water courses (groundwater baseflow) as suggested by GRA II (Table 2.2). The stage of each river node was carefully aligned with the height of the Digital Elevation Model (DEM) at that point and an incision the river bottom of 5 m below topography assumed.

Water leaves the model domain via numerous perennial and non-perennial rivers. Notwithstanding the type, all surface water drainages were classified as continuously gaining river courses. A river or 3rd type (Cauchy) boundary condition was assigned to the streams and river courses within the model domain whereby the leakage of groundwater into the river (or vice versa) depends on the prevailing gradient. Based on estimated baseflow rates for the catchments of interest, the streams/rivers were generally classified as potentially gaining streams/rivers and no leakage of surface water into the aquifer respectively the model domain allowed. With the chosen approach, no water losses occur from the perennial and non-perennial rivers into the model domain, but groundwater on either side of the river/drainage might discharge into it as a function of the calculated gradients. The streams act therefore only as groundwater sinks. In the absence of site-specific data, a river bed conductance of 1E-7 m/s was assumed for all river courses within the model area and an incision of 5 meters below the surrounding topography is assumed for the hydraulic active riverbed.

6.4.3. Pollution Control Dams

The Pollution Control Dams (PCDs) and brine dam will be lined with a Class C liner, i.e. a composite liner (GM/CCL) comprising of a HDPE Geomembrane (GM), a low permeability compacted clay liner (CCL) of 300 mm thickness and an underdrainage system (e.g. finger drains) for leak detection. Due to the extremely low permeability of the HDPE liner, leakage through a composite liner occurs predominantly through geomembrane defects, with the fluid passing through the geomembrane defect (pinholes and welding defects), flowing laterally some distance between the geomembrane and the clay liner (interface flow due to liner wrinkling) before it infiltrates and seeps through the clay liner (Giroud 1997).

Considering a class C liner for the PCDs and Brine Dam, Giroud (1997) gives the following equation to estimate the leakage rate through composite liners with a head larger than the thickness of the CCL (300 mm) of fluid on top of the liner and for a circular defect:

$$Q = A \cdot n \cdot 0.976 C_{qo} [1 + 0.1(h/t_s)^{0.95}] d^{0.2} h^{0.9} k^{0.74}$$

A	Geomembrane area (m^2)
n	Number of defects
h	Hydraulic head on top of the geomembrane (m)
t	Thickness of CCL (m)

Assuming a hydraulic head h of 1 m on top of the liner for the PCDs and Brine dam, a diameter d of 0.0005 m for one (n) circular defect per 1 000 m^2 and a hydraulic conductivity k of 1E-08 m/s for the CCL (values suggested by Giroud 1997 for an average CCL), a flow rate of 3.88E-10 $m^3/s*m^2$ or 12.23 $mm/a*m^2$ is estimated and used as a "recharge" rate for the PCDs and Brine dam.

6.4.4. Underground Mine workings

The proposed underground mine workings were integrated in annual increments as per mining schedule (Figure 6.3, Figure 6.4) into element layer V and VIIU, representing the targeted No. 4 and No. 2 coal seams respectively, of the numerical model. Note that the pink blocks in Figure 6.3 are excluded from mining. The underground mine workings are represented as zones of elevated hydraulic conductivity (1E-03 m/s) and porosity (68%). The porosity is hereby based on the envisaged average extraction rate of 68 %, with 32% pillars remaining behind (average extraction height: 3m).

In order to estimate groundwater inflows into the future underground mine workings (Figure 6.3) and quantify thereby dewatering requirements associated with the mine development, a free seepage boundary (with no losses or flow of water into the model domain) were assigned to the floor elevations of the targeted No. 4 and 2 Seams (node layer 6 and 8). The chosen approach assumes that any groundwater entering any of the underground workings is removed immediately and no groundwater storage or flow within the mine workings or return flows into the aquifer is considered. In other words, it is assumed that the entire mine workings are dry due to continuous dewatering of any water ingress.

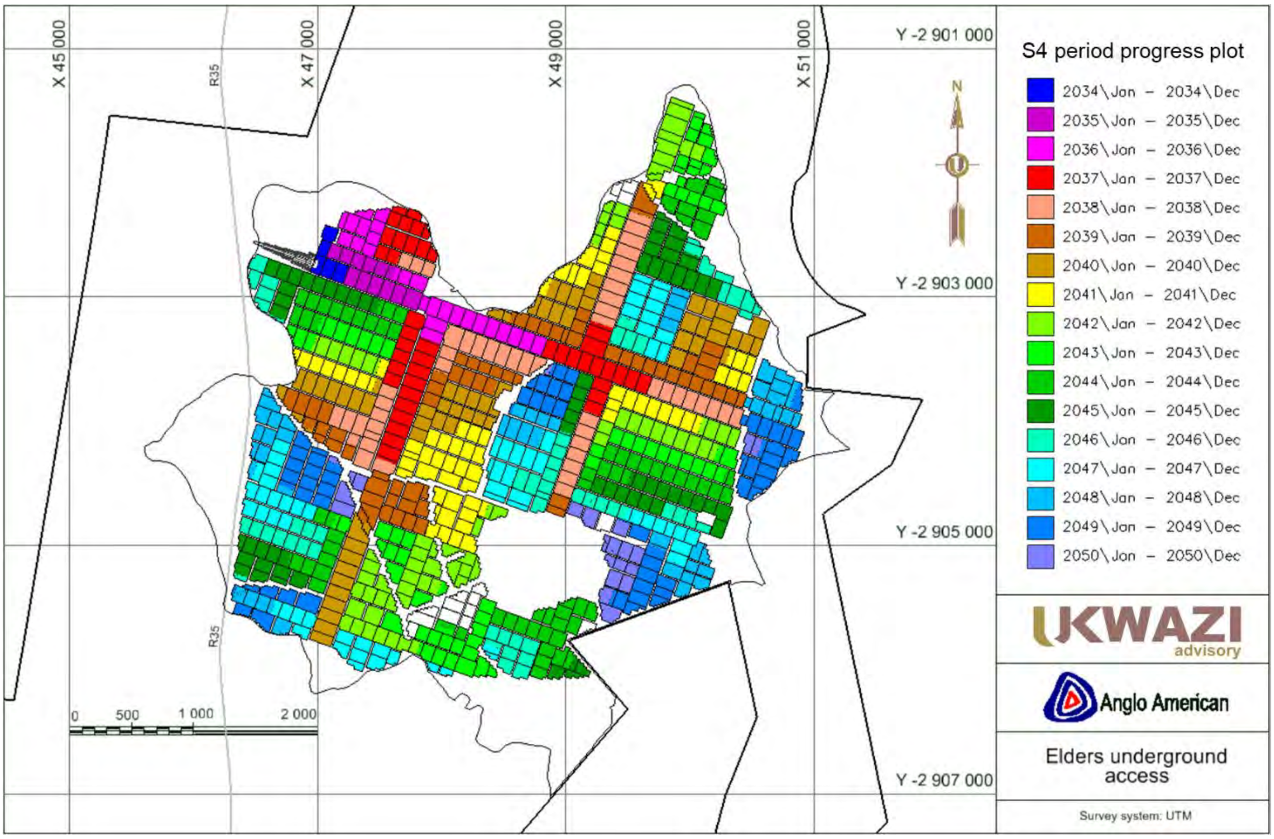

Figure 6.3: Proposed life of mine plan for No. 4 Seam, Elders Colliery (file name: EldersPPP_v1.pptx).

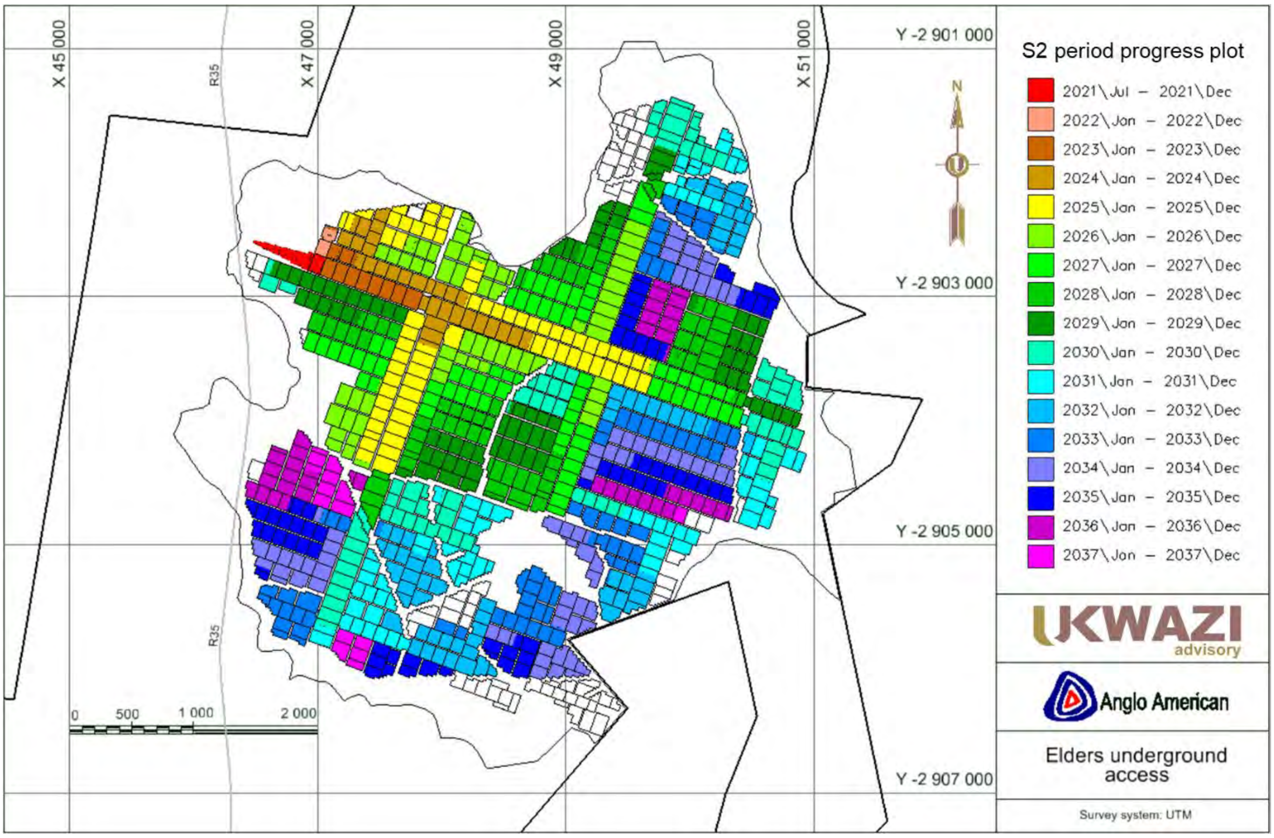

Figure 6.4: Proposed life of mine plan for No. 2 Seam, Elders Colliery (file name: EldersPPP_v1.pptx).

6.4.5. Groundwater Abstractions

While Elders Colliery itself does currently not abstract any groundwater, a number of external water users were recognised during 2002 and 2012 hydrocensus (JMA 2006, 2014, see Table 4.12) as well as the recent 2019 hydrocensus. While no actual abstraction rates could be established, JMA (2015) summarised the groundwater use as follows:

- 19 boreholes are used solely for domestic purposes.
- 17 boreholes are used for both agricultural and domestic purposes.
- 26 boreholes are used solely for stock watering.
- The above boreholes supply roughly 789 people, 4 gardens, one nursery, 5 622 large stock units, 1 dairy, 1 200 small stock units and 27 050 poultry units.

In view of the various yields and usages of the boreholes, Delta H assigned 1% of the borehole yields in Table 4.12 (as reasonable agricultural and domestic usage rates) as abstraction rates to used boreholes only. This is obviously an oversimplification of the actual abstraction rates and patterns, but in view of no other available data and variable water levels observed in neighbouring (used and unused) boreholes considered a reasonable approach.

6.4.1. Regional Groundwater Flow

Due to the lack of data, deeper (> 60 mbgl) regional groundwater flow across the model boundaries were neglected in the model. This contributes potentially to errors associated with the model calibration and predictions, but these are considered acceptable in the context of the model application. The errors affect predominantly the water balances, as water which would have otherwise left the model domain as deeper regional groundwater flow reports now to surface water courses, leading to an overestimation of groundwater baseflow, especially at the model boundaries. Since these are far removed from the colliery, errors with regard to predicted mine inflows and associated impacts are considered marginal.

6.5. CONCEPTUAL MODEL

The conceptual understanding of the different aquifers in the area, namely the

1. Shallow alluvial and weathered Karoo aquifer,
2. Fractured Karoo aquifer including Dolerite intrusions, and the
3. Artificial mine aquifer

is summarised in chapter 4.3.2. While the alluvial and weathered aquifer were considered a single unit for the numerical model setup (due to absent geological mapping of alluvial aquifers in the area), the weathered and fractured Karoo aquifers were incorporated into the numerical model as such, as well as mapped faults and dykes (file names: s2faults_0316.dxf and s4faults_0316.dxf, aeromag_interp_2005.dxf).

While both, the shallow weathered and deep fractured Karoo aquifers will contribute to future mine inflows and water levels will be impacted upon, the shallow weathered zone aquifer will be the main receptor and pathway of potential pollution from mine residue deposits. The water quality in the deep fractured Karoo aquifer will mostly be impacted post closure due to acid rock drainage within the open mine voids once the water table rebounds.

6.6. NUMERICAL MODEL

6.6.1. Numerical Parameters

SPRING uses an efficient preconditioned conjugate gradient (PCG) solver for the iterative solution of the flow equation. The closure criterion for the solver, i.e. the convergence limit of the iteration process was set at a residual below 1e-06 m. The Picard iteration, used for the iterative computation of the relative permeability for each element as a function of the relative saturation (i.e. capillary pressure), used a damping factor of 0.5 and was limited to 8 iterations. The mean difference between the computed pressures for the last two iterations was generally lower than 0.01 m.

6.6.2. Initial and Assigned Conditions

The initial conditions specified in the numerical model were as follows:

- Starting heads for the shallow aquifer were interpolated from measured water levels using Bayesian interpolation, i.e. co-kriging using the established correlation between surface topography and groundwater elevation (Figure 4.6).
- Hydraulic conductivities of 1E-06 m/s for the weathered aquifers and 1E-07 m/s for the fractured aquifers.
- Vertical hydraulic conductivities were set at 10% of the horizontal conductivities
- Effective porosity values were specified as 8% for the weathered Karoo and Basement aquifer, 5% for the fractured Karoo and basement aquifers decreasing to 3% with depth.
- In the absence of site specific data, values of dispersivity were inferred from literature values.
    - A uniform longitudinal dispersivity of 50 m was used for all aquifers units.
    - The transversal dispersivity is set at 10 % of the longitudinal dispersivity (NRC, 1990).

6.6.3. Selection of Calibration Targets and Goals

The 104 groundwater levels (in metres above mean sea level) collated from the 2002, 2012 (
Table 4.8 and Table 4.12, both by JMA) and the current 2019 (Table 3.1) were used as calibration targets for the steady state flow model calibration. While it is obviously far from ideal to combine water level observations spanning over more than a decade, neglect of the older 2002 water level measurements would have resulted in a limited number and spatial coverage of water levels. More emphasis was obviously placed on fitting the most recent water levels monitored at Elders Colliery.

6.6.4. Steady State Calibration

Since the modelled groundwater levels are directly related to the assigned recharge rates and hydraulic conductivities, an independent estimate of one or the other parameter is required to arrive at a potentially unique calibration of the model. The estimated regional recharge rates were therefore considered fixed during the calibration and only the hydraulic conductivities varied. The original model was run with the initial conditions and aquifer conductivities adjusted within sensible boundaries until a best fit between measured and computed heads was achieved. No attempt was made to change hydraulic conductivity values within the different hydro-stratigraphic units, to achieve representative uniform parameters for these.

The root mean square error (RMSE) respectively the normalised root mean square error (NRMSE) were used as quantitative indicators for the adequacy of the fit between the 111 (=n) observed (h_{obs}) and simulated (h_{sim}) water levels:

$$RMSE = \sqrt{\frac{\sum(h_{obs} - h_{sim})^2}{n}}$$

$$NRMSE = \frac{RMSE}{h_{max} - h_{min}}$$

The normalised root mean square error scales the error value to the overall range of observed heads within a model domain (here h_{max} – h_{min} =1673.52 mamsl – 1557.08 mamsl = 116.45 m), with values lower than 10% considered acceptable.

While the corresponding root mean square error of **6.31** and normalised root mean square error of **5.42 %** are slightly higher than in the previous model update (5.81 and 4.85 %, respectively, Delta H 2020a), they are still considered more than acceptable for the purpose of the model.

Despite the intended constraint of uniform hydraulic conductivity values for the different geological units, a good correlation between observed and modelled water levels (R^2 = 0.95 or 95% correlation, Figure 6.5) was achieved for the steady-state calibration, with no apparent bias of systematically under- or overestimating water levels with the model (even distribution of points around regression line in Figure 6.5).

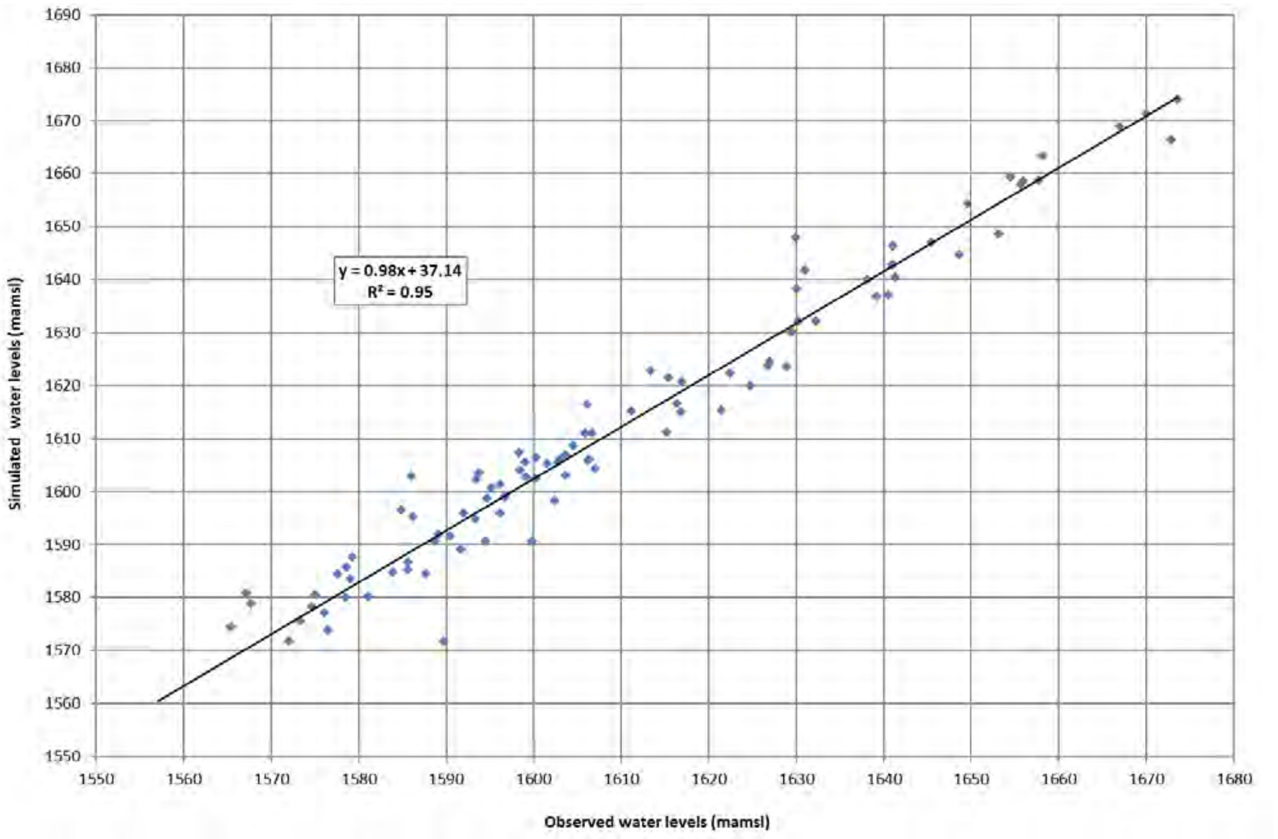

Figure 6.5: Steady-state calibration of the Elders Groundwater Model

The calibrated hydraulic conductivity values as given in Table 6.2 and simulated steady-state water levels (Figure 6.6) were subsequently used for the predictive model scenarios.

Table 6.2: Final calibrated hydraulic conductivities.

Aquifer	Hydraulic conductivity	
	[m/s]	[m/d]
Weathered Karoo	5 E-06	0.43 – 0.35
Lower weathered/upper fractured Karoo	8.4E-07	0.07
Fractured Karoo, decreasing with depth	4 - 3E-08	3.5E-03 - 2.6E-03
No. 4 and No. 2 coal seam	5E-08	4.3E-03
Dykes	6E-09	5E-4

6.7. RESULTS OF THE MODEL

6.7.1. Pre – Mining

The pre-mining water levels as simulated by the calibrated model (Figure 6.6) represent the status-quo or baseline hydrogeological conditions against which potential impacts on groundwater in storage (water level drawdown) or groundwater flow directions by the proposed mining project will be evaluated.

The pre-mining or baseline groundwater quality, based on earlier and current hydrocensus results, was discussed in chapter 4.6. Potential constituents of concern associated with the mining project which could impact on the ambient groundwater quality are given in chapter 4.5 .Considering the low to non-detectable background concentrations of sulphate, which is a prime constituent of concern, impacts on the ambient groundwater quality associated with leachate from mine residue deposits or mine workings are presented as net impacts without any assumed background concentration.

While this approach is certainly applicable for sulphate, it must be kept in mind that several water samples in the project area showed naturally elevated iron and manganese concentrations, which were also identified as constituents of concern (Table 4.5). Since these metals are highly redox-sensitive and their transport generally delayed by sorption in comparison to sulphate, sulphate transport was conservatively chosen to visualise mining related impacts on the ambient groundwater quality.

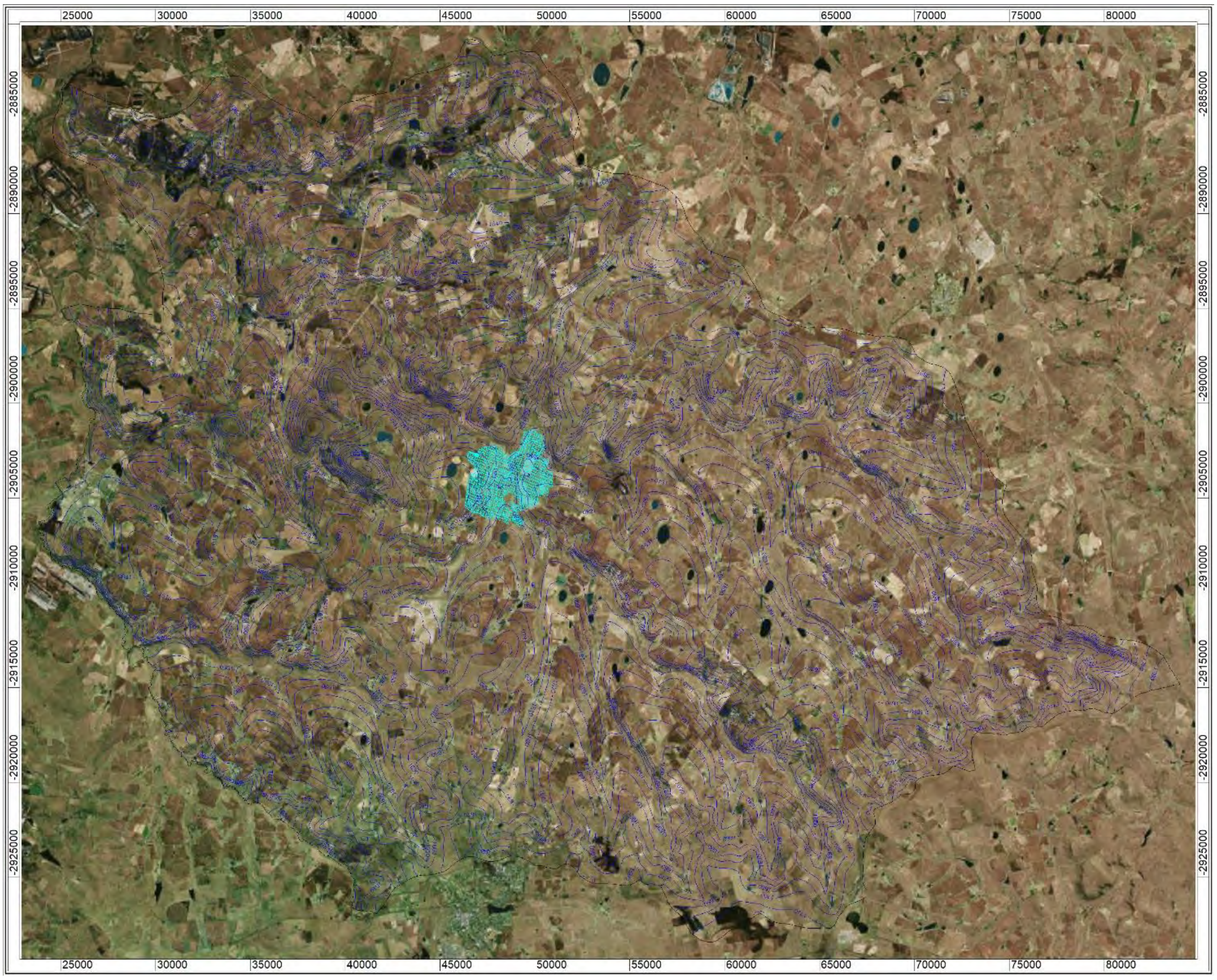

Figure 6.6: Simulated steady-state water levels of the Elders Groundwater Model (proposed mining area indicated in bright blue).

6.7.2. During Life of Mine

6.7.2.1. Life of Mine Inflows

Elders Colliery intends to mine the No.2 and 4 coal seams using the bord-and-pillar method with an envisaged average extraction factor of 65 % and an average stoping height of 3.5 m. The continuous development of the mine voids will lead to water ingresses during the LoM with an associated dewatering of the surrounding aquifers. The calibrated steady-state groundwater model was used to predicted the mine inflow rates and associated cones of aquifer dewatering over the LoM.

In order to reflect the annual planned underground mining blocks, the following changes to the boundary conditions in the model were performed:

1. For each year of LoM a free seepage boundary (with no losses or flow of water) was assigned to the floor elevation of the targeted seam and mining block as per schedule (Figure 6.3 and Figure 6.4).
2. Updated hydraulic conductivity values (1E-03 m/s or ~90 m/d) and porosity values equal to the envisaged average extraction factor (0.68, consider remaining pillars as well as coal remaining in the roof and floor of the respective workings) are assigned to the mine block.

The model was then run (with a time step width of 3 days) for the given year, before the next mining block was incorporated until the end of LoM (2050).

The chosen approach assumes that any groundwater entering the underground mine workings is removed immediately and no groundwater storage or flow within the mine workings or return flows into the aquifer is considered. In other words, it is assumed that the entire LOM workings are dry due to continuous dewatering of any water ingress. The estimated dewatering rates do not account for any water storage in mining compartments, sealing of mining areas or grouting of mine inflows and are therefore considered an upper estimate.

The simulated average annual mine inflows into planned No. 2 and No. 4 Seam underground mine workings of Elders Colliery are given in Table 6.3 and shown in Figure 6.7.

Table 6.3: LoM inflows into the No. 2 and No. 4 Seam underground workings of Elders Colliery.

Year	4 Seam	2 Seam	Total
	All in Ml/d		
2021		0.42	0.42
2022		0.29	0.29
2023		0.91	0.91
2024		2.76	2.76
2025		4.10	4.10
2026		5.61	5.61
2027		6.10	6.10
2028		6.66	6.66
2029		6.89	6.89
2030		7.38	7.38
2031		8.17	8.17
2032		9.28	9.28
2033		9.02	9.02
2034	0.10	8.13	8.23
2035	0.23	7.76	7.98
2036	0.52	7.08	7.60
2037	0.71	5.80	6.52
2038	1.35		1.35
2039	1.63		1.63
2040	1.65		1.65
2041	1.84		1.84
2042	2.07		2.07
2043	2.29		2.29
2044	2.08		2.08
2045	1.81		1.81
2046	1.57		1.57
2047	1.69		1.69
2048	1.83		1.83
2049	2.03		2.03
2050	1.62		1.62

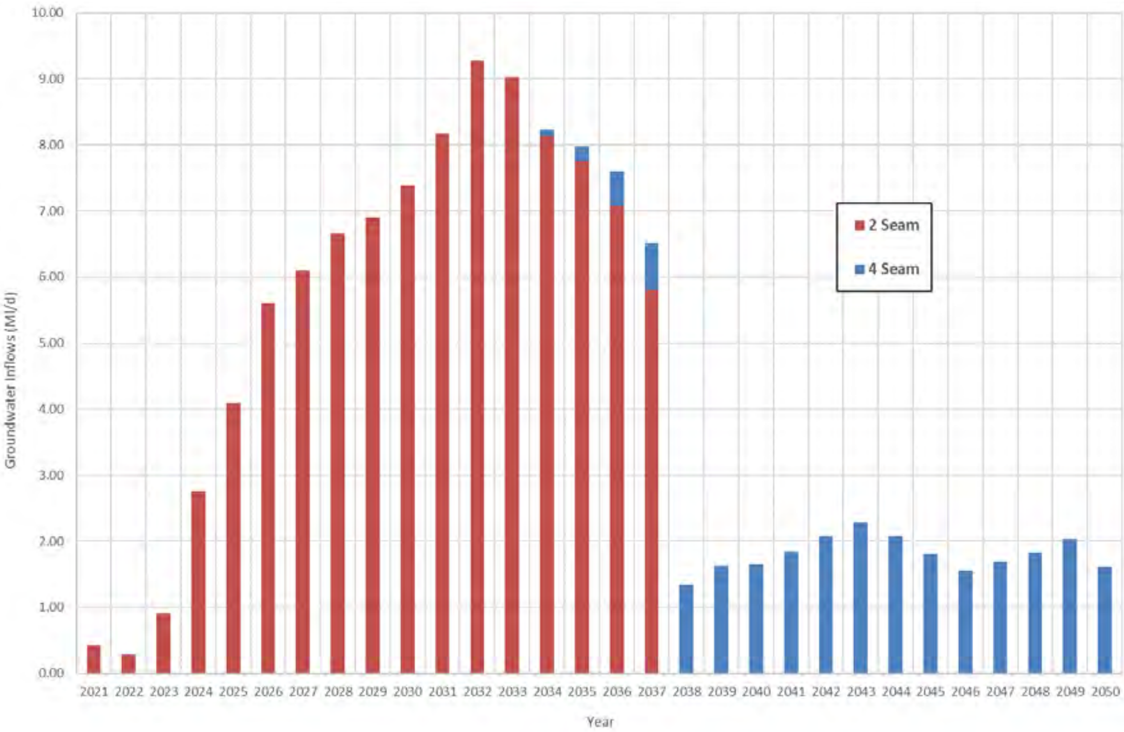

Figure 6.7: LoM inflows into the No.2 and No. 4 Seam underground workings of Elders Colliery.

The predicted future inflows reflect mostly the depth of the targeted seam and extent of planned mine extensions, moderated by increasing dewatering of the aquifer and variable mining depths. Especially the earlier mining of the No. 2 Seam triggers significant inflows of up to around 9.3 Ml/d in 2032 as deeper sections of the seam (in the central area of the bowl shaped seam topography in the mining area) are mined out. This represents also the predicted total peak inflow, albeit inflow remain high thereafter until mining of the No. 2 seam cedes in 2037. Inflows into the shallower No. 4 seam remain thereafter generally below 2.3 Ml/d due to the preceding dewatering of the No. 2 seam, with water levels still recovering and thereby reducing predicted inflows into the shallower mine workings.

It must be emphasised that the predicted inflow values do not consider any interventions like grouting or upfront dewatering and are considered conservative upper estimates. They are furthermore very sensitive to assigned hydraulic parameter for the fractured Karoo aquifer (e.g. hydraulic conductivity and unsaturated flow/van Genuchten parameter), which are generally considered to be highly heterogeneous. They should therefore be reviewed once measured early inflow values become available.

6.7.2.2. Water table drawdown during LoM

Assuming re-use or other environmentally acceptable disposal practices of the groundwater entering the underground mine voids, the environmental impacts associated with the mine inflows are primarily associated with:

- the partial dewatering of the aquifer above and in the vicinity of the underground mine voids with subsequent impacts on groundwater dependant eco-systems and groundwater users,
- the interception of ambient groundwater flow, which would have under natural conditions discharged into the surface drainages, provided baseflow to the rivers, or contributed to deeper regional groundwater flow.

The simulated impact of the partial dewatering of the weathered and fractured Karoo aquifer due to mine inflows is depicted in Figure 6.8 and Figure 6.9 respectively as contours of predicted maximum drawdown at the end of life of mine (2050) from the pre-mining groundwater table in meters. The cones of dewatering are presented as contour areas with cut-off values of 1 and 5 m respectively, representing the perceived seasonal variability of water levels (water level fluctuations are typically larger in the lower porosity, fractured Karoo aquifers) as well as the uncertainties associated with the model predictions for the different aquifers (fractured aquifers are generally more heterogeneous and hence difficult to characterise hydraulically).

Due to a limited hydraulic connectivity between the shallow weathered and deeper fractured Karoo aquifers, the cone of dewatering is expectedly far more pronounced in the actually mined, deeper fractured aquifer. The cone of dewatering in the fractured aquifer is furthermore steeper due to its low permeability, whereas the higher permeability of the weathered aquifer results in a wider, but shallower cone. Both cones of dewatering, i.e. in the shallow and deeper Karoo aquifers, are most pronounced at the projected end of mining (2050) in the eastern mining areas, with maximum drawdowns of around 10 and 90 metres, respectively.

The simulated extent of the (steady-state) zone of impact (1m cut-off) of the underground workings on the shallow weathered aquifer extends around 400 meters from the mine workings, with maximum extents of 900 metres in the west (Figure 6.8), correlating with the area of the last No. 4 seam mining blocks (Figure 6.3). Drawdowns above 5m within the deeper fractured Karoo aquifer extend around 700 metres from the last underground mining blocks in the west and east, with the most pronounced drawdown in the east, also visible within the shallow aquifer.

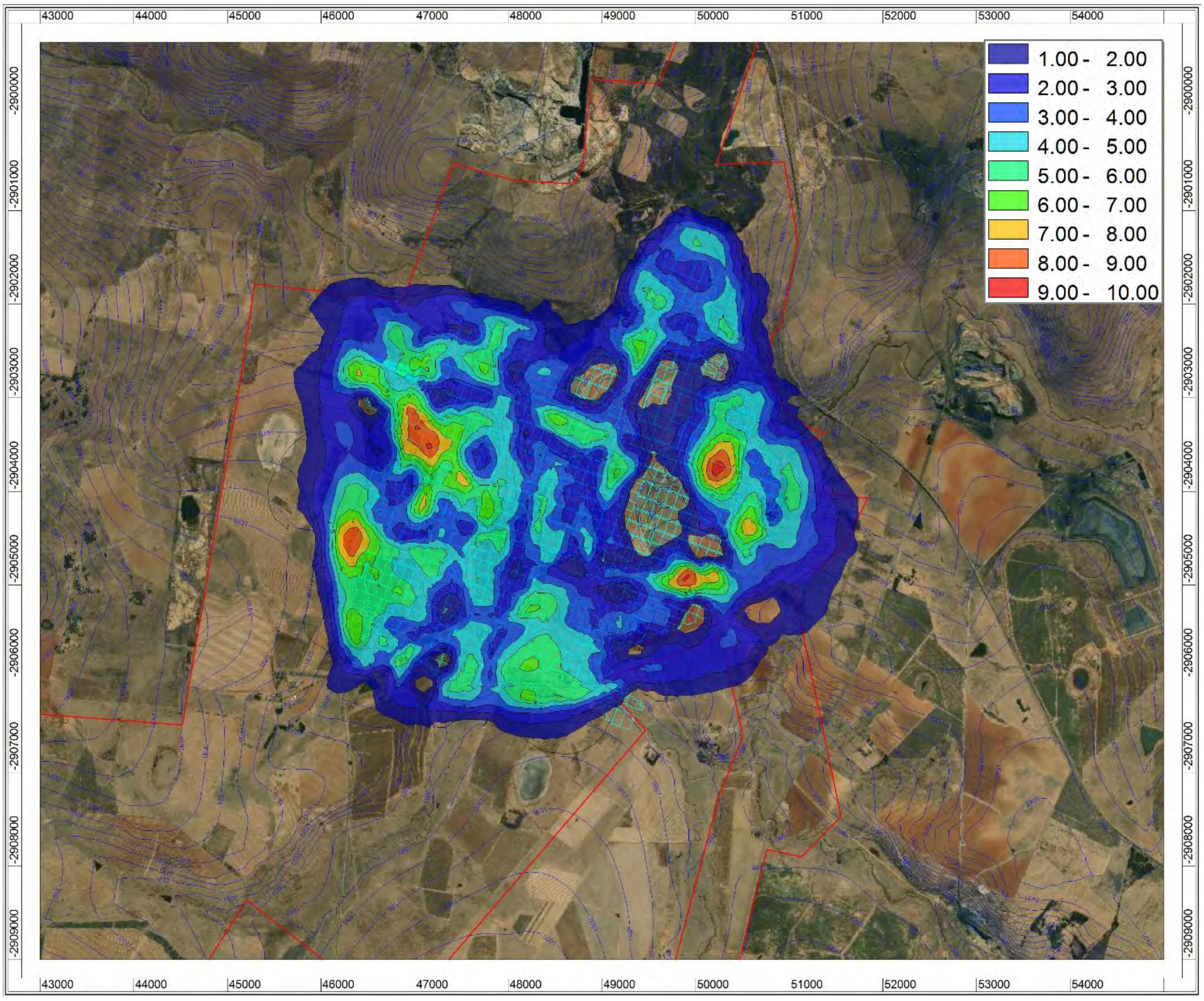

Figure 6.8: Final (2050) water table contours and drawdown within the shallow weathered Karoo aquifer at the end of life of mine (mining area indicated in bright blue, mine lease boundary in red).

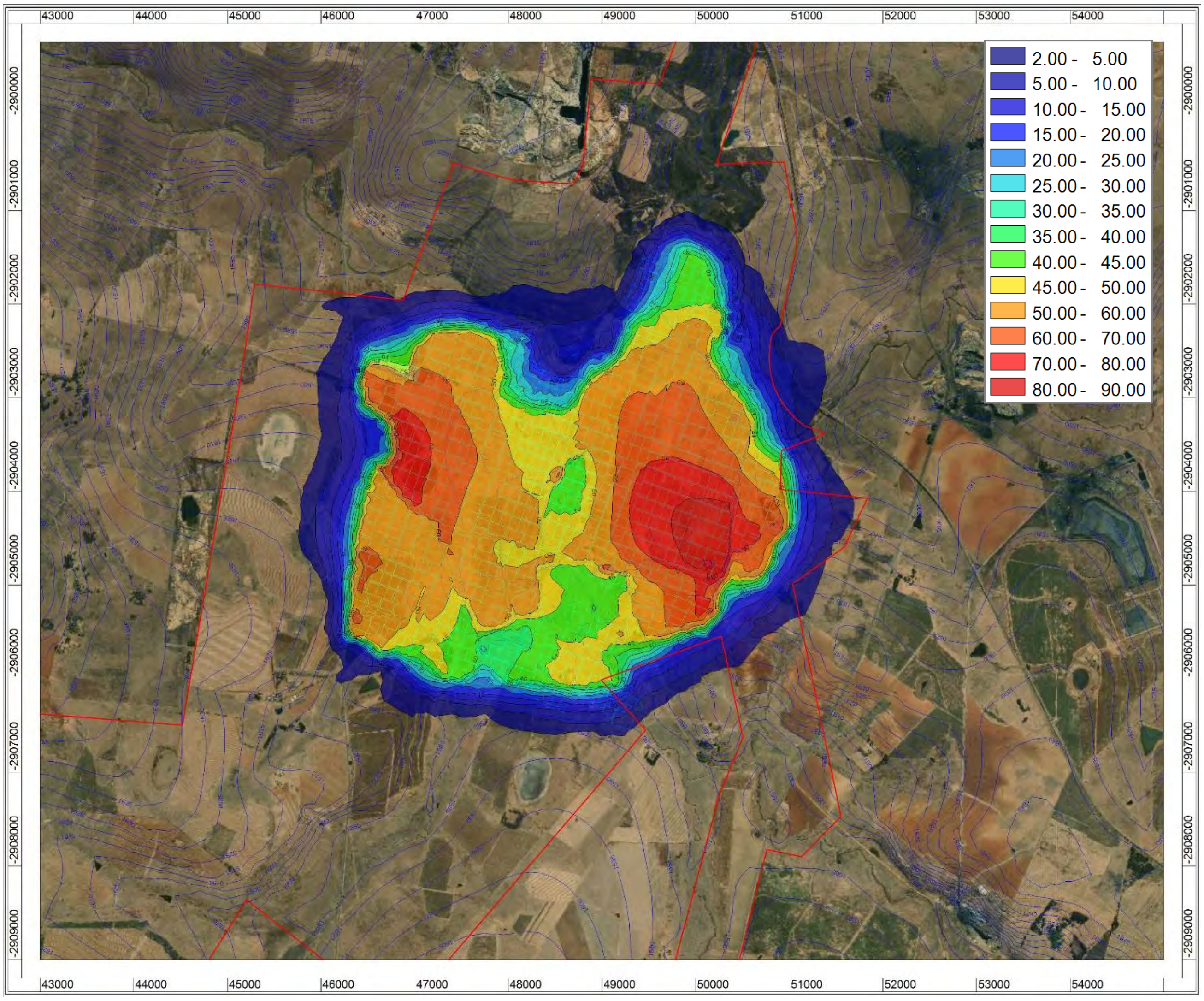

Figure 6.9: Final (2050) water table drawdown within the deeper fractured Karoo aquifer (actually mined blocks indicated in bright blue, mine lease boundary in red).

6.7.2.3. Transport from MRDs

The solution of the calibrated steady-state groundwater model was used as the basis for the transport model using the transport code built into SPRING (chapter 6.1). The overburden stockpile, PCDs and Brine dam were identified as potential pollution sources and incorporated into the model as recharge boundaries with specified recharge/seepage rates (chapter 3.7) and source concentrations (100%). Because the ROM stockpile will be designed as a bin (with an emergency stockpile area that will be cleared within in 24 hours, should the need arise to use it), it was not considered a pollution source for the groundwater transport simulations.

The model was then run with a weekly time-step width for the Life of Mine (30 years or 2050). Following the precautionary principle, only advective-dispersive transport of a potential pollutant without any retardation or transformation was assumed. The impact assessment of the potential pollution sources on the groundwater quality are therefore considered conservative.

A uniform longitudinal dispersion length of 75 m was assigned to all model layers, with transversal dispersivities set at 10% and vertical dispersivities at 1% thereof. Porosities were assigned as per Table 4.9.

Since no element specific retardation or transformation is simulated, a unit source concentration of 100% was assigned to the pollution sources and the seepage plume contours visualised as percentages of the unit input/source concentration with a minimum and increment of 10 % up to 100 %.

Considering that the tested over-/interburden samples were generally classified as potentially acid generating (Table 4.1), JMA (2006) estimated a range of likely water qualities for the operational (if patches of water are allowed to accumulate in the mine workings) and post-closure mining phases (Table 4.5), which can be applied to the overburden stockpile exposed to oxygen and rain water, PCDs and Brine dam (representing also contact water from the underground mine voids). The single legend Table 6.4 shows the expected ranges of both sulphate and Total Dissolved Solids (TDS) concentrations for the operational phase of the mine based on these and Delta-H's (2020) predictions.

Table 6.4: Contamination map legend for the Elders LoM (30 years) transport model (all values in mg/l).

Legend (Unit %)	Sulphate (mg/l)			TDS (mg/l)	
	Lower Case	Likely Case	Upper Case	Lower Case	Upper Case
10.00	0.6	100	160	20	450
20.00	1.2	200	320	40	900
30.00	1.8	300	480	60	1 350
40.00	2.4	400	640	80	1 800
50.00	3	500	800	100	2 250
60.00	3.6	600	960	120	2 700
70.00	4.2	700	1 120	140	3 150
80.00	4.8	800	1 280	160	3 600
90.00	5.4	900	1 440	180	4 050
100.00	6	1 000	1 600	200	4 500

It must be emphasised that the source concentrations in Table 6.4 are very broad estimates, which should be reviewed along with the transport model simulations once actually observed source concentrations or further geochemical test results become available.

The source concentrations above are furthermore considered very conservative for the overburden stockpile, as carboniferous over- and interburden material will be trucked to Goedehoop South mineral residue dump. However, following the precautionary principle they provide and should be seen as a worst case scenario for the stockpile.

No initial or background concentrations of e.g. sulphate (see chapter 6.7.1) or any other constituent of concern are assumed in the predictive model runs and the simulated plumes represent therefore predicted net effects of the Overburden Stockpile, PCDs and Brine dam seepage quality on the ambient groundwater quality.

The maximum extent of the seepage plume (with a cut-off value of 10%) at the end of LoM (2050) emanating from Overburden Stockpile is around

- 105 m towards the east, driven by the hydraulic gradient towards the underground mine workings,
- 50 m towards the north or the box-cut area, and
- 30 m towards the west and south.

The plume extent is confined to the site and it is not foreseen that the plume impacts on any groundwater user.

The maximum extents of the seepage plume at the end of LoM emanating from the lined PCDs and Brine dam are around 20 m. The limited plume extents due to the lined nature of the facilities (albeit still assumed to leak due to average construction, chapter 6.4.3) and are almost confined to the footprint areas itself. No impact on any groundwater user are foreseen.

Figure 6.10: Simulated pollution plumes emanating from the MRDs at the end of LoM (surface layout indicated in black, underground mining areas in bright blue).

6.7.2.4. Transport from Underground Mine Workings

Due to continuous dewatering of the underground mine voids during the Life of Mine, the hydraulic gradients in the aquifer are generally directed towards the underground mine voids and capture therefore any potentially released contaminant. No transport from the underground mine voids was therefore simulated for the Life of Mine.

6.7.3. Post –Closure

6.7.3.1. Water Table Rebound and Potential Decant

For the post-closure model simulations, the predicted potential heads at the end of life of mine (2050) were assigned as starting heads. Groundwater seepage into the underground mine voids is no longer removed from the model domain (i.e. the seepage boundary was removed) but allowed to fill up the mine voids over time. In other words, it is assumed that pumping ceases immediately at the end of the 'life of mine' from the No. 4 Seam workings and the ground-water levels in the deeper fractured Karoo aquifer are allowed to rebound freely and flood the mine. It must be noted that the rebound of the water table within the 2 Seam workings was assumed to have already started in 2037 as mining ceased (Figure 6.4), i.e. 13 years before final mine closure. The model was then run with weekly time-steps for a period of 100 years to simulate the establishment of the new equilibrium water levels post-mining.

Considering approximate final underground mining areas of 12.57 and 12.09 km^2 for the No. 2 and No.4 Seam workings respectively, an average mining height of 3 m and an average extraction rate of 68%, the total underground mine volumes to be flooded amount to approximately 25.65 and 24.67 Mm^3 respectively.

The numerical post-closure modelling results (Figure 6.12) suggest that it will take around 90 years after closure before the water levels within the shallow weathered aquifer have stabilised, albeit the rebound or recovery curves show a typical parabolic profile with a substantial recovery of water levels within earlier years post closure. It must be noted that the simulated timeframe of water table rebound is highly sensitive to assigned aquifer storativities and the regional recharge rate; both of which are poorly defined input parameter into the numerical model. The predicted rate of mine flooding and water table rebound should therefore be re-evaluated once groundwater abstractions from the mine voids start and groundwater monitoring data of the actual water table drawdown become available, as these will allow for better estimates of storativities and recharge rates. The simulated rebound rates should therefore be seen as a first order estimate only.

The simulated post closure water levels suggest no direct decant of mine impacted water to surface via the decline. However, the bowl shape topography of the seams (Figure 4.2) means that the hydraulic heads at the higher lying edges of the mine workings equilibrate across the mine workings, which could trigger direct surface decant of mine impacted water if exploration boreholes within the mining area are not sealed off. The open mine voids create essentially an artificial network of communicating pipes, in which the pressure head (not the free water table) equilibrates (Figure 6.11). While the equilibrated heads are insufficient to cause decant along the incline (starting at higher ground), open boreholes could provide a pathway to the surface. It is therefore of utmost importance that any exploration borehole, especially within the central lower lying mining area, is sealed.

While no direct decant to surface is expected, the elevated pressure heads within the open mine voids cause upwards directed flow gradients (i.e. from the deeper fractured Karoo aquifer towards the shallow weathered aquifer) and thereby potential transport of mine impacted water. This issue is addressed in chapter 6.7.3.3.

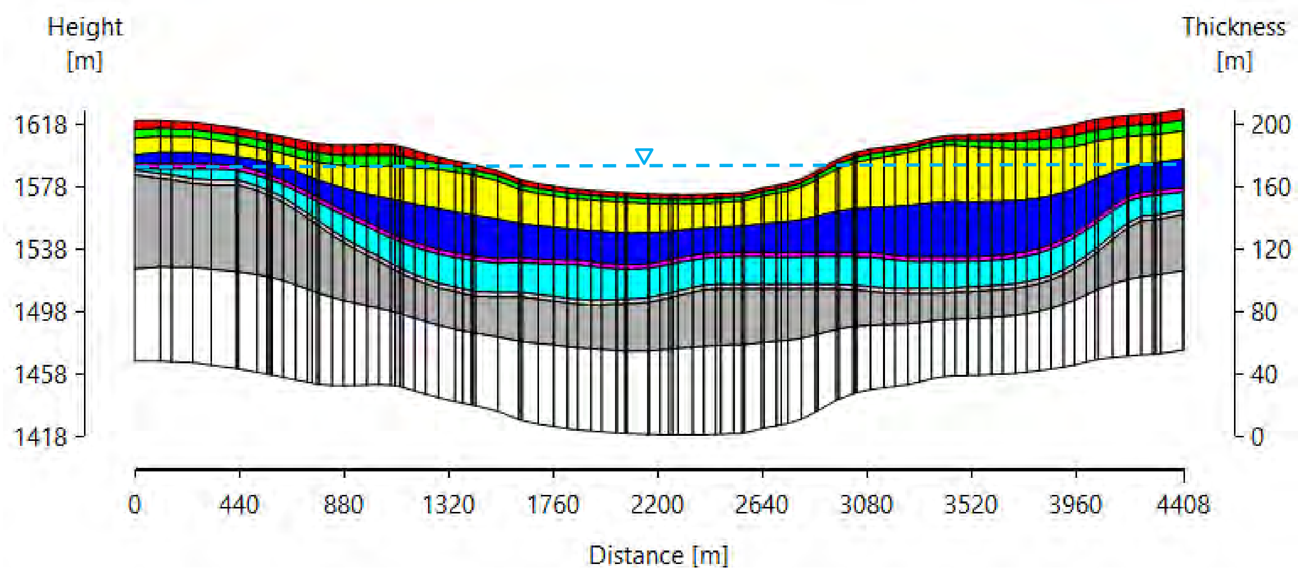

Figure 6.11: Conceptual cross-section of pressure heads within 4 Seam workings (turquois layer).

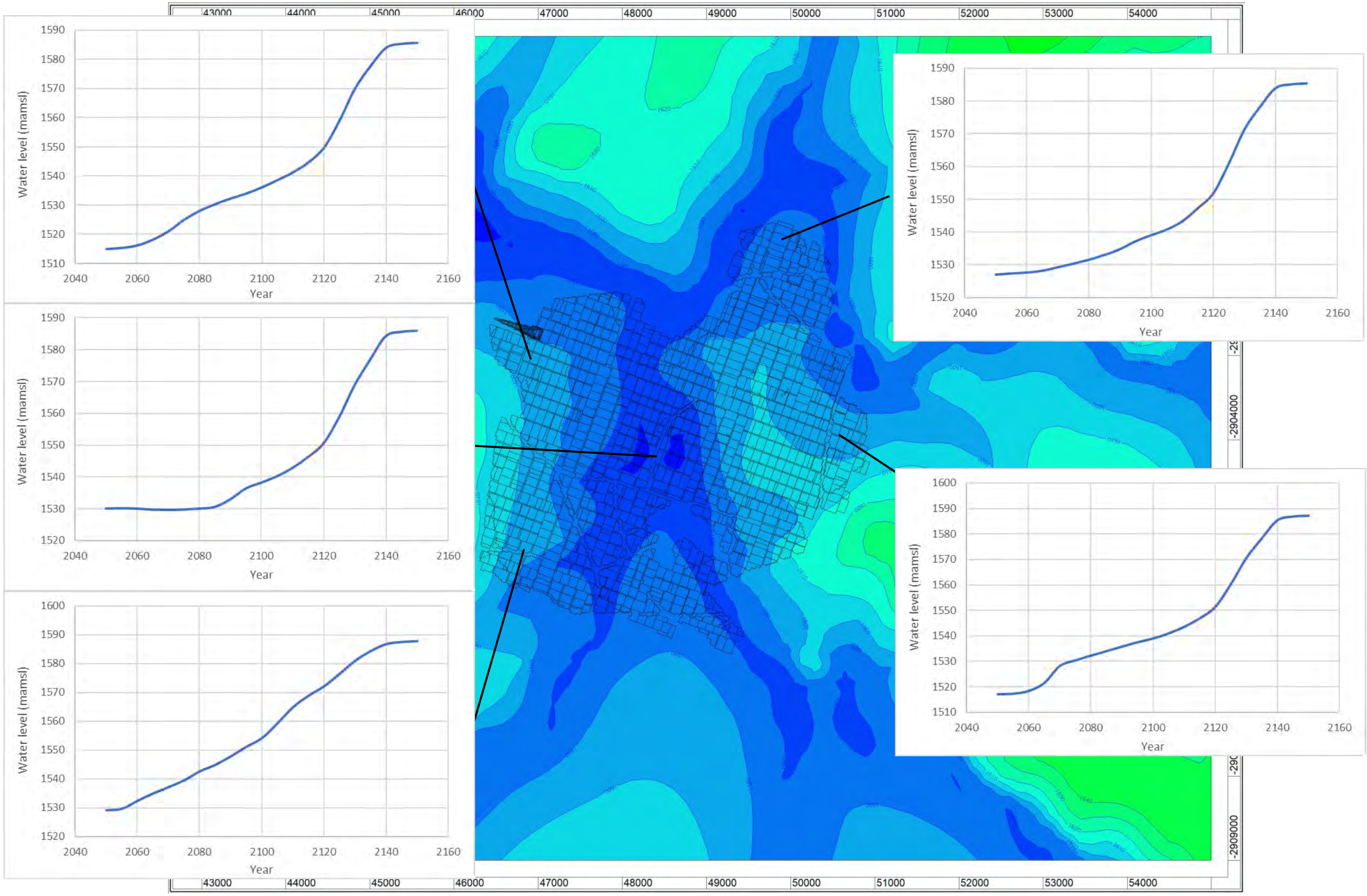

Figure 6.12: Simulated steady-state post closure water tables for Elders Colliery (mining blocks indicated in black) and water table rebound curves.

6.7.3.2. Transport from MRDs

The solution of the life of mine transport model for the MRDs (Figure 6.10) was used as the basis (starting heads and concentrations) for the post closure transport model, which was run with weekly time steps for a period of 100 years post closure. It is assumed that the PCDs and Brine dam will be no longer active post closure (i.e. removed and rehabilitated) and the assigned recharge rates and concentrations therefore removed from the model. The predictions simulate therefore the dissipation of the existing life of mine plume from these sources under changing post closure gradients.

Furthermore, it is assumed that the overburden stockpile will be fully covered, top-soiled and seeded post closure, limiting rainwater and oxygen ingress. The source concentration of the Overburden stockpile was therefore reduced from 100% to 50% for the post closure simulations. The post closure transport model simulates therefore the continuous migration of the seepage plume from the Overburden stockpile, albeit at a lower recharge rate (equal to natural background) and concentration due to its assumed rehabilitation and with changing gradients due to the post closure rebound of water levels (Figure 6.13 to Figure 6.16).

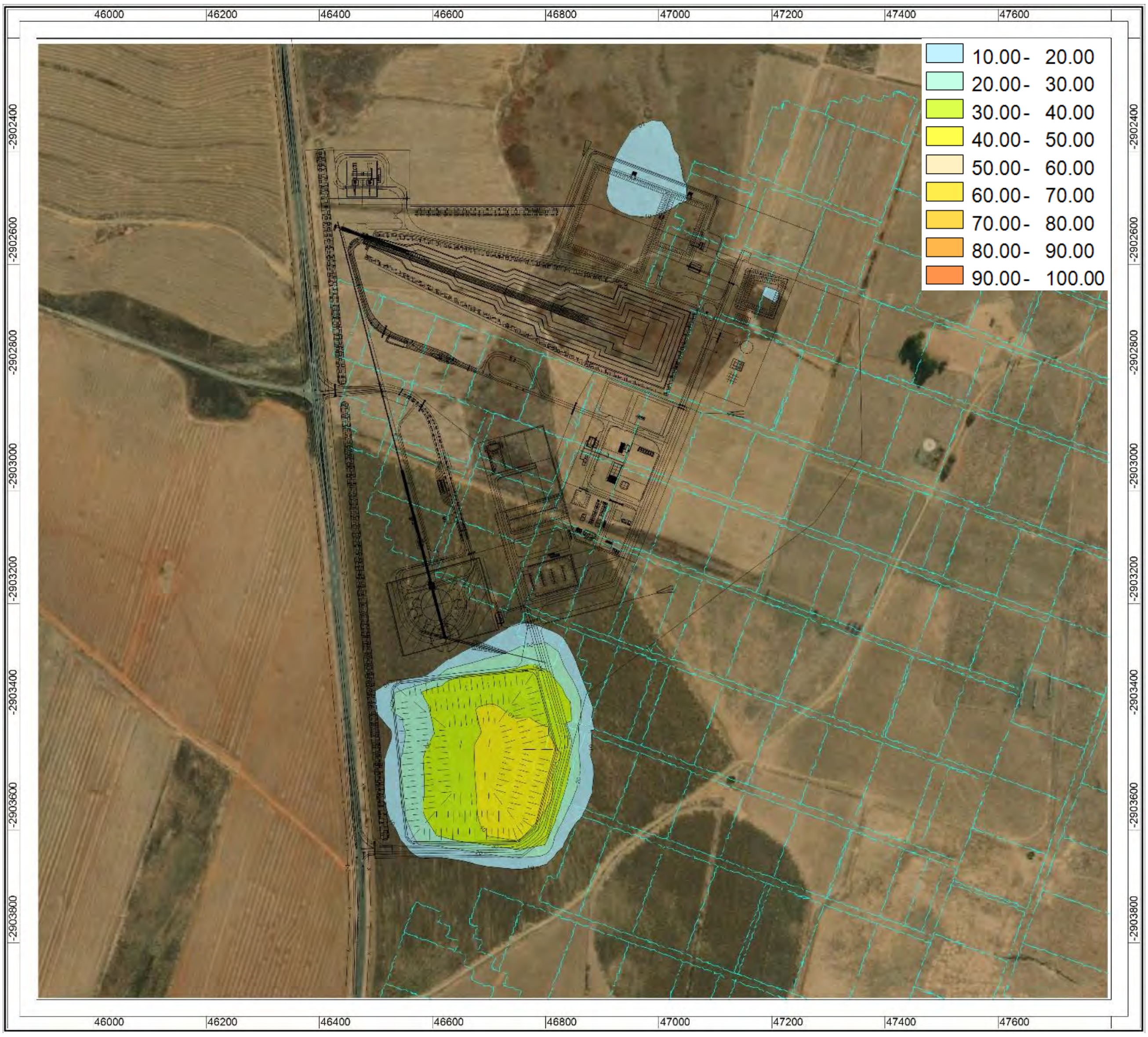

Figure 6.13: Simulated pollution plumes emanating from the MRDs 10 years post closure (surface layout indicated in black, underground mining areas in bright blue).

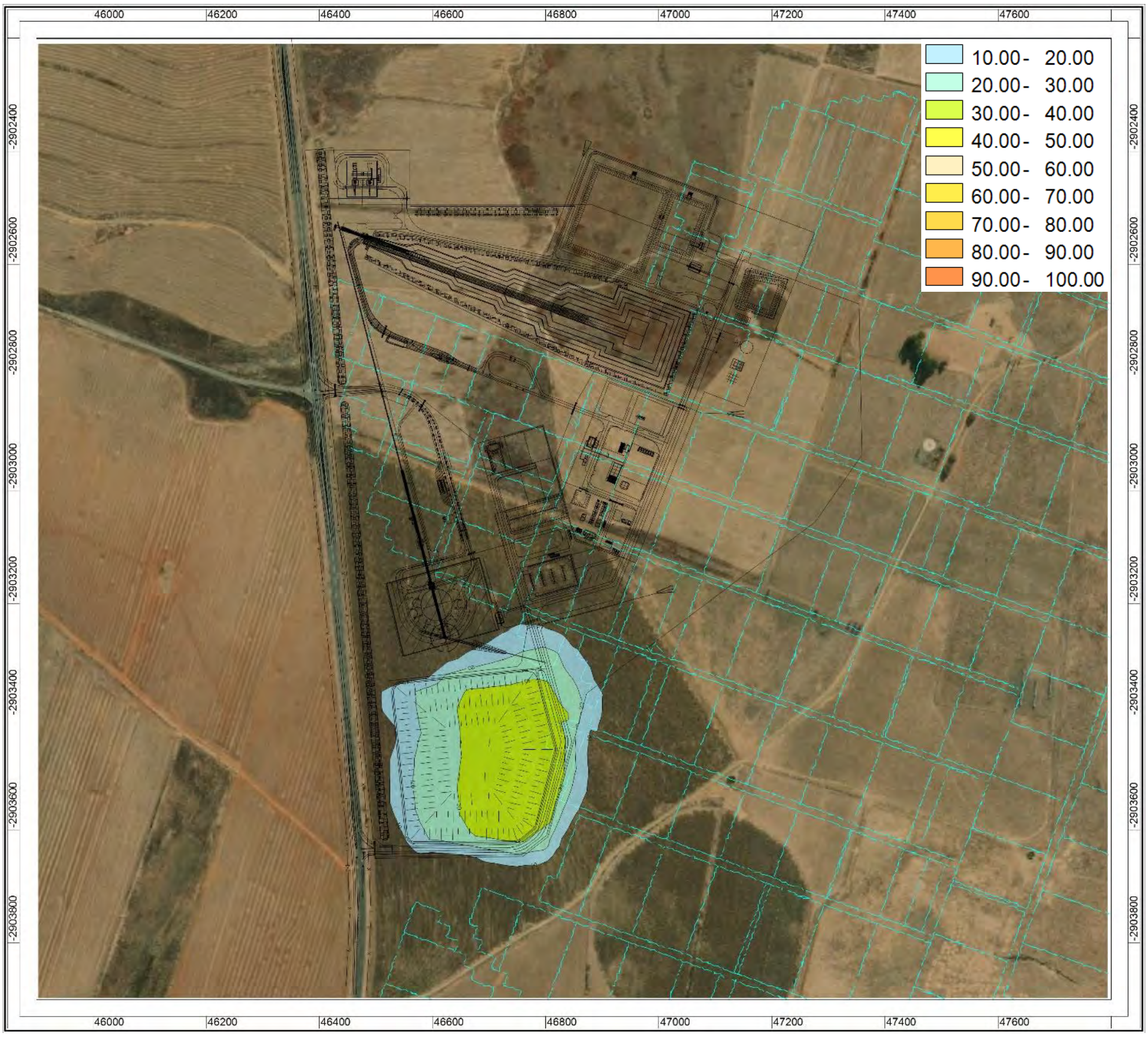

Figure 6.14: Simulated pollution plumes emanating from the MRDs 25 years post closure (surface layout indicated in black, underground mining areas in bright blue).

While the remnant pollution plumes from the PCDs and Drine dam is still evident (albeit at low concentrations with a maximum of 10%) and migrates slightly further northwards 10 years after mine closure (Figure 6.13), they are entirely dispersed (to below 10% of source concentrations) within 25 years post closure (Figure 6.14). Similarly, the seepage plume from the overburden stockpile plume dissipates due to a lower source strength (concentration and seepage rate) with maximum predicted groundwater concentrations of around 30% to 40% in the weathered aquifer and an essentially unchanged spatial extent (Figure 6.14).

Due to natural attenuation (dispersion and mixing) and a low source strength, the seepage plume from the overburden stockpile migrates only very slowly towards the north and east according to the new prevailing gradients (Figure 6.15) and is predicted to extend 100 years post closure approximately 80 m northwards and 140 m eastwards from the footprint area (Figure 6.16).

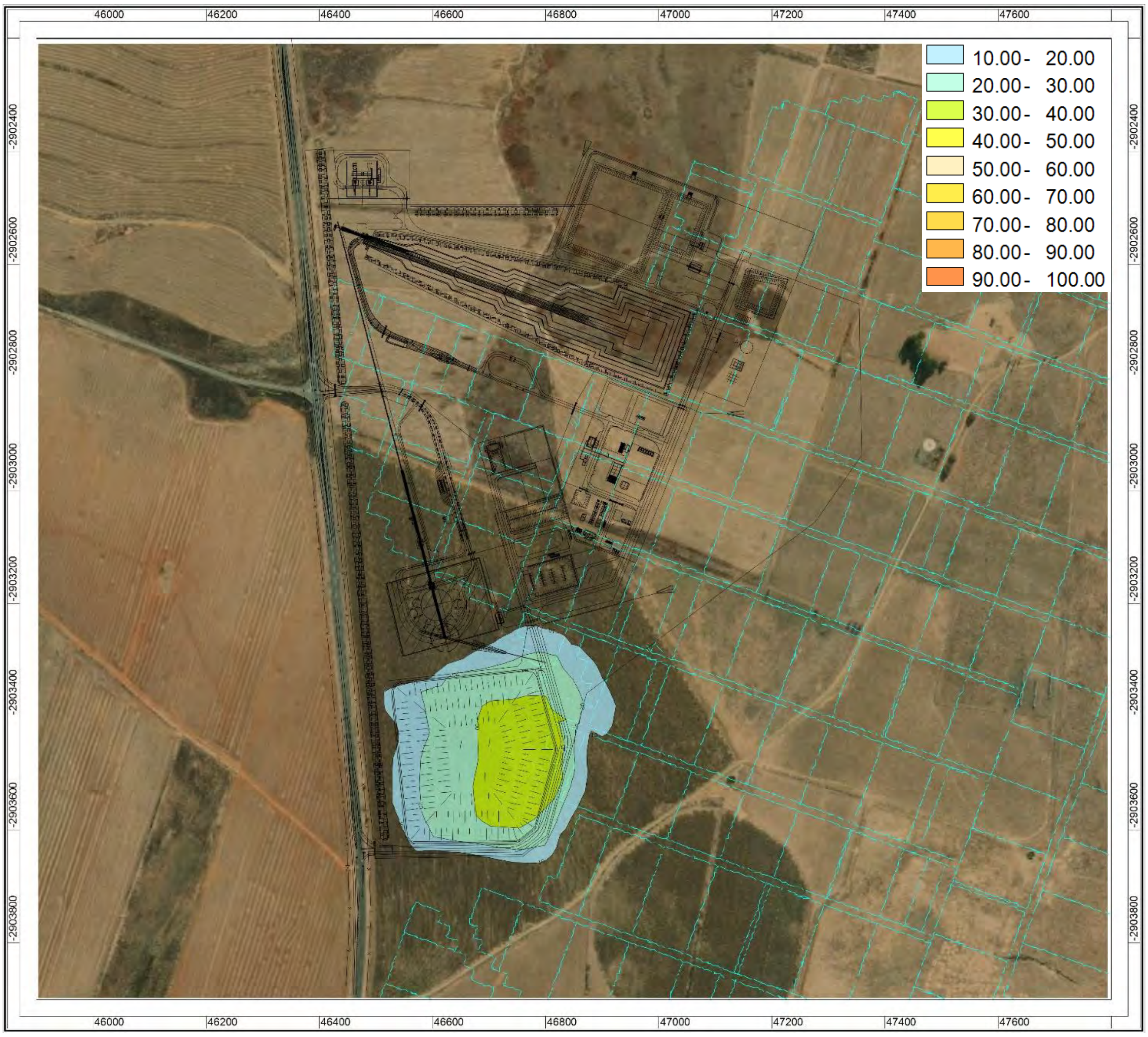

Figure 6.15: Simulated pollution plumes emanating from the MRDs 50 years post closure (surface layout indicated in black, underground mining areas in bright blue).

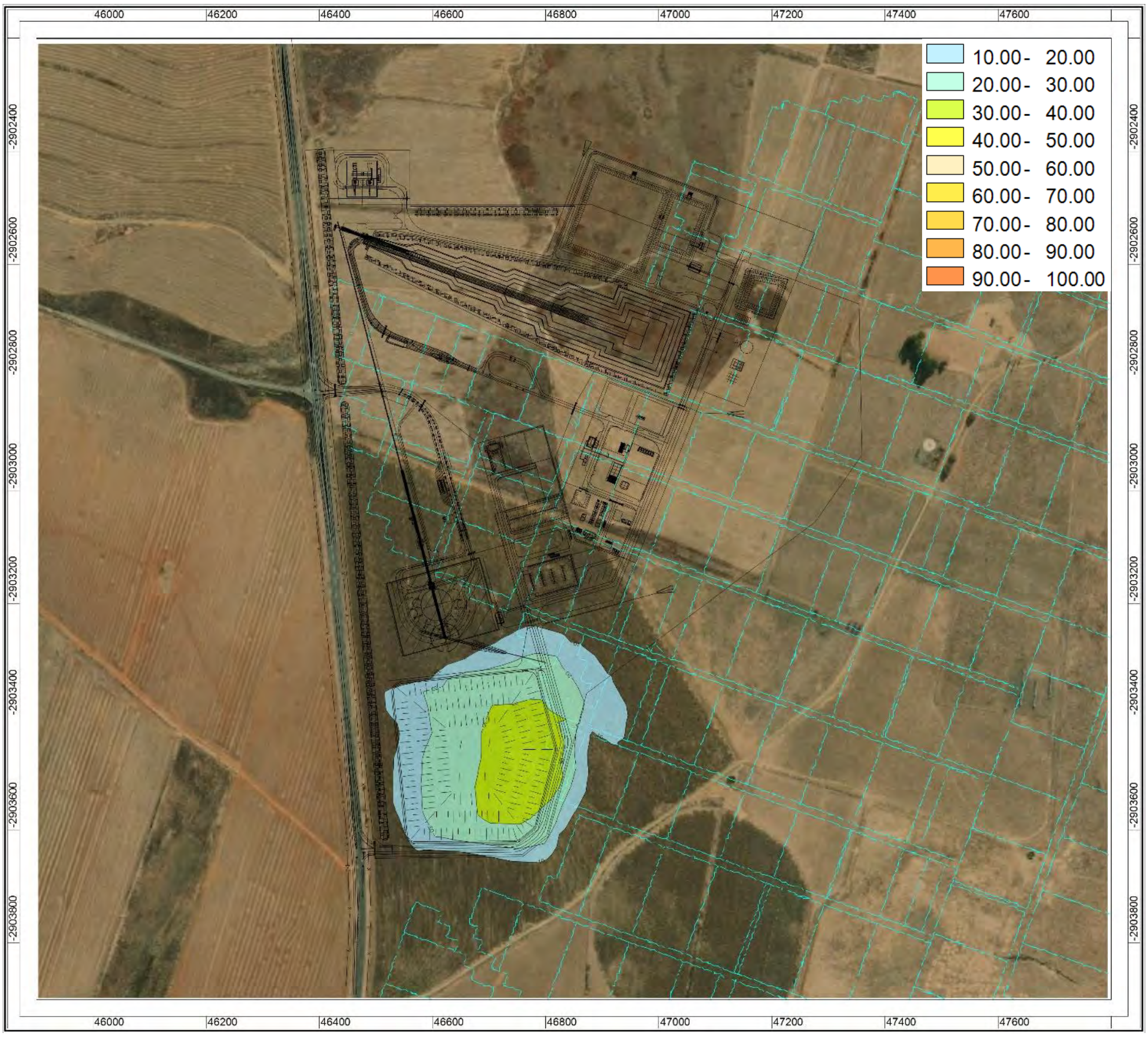

Figure 6.16: Simulated pollution plumes emanating from the MRDs 100 years post closure (surface layout indicated in black, underground mining areas in bright blue).

6.7.3.3. *Transport from Underground Mine Workings*

While the underground mine voids acted generally as groundwater sinks during the Life of Mine, with the cessation of groundwater abstractions at mine closure and the subsequent rebound of the water table, contaminants linked to acid rock drainage from the previously exposed (oxidised) sulphide bearing coal seams (see chapter 4.2) can be released.

To simulate the potential release of contaminants from the No. 2 and 4 Seam mine workings, the previously assigned seepage boundary was removed and a constant concentration boundary of 100% assigned to the floor and roof of the respective mine workings. Following the precautionary principle, no reduction of post closure source concentrations due to e.g. depleted sulphide sulphur contents in the coal seam or consumption of oxygen or ferric iron (as the oxidising agents in acid rock drainage reactions) were assumed for the simulations. The simulated heads at the end of the Life of Mine (Figure 6.8 and Figure 6.9) were used as starting heads and the model run in transient state for a period of 100 years with a weekly time step width.

Since no element specific retardation or transformation is simulated and a unit source concentration of 100% assigned to the mine workings, the emanating plume is visualised as percentages of the unit source concentration with a minimum and increment of 10 % up to 100 %. As for the LoM transport model, expected post closure ranges of both sulphate and Total Dissolved Solids (TDS) concentrations in Table 6.5 are based on estimates by JMA (2006, see Table 4.5). Since no background concentrations are assumed in the predictive model runs, the simulated plumes represent predicted net effects of pollutants released from the underground mine voids on the ambient groundwater quality.

Table 6.5: Contamination map legend for the Elders post closure underground transport model (all values in mg/l).

Legend (Unit %)	Sulphate (mg/l)		TDS (mg/l)	
	Lower Case	Upper Case	Lower Case	Upper Case
10.00	160	450	450	650
20.00	320	900	900	1 300
30.00	480	1 350	1 350	1 950
40.00	640	1 800	1 800	2 600
50.00	800	2 250	2 250	3 250
60.00	960	2 700	2 700	3 900
70.00	1 120	3 150	3 150	4 550
80.00	1 280	3 600	3 600	5 200
90.00	1 440	4 050	4 050	5 850
100.00	**1 600**	**4 500**	**4 500**	**6 500**

It must be emphasised that the source concentrations in Table 6.5 are very broad estimates, which should be reviewed along with the transport model simulations once actually observed concentrations or further geochemical test results become available.

The simulated pollution plume within the deeper fractured Karoo aquifer (No. 4 Seam mining horizon) 100 years after mine closure is shown in Figure 6.17. Due to the low hydraulic conductivity of the Karoo aquifer, minimal lateral hydraulic gradients prevailing post closure (Figure 6.12) and the bowl-shape topography of the No 4 (and 2) coal seam in the mining area (promoting flow towards the lower lying seam areas in the centre of the mine void, see Figure 4.2), no significant transport of pollutants from the mine void into the surrounding fractured Karoo aquifer is simulated. The maximum simulated lateral plume migration 100 (!) years post closure within the fractured aquifer is around 400 m (with a plume cut-off value of 10%) at the shallower northern and eastern edges and around 200 m at the southern and western edges of the mine voids. No separate visualisation of the 50-year plume extent was considered for the deeper fractured aquifer due to the scale of the plume.

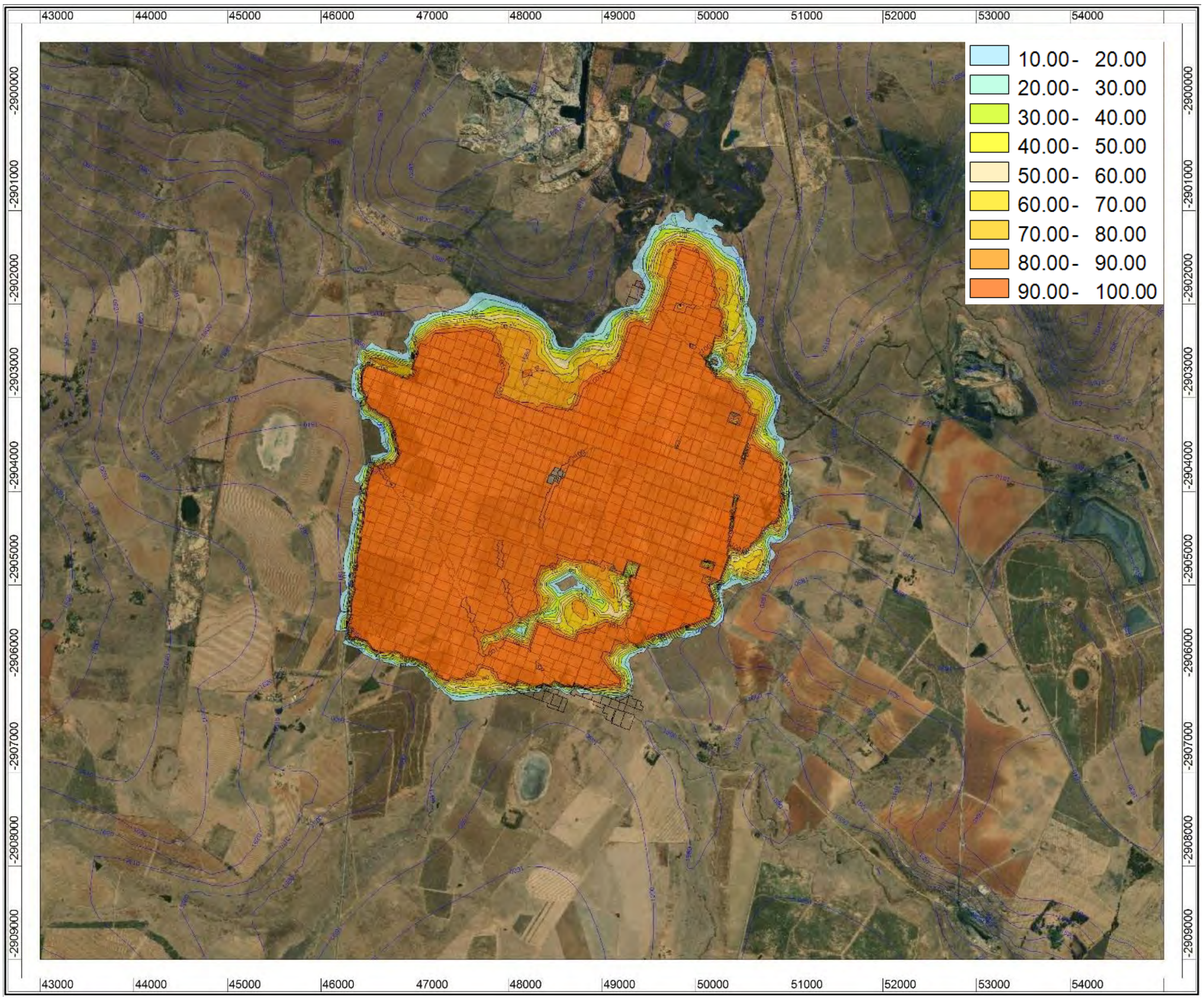

Figure 6.17: Simulated pollution plume within the fractured Karoo aquifer (4 Seam elevation) 100 years post closure.

With mine void roof elevations between approximately 1 524 and 1 590 mamsl and surface elevations between 1 569 and 1 626 mamsl within the undermined area, there is a theoretical possibility that the flooded mine voids decant to surface. However, the topography lows and coal seams highs do not overlap (the minimum overburden thickness or distance between the underground mine roof and surface topography is around 26 to 30 m at the box-cut and southern boundary of the mine voids) and no decant should occur, unless preferential flow paths (e.g. unsealed exploration boreholes) facilitate the upward migration of mine water (see also chapter 6.7.3.1).

If the term 'decant' is used in a wider context as the movement of groundwater from the flooded mine workings into the shallow Karoo aquifer (which is in hydraulic connection with surface drainages), the likelihood of decant is not only dependent on the hydraulic pressure exerted, but also dependent on the proximity and connectivity of the mine workings to the shallow aquifer. As the water table rebounds and floods the mine, the hydraulic pressure heads within the open mine voids equilibrate (principle of communicating pipe, Figure 6.11). Due to the bowl shaped No. 4 and 2 seam topography within the mining area (Figure 4.2), the hydraulic heads at the edges of the mine void result in upwards directed gradients for the central (lower lying) parts of the mine voids during flooding. These gradients drive potential contaminant transport from the mine voids into the overlying fractured and eventually the weathered aquifer.

Figure 6.18 to Figure 6.20 show the simulated pollution plume2 within the shallow Karoo aquifer 25, 50 and 100 years post closure. It becomes evident that the upwards gradients within the central part of the mine workings as well as the proximity of the mine workings to the shallow Karoo aquifer at the boundaries of the mine could facilitate the transport of mine impacted water into the shallow weathered Karoo aquifer. Similarly, the thinner overburden at the edges of the mine workings promote upward migration of pollutants from the (especially the No. 4 seam) mine voids into the weathered aquifer at the edges of the mine workings. While the potential subsurface "decant" plume dissipates after a relative short flow distance within the mine lease area, potential groundwater baseflow to surface waters could trigger off-site migration. Post closure monitoring of water qualities within this area is therefore required.

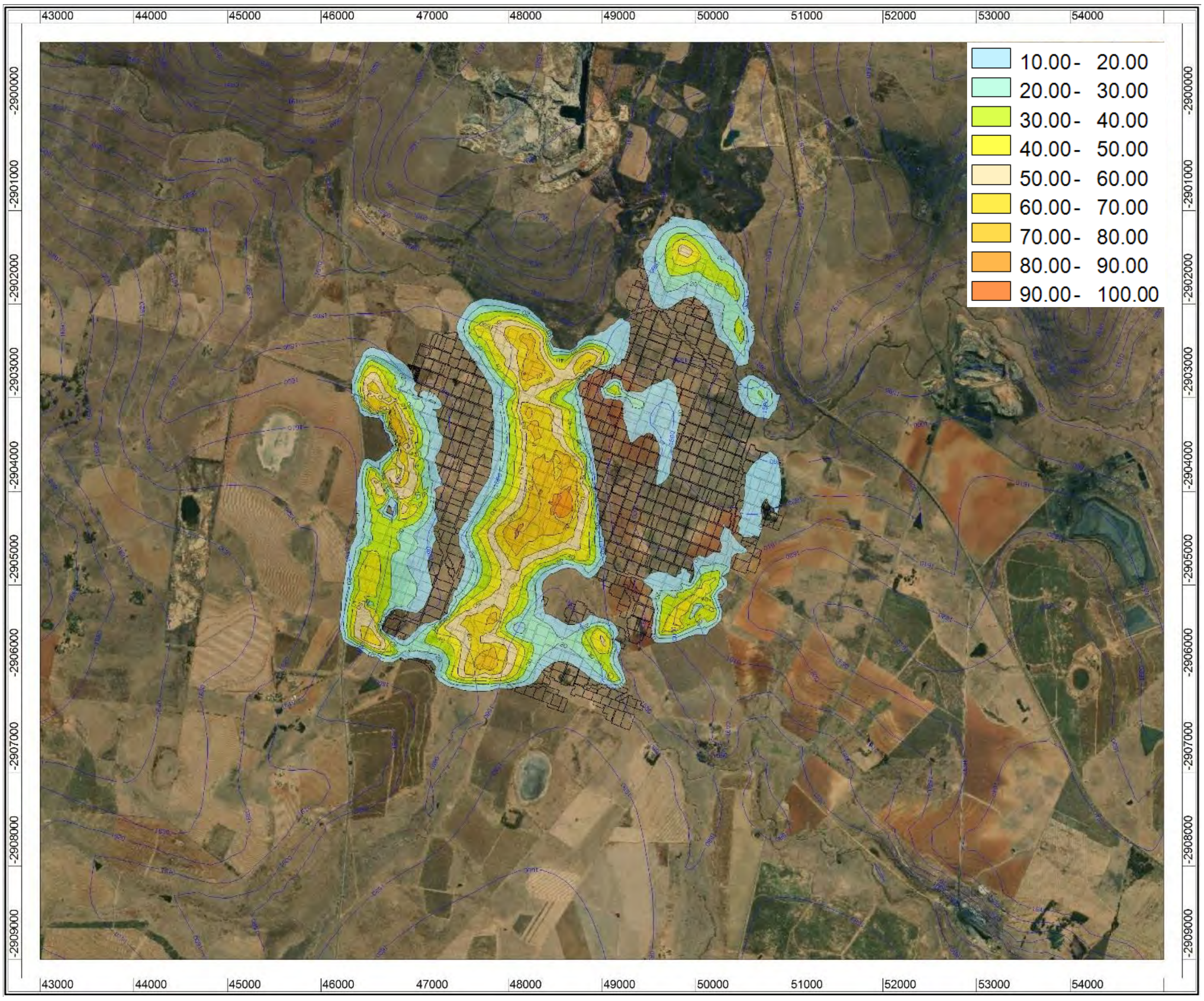

Figure 6.18: Simulated pollution plume within the shallow weathered Karoo aquifer 25 years post closure.

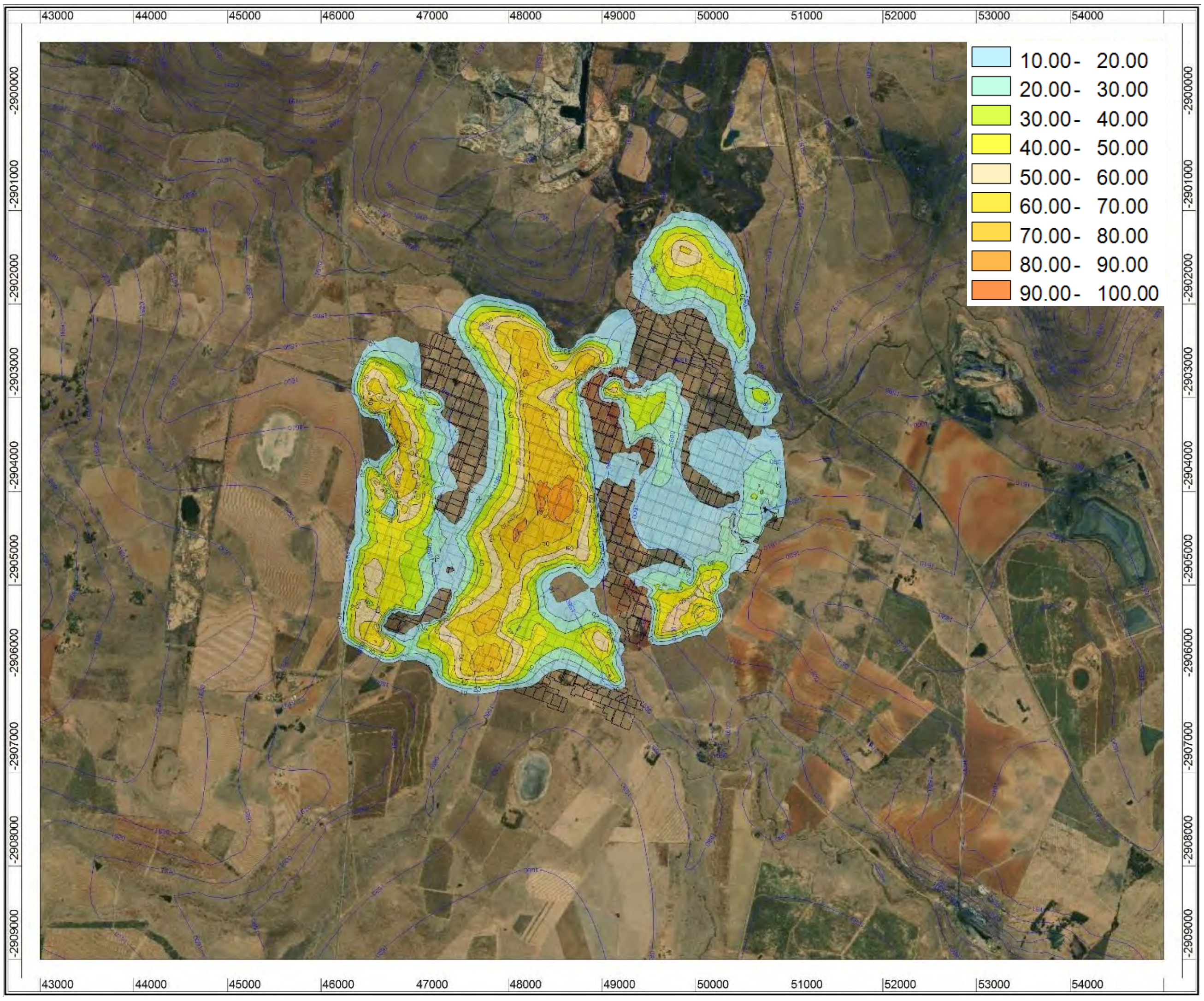

Figure 6.19: Simulated pollution plume within the shallow weathered Karoo aquifer 50 years post closure.

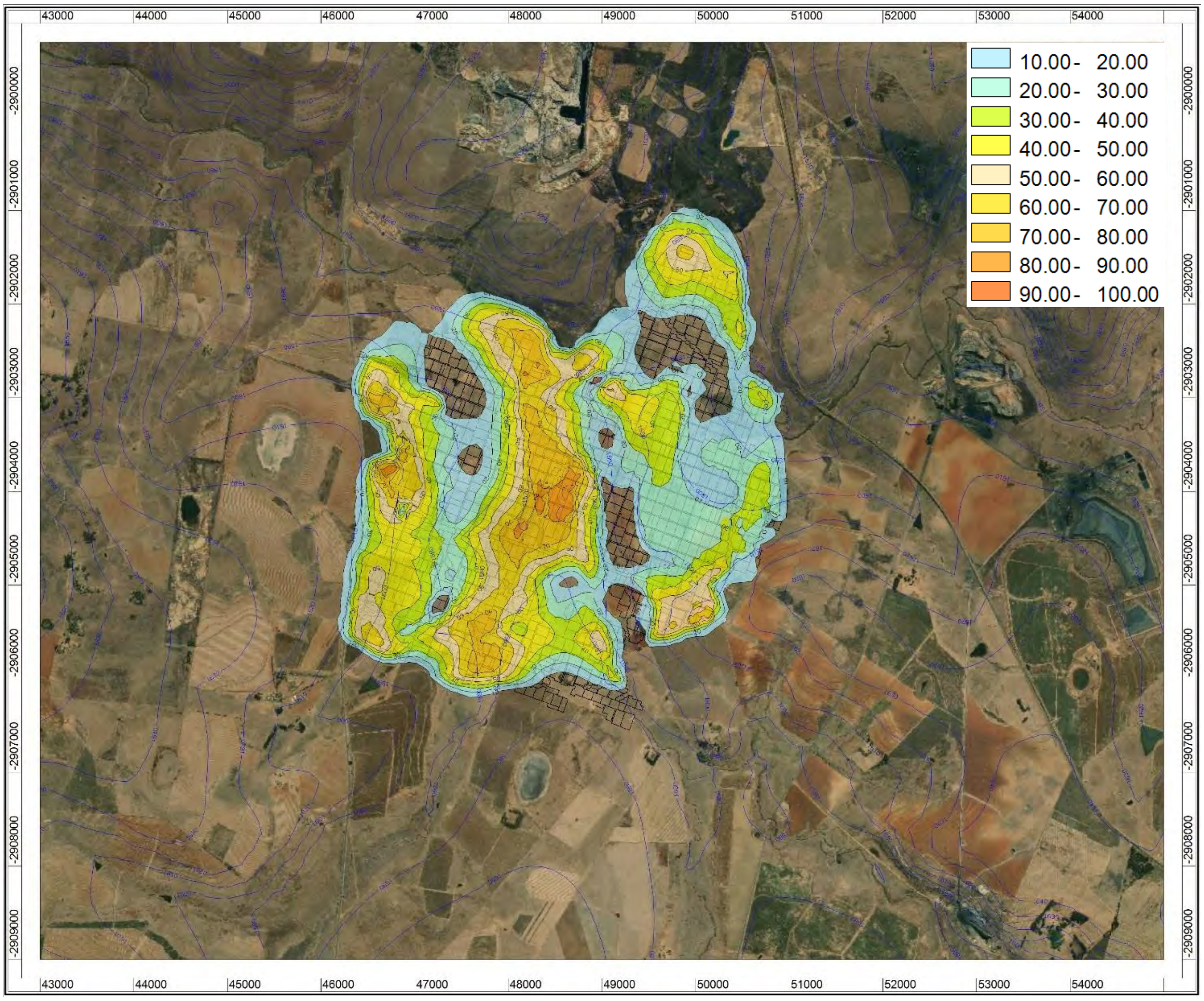

Figure 6.20: Simulated pollution plume within the shallow weathered Karoo aquifer 100 years post closure.

6.8. Confidence in Model Predictions

Preamble: "A decision often must address the fact that something bad may happen. We may be willing to pay a price to reduce the likelihood of its occurrence. How much we are prepared to pay depends on the cost of its occurrence and the amount by which its likelihood can be reduced through pre-emptive management. The role of modelling in this process is to assess likelihood. This must not be confused with predicting the future." (Australian groundwater modelling guidelines, Barnett et al. 2012). Delta H shares this view, specifically for long-term predictions of the behaviour of a natural groundwater system under a limited set of changing parameters.

6.8.1. Methodology

In the absence of other internationally accepted standard, Delta H follows the Australian groundwater modelling guidelines (Barnett et al. 2012) to distinguish the confidence-levels (Class 1, Class 2 or Class 3 in order of increasing confidence) of a model. The factors used by the guideline for the classification depend foremost on

- the available data, including their spatial and temporal coverage to fully characterise the aquifer and the historic groundwater behaviour,
- the calibration procedures, including types and quality of data used as calibration targets,
- the consistency between the calibration and predictive analysis, e.g. a steady state calibration is bound to produce transient predictions of low confidence and a transient prediction is expected to have a high level of confidence if the time frame of the predictive model is of less or similar to that of the calibration model (e.g. a 10 year transient calibration period would be required for a high confidence prediction over 25 years), and
- the level of stresses applied in predictive model in relation to the stresses included in the calibration (e.g. if a model was calibrated without major abstractions, simulations of significant abstractions or mine inflows will be of low confidence).

While a model may fall into different classes for the various criteria (data, calibration and prediction), it should be classified as Class 1 if any of the criteria fall into a Class 1 classification irrespective of all other ratings. A class 1 or low confidence model is often used for an initial assessment of a project if insufficient data are available to support a full conceptualisation of the aquifer(s) and subsequently improved to higher confidence classes as additional data from e.g. an associated monitoring programme become available.

6.8.2. Classification

In accordance with the guideline, Delta H provides a classification for each of these criteria as well as an overall model classification that reflects their importance with regard to the model objectives (Table 6.6).

Table 6.6: Criteria specific and overall model confidence level classification.

Criteria	Confidence level classification	Key indicators
Data	1	Limited/absent groundwater monitoring data for deep Karoo aquifer. Limited site-specific hydraulic parameter for targeted deeper Karoo aquifer. No pollution plume monitoring data obviously yet available. No independent estimation of MRD seepage rates. No data on river flows.
Calibration	2	Steady-state calibration statistics are good (water levels), but obviously not based on datasets required for prediction (future inflows and contaminant transport).
Prediction	1	Transient inflow and transport predictions are made when calibration is in steady state only.
Overall	1	Two criteria fall into a Class 1, model to be updated once more data become available.

It is obvious that the model confidence is significantly curtailed by the obvious absence of mine inflow and pollution plume monitoring data for a non-existent mine, albeit the model is used to predict these parameters. The model predictions must therefore be inherently of low confidence.

However, this does not mean that the model is not fit for purpose, namely to provide first-pass estimates of extraction volumes and rates required for mine dewatering, the prediction of long-term impacts of proposed developments in low-value aquifers and as a starting point on which to develop higher class models as more data is collected (Barnett et al. 2012).

6.8.3. Recommendations to improve Model Confidence

In order to increase the formal classification of the model confidence from Class 1 to Class 2, the following steps should be undertaken as part of future model updates (in decreasing priority):

- Annual (for first 2 years) to Biennial (thereafter) model updates as monitoring data become available. The first 2 years of mine development are in this regard of special interest for predicted mine inflows, as they give first actual observations of inflows due to shallow mining within the fractured Karoo aquifer.
- Drilling and testing of monitoring boreholes targeting the future underground mine workings.
- Independent measurement/estimation of seepage rates for the overburden stockpile, PCDs and Brine dam.

7. GEOHYDROLOGICAL IMPACTS

Impacts on the local and regional ambient groundwater environment due to the proposed mining of the No 2 and 4 Coal Seams at Elders Colliery may consist of changes in the groundwater quantity (i.e. groundwater levels and flow directions), changes in the ambient groundwater quality, or both. Altered groundwater conditions will most likely impact on other aspects of the environment such as river baseflow, in-stream water quality or vegetation types (for e.g. groundwater dependent wetlands).

The most significant groundwater impacts which could potentially arise from the following activities / infrastructure:

- Construction
  - Although the impact of surface clearing for the box-cut and a local lowering of the water table will be evident, associated groundwater impacts are assessed as part of the overall life of mine inflows and associated drawdowns and discussed as part of the operational phase.
  - Accidental spillages may occur during the construction and operational phase of the project.
- Operational
  - The operational phase entails active underground mining using continuous miners.
  - Groundwater inflows into the box cut and underground mine voids change the volume of groundwater in the aquifer storage (lowering of water table) and re-directs local to regional groundwater flow towards the mine voids (representing a new, lower drainage elevation). Initial shortfalls in water inflows during construction and ramp up of production will be (partially) met by groundwater abstractions with similar impacts on groundwater storage, i.e. a lowering of water table and a re-direction of local to regional groundwater flow towards abstraction boreholes.
  - Influences on the groundwater quality during LoM are associated with seepage from Mine Residue Deposits (MRDs), namely the Pollution Control Dams (PCDs), the Brine dam as well as the overburden stockpile.
  - Once groundwater enters the mine voids, it is considered “dirty” due to the interaction with exposed sulphide bearing minerals, dust, etc. and will require appropriate management after abstraction. However, since the groundwater flow is towards the mine, no impacts on the surrounding ambient groundwater quality are expected from the underground mine voids itself during Life of Mine (LoM).
- Closure/Post-closure
  - The mine voids are highly permeable flow paths, which will result in new equilibrium water levels within the area of influence, different from the pre-mining water levels.
  - Groundwater quality within the underground(s) mine voids is expected to deteriorate due to acid mine drainage and other chemical interactions between the geological and the groundwater regime. The resulting groundwater pollution plume will migrate along the new local and regional hydraulic gradients as the water table rebounds. Depending on the topographic setting of the mine and the post-closure topography, the rebounding water table might lead to the surface decant of mine water.

The applied impact significance rating system involves the following four parts:

A. Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/population and duration;
B. Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A;
C. Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence; and
D. Define the Confidence level.

The impact significance rating system is summarised in Table 1.

Table 7.1: Method for rating the significance of impacts.

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE Use these definitions to define the consequence in Part B		
Impact characteristics	**Definition**	Criteria
MAGNITUDE	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement; within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favourable publicity
DURATION	Short term	Up to 18 months
	Medium term	18 months to 5 years
	Long term	Longer than 5 years
SPATIAL SCALE OR POPULATION	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond

PART B: DETERMINING CONSEQUENCE RATING Rate consequence based on definition of magnitude, spatial extent and duration					
			SPATIAL SCALE/ POPULATION		
			Site or local	**Regional**	**National/ International**
MAGNITUDE					
Minor	**DURATION**	Long term	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**Duration**	Long term	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**Duration**	Long term	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING Rate significance based on consequence and probability				
		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

PART D: CONFIDENCE LEVEL		
High	Medium	Low

7.1. CONSTRUCTION PHASE

7.1.1. Impacts on Groundwater Quantity

Although the impact of surface clearing for the box-cut and a local lowering of the water table will be evident, associated groundwater impacts are assessed as part of the overall life of mine inflows and associated drawdowns and discussed as part of the operational phase.

7.1.2. Impacts on Groundwater Quality

Potential contamination of shallow groundwater resources due to accidental hydrocarbon or other chemical spillages from vehicles and operational activities might occur. Spillages are commonly minor and localised.
The significance rating of the groundwater quality impacts during the construction phase is provided in Table 7.2.

Table 7.2: Groundwater quality impacts during the construction phase.

Activity	Accidental spillages							
Project phase	Construction through to end of LoM							
Impact summary	Minor and local deterioration of shallow groundwater quality							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Short term	Local	Medium	Possible	Medium	-	High
Management Measures	Develop and maintain a Standard Operating Procedure to contain and remediate any accidental hydrocarbon or other chemical spillages.							
	Spill kits should be made available and used in the event of a spill. Contain spillage, excavated and dispose of contaminated material/soil required at accredited disposal site. .							
	If properly contained and/or excavated quickly impacts are reversible and unlikely to occur							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Short term	Local	Low	Possible	Low	-	High

7.1.3. Groundwater Management

The mine should develop and maintain a Standard Operating Procedure to contain and remediate any accidental hydrocarbon or other chemical spillages. Such containment can be achieved by utilisation of spill kits and/or excavation of affected soil with subsequent disposal at an accredited disposal site. Staff should be trained in the appropriate usage of spill kits and excavation of affected soils. Any excavation of affected soils should be supervised by the Environmental Site Officer.
Groundwater inflows into the box-cut area should be minimised by grouting, measured during abstraction (using a flow meter), re-used in the operations or disposed of in an environmentally acceptable way. Depending on observed water qualities, treatment might be required before disposal.

7.2. OPERATIONAL PHASE

7.2.1. Impacts on Groundwater Quantity

It is expected that the groundwater inflows into the proposed No. 2 and No. 4 seam underground mine voids change the volume of groundwater in the aquifer storage (i.e. lowering of water table), especially in the deeper fractured aquifer and to a lesser degree in the shallow weathered Karoo aquifers during life of mine and for more than 50 years post closure (until the water table rebounds). The partial dewatering of the aquifer above and in the vicinity of the underground mine voids will impact:

- on groundwater baseflow, spring yields and Groundwater Dependant Eco-systems (GDEs), which rely on groundwater within the shallow weathered aquifer, within the depicted cone of dewatering area (Figure 6.8),
- on other groundwater users, which rely at least partially on groundwater within the shallow and deeper fractured aquifer, within the depicted cone of dewatering area (Figure 6.9). The lowering of the water table will result in a partial to complete reduction of borehole yields within the affected areas.

The significance rating of impacts on the groundwater quantity during the operational phase of the mine is provided in Table 7.3. Note that the confidence rating below refers to the confidence in predicted inflow volumes and associated extent of aquifer dewatering, not to the general occurrence of mine inflows and water table drawdown (which would be rated high/definite).

Table 7.3: Groundwater quantity impacts during the operational phase.

Activity	Mine inflows and associated lowering of water table							
Project phase	Construction through to end of LoM and 50 years post closure							
Impact summary	Moderate lowering of water table with an associated reduction in groundwater baseflow (to surface waters and GDES) and borehole yields							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Major	Long term	Local	High	Definite	High	-	Medium
Management Measures	Continuous monitoring of underground mine inflows (daily quantity and quarterly quality) and water levels (quarterly) within the predicted zone of dewatering							
	Excess water must be pumped to the surface water storage facilities (PCDs) for re-use and/or treatment and environmentally acceptable disposal.							
	Provision of alternative water supply to affected users / compensation for well yield losses or increased pumping costs (due to increased lift height and/or yields)							
	Monitoring of GDEs, potential augmentation of groundwater flows or wetland off-sets, monitoring of surface water qualities up- and downstream of the underground mining area							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Local	Medium	Definite	Medium	-	Medium

7.2.2. Impacts on Groundwater Quality

Impacts on the shallow aquifer groundwater quality due to seepage from MRDs

The seepage plumes emanating from the PCDs, Brine dam and overburden stockpile will predominantly impact on the ambient groundwater quality of the shallow weathered aquifer. The predicted extents of the plumes (Figure 6.10) are limited due to lining of the PCDs and Brine dam. The plume extents are foreseen to be confined to the immediate surroundings of the site and not impacting any groundwater user. The significance rating of impacts of the seepage plume emanating from the MRDs on the shallow groundwater quality during the operational phase of the mine is provided in Table 7.4.

Table 7.4: Groundwater quality impacts on the shallow weathered aquifer during the operational phase.

Activity	Stockpiling of overburden, storage of polluted water (PCDs) and brine (Brine dam)							
Project phase	Construction through to end of LoM (PCDs and Brine dam) and post closure (Overburden stockpile)							
Impact summary	Minor to moderate impacts on ambient groundwater quality due to seepage from MRDs							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Local	Low	Definite	Medium	-	High
Management Measures	Continuous monitoring of pollution source and plume concentrations							
	Concurrent rehabilitation/covering of overburden stockpile (smooth slope angles, topsoiling and seeding)							
	Adaptive management of plumes, i.e. hydraulic plume containment if and when required							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Local	Low	Possible	Low	-	High

Impacts on the deeper aquifer groundwater quality due to underground mine voids

The underground mine voids are a “sink of groundwater” due to underground mine inflows (and subsequent abstractions) during life of mine. Since the groundwater gradient within the deeper Karoo aquifer is generally re-directed towards the mine voids, no contaminant will be released from the mine during life of mine and no changes in the ambient groundwater quality due to the underground mine voids (acid mine drainage) are expected.

7.2.3. Groundwater Management

The mine should develop and maintain a Standard Operating Procedure to contain and remediate any accidental hydrocarbon or other chemical spillages. Such containment can be achieved by utilisation of spill kits and/or excavation of affected soil with subsequent disposal at an accredited disposal site. Staff should be trained in the appropriate usage of spill kits and excavation of affected soils. Any excavation of affected soils should be supervised by the Environmental Site Officer.

Groundwater inflows into the box-cut and underground mining areas should be minimised by grouting, measured during abstraction (using a flow meter), re-used in the operations or disposed of in an environmentally acceptable way. Depending on observed water qualities, treatment might be required before disposal.

Monitoring of mine effluent and seepage should be performed to assure protection of the environment. Monitoring and field testing provide early detection of potential environmental issues, allowing evaluation and, if necessary, adaptive management interventions

It is furthermore recommended that the numerical model and geochemical study is updated biennially during the life of mine in order to calibrate and validate its results and to inform effective water management and closure planning.

7.3. DECOMMISSIONING PHASE

No immediate impacts on the groundwater quantity are foreseen during the decommissioning of facilities, i.e. the rebound of the water table due to cessation of pumping as well as continuing contaminant transport are longer term processes assessed in the post-mining phase (chapter 7.4). The only foreseen groundwater impacts associated with the decommissioning phase are accidental hydrocarbon or other chemical spillages from vehicles and operational activities, which are commonly minor and localised. The impact and associated management measures are equivalent to the construction phase and were already assessed in chapter 7.1.

7.4. POST- MINING PHASE

7.4.1. Groundwater Quantity

Post-closure, groundwater seepage into the underground mine voids is no longer abstracted, and the water levels start to re-bound, filling up the mine void itself as well as the previous cone of dewatering. In other words, the previous impacts on water-levels and flow directions associated with the mine dewatering will start to dissipate and water levels similar to pre-mining conditions will be re-established. However, since the underground mine voids are now highly permeable flow paths, which will equilibrate the water levels across their extent, slightly altered water levels in comparison to the pre-mining water levels will be established within the deeper fractured Karoo aquifer, while only insignificant impacts on water levels within the weathered aquifer are foreseen once they have rebound. While no direct post-closure decant to surface is predicted, it might occur if unsealed exploration boreholes are left behind.
The significance rating of impacts on the groundwater quantity post closure are provided in Table 7.5

Table 7.5: Groundwater quantity impacts during the post closure phase.

Activity	Rebound of water levels within mine voids and Karoo aquifers							
Project phase	Post closure							
Impact summary	Minor impact on deeper fractured Karoo aquifer water levels due to high permeability underground mine voids							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Local	Medium	Definite	Medium	-	High
Management Measures	Monitoring of water levels (quarterly) within mine voids to ensure no decant to surface occurs							
	Adaptive Management of mine water levels should environmentally critical water levels be breached, i.e. decant to surface							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Local	Medium	Definite	Medium	-	High

7.4.2. Groundwater Quality

Impacts on the shallow aquifer groundwater quality due to seepage from MRDs

With the assumed removal of the PCDs and Brine dam and rehabilitation of the overburden stockpile at mine closure, the source strengths are eliminated or significantly reduced, resulting in dissipating seepage plumes from these footprints. While the seepage plumes associated with the PCDs and Brine dam are likely to disperse to below 10% of the initial source concentrations within 25 years, the seepage plume from the overburden stockpile continues to migrate up to 700 m northwards under the new post closure water levels and gradients. However, associated concentrations are low.

The significance rating of post closure impacts of seepage plumes emanating from the MRDs on the ambient groundwater quality of the shallow weathered Karoo aquifer is provided in Table 7.6.

Table 7.6: Groundwater quality impacts on the shallow weathered Karoo aquifer during the post closure phase.

Activity	Stockpiling of overburden, storage of polluted water (PCDs) and brine (Brine dam)							
Project phase	Post closure							
Impact summary	Minor to moderate impacts on ambient groundwater quality due to seepage from MRDs							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Local	Medium	Definite	Medium	-	High
Management Measures	Monitoring of natural plume attenuation							
	Adaptive management of plume. i.e. hydraulic plume containment if and when required							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Local	Low	Possible	Low	-	High

Impacts on the deeper aquifer groundwater quality due to underground mine voids

Post closure, groundwater abstractions cede and the underground mine voids act no longer as groundwater sinks, allowing contaminants from previously exposed sulphide bearing minerals (acid rock drainage) to be released into the groundwater and migrate according to the new hydraulic gradients. While the source concentrations should gradually (decades)improve as the system is starved of oxygen and the sulphide sulphur content depleted, the model predictions assumed conservatively constant source concentrations 100 years post closure. They represent therefore a worst case scenario. The significance rating of post closure impacts of seepage plumes emanating from the underground mine voids on the ambient groundwater quality of the shallow weathered and deep fractured Karoo aquifer is provided in Table 7.6.

Table 7.7: Groundwater quality impacts on the Karoo aquifers during the post closure phase.

Activity	Acid Rock Drainage from underground mine voids							
Project phase	Post closure							
Impact summary	Moderate impacts on ambient groundwater quality due to Acid Rock Drainage within the underground mine voids, might contribute to surface water discharge if unmanaged							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Regional	High	Possible	Medium	-	High
Management Measures	Monitoring of water qualities (quarterly for 5 years, thereafter annually until stabilised) within mine voids and overlying aquifer							
	Adaptive Management of mine water levels should environmentally critical water levels be breached, i.e. “decant” to weathered Karoo aquifer							
	Should mine water enter the shallow Karoo aquifer, hydraulic plume containment should be initiated							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Local	Low	Possible	Low	-	Medium

7.4.3. Groundwater Management

The mine should ensure that any exploration borehole within the mine lease area is properly sealed to prevent vertical flow paths to surface based on best practice. Similarly, the declines should be sealed to prevent surface water and minimise oxygen ingress. Prior the installation of a seal adequate monitoring equipment within the underground mine workings should be installed to monitor the rate of flooding and quality of water within the flooded mine voids. Monitoring of water level rebound and qualities within the shallow weathered aquifer should continue until stabilised; this will take several decades. It is furthermore recommended that the numerical model is updated biennially post closure for 20 years to increase the confidence in the post closure predictions.

8. GROUNDWATER MONITORING SYSTEM

8.1. GROUNDWATER MONITORING NETWORK

8.1.1. Source, plume, impact and background monitoring

The spatial distribution of proposed monitoring boreholes for Elders Colliery is shown in Figure 8.1, while Table 8.2 list the coordinates and purpose of the different boreholes.

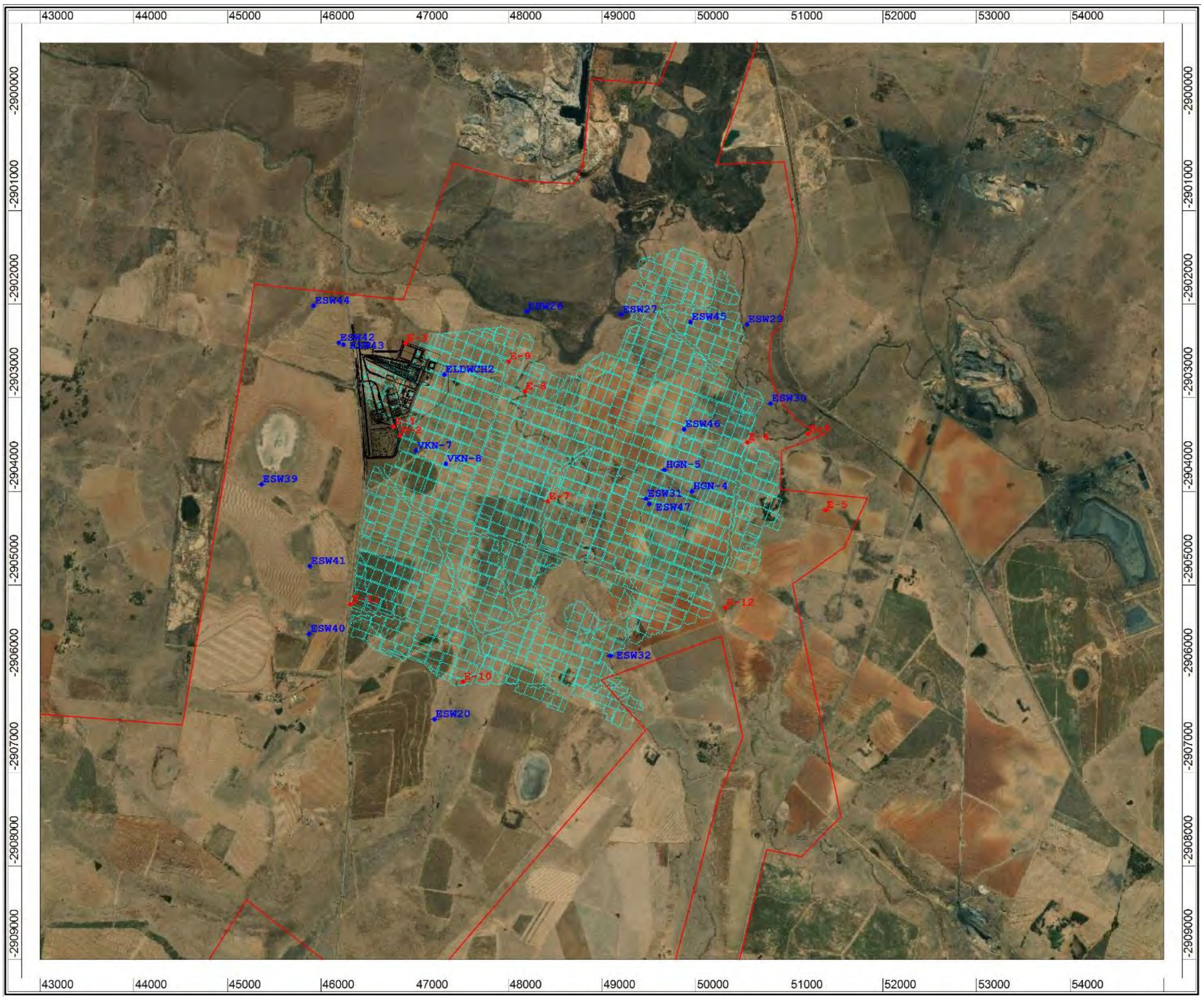

Figure 8.1: Existing (blue) and proposed (red) groundwater monitoring network for Elders Colliery (surface layout indicated in black, underground mining areas in bright blue).

8.1.2. System response monitoring network

The system response monitoring network relates to the predicted drawdown of groundwater levels due to mine dewatering and the rebound thereof once dewatering ceases post closure. A number of monitoring boreholes were strategically sited within the predicted cone of dewatering and potential future decant areas to monitor these responses during life of mine and post closure (see Table 8.2).

8.1.3. Monitoring frequency

The following monitoring frequencies are recommended during the construction and Life of Mine:

- Mine inflows: Continuously, and aggregated on a daily inflow rates
- Water levels: Quarterly
- Water qualities: Quarterly

The monitoring frequency could be relaxed post-closure once water levels and qualities stabilise:

- Mine inflows: Not applicable
- Water levels: Annually
- Water qualities: Annually

8.2. MONITORING PARAMETERS

A list of groundwater parameters to be monitored is given in Table 8.1.

Table 8.1: List of groundwater monitoring parameter.

Description	Parameter	Comments
Potential heads	Static groundwater levels	Measured in metres below ground level (mbgl) and converted into metres above mean seal level (mamsl). Collar elevations of the boreholes need to be considered.
Physico-chemical parameter, field	pH, Electrical Conductivity (EC), Temperature, Redox-Potential (mV), colour and smell (if any)	Parameters to be measured during sampling in the field, should stabilize before sample is retrieved
Physico-chemical parameter, laboratory	pH, Electrical Conductivity (EC), Temperature, Redox-Potential (mV)	To assess deviations from field measurements
Major elements	Ca, Mg, Na, K, Total Alkalinity, SO_4, NO_3, Cl, Total Dissolved Solids (TDS)	
Trace elements	Al, As, B, Ba, Cr, Cu, F, Fe, Mn, Mo, Ni, Pb	Samples to be filtered and acidified on-site.

The following recommendations are given with regard to the monitoring protocol for the mine:

- The static groundwater levels should be measured in the boreholes without any preceding abstractions.
- The boreholes should be purged (replacing approximately three times the stagnant water within the borehole) until the physic-chemical parameters stabilize and are determined. Samples for analysis should be retrieved after stabilization of the field parameters.
- Suitable sample containers should be utilised for the sample collection, i.e. plastic or glass containers for major elements and plastic or boron-glass containers for minor and trace elements.
- Samples for trace element analysis should be filtered and acidified (HNO_3, pH < 2) on-site.
- Sample collection including determined physic-chemical parameter should be documented in a sample protocol for each site and signed off by the sampling personnel as part of the chain of custody.
- The samples should be delivered to an accredited laboratory as soon as possible for analysis of the above parameters.

8.3. MONITORING BOREHOLES

Figure 8.1 gives an overview of existing and proposed new monitoring boreholes for Elders Colliery, with the coordinates of the proposed boreholes and their scope provided in Table 8.2. The borehole locations should be refined based on site specific geophysical investigations and ground truthing regarding potential infrastructure conflicts.

Table 8.2: List of coordinates for the proposed monitoring boreholes.

Name	X	Y	Comment (depth)
ESW20	47207.29	-2906435.03	Background Monitoring
ESW24	464367.81	-2902704.75	Background Monitoring
ESW26	48195.48	-2902078.66	Background Monitoring
ESW27	49203.61	-2902112.36	Background Monitoring
ESW29	50546.3	-2902218.35	Background Monitoring
ESW30	50798.8	-2903061.39	Background Monitoring
ESW31	49469.89	-2904079.89	Background Monitoring
ESW32	49089	-2905754.03	Background Monitoring
ESW39	45361.72	-2903924.57	Background Monitoring
ESW40	45871.34	-2905520.18	Background Monitoring
ESW41	45878.64	-2904797.1	Background Monitoring
ESW42	46188.88	-2902412.92	Background Monitoring
ESW43	46238.28	-2902434.35	Background Monitoring
ESW44	45917.98	-2902017.92	Background Monitoring
ESW45	49944.38	-2902191.86	Background Monitoring
ESW46	49876.16	-2903336.46	Background Monitoring
ESW47	49503.09	-2904136.56	Background Monitoring
ELDWCH2	47314	-2902752	Background Monitoring
VKN-7	47010.92	-2903568.21	Background Monitoring
VKN-8	47330.15	-2903706.75	Background Monitoring
HGN-4	49958.768	-2903998.676	Background Monitoring
HGN-5	49666.96	-2903772.01	Background Monitoring
Newly proposed boreholes*			
E-1	46775	-2903310	Overburden Stockpile
E-2	46840	-2903405	Overburden Stockpile
E-3	46900	-2902420	PCD / Brine Dam
E-4	50549	-2903478	Impact Drawdown (60 mbgl)
E-5	51387	-2904200	Impact Drawdown
E-6	51200	-2903385	Impact Drawdown
E-7	48419	-2904109	Impact Post Closure
E-8	49900	-2901380	Impact Post Closure
E-9	48150	-2902290	Impact Post Closure
E-10	47630	-2906040	Impact Post Closure (60 mbgl)
E-11	46314	-2905204	Impact Post Closure
E-12	50200	-2905305	Impact Post Closure (60 mbgl)
E-13	46430	-2904325	Impact Post Closure (60 mbgl)

* - Only approximate location (proper siting of positions using ground geophysics required)

The newly proposed boreholes monitoring boreholes should be drilled with a nominal inside diameter of 77.8 mm to the bottom of weathered aquifer plus 1m into fractured rock unless specified otherwise in Table 8.2. The boreholes should be equipped with screened casing throughout the saturated thickness of the aquifer.

Additional monitoring boreholes into the underground mine voids should be drilled (or installed in shafts and declines) post closure to monitor the flooding of these and enable sampling. These boreholes should be sited and designed as part of the post closure strategy for the entire mine site, considering potential mining compartments and/or sealed off areas.

9. GROUNDWATER ENVIRONMENTAL MANAGEMENT PROGRAMME

9.1. CURRENT GROUNDWATER CONDITIONS

The current groundwater conditions presented in chapter 4.6 indicate a typical Karoo aquifer system, with shallow and fresh groundwater (Ca-Mg-HCO_3 or Na-HCO_3 water facies) within the shallow weathered Karoo aquifer and deeper water levels and higher mineralised water (Na+K-Cl water facies) due to prolonged residence times in the underlying fractured Karoo aquifer. Elevated iron and nitrate concentrations observed in several boreholes are a result of well design and land use practices.

9.2. PREDICTED IMPACTS OF MINING

The predicted impacts of the proposed underground coal mine on the ambient groundwater conditions are primarily associated with:

- Potential accidental spillages of pollutants (life of mine)
- Lowering of the groundwater table due to mine inflows (life of mine, Figure 6.8 and Figure 6.9).
- Seepage from the Overburden stockpile, PCDs and Brine dam (life of mine and post closure, Figure 6.10 and Figure 6.13 to Figure 6.16).
- Migration and potential decant of mine influenced water (post closure, Figure 6.17, Figure 6.18 and Figure 6.20).

The main impacts of Elders Colliery to be monitored and managed are therefore the seepage plumes within the shallow weathered aquifer emanating from the Overburden stockpile, PCDs and Brine dam as well as water levels within and beyond the proposed underground mining area.

9.3. MITIGATION MEASURES

9.3.1. Lowering of groundwater levels during mining

Groundwater inflows into the Elders underground coal mine will result in a partial dewatering of the aquifer above and in the vicinity of the underground mine voids, which will impact on groundwater baseflow, spring yields and Groundwater Dependant Eco-systems (GDEs) and other groundwater users.

Continuous monitoring of underground mine inflows (daily quantity and quarterly quality), water levels (quarterly) and GDEs (frequency to be determined by wetland expert) within the predicted zone of dewatering should therefore be initiated. Potential augmentation of groundwater flows (or wetland off-sets) to affected GDEs as well as provision of alternative water supply to affected users (or compensation for well yield losses or increased pumping costs) should be considered.

Excess water must be pumped to the surface water storage facilities (PCDs) for re-use and/or treatment and environmentally acceptable disposal.

9.3.2. Rise of groundwater levels post-mining

The post-closure rebound of the groundwater level within the mine void and Karoo aquifers should be monitored until a new dynamic equilibrium (i.e. stable water levels with seasonal fluctuations only) is established. Adaptive management of mine water levels might be required should environmentally critical water levels be breached, i.e. decant to surface via unsealed exploration boreholes be observed.

9.3.1. Spread of groundwater pollution during mining

No spread of groundwater pollution from the underground mine void itself are expected due to the prevailing hydraulic gradients towards the mine. Potential seepage plumes emanating from the PCDs, Brine dam and overburden stockpile will impact on the ambient groundwater quality of the shallow weathered aquifer and will require continuous monitoring of pollution source and plume concentrations. Adaptive management of seepage plumes (i.e. hydraulic plume containment) should be initiated if and when required. It is furthermore recommended to rehabilitate (top-soiling and seeding) as soon as disposal operations allow to minimise air and rainwater ingress.

9.3.2. Spread of groundwater pollution post mining

Post mining groundwater pollution will spread from the underground mine void and the overburden stockpile, while the PCDs and Brine dam are assumed to be removed at closure. Continuous monitoring of the potential overburden stockpile seepage plume as well as underground mine plume will be required until the plume migration has stabilised. Adaptive management of the stockpile seepage plume (i.e. hydraulic plume containment) should be initiated if and when required. Furthermore, should decant of mine water to surface or into the shallow weathered aquifer be detected, the water level should be managed below environmentally critical levels, e.g. the bottom of the weathered zone.

10. POST CLOSURE MANAGEMENT PLAN

There is currently insufficient information available to develop a detailed post closure management. The currently outlined brief measures should therefore be seen preliminary and should be updated throughout the life of mine as new monitoring data and mining information become available.

10.1. REMEDIATION OF PHYSICAL ACTIVITY

The proposed project entails the extraction of coal from the No. 4 coal seam, which in itself can obviously not be remediated. However, potential decant of mine water to surface should be monitored and managed, i.e. environmentally critical levels defined beyond which management of water levels will be required.

10.2. REMEDIATION OF STORAGE FACILITIES

It is recommended that the PCDs and Brine dam are removed post mine closure and their respective footprint areas rehabilitated (top-soiling and seeding). The rehabilitation of the overburden stockpile should entail re-shaping to encourage surface run-off (with smooth transitions to the surrounding topography) and prevent any ponding of rainwater to minimize water ingress into the dump. The stockpile should furthermore be covered with soil and seeded to promote evapotranspiration and limit water and oxygen ingress into the dump, thereby reducing seepage generation and oxidation of sulphide bearing minerals respectively, i.e. the overall source strength of the dump pots closure.

10.3. REMEDIATION OF ENVIRONMENTAL IMPACTS

The seepage plumes emanating from the lined PCDs and Brine dam are considered marginal and no significant off-site migration of pollutants is expected. Monitored natural attenuation of seepage plumes is therefore recommended post closure.

Depending on actual seepage concentrations (to be determined during life of mine), the plume emanating from the Overburden stockpile during the operational and post-closure phase should be hydraulically contained if acceptable concentration thresholds (i.e. Resource Quality Objectives) for constituents of concern are breached in downstream monitoring boreholes. Monitored natural attenuation of seepage plumes is otherwise (or after hydraulic plume containment) recommended for the post closure phase.

Post closure water levels within and above the underground mining area should be monitored and potential decant of mine water to surface prevented by maintaining levels below environmentally critical levels (e.g. minimum surface or weathered aquifer elevation within the mining area). Potentially abstracted groundwater should be treated, re-used or discharged into the environment.

10.4. REMEDIATION OF WATER RESOURCES IMPACTS

Considered in chapter 10.3 above.

10.5. BACKFILLING OF THE PITS

The proposed project entails no opencast, but underground mining. However, a box-cut area will be required to access the targeted No. 2 and 4 coal seam and could be interpreted as a remaining open mine void. The potential positive and negative impacts of backfilling the box-cut area with the overburden material should be assessed as part of a closure plan. While the removal of the overburden stockpile in itself would generally be positive, the re-handling and exposure of overburden material to the atmosphere before placing it in direct contact with groundwater within the box-cut area needs to be assessed as actual seepage quality data for the stockpile become available throughout life of mine.

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APPENDIX A – MODEL CONFIDENCE CLASSIFICATION

Confidence level classification	*Data*	*Calibration*	*Prediction*	*Key indicator*	*Examples of specific uses*
Class 3	• Spatial and temporal distribution of groundwater head observations adequately define groundwater behaviour, especially in areas of greatest interest and where outcomes are to be reported. • Spatial distribution of bore logs and associated stratigraphic interpretations clearly define aquifer geometry. • Reliable metered groundwater extraction and injection data is available. • Rainfall and evaporation data is available. • Aquifer-testing data to define key parameters. • Streamflow and stage measurements are available with reliable baseflow estimates at a number of points. • Reliable land-use and soil-mapping data available. • Reliable irrigation application data (where relevant) is available. • Good quality and adequate spatial coverage of digital elevation model to define ground surface elevation.	• Adequate validation* is demonstrated. • Scaled RMS error (refer Chapter 5) or other calibration statistics are acceptable. • Long-term trends are adequately replicated where these are important. • Seasonal fluctuations are adequately replicated where these are important. • Transient calibration is current, i.e. uses recent data. • Model is calibrated to heads and fluxes. • Observations of the key modelling outcomes dataset is used in calibration.	• Length of predictive model is not excessive compared to length of calibration period. • Temporal discretisation used in the predictive model is consistent with the transient calibration. • Level and type of stresses included in the predictive model are within the range of those used in the transient calibration. • Model validation* suggests calibration is appropriate for locations and/or times outside the calibration model. • Steady-state predictions used when the model is calibrated in steady-state only.	• Key calibration statistics are acceptable and meet agreed targets. • Model predictive time frame is less than 3 times the duration of transient calibration. • Stresses are not more than 2 times greater than those included in calibration. • Temporal discretisation in predictive model is the same as that used in calibration. • Mass balance closure error is less than 0.5% of total. • Model parameters consistent with conceptualisation. • Appropriate computational methods used with appropriate spatial discretisation to model the problem. • The model has been reviewed and deemed fit for purpose by an experienced, independent hydrogeologist with modelling experience.	• Suitable for predicting groundwater responses to arbitrary changes in applied stress or hydrological conditions anywhere within the model domain. • Provide information for sustainable yield assessments for high-value regional aquifer systems. • Evaluation and management of potentially high-risk impacts. • Can be used to design complex mine-dewatering schemes, salt-interception schemes or water-allocation plans. • Simulating the interaction between groundwater and surface water bodies to a level of reliability required for dynamic linkage to surface water models. • Assessment of complex, large-scale solute transport processes.
Class 2	• Groundwater head observations and bore logs are available but may not provide adequate coverage throughout the model domain. • Metered groundwater-extraction data may be available but spatial and	• Validation* is either not undertaken or is not demonstrated for the full model domain. • Calibration statistics are generally reasonable but may suggest significant errors in parts of the model domain(s).	• Transient calibration over a short time frame compared to that of prediction. • Temporal discretisation used in the predictive model is different from that used in transient	• Key calibration statistics suggest poor calibration in parts of the model domain. • Model predictive time frame is between 3 and 10 times the duration of transient calibration. • Stresses are between 2 and 5 times greater than those included in calibration. • Temporal discretisation in predictive model is not the same as that used in calibration.	• Prediction of impacts of proposed developments in medium value aquifers. • Evaluation and management of medium risk impacts. • Providing estimates of dewatering requirements for mines and excavations and the associated

Confidence level classification	*Data*	*Calibration*	*Prediction*	*Key indicator*	*Examples of specific uses*
	temporal coverage may not be extensive. • Streamflow data and baseflow estimates available at a few points. • Reliable irrigation-application data available in part of the area or for part of the model duration.	• Long-term trends not replicated in all parts of the model domain. • Transient calibration to historic data but not extending to the present day. • Seasonal fluctuations not adequately replicated in all parts of the model domain. • Observations of the key modelling outcome data set are not used in calibration.	calibration. • Level and type of stresses included in the predictive model are outside the range of those used in the transient calibration. • Validation* suggests relatively poor match to observations when calibration data is extended in time and/or space.	• Mass balance closure error is less than 1% of total. • Not all model parameters consistent with conceptualisation. • Spatial refinement too coarse in key parts of the model domain. • The model has been reviewed and deemed fit for purpose by an independent hydrogeologist.	impacts. • Designing groundwater management schemes such as managed aquifer recharge, salinity management schemes and infiltration basins. • Estimating distance of travel of contamination through particle-tracking methods. Defining water source protection zones.
Class 1	• Few or poorly distributed existing wells from which to obtain reliable groundwater and geological information. • Observations and measurements unavailable or sparsely distributed in areas of greatest interest. • No available records of metered groundwater extraction or injection. • Climate data only available from relatively remote locations. • Little or no useful data on land-use, soils or river flows and stage elevations.	• No calibration is possible. • Calibration illustrates unacceptable levels of error especially in key areas. • Calibration is based on an inadequate distribution of data. • Calibration only to datasets other than that required for prediction.	• Predictive model time frame far exceeds that of calibration. • Temporal discretisation is different to that of calibration. • Transient predictions are made when calibration is in steady state only. • Model validation* suggests unacceptable errors when calibration dataset is extended in time and/or space.	• Model is uncalibrated or key calibration statistics do not meet agreed targets. • Model predictive time frame is more than 10 times longer than transient calibration period. • Stresses in predictions are more than 5 times higher than those in calibration. • Stress period or calculation interval is different from that used in calibration. • Transient predictions made but calibration in steady state only. • Cumulative mass-balance closure error exceeds 1% or exceeds 5% at any given calculation time. • Model parameters outside the range expected by the conceptualisation with no further justification. • Unsuitable spatial or temporal discretisation. • The model has not been reviewed.	• Design observation bore array for pumping tests. • Predicting long-term impacts of proposed developments in low-value aquifers. • Estimating impacts of low-risk developments. • Understanding groundwater flow processes under various hypothetical conditions. • Provide first-pass estimates of extraction volumes and rates required for mine dewatering. • Developing coarse relationships between groundwater extraction locations and rates and associated impacts. • As a starting point on which to develop higher class models as more data is collected and used.

Appendix G8: Wetland Specialist Study

DRAFT
WETLAND DELINEATION AND IMPACT ASSESSMENT FOR THE ELDERS COLLIERY PROJECT WATER USE LICENCE APPLICATION MPUMALANGA PROVINCE

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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions, and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and WCS Scientific (Pty.) Ltd. and its staff reserve the right to modify aspects of the report including the recommendations when new information may become available from ongoing research or further work in this field or pertaining to this investigation.

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1. INTRODUCTION AND TERMS OF REFERENCE

WCS Scientific (Pty.) Ltd. (WCSS), a member of the Wetland Consulting Services Group, was appointed by SRK Consulting (South Africa) (Pty.) Ltd. to undertake a wetland delineation and impact assessment to support a Water Use Licence Application being compiled for the Elders Colliery near Bethal, Mpumalanga Province. Although the Elders Colliery mine development is already approved (though not yet constructed), the Colliery requires additional activities to be authorised due to changes in the mine plan.

The initial Water Use Licence (WUL) Authorisation for the Elders Colliery was received in April 2017 and amended in November 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1). Since issuing of the WUL, synergy has been lost with Goedehoop, to which Elders Colliery was originally envisaged to serve as a life extension project. Consequently, there have been resultant changes to project description and block plan layout for Elders Colliery. Specifically, for the purpose of this wetland assessment report, the Section 21 (c) and (i) Water Uses under consideration are detailed in Table 1 below.

The purpose of this report is to provide a detailed delineation and baseline assessment of wetlands likely to be impacted by the water uses under consideration, to identify and assess expected impacts, and to provide mitigation and management recommendations within the context of the mitigation hierarchy.

Table 1. Summary of Section 21 (c) and (i) water uses that form the focus of this wetland assessment.

Water Use Type	Water Use Name	Reason	Volume	Location
Section 21 (f)	Combined discharge of treated water from Water Treatment Plant	Authorised in WUL but increase in volume required.	1 168 000 m^3 3200 m^3/d	Portion 6 of Middelkraal 50 IS 26° 14' 17.47" S, 29° 28' 42.89" E
Section 21 (g)	Dust Suppression using wastewater from PCD	Authorised in WUL but increase in volume required.	60 955 m^3	Portion 3 of Middelkraal 50 IS 26° 14' 0.91" S, 29° 28' 0.42" E
Section 21 (g)	Main PCD with silt trap and silt drying area, collecting water from the underground workings and dirty water collection from the shaft complex dirty water areas	Authorised in WUL but increase in volume required. Capacity is reduced.	1 218 370 m^3 Capacity ≥ 29 ML	RE/3 of Middelkraal 50 IS 26° 13' 50.05" S, 29° 28' 13.80" E
Section 21 (g)	Emergency coal loading area	New Water Use		RE/3 of Middelkraal 50 IS 26° 14' 12.19" S, 29° 28' 0.37"E

To meet the project objectives, the terms of reference for the current study were defined as follows:

- Review of available wetland data for the study area from published sources as well as previous wetland assessment studies;
- Field survey to verify delineated wetlands and update as necessary. Use was made of the delineation methodology detailed in the DWAF (2005) wetland delineation guidelines;
- Delineated wetlands were subdivided and typed into hydro-geomorphic wetland units as per the Level 4 classification (Ollis et al., 2013);
- Present Ecological State of all wetland units identified within the project study area was undertaken using the recently published WET-Health Version 2 Level 1b assessment tool;
- Wetland Importance and Sensitivity (IS) was determined for all wetland units identified within the project study area using the Rountree (2012) methodology;
- A wetland functional assessment was undertaken for each of the different wetland types recorded on site suing the WET-EcoServices assessment tool;
- Review of the proposed project activities;
- Identification and assessment of impacts;
- Development of suitable mitigation and management measures to avoid, minimize and mitigate impacts to wetlands; and
- Compilation of a specialist wetland assessment report.

2. SPECIALIST REPORT REQUIREMENTS

This report has been compiled to comply with the requirements for specialist technical reports as detailed in Government Notice 267 (24 March 2017) which details regulations and procedural requirements for water use license applications and appeals. The section below details the requirements in table format and references the relevant section of this report where the required information can be located.

Table 2. Checklist for specialist wetland assessment reports as detailed in GN 267 (24 March 2017).

No.	Requirement	Section in report
6	**Wetland Delineation Report**	
1	Introduction	Section 1
2	Terms of Reference	Section 1
3	Knowledge Gaps	Section 6
4	Study Area	Section 7 (7.1.1)
5	Expertise of Specialist	Section 3
6	Aims and Objectives	Section 1 and Section 5
7	**Methodology**	
7.1	Wetland identification and mapping	Section 5 (5.3)
7.2	Wetland delineation (riparian habitat)	Section 5 (5.3)
7.3	Wetland functional assessment	Not applicable
7.4	Determining the ecological integrity of wetlands (riparian habitat)	Section 5 (5.4)
7.5	Determining the Present Ecological State of wetlands (riparian habitat)	Section 5 (5.4)
7.6	Determining the Ecological Importance and Sensitivity of wetlands (riparian habitat)	Section 5 (5.4)
7.7	Ecological classification and description	Not applicable
8	**Results**	
8.1	Wetland delineation (riparian habitat)	Section 7 (7.2.1)
8.2	Wetland unit identification	Section 7 (7.2.1)
8.3	Wetland unit setting	Section 7 (7.2.1)
8.4	Wetland soils	Section 7 (7.2.1)
8.5	Description of wetland type (riparian habitat)	Section 7 (7.2.1)
8.6	General functional description of wetland types	Section 7 (7.2.1)
8.7	Wetland ecological functional assessment	Section 7 (7.2.2)
8.8	The ecological health assessment of the study area	Not applicable
8.9	The PES assessment of the remaining wetland areas (riparian habitat)	Section 7 (7.2.2)
8.10	The EIS assessment of the remaining wetland areas (riparian habitat)	Section 7 (7.2.3)
9	Impact Assessment Discussions	Section 8
10	Conclusions & Recommendations	Section 9
11	References	Section 10

3. DETAILS OF SPECIALIST

3.1 DETAILS OF THE SPECIALIST WHO PREPARED THE REPORT

Table 3. Details of the Specialist

Project Consultancy	WCS Scientific (Pty.) Ltd.
Company Registration	2017/076482/07
Professional Affiliation	South African Council for Natural Scientific Professions (SACNASP)
Contact Person	Mr Dieter Kassier (Pr. Sci. Nat.)
Physical Address	Building 1, Eulophia Corner, 38 General van Ryneveld, Persequour Park, Pretoria 0184
Postal Address	P O Box 72295, Lynnwood Ridge, 0040
Telephone Number	+27 12 349 2699
Fax Number	+27 12 349 2993
E-mail	dieterk@wetcs.co.za

3.2 EXPERTISE OF THE Specialist

3.2.1 Qualifications of the Specialist

Dieter Kassier holds the following degrees:

- B.Sc. from UNISA (2007) Environmental Management (Zoology Stream).
- B.Sc. (Hons) from the NWU Potchefstroom Campus (2012) in Environmental Science: Aquatic Ecosystem Health.

Dieter Kassier holds a Professional Registration with SACNASP since 2014 – 400254/14. He is registered in two fields:

- Environmental Science
- Ecological Science

3.2.2 Past Experience of the Specialist

Dieter Kassier, Wetland Ecologist, Holds a B.Sc. degree in Environmental Management (with specialisation in Zoology) from the University of South Africa (UNISA) as well as a BSc degree (Hons – with distinction) in Aquatic Ecosystem Health from the University of the North West (Potchefstroom Campus). After 5 years working within the field of nature conservation and tourism in the Limpopo Lowveld and a short stint as an environmental consultant, Dieter joined Wetland Consulting Services in 2007 and is based in Pretoria. Since 2017 he has also been a Director of WCS Scientific. Over the past few years he has gained extensive experience in the delineation and assessment of wetlands and riparian zones and the development of mitigation and management measures for the purposes of Environmental Impact Assessments in a wide range of projects, with special emphasis on coal mining in the Mpumalanga Coalfields and infrastructure developments within the greater Gauteng and Mpumalanga region. International work experience includes wetland prioritisation and rehabilitation planning in the Highlands of Lesotho as well as mining-related wetland impact assessment studies in Mozambique and the Democratic Republic of Congo. In addition, he has contributed to the wetland component of various Ecological Reserve studies, including for the Olifants/Letaba River System.

4. DECLARATION OF INDEPENDENCE

I, **Dieter Kassier,** as the appointed specialist hereby declare/affirm the correctness of the information provided as part of the application, and that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

WCS Scientific (Pty) Ltd

Name of company

23 September 2021

Date

5. SCOPE, PURPOSE, APPROACH AND METHODOLOGY

5.1 Scope and Purpose

The purpose of this report is to provide a detailed summary of the current conditions of any wetlands within the project study area from an ecological perspective, focussing on the following key considerations:

- Presence and extent of wetland habitat;
- Present ecological status (PES) of wetlands on site;
- Importance and Sensitivity of wetlands on site;
- Functional value of wetlands on site;
- Identification and assessment of likely impacts to wetlands;
- Provide practical and detailed mitigation and management measures to avoid, minimise and mitigate impacts to wetlands; and
- Compile a specialist wetland assessment report for submission as part of the WUL Application.

5.2 Consolidation of Existing Information

Wetland Consulting Services has in the past undertaken the specialist wetland assessments as part of the EIA and WUL applications for the Elders Project. The baseline information from these existing studies has been used for this risk assessment. The previous report from which wetland information was sourced is referenced as follows:

- *WCS, 2015. Wetland Delineation and Baseline Assessment for the Proposed Anglo Operations Limited Elders Colliery Project, Mpumalanga Province. Report Reference: 1117-2015. October 2015.*

More recently, WCSS compiled a technical memorandum (March 2020) detailing the wetland assessment and GN509 Water Use Risk Assessment for several boreholes associated with the Anglo Elders Colliery, which included consideration of 8 abstraction boreholes in the general vicinity of the surface infrastructure area.

5.3 Wetland Delineation and Classification

The National Water Act, Act 36 of 1998, defines wetlands as follows:

> "*Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.*"

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics; i.e. on the position of the wetland in the landscape, soil type, slope, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in the figure below.

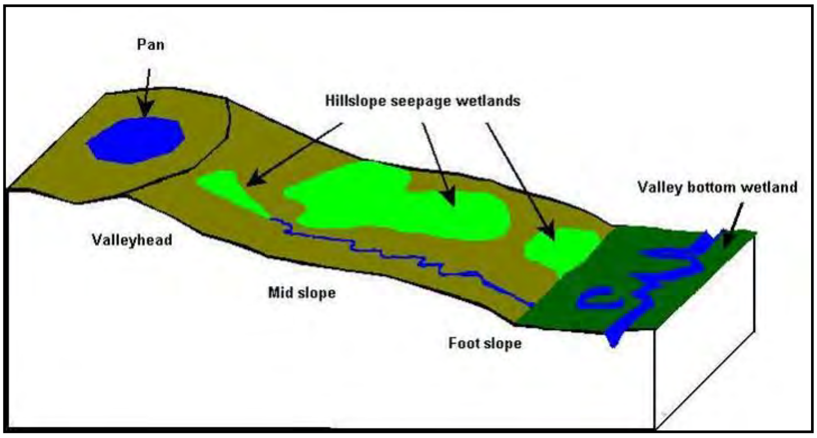

Figure 1. Diagram illustrating the position of the various wetland types within the landscape.

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcMap 10.1. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps. All identified areas suspected to be wetlands were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as described by (DWAF, 2005) and (Kotze & Marneweck, Guidlines for delineating the boundries of a wetland and the zones within a wetland in terms of the South African Water Act, 1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use was made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within the first 50cm of the soil surface for an area to be classified as a wetland (DWAF, 2005).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system detailed by Ollis, Snaddon, Job and Mbona (2013).

5.4 Present Ecological State and Importance & Sensitivity

The Present Ecological State (PES) of wetlands was assessed using the recently published WET-Health Version 2 Level 1b assessment methodology (Macfarlane *et al.*, 2020). Broadly based on the principles and structure of the WET-Health Version 1 assessment tool (Macfarlane *et al.*, 2007), the Version 2 assessment techniques require a combination of desktop and field-based data collection and includes an assessment based on detailed mapping of land use and disturbance units. The WET-Health Version 2 methodology is considered to have several advantages over the WET-Health Version 1 assessment tool, most notably that the Version 2 assessment can also be applied to Pan wetlands.

The method utilizes calculations of within wetland and surrounding wetland land-uses as a proxy to determine wetland impacts, supplemented by in-field wetland observations, to determine wetland ecological state. The extent of different land uses and/or disturbance units is determined within the wetland, within a 200m buffer surrounding the wetland, and within the wetland catchment. Using pre-defined land use intensity scores contained within the excel spreadsheet tool (WET-Health-V2_Level-2_Dec2018_blank.xlsx), the Present Ecological State (PES) of the wetland is determined for each of the hydrology, geomorphology, water quality and vegetation components. A consolidated overall PES score and category is obtained by combining the above 4 scores using a weighted formula, with the highest weighting applied to the hydrology component[1]. PES categories are determined on a scale from A - Unmodified/Natural to F – Critically Modified, as detailed in Table 4.

Table 4. Rating scale used for the PES assessment.

Class	Description	Score (% of total)
A	Unmodified	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

Use was made of the Importance and Sensitivity (IS) assessment tool developed by Rountree, Malan and Weston (2013). The tool allows the Importance and Sensitivity of a wetland to be determined within each of the following modules:

- Ecological Importance and Sensitivity (EIS) – considers the presence of Red Data species, populations of unique species, importance for migration, breeding and feeding sites for species, the protection status of the wetland and vegetation type/s present, the diversity of habitat types, the regional context of ecological integrity of the wetland, and the sensitivity of the wetland to changes in hydrology and water quality;

[1] Overall PES score is determined based on the following formula: (3 x Hydrology + 2 x Geomorphology + 2 x Water Quality + 2 x Vegetation)/9 = Overall PES. Where the hydrology PES category is E or F, the formula is adjusted as follows: (6 x Hydrology + 2 x Geomorphology + 2 x Water Quality + 2 x Vegetation)/12 = Overall PES

- Hydro-functional importance – considers the ecosystem services the wetland provides in terms of flood attenuation, stream-flow regulation water quality enhancement, sediment trapping, phosphate, nitrate and toxicant assimilation, erosion control, and carbon storage; and
- Direct human benefit importance - considers the subsistence uses and cultural benefits of the wetland system.

Based on this assessment, each of the criteria above were scored and categorized on a scale from 0 to 4 and assigned a category, according to that indicated in Table 5. The overall IS of the wetland was derived from the highest of the three main criteria (EIS, hydro-functional importance or direct human benefit importance).

Table 5. Scoring System Used for the IS Assessment (modified from DWAF, 1999 and used in Rountree et al., 2013).

Ecological Importance and Sensitivity Categories	Range of EIS Scores
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

5.5 Impact Assessment

The following impact assessment methodology was applied:

The EIA Methodology requires that each potential impact identified is clearly described (providing the nature of the impact) and be assessed in terms of the following factors:

- ***extent*** (spatial scale) - will the impact affect the national, regional or local environment, or only that of the site;
- ***duration*** (temporal scale) - how long will the impact last;

- ***magnitude*** (severity) - will the impact be of high, moderate or low severity; and
- ***probability*** (likelihood of occurring) - how likely is it that the impact may occur.

To enable a scientific approach for the determination of the environmental significance (importance) of each identified potential impact, a numerical value has been linked to each factor.

The following ranking scales are applicable:

Occurrence	**Duration (D):**	**Probability (P):**
	5 – Permanent	5 – Definite/don't know
	4 - Long-term (ceases with the operational life)	4 – Highly probable
	3 - Medium-term (5-15 years)	3 – Medium probability
	2 - Short-term (0-5 years)	2 – Low probability
	1 – Immediate	1 – Improbable
		0 – None
Severity	**Extent/scale (E):**	**Magnitude (M):**
	5 – International	10 - Very high/uncertain
	4 – National	8 – High
	3 – Regional	6 – Moderate
	2 – Local	4 – Low
	1 – Site only	2 – Minor
	0 – None	

Once the above factors had been ranked for each identified potential impact, the environmental significance of each impact can be calculated using the following formula:

Significance *= (duration + extend + magnitude) x probability*

The maximum value that can be calculated for the environmental significance of any impact is 100.

The environmental significance of any identified potential impact is then rated as either: high, moderate or low on the following basis:

- More than 60 significance value indicates a high (H) environmental significance impact;
- Between 30 and 60 significance value indicates a moderate (M) environmental significance impact; and
- Less than 30 significance value indicates a low (L) environmental significance impact.

In order to assess the ***degree to which the potential impact can be reversed and be mitigated***, each identified potential impact will need to be assessed twice.

- Firstly the potential impact will be assessed and rated prior to implementing any mitigation and management measures; and

- Secondly, the potential impact will be assessed and rated after the proposed mitigation and management measures have been implemented.

6. ASSUMPTIONS, UNCERTAINTIES AND KNOWLEDGE GAPS

6.1 Assumptions

Wetland boundaries reflect the ecological boundary where the interaction between water and plants influences the soils, but more importantly the plant communities. The depth to the water table where this begins to influence plant communities is approximately 50 centimetres. This boundary, based on plant species composition, can vary depending on antecedent rainfall conditions, and can introduce a degree of variability in the wetland boundary between years and/or sampling period.

A single day site visit was undertaken on the 25th August 2021 during which all wetlands within and immediately adjacent to the study area were verified and assessed. For this study field work was focussed solely on wetlands within the project study area (refer to Figure 3). All wetlands outside the project study area are derived from previous specialist wetland work (WCS, 2015) and are assumed to accurately reflect conditions on the ground.

Due to the scale of the remote imagery used (1:10 000 orthophotos and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineate wetlands in the field, the delineated wetland boundaries cannot be guaranteed beyond an accuracy of about 15m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

In addition, it is recognised that the passage of time may affect the information and assessment provided in this report. WCSS's opinions are therefore based upon the information that was made available to WCSS and which existed at the time of compiling this report.

6.2 Knowledge Gaps

Reference conditions of the wetland habitats are unknown. This limits the confidence with which the present ecological category (PES) is assigned.

7. CURRENT ENVIRONMENTAL CONDITIONS

7.1 Regional Characteristics

7.1.1 Study Area

The project study area for this project has been defined as the surface infrastructure footprint and its immediate vicinity (500m buffer – to give effect to the GN509 Regulated Area around a wetland) as illustrated in Figures 2 and 3. Three of the 4 water uses under consideration in this study fall within the surface infrastructure area, with the fourth water use located just to the east.

The study area is located along the R35 between Middelburg and Bethal, roughly 22 km due north of the Town of Bethal. The Olifants River is located just to the north of the project study area and the Viskuile River just to the east, with the confluence of the Olifants and Viskuile Rivers immediately adjacent to the site.

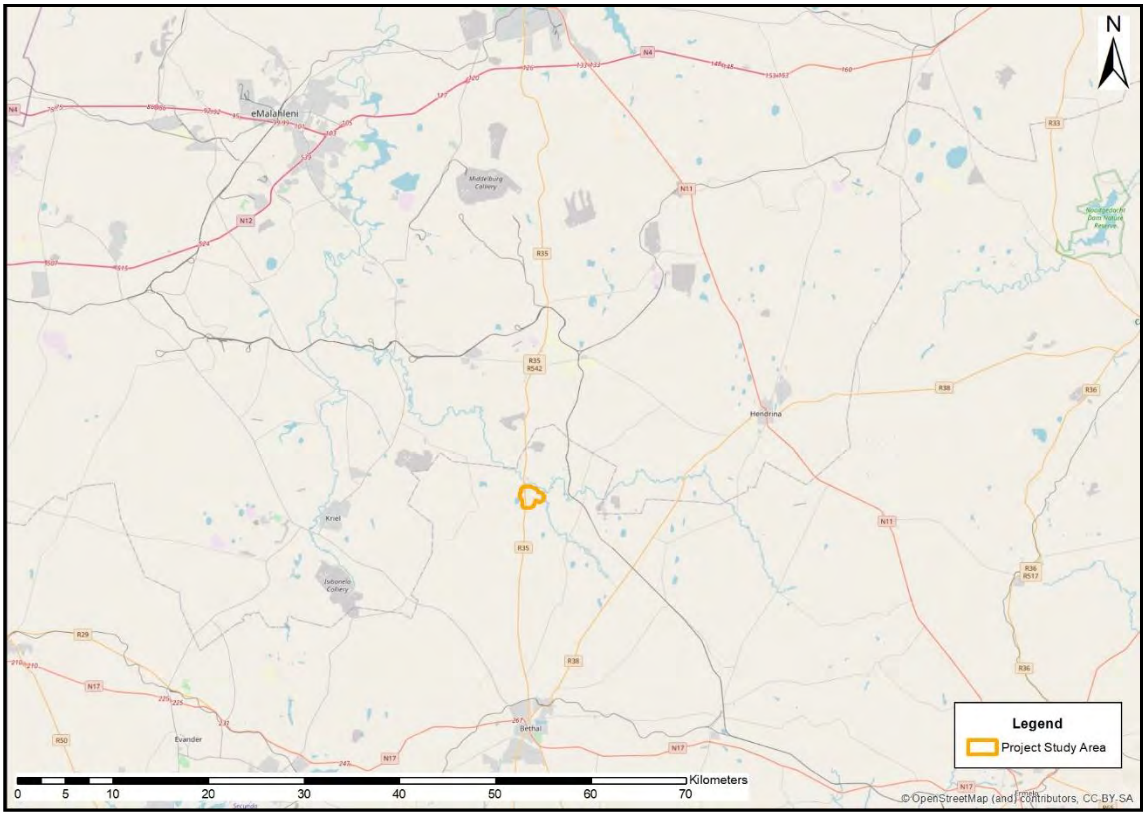

Figure 2: Map showing the location of the study area.

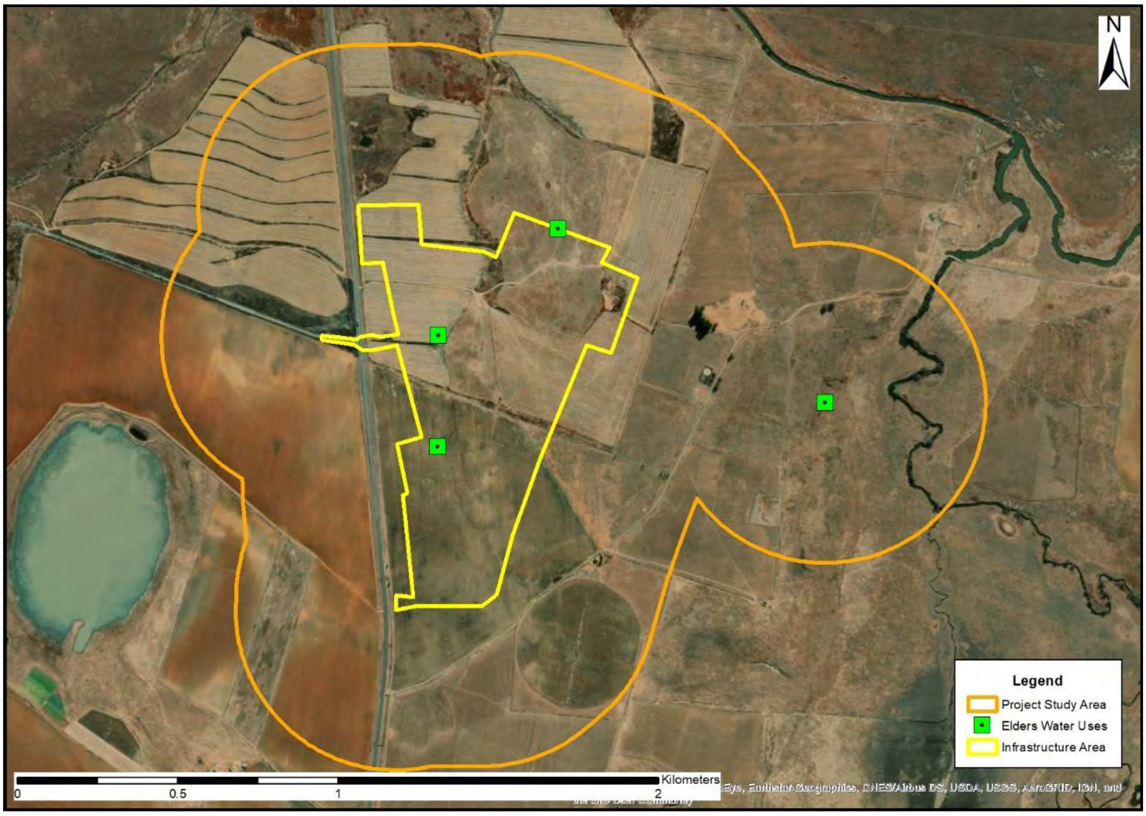

Figure 3. Map showing the study area overlain on recent aerial imagery. Also shown is the location of the 4 water uses forming the focus of this report.

7.1.2 Catchments & Rivers

The study area is located within the Olifants River Catchment (Primary Catchment B), with the specific affected quaternary catchment being B11A. Catchment B11A is drained by the Olifants River and its tributaries the Viskuile, Joubertsvleispruit, Leeufonteinspruit and Vlakkuilenspruit. Information regarding catchment size, mean annual rainfall and runoff for the quaternary catchment is provided in the table below (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990).

Table 6. Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990).

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Rainfall (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as % of MAP	Potential Evaporation (PE) in mm	Ratio of MAR to PE
B11A	94 549	699	67.8	9.7 %	1942.8	0.36

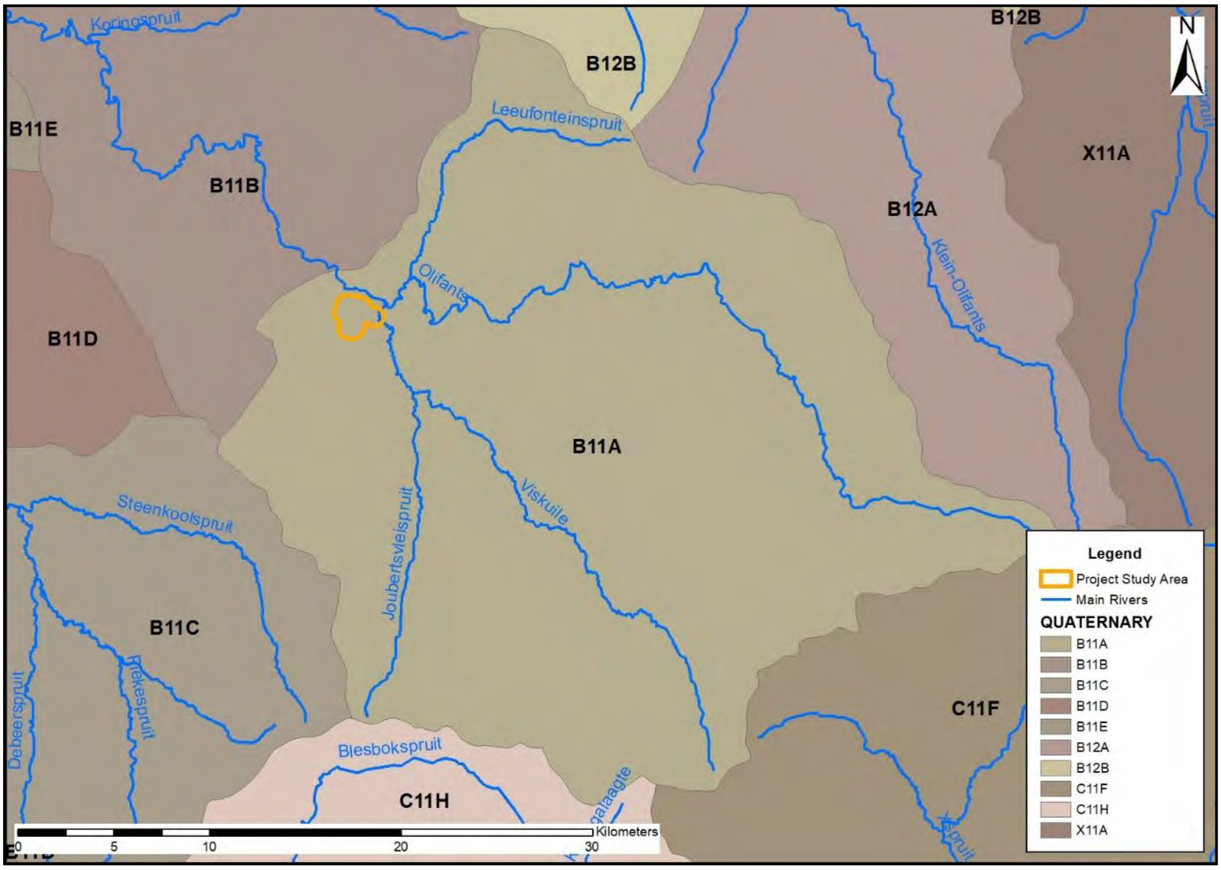

Figure 4: Map showing the approximate location of the study area in relation to the quaternary catchment, with principal rivers also illustrated.

7.1.3 Freshwater Ecosystem Priority Areas and National Wetland Inventory 5

The Atlas of Freshwater Ecosystem Priority Areas (FEPA) in South Africa (Nel *et al*, 2011) (The Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPA's were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. For the Mpumalanga Highveld, the NFEPA dataset was updated through a WRC funded project (Mbona *et al*., 2015), resulting in the generation of the Mpumalanga Highveld Wetlands (MPHG Wetlands) dataset.

The MPHG Wetlands dataset indicates numerous wetlands as occurring within the project study area as well as immediate surroudnings. However, none of these wetlands are classified as Freshwater Ecosystem Priority Area (FEPA) wetland.

The more recent National Wetland Inventory 5 wetland dataset was also consulted, as illustrated in Figure 6. Based on the National Wetland Map 5, a number of wetland systems occur within the general area, with Seep and Floodplain wetlands indicated as occurring within the project study area.

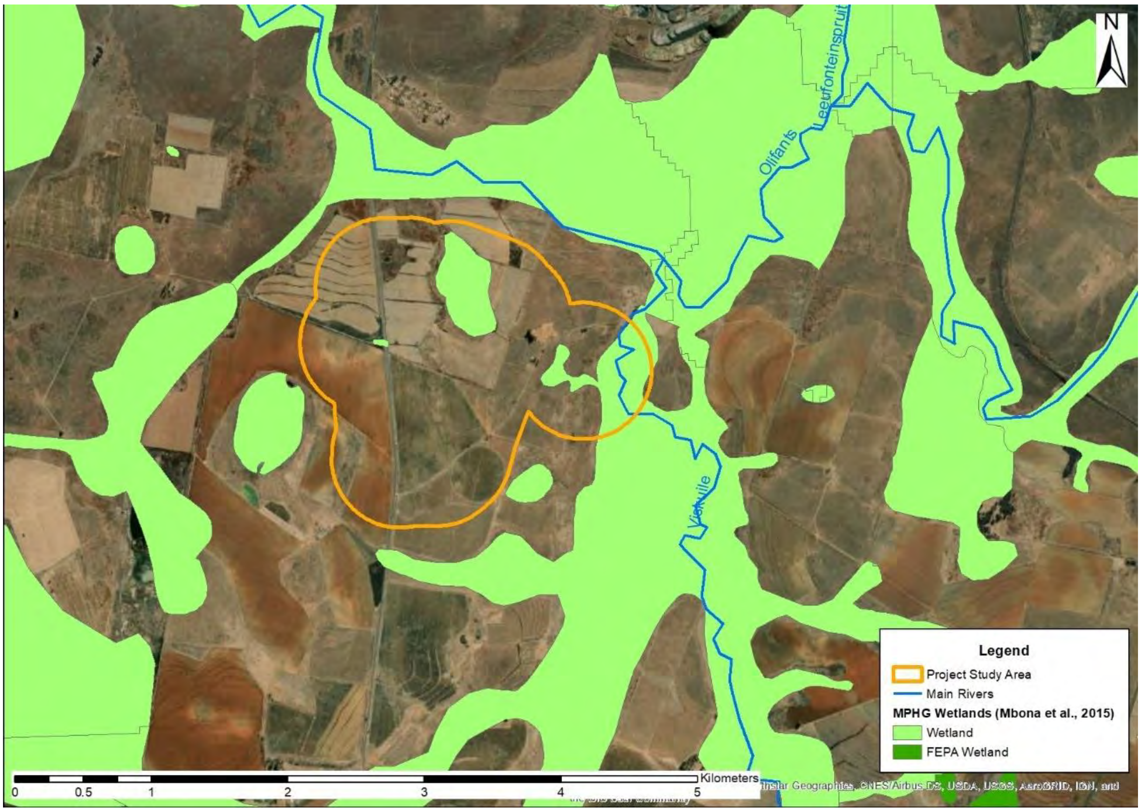

Figure 5. Map showing wetlands and wetland FEPA's within the study area and surroundings as per Mbona et al. (2015). No wetland FEPA's occur within the project study area.

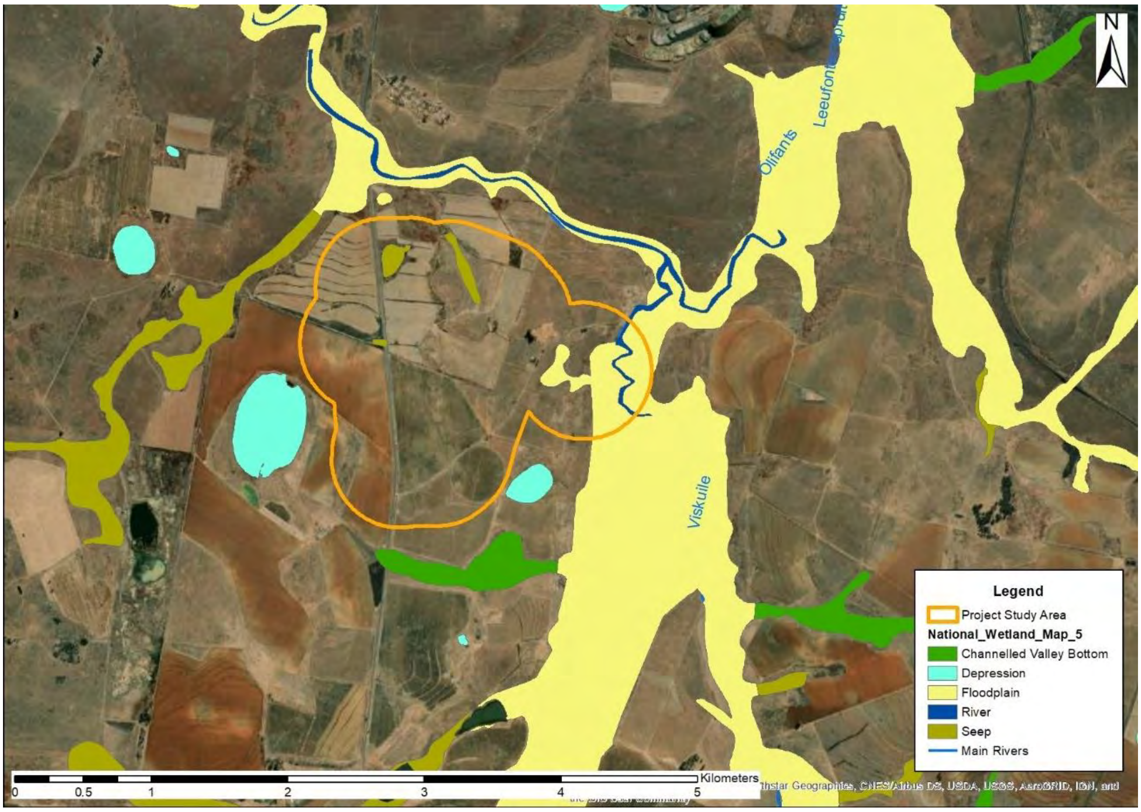

Figure 6. Extract of the National Wetland Map 5 for the project study area and surrounds.

7.1.4 Vegetation

Several vegetation classification systems have been compiled for South Africa. According to the most recent vegetation classification of the country, "*The Vegetation of South Africa, Lesotho and Swaziland*" (Mucina and Rutherford, 2006), the study area falls within the Grassland Biome, Mesic Highveld Grassland Bioregion. At a finer level, the area is categorised as Eastern Highveld Grassland (Gm12). Eastern Highveld Grassland is listed as ***Vulnerable*** in the National List of Ecosystems that are Threatened and in Need of Protection (GN1002 of 2011).

The 2018 National Wetland Map (Van Deventer et al., 2018) compiled as part of the 2018 National Biodiversity Assessment (2018 NBA) determined the Ecosystem Threat Status (ETS) and Ecosystem Protection Level (EPL) for all wetland ecosystem types in South Africa. Threat categories for the wetland ecosystem types represented within the project study area and surrounds are indicated in **Table 7**.

Table 7. Wetland ecosystem type, and its assigned threat status category (Mbona et al., 2015), occurring on site. ETS – Ecosystem Threat Status, EPL – Ecosystem Protection Level.

Wetland Ecosystem Type	EPL	ETS
Mesic Highveld Grassland Bioregion (Floodplain)	Not Protected	Critically Endangered
Mesic Highveld Grassland Bioregion (Valley Bottom)	Not Protected	Critically Endangered
Mesic Highveld Grassland Bioregion (Depression)	Poorly Protected	Least Concern
Mesic Highveld Grassland Bioregion (Seep)	Poorly Protected	Critically Endangered

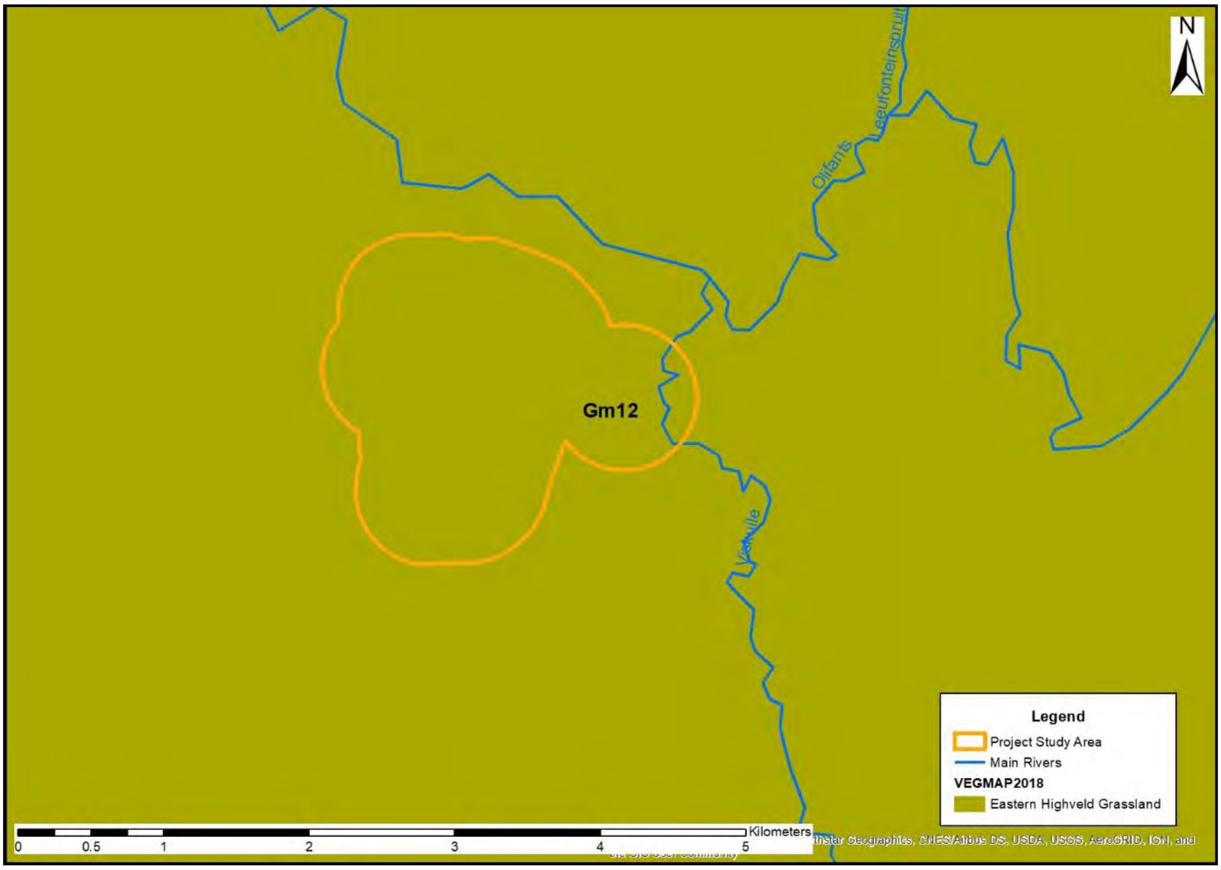

Figure 7. Map showing the vegetation types of the study area and surrounds as per Mucina and Rutherford (2006).

7.1.5 Mpumalanga Biodiversity Sector Plan 2013

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool that comprises a set of maps of biodiversity priority areas for use in land-use and development planning, environmental assessment and regulation, and natural resource management (MTPA, 2014). One of the key outputs of the MBSP is the identification of biodiversity priority areas. This was achieved through the compilation of maps indicating Critical Biodiversity Areas (CBAs).

Figure 8 illustrates the terrestrial biodiversity assessment of the MBSP for the study area. A CBA Irreplaceable area occurs within the east of project study area associated with the Viskuile floodplain wetland, with an adjacent ESA (Ecological Support Area) overlapping with Seep wetlands located on the slope. Extensive CBAs are associated with the Olifants River floodplain just to the north of the site. Most of the project study area is however classified as Modified or Modified – Old Lands, with some further areas of Other Natural Habitat.

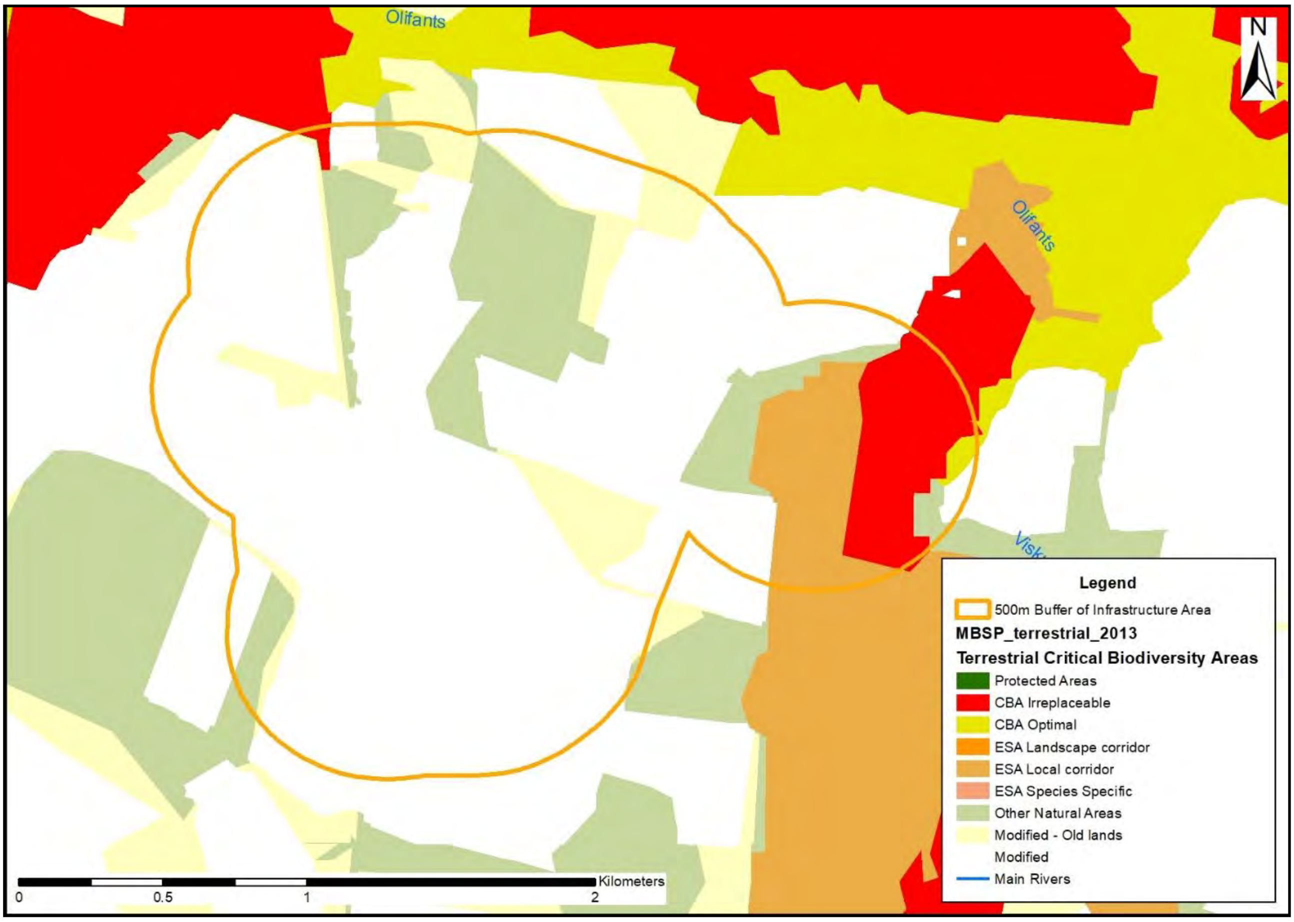

Figure 8. Extract from the provincial conservation plan for the study area.

7.1.6 Olifants Letaba Reserve

The Reserve Determination of Water Resources for the Catchments of the Olifants and Letaba in Terms of Section 16(1) and (2) of the National Water Act was gazetted as Government Notice 932 of 7 September 2018. As part of the Reserve study the Viskuile wetland system, referred to as the Viskuile floodplain complex, was ***identified as a Priority Wetland in the Olifants Catchment***. The relevant excerpt from Table 8.1 in GN 932 detailing the Ecological Specifications for the Viskuile wetland is provided in Table 8 below.

Table 8. Excerpt from Table 8.1 in GN 932 (Olifants Letaba Reserve).

1	B11A Oli_1.13	Viskuile floodplain complex Floodplain	-26.261	29.492	C	High to Very High	B	Maintain the existing flow distribution and retention patterns in the system. Currently unchannelled wetlands must be maintained as unchannelled systems. Maintain existing vegetation structure and composition. Lateral flow inputs to the wetland must be protected through application of hydrological buffers determined via hydro-pedological assessments undertaken as part of EIA and/or WUL applications, and strict licensing conditions including monitoring of the systems should apply. Any application for development including mining likely to impact this system, besides going through the normal licensing processes, should also include as a minimum an Intermediate Level Wetland Reserve which includes flow modelling (surface and groundwater including interflow) of scenarios to establish the potential impact in terms of achieving the REC. Rehabilitation measures should be implemented in this system to improve its current state.

7.2 Site Specific Assessment

7.2.1 Wetland Delineation and Classification

Four different natural hyrdogeomorphic wetland types were identified on site:

- Channel
- Floodplain wetland
- Unchannelled Valley Bottom wetland
- Seep wetland

These wetlands cover approximately 116.7 hectares, which makes up 29.4 % of the study area. Delineated wetlands are illustrated in Figure 9 below, while more detail on the extent and types of wetland habitat identified is provided in Table 9.

Table 9. Extent of the different wetland types identified on site.

Wetland Type	Area (ha)	% of study area
Unchannelled Valley Bottom	2.4	0.6 %
Floodplain	26.6	6.7 %
Channel	0.8	0.2 %
Seep	86.9	21.9 %
TOTAL	116.7	29.4 %
Dam	0.1	1.0 %

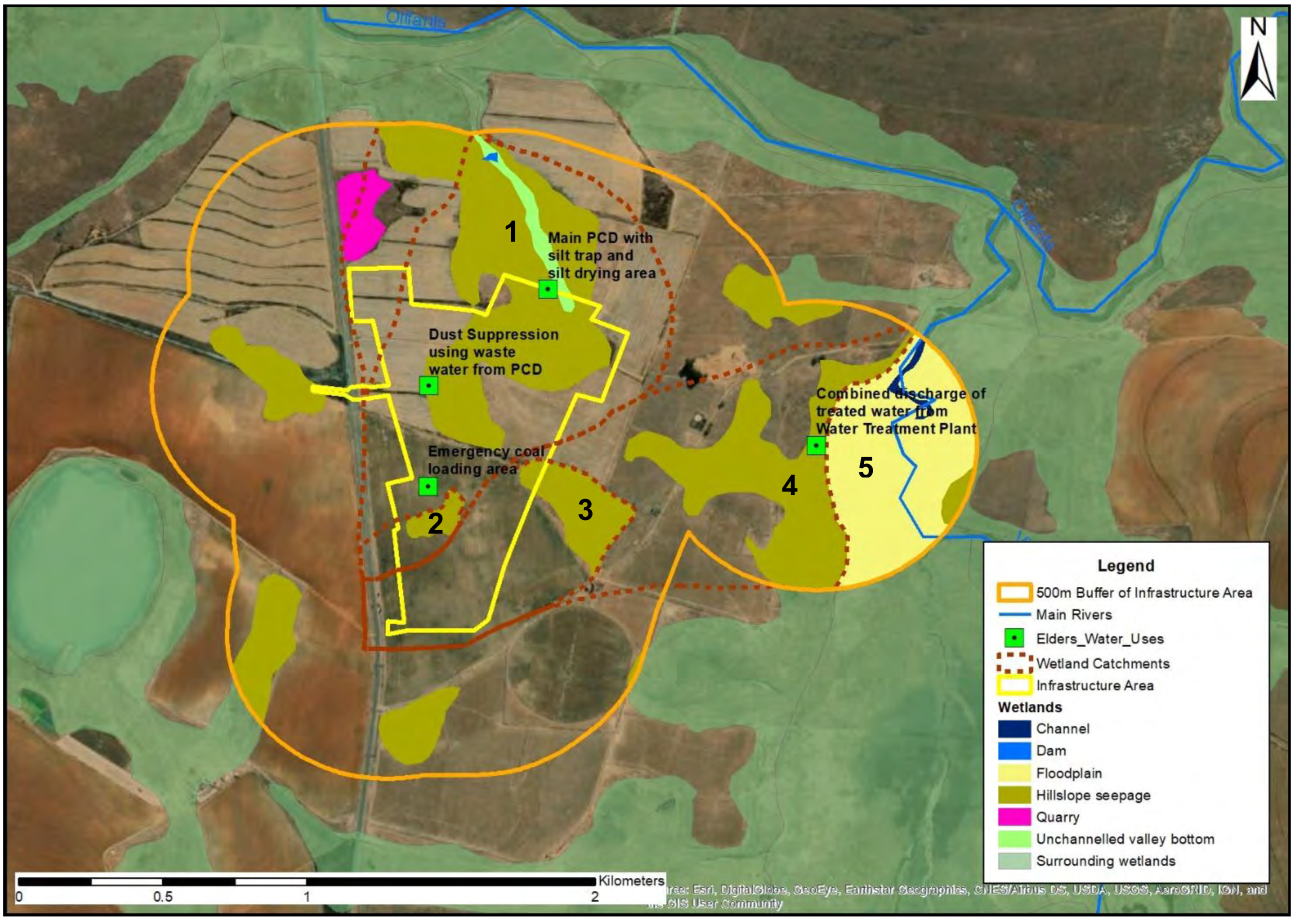

Figure 9: Map showing the extent of the delineated and classified wetlands within the study area and immediate vicinity. Also shown are approximate catchment boundaries of the various wetland units identified. Numbering of wetland units is reference in the text below.

Seep wetlands are the most extensive wetland habitat within the area, making up almost 75 % of the wetland habitat identified within the project study area. This is not unexpected within the general vicinity, where the typically sandy soils derived from the underlying sandstone provide ideal conditions for the development of Seep wetlands. As is typical of the Seep wetlands in the area, these systems are characterised by sandy soils with impeded vertical drainage due to the presence of typically a soft-plinthic layer within the soil profile which limits vertical movement of water and encourages lateral seepage and formation of interflow. The Seep wetlands on site consists of a mosaic of temporary and seasonally saturated habitat, with saturation mostly experienced during the summer rainfall season and into the early dry season. Surface water is mostly absent from the wetlands except immediately after rainfall events and at localised Seep fronts.

Wetland system 1 consists of a large Valleyhead Seep wetland and associated Unchannelled Valley Bottom wetland that forms a small tributary to the Olifants River to the north. The wetland is considered temporary to seasonal in nature across most of its extent, with only a small pool-like area near the top of the Unchannelled Valley Bottom wetland supporting surface water for extended periods. This pool-like area is shown in Figure 10 (top right photo) and supports a stand of Typha capensis. Shallow surface water was present at the time of the site visit – pH 7.49, Electrical Conductivity 218 µS/cm, Total Dissolved Solids 109mg/l. A small farm dam (partially breached) was also observed within the Valley Bottom wetland. Flow within the wetland is predominantly in the sub-surface as interflow, though surface runoff during wet periods and large rainfall events also occurs. Surface flow through the wetland is mostly diffuse, with some channel incision observed just upstream of the dam. Downstream of the dam flows become more confined.

The wetland is characterised by a typical grassland vegetation including species such as *Aristida congesta, Berkheya sp., Bidens formosa, Eragrostis plana, Nidorella anomala, Themeda triandra* and *Verbena bonariensis*. Stands of *Imperata cylindrica* also occur, especially along the wetland margins where sediment from cultivated fields accumulates. The wetland is surrounded by cultivated fields that marginally extend into the wetland habitat and have resulted in some direct habitat transformation and some habitat degradation due to edge effects (such as sedimentation). The upper reach of the Seep wetland was mowed at the time of the most recent site visit, while Google Earth imagery suggests mowing of the wetland is a regular occurrence.

Figure 10: Photos showing typical wetland habitat observed in the Seep and Unchannelled Valley Bottom wetland of wetland system 1.

Wetland system 2 represents a small, isolated Seep wetland located within a cultivated field. The entire wetland has been cultivated and now natural vegetation remains within the wetland. The wetland is only evident on site through a patch of greyer, more leached soils. The presence of a clear e-horizon within the soil profile indicates that subsurface interflow is the main driver of this wetland habitat. A picture of the wetland is provided in Figure 11 below

Figure 11. Photo of wetland system 2, which is entirely cultivated. The green outline shows the approximate location and extent of the wetland area.

Wetland system 4 consists of a Seep wetland located on an east facing slope along the western bank of the Viskuile Floodplain, which in turn forms wetland system 5. The upper reach of the wetland system 4 Seep is characterised by low slopes and has been disturbed by past agricultural activity, while the lower reach is much steeper and consequently has been excluded from past cultivation and is more intact. This wetland is also considered temporary to seasonal in nature and maintained by interflow. An old erosion feature was observed within the wetland just to the north of the proposed discharge point (water use being applied for). This old erosion gully has exposed the subsurface interflow and some surface seepage of water was in evidence (see bottom photos in Figure 12.), though the visible wetness is very localised and does not extend significantly into the Floodplain of wetland system 5. The Seep is characterised by typical moist grassland vegetation on sandy soils, with a high prevalence of weeds. Typical species observed include *Agrostis lachnantha, Aristida congesta, Conyza sp., Eragrostis chloromelas, E. gummiflua, Kyllinga erecta, Imperata cylindrica, Scirpoides burkeii, Themeda triandra* and *Verbena bonariensis*.

The Floodplain reach falling within the project study area is characterised by a broad, flat valley floor approximately 350m wide. A clearly defined channel lined with large *Salix babylonica* trees meanders through the centre of the Floodplain. The confluence with the Vlakkuilenspruit is located just upstream and the confluence with the Olifants River just downstream. A large weir on the Olifants River results in backflooding within the channel of the Viskuile Floodplain, resulting in a near bank-full channel within the affected reach of the Floodplain. Regular overtopping of the channel results in seasonal wetting and occasional inundation of the Floodplain. The Floodplain is dominated by typical moist grassland vegetation

Figure 12. Photos of the wetland habitat associated with the Seep and Floodplain wetlands (wetland systems 4 & 5).

A large seasonal Pan wetland occurs just to the southwest of the project study area (refer to Figure 13 below). It is clear from this map that the infrastructure area falls outside the topographic catchment of the Pan. It can therefore be concluded that the large Pan will not be impacted by currently proposed project activities.

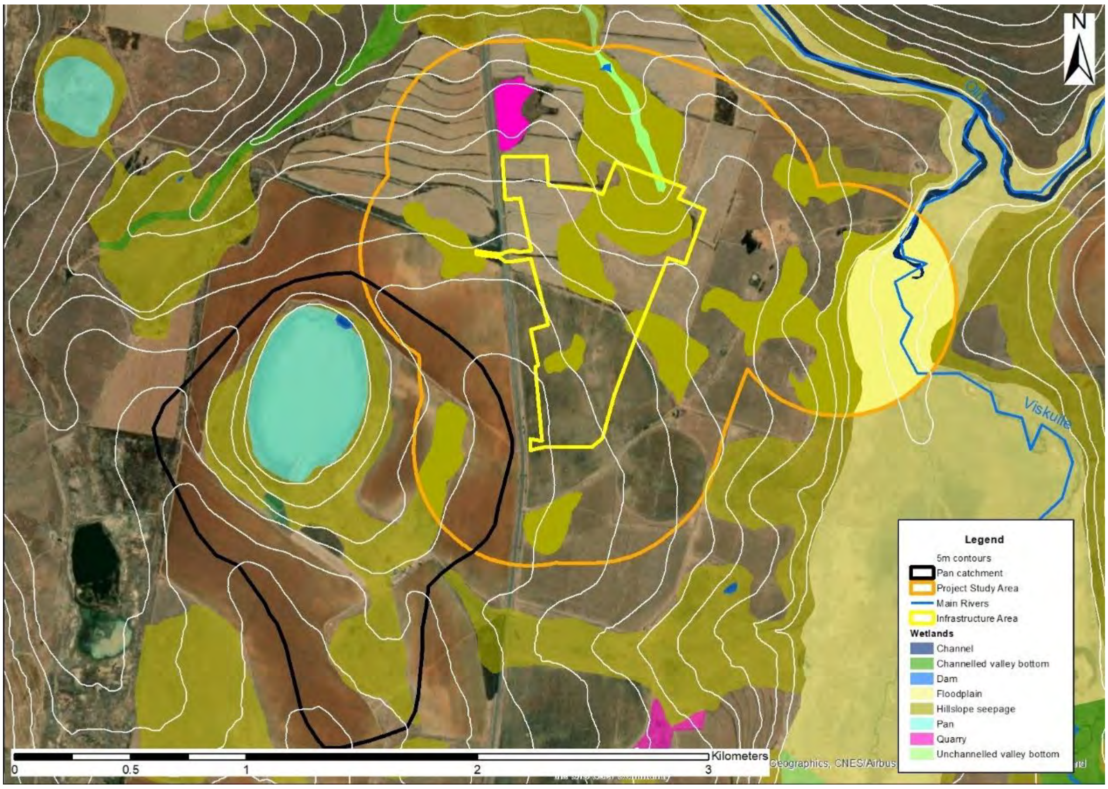

Figure 13. Map showing the location of the large Pan wetland and its associated catchment in relation to the project study area and proposed surface infrastructure area.

7.2.2 *Present Ecological Status (PES) Assessment*

A WET-Health Version 2 Level 1b assessment was undertaken for wetlands within the study area and likely to be affected by the proposed project activities. Results are shown in Figure 14 and summarised in Table 10. The PES results differ marginally for some wetlands when compared to the WCS (2015) study, though this is attributed mostly to the change in wetland assessment tool utilised (change from WET-Health Version 1 to Version 2), as little change to the wetlands was evident on site.

The large floodplain wetland habitat associated with Viskuile and Vlakkuilenspruit confluence is considered to be in a B/C category, indicating wetland habitat that is Largely Natural to Moderately Modified. Some back-flooding occurs within the Viskuile channel from the weir on the Olifants River, while some channel incision is also evident within the lower reaches of the Vlakkuilenspruit. The vegetation of the floodplain is largely intact, though evidence of heavy livestock utilisation was observed, while linear disturbances associated with fence lines and firebreaks also occur.

The Seep wetlands within the study area vary from Moderately Modified (category C) to Seriously Modified (category D) depending mostly on the level of direct alteration of habitat through conversion to cultivated fields.

Table 10. Results of the PES assessment sowing the revised PES categories determined as part of the current study as well as the 2015 PES categories.

Wetland System	2015 PES	Assessment categories				Combined score
		Hydrology	Geomorphology	Water Quality	Vegetation	
Wetland 1 - Seep	C	46%	66%	40%	70%	**D**
Wetland 1 – Valley Bottom	C	61%	90%	83%	84%	**C**
Wetland 2 – Seep	n/a	14%	47%	16%	0%	**E**
Wetland 3 - Seep	D	32%	46%	32%	38%	**E**
Wetland 4 - Seep	C	59%	81%	75%	76%	**C**
Wetland 5 - Floodplain	B/C	**n/a**				

Table 11. Table showing the rating scale used for the PES assessment.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

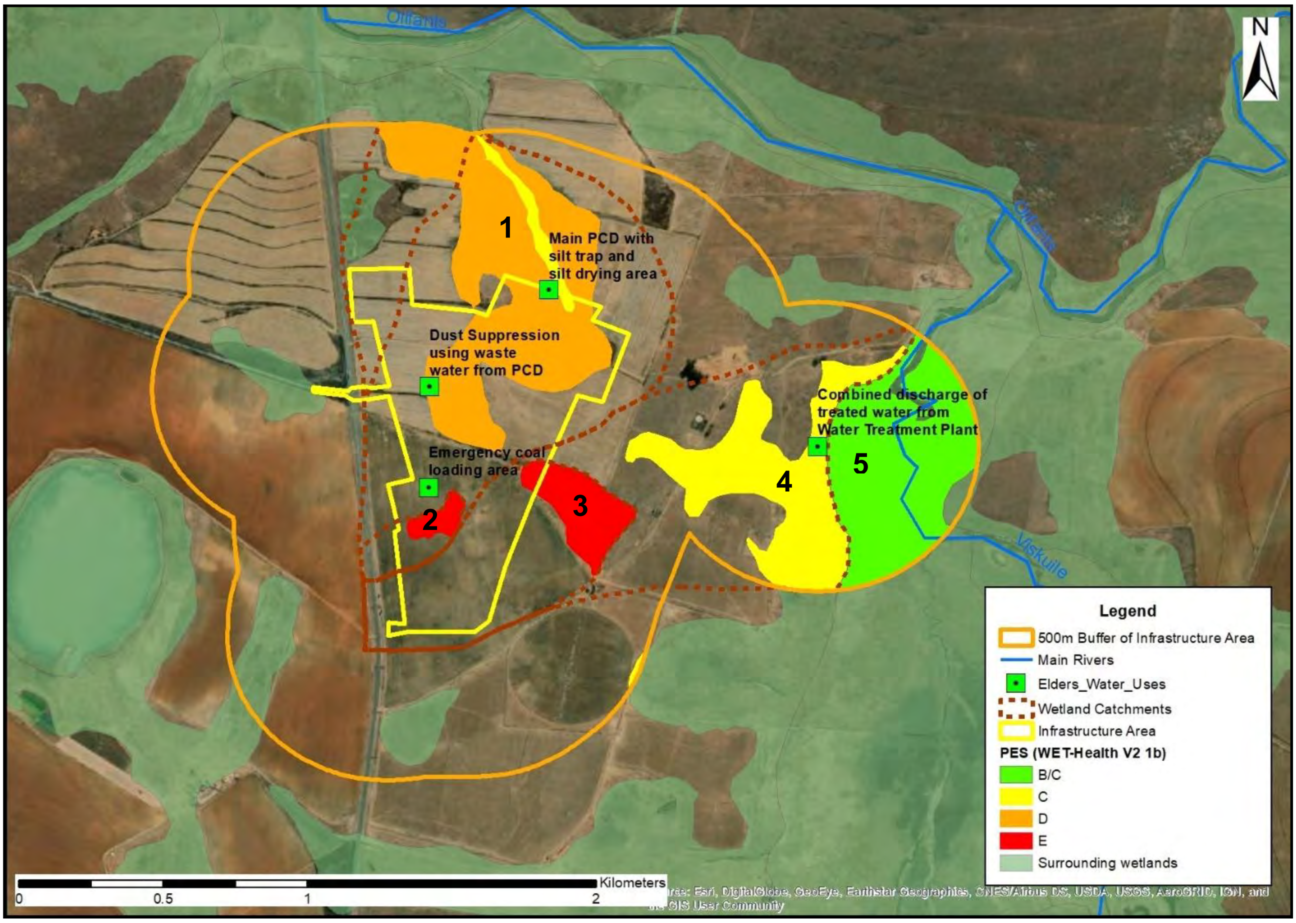

Figure 14. Results of the PES assessment.

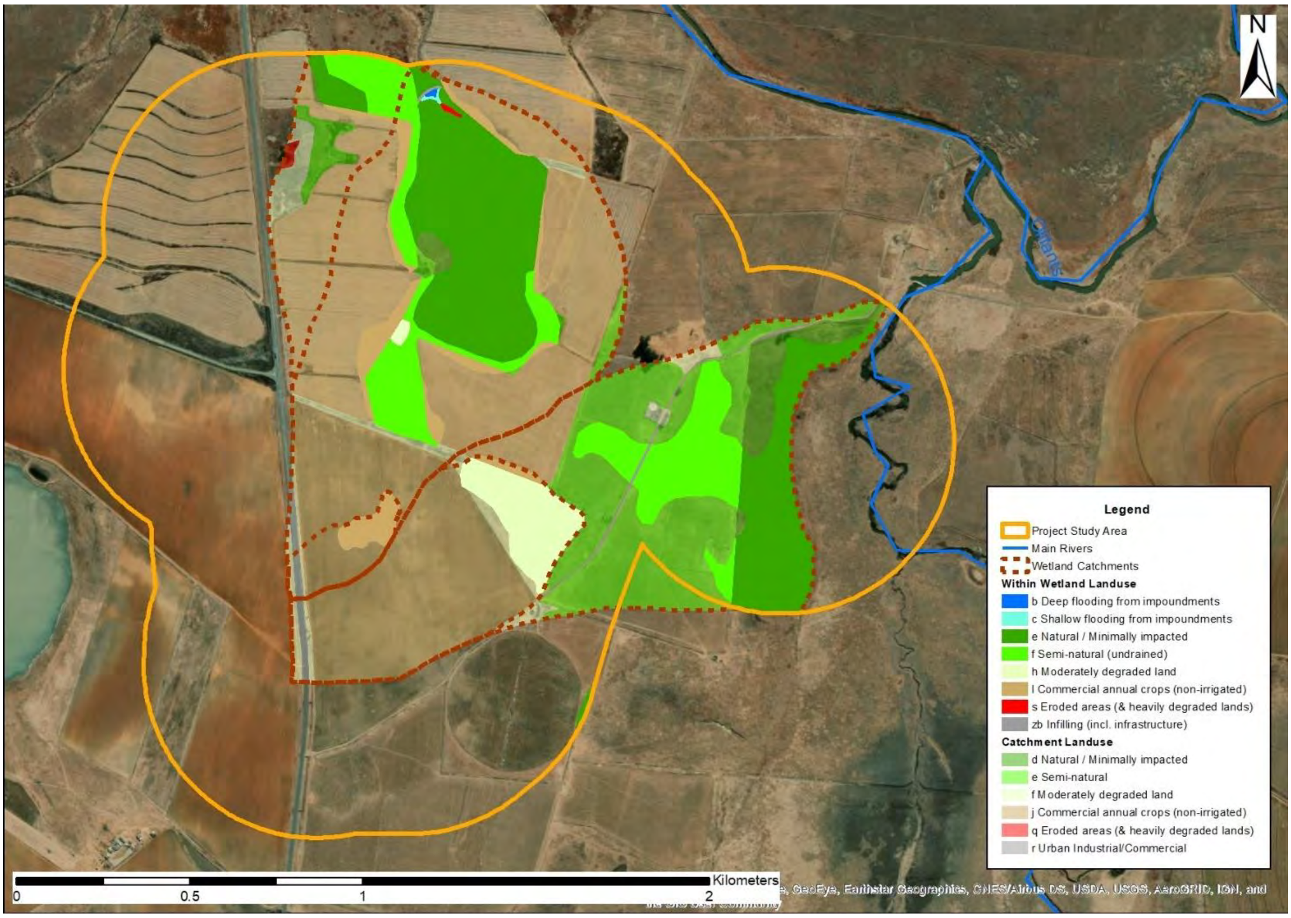

Figure 15. Map showing the landuse mapping used to inform the PES assessment.

7.2.3 Wetland Importance and Sensitivity

The wetlands within the study area form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality and quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context an IS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the IS assessment include:

- The location of the study area within a vegetation type (***Eastern Highveld Grassland***) considered extensively transformed and threatened, having been classed as ***Vulnerable.***
- The wetland vegetation associated with the Vlakkuilenspruit has been typed as ***Eastern Temperate Freshwater Wetlands*** vegetation, which is considered ***Vulnerable***.
- The wetland ecosystem types of the area, Mesic Highveld Grassland Bioregion (Seep), which is ***Critically Endangered*** and ***Not Protected***.

- The presence of Red Data species within the wetlands on site. The ***Near threatened*** endemic ***Kniphofia typhoides*** was observed within the Vlakkuilenspruit wetland, as well as several individuals of the near-endemic Blue Korhaan. During the WCS (2015) study a spotted-necked otter (Near Threatened) and several Red Data listed bird species were observed in the study area (African Grass Owl, Stanley's Bustard, Greater & Lesser Flamingo, Southern Bald Ibis and Black Harrier)
- The generally well-connected nature of the wetlands and watercourses which provide effective movement corridors for wildlife.
- The generally moderately modified state of the wetlands and watercourse within the study area, with the large floodplain considered largely natural to moderately modified.

It is these considerations that have informed the scoring of the systems in terms of their importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands are illustrated in Figure 16.

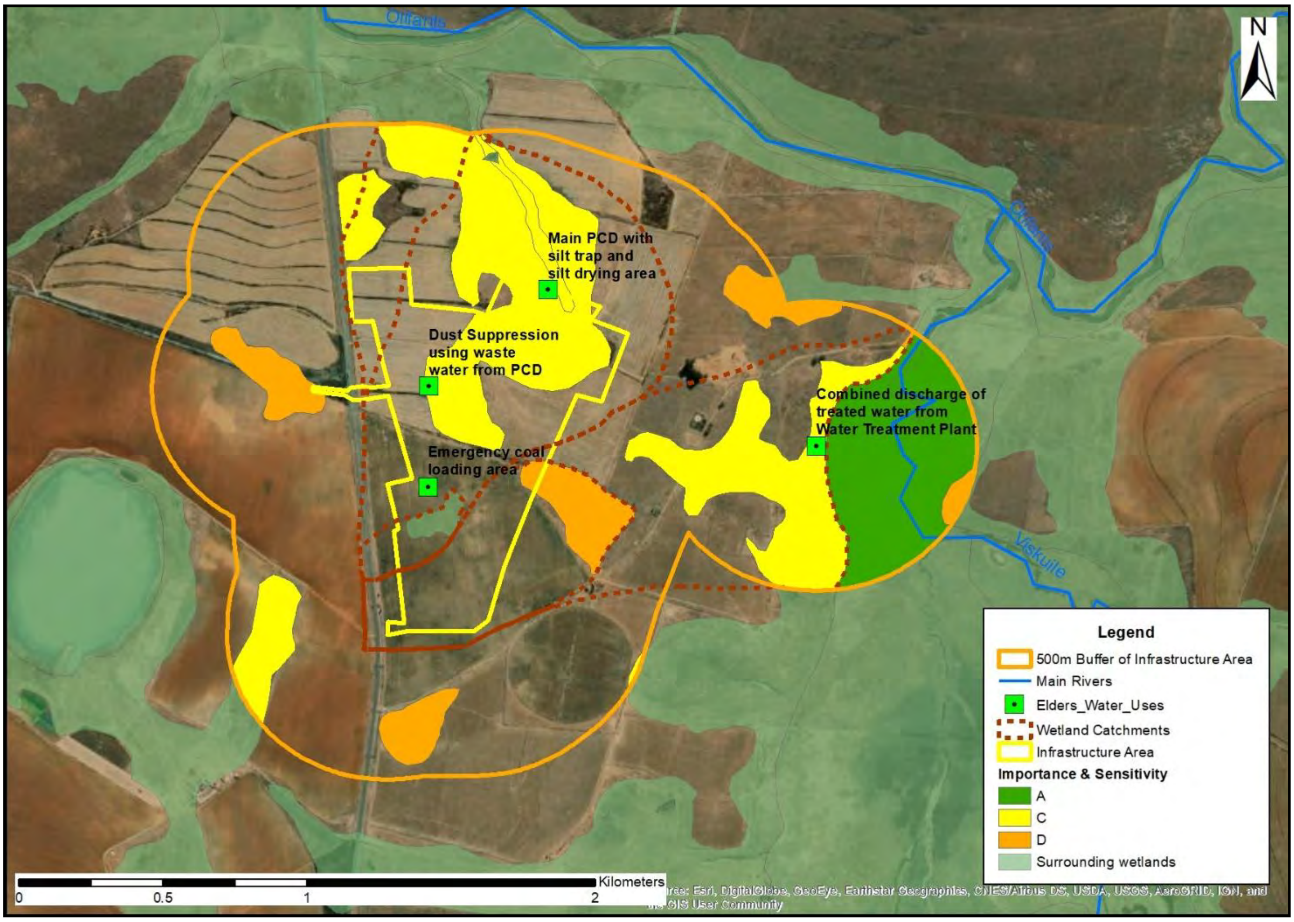

Figure 16. Results of the Wetland Importance and Sensitivity Assessment.

8. IMPACT ASSESSMENT

The Elders Colliery mine development, including the proposed surface infrastructure area, is already approved, though not yet constructed. The initial Water Use Licence (WUL) Authorisation for the Elders Colliery was received in April 2017 and amended in November 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1). Since issuing of the WUL, synergy has been lost with Goedehoop, to which Elders Colliery was originally envisaged to serve as a life extension project. Consequently, there have been resultant changes to project description and block plan layout for Elders Colliery.

The specific changes and activities under consideration in this report are detailed in Table 12 below. Most of these activities fall within the greater surface infrastructure footprint which has already been approved. These activities will therefore contribute towards impacts on wetlands that were already identified and assessed as part of the WCS (2015) wetland report and authorised in the existing WUL. The project activities will impact on the same wetland systems as assessed in the WCS (2015) study and will do so in much the same location, though some small changes have occurred as a result of changes in the block plan layout and the proposed changes in volume associated with the project activities.

For the purpose of this impact assessment, it is not possible to isolate the impact of the 4 water uses detailed below from the impact of the greater surface infrastructure area (with the exception of the water use associated with discharge of treated water). ***This impact assessment therefore considers the impact of the greater infrastructure area on affected wetlands, even though, as mentioned above, the greater infrastructure area has already been authorised.***

Table 12. Summary of Section 21 (c) and (i) water uses that form the focus of this wetland assessment.

Water Use Type	Water Use Name	Reason	Volume	Location
Section 21 (f)	Combined discharge of treated water from Water Treatment Plant	Authorised in WUL but increase in volume required.	1 168 000 m^3 3200 m^3/d	Portion 6 of Middelkraal 50 IS 26° 14' 17.47" S, 29° 28' 42.89" E
Section 21 (g)	Dust Suppression using wastewater from PCD	Authorised in WUL but increase in volume required.	60 955 m^3	Portion 3 of Middelkraal 50 IS 26° 14' 0.91" S, 29° 28' 0.42" E
Section 21 (g)	Main PCD with silt trap and silt drying area, collecting water from the underground workings and dirty water collection from the shaft complex dirty water areas	Authorised in WUL but increase in volume required. Capacity is reduced.	1 218 370 m^3 Capacity ≥ 29 ML	RE/3 of Middelkraal 50 IS 26° 13' 50.05" S, 29° 28' 13.80" E
Section 21 (g)	Emergency coal loading area	New Water Use		RE/3 of Middelkraal 50 IS 26° 14' 12.19" S, 29° 28' 0.37"E

Impacts to wetlands were identified by superimposing the proposed project activities with the delineated wetland areas. This is shown in Figure 17 below.

From the map in Figure 17 it is clear that most of the project activities fall within the greater footprint of the surface infrastructure area, which is already authorised, but which overlaps substantially with delineated wetland habitat. Approximately 20 hectares of wetland habitat falls directly within the greater surface infrastructure footprint. The project activities considered in this assessment contribute towards this loss of wetland habitat but, as stated above, the greater infrastructure area has already been authorised.

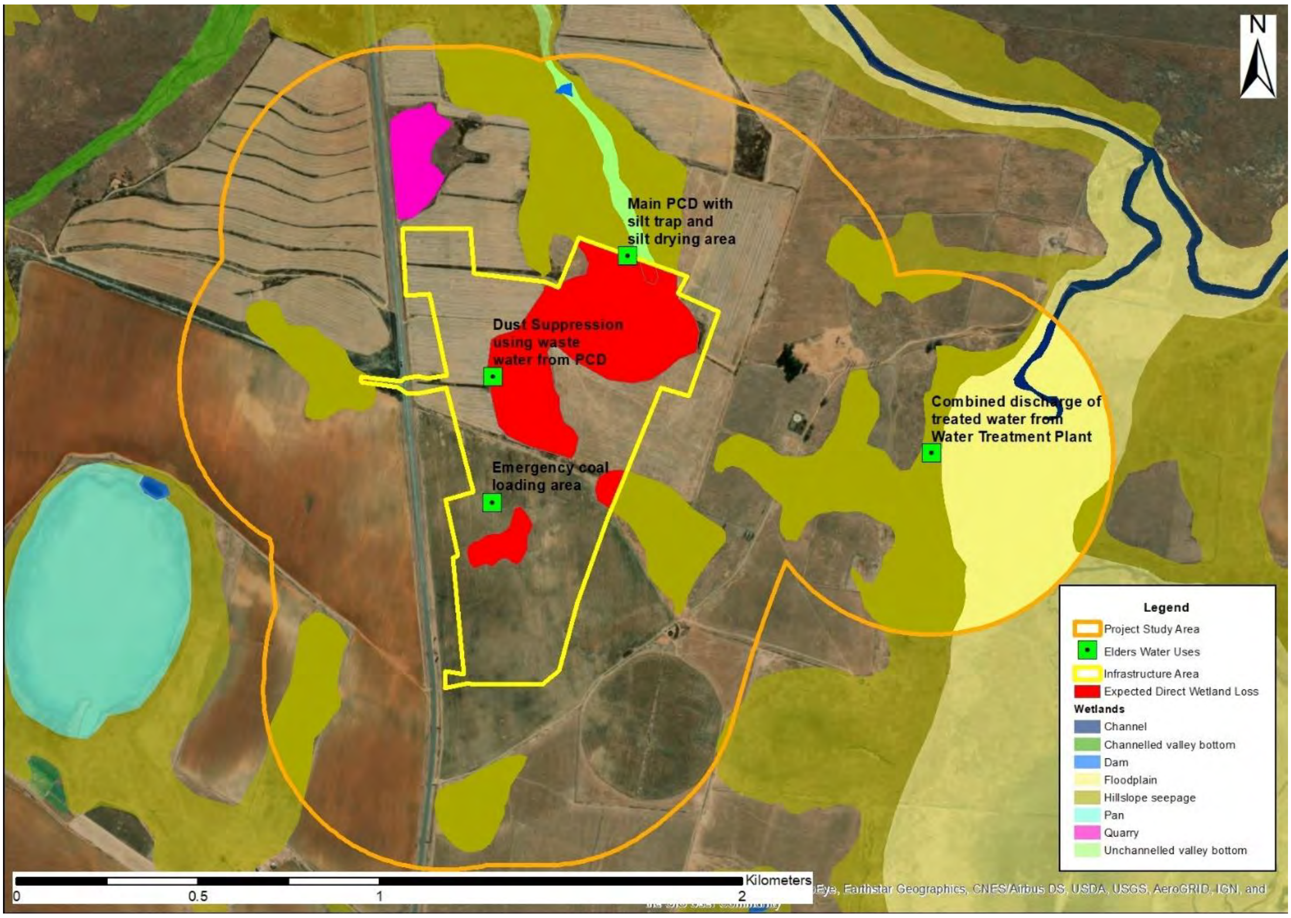

Figure 17. Map showing the proposed surface infrastructure project layout plan in relation to delineated wetlands. Wetland habitat falling within the direct surface infrastructure footprint has been highlighted in red.

Likely impacts are identified based on an evaluation of the project description in relation to the wetland habitats identified on site and within the affected area of the proposed project activities. Expected impacts are as follows:

<u>Construction Phase</u>

1. Loss and disturbance of wetland habitat and fauna – 20 hectares of wetland habitat, mostly Seep wetland habitat, falls within the direct footprints of the greater surface infrastructure area, which includes the project activities under consideration. Adjacent wetland habitat is however also at risk

of being disturbed during construction activities as machinery and staff traverse the development footprints and the required earthworks are undertaken. Edge effects are likely to materialise, while noise, dust, light contamination, and fugitive waste are further likely to impact on adjacent wetlands and the biota they support. Sensitive species might be displaced.

2. Increased erosion in wetlands – flow concentration caused by access road crossings or point source discharges of clean stormwater could lead to erosion within receiving wetlands. Channel incision and erosion within wetlands will result in lowering wetland integrity, will mobilise sediments to downstream wetland reaches and will result in partial desiccation of wetland habitat through lowering of the localised water table within the affected wetlands.

3. Increased sediment movement into wetlands - Construction activities will involve the clearing of large areas of soil, as well as the movement of soil and subsequent stockpiling. This will expose large areas and large volumes of soil to erosion by wind and water, which will likely be aggravated by an increase in surface runoff from bare soil areas and concentration of flows. Sediment could be transported downslope via surface runoff to the adjacent wetland areas, leading to increased turbidity with resultant impacts on aquatic habitats, including loss of sensitive species, as well as increased sediment deposition in wetlands, leading to habitat degradation as these areas become colonised by alien and pioneer species. Severe sedimentation could also impact of flow distribution within the wetlands.

4. Increase in alien vegetation - Disturbance brought about by construction activities, specifically the clearing of vegetation will provide opportunity for alien and pioneer species to establish and replace indigenous grassland/wetland species.

5. Increased turbidity and water quality degradation in adjacent wetlands - During the construction phase, as activities are taking place adjacent to wetlands, there is a possibility that water quantity and quality can be impaired through contaminated surface runoff entering the wetlands. Typically, impairment will occur because of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired because of accidental spillages and the intentional washing and rinsing of equipment within the wetlands. It is possible that hydrocarbons will be temporarily stored and used on site, as well as cement and other potential pollutants.

<u>Operational Phase</u>

6. Disturbance of wetland habitat and fauna – Day to day operation of the surface infrastructure will be limited to the defined infrastructure footprint area. However, edge effects are likely to materialise, with noise, dust, light contamination, and fugitive waste likely to continuously impact on adjacent wetlands and the biota they support. Sensitive species might be displaced. Prevalence of fire within adjacent wetlands will likely increase in some areas through burning of firebreaks (within the footprint of the firebreaks, which will be burnt annually), impacting on vegetation and winter breeding bird species such as the African Grass Owl, while decreasing in other areas due to fire exclusion.

7. Deterioration in water quality due to seepage and leakage out of the dirty water area – Sections of the surface infrastructure area will be classed as a dirty water areas and include numerous potential sources of contaminated water, including the dirty water collection sump, pollution control dam system, and coal loading area. Runoff, seepage, and leakage of water out of these areas could lead to deterioration in water quality within downslope wetlands.

8. Decreased flow within wetlands adjacent to the surface infrastructure footprint – The excavation and operation of the shaft will likely result in a localised draw down of the shallow weathered aquifer, possibly resulting in decreased flows entering the adjacent wetlands. This impact will be most significant immediately adjacent to the shaft and decrease in severity with increasing distance from the shaft. In addition, the isolation of dirty water areas will reduce the catchment area contributing to downslope wetlands, while an increase in hardened surfaces will also reduce recharge of interflow, which is the main driver of the wetland systems on site. A reduction in flow inputs to remaining downslope wetlands can therefore be expected.

9. Increased flow within wetlands – wetlands receiving discharges from the treated water will experience increased flow. This could have various consequences to the wetland. Increased erosion could materialise at the point of discharge, especially if discharge takes place on steep slopes (e.g., in the Seep wetland) or as high velocity point source discharges. Increased flow will result in increased wetness and extended hydroperiod, impacting on vegetation structure and composition. It is likely that pioneer species such as *Typha capensis* could establish at the discharge point.

10. Water quality deterioration due to discharges – discharge of treated water could lead to changes and deterioration in water quality if treatment to the relevant standards is not maintained or if any aspect pf the treatment process is impaired or malfunctions. This could result in introducing contaminants to the receiving wetland (Viskuile Floodplain), with a risk of eutrophication due to increased nutrient inputs from treated sewage.

<u>Decommissioning and Closure Phase:</u>

11. Sediment movement into wetlands – Rehabilitation of the surface infrastructure area will involve significant earth moving and the placement of a topsoil layer across the site, followed by the re-vegetation of the disturbed footprint. Exposing large areas of bare soil with sparse vegetation cover could provide a significant sediment source to adjacent wetlands. Sediments entering adjacent wetlands via surface runoff will likely deposit in the wetlands, with deposition areas providing an opportunity for the establishment of pioneer and weedy species within the wetlands, leading to habitat degradation.

12. Establishment of alien vegetation – The replaced topsoil could provide opportunity for the establishment of alien vegetation, with such alien vegetation providing a source of seeds to spread into adjacent wetland areas.

13. Increased flow velocities within wetlands - Once rehabilitated, runoff from rehabilitated footprint will be considered clean water and released back into the environment. Poor vegetation cover and more compacted soils could encourage higher velocity flows that could lead to erosion within adjacent wetland areas, though the generally low slopes of the area should limit this.

14. Water quality deterioration - Oxidation and leaching of carbonaceous and pyritic material remaining on surface post-rehabilitation could result in the seepage of low pH, high metal and sulphate rich water out of the material and into adjacent wetland areas. In addition, any decant from the shaft area is also likely to be contaminated and could impact on adjacent wetlands and the downstream Klippoortjiespruit.

Table 13. Impact significance rating table for expected impacts to wetlands.

Nature of the impact		Significance of potential impact before mitigation						Significance of potential impact after mitigation					
		Probability	Duration	Extent	Magnitude	Significance		Probability	Duration	Extent	Magnitude	Significance	
Shaft Area and Surface Infrastructure													
Construction Phase													
Loss and disturbance of wetland habitat	-	5	5	2	8	**75**	**Moderate**	5	5	2	6	**65**	**Low**
Increased erosion in wetlands	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**
Increased sedimentation in wetlands	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**
Increase in alien vegetation	-	3	4	2	6	**36**	**Moderate**	2	1	1	2	**8**	**Low**
Increased turbidity and water quality deterioration in adjacent wetlands	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**
Operational Phase													

Nature of the impact		Significance of potential impact before mitigation						Significance of potential impact after mitigation					
		Probability	Duration	Extent	Magnitude	Significance		Probability	Duration	Extent	Magnitude	Significance	
Disturbance of wetland habitat and fauna	-	3	4	1	6	**33**	**Moderate**	2	4	1	2	**14**	**Low**
Deterioration in water quality due to seepage and leakage out of the dirty water area	-	4	4	2	6	**48**	**Moderate**	2	4	1	4	**18**	**Low**
Decreased flow within wetlands adjacent to the infrastructure footprint	-	5	4	2	6	**60**	**High**	3	4	1	4	**27**	**Low**
Increased flow due to discharges	-	5	4	1	6	**55**	**Moderate**	5	4	1	4	**45**	**Moderate**
Water quality impact due to discharges	-	4	4	3	8	**60**	**High**	2	4	1	4	**18**	**Low**

Nature of the impact		Significance of potential impact before mitigation						Significance of potential impact after mitigation					
		Probability	Duration	Extent	Magnitude	Significance		Probability	Duration	Extent	Magnitude	Significance	
Decommissioning and Closure Phase													
Sediment movement into wetlands	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**
Establishment of alien vegetation	-	3	4	2	6	**36**	**Moderate**	2	1	1	2	**8**	**Low**
Increased flow velocities in wetlands	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**
Water quality deterioration	-	4	2	2	6	**40**	**Moderate**	2	2	1	4	**14**	**Low**

8.1 Mitigation Measures

Construction Phase

- Design of surface infrastructure areas should be optimised to minimise the size of the development footprint and to minimise encroachment into wetland habitat.
- All disturbance footprints must be separated from adjacent wetland habitat by a fence, either a security fence or as minimum a five-strand cattle fence (ideally not utilising barbed wire). The purpose of the fence is to clearly demarcate sensitive areas and prevent accidental vehicle and construction machinery access to these areas.
- All construction staff should be educated on the sensitivity of wetland areas and should be made aware of all wetland areas near the construction sites.
- Locate all temporary stockpiles, constructor's camps, laydown areas, ablution facilities etc. within the fenced off surface infrastructure footprint area.
- Develop and implement a construction stormwater management plan prior to the commencement of site clearing activities. Such a plan should aim to minimise the transport of sediment off site. Sediment traps and sediment barriers should be installed where necessary, and stormwater discharge points should be protected against erosion and incorporate energy dissipaters.
    - Erosion within the construction site must be minimised through the following:
        - Limiting the area of disturbance and vegetation clearing to as small an area as possible;
        - Where possible, undertaking construction during the dry season;
        - Phasing vegetation clearing activities and limiting the time that any one area of bare soil is exposed to erosion;
        - Control of stormwater flowing onto and through the site. Where required, stormwater from upslope should be diverted around the construction site;
        - Prompt stabilisation and re-vegetation of soils after disturbance and construction activities in an area are complete; and
        - Protection of slopes. Where steeper slopes occur, these should be stabilised using geotextiles or any other suitable product designed for the purpose.
    - Sediment transport off the site must be minimised through the following:
        - Establishing perimeter sediment controls. This can be achieved through the installation of sediment fences along downslope verges of construction sites where surface flows leave the site. Where channelled or concentrated flow occurs, reinforced sediment fences or other sediment barriers such as sediment basins should be used (refer to US EPA guidelines on Stormwater Pollution Prevention);
        - Discharge of stormwater from the construction site into adjacent grassland. Discharged flows must be slow and diffuse; and
        - Regular inspection and maintenance of sediment controls
- Ensure that no equipment is washed in the wetlands of the area, and if washing facilities are provided. No abstraction of water from the wetlands or pans should be allowed unless expressly authorized in the IWULA.
- Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal

with minor spills. Larger spills should be reported to the Environmental Co-coordinator and the relevant authorities (DWS) immediately, with specialists appointed to oversee the clean-up operations.

- An alien vegetation management plan should be drawn up and implemented to limit the spread of alien vegetation into wetland habitat.
- All disturbed areas outside the direct development footprints should be rehabilitated and re-vegetated as soon as possible.
- A detailed procedure for the handling, storage and disposal of waste must be developed and fully implemented during construction.
- The construction servitudes should be regularly inspected for waste or littering, and clean-up operations initiated if required.
- Treated water discharged to the environment must not impact negatively on the Olifants River RQOs and be in line with DWS General Limits for treated sewage effluent.
- Discharge point to be located at the bottom of the slope to minimise erosion. Monitor discharge point for any erosion damage over time

Operation Phase

- Implement the surface water management plan that will ensure effective clean and dirty water separation;
- Implement and maintain dirty water infrastructure around all sources of potential dirty water. Regular inspections of all water management infrastructures must be undertaken and detailed records of such inspections maintained;
- Minimise extent of dirty water areas;
- Ensure all clean water is diverted around dirty water areas and allowed to re-enter the environment;
- Clean water diversion canals must be constructed as vegetated swales rather than cement lined canals wherever possible;
- Implement dust suppression within areas where carbonaceous dust may be generated and areas of heavy vehicle traffic. Implement dust suppression on haul trucks;
- Implement water quality strategy;
- Compile an emergency response procedure for clean-up of any major spillages.
- All areas involving the handling of carbonaceous material and coal should be considered dirty water areas and should be isolated from the surrounding catchment. No run-off from the ROM stockpile should be discharged to the environment.
- Any dump or stockpile, if containing carbonaceous material, should be considered a dirty water area. No run-off from such stockpiles should be discharged to the environment without treatment.
- The topsoil stockpile should be located within a clean water area and no contaminated water should come into contact with the topsoil stockpiles. Side slopes of the topsoil stockpiles should be kept as low as possible and should ideally be vegetated to minimise sediment loss and colonisation by alien/weed vegetation. All runoff from the topsoil stockpile should be conveyed through a sediment trap which is regularly cleaned and maintained. Clean stormwater should ideally be conveyed in grassed swales rather than cement lined channels or excavated trenches. Clean water discharge points into the environment should be protected against erosion and be subjected to regular maintenance.

- All pollution control dams must be lined and designed according to industry best practice.

Decommissioning and Closure Phase

During the decommissioning and closure phase the incline shaft will be closed and all surface infrastructures are to be removed from site. The site will be rehabilitated to approximate the current landscape profile and will be re-vegetated with locally occurring indigenous grasses. Additional mitigation measures include:

- Implement measures to manage stormwater runoff from the rehabilitated site;
- Safely introduce runoff into adjacent areas at flow velocities that will not result in erosion and scour of receiving wetland systems;
- The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed;
- All disturbed and transformed areas should be landscaped to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off where possible;
- Compacted soils should be ripped and scarified;
- The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion;
- Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately;
- The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation; and
- Sediment traps should be placed in rehabilitated areas to avoid sedimentation.

9. CONCLUSIONS & RECOMMENDATIONS

WCS Scientific (Pty.) Ltd. (WCSS), a member of the Wetland Consulting Services Group, was appointed by SRK Consulting (South Africa) (Pty.) Ltd. to undertake a wetland delineation and impact assessment to support a Water Use Licence Application being compiled for the Elders Colliery near Bethal, Mpumalanga Province. Although the Elders Colliery mine development is already approved (though not yet constructed), the Colliery requires additional activities to be authorised due to changes in the mine plan.

The project study area for this project has been defined as the surface infrastructure footprint and its immediate vicinity (500m buffer – to give effect to the GN509 Regulated Area around a wetland). Three of the 4 water uses under consideration in this study fall within the surface infrastructure area, with the fourth water use located just to the east. The study area is located within the Olifants River Catchment (Primary Catchment B), with the specific affected quaternary catchment being B11A. Catchment B11A is drained by the Olifants River and its tributaries the Viskuile, Joubertsvleispruit, Leeufonteinspruit and Vlakkuilenspruit.

Site sensitivity determined from Regional and National databases includes:

- Eastern Highveld Grassland vegetation type which is Vulnerable.
- Wetland ecosystem types are considered Critically Endangered and Not Protected.
- No FEPA wetlands within the study area.
- A CBA and ESA occurs in association with the Viskuile and Olifants Floodplain wetlands.
- The Viskuile Floodplain complex has been identified as a Priority Wetland in the Olifants Reserve.

Four different natural hyrdogeomorphic wetland types were identified on site:

- Channel
- Floodplain wetland
- Unchannelled Valley Bottom wetland
- Seep wetland

These wetlands cover approximately 116.7 hectares, which makes up 29.4 % of the study area.

The large floodplain wetland habitat associated with Viskuile and Vlakkuilenspruit confluence is in a B/C category, indicating wetland habitat that is Largely Natural to Moderately Modified. The Seep wetlands within the study area vary from Moderately Modified (category C) to Seriously Modified (category D) depending mostly on the level of direct alteration of habitat through conversion to cultivated fields.

The Viskuile wetland is considered to be of Very High Importance and Sensitivity, while the Seep wetlands vary from Low/Marginal to Moderate Importance and Sensitivity.

The Elders Colliery mine development, including the proposed surface infrastructure area, is already approved, though not yet constructed. The initial Water Use Licence (WUL) Authorisation for the Elders Colliery was received in April 2017 and amended in November 2017 (WUL No. 03/B22A/ACFGIJ/5047, File

No. 27/2/2/B111/11/1). Since issuing of the WUL, synergy has been lost with Goedehoop, to which Elders Colliery was originally envisaged to serve as a life extension project. Consequently, there have been resultant changes to project description and block plan layout for Elders Colliery.

The specific changes and activities under consideration in this report are detailed in Table 12. ***Three of these activities fall within the greater surface infrastructure footprint which has already been approved***. These activities will therefore contribute towards impacts on wetlands that were already identified and assessed as part of the WCS (2015) wetland report and authorised in the existing WUL. ***The project activities will impact on the same wetland systems as assessed in the WCS (2015) study and will do so in much the same location and to a similar extent***, though some small changes have occurred as a result of changes in the block plan layout and the proposed changes in volume associated with the project activities.

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Appendix G9: Surface Water Specialist Study

SRK CONSULTING

SPECIALIST SURFACE WATER REPORT AS INPUT TO THE EIA FOR THE PROPOSED ELDERS COLLIERY

Report No.: JW210/15/D202 – Rev 0

October 2015

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DOCUMENT APPROVAL RECORD

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Executive Summary

Anglo Operations (Pty) Ltd (AOL) intends to extract coal through underground mining operations at the proposed Elders Colliery. The No. 2 and No. 4 Seam Coal will be mined by bord and pillar mining methods. Coal will be conveyed via an overland coal conveyor between the Elders shaft and the Goedehoop Colliery Block 20, to be 8383

The proposed Elders Colliery is located to the north of Bethal and to the east of Kriel in the Mpumalanga Province. The mining area is located southeast of AOL's Goedehoop Colliery. The regional location for the site is shown in Figure 1.1(a) and a locality plan is shown in Figure 1.1(b).

SRK Consulting has been appointed by AOL to compile the necessary environmental applications for the proposed Elders Colliery. SRK have in turn appointed Jones & Wagener Engineering and Environmental Consultants (J&W) to carry out the surface water specialist study required for input into the Environmental Impact Assessment (EIA), Environmental Management Programme (EMP) and Water Use License Application (WULA).

This report details the surface water specialist study for the construction and operation of the proposed Elders Colliery.

This document supersedes the previous draft specialist surface water report, J&W report No. JW155/13/D202-RevG, dated June 2014.

Study Approach

The surface water study entails an assessment of the baseline surface water environment in the vicinity of the proposed activities. This is to characterise the surface water regime at the proposed development site and the catchment in which it resides, in terms of surface water quality and quantity.

A mine water balance model was developed to determine the quantity of water that will need to be managed at the Elders operation over the life of mine.

Thereafter an assessment of the potential impacts and mitigation of the impacts of the proposed development on the receiving water environment can be defined and addressed. The method by which the impacts are quantified is to first assess the impact assuming no mitigatory measures are applied in order to provide a "worst case" scenario. Thereafter the mitigation measures are evaluated and the residual impact indicated.

A preliminary surface water management plan, as well as a surface water monitoring programme, is provided.

Project Description

The Elders coal resource is situated in the magisterial district of Bethal, approximately 40 km south of Witbank and 15 km north of Bethal in the Mpumalanga Province. It is proposed to mine the No. 2 and No. 4 coal seams by underground bord and pillar methods.

As with existing AOL underground mining operations, it is currently planned to make use of Continuous Miners (CM) and Shuttle Cars for coal winning. The underground workings will be accessed via an incline shaft to be used for personnel, material and coal clearance.

It is projected that approximately 6 million tons of No. 2 and No. 4 seam coal will be mined annually, utilising six continuous miner (CM) sections.

Coal will be transported from the underground workings to a 9000 t surface silo using an underground conveyor network comprising section and trunk conveyors. Coal will be withdrawn from the 9000 t surface silo via a belt feeder and crushed to obtain a nominal particle size of 150 mm, which is suitable for transport on the proposed 11km overland conveyor.

The overland conveyor belt will convey the sized coal from Elders Colliery to Block 20. Block 20 is a mined out shaft, currently under care and maintenance and is located roughly half way between the proposed Elders shaft and the existing Goedehoop Colliery Plant complex. A previously existing, decommissioned overland conveyor runs between Block 20 and the Goedehoop Colliery Plant complex. This overland conveyor is to be re-established and coal transported along the proposed Elders Colliery conveyor to Block 20 will be deposited on this re-established conveyor, which will be utilised to transport the coal the remainder of the distance to the coal processing plant at Goedehoop.

The proposed overland conveyor between the proposed Elders Colliery and Goedehoop Block 20 will be constructed within a 50 m servitude. Other infrastructure planned for this servitude includes a water pipeline, service road and two 22 kV single pole power lines.

The life of mine (LOM) for the 2 Seam workings is approximately 8 years. The CM sections will start to migrate from the No. 2 Seam to the No. 4 Seam in around 2022, with all sections being deployed in the No. 4 Seam by around 2026. The planned LOM for the No. 4 Seam is also approximately 9 years, with the end of LOM at around 2030.

During construction of the boxcut, coal from the No. 2 and No. 4 seams will be transported by truck via the R35 and R542 provincial roads, to Goedehoop Colliery, where the coal will be processed.

An informal settlement, the Vlakkuilen Community, is located within the project mining right boundary. The community consists of 24 households with a total population of 124 people. The Middelkraal Community is located to the north of the Olifants River.

The majority of the households have subsistence vegetable gardens and livestock.

<u>Proposed infrastructure at the underground workings:</u>

- Shaft complex roads and parking
- Administration building (Shaft offices)
- Control room/medical facility, proto building
- Change house
- Ventilation fans and associated infrastructure
- Fire tanks
- Surface silo
- Stone dust silo
- Pollution control dams
- Sewage treatment plant
- Water treatment plant
- Topsoil stockpile
- Overburden stockpile
- Bus shelter
- Carports
- Covered shaft waiting area Lamp and crush room building
- Salvage yard
- Fencing
- Washbay and oil separator
- Security and access control
- Break test ramp
- Crusher
- Outdoor yard Substation
- Bulk fuel store
- General and Hazardous waste facilities
- Green room covered assembly

- Engineering/Mining /general store
- Paint/Oil/Gas store yard
- LDV Wash Bay
- Assembly point open area
- Cable repair workshop
- Banksman Cabin

<u>Other surface infrastructure:</u>

- Access roads
- Service roads
- Internal roads
- Two 22kV powerline
- Pipelines
- Conveyor belt

<u>Water supply</u>

Two types of water will be required on the site, namely potable water and process water. It is planned to maximise the reuse of water on site. To this end, a water treatment plant (WTP) will be constructed to treat mine water and surface runoff to the standards required for reuse. The proposed water treatment plant will comprise a filtration module as well as a reverse osmosis (RO) module.

It is proposed to supply water for the construction phase from a borehole well-field, which will be created for the purpose of the project. During operations, mine water will be recycled to supply the mine's water needs (in terms of both potable and dust suppression water). However, it is expected that there will be a deficit during the dry season of the early years of mining. It is planned to make up this deficit from the borehole well-field. Any water that the well-field is unable to supply will be imported from Goedehoop Colliery, via the planned pipeline.

Surplus dirty water from the pollution control dams (PCDs) (that cannot be treated) will be stored in underground workings at Elders, where storage will become available from 2025 onwards. Prior to 2025 there will be no storage capacity available in the underground workings and surplus water will either need to be pumped to Goedehoop Return Water Dam for reuse at the Goedehoop coal processing plant, or alternative storage will need to be made available at Elders.

<u>Waste management</u>

<u>Disposal of general, industrial, hazardous and healthcare risk waste</u>

All domestic, commercial, industrial waste, builder's rubble and other waste classified as General Waste (G) will be separated at source and temporarily stored in a designated area at the salvage yard. The storage period will be less than 90 days before removal from the site by an appropriately licensed waste removal contractor and disposed of at a licensed general waste facility.

All industrial waste, including wood, rubber, paper and re-furbishable waste (i.e. pumps, valves etc.) will be sorted and stored in designated areas. Materials that can be recycled will be re-claimed, re-used or sold to scrap metal dealers. Items such as used tyres will be taken back to the suppliers as well as oil will be returned to suppliers for re-use.

Wood may be taken to an area outside the shaft area for re-use by the community. Plastic waste (i.e. PVS, HDP, plastic containers, electrical cables) that will be generated will be removed by a licenced contractor for recycling.

All waste classified as Hazardous, including hydrocarbon or chemical contaminated waste, battery waste, recovered oil, grease, acids, fluorescent tubes, etc. will be separated at source and temporarily stored in waste skips or other specialised containers.

The storage period will be less than 90 days before removal from the site by an appropriately licensed waste removal contractor and disposed of at an appropriately licensed hazardous waste disposal facility.

Hazardous waste will be stored according to the applicable requirements under the NEM:WA and Regulations.

The storage area will, as a minimum, be paved with concrete, covered and provided with bunds and drainage facilities to collect and contain any spills or adversely affected runoff.

All healthcare risk waste, including bandages, used dressings, urine cups, used HIV kits, used needles and syringes and used urines teat strips etc. will be placed in a designated container for disposal until collected by a registered medical waste company.

Disposal of mine residue

With the exception of primary crushing, there is no coal processing or beneficiation planned for the Elders Colliery, as all processing is to be carried out at the Goedehoop Colliery Plant complex. There will therefore be no coal residue generated on the site.

Overburden from the box cut will be excavated selectively. Overburden material contaminated with acidifying carbonaceous material will be excavated and transported to a registered waste disposal area at the Goedehoop Mine Complex. The excavated hard material (without carbonaceous material) will be stockpiled and later used to backfill the mine shaft at mine closure. Approximately 1.6 Mm^3 will excavated from the box cut. Some of the uncontaminated overburden softs will be utilised to construct the berm around the shaft complex area.

Topsoil will be separated from sub soil and hard overburden and will be used to form a visual screening berm along the provincial road, as well as and to construct a berm diverting clean runoff water around the complex.Disposal of waste from the water treatment plant

At the WTP water will be treated for domestic use, as well as for dust suppression on surface and underground.

Water to be used for dust suppression will undergo pre-treatment by filtration before use, whereas the water treated by RO module will be for domestic use and will therefore be treated to a quality that will meet the current interim Resource Water Quality Objectives (RWQO) for the Olifants River.

It is expected that both liquid waste (brine) and solid waste in the form of a gypsum sludge will be generated at the WTP.

Provision has therefore been made for the following:

- Lined brine dams for the disposal of brine generated in the treatment process;
- A gypsum drying pad will be constructed for the temporary storage and drying of gypsum prior to it being collected and transported from the site. The gypsum storage area will overflow to the brine ponds via a sloping pad and channel that is concrete lined. Gypsum will be removed from the site by a licensed waste removal contractor and disposed of at an appropriately licensed waste disposal facility within an appropriate radius depending on the outcome of the waste assessment study, which is still to be concluded.

Domestic waste water management

During construction, chemical toilets will be used by the contractors and a conservancy tank will be established in the contractor's laydown area (three 6 m^3 tanks). These will be emptied regularly for disposal at an authorised off-site sewage treatment plant.

Once operational, the site will be serviced by a conventional waterborne sewerage system capable of treating typical domestic raw sewage located at the shaft complex area. Sludge generated will be disposed of on sludge drying beds for collection by suitably licensed waste contractor for off-site disposal at an appropriately licenced waste facility. The effluent will be treated to the Special Effluent Standards as published in GNR 991 on 18 May 1984, as amended, and will be jointly discharged with effluent from the WTP to the Olifants River system.

A 6 m^3 conservancy tank will be installed at the guard house at the main security entrance and will be emptied regularly for disposal at an authorised off-site sewage treatment plant.

Storm water management

An effective surface water management system will be essential to ensure efficient mining and to protect the natural water resource during the construction, operation, decommissioning and post closure phases of the mine. This will entail management of dirty water generated through the mining process (including the mine water make and run-off from mine infrastructure areas), as well as handling of clean water flowing towards the mining area.

The Olifants, Vlakkuilen and Viskuile Rivers flow through the mining area and will therefore be directly affected by the mining activities. Measures to minimise the potential impacts on the Vlakkuilen and Viskuile Rivers and in turn the Olifants River and its tributaries will thus be required.

Water management measures that are required will include the diversion of clean runoff from upstream of the infrastructure around the site, and the containment of dirty runoff from the site in pollution control dams. These measures need to be designed to accommodate events up to at least the 1:50 year event, in line with GNR 704. Storm water that is generated around the mining area will consist of clean and dirty runoff. These include:

- Clean runoff from clean catchments draining towards the mining activities and infrastructure. Measures will be implemented to ensure that significant clean catchments are diverted away from the workings. Clean water diversions and flood protection measures will be designed to accommodate at least the 1:50 year event.
- Dirty runoff will be generated at the mine infrastructure areas. Measures will be implemented to contain this runoff by directing it to the pollution control dam. The dirty water management system, including the pollution control dam, will be designed in accordance with GNR 704 to accommodate the 1:50 year event as a minimum (i.e. 2% risk of spillage) with 800 mm freeboard.

Water Balance

The objective of the water balance modelling is to estimate the volumes of water that will be generated by the proposed activities, including effluent water and surface runoff from the dirty areas. This is assessed together with the water demands on the site to determine whether the site will operate with a water surplus or deficit and to determine the storage capacity required to ensure legal compliance in terms of prevention of spills from the site. The water balance modelling is therefore a key input to the overall water management strategy for the site.

Computational Methodology

Daily rainfall data from the South African Weather Service (SAWS) rainfall stations 0478292 Langsloot and 0478303 Secunda, together with monthly evaporation data estimated from the "Surface Water Resources of South Africa 1990" (WRC, 1995), also known as WR90, were input to a hydrological model based on the Soil Conservation Services (SCS) method to determine runoff on a daily basis using antecedent conditions. The method (as adapted to South African conditions by Schmidt & Schulze) is believed to be highly suitable for the site, having been developed in catchments with areas of approximately 8 km^2, and smaller.

The underground water inflows were derived by JMA using a modelling approach developed for the Kriel / Secunda area. This involves the development of grids for which recharge rates can be computed.

Recharge and dewatering through fracturing of strata have been taken into account. These rates of inflow are then brought into the J&W model, where extreme rainfall impacts and surface water make can be assessed. The water use and storage requirements to ensure a 2% or lower risk of spilling can subsequently be computed.

The surface runoff areas were measured from layout drawings prepared by the design engineers. Water consumption information related to the mining operation was provided by AOL and the design engineers. This data was entered into the water balance model.

The overall water balance for the proposed mine was subsequently calculated.

Water management strategy

Following numerous iterations on water management options and the mine water balance, the following broad water management strategy has been adopted:

- A PCD will be provided on surface at the shaft complex (Main PCD) to accommodate storm events from the surface infrastructure area. This PCD will have a capacity of 45 Mℓ;
- A water treatment plant with a treatment capacity of initially 0.5 Mℓ/day and increasing first to 2.5 Mℓ/day and finally 5.0 Mℓ/day will be provided to treat the mine water make to supply the mine's water needs, with surplus water discharged to the Olifants River system;
- Surplus water that cannot be treated by the water treatment plant will be stored in the underground workings, when this becomes available. Prior to storage becoming available in the underground workings, surplus water will be pumped to Goedehoop Colliery;
- During dry periods and during the dry season months of the first years of mining, make-up water will be required. This will be sourced from Goedehoop Colliery;
- For the current water balance modelling it has been assumed that a volume of approximately 5 000 m^3 of water will be maintained as operational storage in the PCD at all times.

The water balance modelling described below has shown that there will be insufficient storage at Elders Colliery to accommodate the water make, even for average rainfall, prior to 2025, when mining at the No. 2 Seam will cease and the first capacity to store water underground will become available (under the current LOM plan). It is recommended that the LOM plan be re-evaluated to facilitate the early mining of low-lying areas on the No. 2 Seam, making storage capacity available timeously.

Water management for average rainfall

Current planning is to provide a 45 Mℓ pollution control dam (PCD) for the mine surface infrastructure area and the underground shaft area. Contaminated surface water runoff and excess water from the underground will be discharged to the Main PCD.

Surplus water that cannot be treated, reused or discharged to the Vlakkuilenspruit will be stored in the underground workings. Under **average rainfall** conditions, it is expected that underground storage will not be required if water can be treated to a quality that is acceptable for discharge, at a rate of 2.5 Mℓ/day from 2018 to 2022, and a rate of 5.0 Mℓ/day from 2023 onwards.

There will therefore be adequate storage and treatment capacity available throughout the life of mine to accommodate the water make for **average rainfall**.

Storage requirements for extreme rainfall

South African legislation, detailed in GNR 704 in terms of the NWA, stipulates that dirty water on mining sites needs to be contained for events up to the 1:50 year recurrence interval. The Department of Water Affairs' (DWA) Best Practice Guideline for water management defines a spill "event" as a series of spills occurring during a given 30 day period.

When determining storage requirements, it is important to understand that a particular recurrence interval does not refer to a single discrete event. For each recurrence interval there is an infinite number of events, depending on the storm duration considered. It is important to determine the appropriate storm duration to use, based on the assessment being carried out. Typically, for peak flow events, shorter duration events (< 24 hours) are considered, as these are of higher intensity and generate greater flow rates. However, for volumetric assessments (sizing of dirty water containment facilities), the duration used could be months, an entire season, or longer, as two or three months of high rainfall, for example, could raise a dam's water level to such an extent that a subsequent low recurrence interval storm could cause a spill event.

For extreme rainfall there are two considerations:

- Mine water balance management: During longer term extreme events (in the order of years), the management of the large volumes of water generated needs to be considered, in terms of available storage and reuse / treatment options;
- Surface water management: The sizing of the PCD will be driven by the storm water volumes generated on the surface infrastructure during short duration (in the order of one day to a few days) events.

The risk of spill from a PCD is a function of both dam capacity (for temporary storage of storm water runoff) and the rate at which water can be abstracted from the dam for reuse or storage elsewhere.

Although the legislation allows for the spillage of dirty water for events in excess of the 1:50 year event (2% risk of occurrence in any one year), it is Anglo American's policy to adopt a risk-based approach to determining an appropriate risk of spill.

Treatment

It is currently planned to increase the water treatment rate, as indicated above, from an initial treatment rate of 0.5 Mℓ/day, to 2.5 Mℓ/day and later to a maximum of 5.0 Mℓ/day during the operational period to manage the surplus water generated on the mine during both average and extreme rainfall conditions.

The monthly water volume in the Main PCD, modelled over the life of mine at a water treatment rate of 2 500 m^3/day indicates that under average rainfall conditions, the Main

PCD is expected to remain empty (or at operating level), even during the summer months, until around 2023, when summer inflows will begin to exceed the treatment capacity. From around 2024 it is expected that the summer inflows will exceed the dam's capacity and surplus water will need to be pumped for storage elsewhere.

Storage in the No. 2 Seam underground workings is only expected to become available in 2025, leaving a two year period where there will not be sufficient storage at the mine to accommodate the water make, even for average rainfall.

If the treatment plant capacity is increased (for the purposes of the modelling here, it has been increased to the maximum rate indicated by the design engineers, of 5.0 Mℓ/day) in 2023, then under average rainfall conditions the Main PCD is expected to remain empty (or at operating level), even during the summer months, until around 2028/29, when summer inflows will begin to exceed the treatment capacity.By this stage, storage capacity will be available in the underground workings.

Brine and gypsum sludge management

The Reverse Osmosis component of the water treatment plant will generate both a brine waste and a gypsum sludge product. The brine will be collected in brine dams and the gypsum sludge will be placed on an appropriately lined drying pad with drainage directed to the brine dam, prior to being removed from site to a licensed waste handling facility, by a licensed waste removal contractor.

Post closure water balance

Post closure the Elders surface infrastructure will be demolished and removed from the site. The shaft will be plugged with a concrete plug for safety reasons and backfilled using the material in the overburden stockpile, which will be rehabilitated and made free draining, including the pollution control dam and infrastructure areas.

Post rehabilitation, all surface runoff will be clean, and will be allowed to drain to the receiving environment.

The post closure water make is expected to amount to approximately 2 600 m^3/day. Note that post closure, recharge from the wetland area is expected to be approximately 990 m^3/day, or some 38% of the total post closure water make.

Once mining ceases, it is expected that approximately 48.7 million m^3 of storage will be available in the No. 2 and No. 4 seam workings.

The estimated time to decant, if the workings are left to fill post closure, has been estimated by JMA as 35 to 42 years.

An environmental safe water level for the workings (below decant elevation) will be determined and the water level will be maintained at or below this level by abstracting excess water via boreholes and pumping to a water treatment facility.

Baseline surface water environment

The proposed Elders Colliery is situated within the Witbank Dam catchment, which is part of the Loskop Dam catchment. The majority of the mine property is located within the quaternary sub-catchment B11A. A portion of the western section of the mine boundary, as well as the conveyor is located in B11B of the Limpopo-Olifants primary drainage region.

The site also is located within catchment management unit 8 (CMU 8).

All mining areas drain to the Olifants River. Much of the underground mining area underlies the Vlakkuilen and Viskuile Rivers and their floodplains. The mining area drains into Vlakkuilen and Viskuile River. These streams are tributaries of the Olifants River, which flows through the northern portion of the mine boundary.

The Olifants River flows into the Witbank Dam, which in turn flows into the Loskop Dam. From the Loskop Dam, the Olifants River flows through Mpumalanga and the central part of the Kruger National Park to Mozambique.

Surface water quantity

The gross MAR for quaternary sub-catchment B11A is quoted in *WR90* as 39 mm. Runoff modelling calibrated on the B1H018 (Olifants at Middelkraal) streamflow gauge gave a MAR of 43.7mm. The expected MAR for various catchments affected by the mining are small in relation to the Witbank Dam catchment.

However the impact in terms of loss in yield associated with mining at the Elders operation will be primarily due to the mine infrastructure area, which will be isolated from the catchment, as well as potential ingress to shallow underground workings below the Viskuile and Vlakkuilen wetland system.

Potential Loss of yield to the watercourses:

The potential loss of yield to the watercourses is quantified in **Table 1** below:

Table 1 Impact on Catchment yield

Location	Catchment area (km^2)	MAR Pre-mining (m^3x10^6)	Loss in MAR (m^3x10^6)	MAR during operations (m^3x10^6)	Percentage reduction (%)
Elders Mine Infrastructure (Offices, workshops, etc.) access shaft	0.83	0.03	0.03	0	100
Viskuile and Vlakkuilen Rivers upstream of Olifants River	392.3	17.16	0.39* (Max at end of LOM)	16.77	2.27
Mineral rights area	58.7	2.57	0.47	2.10	18.29
Olifants River downstream of mineral rights area	1070	46.81	0.47	46.34	1.00
Witbank Dam	3 579	125	0.47	124.53	0.38
Loskop Dam	12185	384	0.47	383.53	0.12

* Note: * Conservatively estimated by JMA Consulting

** The runoff calculations are not accurate to two decimal places. However, the values remain indicative of the magnitude of the impact.

Surface water quality

J&W were appointed by Oryx Environmental in 2005/6 to compile the Surface Water specialist report for the proposed Elders mine. This included baseline surface water sampling and hydrology, as well as a mine water balance and an interim, incomplete draft report was submitted in September 2006. The project was, however, discontinued before the impact assessment, mitigation and IWULA were completed.

Baseline water quality sampling undertaken in the 2005/6 study is out-dated, but has been included in this assessment for completeness. Updated monthly sampling over a 12 month period (i.e. from Aug 2012 to July 2013) was carried out. The baseline surface water quality monitoring programme has been expanded to include 19 locations, consisting of 6 locations along the conveyor and 13 located where streams enter and leave the mine boundary. Each location was sampled 12 times, being once a month over a period of one year.

The proposed Elders Colliery falls within the Olifants River water management area, and within the MU 8 management unit. The results of the water quality monitoring undertaken at the proposed development site were compared to the interim RWQO for MU 8.

The 2005/6 results show that in terms of pH levels,the monitoring locations are compliant with the interim RWQO. However, the updated 2013 results indicate a very high pH of above 8.4 for the two pans, along the Olifants River, Vlakkuilen and Viskuile Rivers Leeufontienspruit, as well as around the project This may be due to farming activities in the surrounding area that have expanded over the last 5 to 7 years.

For Sulphates, the 2005/6 results show that along the Olifants River elevated sulphates were found. Current studies show the same, with elevated concentrations of sulphates found at both pans, along the Olifants River, Vlakkuilen and Viskuile Rivers, Leeufontienspruit, as well as around the project area. This baseline water quality indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

Similarly to Sulphates the EC levels in the 2005/6 results show that along the Olifants River, as well as along Leeufonteinspruit, elevated levels of EC were found. Current studies show the same with elevated levels of EC at similar locations to those where elevated SO_4 was found (i.e. both pans, along the Olifants River, Vlakkuilen and Viskuile Rivers as well as around the mining area.The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

In general, the 2005/6 results show elevated iron, aluminium and manganese concentrations in the Olifants River. The current study indicate iron concerntrations below or at this level, or slightly elevated (but below 2 mg/ℓ).Highly elevated iron concentrations were noted in both pans.

For aluminium and manganese concentrations, current studies show the same as the 2005/6 study, with elevated aluminium and manganese concentrations along the Olifants River, Vlakkuilen and Viskuile Rivers, as well as around the mining area. Elevated alumium under the current results were also elevated in the pans and Leeufontienspruit.

The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

The current study also shows high counts of Total coliforms when comparing the results to South African Water Quality Guidelines for domestic use (2nd Edition 1996) along the Olifants River, Vlakkuilen and Viskuile Rivers, as well as around the project area, which may be attributed to cattle farming in the area.

Analysis of the other constituents indicates the following for catchment MU 8:

- In both pans elevated concentrations of TDS, Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg) and Sodium (Na) were observed. These elevated concentrations may be due to farming activities in the area.
- In pan (ESW01) elevated concentrations of Potassium (K) were observed, which may be due to farming activities in the area.
- Around the Elders mine boundary, elevated levels of TDS, Chloride (Cl), Fluoride (F), Calcium (Ca), Sodium (Na) and Magnesium (Mg) were observed. These elevated concentrations may be due to a combination of mining activities in the area, as well as farming activities.

Impact Assessment

The surface water impact assessment is detailed in Chapter 8. A summary table of impacts is included overleaf.

Cumulative impacts

The proposed Elders Colliery project's area of surface disturbance will be very small in relation to the other activities in the area that could potentially impact on surface water. Such activities include other mining operations both upstream and downstream of Elders Colliery. There are numerous coal mines in the Olifants River catchment, with mining being most intensive downstream of the Elders. In addition, surrounding agricultural activities also potentially impact on the water quality and quantity in the catchment.

In terms of the Significance on Socio-economic and Biodiversity aspects, impacts would be due to the deterioration of water quality, as discussed in the impact assessment, that would result in health impacts in local communities, as well as reductions in certain plant and animal species that are sensitive to elevated sulphates and pH, etc.

The impact, if not mitigated, is considered HIGH. Mitigation would include a social management plan and biodiversity management plan to be put in place (which will be covered by the respective specialists), together with the mitigation measures detailed in this document. After mitigation, would be considered MEDIUM to LOW.

The cumulative impact of the Elders mining operation, with the mitigation measures described in the impact assessment, is therefore considered to be small in relation to the current and anticipated future activities in the area. The cumulative impact of all of the coal mines in the area has, however, resulted in a regional crisis in terms of water quality and quantity. Every new mine contributes to the further reduction and / or deterioration of the water resources in the Mpumalanga region and it is essential that good water management be implemented at the Elders operations to prevent further contributions to the existing impacts in the catchment.

The treatment and discharge of clean water at the Elders Colliery will have a positive impact on both surface water quality and quantity. The annual flow in the Olifants River will be increased by an estimated 1.4% through the discharge of treated water. This will help to mitigate the loss of yield during the operational period, but also the loss of yield due to other mining and agricultural activities in the catchment. In addition, the good quality of the water will have a dilution effect (albeit a small one), potentially improving the water quality in the Olifants River.

Surface water impact assessment – summary table

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
PRE-CONSTRUCTION AND CONSTRUCTION PHASE										
Mine surface infrastructure and conveyor	Construction camps, construction works, movement of materials and construction equipment	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*
Initial boxcut and incline shaft development	Removal of material from the boxcut and incline shaft	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*
	Dewatering of water ingress to boxcut and incline shaft	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Mine surface infrastructure , incline shaft, boxcut area and conveyor	Construction camps, construction works, movement of materials and construction equipment, excavation of boxcut and incline shaft	Water Quantity	Before Management							
			Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*
			After Management							
			Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*
OPERATIONAL PHASE										
Mine w		Wat	Before Management							

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
	Discharge of mine water to the natural watercourse		*Major*	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*High*
			After Management							
			Moderate	*Medium term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
Mine surface infrastructure	Access shaft area, workshops, offices and related infrastructure	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*High*
			After Management							
			Moderate	*Medium term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
Ablution facilities and sewage treatment plant	Handling, disposal and treatment of sewage	Water quality	Before Management							
			Moderate	*Medium term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Medium term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Pollution control dams	Storage of polluted water	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Possible***	***High***	-	*High*
			After Management							
			Moderate	*Short term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
Dust and fire suppression	Dust and fire suppression with contaminated water	Water quality	Before Management							
			Minor	*Short term*	*Site*	***Low***	***Possible***	***Low***	-	*High*
			After Management							

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Water treatment plant	Operation of the water treatment plant, treatment of contaminated mine water	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Possible***	***High***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*
	Handling and storage of brine and gypsum	Water quality	Before Management							
			Moderate	*Long term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*
	Discharge of treated water to the Olifants River	Water quality	Before Management							
			Moderate+	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
			After Management							
			Moderate+	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
Conveyance of coal	Transport of coal by road (initially) and conveyor from Elders operation Goedehoop Colliery	Water quality	Before Management							
			Moderate	*Long Term*	*Site*	***Medium***	***Definite***	***Medium***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*
Dirty Water Pipeline	Pumping of water from Goedehoop Colliery to Elders Colliery as make-up water	Water quality	Before Management							
			Major	*Long Term*	*Regional*	***High***	***Possible***	***High***	-	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
			After Management							
			Moderate	*Long term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
Consequence of extreme floods	Flooding of mine or mine infrastructure during extreme flood events	Water quality and quantity	Before Management							
			Moderate	*Long term*	*Site*	***Medium***	***Unlikely***	***Medium***	-	*High*
			After Management							
			Minor	*Medium term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Elders Operation	Isolation of dirty catchment – Impact on watercourses	Water quantity	Before Management							
			Moderate	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*Medium*
			After Management							
			Minor	*Long term*	*Site*	***Low***	***Definite***	***Low***	-	*Medium*
Water Treatment Plant	Discharge of treated water to the Olifants River	Water quantity	Before Management							
			Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*
			After Management							
			Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*
DECOMMISSIONING AND CLOSURE PHASE										
General decommissioning and rehabilitation	Construction camps, construction (demolition) works, movement of materials and	Water quality	Before Management							
			Moderate	*Short term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
	construction equipment									
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Water management infrastructure	Decommissioning and rehabilitation of water management infrastructure	Water quality	Before Management							
			Moderate	*Short term*	*Regional*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Mine water balance	Recovery of water levels and possible decant	Water quality	Before Management							
			Moderate	Medium term	Regional	***Medium***	***Definite***	***Medium***	-	High
			After Management							
			Minor	Medium term	Site	***Low***	***Possible***	***Low***	-	High
POST CLOSURE PHASE										
Potential for acid mine drainage (AMD) and poor quality		Water quality	Before Management							
			Major	Long Term	Regional	***High***	***Definite***	***High***	-	High
			After Management							
			Minor	Long term	Regional	***Medium***	***Unlikely***	***Low***	-	High

Conclusion

The water balance modelling indicates the following:

- The currently planned PCD capacity of 45 000 m^3 with a treatment capacity of 2.5 Mℓ/day, increasing to 5.0 Mℓ/day not later than 2023, is sufficient to prevent spillage for average rainfall.
- During long term extreme rainfall events, alternative storage will need to be provided in the period prior to 2025, when the 2 Seam mining is completed and the 2 Seam becomes available for storage. It is currently planned to pump the surplus water to Goedehoop Colliery.
- Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the 2 Seam, surplus water will be stored in the underground workings at Elders. The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.
- Legal compliance in terms of the NWA and GNR 704 can therefore be achieved with the currently proposed water management strategy.

The water balance will need to be refined as the mine design develops and the results presented here should be viewed as preliminary, for input to the mine design process.

The following conclusions can be drawn from the surface water study:

- All dirty water generated on the site will be directed to the PCD and reused in the mining operations, with surplus treated water being discharged to the Olifants River.
- Surface water impacts from the site can be effectively mitigated by applying best practice water management principles.
- The success of surface water impact management will be judged on the basis of successful prevention of spills from the site.

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APPENDICES

Appendix A

FLOODLINE DRAWINGS

Appendix B

WATER QUALITY RESULTS

List of Tables

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Abbreviations used

AAIC	**A**nglo **A**merican **I**nyosi **C**oal
BEE	**B**lack **E**conomic **E**mpowerment
BEEH	**B**io-resources **E**ngineering and **E**nvironmental **H**ydrology
BPG	**B**est **P**ractise **G**uidelines
CM	**C**ontinuous **M**iner
DNWRP	**D**irectorate **N**ational **W**ater **R**esource **P**lanning
DM	**D**istrict **M**unicipality
DMR	**D**epartment of **M**ineral **R**esources
DRH	**D**irect **R**un-off **H**ydrograph
DTM	**D**igital **T**errain **M**odel
DWS	**D**epartment of **W**ater and **S**anitation
DWAF	**D**epartment of **W**ater **A**ffairs and **F**orestry
DWF	**D**ry **W**eather **F**low
EC	**E**lectrical **C**onductivity
EIA	**E**nvironmental **I**mpact **A**ssessment
EIR	**E**nvironmental **I**mpact **R**eport
EMP	**E**nvironmental **M**anagement **P**rogram
EMPR	**E**nvironmental **M**anagement **P**rogram **R**eport
ERA	**E**nvironmental **R**isk **A**ssessment
FCT	**F**lexible **C**onveyor **T**rain
GA	**G**eneral **A**uthorisation
GN	**G**overnment **N**otice
GNR	**G**overnment **N**otice **R**egulation
HCV	**H**igh **C**alorific **V**alue
HDPE	**H**igh **D**ensity **P**oly**e**thylene
ICFR	**I**nstitute for **C**ommercial **F**orestry **R**esearch
IWULA	**I**ntegrated **W**ater **U**se **L**icence **A**pplication
IWWMP	**I**ntegrated **W**ater and **W**aste **M**anagement **P**lan
J&W	**J**ones **&** **W**agener
MDEDET	**M**pumalanga **D**epartment of **E**conomic **D**evelopment, **E**nvironment and **T**ourism
LCV	**L**ow **C**alorific **V**alue
LM	**L**ocal **M**unicipality
mamsl	**m**etres **a**bove **m**ean **s**ea **l**evel
MAP	**M**ean **A**nnual **P**recipitation
MAR	**M**ean **A**nnual **R**unoff
MU	**M**anagement **U**nit
NDA	**N**ational **D**epartment of **A**griculture
NEMA	**N**ational **E**nvironmental **M**anagement **A**ct

NEM:WA	**N**ational **E**nvironmental **M**anagement: **W**aste **A**ct
NWA	**N**ational **W**ater **A**ct, 1998 (Act 36 of 1998)
PCD	**P**ollution **C**ontrol **D**am
PP	**P**ublic **P**articipation
RDF	**R**ecommended **D**esign **F**lood
RMF	**R**egional **M**aximum **F**lood
RO	**R**everse **O**smosis
ROM	**R**un **O**f **M**ine
RWQO	**R**esource **W**ater **Q**uality **O**bjectives
SANCOLD	**S**outh **A**frican **N**ational **C**ommission **o**n **L**arge **D**ams
SAWS	**S**outh **A**frican **W**eather **S**ervice
SDF	**S**tandard **D**esign **F**lood
SEF	**S**afety **E**valuation **F**lood
SS	**S**uspended **S**olids
t	Metric **t**onne
TDS	**T**otal **D**issolved **S**olids

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SRK CONSULTING

SPECIALIST SURFACE WATER REPORT AS INPUT TO THE
EIA FOR THE PROPOSED ELDERS COLLIERY

REPORT NO: JW210/15/D202 – Rev 0

1. INTRODUCTION

1.1 Background

Anglo Operations (Pty) Ltd (AOL) intends to extract coal through underground mining operations at the proposed Elders Colliery. The No. 2 and No. 4 Seam Coal will be mined by bord and pillar mining methods. Coal will be conveyed via an overland coal conveyor between the Elders shaft and the Goedehoop Colliery Block 20, to be processed at the existing Goedehoop processing plant.

The proposed Elders Colliery is located to the north of Bethal and to the east of Kriel in the Mpumalanga Province. The mining area is located southeast of AOL's Goedehoop Colliery. The regional location for the site is shown in **Figure 1.1(a)** and a locality plan is shown in **Figure 1.1(b)**.

SRK Consulting has been appointed by AOL to compile the necessary environmental applications for the proposed Elders Colliery. SRK have in turn appointed Jones & Wagener Engineering and Environmental Consultants (J&W) to carry out the surface water specialist study required for input into the Environmental Impact Assessment (EIA), Environmental Management Programme (EMP) and Water Use License Application (WULA).

This report details the surface water specialist study for the construction and operation of the proposed Elders Colliery.

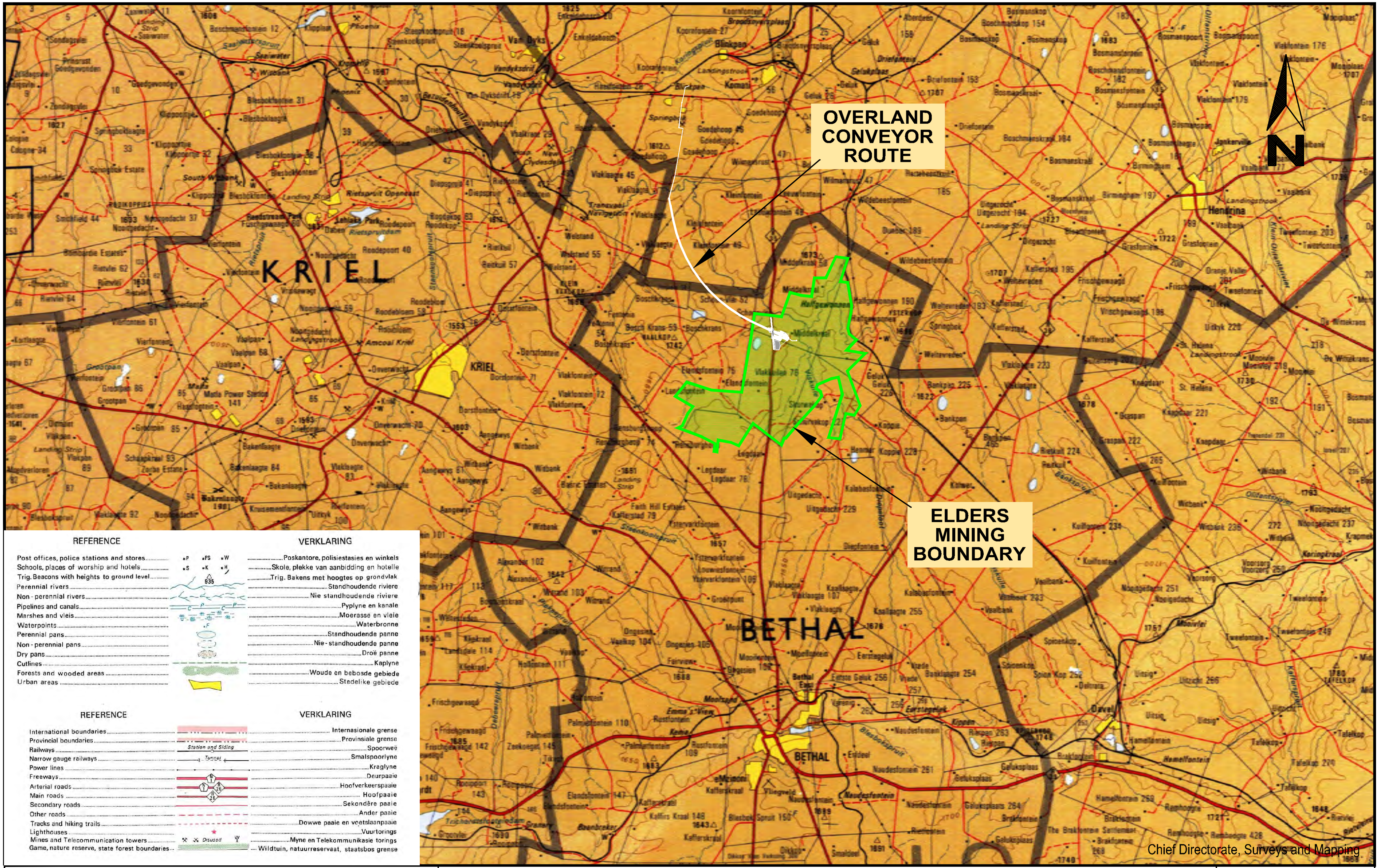
This document supersedes the previous draft specialist surface water report, J&W report No. JW155/13/D202-RevG, dated June 2014.

1.2 Terms of reference

The terms of reference for the specialist surface water study are summarised below.

The project involves the compilation of a specialist surface water report, IWULA and IWWMP for the proposed mine and conveyor.

Specific components to be addressed include the following:



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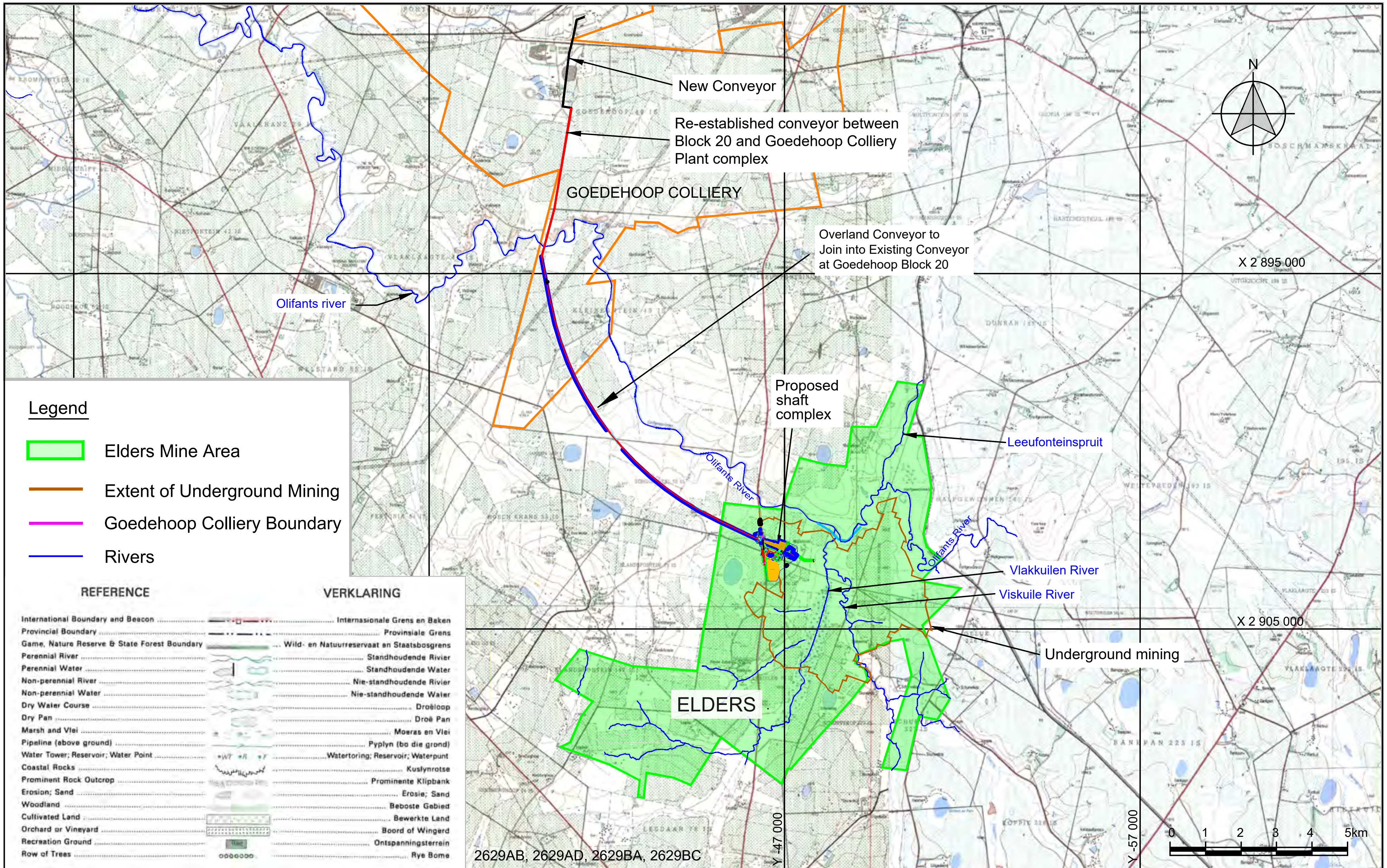
SRK Consulting
Elders Colliery

REGIONAL LOCATION

CO-ORDINATE SYSTEM
CLARKE 1880 Lo29
2629AB, 2629AD, 2629BA, 2629BC

Ø: D202/10

Figure 1.1(a)



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SRK Consulting
Elders Colliery

LOCALITY PLAN

CO-ORDINATE SYSTEM
CLARKE 1880 Lo29

Ø: D202/10

Figure 1.1(b)

1.2.1 Baseline assessment

The objective of the baseline study is to characterise the surface water regime at the site and the catchments in which it resides in terms of surface water quality and quantity.

Please note that the surface water study does not include the delineation of sensitive areas such as pans and wetlands, or the assessment of aquatic ecology. This information will be included in separate specialist studies.

1.2.2 Site water management

A review of surface water management aspects in terms of the environmental legislation, with surface water input to the environmental applications for the proposed mine, as well as the formulation of a preliminary surface water management plan for the site.

1.2.3 Water and salt balance for the mine

Compilation of a site water and salt balance and water balance flow diagram for proposed mine.

1.2.4 Impact assessment

Assessment of the impact of the project and its components on surface water in the area, in terms of both water quality and water quantity.

Formulation of proposed mitigation measures for significant impacts, as well as monitoring required to measure the success of the mitigation measures.

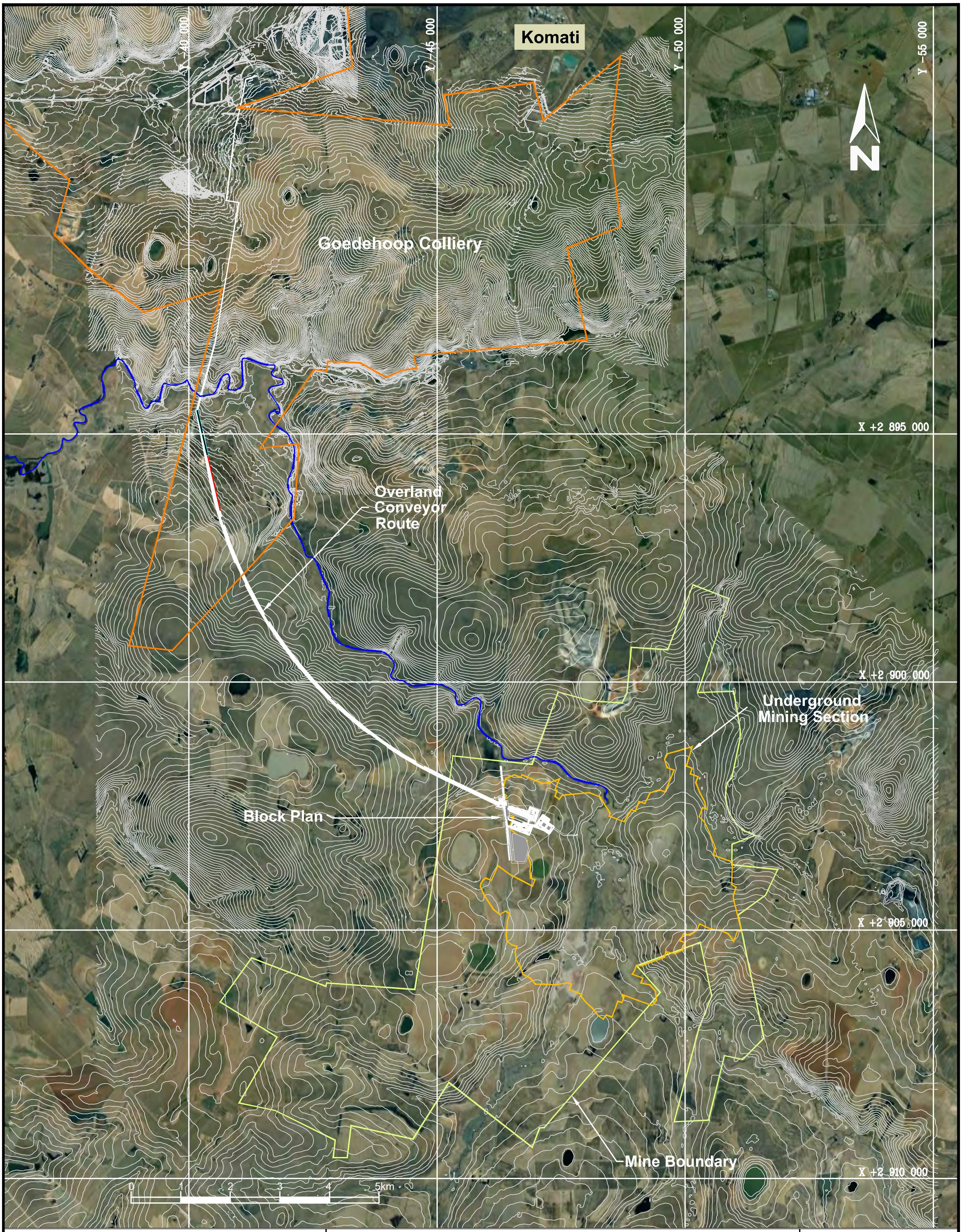
1.3 Study area

The study area is indicated on **Figure 1.3(a)** with the Life of Mine Plan shown in **Figure 1.3(b)**. The study area covers the area enclosed by the proposed mineral reserve boundary, as well as a servitude, 50 m in width, between the proposed Elders Colliery and Goedehoop Colliery Block 20, which will house a conveyor belt, service road, water pipeline and two 22 kV powerlines.

1.4 Approach and methodology

The following actions were taken as part of the surface water specialist study for this project:

- Information received from Anglo Operations (Pty) Ltd (AOL), Hatch Goba (Pty) Ltd (the civil design consultant) and the SRK Consulting (the lead environmental consultant) was reviewed and relevant issues noted.
- Rainfall data was obtained from the Institute for Commercial Forestry Research (ICFR) database and the South African Weather Service (SAWS) and processed for use in the hydrological calculations and water balance modelling.
- Topographical maps and satellite imagery (Google Earth) were reviewed to assess catchment conditions and to delineate the catchments within the study area.
- Peak flood flows at relevant locations within the study area were estimated for various recurrence intervals using a number of methodologies applicable to South African conditions.



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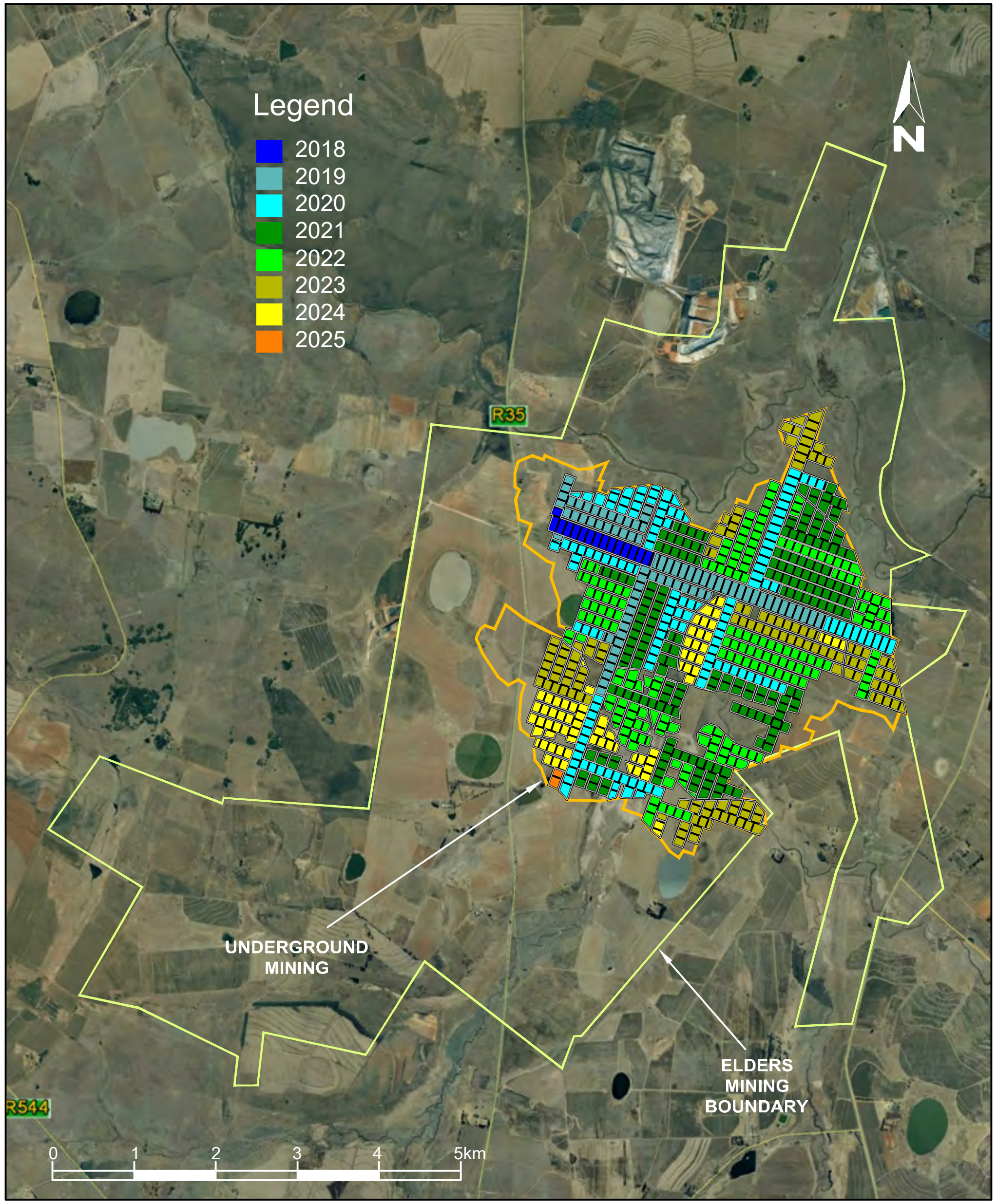
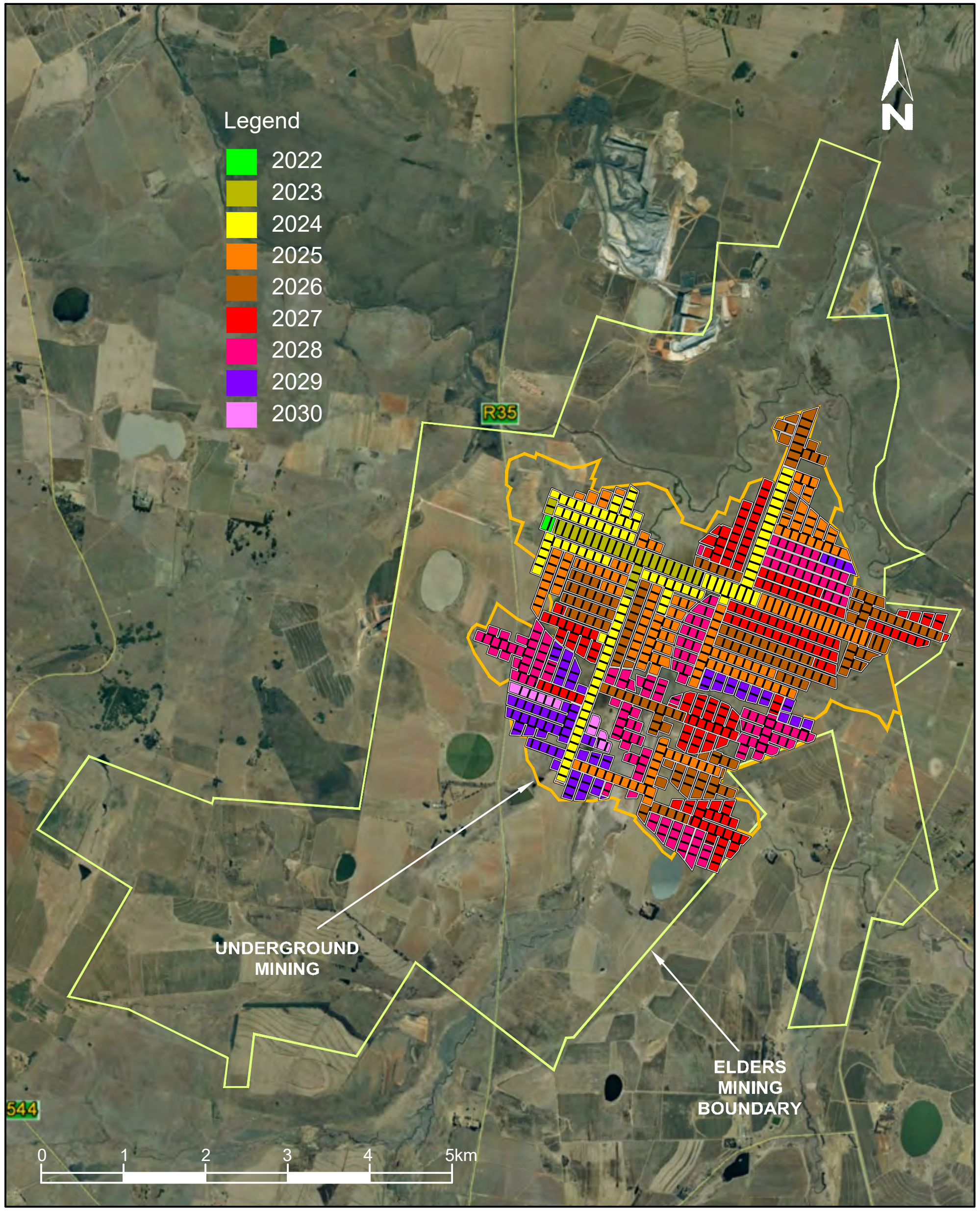
STUDY AREA

Ø: D202/10

Figure 1.3(a)



LOM PLAN FOR 2 SEAM



LOM PLAN FOR 4 SEAM

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SRK Consulting
Elders Colliery

LIFE OF MINE PLAN FOR ELDERS 2 AND 4 SEAM

Ø:D202/10

Figure 1.3 (b)

- Mean annual runoff and dry weather flows were determined using the WRSM2000 (Pitman) synthetic streamflow generation model. The output was used to determine the impact of the project on catchment yield.
- A site-specific water and salt balance model was developed to:
    - Estimate the site water surplus/ deficit, water make-up requirements and surplus water generation.
    - To assess the storage capacity of the proposed pollution control dams, required to prevent spillage of dirty water from the site.
    - Estimate the expected water quality on the mine over the life of mine.
- Input was provided to the project team on the overall water management strategy for the proposed mine.
- Conceptual design drawings compiled by Hatch Goba (Pty) Limited (Hatch) were reviewed and input provided in terms of the following:
    - Legislative compliance in terms of water and waste management
    - Best Practice in terms of water management
    - DWS requirements for Water Use License Applications.
- The potential impacts associated with the proposed project were assessed according to the methodology stipulated by the lead environmental consultant. Impacts were assessed for the construction, operational, decommissioning and post closure phases. Potential impacts were detailed, then mitigation measures described, with residual impacts then being assessed.
- Surface water monitoring was undertaken and a water quality monitoring programme for the site was compiled. The water quality data collected was then assessed against the interim Resource Water Quality Objectives (RWQO) guideline values for the relevant catchment management unit (CMU).

2. LEGISLATIVE ASPECTS

2.1 Regulatory Requirements

A detailed legal assessment is discussed in the main Environmental Impact Report (EIR) compiled by SRK Consulting. The Acts and Regulations that pertain to the surface water for mining projects include:

- The Constitution of the Republic of South Africa (Act 108 of 1996).
- The National Water Act, Act 36 of 1998 (hereafter referred to as NWA).
- The National Environmental Management Act, Act 107 of 1998 (hereafter referred to as NEMA).
- National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA).
- Government Notice Regulations (GNR) 704 of 4 June 1999: Regulation on use of water for mining and related activities aimed at the protection of water resources (hereafter referred to as GNR 704).
- Government Notice (GN) R139 of 24 February 2012: Regulations regarding the safety of dams in terms of Section 123(1) of the NWA.
- Government Notice (GN) R991 of 18 May 1984: Requirements for the purification of waste water or effluent.
- Government Notice (GN) R399 of March 2004: General Authorisations in terms of the NWA.
- GN 1199 of December 2009: Replacement of General Authorisation in terms of Section 39 of the NWA: S21(c) and (i) water uses
- Government Notice (GN) R982 to 985 of December 2014:Environmental Impact Assessment Regulations and Listing Notices in terms of NEMA.
- Government Notice (GN) R636 of August 2013: National norms and standards for disposal of waste to landfill, in terms of NEM:WA.

2.2 Applicable policies and/or guidelines

The following DWS (Former DWA) Best Practice Guideline documents are relevant to this project:

- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A2: Water Management for Mine Residue Deposits, July 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A4: Pollution Control Dams, August 2007
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A6: Water Management for Underground Mines, July 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G1: Storm Water Management, August 2006
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G2: Water and Salt Balances, August 2006
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G3: Water Monitoring Systems, July 2007

- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G4: Impact Prediction, December 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G5: Water Management Aspects for Mine Closure, December 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H1: Integrated Mine Water Management, December 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H2: Pollution Prevention and Minimization of Impacts, July 2008
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H3: Water Reuse and Reclamation, June 2006

3. DETAILS OF THE APPLICANT AND ENVIRONMENTAL ASSESSMENT PRACTITIONER

3.1 Information from EIA application form

Project applicant:	Anglo Operations Proprietary Limited
Trading name (if any):	Anglo Operations (Pty) Limited (AOL)
Physical address:	55 Marshall Street, Johannesburg
Postal address:	Private Bag X1, Marshalltown, Johannesburg
Postal code:	2017

3.2 Details of the surface water specialists

SRK Consulting was appointed by AOL as the Environmental Assessment Practitioner to conduct the EIA for the proposed Elders Colliery.

J&W were appointed as sub-consultants to address the surface water components of the EIA. Details of the J&W project team members and their experience are provided in **Table 3.2(a)**.

Table 3.2(a) J&W team members and relevant experience

Jones & Wagener (Pty) Ltd			
Postal address:	P.O. Box 1434, Rivonia, 2128		
Tel:	(011) 519 0200		
Fax	(011) 519 0201		
Project team members			
Name	**email address**	**Experience**	**Responsibility**
Malini Moodley	moodley@jaws.co.za	Pr Eng, BSc Eng GDE Civil (Water, Environmental) 8 years experience	Review of surface water quantity baseline assessment Impact Assessment
Michael Palmer	palmer@jaws.co.za	Pr Eng, MSc Eng Civil (Water, Environmental) 17 years experience	Review of surface water specialist report Water Balance iterations Review of Impact assessment
Tolmay Hopkins	tolmay@jaws.co.za	MSc (Agric) Microbiology; 17 years experience in water and waste management	Review of surface water quality baseline assessment Surface water users

4. DESCRIPTION OF THE PROJECT

The overall project is described in the main EIA document, compiled by the lead environmental consultant. Aspects relevant to the surface water component are detailed in the sections that follow.

4.1 Project location

The proposed Elders Colliery project is located in the Mpumalanga Province, approximately 20 km north of the town of Bethal. The regional location and a locality plan is shown on **Figures 1.1(a)** and **(b)**. The proposed mine falls within the Gert Sibande District Municipality and the Govan Mbeki Local Municipality, as well as the Nkangala District Municipality and the Stever Tshwete Local Municipality. The closest towns to the proposed Elders Colliery are listed in **Table 4.1(a)**.

Table 4.1(a) Towns surrounding the proposed Elders Colliery

Town	Approximate distance (km)	Direction
Kriel	12	West
Bethal	20	South
Hendrina	30	North west
eMalahleni	55	North-north west
Middelburg	47	North

4.2 General description

The Elders coal resource is situated in the magisterial district of Bethal, approximately 40 km south of Witbank and 15 km north of Bethal in the Mpumalanga Province. It is proposed to mine the No. 2 and No. 4 coal seams by underground bord and pillar methods.

As with existing AOL underground mining operations, it is currently planned to make use of Continuous Miners (CM) and Shuttle Cars for coal winning. The underground workings will be accessed via an incline shaft to be used for personnel, material and coal clearance.

It is projected that approximately 6 million tons of No. 2 and No. 4 seam coal will be mined annually, utilising six continuous miner (CM) sections.

Coal will be transported from the underground workings to a 9000 t surface silo using an underground conveyor network comprising section and trunk conveyors. Coal will be withdrawn from the 9000 t surface silo via a belt feeder and crushed to obtain a nominal particle size of 150 mm, which is suitable for transport on the proposed 11km overland conveyor.

The overland conveyor belt will convey the sized coal from Elders Colliery to Block 20. Block 20 is a mined out shaft, currently under care and maintenance and is located roughly half way between the proposed Elders shaft and the existing Goedehoop Colliery Plant complex. A previously existing, decommissioned overland conveyor runs between Block 20 and the Goedehoop Colliery Plant complex. This overland conveyor is to be re-established and coal transported along the proposed Elders Colliery conveyor to Block 20 will be deposited on this re-established conveyor, which will be utilised to transport the coal the remainder of the distance to the coal processing plant at Goedehoop.

The proposed overland conveyor between the proposed Elders Colliery and Goedehoop Block 20 will be constructed within a 50 m servitude. Other infrastructure planned for this servitude includes a water pipeline, service road and two 22 kV single pole power lines.

The life of mine (LOM) for the 2 Seam workings is approximately 8 years. The CM sections will start to migrate from the No. 2 Seam to the No. 4 Seam in around 2022, with all sections being deployed in the No. 4 Seam by around 2026. The planned LOM for the No. 4 Seam is also approximately 9 years, with the end of LOM at around 2030.

During construction of the boxcut, coal from the No. 2 and No. 4 seams will be transported by truck via the R35 and R542 provincial roads, to Goedehoop Colliery, where the coal will be processed.

An informal settlement, the Vlakkuilen Community, is located within the project mining right boundary. The community consists of 24 households with a total population of 124 people. The Middelkraal Community is located to the north of the Olifants River.

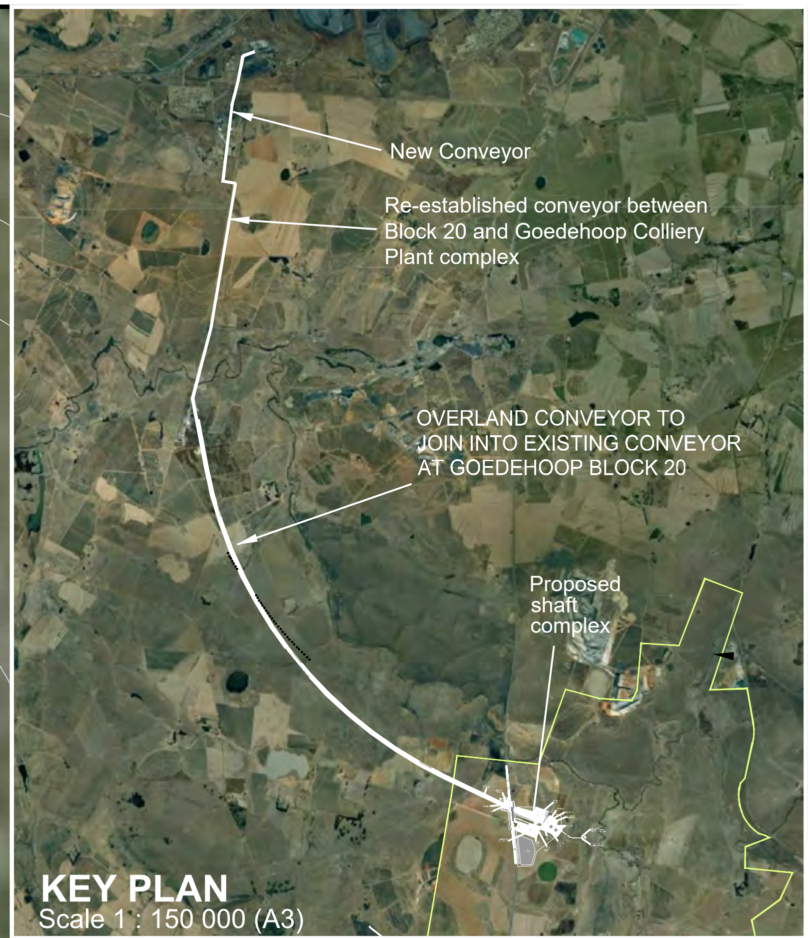
The majority of the households have subsistence vegetable gardens and livestock.

4.3 Surface infrastructure

Elders Colliery is a new mine, therefore there is no mining-related infrastructure currently in the project area.

4.3.1 Site layout

The proposed site layout is shown in **Figure 4.3.1(a)**. The project will involve the construction of the following facilities:



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SRK Consulting
Elders Colliery

Scale 1 : 25 000 (A3)

Job No: D202-10

PROPOSED INFRASTRUCTURE LAYOUT FOR THE ELDERS COLLIERY PROJECT

Figure 4.3.1(a)

4.3.1.1. Proposed infrastructure at the underground workings:

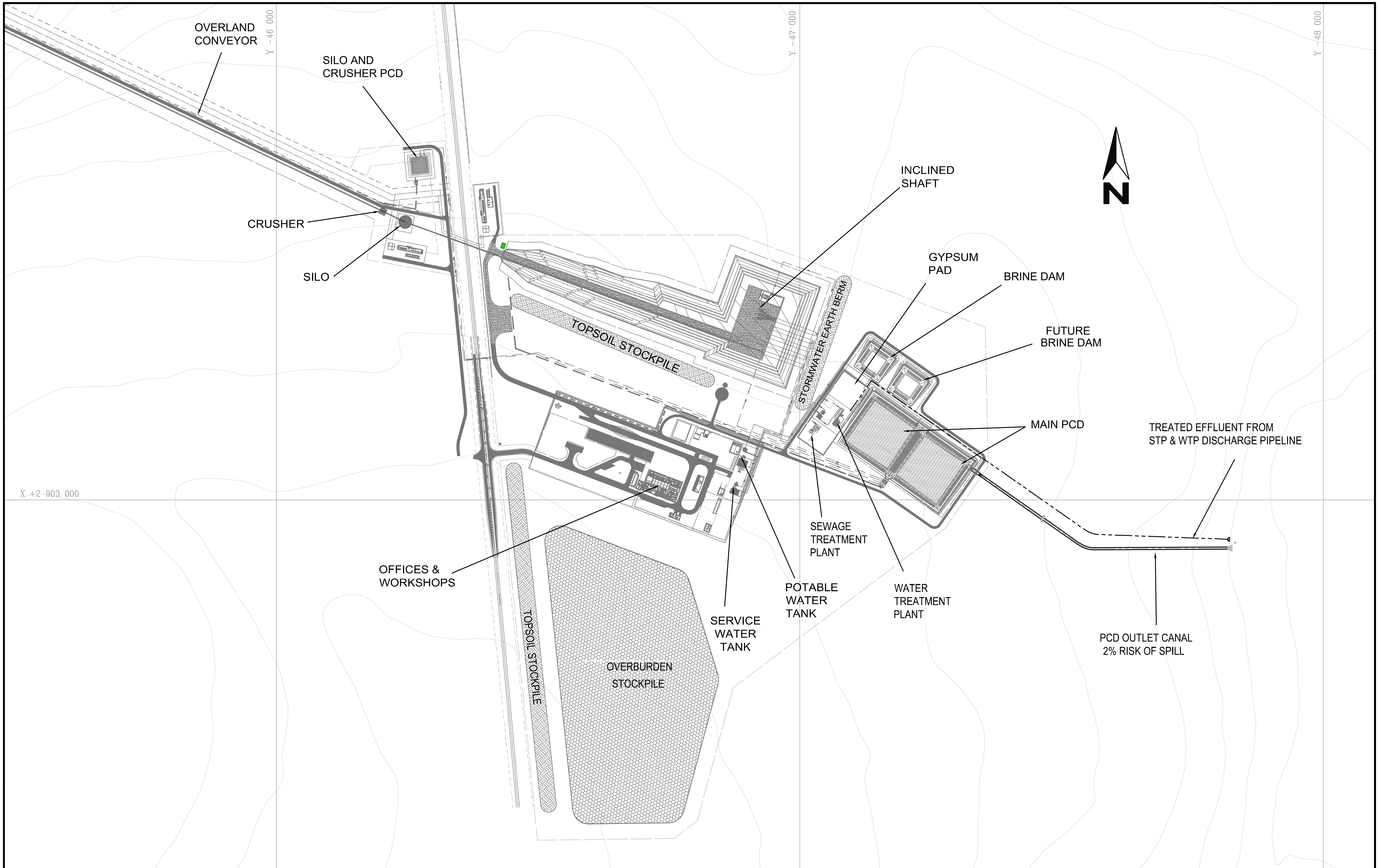
- Shaft complex roads and parking
- Administration building (Shaft offices)
- Control room/medical facility, proto building
- Change house
- Ventilation fans and associated infrastructure
- Fire tanks
- Surface silo
- Stone dust silo
- Pollution control dams
- Sewage treatment plant
- Water treatment plant
- Topsoil stockpile
- Overburden stockpile
- Engineering/Mining /general store
- Paint/Oil/Gas store yard
- LDV Wash Bay
- Bus shelter
- Carports
- Covered shaft waiting area Lamp and crush room building
- Salvage yard
- Fencing
- Washbay and oil separator
- Security and access control
- Break test ramp
- Crusher
- Outdoor yard Substation
- Bulk fuel store
- General and Hazardous waste facilities
- Green room covered assembly
- Assembly point open area
- Cable repair workshop
- Banksman Cabin

4.3.1.2. Other surface infrastructure:

- Access roads
- Service roads
- Internal roads
- Two 22kV powerline
- Pipelines
- Conveyor belt

4.3.2 Project schedule

Elders Colliery project schedule will be divided into three phases, namely construction, operation and closure. The Block plan for the Shaft complex is shown in **Figure 4.3.2(a)**. **Figure 4.3.2(b)** provides a breakdown of the various phases, activities and time frames.



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PROPOSED SHAFT COMPLEX BLOCK PLAN

Ø:D202/10

Figure 4.3.2 (a)

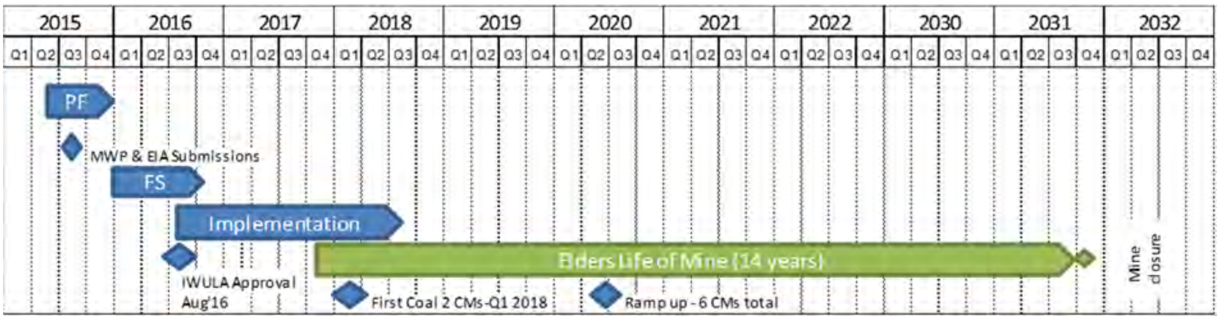


Figure 4.3.2(b) Proposed Schedule for the Elders Colliery project

4.3.3 Sources of water

Two types of water will be required on the site, namely potable water and process water. It is planned to maximise the reuse of water on site. To this end, a water treatment plant (WTP) will be constructed to treat mine water and surface runoff to the standards required for reuse. The proposed water treatment plant will comprise a filtration module as well as a reverse osmosis (RO) module.

It is proposed to supply water for the construction phase from a borehole well-field, which will be created for the purpose of the project. During operations, mine water will be recycled to supply the mine's water needs (in terms of both potable and dust suppression water). However, it is expected that there will be a deficit during the dry season of the early years of mining. It is planned to make up this deficit from the borehole well-field. Any water that the well-field is unable to supply will be imported from Goedehoop Colliery, via the planned pipeline.

Surplus dirty water from the pollution control dams (PCDs) (that cannot be treated) will be stored in underground workings at Elders, where storage will become available from 2025 onwards. Prior to 2025 there will be no storage capacity available in the underground workings and surplus water will either need to be pumped to Goedehoop Return Water Dam for reuse at the Goedehoop coal processing plant, or alternative storage will need to be made available at Elders.

4.3.3.1. <u>Potable water</u>

Potable water will be required for domestic use at the mine. This will include supply to the workshops, offices and change houses. Potable water will be sourced from the RO module of the WTP.

4.3.3.2. <u>Process water</u>

Process water will be required as supply to the CMs, conveyor and wash bays, as well as for fire and dust suppression.

Service water for the CMs, as well as to the wash bays, for dust and fire suppression on the conveyors and general surface dust suppression will be sourced from the pre-treatment (filtration) module of the WTP.

4.4 Solid waste – water management

Solid waste has the potential to impact on surface water through contaminated runoff and seepage. The waste management proposed for the site is discussed below. The following sources will generate waste on the site:

- Offices
- Workshops
- Water treatment plant
- Mining operations.

It is anticipated that both hazardous and general waste will be produced.

4.4.1 Disposal of general waste

All domestic, commercial, industrial waste, builder's rubble and other waste classified as General Waste (G) will be separated at source and temporarily stored in a designated area at the salvage yard. The storage period will be less than 90 days before removal from the site by an appropriately licensed waste removal contractor and disposed of at a licensed general waste facility.

There will be capacity to store a maximum of 132 m^3 of general waste in waste bins during the life of the project. The phasing of the bins is planned as follows:

- During the construction phase: 6 x 6 m^3 bins
- During the operational phase: 22 x 6 m^3 bins.

4.4.2 Disposal of industrial waste

All industrial waste, including wood, rubber, paper and refurbishable waste (i.e. pumps, valves etc.) will be sorted and stored in designated areas. Materials that can be recycled will be re-claimed, re-used or sold to scrap metal dealers. Items such as used tyres will be taken back to the suppliers as well as oil will be returned to suppliers for re-use.

Wood may be taken to an area outside the shaft area for re-use by the community. Plastic waste (i.e. PVS, HDP, plastic containers, electrical cables) that will be generated will be removed by a licenced contractor for recycling.

4.4.3 Disposal of hazardous waste

All waste classified as Hazardous, including hydrocarbon or chemical contaminated waste, battery waste, recovered oil, grease, acids, fluorescent tubes, etc. will be separated at source and temporarily stored in waste skips or other specialised containers.

The storage period will be less than 90 days before removal from the site by an appropriately licensed waste removal contractor and disposed of at an appropriately licensed hazardous waste disposal facility.

Hazardous waste will be stored according to the applicable requirements under the NEM:WA and Regulations.

The storage area will, as a minimum, be paved with concrete, covered and provided with bunds and drainage facilities to collect and contain any spills or adversely affected runoff.

4.4.4 Disposal of healthcare risk waste

All healthcare risk waste, including bandages, used dressings, urine cups, used HIV kits, used needles and syringes and used urines teat strips etc. will be placed in a designated container for disposal until collected by a registered medical waste company.

4.4.5 Disposal of mine residue

With the exception of primary crushing, there is no coal processing or beneficiation planned for the Elders Colliery, as all processing is to be carried out at the Goedehoop Colliery Plant complex. There will therefore be no coal residue generated on the site.

Overburden from the box cut will be excavated selectively. Overburden material contaminated with acidifying carbonaceous material will be excavated and transported to a registered waste disposal area at the Goedehoop Mine Complex. The excavated hard material (without carbonaceous material) will be stockpiled and later used to backfill the mine shaft at mine closure. Approximately 1.6 Mm^3 will excavated from the box cut. Some of the uncontaminated overburden softs will be utilised to construct the berm around the shaft complex area.

4.4.6 Topsoil will be separated from sub soil and hard overburden and will be used to form a visual screening berm along the provincial road, as well as and to construct a berm diverting clean runoff water around the complex.Disposal of waste from the water treatment plant

At the WTP water will be treated for domestic use, as well as for dust suppression on surface and underground.

Water to be used for dust suppression will undergo pre-treatment by filtration before use, whereas the water treated by RO module will be for domestic use and will therefore be treated to a quality that will meet the current interim Resource Water Quality Objectives (RWQO) for the Olifants River.

It is expected that both liquid waste (brine) and solid waste in the form of a gypsum sludge will be generated at the WTP.

Provision has therefore been made for the following:

- Lined brine dams for the disposal of brine generated in the treatment process;
- A gypsum drying pad will be constructed for the temporary storage and drying of gypsum prior to it being collected and transported from the site. The gypsum storage area will overflow to the brine ponds via a sloping pad and channel that is concrete lined. Gypsum will be removed from the site by a licensed waste removal contractor and disposed of at an appropriately licensed waste disposal facility within an appropriate radius depending on the outcome of the waste assessment study, which is still to be concluded.

4.5 Liquid waste – water management

4.5.1 Disposal of process effluent

It is not expected that the Elders operation will produce any process effluent, with process water being recycled within the operations as far as is practicable. Any spills of process water during upset conditions will report via the dirty storm water system via a silt trap to the Main Pollution Control Dam (PCD). From here, it will be pumped back to the WTP for reuse, or to underground storage at Elders.

4.5.2 Disposal of domestic waste water

The disposal of domestic sewage is described in Section 4.6.1 below.

4.6 Water pollution management facilities

4.6.1 Domestic waste water management

During construction, chemical toilets will be used by the contractors and a conservancy tank will be established in the contractor's laydown area (three 6 m^3 tanks). These will be emptied regularly for disposal at an authorised off-site sewage treatment plant.

Once operational, the site will be serviced by a conventional waterborne sewerage system capable of treating typical domestic raw sewage located at the shaft complex area. Sludge generated will be disposed of on sludge drying beds for collection by suitably licensed waste contractor for off-site disposal at an appropriately licenced waste facility. The effluent will be treated to the Special Effluent Standards as published in GNR 991 on 18 May 1984, as amended, and will be jointly discharged with effluent from the WTP to the Olifants River system.

A 6 m^3 conservancy tank will be installed at the guard house at the main security entrance and will be emptied regularly for disposal at an authorised off-site sewage treatment plant.

4.6.2 Storm water management

4.6.2.1. Background

An effective surface water management system will be essential to ensure efficient mining and to protect the natural water resource during the construction, operation, decommissioning and post closure phases of the mine. This will entail management of dirty water generated through the mining process (including the mine water make and run-off from mine infrastructure areas), as well as handling of clean water flowing towards the mining area.

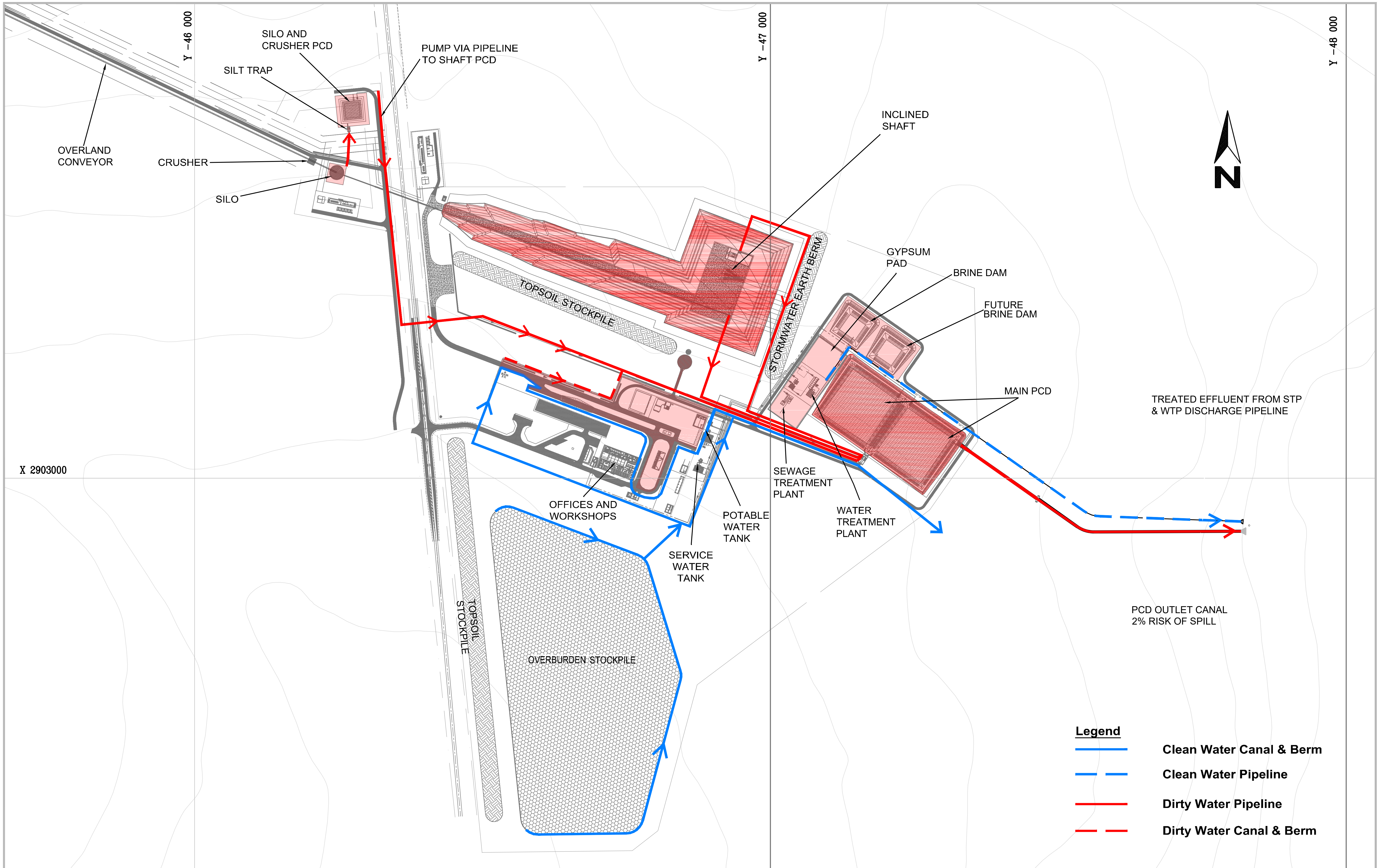
The Olifants, Vlakkuilen and Viskuile Rivers flow through the mining area and will therefore be directly affected by the mining activities. Measures to minimise the potential impacts on the Vlakkuilen and Viskuile Rivers and in turn the Olifants River and its tributaries will thus be required.

Water management measures that are required will include the diversion of clean runoff from upstream of the infrastructure around the site, and the containment of dirty runoff from the site in pollution control dams. These measures need to be designed to accommodate events up to at least the 1:50 year event, in line with GNR 704. Storm water that is generated around the mining area will consist of clean and dirty runoff. These include:

- Clean runoff from clean catchments draining towards the mining activities and infrastructure. Measures will be implemented to ensure that significant clean catchments are diverted away from the workings. Clean water diversions and flood protection measures will be designed to accommodate at least the 1:50 year event.
- Dirty runoff will be generated at the mine infrastructure areas. Measures will be implemented to contain this runoff by directing it to the pollution control dam. The dirty water management system, including the pollution control dam, will be designed in accordance with GNR 704 to accommodate the 1:50 year event as a minimum (i.e. 2% risk of spillage) with 800 mm freeboard.

The proposed storm water management measures are discussed in more detail below.

A layout of the proposed surface water management infrastructure is shown in **Figure 4.6.2(a)** for the mine infrastructure area at the shaft complex.



Legend

- Clean Water Canal & Berm
- Clean Water Pipeline
- Dirty Water Pipeline
- Dirty Water Canal & Berm

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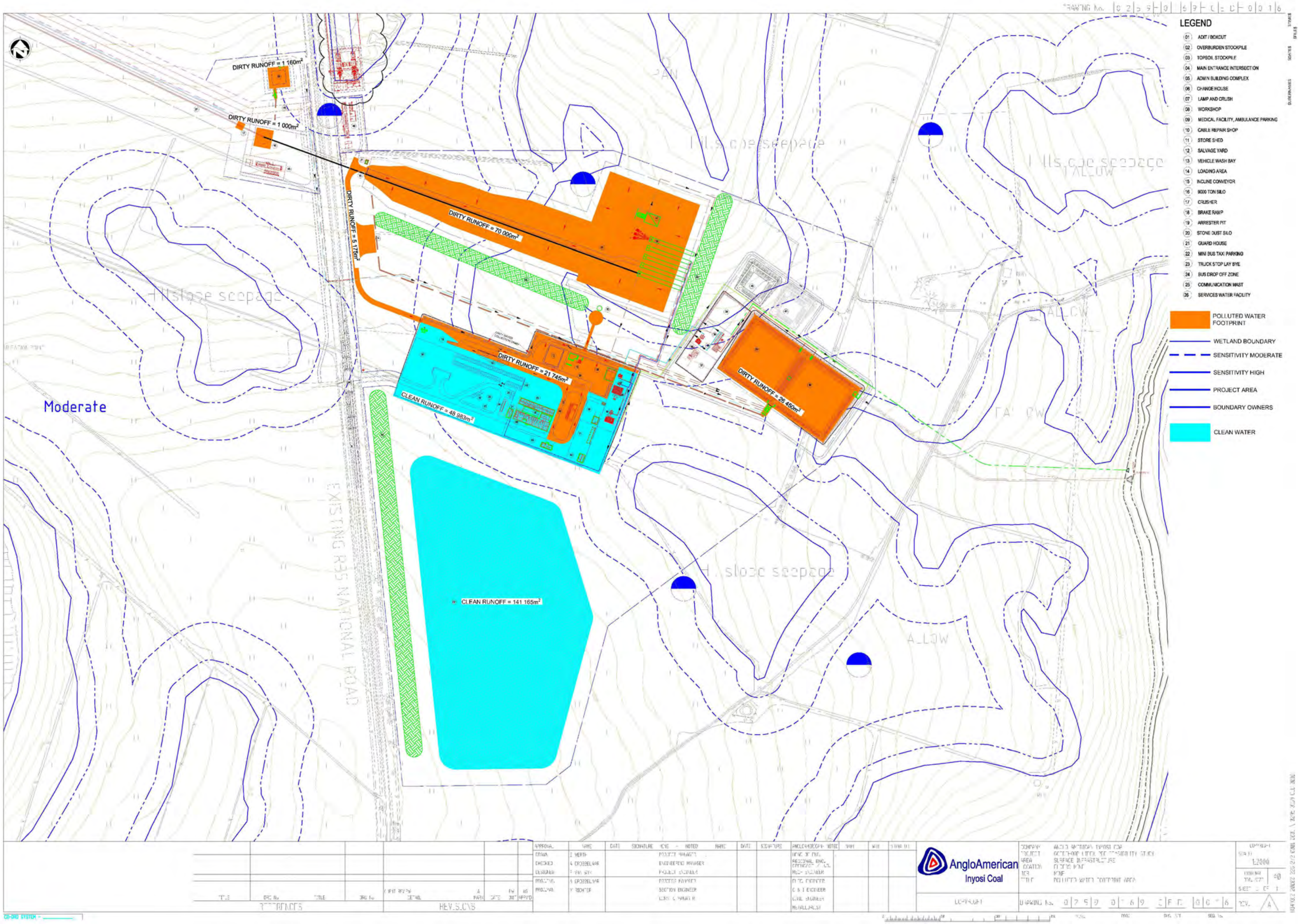
Elders Colliery

SCHEMATIC STORM WATER MANAGEMENT AT MINE INFRASTRUCTURE AREA

Scale 1 : 10 000 (A3)

Job No: D202-10

Figure 4.6.2(a)



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Elders Project

CLEAN AND DIRTY WATER AREAS DELINEATED BY HATCH

Job No D202-10

Figure 4.6.2(b)

4.6.2.2. Storm water management in clean areas

In line with best practice, as well as the requirements of the National Water Act (and the associated Regulation GNR 704), contaminated storm water runoff volumes will be minimised by preventing runoff from clean areas flowing into the dirty areas. This will be achieved by means of clean water diversion canals that will collect clean runoff, diverting it around the dirty areas. These dirty areas include:

Transfer points along the conveyor:

- Transfer point near the silo and crusher PCD;
- Water management at transfer points at the Goedehoop section of conveyor covered separately by Goedehoop Colliery.

At the silo and crusher area:

- Transfer point (as mentioned above)
- The Silo and crusher PCD.

At the shaft complex:

- The mine infrastructure area including workshops, offices, hard park areas washbay, contractors laydown area, water treatment plant, sewage treatment works, etc.
- Incline shaft
- Adit
- Overburden stockpiles
- The Main PCD
- The overland conveyor.

All clean water diversions will be designed to accommodate the peak flow expected for at least a 1:50 year event.

Silo and crusher area

The silo and crusher area will be located to the west of the adit and to the north east of the pan along the watershed between two unnamed tributaries. The silo and crusher area is small, approximately 0.1 ha in extent. The area will be contained, with clean runoff approaching from the south being diverted around the dirty area.

Shaft complex infrastructure area

The shaft complex infrastructure area will be located within the catchment of an unnamed tributary of the Olifants River. The site drains in a northerly direction towards the watercourse. Clean runoff draining towards the mine infrastructure area from the south will be diverted by means of a clean water diversion canal and berm, constructed around the southern, eastern and western boundaries of the mine infrastructure area. Adequate energy dissipation and erosion protection will be provided at the discharge points. The storm water management at the shaft complex can be seen in **Figure 4.6.2(a)**.

Incline shaft

There will be a small clean catchment between the shaft infrastructure complex and the incline shaft itself. Storm water runoff from this area will be diverted around the shaft and into the veld downstream by means of berms and canals, sized to accommodate at least the 1:50 year peak flow event.

Overburden stockpile

The shaft overburden stockpile will be located to the south of the infrastructure area. This material should not be contaminated as the overburden excavation process to be implemented entails a selective excavation in which contaminated material will be identified and transported off site to the registered waste disposal area at Goedehoop Colliery.

The storm water runoff from the overburden stockpile will be caught in a clean water cut off channel. The channel will convey the water to a silt trap from where it will discharge into the clean water canal at the offices area before being conveyed into the veld.

Overland conveyor and servitude

The overland conveyor route servitude will house the conveyor belt, service road, water pipeline and two 22kV powerlines between Elders Colliery and Block 20 Shaft. The overland conveyor and its associated structures will be constructed above ground with structural steel supported on reinforced concrete plinths.

The conveyor will cross a total of 12 wetland crossings along its route between Elders Colliery and Block 20, with 3 wetland crossings between Block 20 and the Goedehoop Colliery Plant complex. The gantries will be designed to span these wetland crossings where possible with a 1m freeboard allowed above the 1:100 year floodline. The river bed and banks will be protected with gabion structures.

The service road parallel to the conveyor will also cross these wetlands. Depending on the water level at the crossings, either reinforced concrete drifts or pipe culverts will be used to allow water to flow across the service road. Storm events above the 1:2 year return period will be allowed to overtop the culvert crossings. Consideration will be given in the design to ensuring that sub-surface flows are not cut off by the road and its layerworks.

The water pipeline will be a HDPE pipeline buried at least 1m below ground-level or it will consist of a galvanised mild steel pipeline that will either be mounted on the overland conveyor trestles or supported on concrete plinths at wetland crossings. The type of support at wetland crossings will depend on the sequence of construction of the conveyor and the pipeline. Simultaneous construction of the conveyor and the pipeline will result in the pipeline being mounted on the conveyor at the crossings but if the pipeline is required to be constructed before the conveyor then it will need to be supported on concrete plinths at all wetland crossings.

The 22 kV overhead powerlines will also be constructed within the conveyor route servitude. The line will be constructed with single wooden poles, which will be located, as far as is practicable, outside of the watercourse and wetland areas.

The conveyor transfer points will be bunded to prevent clean storm water from surrounding areas from running onto the dirty footprint, as well as to contain dirty runoff.

Brine dams and Gypsum pads

The proposed water treatment plant will generate both liquid waste (brine), and solid waste in the form of a gypsum sludge.

Gypsum will be temporarily stored on a purpose-built gypsum pad, located adjacent to the WTP and the Main PCD.

The gypsum pad and brine ponds will be located within a bunded area and provided with a clean water diversion berm/canal to divert clean runoff from upstream areas and ensure the runoff remains clean.

4.6.2.3. Storm water management in dirty areas

No contaminated water will be discharged from the site for events up to at least the 1:50 year recurrence interval. Infrastructure that will be provided to ensure the containment of contaminated water is described in the sections that follow, and illustrated in **Figure 4.6.2(a)**.

Silo and crusher area

Storm water runoff generated on this area will be collected in lined storm water channels and directed via a silt trap to the Silo and Crusher PCD. Water collected in the Silo and Crusher PCD will be pumped to the Main PCD.

Shaft complex infrastructure area

In order to minimise the dirty water footprint of the mine infrastructure area, various catchment areas within the shaft complex that could be considered clean, were delineated by the design engineers (i.e.Hatch). These areas will be provided with a separate storm water drainage system and allowed to drain to the environment. These areas include:

- Offices
- Parking areas.

Storm water runoff from the remainder of the site will be considered dirty. These areas include:

- Workshops
- Washbays
- Incline shaft
- Adit etc.

The clean areas delineated by the design engineers can be seen in **Figure 4.6.2(b)**. However, providing a separate, internal clean storm water drainage system within the infrastructure area will require under-overflow systems where clean and dirty storm water drains will need to cross. This adds additional complexity to the water management at the site and the practicality of achieving effective internal clean and dirty storm water separation must be carefully considered. It should be noted that the water balance presented in Section 5 assumes that this internal clean and dirty storm water management is implemented.

Storm water runoff and wash-down water from the dirty areas will be conveyed via a dedicated storm water system comprising concrete lined channels and pipes to the Main PCD. Prior to discharging contaminated water into the Main PCD, the storm water will pass through a silt trap to allow the majority of the suspended solids to settle out.

The storm water channels and pipes will be sized to prevent the spillage of dirty water to clean areas (i.e. beyond the mine surface infrastructure boundaries) for events up to at least the 1:50 year recurrence interval (a 2% or lower risk of spill in any one year).

The Main PCD will temporarily store storm water and washdown water. It will also serve as a containment facility for water pumped from the mine workings, prior to treatment in the water treatment plant for reuse in the mine process water systems, potable supply or discharge to the Olifants River.

During periods of excess rainfall, surplus water that cannot be treated will be pumped to underground storage compartments in the underground workings at Elders, or to Goedehoop Return Water Dam.

Incline shaft

Storm water runoff from the incline shaft area itself will drain down the shaft ramp towards the adit. The water will be collected in the Adit Sump and pumped to the Main PCD.

Overburden stockpile

As mentioned above the overburden material which contains carbonaceous material will be transported to the registered waste disposal area at Goedehoop. The overburden stockpile will therefore be considered clean.

Overland conveyor and servitude

The proposed conveyor route is shown in **Figure 1.1(b)**. The conveyor will cross 12 watercourses.

To prevent direct rainfall from falling onto the conveyor and the coal it transports, the conveyor will be installed with a doghouse steel sheeting along its length. This shroud will be located on the upwind (of the prevailing wind direction) side of the conveyor, which will also minimise the quantity of coal or coal dust that is blown off the conveyor. Fully enclosed conveyor gantry sections will be installed over areas within channelled watercourse demarcations.

Conveyor structures will be constructed above ground with structural steel gantries on reinforced concrete plinths. The gantries will be designed to span the wetland crossings where possible and a 1 m freeboard will be allowed above the 1:100 year flood line. The river bed and banks will be protected with gabion structures.

The conveyor will be equipped with belt turnovers and scrubbers at each end. This ensures that the majority of loose material that could fall off the lower (returning) portion of the belt is removed and that the dirty side of the belt always faces upwards, minimising the risk of contaminated material dropping from the conveyor onto the ground along the route.

The entire conveyor belt transfer infrastructure at the Elders Colliery end, including the silo, crusher, transfer house and belt turnover will be located within concrete paved and bunded area, draining to a silt trap and the Silo and Crusher Area PCD before being pumped to the Main PCD.

At the Goedehoop Block 20 end of the conveyor, the belt transfer infrastructure will be located within the existing Block 20 designated dirty water area. All dirty water and storm water will be collected in the Block 20 PCD and pumped from there via an existing pipeline to the pollution control dams at Goedehoop Colliery Hope Section.

Pollution control dams

All dirty water generated at the Elders operation will be collected (either by gravity or by pumping) in the PCDs, at the silo and crusher area and the shaft complex.

These dams will be equipped with a geomembrane (2.0 mm thick High Density Polyethylene (HDPE)) liner to minimise seepage of contaminated water to the groundwater system and will be sized to prevent spillage for events up to at least the 1:50 year event (a 2% or lower risk of spill in any one year). Silt traps will be provided at the inlets to the PCDs to collect suspended solids and minimise the risk of capacity loss in the dams due to siltation.

In line with best practice, the PCDs will be operated as empty as possible at all times to ensure that sufficient storm water retention capacity is available at all times.

The water management at the PCDs has been detailed in the preceding sections.

Brine dams and Gypsum pads

Brine waste generated from the water treatment plant will be accommodated in brine dams. These dams will be lined with 300mm compacted clayey layer with a 1.5 mm thick HPDE geomembrane above and below a 6 mm hi-drain, to minimise seepage of contaminated water to the groundwater system. The brine dams will also be equipped with a leak detection sump.

The gypsum pads will be paved with concrete. The concrete slabs will be underlain by a 1.5 mm thick HDPE geomembrane liner. The gypsum pad will be provided with concrete bunds to ensure no storm water runoff from the area. The storm water will be directed to a sump at the lower end of the gypsum area, from which water will be directed to the brine dam via a sloping pad and concrete lined channel.

Typical sections and details for the brine dams and gypsum pads can be seen in **Figures 4.6.4 (b) to (d)**.

4.6.3 Mine water management

Following numerous iterations on water management options and the mine water balance (detailed in Section 5), the following broad water management strategy has been adopted:

- A Shaft PCD (Main PCD) will be provided on surface to accommodate storm events from the surface infrastructure area. This PCD will have a capacity of 45 Mℓ.
- A water treatment plant with a treatment capacity of initially 0.5 Mℓ/day and increasing first to 2.5 Mℓ/day and finally 5.0 Mℓ/day will be provided to treat the mine water make to supply the mine's water needs, with surplus water discharged to the Olifants River.
- Surplus water that cannot be treated by the water treatment plant will be stored in the underground workings, when this becomes available. Prior to storage becoming available in the underground workings, surplus water will be pumped to Goedehoop Colliery.
- During dry periods and during the dry season months of the first years of mining, make-up water will be required. This will be sourced from Goedehoop Colliery.
- For the current water balance modelling it has been assumed that a volume of approximately 5 000 m^3 of water will be maintained as operational storage in the PCD at all times.

The water balance modelling detailed in Section 5 has shown that there will be insufficient storage at Elders to accommodate the water make, even for average rainfall, prior to 2025, when mining at the 2 Seam will cease and the first capacity to store water underground will become available (under the current LOM plan). It is recommended that low-lying areas be identified on the coal seams within the LOM footprint area for optimised underground storage.

4.6.4 Water storage facilities

4.6.4.1. General description of dams and ponds

There are no clean water dams or ponds planned for the proposed Elders Colliery project. Clean water from the WTPs will be pumped for temporary storage in various tanks prior to use, or discharged to the Olifants River.

Two PCDs are planned, one to the north of the silo and crusher area and one in the eastern area of the Shaft complex.

Silo and crusher PCD

A PCD will be provided on surface to accommodate storm water runoff from the silo and crusher area. This PCD will have a capacity of 1.25 Mℓ and will be located to the north of the silo and crusher designated dirty water area.

Shaft Complex PCD

Similar to the silo and crusher PCD, the Shaft complex will have a PCD on surface to accommodate storm events from the surface infrastructure area. The PCD will have a capacity of 45 Mℓ in two equally sized compartments, linked via an overspill on the partition wall so that both compartments will fill to capacity before spilling over the spillway.

Brine dams

Initially one brine dam will be constructed, with a second to be constructed at a later stage, as the WTP's treatment capacity is increased.

4.6.4.2. Safety Aspects

All dams will have a wall height of less than 5 m and storage capacity less than 50 000 m^3 and will therefore not be classified in terms of Dam Safety Legislation (under Section 117(c) of the NWA).

All dams will be surrounded by a security fence and lockable gate to prevent unauthorised access. In addition to this, warning signs at the dams as to dangers of drowning, warnings against drinking of, or swimming in the water and provision of emergency flotation devices will be provided. Access in and out of all water retaining structures will be ensured by means of ramps or ladders, as well as safety ropes (where ramps or slopes cannot be provided).

4.6.4.3. Sizing of dams

Legislation

South African legislation, in the form of Government Notice 704 (GNR 704) of 1999, in terms of the National Water Act, Act 36 of 1998, stipulates that all dirty water must be contained, with a 2% or lower risk of spilling to the clean system in any one year (spill events are to be limited to once in 50 years or longer). Similarly, clean water diversion systems must also be designed to accommodate the 1:50 year event.

Sizing of the Dams

The PCDs have been designed and sized by the design engineers, Hatch Goba (Pty)Ltd. According to their design report (H349312-10000-226-210-0001_RevA_22Sep2015), the dams have been sized in accordance with GNR 704 to have a risk of spill of 2% or less in any one year, by means of a dynamic, daily time step water balance model.

It should be noted that the dams are only one part of the overall water management strategy and as such the risk of spilling is dependent on several other components of the water management system, including operational practices, the rate of reuse of water from the dams and effective water level control in the dams. A commitment is made in the impact assessment to calibrate the water balance once actual measured data is available from the site.

4.6.4.4. Technical design of the proposed dams

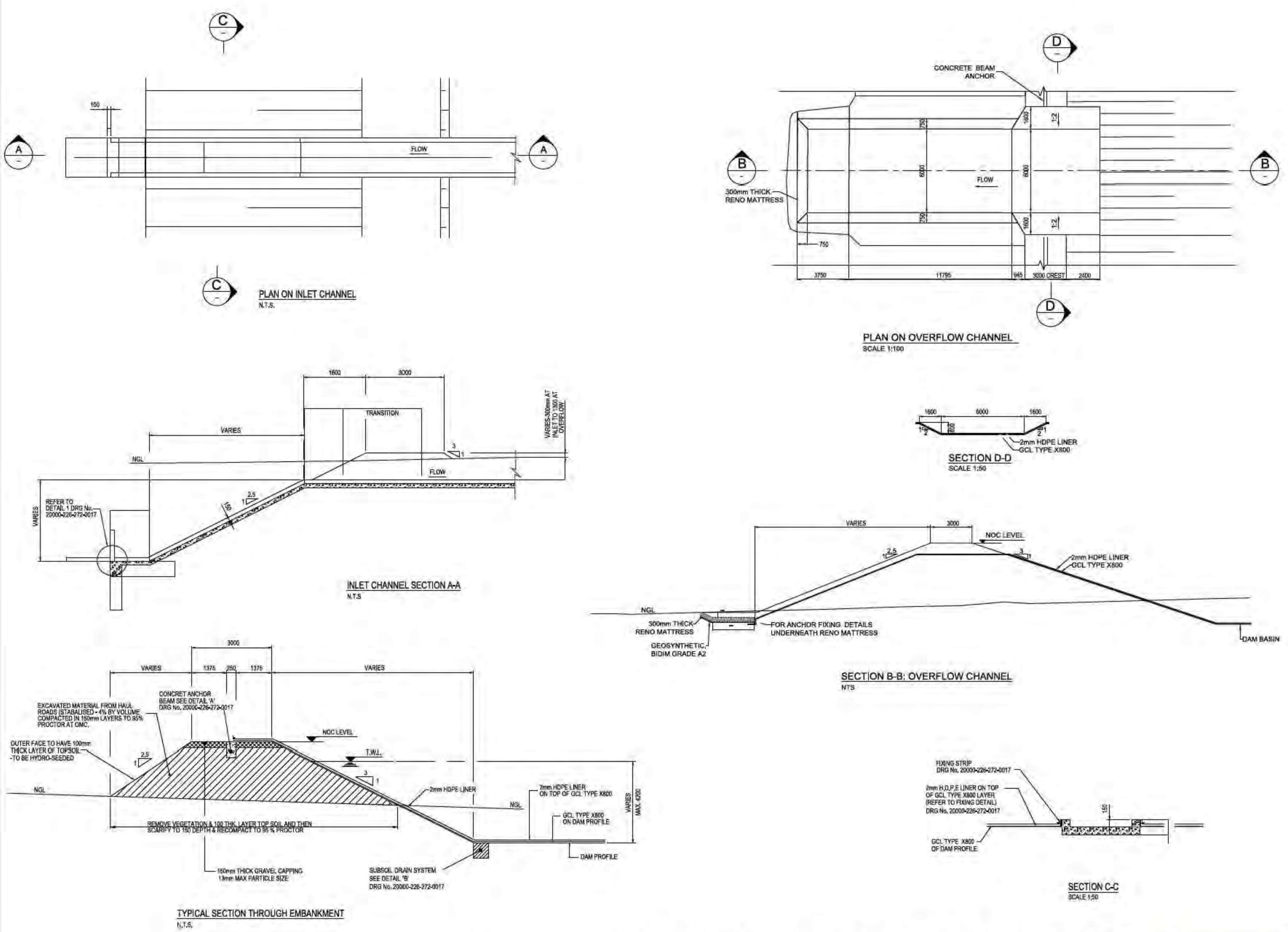
The design of the dams and ponds will be based on the principles set out below.

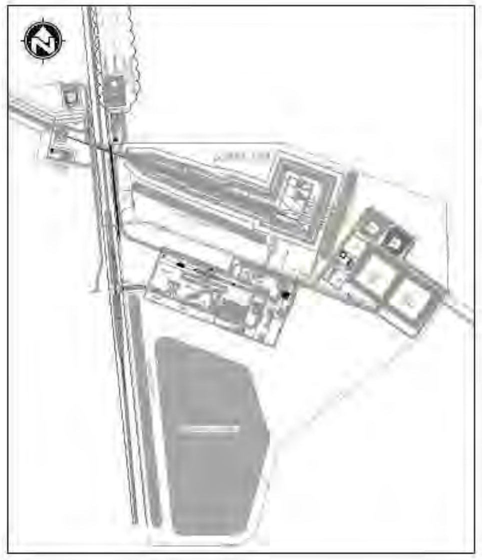
Conceptual layout and sections drawings, as prepared by Hatch, are shown in **Figures 4.6.4(a)**.

Design parameters

Key design parameters for the dams are summarised below:

- The PCDs have been sized based on daily water balance model to ensure no spill for at least the 1:50 year event.
- In accordance with GNR 704 a minimum of 800 mm freeboard between spillway level and the non-overspill crest will be provided
- The PCDs will be equipped with geomembrane, (2.0 mm thick (HDPE)) liner to minimise seepage of contaminated water to the groundwater system.
- The brine dams will be lined with 300mm compacted clayey layer with a 1.5 mm thick HPDE geomembrane above and below a 6 mm hi-drain, to minimise seepage of contaminated water to the groundwater system. The brine dams will also be equipped with a leak detection sump.





KEY PLAN
N.T.S

DAM LINING BEDDING LAYER

DAM LINING BEDDING LAYER TO BE AS PER THE HDPE LINER SUPPLIERS SPECIFICATION

LINING NOTES

1. MATERIAL DESCRIPTION
LINING TO COMPLY WITH SANS 1526-1991 AND SHALL CONSIST OF SUITABLE COMPOUNDED HIGH DENSITY POLYETHYLENE, THICKNESS : 2mm

GENERAL NOTES:

1. GENERAL
1,1 WORK TO BE IN ACCORDANCE WITH S.A.N.S. 1200 CIVIL ENGINEERING SPECIFICATION AND A.A.C. SPECIFICATIONS WHERE APPLICABLE.
2. CONCRETE
2,1 CONCRETE TO BE "STRENGTH CONCRETE" AS SPECIFIED BELOW UNLESS OTHERWISE NOTED.
MASS CONCRETE — GRADE 10/38
BLINDING CONCRETE — GRADE 10/19
ALL STRUCTURAL CONCRETE. — GRADE 35/19
2,2 50mm THICK BLINDING TO BE PROVIDED UNDER FOUNDATIONS.
2.3 50mm THICK BLINDING OR 250 MICRON PVC SHEETING IN ACCORDANCE WITH S.A.N.S. 952 - 1985 TYPE C TO BE PROVIDED UNDER ALL GROUND SLABS. PVC SHEETING SHOULD GENERALLY BE USED UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER FOR COMPLEX AND/OR HEAVILY REINFORCED SLABS.
3. FORMED AND UNFORMED SURFACES.
3,1 FORMWORK TO BE CLASSIFIED AS SPECIFIED BELOW UNLESS OTHERWISE NOTED.
"ROUGH" WHERE FACE IS NOT EXPOSED
"SMOOTH" WHERE FACE IS EXPOSED
SMOOTH FORMWORK TO EXPOSED FACES TO BE CARRIED DOWN TO 150mm BELOW ADJOINING FINAL GROUND OR PAVING LEVEL.
3,2 ARISES TO BE CHAMFERED 20 x 20mm.
3,3 EXPOSED UNFORMED SURFACES AND SURFACES TO RECEIVE GROUT TO BE "WOOD FLOAT FINISH" UNLESS OTHERWISE NOTED.
4. FOUNDING MATERIAL
4.1 THE MINIMUM DESIGN BEARING PRESSURE FOR FOUNDATIONS IS 150kPa UNLESS NOTED OTHERWISE.
4.2 FOUNDING MATERIAL IS TO BE ENGINEERED TERRACE
5. CAST IN ITEMS AND GROUTING
5,1 CAST IN ITEMS TO BE SUPPLIED BY CIVIL CONTRACTOR UNLESS OTHERWISE NOTED.
5,2 GROUTING UNDER BASE PLATES TO BE DONE BY CIVIL CONTRACTOR UNLESS OTHERWISE NOTED.
6. BALAST SAND BAGS TO BE USED AT NOT MORE THAN 5m INTERVALS BOTH WAYS TO ENSURE THAT THE HDPE LINER IS HELD IN PLACE

COMPANY	ANGLO AMERICAN INYOSI COAL
PROJECT	GOEDEHOOP LIFEX PRE-FEASIBILITY STUDY
AREA	SURFACE INFRASTRUCTURE
LOCATION	ELDERS MINE
JOB	
TITLE	POLLUTION CONTROL DAM TYPICAL DAM WALL DETAIL
DRAWING No.	0295-0169-CED-0009
SCALE	NTS
ORIGINAL DRG. SIZE	A0
SHEET	1 OF 1
REV.	D

AngloAmerican Inyosi Coal

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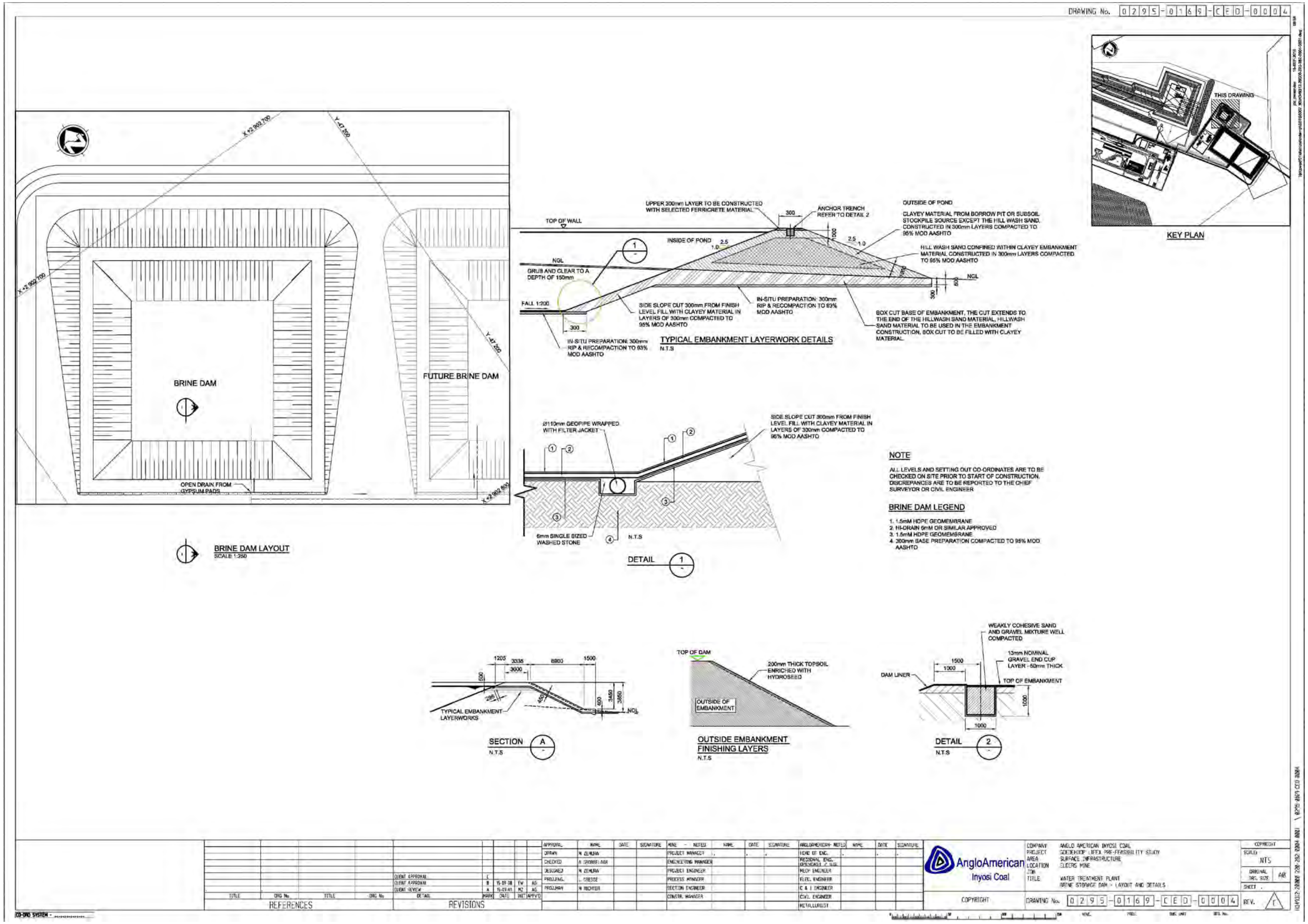
SRK Consulting
Elders Colliery

TYPICAL SECTION AND DETAILS PCD

Job No D202-10

Figure 4.6.4(a)



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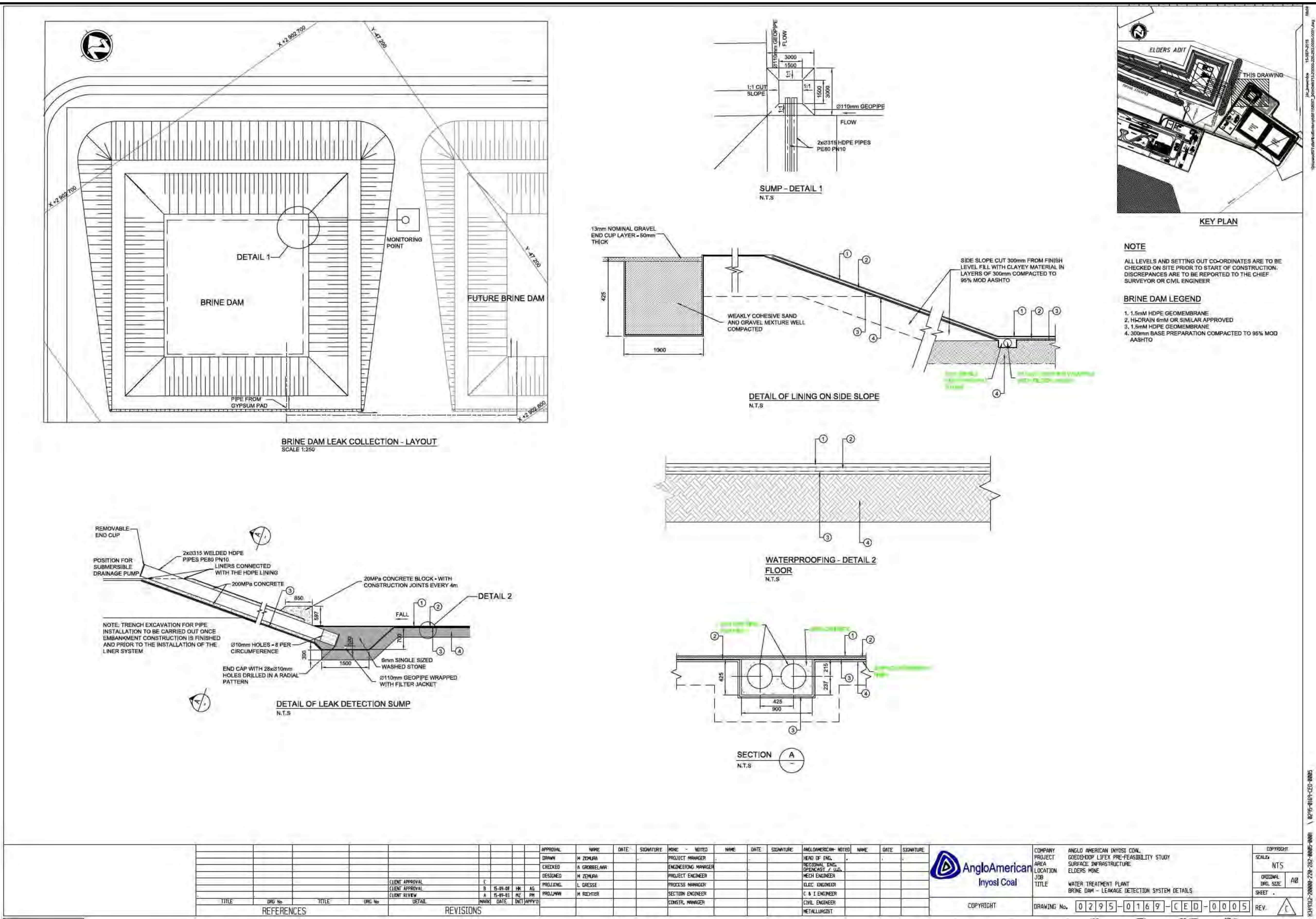
SRK Consulting
Elders Project

TYPICAL SECTION AND DETAILS - BRINE DAM - SHEET1

Job No D202-10

Figure 4.6.4(b)



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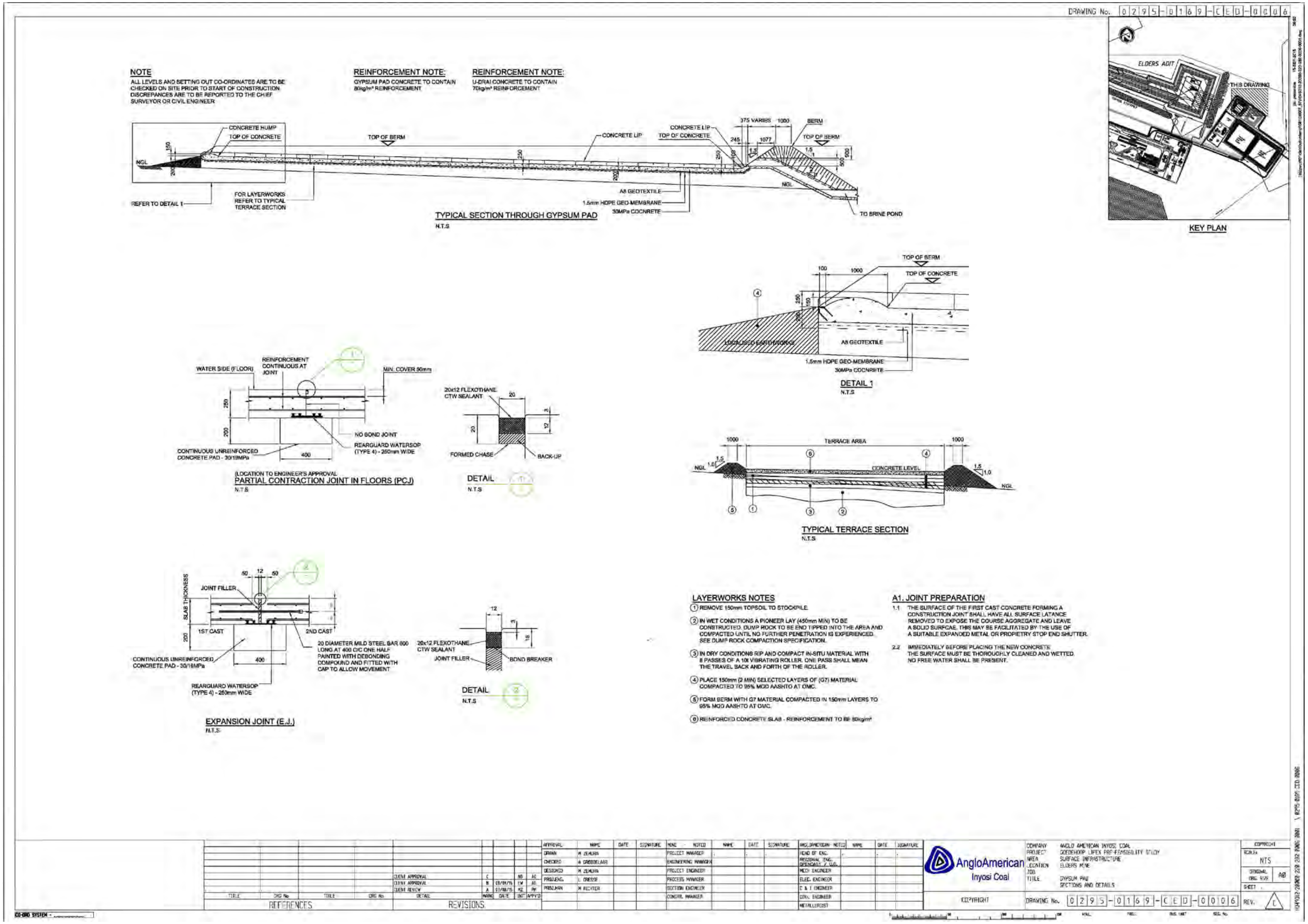
Elders Project

TYPICAL SECTION AND DETAILS - BRINE DAMS - SHEET 2

Job No D202-10

Figure 4.6.4(c)



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SRK Consulting
Elders Project
TYPICAL SECTION AND DETAILS - GYPSUM DRYING PAD

Job No D202-10

Figure 4.6.4(d)

Dam construction

The dams will be constructed in a cut-to fill operation. Material excavated from the dam basin will be used for the construction of the earthfill embankment dam walls.

Minimisation of siltation and seepage

- Siltation

  Silt traps will be provided at the inlets to the PCDs to collect fines in the storm water. The silt traps will be equipped with a concrete paved drying bed adjacent to the silt trap. Sludge removed from the silt trap will be placed on the drying bed to dry prior to being removed. The drying bed will drain directly back into the silt trap.

- Seepage

  The dams will be provided with lining systems, designed in accordance with the relevant waste disposal regulations, to minimise the risk of seepage of contaminated water from the dams into the groundwater system. The following liners will be provided:

  - PCDs will be equipped with a 2 mm thick HDPE geomembrane liner, directly placed on a geosynthetic clay liner (GCL). This is illustrated in **Figures 4.6.4(a).**
  - The brine dams will be lined with 300mm compacted clayey layer with a 1.5 mm thick HPDE geomembrane above and below a 6 mm hi-drain, to minimise seepage of contaminated water to the groundwater system. The brine dams will also be equipped with a leak detection sump. This is illustrated in **Figure 4.6.4(b).**
  - The gypsum pad will be paved with concrete. The concrete slabs will be underlain by a 1.5 mm thick HDPE geomembrane liner. This is illustrated in **Figure 4.6.4(c).**

Inlets

Water will enter both PCDs via a controlled inlet, being the outlet of the silt trap.

Emergency overflow

The dams will be equipped with spillways to cater for emergency overflows, as follows:

- The spillway at each PCD will comprise a rectangular channel, the inlet portion being concrete lined, and the outlet will being lined with 300 mm thick Reno mattress.

The spillways will be sized to accommodate the required recommended design flood (RDF) and safety evaluation flood (SEF), as per the relevant South African National Commission on Large Dams (SANCOLD) guidelines.

Monitoring

- Stability

  The dam walls will be inspected regularly to ensure their stability and safety.

- Water quality

The water quality in the dams, will be sampled in accordance with the water quality monitoring programme detailed in Section 11.

- Water quantity

  Water levels in the dams, as well as pumping volumes, will be monitored on a regular basis to ensure that the site water balance is efficiently managed and to provide data that will allow calibration of the water balance model.

These activities will be undertaken in accordance with the monitoring programme detailed in Section 11.

4.6.5 Polluted water treatment facilities

4.6.5.1. Water treatment plant

Water from the Main PCD will be stored in a ground level tank before being sent to the WTP for treatment.

It is currently planned to increase the water treatment rate from an initial treatment rate of 500 m^3/day, to 2 500 m^3/day and later to a maximum of 5 000 m^3/day as indicated by Hatch. At the WTP water will be treated for domestic use as well as for dust suppression on surface and underground.

Water to be used for dust suppression will undergo pretreatment by filtration before use whereas the water treated by reverse osmosis (RO) module will be for domestic use and will therefore be treated to a quality that will meet the current interim Resource Water Quality Objectives (RWQO) for the Olifants River.

4.6.5.2. Sewage water treatment

All sewage from the Elders operation will be treated to the DWS general limits and the effluent will be released into the tributary of the Olifants River. The planned sewage treatment plant is described in Section 4.5.2.

4.7 Watercourse alterations

The mining area is located on the Olifants River, as well as the Viskuile and Vlakkuilen watercourses. The following watercourse alterations are envisaged for Elders Colliery:

- Watercourse crossings:

  The conveyor will cross tributaries of the Olifants River between Elders Colliery and Goedehoop Block 20 as well as along the re-establised conveyor route between Block 20 and the Goedehoop Colliery Plant complex.

  12 wetlands will be crossed between Elders Colliery and Goedehoop Block 20 and 3 wetlands will be crossed between Block 20 and the Goedehoop Colliery Plant complex.

  Associated with the conveyor will be a service road, buried pipeline, two 22kV powerlines and a fence line.

- Discharge of water:

  Excess treated water from the WTP, as well as effluent from the sewage treatment plant will be discharged to a seepage wetland associated with the Vlakkuilenspruit.

  During rainfall events in excess of the 1:50 flood event, water from the Main PCD will spill via a lined channel into the receiving water resources. The point of discharge is located in the same proximity as the WTP/STP discharge point in the seepage wetland associated with the Vlakkuilenspruit.

- Undermining of watercourses:

  The underground mine will undermine the Viskuile and Vlakkuilen rivers and wetland system. Only bord and pillar mining methods will be employed and no high extraction mining will occur. Although this does not constitute a physical watercourse alteration, undermining of watercourses must be authorised in terms of a GNR 704 exemption.

The relevant water use licenses in terms of Section 21(c) (impeding or diverting the flow of a watercourse) and Section 21(i) (altering the beds, banks and characteristics of a watercourse) of the NWA will need to be obtained for these activities. A ground and pillar stability report will need to be produced and submitted with the water use license application.

5. WATER AND SALT BALANCE

The objective of the water balance modelling is to estimate the volumes of water that will be generated by the proposed activities, including effluent water and surface runoff from the dirty areas. This is assessed together with the water demands on the site to determine whether the site will operate with a water surplus or deficit and to determine the storage capacity required to ensure legal compliance in terms of prevention of spills from the site. The water balance modelling is therefore a key input to the overall water management strategy for the site.

This section details the water balance for the proposed Elders Colliery. It is intended for the following purposes:

- To be used by the mine development team for planning purposes, in terms of sizing and phasing of water containment facilities, as well as the planned water treatment plant.
- As input to the IWULA and IWWMP in support of the environmental applications for the mine.

This document supersedes the water balance detailed in the draft specialist surface water report, **J&W report No. JW155/13/D202-RevG,** dated June 2014.

5.1 Computational methodology

Daily rainfall data from the South African Weather Service (SAWS) rainfall stations 0478292 Langsloot and 0478303 Secunda, together with monthly evaporation data estimated from the "Surface Water Resources of South Africa 1990" (*WRC, 1995*), also known as *WR90*, were input to a hydrological model based on the Soil Conservation Services (SCS) method to determine runoff on a daily basis using antecedent conditions. The method (as adapted to South African conditions by Schmidt & Schulze) is believed to be highly suitable for the site, having been developed in catchments with areas of approximately 8 km^2, and smaller.

The underground water inflows were derived by JMA Consulting (JMA) using a modelling approach developed for the Kriel / Secunda area. This involves the development of grids for which recharge rates can be computed.

Recharge and dewatering through fracturing of strata have been taken into account. These rates of inflow are then brought into the J&W model, where extreme rainfall impacts and surface water make can be assessed. The water use and storage requirements to ensure a 2% or lower risk of spilling can subsequently be computed.

The surface runoff areas were measured from layout drawings prepared by the design engineers (i.e. Hatch). Water consumption information related to the mining operation was provided by Anglo American and the design engineers (i.e. Hatch).. This data was entered into the water balance model.

The overall water balance for the proposed mine was subsequently calculated.

5.2 Assumptions, information used and limitations

5.2.1 Assumptions and information used

The overall schematic water balance for Elders is presented in **Figure 5.4.7(a)** to **(c)**, found in Section 5.4.7 below, indicating the average underground and surface water make over the life of the mine.

The following activities are included:

- Mining underground will commence in 2018 and end in 2030.
- Water supply to continuous miners (CM) at Elders will be sourced from the potable water treatment plant.
- The proposed water treatment rate will initially be **0.5 Mℓ/day**, increasing first to **2.5 Mℓ/day** and later to **5.0 Mℓ/day** once the mine becomes water positive.
- Water losses due to the CM usage, ventilation system and the coal removed from the workings have been accounted for.
- Service water to the conveyor system has been accounted for.
- During the initial years of mining, make up water will be provided from Goedehoop Colliery Block 8. This water will be treated at the Water Treatment Plant before use.
- Surplus dirty water from the Main Pollution Control Dam (PCD) (that cannot be treated) will be stored in the underground workings.
- Potable water for use at the workshops, offices and change house will be supplied from the potable water treatment plant.
- Sewage flows from the change house, workshops and offices will be directed to the sewage treatment plant. The treated sewage wastewater will be released into the environment.
- Dirty runoff from the wash bays and boot washing area will be directed to the Main PCD.
- Dirty runoff from the silo and crusher area will be directed to the Silo and Crusher PCD from where water will be pumped to the Main PCD.
- Water pumped to the Main PCD will be pumped back to the potable water treatment plant for reuse or to storage in the underground workings.

The following key assumptions and information have been used:

- Runoff from the external catchment draining towards mine surface infrastructure area will be diverted, minimising the volume of water reporting to the PCDs.
- The underground mining areas used for the modelling are based on the LOM plans (file names: "*Elders_UG2015_LL6_s4 and Elders_UG2015_LL7_s2"*) provided to J&W by SRK and AOL.
- The surface and underground water use and consumption at Elders is based on values provided by Hatch and AOL (file names: "*H349-10000-226-210-001, and H349312-20000-226-210-001*" received on 2 October 2015). This data will need to be refined as measured data becomes available.
- The surface water inflows to the dams are estimated, based on the surface runoff model.
- The layout pdf used to delineate the various sub-catchments on the mine surface infrastructure site were provided by Hatch (file name: " H349312-20000-226-272-0001-0001-CLEAN-DIRTYRUNOFF.pdf, received on 15 September 2015).
- The capacities of the PCDs were provided by the design engineers as:
    - Main PCD: A dual compartment main PCD with total capacity of **45 000 m^3** (each compartment having 22 500 m^3 storage capacity).
    - Silo and Crusher Area PCD: **1 250 m^3**.

- The capacity of the WTP will ramp up over the life of mine from an initial treatment capacity of 500 m^3/day to a maximum of 5 000 m^3/day. A multi-stage treatment process will be employed, with pre-treatment to render water that is fit for use as service water and for dust suppression, with a reverse osmosis (RO) module to treat water to potable standards for domestic use, as well as to a quality that will meet the current interim Resource Water Quality Objectives (RWQO) for the Olifants River. The proposed water treatment plant will generate both liquid waste (brine), and solid waste in the form of a gypsum sludge.
- Feed water to the WTP will first be sourced from the Main PCD. If there is insufficient water available in the Main PCD, water will be sourced from Goedehoop Colliery Block 8.
- In terms of water losses in the underground workings and upon consultation with AOL, the following assumptions were considered reasonable for the purpose of the water balance modelling:
    - The water loss in the mining of the coal was estimated by JMA.
    - A loss of water from CM usage of 5% was assumed.
    - Ventilation losses were provided by JMA.
- Groundwater inflows were obtained from JMA. Modelling results for underground workings dated 22 September 2015 (file name: "*1509EldersGroundwaterBalance2015V0.2-JAWS, Chapter 9 of Groundwater Report-Water Balances*") were used. The value used for recharge from the wetlands into the underground workings is noted by JMA to be conservative.
- The availability of storage in the underground workings was provided by JMA.

A list of drawings from which information for the water balance was obtained is provided in **Table 5.2(a)**.

5.2.2 Limitations

By their nature, models are theoretical estimates of natural phenomena that are too complex to be derived exactly. It is inevitable that there will be variations in the actual flows when compared to the predicted flows. This can only be addressed by the recalibration of modelled data with measured data, from which more reliable estimates of extreme and average water make and runoff volumes can be developed.

5.3 Rainfall data

The water balance modelling requires historical daily rainfall data from a gauge in close proximity to the site. The rainfall data from the Langsloot and Secunda rainfall stations was evaluated and found to have reliable data, with observed extreme events within the record. The records were found to have similar characteristics and were combined to create a rainfall record spanning from 1914 to 2008, a record length of 95 years. The statistical extremes for the combined rainfall record are presented in **Table 5.3(a)**. Further detail on the rainfall data and selection of the record used is provided in Section 6.3.1.

Table 5.2(a) List of Drawings received from Hatch mining and SRK consulting

Drawing No.	Rev	Details
H349312-20000-220-270-0001-0001	Rev G (pdf) received 14/9/2015; dwg received 11/9/2015	Final Block Plan
H349312-20000-220-270-0002-0001 H349312-20000-244-270-0001-0001 H349312-20000-244-270-0001-0002 H349312-20000-244-270-0001-0003	Rev C (pdf) received 14/9/2015 Rev A received 2/10/2015 Rev A received 2/10/2015 Rev A received 2/10/2015	Conveyor servitude: general
H349312-20000-220-282-0007-0001 H349312-20000-244-270-0001-0005 H349312-20000-244-270-0001-0006 H349312-20000-244-270-0001-0007 H349312-20000-244-270-0001-0008 H349312-20000-244-270-0001-0009	Rev A received 2/10/2015 Rev A received 2/10/2015 Rev A received 2/10/2015 Rev A received 2/10/2015 Rev A received 2/10/2015 Rev A received 2/10/2015	Conveyor servitude: conveyor belt
H349312-20000-220-282-0003-0001	Rev A received 2/10/2015	Conveyor servitude: service road
H349312-20000-226-272-0016-0001 H349312-20000-226-272-0017-0001	Rev A received 2/10/2015 Rev A received 2/10/2015	Pollution control dam
H349312-20000-220-282-0001-0001	Rev B received 22/09/2015	Process flow diagram
H349312-20000-220-282-0002-0001	Rev A received 2/10/2015	Discharge into watercourses
H349312-20000-220-282-0004-0001 H349312-20000-220-282-0005-0001	Rev A received 2/10/2015	Brine dams
H349312-20000-220-282-0006-0001	Rev A received 2/10/2015	Gypsum storage areas
H349312-10000-220-282-0008-0001	Rev A received 14/09/2015	Typical SW management canals and pipes
H349312-20000-226-210-0001	Rev B, received 14/09/2015	Water balance design report
H349312-20000-226-272-0001-0001	Rev A, received 15/09/2015	Clean and dirty water catchment delineation

Table 5.3(a) Statistical extremes for the Langsloot/Secunda rainfall record

Event	Rainfall depth (mm)					
	1 day	2 day	3 day	7 day	1 month	Annual
1:2 yr	59	81	96	143	184	689
1:10 yr	88	117	132	182	246	886
1:20 yr	105	136	150	196	274	946
1:50 yr	132	166	178	215	314	1052
1:100 yr	157	194	202	230	346	1111
1:200 yr	188	226	230	244	382	1174
1:250 yr*	205	245	250	253	400	1190
Max Recorded	175	196	196	212	368	1068

* Interpolated from statistical model output

5.4 Water balance

5.4.1 Water management strategy

The water management strategy, as outlined in Section 4.6.3 above, and was used as the basis for the water balance model.

5.4.2 Water make

5.4.2.1. Overall water make

The total mining water make is expected to be as follows:

- Average water make over LOM = 1 480 m^3/day
- Maximum water make at end of LOM = 2 610 m^3/day
- Peak summer water make = 4 475m^3/day

It is important to note that a significant portion of the underground mine water make is attributable to recharge from the wetland areas of the Viskuile and Vlakkuilen Rivers. The contribution from the wetland is expected to increase to around 990 m^3/day at the end of LOM, averaging approximately 475 m^3/day (or 32% of the total underground water make) over the LOM (as estimated by JMA. Further detail on the modelling of recharge to the underground workings can be found in the groundwater specialist report.

The post closure water make is estimated to be approximately 2 600 m^3/day, for average rainfall.

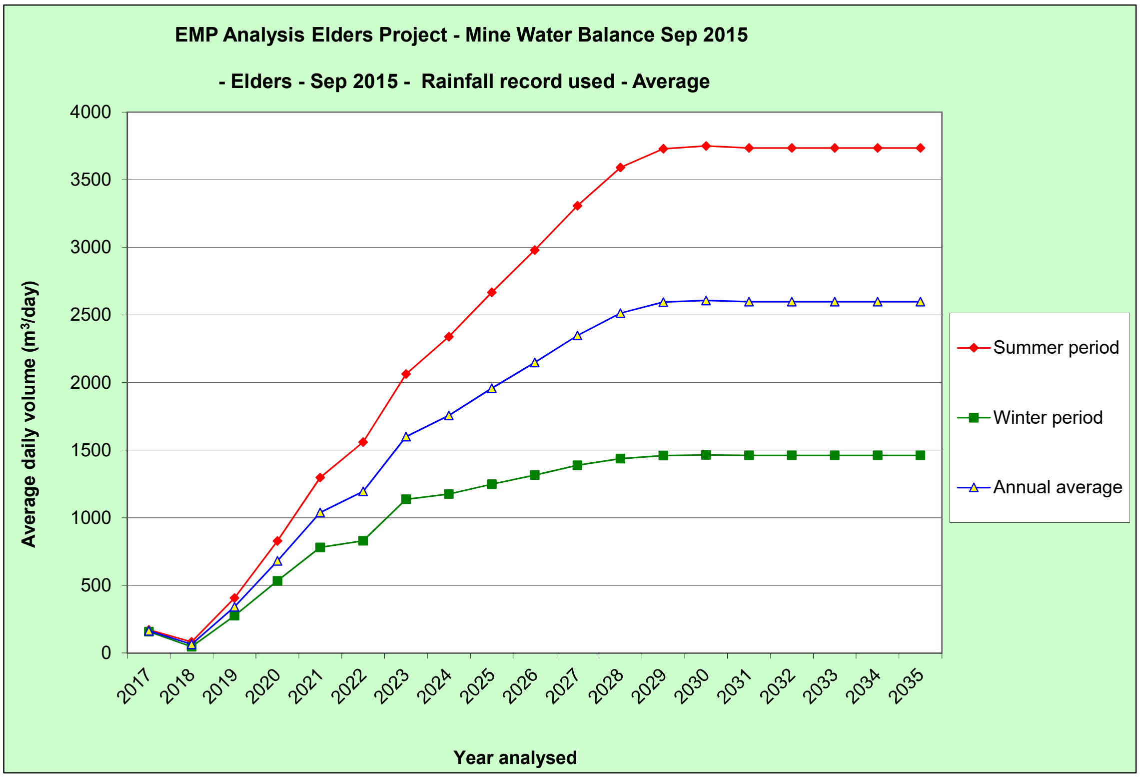


Figure 5.4.2(a) Graphical water balance for average water make during the operational and post closure phases of mining showing seasonal variations

5.4.3 Water use

Water use at Elders will include water for dust suppression and treatment, as well as use by the continuous miners (CMs). These uses, as currently modelled, are indicated in **Table 5.4.3(a)** below. Note that the proposed water treatment plant will consist of two modules. The RO module will supply potable water for domestic use whereas the filtration modules will supply water for, service water to the CMs, dust and fire suppression at the conveyor and washbays. Note also that not all of these uses represent a loss to the system, as a portion of the water is recycled back to the dirty water system e.g. service water to the CMs.

Table 5.4.3(a) Water use at Elders

Description	Water use (m^3/day)	Source
Dust suppression for roads	60	From filtration module of the WTP
Dust suppression for conveyor	66	11 transfer points at 250 ℓ/hour, from the filtration module of the WTP
Wash down	18	5 No. hoses at 0.5 ℓ/s for 2 hour/day, from the filtration module of the WTP
LDV washbay	30	10 underground vehicles per day at 3 000 ℓ/vehicle
CM usage	1376	6 No. CMs (JW 191/14/D952-Rev0)

Description	Water use (m^3/day)	Source
Service water	**1550**	

5.4.4 *Treatment*

It is currently planned to increase the water treatment rate, as indicated above, from an initial treatment rate of 500 m^3/day, to 2 500 m^3/day and later to a maximum of 5 000 m^3/day during the operational period to manage the surplus water generated on the mine during both average and extreme rainfall conditions.

The monthly water volume in the Main PCD, modelled over the life of mine at a water treatment rate of 2 500 m^3/day indicates that under **average** rainfall conditions the Main PCD is expected to remain empty (or at operating level), even during the summer months, until around 2023, when summer inflows will begin to exceed the treatment capacity. From around 2024 it is expected that the summer inflows will exceed the dam's capacity and surplus water will need to be pumped to storage elsewhere.

Storage in the 2 Seam underground workings is only expected to become available in 2025, leaving a two year period where there will not be sufficient storage at the mine to accommodate the water make, even for average rainfall.

If the treatment plant capacity is increased (for the purposes of the modelling here, it has been increased to the maximum rate indicated by the design engineers, of 5 000 m^3/day) in 2023, then under **average** rainfall conditions the Main PCD is expected to remain empty (or at operating level), even during the summer months, until around 2028/29, when summer inflows will begin to exceed the treatment capacity. By this stage, storage capacity will be available in the underground workings.

Please refer to Section 5.4.8 for further detail on dirty water storage requirements.

5.4.5 *Make up water and surplus water*

As mentioned previously, during the initial stages of mining, when the water make is low, there will be periods of water deficit, when water will be imported from Goedehoop Colliery. **Figure 5.4.5(a)** illustrates the water deficit and surplus over the LOM, as modelled for average rainfall and water treatment rates as follows:

- 0.5 Mℓ/day in 2017, if required.
- 2.5 Mℓ/day from 2018 to 2022.
- 5.0 Mℓ/day from 2022 onwards.

The following is shown on the graph:

- The blue line indicates the volume of water flowing into the PCD that is available for treatment in the WTP. This is capped at the rates indicated above. When the line reaches the cap, this means that there is surplus water that cannot be treated. This surplus will be pumped to underground storage at Elders or to the Goedehoop Return Water Dam.
- The green line indicates the demand from the WTP, in terms of water uses, including potable use and service water to the CMs and conveyor.

- The red line indicates the deficit between the water available (blue line) and demand (green line). It is evident that the water make will not be sufficient to meet the water demand during the dry winter months for the first six to seven years of the underground operation. After Year 7 (around 2024/25), no make-up water will be required.
- The black line indicates the surplus treated water, assuming that the water treatment plant is run at full treatment capacity. It is evident that even from Year 1 of mining there is expected to be surplus water make during the wet summer months, which would be discharged to the Olifants River if no alternative use or market could be found. From approximately 2026 (Year 9 of mining), there is expected to be a year-round water surplus.

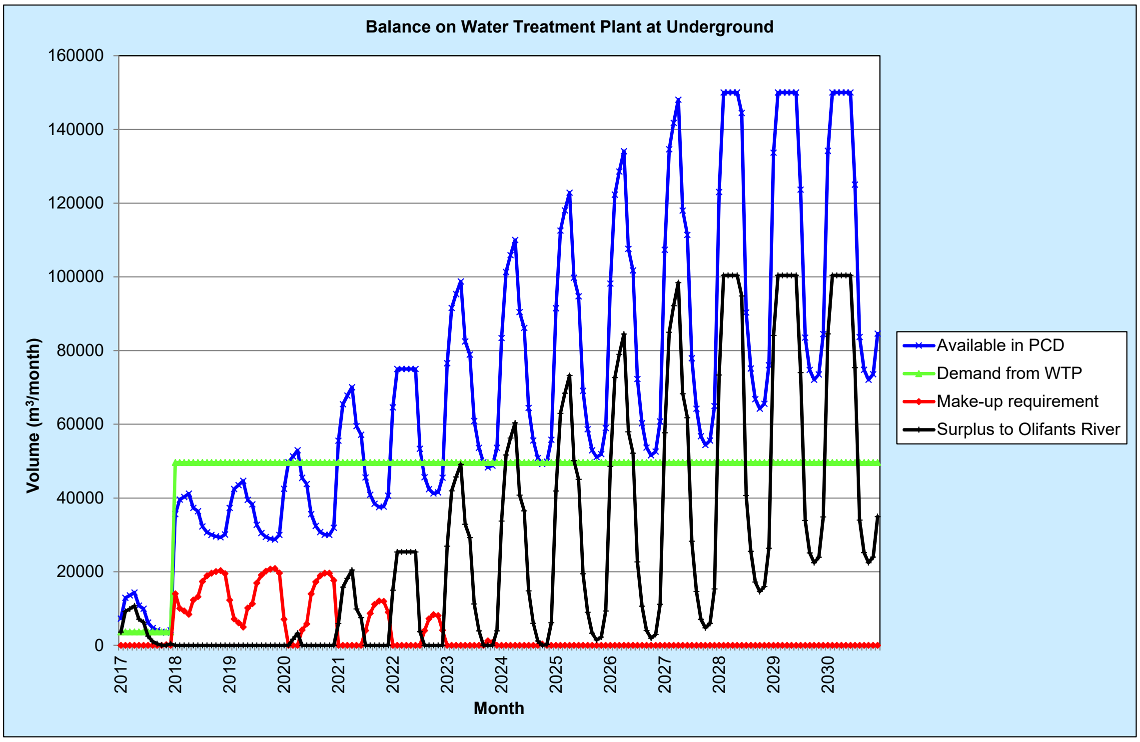


Figure 5.4.5(a) **Graph of modelled water make-up requirements and surplus water generated over LOM (2015 to 2040) – at the underground**

5.4.6 Availability of storage

The availability of storage in the underground workings (as determined by JMA) is shown in **Table 5.4.6(a)**.

Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the 2 Seam, surplus water will be stored in the underground workings at Elders.

The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.

Table 5.4.6(a) Availability of storage over LOM (excluding PCDs)

Year	Storage becoming available (m^3)	Total storage available in workings (m^3)
2017	-	0
2018	-	0
2019	-	0
2020	-	0
2021	-	0
2022	-	0
2023	-	0
2024	-	0
2025	23 380 317	23 380 317
2026	-	23 380 317
2027	-	23 380 317
2028	-	23 380 317
2029	-	23 380 317
2030	-	23 380 317
2031	25 336 541	48 716 858

5.4.7 Schematic water balance diagram

The schematic water balance diagram is presented in **Figures 5.4.7(a)** to **(c)** for the average water flows over the life of mine (2017 to 2030), over the operational period for the underground workings (2018 to 2030) and the average over the last 5 years of mining.

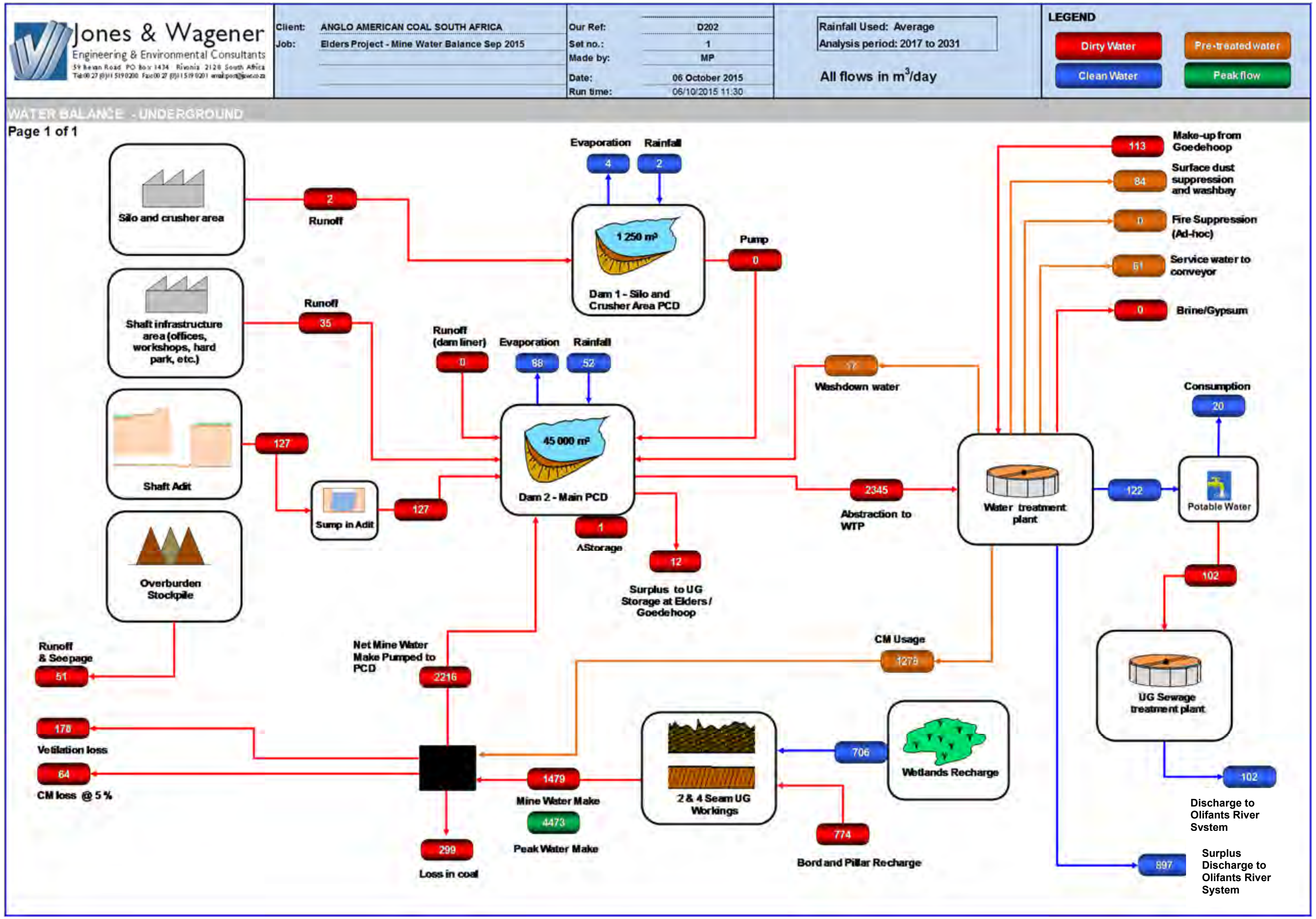


Figure 5.4.7(a) Schematic water balance diagram – average flows over the life of mine (2017 to 2030)

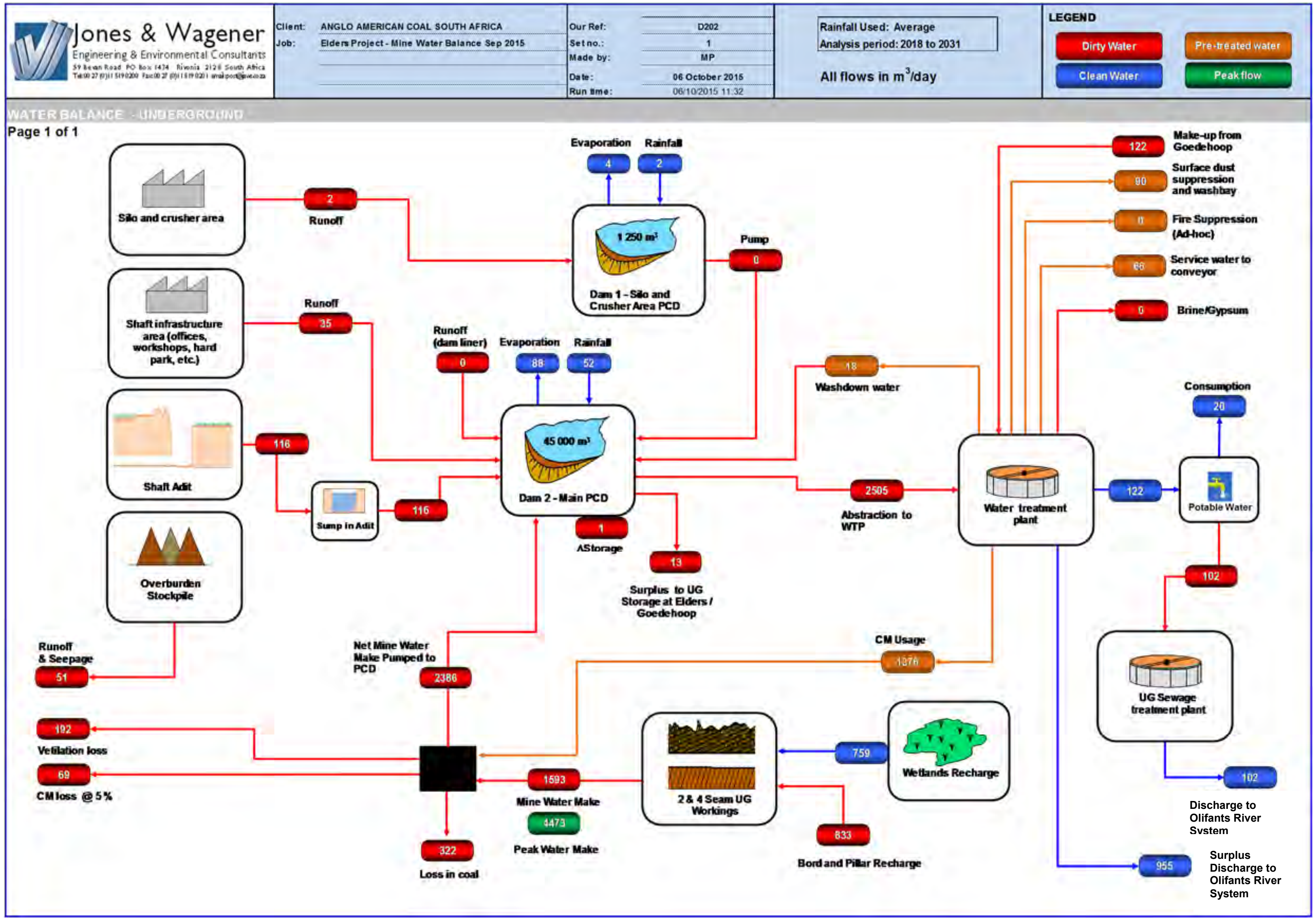


Figure 5.4.7(b) Schematic water balance diagram – average flows over the operational phase of the underground (2018 to 2030)

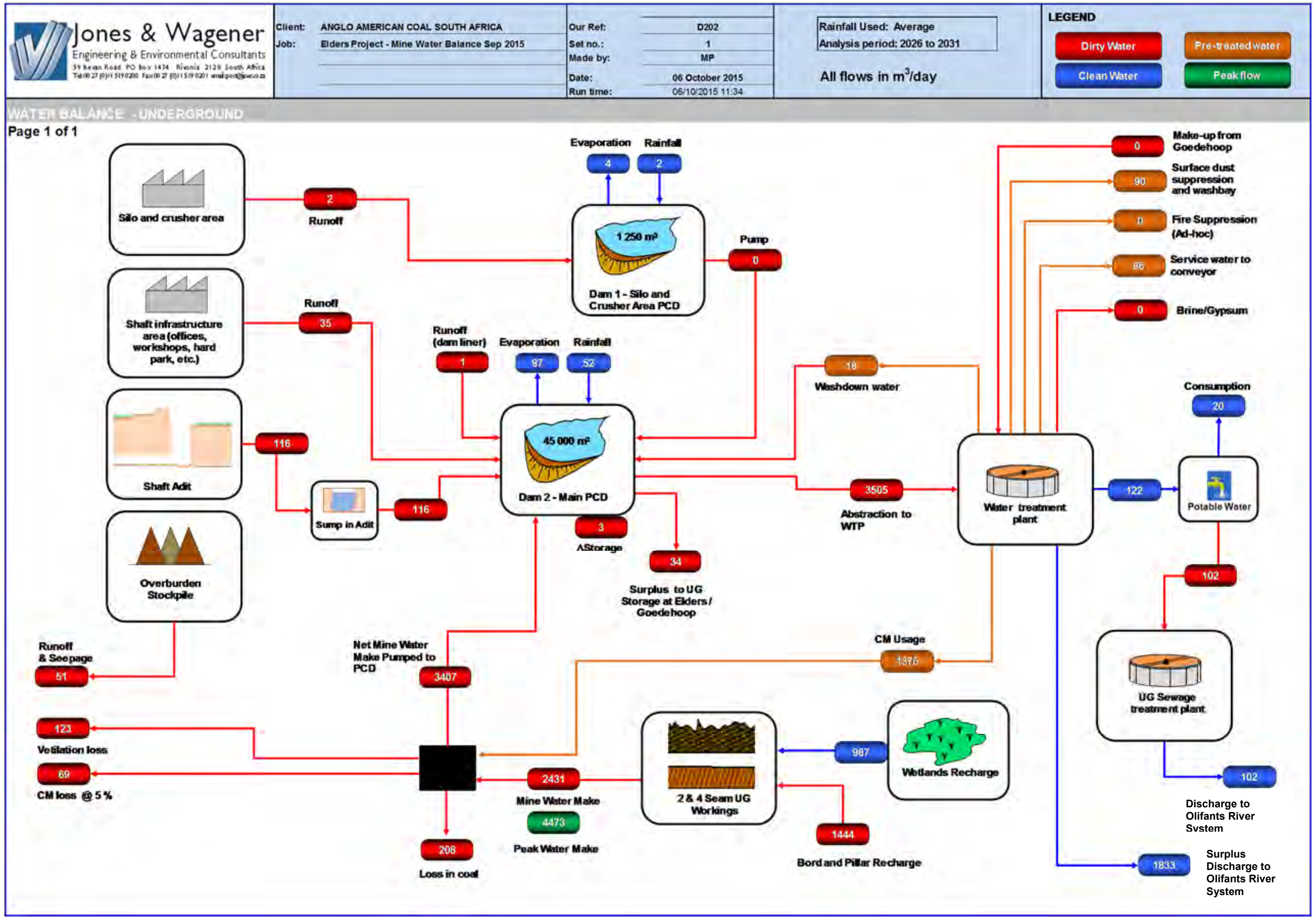


Figure 5.4.7(c) **Schematic water balance diagram – average flows during last 5 years of mining (2026 to 2030)**

5.4.8 Water management and storage requirements

5.4.8.1. Water management for average rainfall

Current planning is to provide a 45 Mℓ pollution control dam for the mine surface infrastructure areas and the underground shaft area. Contaminated surface water runoff and excess water from the underground will be discharged to the pollution control dams.

The modelled performance of the dams at the proposed treatment rates, over the LOM, is described in Section 5.4.4.

Surplus water that cannot be treated, reused or discharged to the Olifants River will be stored in the underground workings. Under **average rainfall** conditions, it is expected that underground storage will not be required if water can be treated to a quality that is acceptable for discharge, at a rate of 2.5 Mℓ/day from 2018 to 2022 and a rate of 5.0 0Mℓ/day from 2023 onwards.

There will therefore be adequate storage and treatment capacity available throughout the life of mine to accommodate the water make for **average rainfall**.

5.4.8.2. Storage required for extreme rainfall

Explanatory note on provision for extreme events

South African legislation, detailed in Government Notice Regulations 704 of 1999 (GNR 704), in terms of the National Water Act, Act 36 of 1998 (NWA), stipulates that dirty water on mining sites needs to be contained for events up to the 1:50 year recurrence interval. The Department of Water Affairs (DWA) Best Practice Guideline for water management defines a spill "event" as a series of spills occurring during a given 30 day period.

When determining storage requirements, it is important to understand that a particular recurrence interval does not refer to a single discrete event. For each recurrence interval there is an infinite number of events, depending on the storm duration considered. It is important to determine the appropriate storm duration to use, based on the assessment being carried out. Typically, for peak flow events, shorter duration events (< 24 hours) are considered, as these are of higher intensity and generate greater flow rates. However, for volumetric assessments (sizing of dirty water containment facilities), the duration used could be months, an entire season, or longer, as two or three months of high rainfall, for example, could raise a dam's water level to such an extent that a subsequent low recurrence interval storm could cause a spill event.

For extreme rainfall there are two considerations:

- Mine water balance management: During longer term extreme events (in the order of years), the management of the large volumes of water generated needs to be considered, in terms of available storage and reuse / treatment options.
- Surface water management: The sizing of the PCD will be driven by the storm water volumes generated on the surface infrastructure during short duration (in the order of one day to a few days) events.

The risk of spill from a PCD is a function of both dam capacity (for temporary storage of storm water runoff) and the rate at which water can be abstracted from the dam for reuse or storage elsewhere.

Although the legislation allows for the spillage of dirty water for events in excess of the 1:50 year event (2% risk of occurrence in any one year), it is Anglo American's policy to adopt a risk-based approach to determining an appropriate risk of spill.

Water balance management during long duration events

Storage requirements

To estimate the storage requirements during longer duration events, extreme annual events were considered. A statistical analysis was carried out on the historical rainfall record to determine the 1:50, 1:100 and 1:250 year annual, monthly and daily precipitation events. These values are shown in **Table 5.8.2(a)** below.

Table 5.4.8(a) Extreme rainfall depths

Recurrence Interval	Magnitude (mm)	Percentage of MAP
Mean Annual Precipitation (MAP)	715	
1:50 year	1052	147%
1:100 year	1111	155%
1:250 year	1190	166%

A synthetic daily rainfall record was generated for each of the above events using the daily rainfall distribution of the year with the wettest summer on record (2005/06). This was then aggregated to a synthetic monthly rainfall record.

The storage required for each year of mining was then estimated for the 1:50, 1:100 and 1:250 year events by modelling each year individually, for each event.

The estimated volumes of surplus water that cannot be treated during extreme annual events, i.e. water that will need to be pumped to storage in the underground workings, or be allowed to spill, have been estimated.

The results are shown in **Tables 5.4.8(b)** and **(c)** (for different water treatment rates.

The modelling indicates that with a treatment rate of 2 500 m^3/day an additional 121 000 m^3 of storage will be required to contain the mine water make by 2024, for **average** rainfall. Increasing the treatment rate to 5 000 m^3/day in 2025 will be sufficient to prevent spillage for **average** rainfall, but additional storage will still be required for extreme rainfall years.

Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the No. 2 Seam, surplus water will be stored in the underground workings at Elders.

The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.

Table 5.4.8(b) Excess water that cannot be treated in the WTP

Year	Available storage in workings (m^3)	Surplus water that cannot be treated – to be stored in underground workings or at Goedehoop (m^3)									
		Max treatment rate of 2 500 m^3/day					Max treatment rate of 5 000 m^3/day				
		Treatment rate (m^3/day)	Average rainfall	1:50 yr season	1:100 yr season	1:250 yr season	Treatment rate (m^3/day)	Average rainfall	1:50 yr season	1:100 yr season	1:250 yr season
2017	0	500	-	-	-	5 322	500	-	-	-	5 322
2018	0	2 500	-	-	-	-	2 500	-	-	-	-
2019	0	2 500	-	-	-	-	2 500	-	-	-	-
2020	0	2 500	-	-	-	-	2 500	-	-	-	-
2021	0	2 500	-	30 611	44 550	64 914	2 500	-	30 611	44 550	64 914
2022	0	2 500	-	116 861	137 295	164 516	2 500	-	116 861	137 295	164 516
2023	0	2 500	33 570	217 378	241 790	274 309	5 000	-	-	4 134	15 455
2024	0	2 500	120 654	334 003	363 201	402 098	5 000	-	24 045	34 440	55 829
2025	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2026	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2027	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2028	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2029	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2030	23 380 317	2 500	-	-	-	-	5 000	-	-	-	-
2031	48 716 858	2 500	-	-	-	-	5 000	-	-	-	-

Water balance management for short duration events

The volumes involved in short term events are significantly smaller than the long duration events. However, the ability to prevent spillage from the PCD is primarily dependent on the rate at which water can be pumped out of the dam for treatment, reuse or storage elsewhere. It is also dependent on the volume of water already stored in the dam at the onset of the extreme event. This in turn depends on a number of factors, including the preceding rainfall, as well as the stage in the season at which the extreme event occurs.

In the preceding sections it has been shown that adequate storage, treatment or pumping of surplus water to Goedehoop Colliery can be provided to prevent spillage for long duration (seasonal or annual) events.

The primary function of the Main PCD is to collect and contain storm water generated on the surface infrastructure areas during short duration, high intensity (in the order of one day to a few days) events. The Main PCD was sized by the design engineers using a water balance model (as detailed in Hatch report No. H349312-20000-226-210-0001 Rev B) to ensure that the dam will not spill more than once in a 50 year period. The required capacity for the Main PCD, as determined by the design engineers is 45 000 m^3. A graph of the modelled daily volume of water in the dam over the entire rainfall record is shown in **Figure 5.4.8(a)**, taken from the Hatch report.

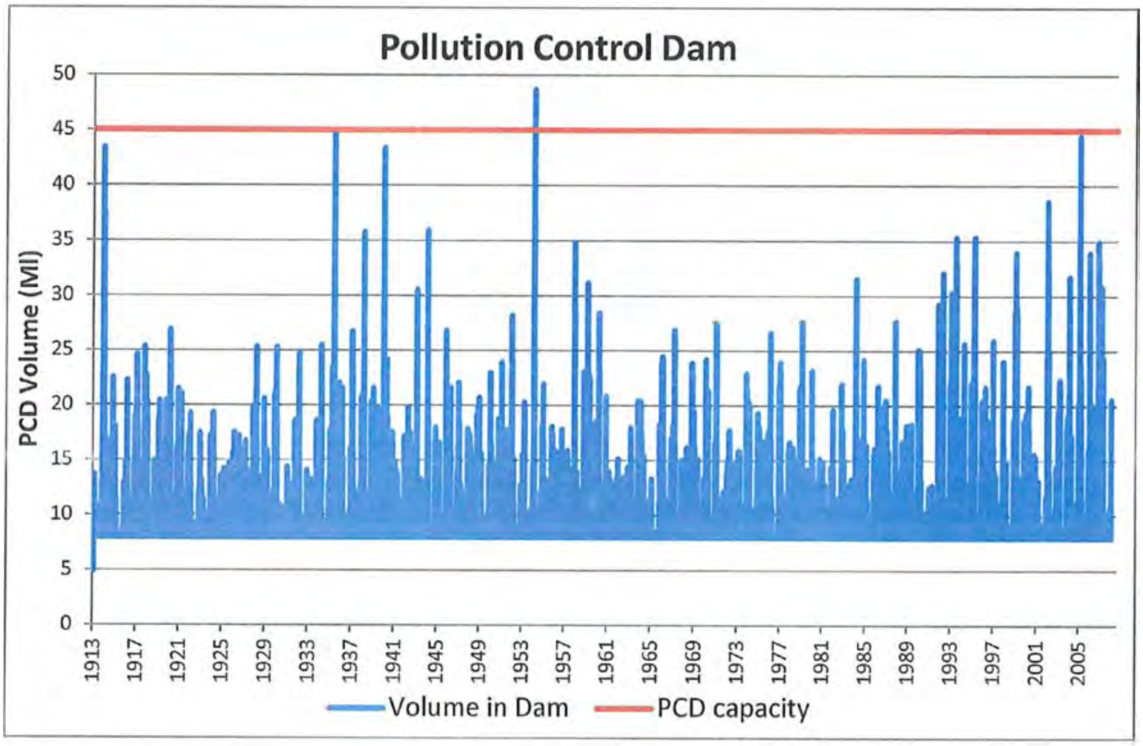


Figure 5.4.8(a) Daily modelled volume in Main PCD (Hatch, 2015)

5.4.8.3. Water management during dry periods

Current planning is to source water from Goedehoop South Colliery when required, including during the early years of mining and during dry periods when the mine water make is not sufficient to meet the water demands on site. The water balance for Goedehoop South Colliery (detailed in J&W report No. JW146/15/F215) indicates that there is sufficient water available at Goedehoop South to supply the Elders Project.

5.4.9 Brine and gypsum sludge management

The RO component of the water treatment plant will generate both a brine waste and a gypsum sludge product. The brine will be collected in Brine dams and the sludge will be placed on an appropriately lined drying pad with drainage directed to the brine dam, prior to being removed from site by a licensed waste removal contractor.

5.4.10 Post closure water make

Post closure the Elders surface infrastructure will be demolished and removed from the site. The shaft will be plugged with a concrete plug for safety reasons and backfilled using the material in the overburden stockpile, which will be rehabilitated and made free draining, including the pollution control dam and infrastructure areas.

Post rehabilitation, all surface runoff will be clean, and will be allowed to drain to the receiving environment.

The post closure water make is expected to amount to approximately 2 600 m^3/day. Note that post closure, recharge from the wetland area is expected to be approximately 990 m^3/day, or some 38% of the total post closure water make.

Once mining ceases, it is expected that approximately 48.7 million m^3 of storage will be available in the 2 and 4 seam workings.

The estimated time to decant, if the workings are left to fill post closure, has been estimated by JMA as 35 to 42 years.

An environmental safe water level for the workings (below decant elevation) will be determined and the water level will be maintained at or below this level by abstracting excess water via boreholes and pumping to a water treatment facility.

5.5 Salt balance

Salt balance modelling has been carried out to estimate the potential quality of the water on the mine, over the life of mine. The water qualities have been estimated as follows:

- Concentrations in the mine water make have been estimated by JMA for the underground workings, as shown in **Table 5.5(a)**. The values indicated as “low” and “high” were taken from the JMA groundwater report (JMA report No. Prj5924 dated September 2015). The values indicated as “likely” have been used in the salt balance modelling, and have been taken as the upper values indicated in the previous JMA report (JMA report No. Prj5924 dated 2013), as agreed by JMA in an email, dated 6 October 2015.
- Estimating the quality of runoff water from the mine infrastructure area (workshops, offices, etc.) is made difficult by the fact that water from such areas is seldom isolated and analysed. Typical measured water quality data was therefore not available and it was necessary to estimate. The assumed water quality of the runoff from the infrastructure area is given in **Table 5.5(b)**.

- The concentrations given in the tables were assumed to be applicable to average rainfall conditions.

Table 5.5(a) Estimated mine water quality during operational phase

Parameter	Operational Phase concentration (mg/l)		
	Low	Likely	High
TDS	200	1100	4500
SO_4	6	800	1600
Na	23	45	250

Table 5.5(b) Assumed runoff water quality from infrastructure area

Parameter	Assumed concentration (mg/l)
	Infrastructure area
TDS	384*
SO_4	200
Na	20

* Based on estimated EC of 60 mS/m, factored by 6.4

The salt balance for sulphate is given in **Figure 5.5(a)** for the LOM.

This should be considered a provisional salt balance, using the water balance in the previous sections, average rainfall and predicted water qualities for the mining area and surface infrastructure. The salt balance will need to be updated and refined once actual water qualities and flows are measured.

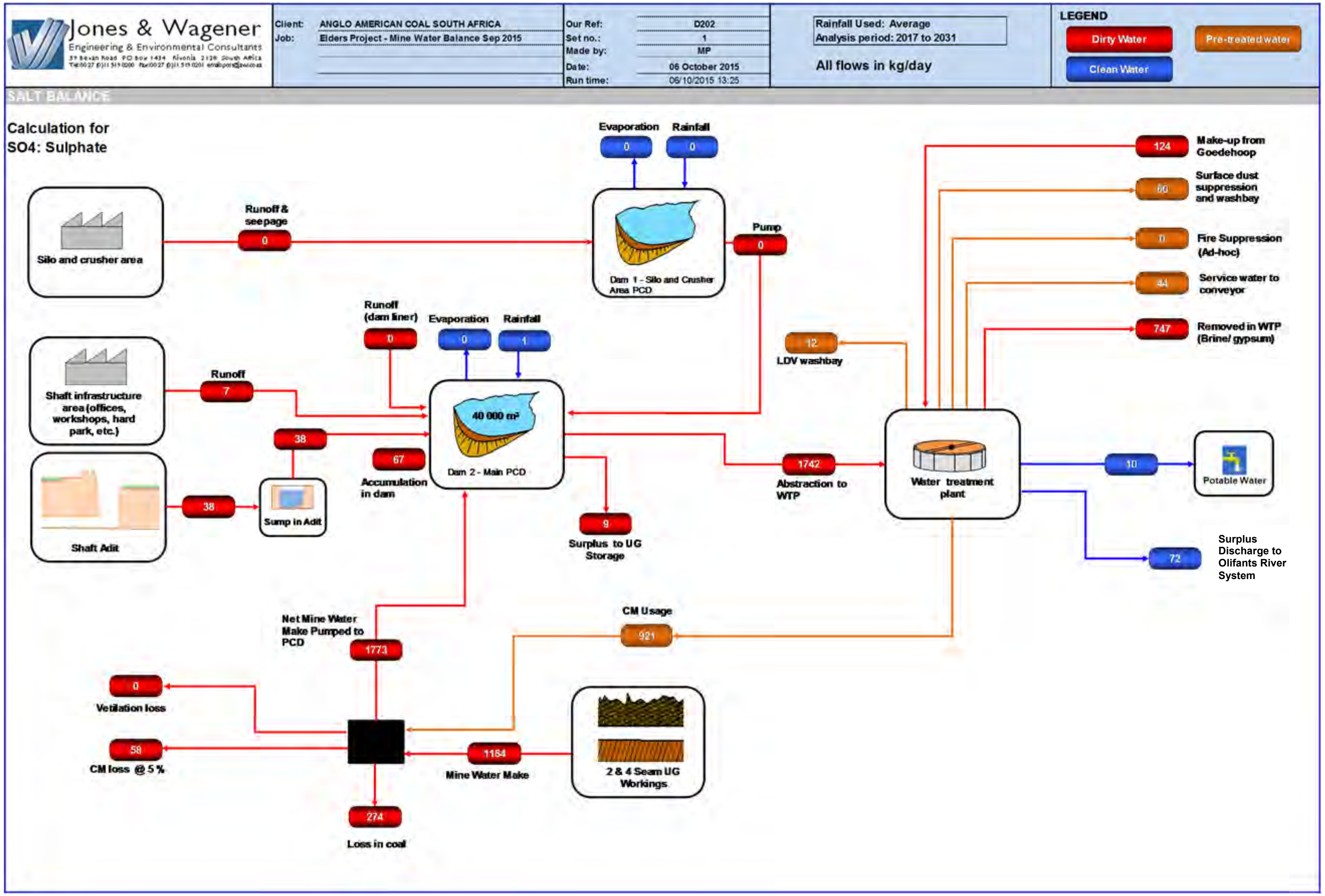


Figure 5.5(a) Salt balance diagram for underground, based on likely concentration: SO_4 at 800 mg/l

5.6 Conclusion

The water balance modelling indicates the following:

- The currently planned PCD capacity of 45 000 m^3 with a treatment capacity of 2.5 Mℓ/day, increasing to 5.0 Mℓ/day not later than 2023, is sufficient to prevent spillage for average rainfall.
- During long term extreme rainfall events, alternative storage will need to be provided in the period prior to 2025, when the 2 Seam mining is completed and the 2 Seam becomes available for storage. It is currently planned to pump the surplus water to Goedehoop Colliery.
- Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the 2 Seam, surplus water will be stored in the underground workings at Elders. The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.
- Legal compliance in terms of the NWA and GNR 704 can therefore be achieved with the currently proposed water management strategy.

The water balance will need to be refined as the mine design develops and the results presented here should be viewed as preliminary, for input to the mine design process.

6. BASELINE ENVIRONMENTAL DESCRIPTION

The baseline information is important for several reasons. These include assessment of possible impacts and setting of objectives for closure. However, for surface water it is also important that the mine is able to identify other point sources that may be impacting on surface water so that the origin of any future impacts can be identified.

6.1 Regional climate

The proposed Elders Colliery is located in the Mpumalanga Highveld region where the climate is characterised as generally dry. Summers are warm to hot with an average daily high temperature of approximately 27°C (with occasional extremes up to 35°C). Winters are mild to cold with an average daily high of approximately 15°C (with occasional extreme minima as low as -10°C). Frost and mist are frequently experienced during the winter months on the Mpumalanga Highveld.

The majority of precipitation is experienced during the summer months, mostly in the form of afternoon thundershowers. Mean annual precipitation (MAP) is 719 mm and the mean annual evaporation (MAE) is approximately 1345 mm.

6.2 Catchment description

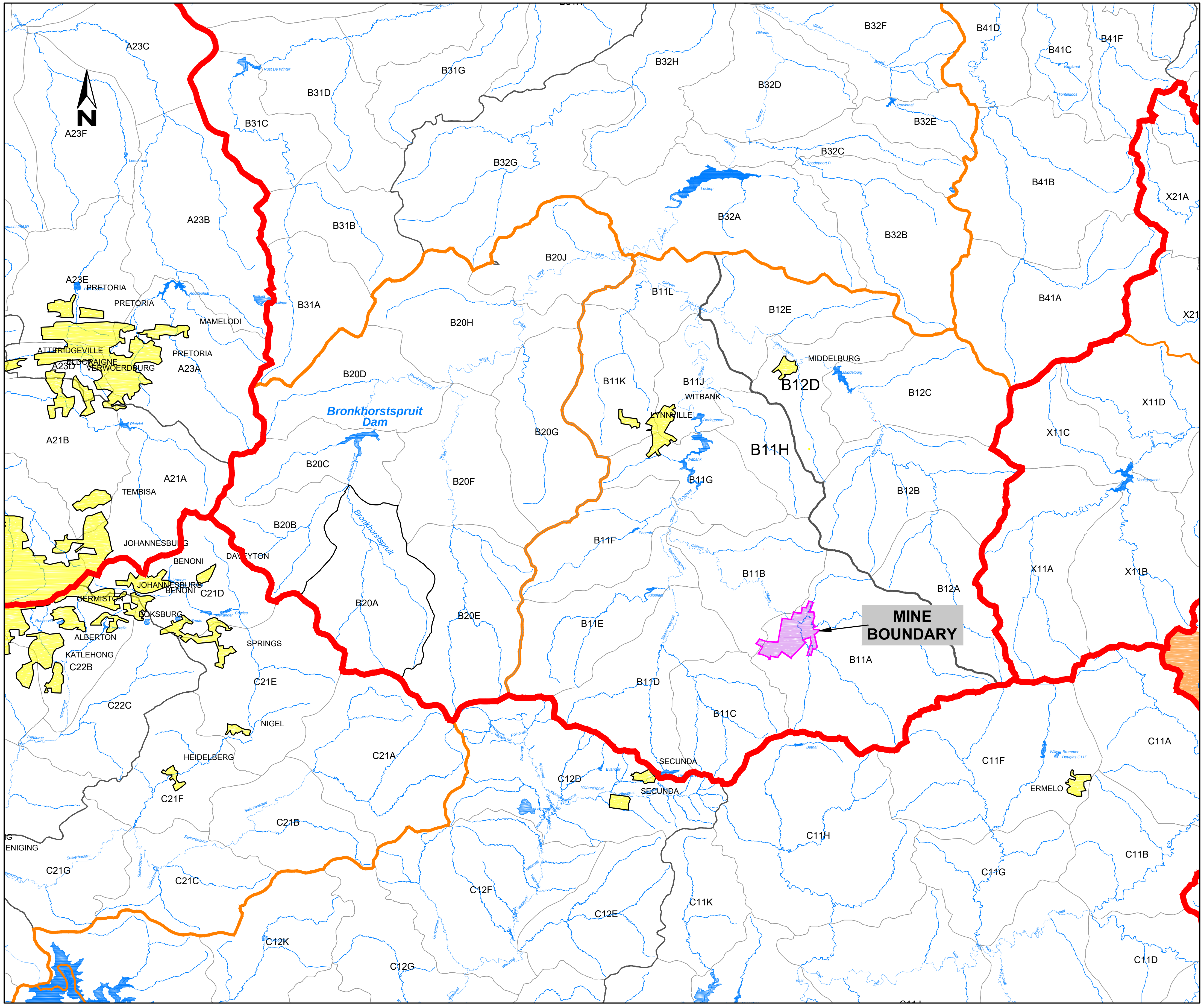
6.2.1 General description

The proposed Elders Colliery is situated within the Witbank Dam catchment, which is part of the Loskop Dam catchment. Majority of the mine property lies within the quaternary sub-catchment B11A, with a portion of the western tip of the mine boundary lying in quaternary sub-catchment B11B. Both fall within the Limpopo-Olifants primary drainage region (refer to **Figure 6.2.1(a)** taken from “Surface Water Resources of South Africa – 1990” Vol 1 (Midgley, Pitman & Middleton, 1995) (WR90)).

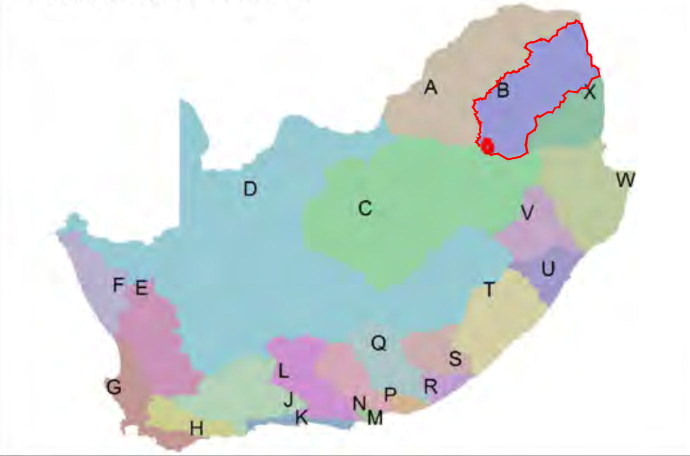
The site also falls within catchment management unit 8 (CMU 8), as show in **Figure 6.2.1(b)**.

All mining areas drain to the Olifants River. Much of the underground mining area underlies the Vlakkuilen and Viskuile Rivers and their floodplains.

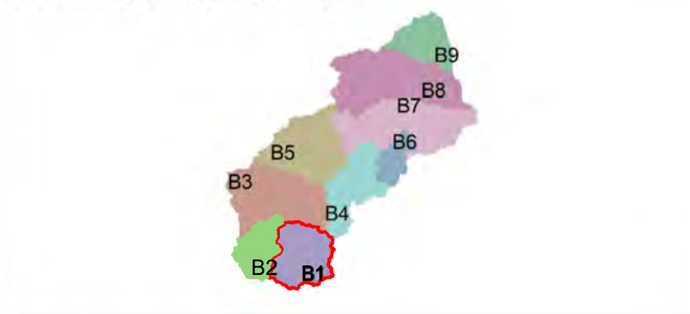
The Olifants River flows into the Witbank Dam, which in turn flows into the Loskop Dam. From the Loskop Dam, the Olifants River flows through Mpumalanga and the central part of the Kruger National Park to Mozambique.



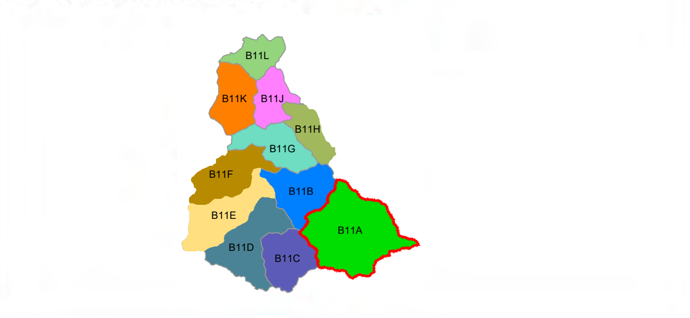
PRIMARY CATCHMENTS



SECONDARY CATCHMENTS



TERTIARY CATCHMENTS



General Notes

* Map From WRC: Surface Water Resources of SA 2005
* Book of Maps Version 1:

Legend

- Major towns and cities
- Rivers
- Impoundments
- Primary catchments
- Secondary catchments
- Tertiary catchments
- Quartenary catchments
- Quartenary sub-catchment B20A

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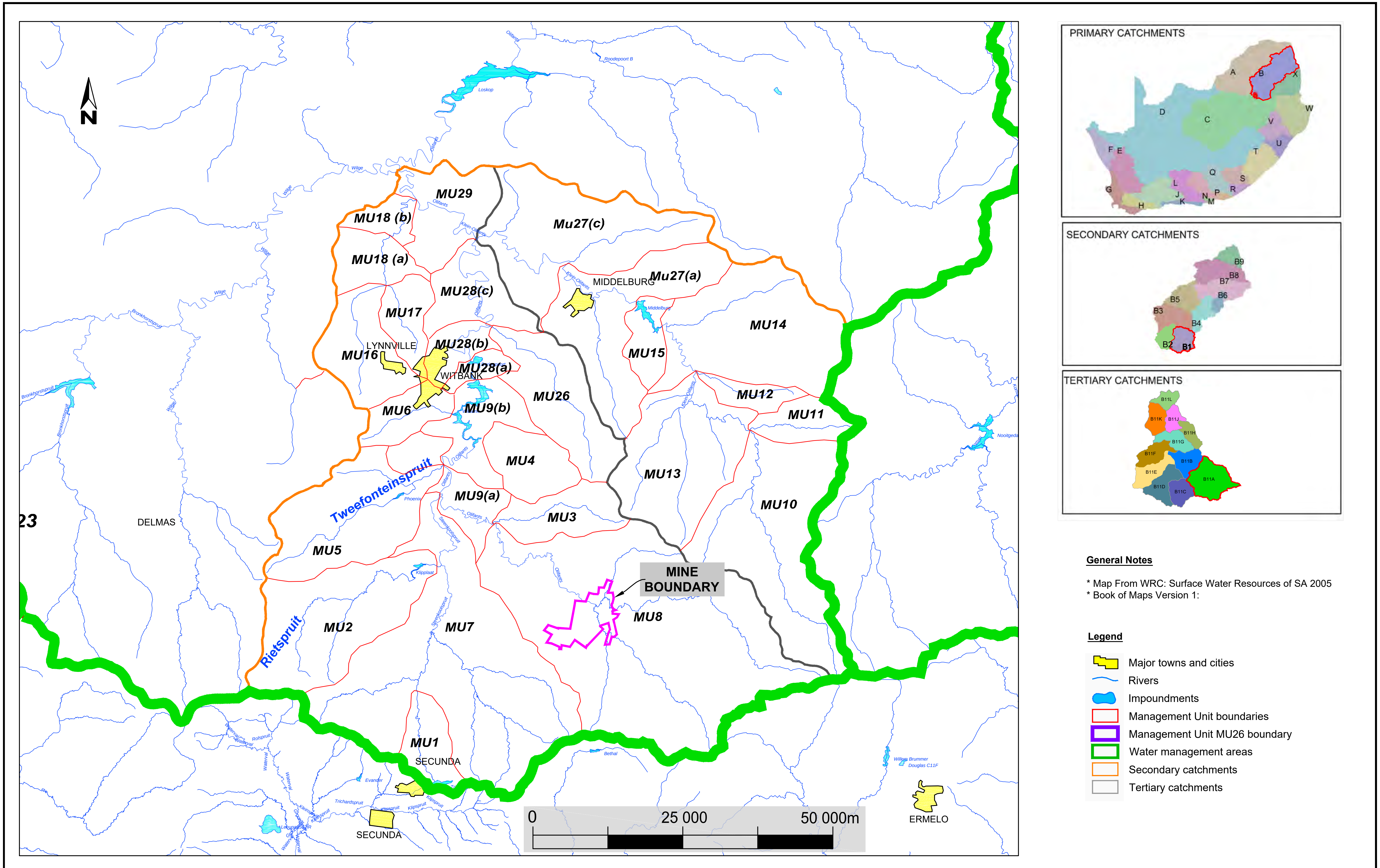
SRK Consulting
Elders Colliery

LOCATION OF SITE IN RELATION TO ITS CATCHMENT

Ø:D202/10

Figure 6.2.1(a)



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SRK Consulting
Elders Colliery

LOCATION OF SITE IN RELATION TO WATER MANAGEMENT UNITS

Ø: D202/10

Figure 6.2.1(b)

6.2.2 Receiving water body

The receiving water body for the assessment of the potential surface water quality impacts related to the proposed Elders Colliery is considered to be Witbank Dam. The use of this dam is motivated on the basis that:

- Beyond Witbank Dam, the potential impact of the mine becomes extremely small due to the water volumes in the catchment and dilution effects.
- Further, by the time the water reaches Witbank Dam it is required to be suitable for use for all of the expected uses (drinking water, agricultural, industrial and aquatic ecosystems). Thus, by achieving compliance in terms of these, no additional impacts are expected downstream of Witbank Dam. The receiving water body is relevant only in so far as it defines the aerial extent of the catchment to be considered in the impact assessment, and described in the baseline study.
- The use of Witbank Dam is based on the relatively small size of the Elders mine area compared to the catchment for Witbank Dam. The next large dam is Loskop Dam.
- The catchment area to the Witbank Dam, is reported as 3 579 km^2, while that for Loskop Dam totals some 12 285 km^2. The proposed area within the mine boundary is approximately 58.7 km^2. The mine area thus totals approximately 1.64% of the Witbank Dam catchment, and only some 0.48% of the Loskop Dam catchment.
- The mean annual runoff (MAR) for Witbank Dam is some 125 x 10^6 m^3, while the MAR for the proposed mining area is estimated at 2.57 x 10^6 m^3.

6.3 Rainfall and evaporation

6.3.1 Rainfall data

The Daily Rainfall Extraction Utility, developed by the Institute for Commercial Forestry Research (ICFR) in conjunction with the School of Bio-resources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, was used to obtain summary data for all rainfall stations within the vicinity of the site. These data were assessed in terms of length of record, completeness of the data set, mean annual precipitation (MAP) and location with respect to the site and the catchment. Key data extracted from the database for the six most reliable stations are shown in **Table 6.3.1(a)**. The ICFR database contains daily patched rainfall data for all official South African Weather Service (SAWS) stations, and includes data up to August 2000.

The Langsloot (0478292W) and Secunda (0478330W) stations have similar MAP, but cover different time spans. The record from Langsloot was therefore appended to the Secunda record to create a combined record with a length of 95 years. Having similar MAP and good, reliable data, combining the records was considered a reasonable approach to obtaining a longer rainfall record for use in the water balance modelling.

A mass plot was produced for the combined record and is shown in **Figure 6.3.1(a)**. A mass plot is a graph showing the cumulative rainfall depth vs. time for the full rainfall record, and is a good indication of the reliability of the data set. A good mass plot should produce a straight line (with slight oscillations for seasonality). Any changes in slope indicate a potential problem in the data set.

Table 6.3.1(a) Key data for selected rainfall stations (ICFR database)

Station number	Station name	MAP (mm)	Length of record
0478292W	Langsloot	719	1914 to 1992 (78 years)
0478330W	Secunda	719	1984 to 2008 (24 years)
0478862	Vlaklaagte	601	1906 to1956 (50 years)
0478837	Bethal	596	1903 to 1977 (74 years)

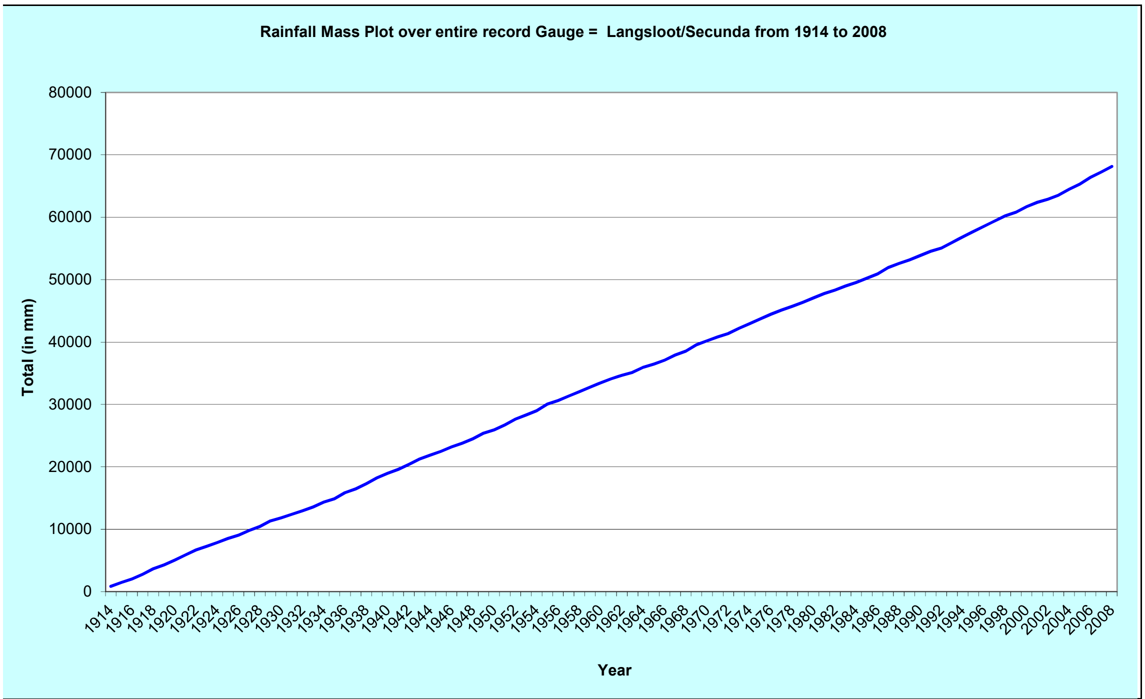


Figure 6.3.1(a) Rainfall mass plot for the combined rainfall record

The mass plot for the combined rainfall record was considered reasonable. The combined record was selected as the representative rainfall data set for the site and this was used in the water balance modelling.

The Langsloot/Secunda rainfall record was also analysed to look at the wet cycles. Extreme rainfall within the hydrological record seldom exceeds two to three years in duration, with the longest "wet cycle" approximately five years to peak. The data is given in terms of a 5 year moving average relative to the mean in **Figure 6.3.2(a)**.

Wet or extreme periods used in the modelling include the rainfall experienced in:

- 1992 and the following four years (wettest five years on record)
- 1951 and the following four years (second wettest five years on record)
- 2004 (short term peak)
- 1961 and the following four years (driest five years on record)

The average monthly rainfall depths are presented in **Table 6.3.1(b)**. The rainfall record is shown graphically in **Figure 6.3.2(a)**. Mean monthly rainfall is shown graphically, together with mean monthly evaporation in **Figure 6.3.2(b)**.

6.3.2 Evaporation data

Evaporation data for Elders was taken directly from *WR90*. The average monthly evaporation depths are presented in **Table 6.3.1(b)** and **Figure 6.3.2(b)**.

Table 6.3.1(b) Average monthly rainfall depths for SAWS station 0478292W Langsloot and 0478303 Secunda (based on period 1914 to 2008) and evaporation depths, from *WR90*

Month	Average rainfall (mm)	Average evaporation (mm)
October	77.2	139.7
November	112.1	133.4
December	121.9	148.7
January	129.9	147.8
February	90.5	129.1
March	82.0	127.4
April	38.0	98.0
May	19.9	81.6
June	9.6	64.7
July	6.8	69.2
August	8.9	89.4
September	21.8	115.9
Annual Total	**718.6**	**1344.9**

6.3.3 Maximum rainfall intensities

6.3.3.1. <u>Rainfall extremes</u>

Apart from the normal criteria of being statistically consistent, normally measured by considering the mass plot and ensuring it is linear, it is also important that the gauge have a long record, and within that record contain rainfall events that correspond to at least the 1:50 year event, since the legal requirement is that a mine should not spill for events up to the 1:50 year recurrence interval, or a 2% risk of spilling in any one year. The duration of the event can vary, and in most of the larger mines, the critical event is not a 24 hour event but rather above average rainfall over a period of several months, typically with several extreme rainfall events occurring during the wetter than average period.

The analysis was carried out using the RegFlood statistical analysis software programme. The data was assessed against a number of statistical distributions and the Log Pearson Type III distribution was found to produce the best fit. The statistically determined events, using the Log Pearson Type III distribution, for various recurrence intervals are presented in **Table 6.3.3(a)**.

It is evident that statistical extremes of 1:50 to in excess of 1:100 years have been recorded at the stations, making this station suitable for the water balance assessment.

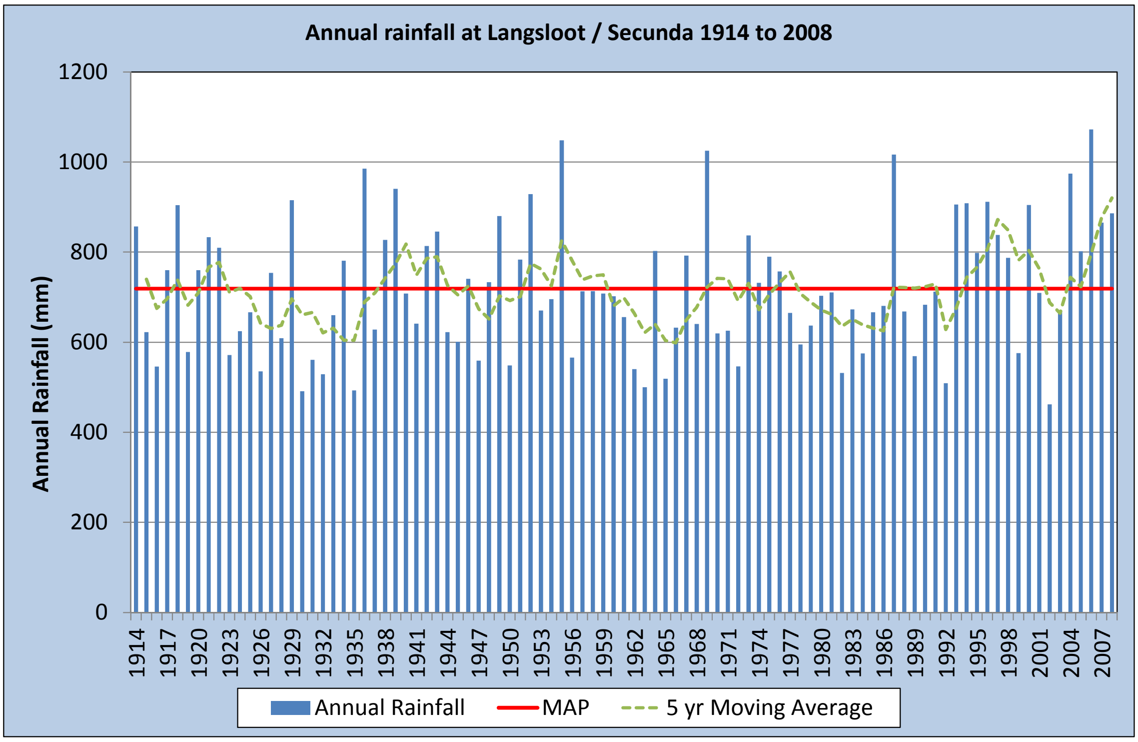


Figure 6.3.2(a) **Rainfall record for Langsloot/Secunda**

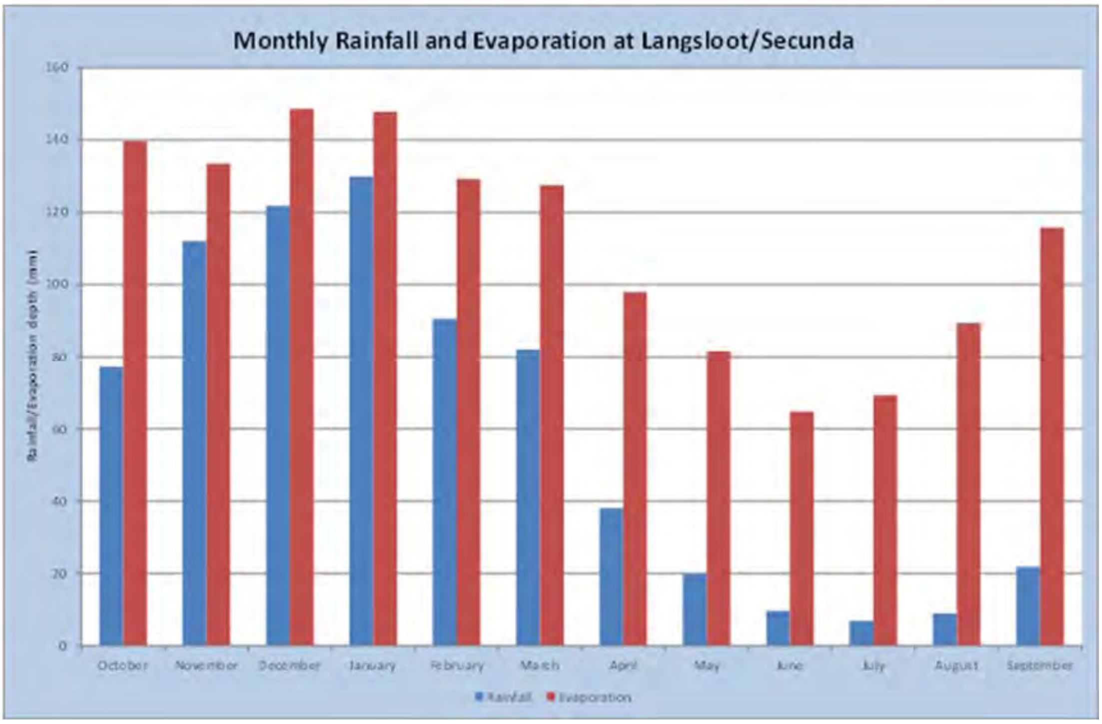


Figure 6.3.2(b) **Mean monthly rainfall and evaporation for Langsloot/Secunda**

Table 6.3.3(a) Statistical rainfall extremes for Langsloot/Secunda rainfall station

Event	Rainfall depth (mm)					
	1 day	2 day	3 day	7 day	1 month	Annual
1:2 yr	59	81	96	143	184	689
1:10 yr	88	117	132	182	246	886
1:20 yr	105	136	150	196	274	946
1:50 yr	132	166	178	215	314	1052
1:100 yr	157	194	202	230	346	1111
1:200 yr	188	226	230	244	382	1174
1:250 yr*	205	245	250	253	400	1190
Max Recorded	175	196	196	212	368	1068

6.4 Surface water quantity

6.4.1 Mean Annual Runoff (MAR)

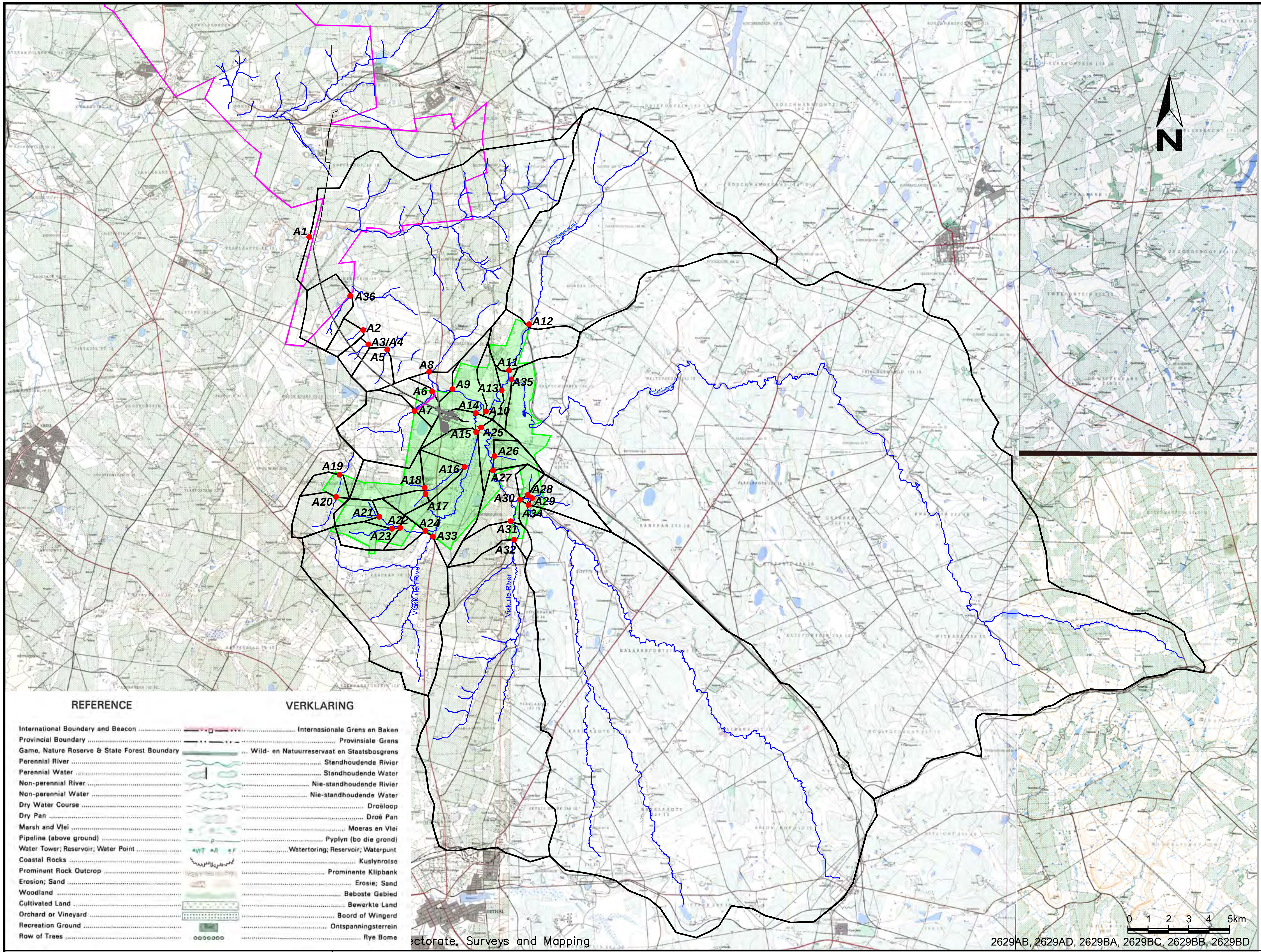
The gross MAR for quaternary sub-catchment B11A is quoted in *WR90* as 39 mm. Runoff modelling calibrated on the B1H018 (Olifants at Middelkraal) streamflow gauge gave a MAR of 43.7mm. The expected MAR for various catchments affected by the mining in relation to Witbank Dam is presented in **Table 6.4.1(a)**.

Table 6.4.1(a) above shows that the various catchments affected by the mining are small in relation to the Witbank Dam catchment. The location of the proposed mining area and the associated catchments considered in this study are shown in **Figure 6.4.1(a)**.

6.4.2 Dry weather flow (DWF)

An accepted definition for dry weather flow is that flow that is equaled or exceeded 70% of the time. DWF flows were therefore determined from the 30th percentile of the simulated flow record. These were compared to the deficient flow-duration-frequency graphs for the hydrozone into which the mining area falls, published in WR90. The simulated DWF was seen to be lower than predicted for the hydrozone. However, the simulated DWF was still selected based on the following:

- The coarseness of the hydrozone (covers a large area).
- The site is located high in the hydrozone and therefore we would expect to generate a lower base flow than regions lower down in the catchment.
- The flows for the hydrozone are generalised for the region, while the simulated flow has been calibrated against recorded flow data.
- The flows for the hydrozone are based on naturalised flows and do not account for changes in the catchment, abstractions etc. Calibrating on actual measured data should allows for these factors.
- It should be noted that selecting the lower DWF flows is more conservative in terms of assessing impacts on watercourses during dry seasons but less conservative if required environmental releases are to be obtained from these numbers.



Legend

ELDERS MINE AREA

CATCHMENT BOUNDARY

A33 CATCHMENT NODE

RIVER

CONVEYOR

GOEDEHOOP BLOCK 20

Scale 1 : 200 000 (A3)

CO-ORDINATE SYSTEM
CLARKE 1880 Lo29

Jones & Wagener
Engineering & Environmental Consultants
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
tel 0027 11 519 0200 www.jaws.co.za email: post@jaws.co.za

SRK Consulting
Elders Colliery

CATCHMENT BOUNARIES AND NODES

Ø: D202/10

Figure 6.4.1(a)

Table 6.4.1(a) MAR for catchments relevant to the proposed Elders Colliery

Catchment	Catchment area (km^2)	MAR ($x\ 10^6\ m^3$)	% of MAR at Witbank Dam	% of MAR at Loskop Dam
Elders Mine Boundary	58.7	2.57	2%	0.7%
A1	1070.00	46.81	37%	12%
A8	956.00	41.82	33%	11%
A9	939.84	41.11	33%	11%
A10	562.63	24.61	20%	6%
A11	81.33	3.56	3%	0.9%
A12	73.24	3.20	3%	0.8%
A13	539.94	23.62	19%	6%
A14	392.30	17.16	14%	4%
A15	65.88	2.88	2%	0.8%
A25	323.76	14.16	11%	4%
A27	318.91	13.95	11%	4%
A30	231.90	10.14	8%	3%
A31	81.92	3.58	3%	0.9%
A32	77.66	3.40	3%	0.9%
A33	35.00	1.53	1%	0.4%
A34	225.87	9.88	8%	3%
A35	457.11	20.00	16%	5%

The expected DWF for various catchments is presented in **Table 6.4.2(a)** and the catchments considered can be seen in **Figure 6.4.1(a)**.

6.4.3 Flood peaks and volumes

Several points of interest, or nodes, were identified for peak flow calculations. These were located where streams enter and exit the mining area, and are indicated on **Figure 6.4.1(a)**.

Catchment areas and slopes were determined from the contour plan provided by the client, as well as the 1:50 000 series topographical maps (2629 AB Vandykdrif, 2629 AD Bethal, 2629 BA Hendrina, 2629 BC Davel, 2628 BB Kendal, 2629 BD Breyten).

There are a multitude of methods available for the determination of peak flows, with the applicability of each method depending largely on catchment area, but also the region in which the peak flow is being determined.

The methods used were the Rational Method, the Standard Design Flood (SDF) method (Alexander, 2002), the Synthetic Unit Hydrograph method, the Regional Maximum Flood (RMF) method (Kovács, 1988) and the Direct Run-off Hydrograph (DRH) method.

Table 6.4.2(a) DWF for catchments relevant to the proposed Elders Colliery

Catchment	Catchment area (km^2)	Computed DWF (x 10^6 m^3 per month average)	Computed DWF (l/s average over month)
A1	1070.00	0.18	69.4
A8	956.00	0.16	62.0
A9	939.84	0.16	61.0
A10	562.63	0.09	36.5
A11	81.33	0.01	5.3
A12	73.24	0.01	4.8
A13	539.94	0.09	35.0
A14	392.30	0.07	25.5
A15	65.88	0.01	4.3
A25	323.76	0.05	21.0
A27	318.91	0.05	20.7
A30	231.90	0.04	15.1
A31	81.92	0.01	5.3
A32	77.66	0.01	5.0
A33	35.00	0.01	2.3
A34	225.87	0.04	14.7
A35	457.11	0.08	29.7

The peak flows calculated using each method were evaluated for each node and a representative value adopted. The 1:50, 1:100, 1:200 year and Regional Maximum Flood (RMF) for each node, together with catchment areas, are presented in **Table 6.4.3(a)**.

The flood volumes were based on the simplified hydrograph proposed by Kovacs, and the relationship between the Regional Maximum Flood and Mean Annual Runoff as derived from the measurement of various extreme flood events across South Africa, documented in various DWS (former DWA) publications.

Note that the Regional Maximum Flood (RMF) method is not applicable to catchments smaller than 1 km^2.

Table 6.4.3(a) Peak flows determined for Elders

Catchment	Area (km^2)	Recurrence interval	Flood Peaks (m^3/s)	Flood volume ($m^3 \times 10^6$)
A1	1070.00	50 year	1500	101.71
		100 year	2087	141.51
		200 year	3033	205.66
		RMF	2071	140.43
A2	4.75	50 year	69	0.24
		100 year	89	0.31
		200 year	109	0.38
		RMF	181	0.63
A3	1.73	50 year	39	0.08
		100 year	50	0.10
		200 year	61	0.12
		RMF	123	0.24
A4	1.42	50 year	35	0.06
		100 year	44	0.07
		200 year	54	0.09
		RMF	114	0.18
A5	3.17	50 year	63	0.17
		100 year	80	0.22
		200 year	99	0.27
		RMF	155	0.42
A6	14.40	50 year	59	0.40
		100 year	75	0.51
		200 year	92	0.63
		RMF	276	1.89
A7	11.39	50 year	49	0.29
		100 year	62	0.37
		200 year	77	0.46
		RMF	252	1.50
A8	956.00	50 year	1497	96.36
		100 year	2083	134.09
		200 year	3030	195.05
		RMF	1949	125.46
A9	939.84	50 year	1450	92.61
		100 year	2017	128.82
		200 year	2933	187.33
		RMF	1931	123.33

Catchment	Area (km²)	Recurrence interval	Flood Peaks (m^3/s)	Flood volume ($m^3 \times 10^6$)
A10	562.63	50 year	1838	94.56
		100 year	2461	126.62
		200 year	3490	179.56
		RMF	1435	73.83
A11	81.33	50 year	520	10.44
		100 year	697	13.99
		200 year	993	19.93
		RMF	532	10.68
A12	73.24	50 year	486	9.13
		100 year	654	12.29
		200 year	884	16.61
		RMF	511	9.60
A13	539.94	50 year	1543	76.35
		100 year	2078	102.83
		200 year	2953	146.12
		RMF	1432	70.86
A14	392.30	50 year	1439	61.48
		100 year	1926	82.28
		200 year	2730	116.63
		RMF	1205	51.48
A15	65.88	50 year	432	7.60
		100 year	583	10.26
		200 year	831	14.62
		RMF	491	8.64
A16	9.97	50 year	109	0.60
		100 year	139	0.76
		200 year	171	0.94
		RMF	240	1.32
A17	1.56	50 year	32	0.06
		100 year	40	0.07
		200 year	49	0.09
		RMF	118	0.21
A18	5.38	50 year	113	0.43
		100 year	144	0.55
		200 year	177	0.67
		RMF	190	0.72
A19	6.02	50 year	59	0.23
		100 year	75	0.30
		200 year	93	0.37
		RMF	198	0.78

Catchment	Area (km^2)	Recurrence interval	Flood Peaks (m^3/s)	Flood volume ($m^3 \times 10^6$)
A20	4.04	50 year	55	0.17
		100 year	70	0.22
		200 year	86	0.27
		RMF	170	0.54
A21	2.37	50 year	41	0.09
		100 year	52	0.11
		200 year	64	0.14
		RMF	139	0.30
A22	6.79	50 year	75	0.33
		100 year	96	0.42
		200 year	118	0.51
		RMF	207	0.90
A23	3.13	50 year	44	0.12
		100 year	56	0.15
		200 year	68	0.19
		RMF	154	0.42
A24	8.39	50 year	74	0.37
		100 year	95	0.47
		200 year	116	0.57
		RMF	224	1.11
A25	323.76	50 year	1220	47.72
		100 year	1635	63.95
		200 year	2321	90.79
		RMF	1086	42.48
A26	2.35	50 year	53	0.12
		100 year	67	0.15
		200 year	83	0.18
		RMF	138	0.30
A27	318.91	50 year	1243	48.30
		100 year	1667	64.78
		200 year	2363	91.82
		RMF	1077	41.85
A28	1.34	50 year	34	0.05
		100 year	43	0.07
		200 year	53	0.09
		RMF	112	0.18
A29	4.57	50 year	71	0.24
		100 year	90	0.30
		200 year	111	0.37
		RMF	178	0.60

Catchment	Area (km²)	Recurrence interval	Flood Peaks (m^3/s)	Flood volume (m^3 x 10^6)
A30	231.90	50 year	922	30.92
		100 year	1238	41.52
		200 year	1760	59.03
		RMF	907	30.42
A31	81.92	50 year	498	10.03
		100 year	671	13.52
		200 year	956	19.26
		RMF	533	10.74
A32	77.66	50 year	492	9.60
		100 year	661	12.89
		200 year	941	18.35
		RMF	523	10.20
A33	35	50 year	309	3.67
		100 year	417	4.96
		200 year	597	7.10
		RMF	386	4.59
A34	225.87	50 year	901	29.87
		100 year	1210	40.12
		200 year	1720	57.03
		RMF	894	29.64
A35	457.11	50 year	1397	64.08
		100 year	1880	86.24
		200 year	2667	122.34
		RMF	1308	60.00
A36	5.90	50 year	58	0.23
		100 year	74	0.29
		200 year	91	0.36
		RMF	196	0.78

6.4.4 Floodline determination

Floodlines were determined based on the calculated flood peaks at each node. A steady flow, backwater analysis was performed for each stream using the HEC-RAS river modelling system. HEC-RAS was developed by the United States Army Corps of Engineers, and is considered industry standard software for floodline determination in many countries, including the United States, the United Kingdom, Europe, Australia and South Africa.

When determining floodlines, each stream is defined by inputting a number of cross sections along the length of the stream. The mapping data used consisted of 1m contour interval dtm (digital terrain model), as well as an elevated 5 m contour interval dtm, received from the client.

It should be noted that the accuracy of the floodlines produced in this study is commensurate with the accuracy of the dtm data provided. With a contour interval of 1 m, the accuracy of the floodlines can be considered to be within 1 m vertically. Therefore the accuracy of the floodlines in areas where the 5 m contour interval dtm was used will be considerably less.

The floodlines given here are considered suitable for planning purposes only. Where infrastructure is to be located adjacent to streams, the floodlines should be determined more accurately using a digital terrain model (dtm) developed from a field survey at the area of concern.

The 1:50, 1:100 and 1:200 year floodlines have been computed for the proposed Elders mine boundary as well as along the conveyor route.

The floodlines can be seen in **Drawing No. D202-02-001 to D202-02-014** in **Appendix A** as well as in **Figure 6.4.4(a)**.

6.4.5 Drainage density

The drainage density of the Elders mining area is given below. The values given are based on the mining area outlined in **Figure 6.4.1(a)**.

- Length of drainage paths = 46 km
- Proposed total reserve extent = 58.7 km^2
- Drainage density = 0.78 km/km^2

6.4.6 Watercourse Alterations

Watercourse alterations planned for Elders Colliery are described in Section 4.7.

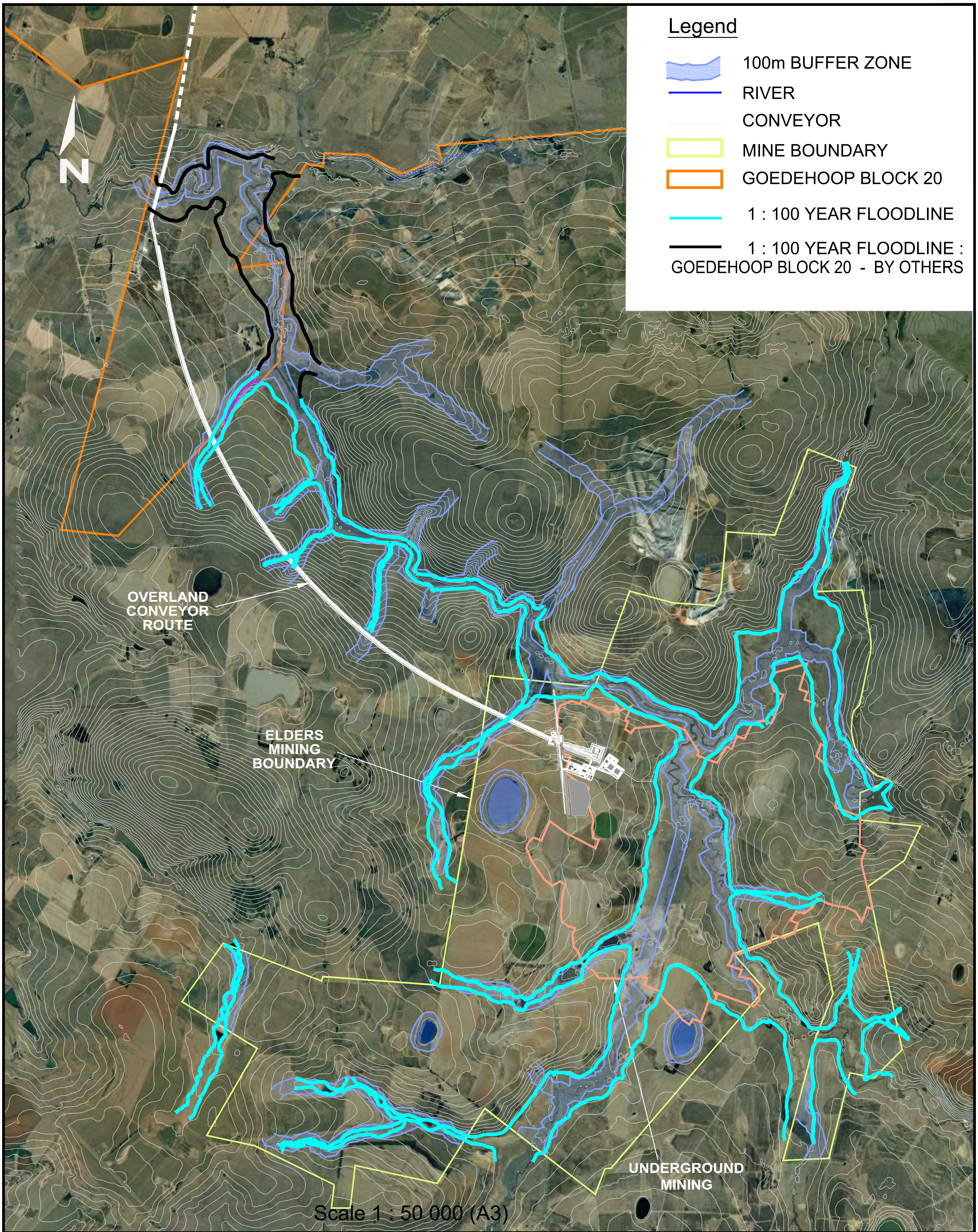
6.5 Surface water quality

The baseline surface water quality is described in this section.

J&W were appointed by Oryx Environmental in 2005/6 to compile the Surface Water specialist report for the proposed Elders mine. This included baseline surface water sampling and hydrology, as well as a mine water balance and an interim, incomplete draft report was submitted in September 2006. The project was, however, discontinued before the impact assessment, mitigation and IWULA were completed.

Baseline water quality sampling undertaken in the 2005/6 study is out-dated but has been included in this assessment for completeness. Updated monthly sampling over a 12 month period (i.e. from Aug 2012 to July 2013) was carried out. The baseline surface water quality monitoring programme has been expanded to include 19 locations, consisting of 6 locations along the conveyor and 13 located where streams enter and leave the mine boundary. Each location was sampled 12 times, being once a month over a period of one year.

The monitoring protocol for the proposed Elders Colliery can be seen in **Appendix B**.



Jones & Wagener Engineering & Environmental Consultants 59 Bevan Road PO Box 1434 Rivonia 2128 South Africa tel: 0027 11 519 0200 www.jaws.co.za email: post@jaws.co.za	SRK Consulting Elders Colliery **FLOODLINES**	Ø:D202/10 **Figure 6.4.4(a)**

6.5.1 *Surface water quality monitoring locations*

The surface water monitoring points for the previous baseline study as well as the updated baseline study for the proposed Elders Colliery are illustrated in **Figure 6.5.1(a)** and the coordinates to these points are given in **Table 6.5.1(a)**.

Table 6.5.1(a) Description and co-ordinates of surface water monitoring locations

Sampling Location	Description	Farm Portion	Coordinates
2005/6 Surface water study monitoring points			
E8	Tributary of the Olifants River	Middelkraal 50 IS	X: 2902540.04 Y: -48267.93
E9	On Olifants River downstream of the proposed 2005/6 activities	Middelkraal 50 IS	X: 2901234.50 Y: -46264.50
E10	Along the Viskuile River upstream of the proposed 2005/6 activities	Schurvekop 227 IS	X: 2906626.29 Y: -49545.91
E11	Along the Olifants River upstream of the proposed 2005/6 activities	Halfgewonnen 190IS	X: 2902428.67 Y: -52595.12
E12	Along the Leeufontienspruit	Middelkraal 50 IS	X: 2892752.96 Y: -53927.84
E13	Along the Olifants River Downstream of the proposed 2005/6 activities	Klienfontein 49 IS	X: 2896378.00 Y: -42095.26
Updated 2013 Surface water study monitoring points			
ESW01	At the Pan (Vlakkuilen Pan)	Vlakkuilen 78 IS	X : 2903338.084 Y: -45540.273
ESW02	At the Pan to the east of the Vlakkuilen River	Schurvekop 227 IS	X: 2906949.854 Y: -48297.872
ESW03	Along the proposed conveyor	Vlakkuilen 78 IS	X: 2902215.422 Y: -45378.899
ESW04	Along the proposed conveyor	Klienfontein 49 IS	X: 2897645.516 Y: -41030.847
ESW05	Along the proposed conveyor	Klienfontein 49 IS	X: 2898000.461 Y: -41194.103
ESW06	Along the proposed conveyor	Klienfontein 49 IS	X: 2899011.434 Y: -41924.440

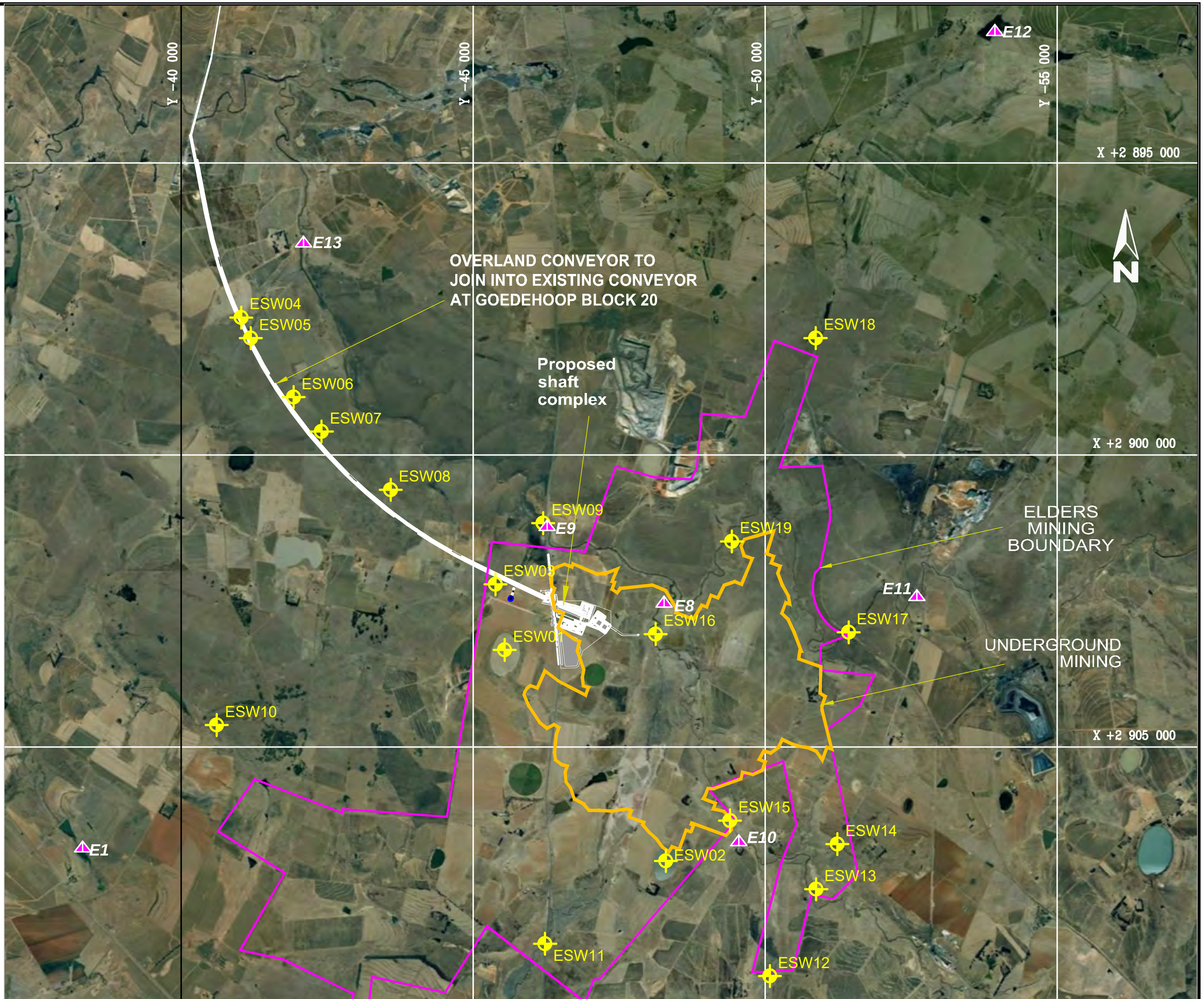
Sampling Location	Description	Farm Portion	Coordinates
ESW07	Along the proposed conveyor	Klienfontein 49 IS	X: 2899600.061 Y: -42405.242
ESW08	Along the proposed conveyor	Schoonvlei 52 IS	X: 2900597.746 Y: -43586.449
ESW09	Along the Olifants River downstream of the workings	Middelkraal 50 IS	X: 2901166.105 Y: 46197.032
ESW10	Tributary of the Olifants River downstream of the proposed activities	Elandsfontein 147 IS	X: 2904623.429 Y: -40608.862
ESW11	Along Vlakkuilen River upstream of the proposed activities	Vlakkuilen 78 IS	X: 2908368.320 Y: -46231.212
ESW12	Along Viskuile River upstream of the proposed activities	Schurvekop 227 IS	X: 2908923.838 Y: -50076.867
EWS13	Along Viskuile River upstream of the proposed activities	Schurvekop 227 IS	X: 2907434.531 Y: -50872.659
ESW14	Along a Tributary Viskuile River upstream of the proposed activities	Schurvekop 227 IS	X: 2906662.004 Y: -51232.102
ESW15	Along Viskuile River upstream of the proposed activities	Schurvekop 227 IS	X: 2906949.854 Y: -48297.872
ESW16	Along Viskuile River downstream of the proposed activities	Middelkraal 50 IS	X: 2903065.150 Y: -48122.063
ESW17	Tributary of the Olifants River upstream of the proposed activities	Halfgewonnen 190IS	X: 2903038.933 Y: -51425.841
ESW18	Along the Leeufontienspruit	Middelkraal 50 IS	X: 2897996.425 Y: -50860.666
ESW19	Along the Olifants River upstream of the proposed activities	Middelkraal 50 IS	X: 2901478.832 Y: -49424.521

Legend

- Conveyor
- Mine Boundary
- Extent of Underground Mining
- ESW04 Monitoring Points (2013)
- E13 Monitoring Points (2005/06)

COORDINATE SYSTEM CLARKE 1880 LO29 2005/6 Monitoring Points		
POINT	**Y**	**X**
E8	-48267.93	2902540.04
E9	-46264.50	2901234.50
E10	-49545.91	2906626.29
E11	-52595.12	2902428.67
E12	-53927.84	2892752.96
E13	-42095.26	2896378.00

COORDINATE SYSTEM CLARKE 1880 LO29 Current and 2013 Monitoring Points		
POINT	**Y**	**X**
ESW01	-45540.27	2903338.08
ESW02	-48297.87	2906949.85
ESW03	-45378.89	2902215.42
ESW04	-41030.84	2897645.51
ESW05	-41194.10	2898000.46
ESW06	-41924.44	2899011.43
ESW07	-42405.24	2899600.06
ESW08	-43586.44	2900597.74
ESW09	-46197.03	2901166.10
ESW10	-40608.86	2904623.42
ESW11	-46231.21	2908368.32
ESW12	-50076.86	2908923.83
ESW13	-50872.66	2907434.53
ESW14	-51232.10	2906662.00
ESW15	-48297.87	2906949.85
ESW16	-48122.06	2903065.15
ESW17	-51425.84	2903038.93
ESW18	-50860.67	2897996.42
ESW19	-49424.52	2901478.83



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SURFACE WATER MONITORING POINTS

Ø: D202/10

Figure 6.5.1(a)

6.5.2 Surface water quality objectives

There are various standards and objectives in terms of surface water quality, depending on what the end use is to be. Some of these include the Department of Water Affairs' (DWA) Water Quality Guidelines and the SANS 241 Drinking Water specifications. In some cases however there are more specific standards in terms of the catchment itself, as determined by the Catchment Management Agency (CMA).

The proposed Elders Colliery falls within the Olifants River water management area, and within the MU 8 management unit. **Figure 6.2.1(b)** shows the site in relation to its catchment MUs.

The Directorate National Water Resource Planning (DNWRP) of the (then) Department of Water Affairs and Forestry (DWAF) developed a water quality management strategy for the Upper and Middle Olifants River catchment, which was published in 2009 (DNWRP, 2009). One of the key elements of this strategy is interim Resource Water Quality Objectives (RWQO).

The results of the water quality monitoring undertaken at the proposed development site were compared to the interim RWQO for MU 8, indicated in **Table 6.5.2(a)**.

6.5.3 Baseline water quality analysis

The 2005/6 baseline water quality results can be seen in **Table 6.5.3(a)** and updated baseline water quality results, which spanned a full year from August 2012 to July 2013, can be seen in **Table 6.5.3(b)**. **Tables 6.5.3(a)** and **(b)** tabulate the average, maximum and minimum surface water quality data as sampled in 2005/6, as well as updated sampling between August 2012 and July 2013. The data shown is for the entire proposed Elders Colliery project area. The monitoring points are indicated on **Figure 6.5.1(a)**.

Please note that the results given in **Tables 6.5.3(a)** and **(b)** were compared to the interim RWQO for catchment management unit MU 8. Values in red indicate where the interim RWQO are exceeded.

Figures 6.5.3(a) to **(c)** indicate the outcome of the comparison of the surface water quality measured (i.e. 2013 data) at the monitoring locations with the interim RWQO for MU8 for pH, SO_4 and EC respectively. The water quality laboratory results are given in **Appendix B**.

6.5.4 Baseline water quality interpretation

The values for various constituents measured around the Elders site were compared to the interim RWQO for catchment management unit MU 8. pH, SO_4, EC and heavy metals (Iron (Fe), Manganese (Mn), Aluminium (Al) and Boron (B)) are discussed below. In addition the updated water quality results are compared to the 2005/6 study results.

6.5.4.1. pH

The pH of natural waters is a measurement of the acidity/alkalinity and is the result of complex acid-base equilibrium of various dissolved compounds. The pH of most raw water sources is within the range of 6.5 - 8.5 (DWAF, 1996). A decrease in the pH of water in a mining area will be an indication of acid mine drainage (AMD).

Table 6.5.2(a) Interim Resource Water Quality Objectives for the Witbank Dam Catchment

Constituent	Unit	MU 8	Witbank Dam
PHYSICAL			
Electrical conductivity (EC)	mS/m	60	70
Dissolved oxygen (DO)	% Sat	70	70
pH	-	6.5-8.4	6.5-8.4
Suspended solids	mg/ℓ	-	25
Turbidity	NTU	-	50
CHEMICAL, INORGANIC			
Alkalinity	mg $CaCO_3$/ℓ	-	120
Boron (B)	mg/ℓ	0.5	0.5
Calcium (Ca)	mg/ℓ	40	32
Chloride (Cl)	mg/ℓ	25	25
Fluoride (F)	mg/ℓ	1.0	1.0
Magnesium (Mg)	mg/ℓ	25	20
Potassium (K)	mg/ℓ	50	25
Sodium (Na)	mg/ℓ	70	70
Sodium Absorption Ration (SAR)	$Meql^{0.5}$	1.5	1.5
Sulphate (SO_4)	mg/ℓ	80	155
Total Dissolved Solids (TDS)	mg/ℓ	440	450
CHEMICAL, ORGANIC			
Dissolved Organic Carbon (DOC)	mg/ℓ	10	10
METALS, DISSOLVED			
Iron (Fe)	mg/ℓ	1.0	0.10
Manganese (Mn)	mg/ℓ	0.4	0.18
Aluminium (Al)	mg/ℓ	0.02	0.02
Chromium VI (Cr VI)	mg/ℓ	0.05	0.05
PLANT NUTRIENTS			
Ammonia (NH_3)*	mg/ℓ as N	0.007	0.007
Nitrate (NO_3)	mg/ℓ as N	6	6
Phosphate (PO_4)**	mg/ℓ as P	0.05	0.02
Total phosphorus**	mg/ℓ as P	0.25	0.05
Total Inorganic Nitrogen**	mg/ℓ as N	1.25	0.25
MICROBIOLOGICAL			
E. coli	# per 100 mℓ	130	130
Chlorophyll a	mg/ℓ	0.02	0.015

* Free ammonia as NH_3
** Median Concentration Values (50 percentiles)

The 2005/6 results show that the monitoring locations are compliant to the interim RWQO. However, the updated 2013 results in **Table 6.5.3(b)** indicate a very high pH of above 8.4 for the two pans, along the Olifants River, Vlakkuilen and Viskuile Rivers Leeufontienspruit, as well as around the project area (monitoring locations EWS01, ESW02, ESW06, ESW09, ESW10, ESW11, ESW13, ESW15, ESW16, ESW17, ESW18 and ESW19), also indicated in **Figure 6.5.3(a)**. This may be due to farming activities in the surrounding area that have expanded over the last 5 to 7 years.

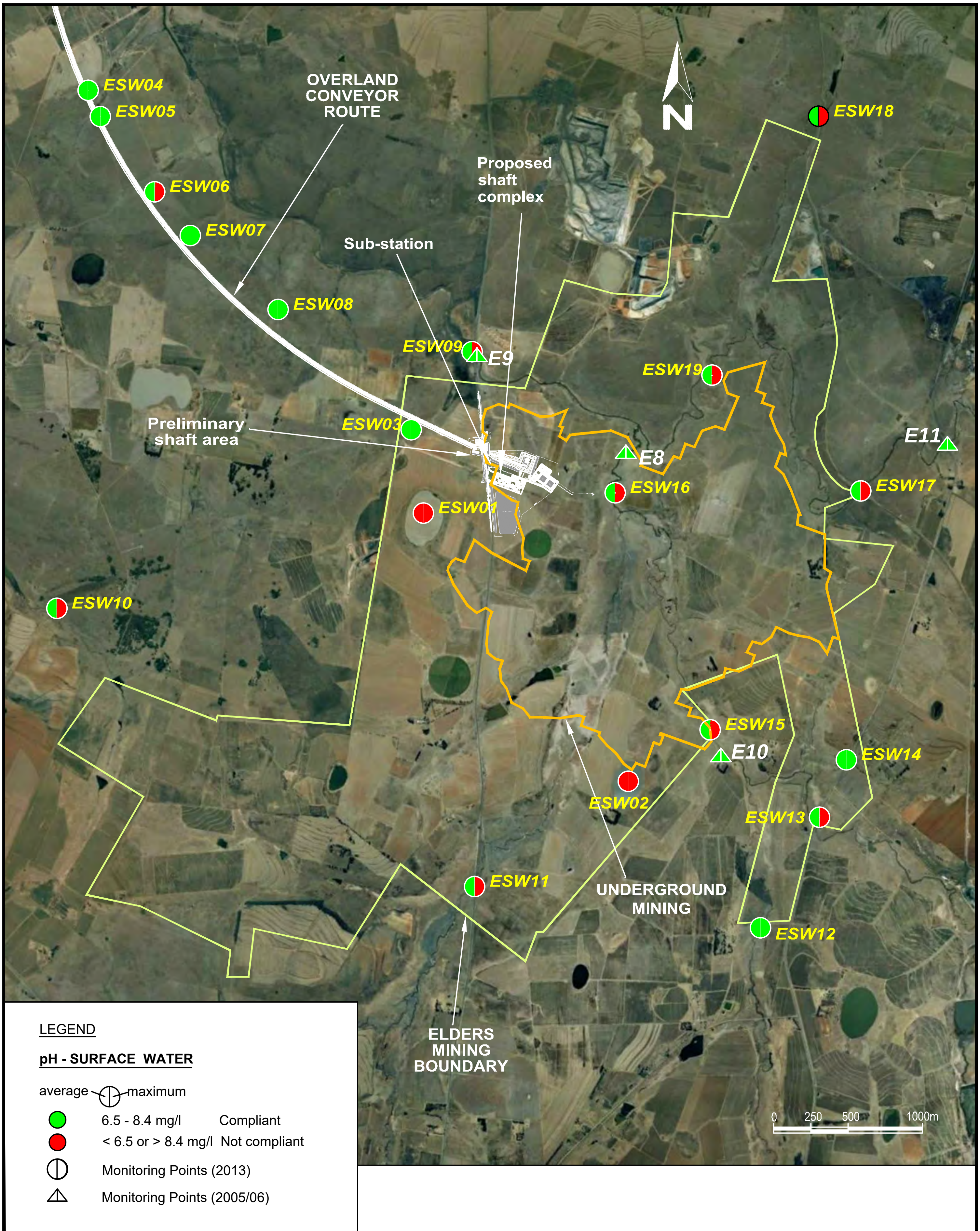
The time series graph indicating the pH values for the 12 month period at each the monitoring locations, together with the interim RWQO can be seen in **Figures 6.5.4(a)** to **(d)**.

6.5.4.2. Sulphate (SO_4)

The concentration of sulphates in surface water is typically low (~5 mg/ℓ), although concentrations of several hundred mg/ℓ may occur where dissolution of sulphate minerals or discharge of sulphate-rich effluents takes place (DWAF, 1996). AMD decanting or seeping from mining areas can increase the sulphate in surface water significantly. Chemical fall-out during rain events in areas where coal burning takes place can also increase the sulphate content of surface water bodies.

The 2005/6 results show that along the Olifants River elevated sulphates were found. Current studies show the same, with elevated values of sulphates found at both pans, along the Olifants River, Vlakkuilen and Viskuile Rivers, Leeufontienspruit, as well as around the project area (monitoring locations ESW01, ESW02, ESW03, ESW09, ESW10, ESW11, ESW12, ESW14, ESW15, ESW16, ESW17, ESW18 and ESW19). These are indicated in **Figure 6.5.3(b)**. This baseline water quality indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

The time series graph indicating the SO_4 concentration for the 12 month period at the monitoring locations, together with the interim RWQO for SO_4, being 80mg/ℓ, as indicated in red, can be seen in **Figures 6.5.4(e)** to **(h)**.



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SURFACE WATER QUALITY - pH

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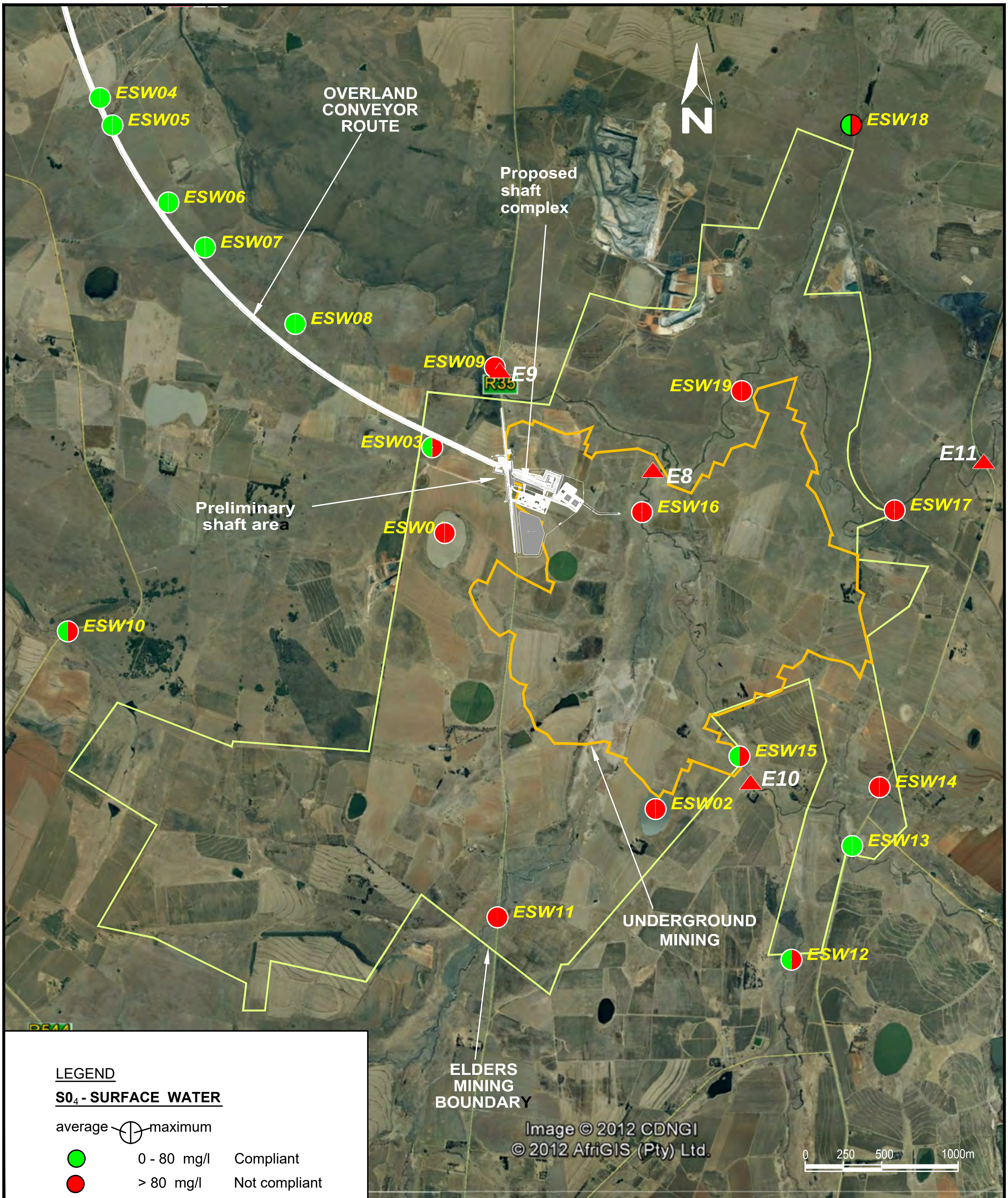
Figure 6.5.3(a)



LEGEND

SO_4 - SURFACE WATER

average maximum

(green)	0 - 80 mg/l	Compliant
(red)	> 80 mg/l	Not compliant
◐	Monitoring Points (2013)	
△	Monitoring Points (2005/06)	

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Figure 6.5.3(b)

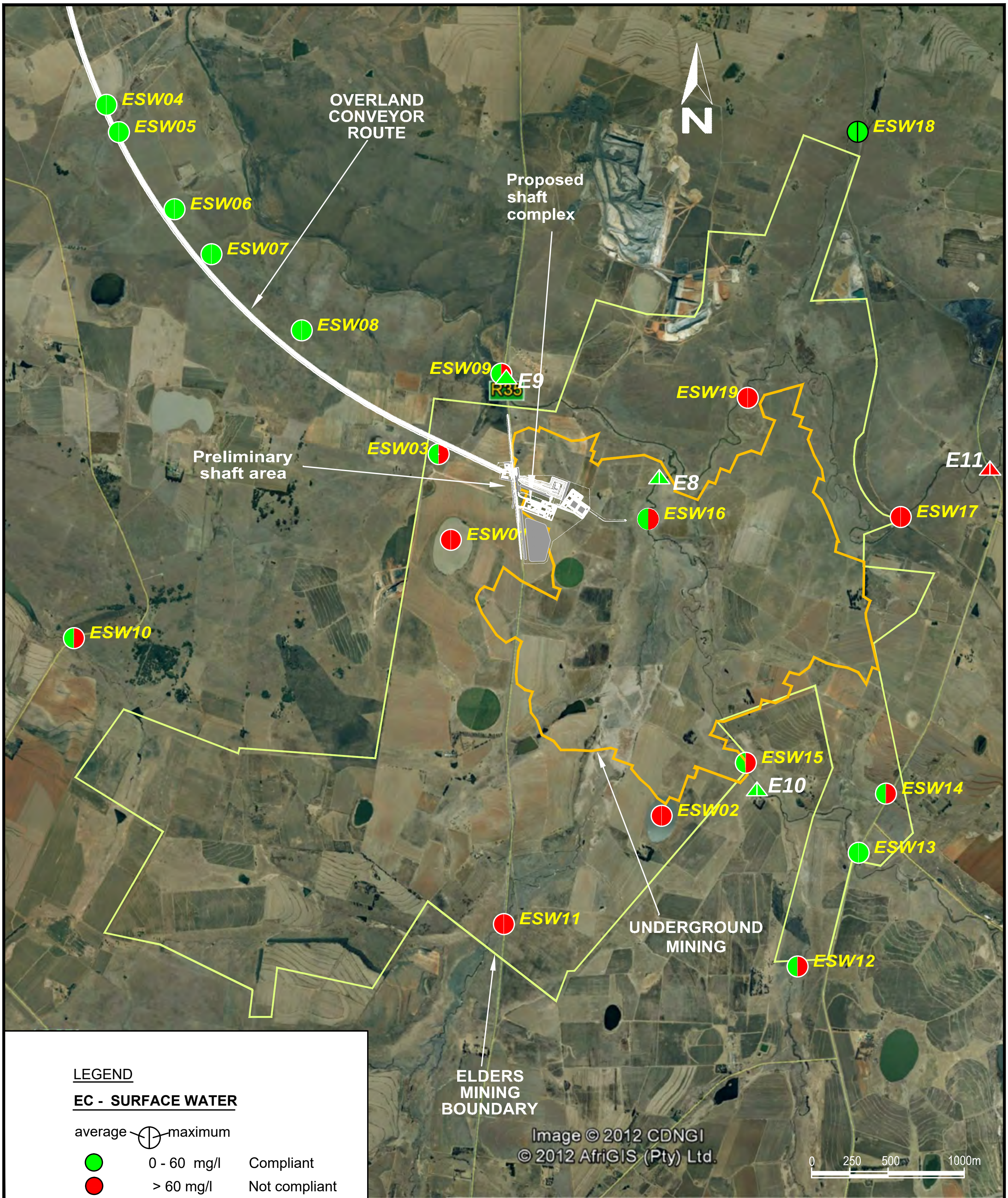

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Figure 6.5.3(c)

Table 6.5.3(a) Water quality baseline survey data for 2005/6

Parameter	Interim RWQO Guideline Value		E8	E9	E10	E11	E12	E13
pH	6.5-8.4	Average	7.6	7.5	8	7.7	8	7.6
		Min-max	7.6-7.7	7.4-7.5	7.9-8.1	7.4-7.9	7.8-8.2	7.5-7.6
		Coeff of var. (%)	0.8	0.8		1.3	2.6	0.9
EC (mS/m)	60	Average	43	29	49	133	111	45
		Min-max	40-46	25-31	47-51	93-176	98-119	44-47
		Coeff of var. (%)	7	11.6		3.5	10.4	4.2
Alkalinity (as $CaCO_3$)	-	Average	128	77	222	139	418	154
		Min-max	126-130	68-82	208-242	98-172	372-464	152-156
		Coeff of var. (%)	1.6	9.9		8	11	1.8
Ammonia	0.007	Average						0.95
		Min-max	<0.2-0.5	<0.2	<0.2	<0.2-0.7	<0.2-1	0.4-1.5
		Coeff of var. (%)						81.9
Nitrate	6	Average		1				
		Min-max	<0.2-0.2	1-1.1	<0.2-0.4	<0.2-0.3	<0.2-0.5	<0.2
		Coeff of var. (%)		5.6				
Cl	25	Average	26	15	23	62	36	23
		Min-max	25-27	13-16	22-23	47-79	29-41	21-24
		Coeff of var. (%)	3.8	10.4		2.5	17.3	9.4
SO_4	80	Average	53	46	8	434	115	50
		Min-max	40-60	41-50	4-11	278-582	97-151	47-52

Parameter	Interim RWQO Guideline Value		E8	E9	E10	E11	E12	E13
		Coeff of var. (%)	20.9	9.9		45.1	26.8	7.1
Na	70	Average	44	25	45	197	216	42
		Min-max	40-47	20-27	44-45	134-269	199-233	41-42
		Coeff of var. (%)	8.5	16.4		1.3	7.9	1.7
K	50	Average	8.5	7.7	5.2	9.3	20.3	8.8
		Min-max	8.3-8.8	6.4-8.4	3.8-5.5	8-9.7	18-22	8.8-8.8
			2.9	14.4		7.2	10.2	0
Ca	40	Average	25	18	27	44	26	25
		Min-max	22-30	16-19	25-30	34-52	23-30	22-27
		Coeff of var. (%)	18.7	8.6		9.8	13.9	14.4
Mg	25	Average	15	12	27	37	18	23
		Min-max	10-19	11-1	24-30	22-56	12-24	21-24
		Coeff of var. (%)	30.8	4.9		11.1	33.3	9.4
Al	0.02	Average	0.87	2.77	0.35	0.72	5.66	2.01
		Min-max	0.52-1.18	1.23-4.35	0.34-0.39	0.44-1.17	2.669-8.48	1.88-2.14
		Coeff of var. (%)	37.8	56.3		8.4	51.5	9.15
Fe	1.0	Average	1.17	4.19	0.5	0.78	2.56	2.49
		Min-max	0.49-1.59	1.47-7.12	0.4-0.64	0.32-1.51	1.29-3.87	2.27-2.71
		Coeff of var. (%)	51.1	67.6		24.9	50.3	12.5

Parameter	Interim RWQO Guideline Value		E8	E9	E10	E11	E12	E13
Mn	0.4	Average	0.374	0.165	0.275	0.425	0.207	0.415
		Min-max	0.161-0.545	0.057-0.248	0.24-0.331	0.251-0.631	0.095-0.36	0.372-.458
		Coeff of var. (%)	52.2	59.4		17.8	67.3	14.7
Zn	-	Average						
		Min-max	<0.025-0.04	<0.025-0.03	<0.025	<0.025	<0.025	<0.025
		Coeff of var. (%)						

Table 6.5.3(b) Water quality baseline survey data for August 2012 to July 2013

Mine	Site	pH	EC (mS/m)	TDS (mg/l)	TALK $(mgCaCO^3/l)$	Cl (mg/l)	SO_4 (mg/l)	F (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	Al (mg/l)	B (mg/l)	Ecoli #per 100ml	Total Coliforms #per 100ml
IRWQ Guideline value		6.5-8.4	60	440	-	25	80	1	40	25	70	50	1	0.4	0.02	0.5	130	-
Elders	ESW01																	
	Ave.	8.83	511.56	3287.60	666.32	620.41	1060.94	16.15	36.80	30.43	1103.30	18.86	0.43	0.03	0.88	0.12	11450.00	17250.00
	Max	9.26	1479.00	11427.00	1793.00	2034.00	4400.00	33.00	140.36	100.90	3721.00	52.40	2.95	0.30	5.27	0.21	21000.00	32000.00
	Min	7.71	63.60	332.00	112.00	61.20	75.30	1.32	13.30	7.62	64.80	7.28	-0.01	0.00	0.00	0.02	1900.00	2500.00
	Coeff. of variation	0.06	0.78	0.95	0.70	0.90	1.16	0.60	1.02	1.11	0.94	0.66	2.09	3.13	1.82	0.52	1.18	1.21
Elders	ESW02																	
	Ave.	8.66	430.40	2448.80	411.97	824.47	469.77	6.06	20.25	15.59	810.69	19.03	1.61	0.08	2.37	0.07	2850.00	5650.00
	Max	9.63	1761.00	9522.00	1515.72	3240.71	1882.67	20.39	61.60	38.40	3379.45	35.10	4.22	0.44	6.37	0.16	3800.00	8200.00
	Min	8.81	256.00	1460.00	295.00	443.00	328.00	4.46	61.60	38.40	438.00	34.30	4.22	0.44	6.37	0.07	1900.00	3100.00
	Coeff. of variation	0.05	1.23	1.18	1.01	1.23	1.18	1.04	0.74	0.74	1.34	0.57	1.00	1.81	1.07	0.70	0.47	0.64
Elders	ESW03																	
	Ave.	7.22	34.48	195.73	61.69	16.39	79.27	0.29	26.32	12.77	18.62	4.37	0.12	0.32	0.03	0.00	1056.00	2132.50
	Max	7.67	79.80	515.00	129.00	28.10	278.00	0.51	78.50	32.80	31.20	7.28	1.20	2.40	0.28	0.01	2100.00	4200.00
	Min	6.50	20.28	96.00	22.20	5.75	15.70	-0.18	12.70	6.60	10.70	2.61	-0.01	0.00	-0.01	-0.01	12.00	65.00
	Coeff. of variation	0.04	0.53	0.64	0.50	0.48	0.96	0.72	0.78	0.64	0.34	0.32	2.98	2.26	3.28	-2.08	1.40	1.13
Elders	ESW04																	
	Ave.	7.68	41.40	216.00	166.00	3.36	39.20	0.46	21.30	27.70	16.00	8.99	0.00	0.62	0.00	0.00		
	Max	7.68	41.40	216.00	166.00	3.36	39.20	0.46	21.30	27.70	16.00	8.99	0.00	0.62	0.00	0.00		
	Min	7.68	41.40	216.00	166.00	3.36	39.20	0.46	21.30	27.70	16.00	8.99	0.00	0.62	0.00	0.00		
	Coeff. of variation																	
Elders	ESW05																	
	Ave.	7.77	31.00	150.00	110.00	1.56	30.80	0.36	10.90	24.20	11.00	5.22	0.00	0.00	0.13	0.00		
	Max	7.77	31.00	150.00	110.00	1.56	30.80	0.36	10.90	24.20	11.00	5.22	0.00	0.00	0.13	0.00		
	Min	7.77	31.00	150.00	110.00	1.56	30.80	0.36	10.90	24.20	11.00	5.22	0.00	0.00	0.13	0.00		
	Coeff. of variation																	
Elders	ESW06																	
	Ave.	7.84	25.43	141.57	87.86	10.39	31.20	0.44	10.63	19.11	9.42	7.14	0.01	0.07	0.02	0.00	1208.67	1753.33
	Max	8.83	46.30	255.00	161.00	26.70	55.80	0.55	17.00	33.10	20.10	8.59	0.07	0.47	0.09	0.01	3000.00	4500.00
	Min	6.67	9.88	67.00	35.10	1.13	8.70	0.35	4.33	7.78	3.28	5.82	0.00	0.00	0.00	0.00	96.00	100.00
	Coeff. of variation	0.10	0.47	0.45	0.47	0.83	0.57	0.14	0.42	0.43	0.65	0.14	3.25	2.69	2.03	2.58	1.30	1.37

Mine	Site	pH	EC	TDS	TALK	Cl	SO4	F	Ca	Mg	Na	K	Fe	Mn	Al	B	Ecoli	Total Coliforms
	IRWQ Guideline	**6.5-8.4**	**60**	**440**	**-**	**25**	**80**	**1**	**40**	**25**	**70**	**50**	**1**	**0.4**	**0.02**	**0.5**	**130**	**-**
Elders	**ESW07**																	
	Ave.	7.15	7.04	21.13	4.81	2.81	6.52	0.17	1.25	0.96	3.55	1.92	0.01	0.00	0.00	0.00	951.67	1350.00
	Max	7.83	8.76	26.00	13.80	7.54	11.40	0.29	1.58	1.29	4.69	3.25	0.11	0.00	0.04	0.00	2700.00	3700.00
	Min	6.68	5.97	17.00	-2.48	-0.42	2.85	0.07	0.85	0.64	2.64	1.16	0.00	0.00	0.00	0.00	5.00	50.00
	Coeff. of variation	0.06	0.12	0.17	1.14	1.02	0.41	0.42	0.19	0.22	0.18	0.38	3.24	0.00	7.07	0.00	1.59	1.51
Elders	**ESW08**																	
	Ave.	7.09	9.77	34.63	12.49	5.20	8.14	0.18	1.89	1.51	7.65	2.18	0.02	0.00	0.03	0.00	5020.00	10734.33
	Max	7.67	12.70	43.00	17.10	9.35	15.00	0.26	2.38	1.92	9.37	6.28	0.13	0.02	0.19	0.00	15000.00	32000.00
	Min	6.55	8.44	31.00	-2.48	1.77	2.75	0.10	1.35	1.19	5.77	0.77	0.00	0.00	0.00	0.00	2.00	3.00
	Coeff. of variation	0.06	0.13	0.12	0.49	0.56	0.58	0.32	0.18	0.17	0.17	0.80	2.21	4.71	2.60	0.00	1.72	1.72
Elders	**ESW09**																	
	Ave.	8.17	52.48	315.08	128.82	19.81	113.18	0.46	33.18	23.60	40.88	6.07	0.06	0.06	0.03	0.00	697.33	974.67
	Max	9.09	113.70	836.00	245.53	42.12	460.50	0.95	67.50	54.52	119.08	8.26	0.49	0.51	0.24	0.02	1800.00	2200.00
	Min	7.63	29.90	157.00	98.90	8.56	20.10	0.28	18.90	13.70	15.20	4.13	-0.01	0.00	-0.01	-0.01	12.00	14.00
	Coeff. of variation	0.05	0.57	0.75	0.33	0.48	1.30	0.42	0.50	0.62	0.93	0.20	2.56	2.52	2.57	-9.68	1.38	1.15
Elders	**ESW10**																	
	Ave.	8.32	46.34	289.92	155.01	14.83	65.14	0.44	45.03	18.17	23.31	4.61	0.05	0.50	0.06	0.00	573.33	1408.33
	Max	9.31	67.30	580.00	236.59	29.80	203.00	0.59	75.58	24.80	35.90	7.87	0.50	1.57	0.54	0.00	1700.00	4200.00
	Min	7.78	29.60	156.00	92.60	7.52	17.06	0.20	19.80	12.40	11.80	2.69	-0.01	0.00	-0.01	-0.01	5.00	5.00
	Coeff. of variation	0.05	0.21	0.41	0.31	0.43	1.03	0.28	0.35	0.18	0.34	0.30	2.93	1.13	2.80	-0.67	1.70	1.72
Elders	**ESW11**																	
	Ave.	8.36	65.45	379.55	228.86	26.67	84.01	0.36	40.11	37.56	48.39	4.69	0.05	0.02	0.03	0.00	1656.33	8423.00
	Max	8.68	91.60	599.00	367.00	49.34	267.50	0.63	55.85	51.40	76.36	7.52	0.62	0.18	0.38	0.00	4900.00	25000.00
	Min	7.56	25.60	135.00	50.50	4.40	22.80	0.18	16.30	9.53	13.20	2.60	-0.01	0.00	-0.01	-0.01	-1.00	-1.00
	Coeff. of variation	0.05	0.33	0.38	0.41	0.53	0.86	0.40	0.31	0.37	0.44	0.34	3.52	3.53	3.41	-1.38	1.70	1.70
Elders	**ESW12**																	
	Ave.	7.87	58.63	333.92	189.94	29.72	76.53	0.45	41.44	28.09	36.31	7.20	0.16	0.68	0.05	0.00	1002.00	1356.33
	Max	8.24	85.90	596.00	246.00	49.20	300.65	0.59	68.03	40.38	52.48	11.70	1.64	5.87	0.49	0.00	2800.00	3600.00
	Min	7.25	26.90	135.00	72.80	10.10	21.35	0.31	18.10	11.60	10.30	3.89	-0.01	0.00	-0.01	-0.01	66.00	69.00
	Coeff. of variation	0.04	0.29	0.34	0.29	0.33	0.99	0.22	0.32	0.30	0.29	0.30	3.01	2.45	2.73	-0.67	1.55	1.44

Mine	Site	pH	EC	TDS	TALK	Cl	SO4	F	Ca	Mg	Na	K	Fe	Mn	Al	B	Ecoli	Total Coliforms
	IRWQ Guideline	**6.5-8.4**	**60**	**440**	**-**	**25**	**80**	**1**	**40**	**25**	**70**	**50**	**1**	**0.4**	**0.02**	**0.5**	**130**	**-**
	ESW13																	
Elders	Ave.	8.08	36.80	206.58	140.08	18.05	30.46	0.37	25.31	18.80	23.74	4.96	0.25	0.34	0.11	0.00	88.00	289.67
	Max	8.85	59.70	313.00	270.00	50.30	60.30	0.75	48.60	38.00	60.60	9.27	1.58	1.68	0.95	0.01	230.00	530.00
	Min	7.45	25.70	124.00	78.00	6.21	8.20	0.26	14.80	9.28	10.40	2.42	-0.01	0.00	-0.01	-0.01	-1.00	-1.00
	Coeff. of variation	0.05	0.35	0.36	0.50	0.72	0.56	0.40	0.38	0.56	0.63	0.38	2.04	1.82	2.58	-1.93	1.41	0.93
	ESW14																	
Elders	Ave.	7.92	58.31	341.80	190.64	11.96	98.04	0.37	61.38	26.52	25.73	2.77	0.08	0.41	0.04	0.00	230.67	1420.67
	Max	8.41	96.30	614.00	295.00	28.50	265.00	0.45	99.20	42.30	48.40	5.61	0.84	1.25	0.41	0.00	570.00	3700.00
	Min	7.31	15.90	71.00	32.00	1.25	20.60	0.23	14.30	5.24	1.28	1.32	0.00	0.00	0.00	-0.01	2.00	2.00
	Coeff. of variation	0.04	0.47	0.54	0.47	0.80	0.76	0.19	0.49	0.49	0.67	0.43	3.28	1.28	3.41	-0.60	1.30	1.40
	ESW15																	
Elders	Ave.	8.18	45.78	256.92	155.93	24.24	49.35	0.58	29.06	20.64	33.57	5.51	0.12	0.26	0.06	0.00	772.00	2749.67
	Max	8.71	82.70	528.00	352.13	63.60	103.00	2.11	51.80	37.40	97.83	7.86	0.74	1.13	0.49	0.01	2200.00	7900.00
	Min	7.50	25.70	131.00	61.30	7.52	9.13	0.27	16.40	10.10	11.00	3.57	-0.01	0.00	-0.01	-0.01	6.00	9.00
	Coeff. of variation	0.04	0.47	0.56	0.57	0.75	0.62	0.86	0.41	0.53	0.82	0.21	2.02	1.74	2.49	-1.46	1.60	1.62
	ESW16																	
Elders	Ave.	7.97	48.05	278.08	134.08	22.37	80.28	0.43	30.87	21.79	35.05	6.42	0.09	0.07	0.05	0.00	793.33	1533.00
	Max	8.52	93.90	582.00	245.98	52.80	267.00	0.72	55.30	42.58	85.46	11.70	0.62	0.55	0.28	0.01	1700.00	2900.00
	Min	7.57	27.70	138.00	84.30	7.79	12.00	0.22	17.50	12.10	12.70	4.12	-0.01	0.00	-0.01	-0.01	90.00	99.00
	Coeff. of variation	0.04	0.53	0.64	0.40	0.68	1.06	0.37	0.45	0.58	0.82	0.33	2.44	2.27	2.02	-1.72	1.04	0.91
	ESW17																	
Elders	Ave.	7.99	79.85	530.67	149.96	22.51	252.95	0.41	60.00	36.96	60.66	6.87	0.07	0.13	0.08	0.01	293.67	540.00
	Max	8.58	141.00	982.00	209.71	40.00	566.00	0.54	126.00	71.31	186.00	8.95	0.68	0.63	0.72	0.06	790.00	1500.00
	Min	7.27	35.80	185.00	76.20	8.33	56.20	0.26	24.00	14.00	18.60	5.54	-0.01	0.00	-0.01	0.00	28.00	30.00
	Coeff. of variation	0.05	0.45	0.60	0.29	0.36	0.83	0.23	0.59	0.57	0.79	0.16	2.83	1.49	2.69	1.70	1.46	1.54
	ESW18																	
Elders	Ave.	7.84	27.09	141.25	50.30	20.40	41.09	0.36	13.25	8.44	18.26	8.95	0.25	0.06	0.01	0.00	7.33	68.33
	Max	8.90	33.50	194.00	84.40	35.17	89.10	0.50	17.00	10.70	33.63	11.00	1.06	0.28	0.12	0.01	16.00	180.00
	Min	7.27	21.30	96.00	22.10	12.20	23.70	0.29	9.89	5.90	10.20	6.90	-0.01	0.00	0.00	-0.01	-1.00	-1.00
	Coeff. of variation	0.06	0.15	0.21	0.41	0.36	0.45	0.18	0.16	0.16	0.35	0.15	1.59	1.64	2.62	-2.04	1.16	1.43
	ESW19																	
Elders	Ave.	8.10	81.59	534.42	129.91	21.41	264.28	0.39	55.05	33.97	73.55	7.29	0.12	0.11	0.07	0.01	303.67	389.00
	Max	8.53	187.00	1416.00	191.09	31.10	846.00	0.57	122.00	72.58	265.00	15.30	1.31	0.63	0.64	0.08	870.00	1100.00
	Min	7.57	35.00	177.00	87.80	9.64	45.00	-0.18	22.90	13.90	16.30	4.41	-0.01	0.00	-0.01	0.00	1.00	1.00
	Coeff. of variation	0.04	0.62	0.74	0.24	0.30	0.97	0.49	0.59	0.57	1.04	0.37	3.10	1.81	2.62	1.85	1.62	1.59

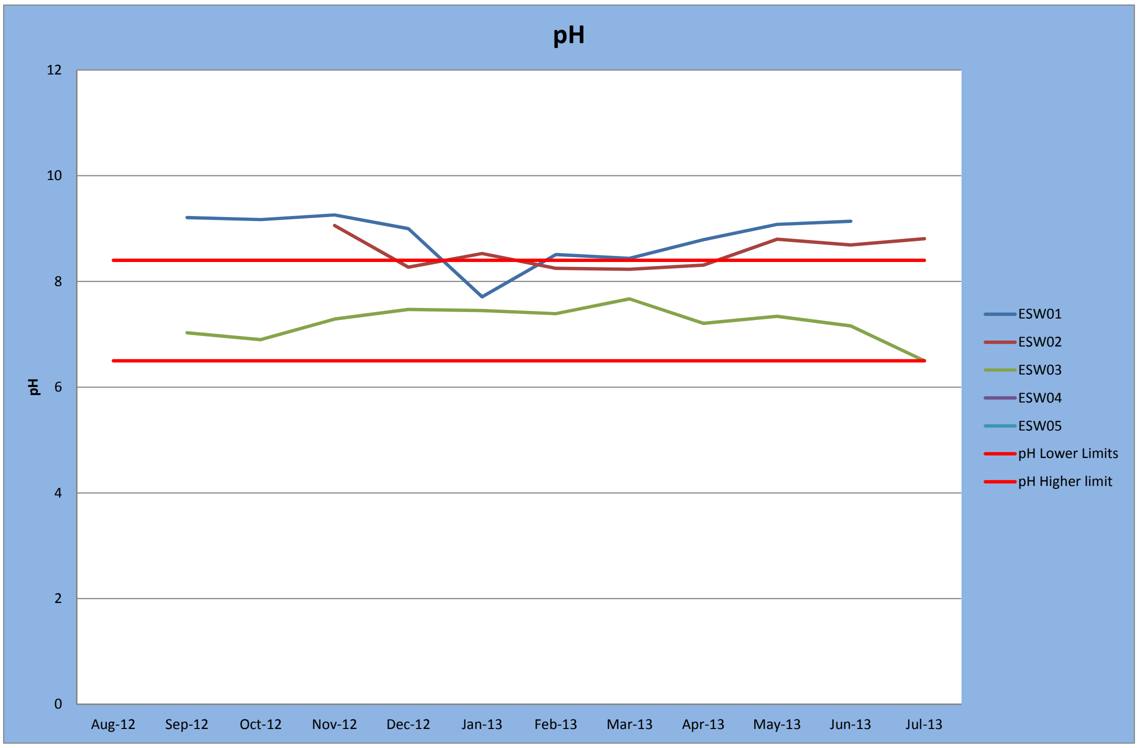


Figure 6.5.4(a) Time series graphs for pH

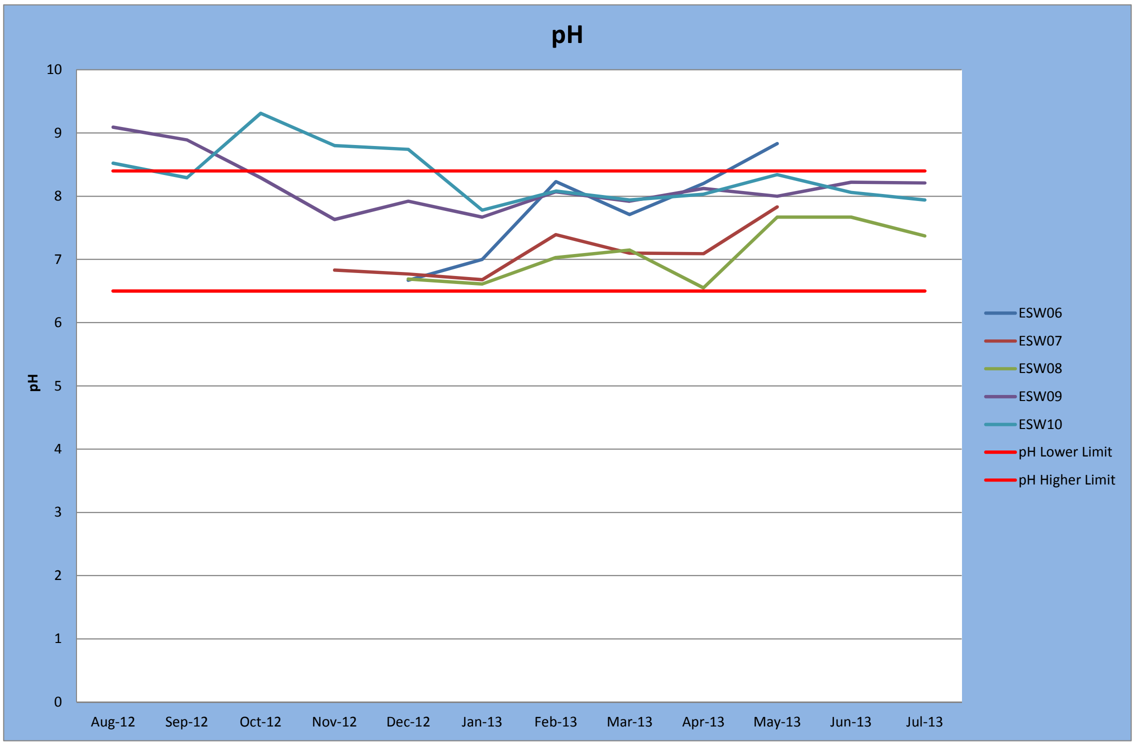


Figure 6.5.4(b) Time series graphs for pH

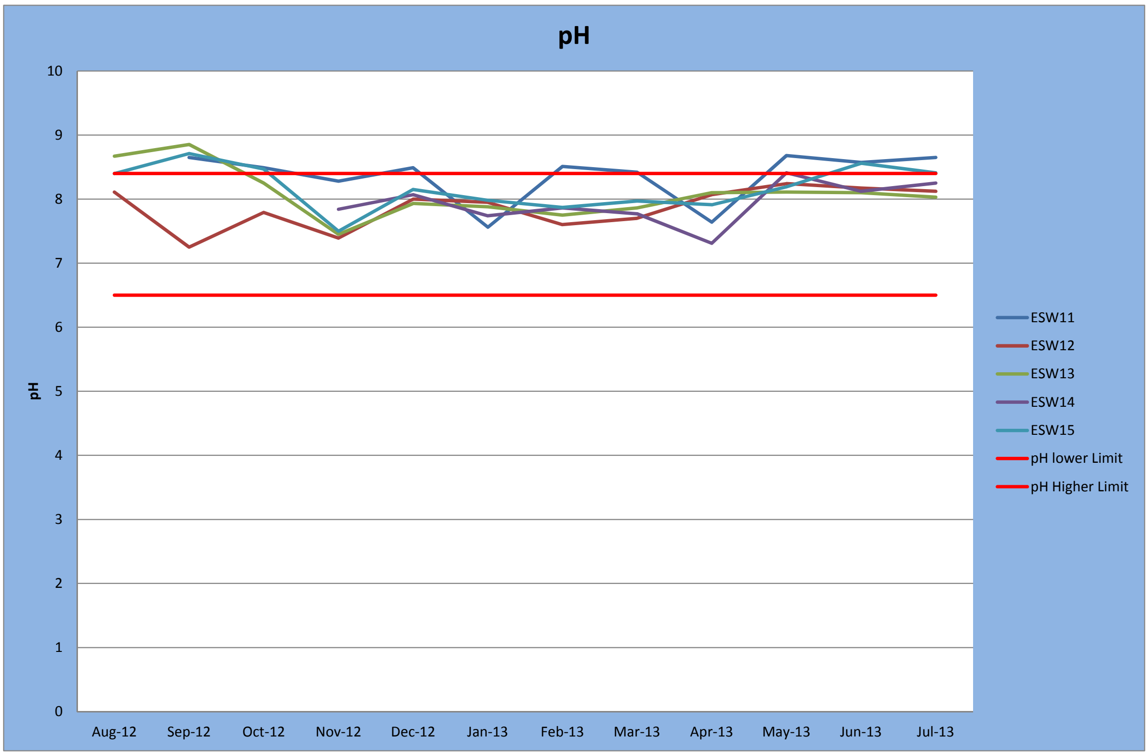


Figure 6.5.4(c) Time series graphs for pH

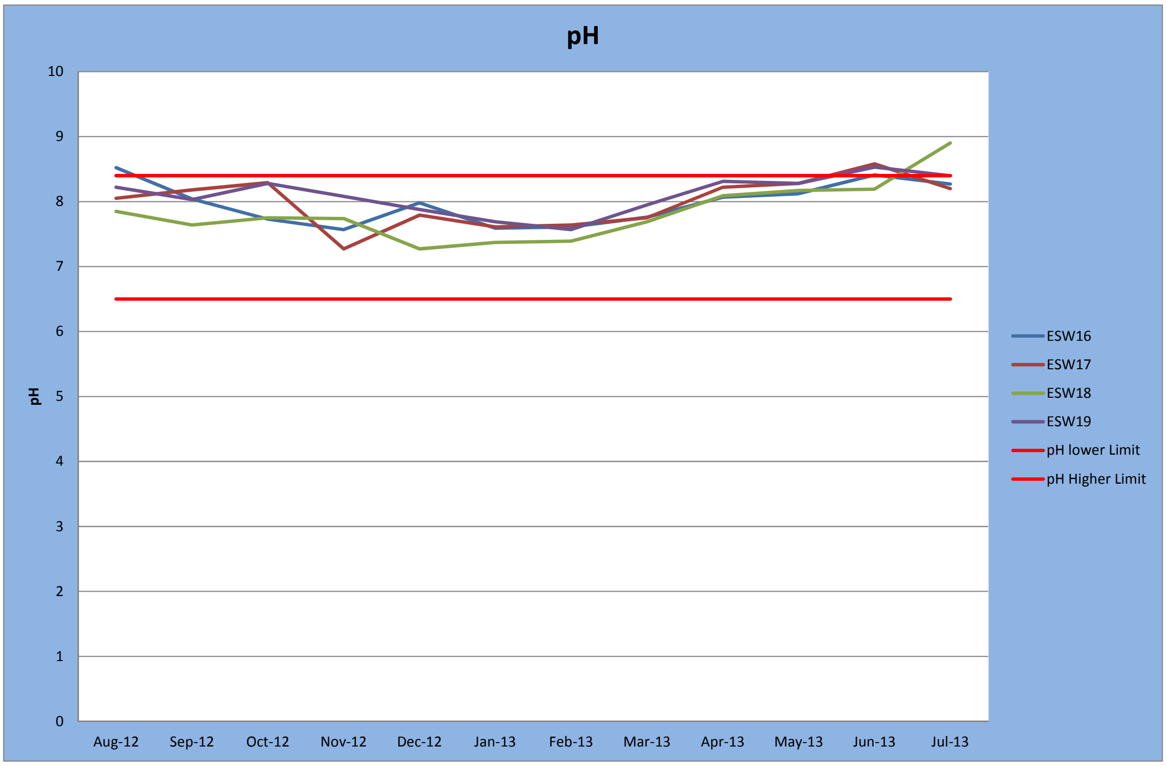


Figure 6.5.4(d) Time series graphs for pH

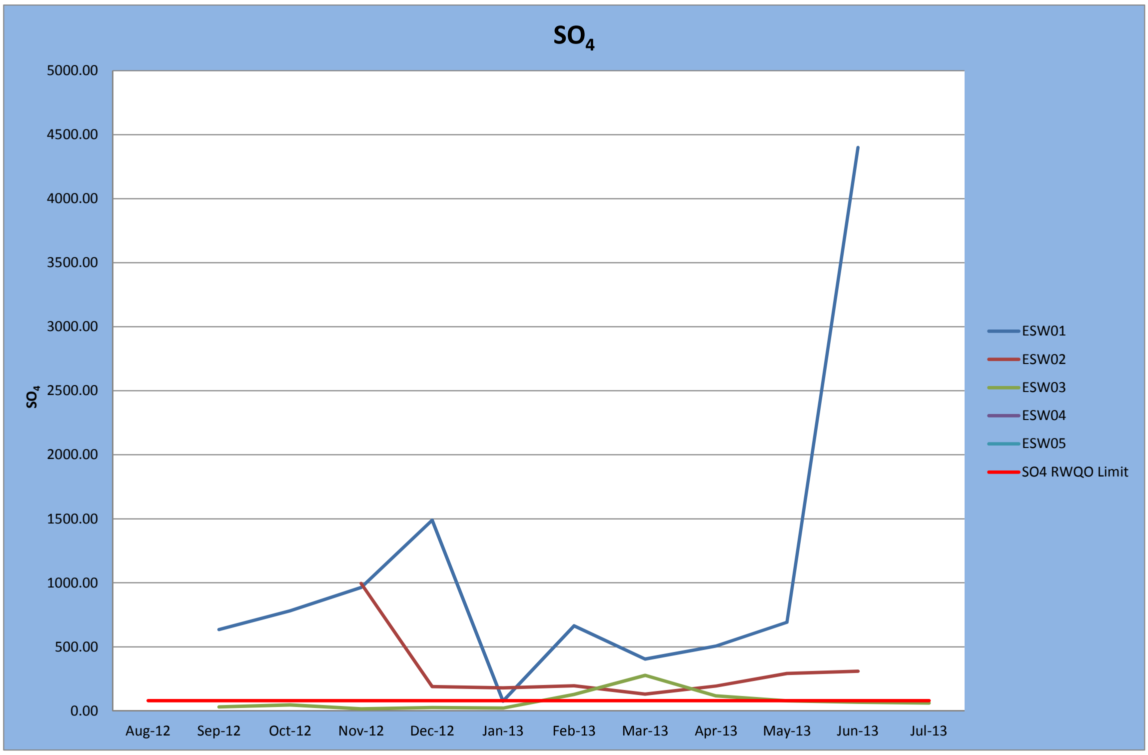


Figure 6.5.4(e) Time series graphs for SO_4

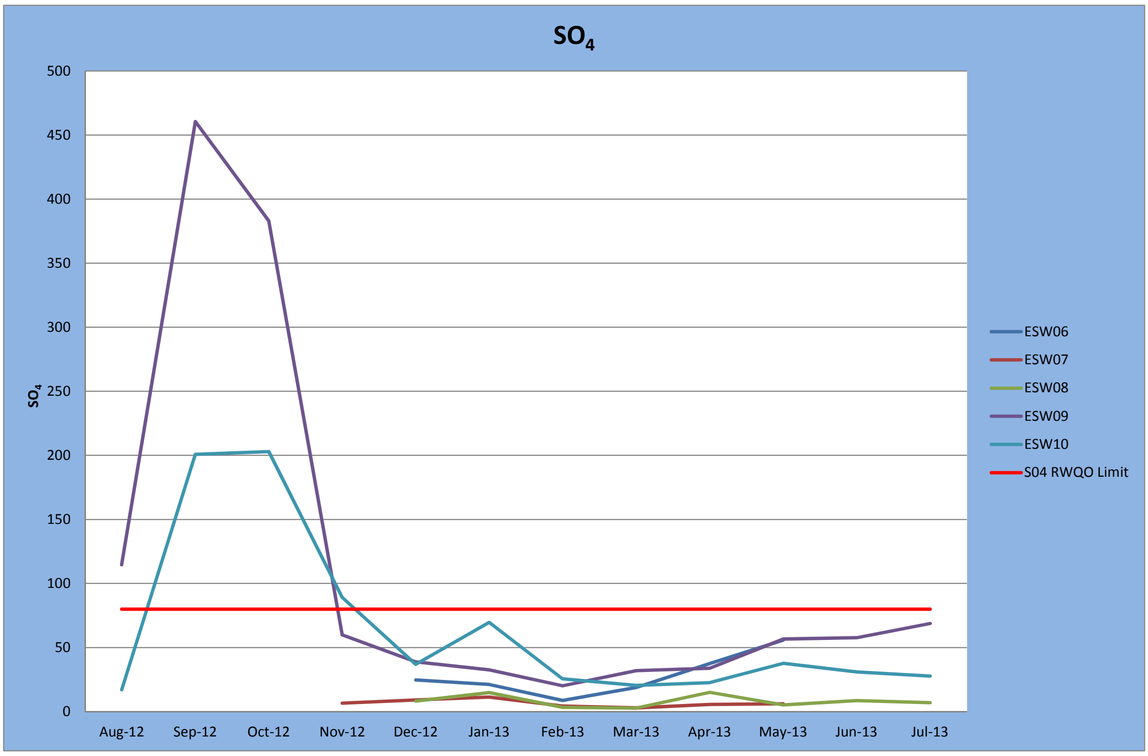


Figure 6.5.4(f) Time series graphs for SO_4

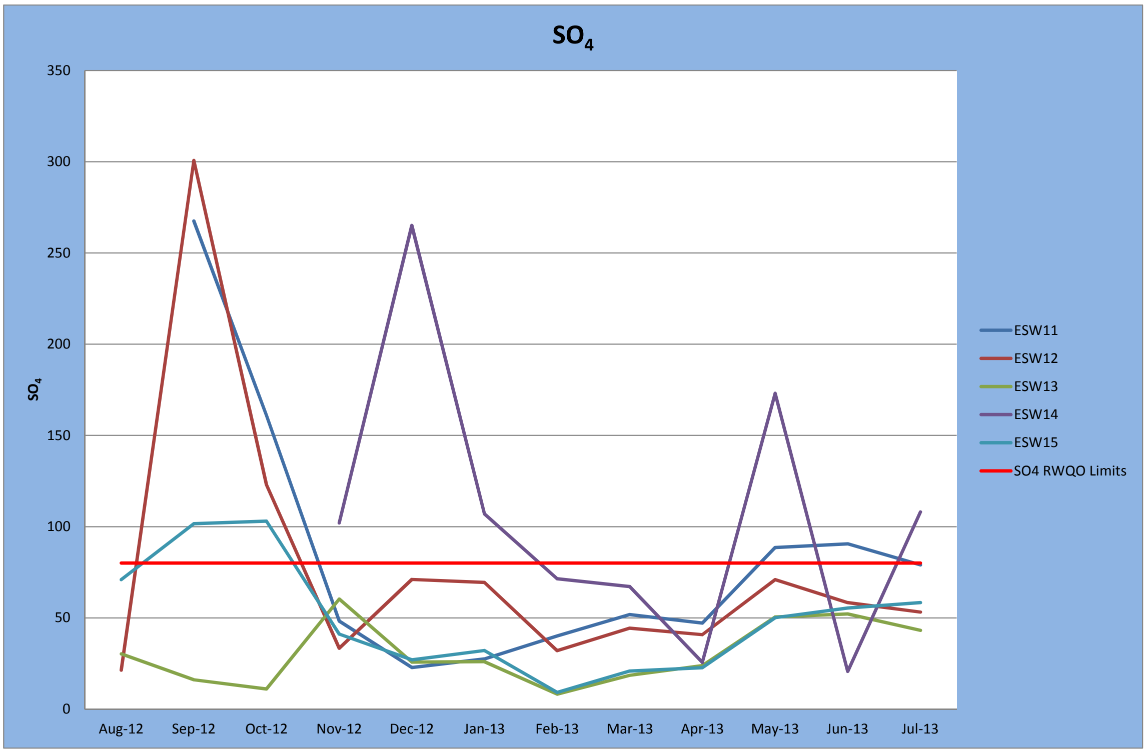


Figure 6.5.4(g) **Time series graphs for SO_4**

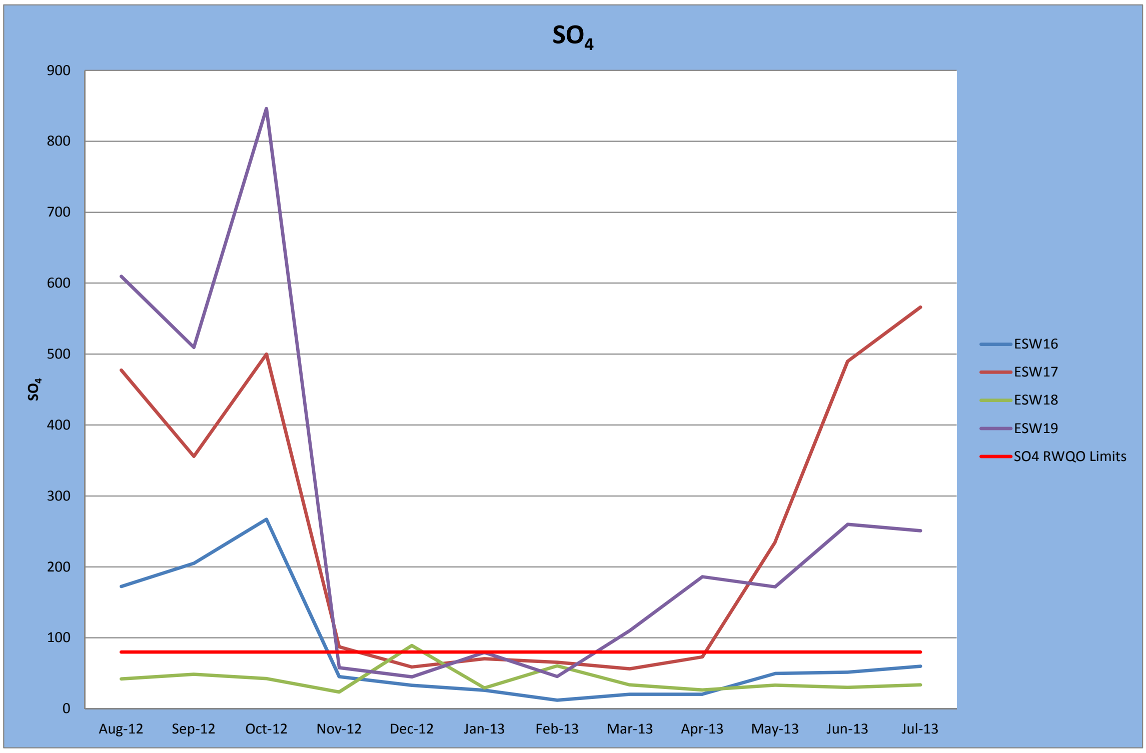


Figure 6.5.4(h) **Time series graphs for SO_4**

6.5.4.3. Electrical conductivity

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current, which is as a result of the presence of charged ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium (DWAF, 1996). It is therefore an indicator of the salinity, or total salt content, of water. Accumulation of salts can influence the potential of downstream water users to use the water for uses such as irrigation for agriculture.

The 2005/6 results show that along the Olifants River, as well as along Leeufonteinspruit, elevated values of EC were found. Current studies show the same with elevated values of EC at similar locations to those where elevated SO_4 was found (i.e. both pans, along the Olifants River, Vlakkuilen and Viskuile Rivers as well as around the mining area, at monitoring locations ESW01, ESW02, ESW03, SEW09, ESW10, ESW11, ESW12, ESW14, ESW15, ESW16, ESW17 and ESW19). These are indicated in **Figure 6.5.3(c)**. The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

The time series graph indicating the EC for the 12 month period at the monitoring locations, together with the interim RWQO for EC, being 60 mg/ℓ, as indicated in red, can be seen in can be seen in **Figures 6.5.4(i)** to **(l)**.

6.5.4.4. Iron (Fe)

Iron (Fe) is the fourth most abundant element, constitutes 5% of the earth's crust and is found in many minerals. An important mineral in the context of this investigation is pyrite (FeS), which is often associated with coal formations. Iron can be present in water as dissolved ferric iron (Fe III), as ferrous iron (Fe II) or as suspended iron hydroxides. The concentration of dissolved iron in unpolluted surface water is typically in the range of 0.001 - 0.5 mg/ℓ (DWAF, 1996). The interim RWQO for iron was set as 1 mg/ℓ for MU8.

In general, the iron concentration in the Olifants River sub-catchment as shown in the 2005/6 study indicate slightly to highly elevated iron concentrations. The current study indicate iron concerntrations below or at this level, or slightly elevated (but below 2 mg/ℓ), as depicted in red in **Tables 6.5.3(a)** and **(b)**.

Highly elevated iron concentrations were noted in both pans at monitoring locations ESW01and ESW02, as depicted in red in **Table 6.5.3(b)**. The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

6.5.4.5. Aluminium

Aluminium occurs in water either as suspended aluminium minerals or as dissolved aluminium species. The concentration of dissolved aluminium in unpolluted water at neutral pH is typically 0.005 mg/ℓ or less. In water with a low pH, or where soluble aluminium complexes are present, the dissolved aluminium concentration can rise to high values (DWAF, 1996).

The 2005/6 results show that along the Olifants River, as well as around the mining areas, elevated concentrations of aluminium were found. Current studies show the same, with aluminium concentrations in both pans, along the Olifants River, Vlakkuilen and Viskuile Rivers, Leeufontienspruit as well as around the mining area, at monitoring locations ESW01, ESW02, ESW03, ESW05, ESW06, ESW07, ESW08, ESW09, ESW10, ESW11, ESW12, ESW13, ESW14, ESW15, ESW16, ESW17, ESW18 and ESW19) exceeding the interim RWQO of 0.02 mg/ℓ, as can be seen in red in **Table 6.5.3 (b)**. The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

It should be noted that the interim RWQO for aluminium in MU 8 is based on the ecological Reserve requirements, which is low (0.02 mg/ℓ). When the levels are compared to the SA Water Quality Guidelines for irrigation and stock watering, all measured water quality is below the target guideline for Al (5 mg/ℓ) with the exception of the pans.

6.5.4.6. Manganese

Manganese (Mn) is a relatively abundant element which constitutes 0.1% of the earth's crust. The median concentration in fresh water is 8 µg/ℓ, with a range of 0.02 to 130 µg/ℓ (DWAF, 1996).

The 2005/6 results show that along the Olifants River, as well as in the Vlakkuilen and Viskuile Rivers, elevated concentrations of Mn were found. Current studies show the same, with the Mn concentration along the Olifants River, Vlakkuilen and Viskuile Rivers, as well as around the mining area at monitoring locations, ESW02, ESW03, ESW06, , ESW09, ESW10, , ESW12, ESW13, ESW14, ESW15, ESW16, ESW17 and ESW19 above the interim RWQO of 0.4 mg/ℓ, as can be seen in red in **Table 6.5.3(b)**.

The baseline water quality therefore indicates that the catchment is already impacted on by mining and agricultural activities in the surrounding area.

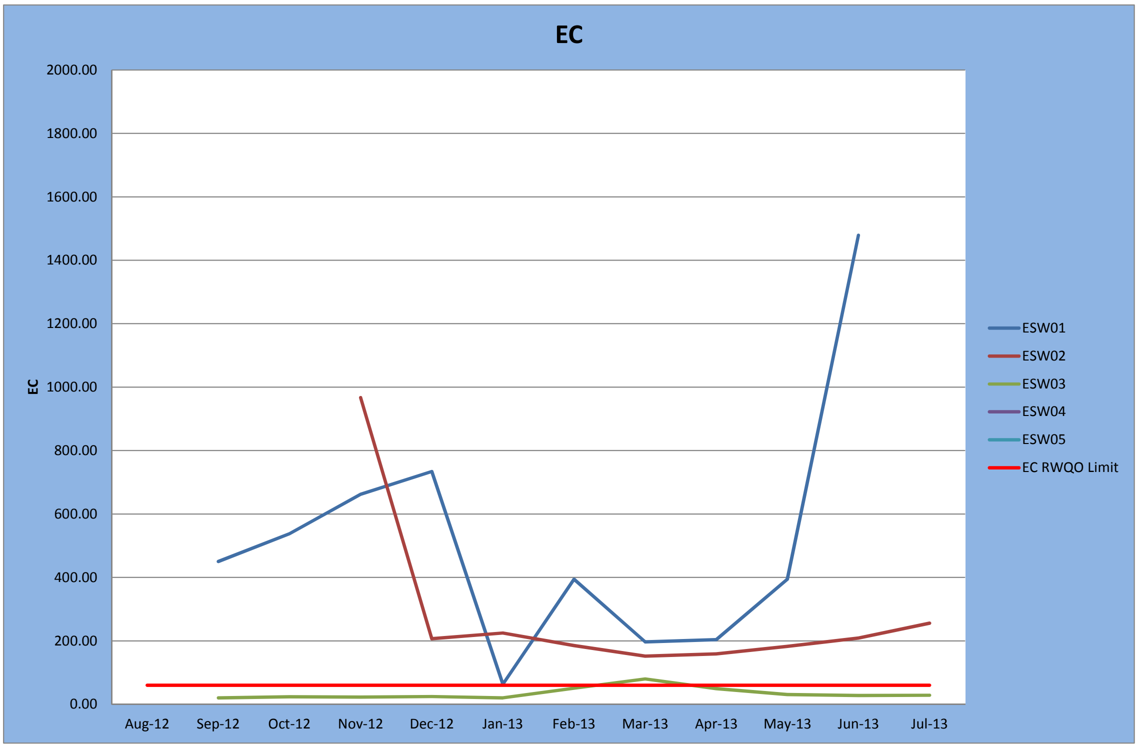


Figure 6.5.4(i) Time series graphs for EC

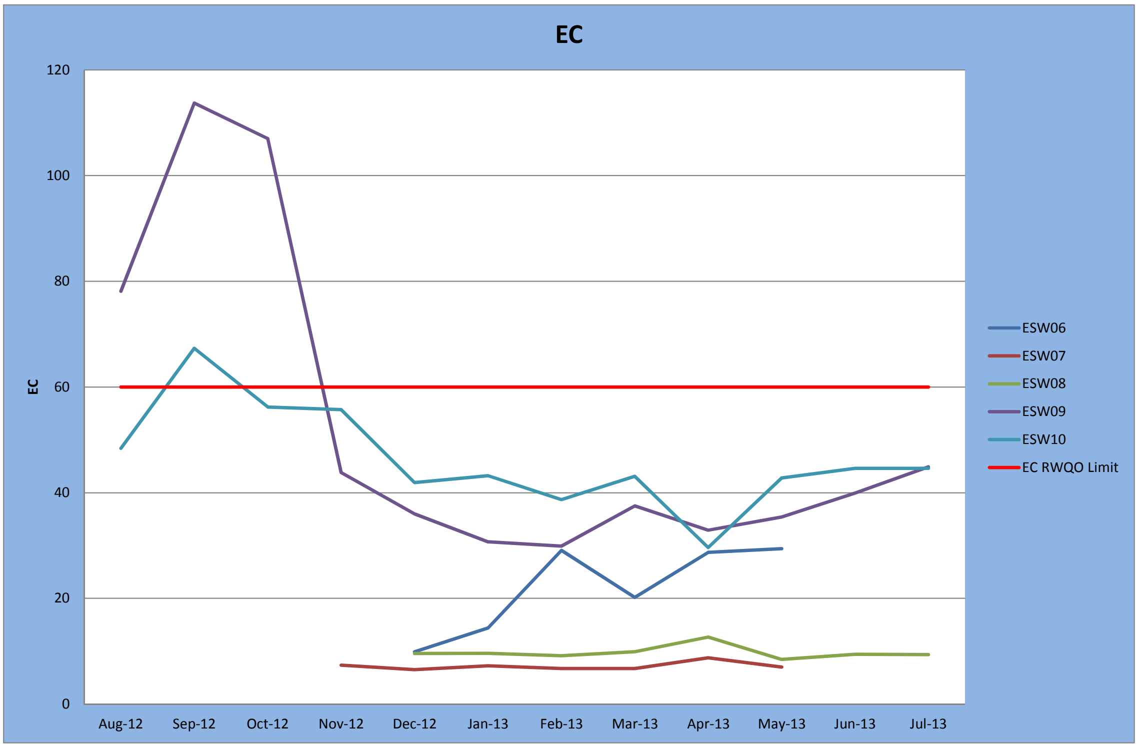


Figure 6.5.4(j) Time series graphs for EC

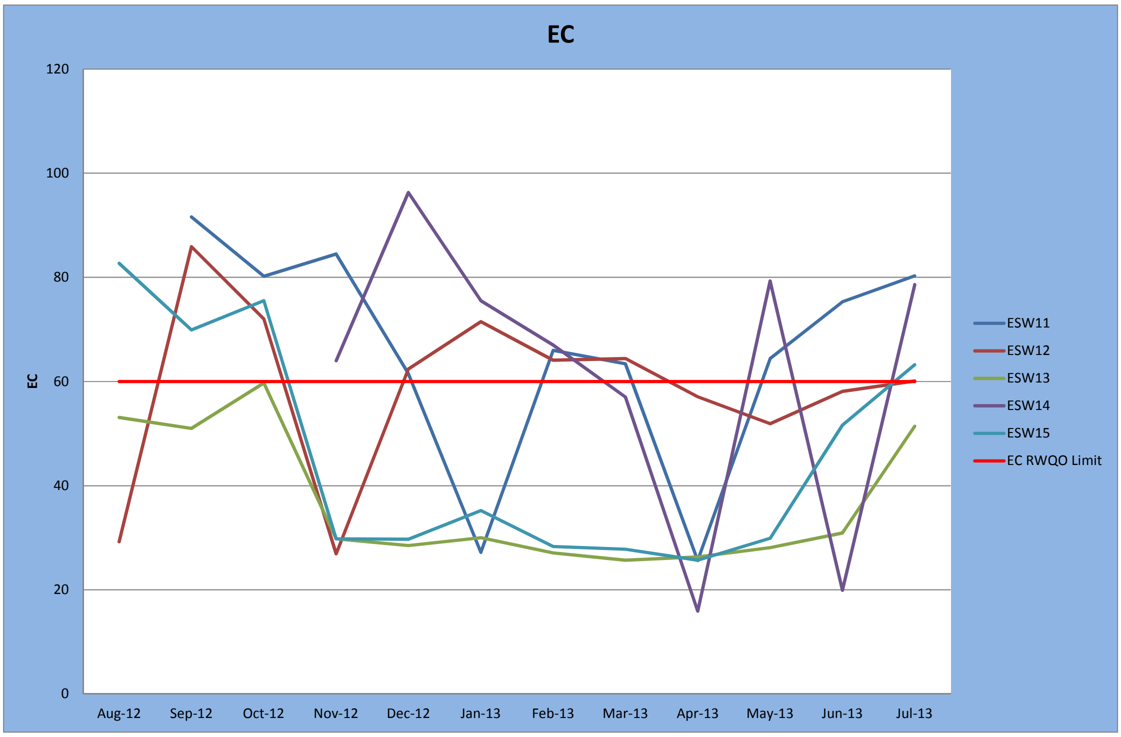


Figure 6.5.4(k) Time series graphs for EC

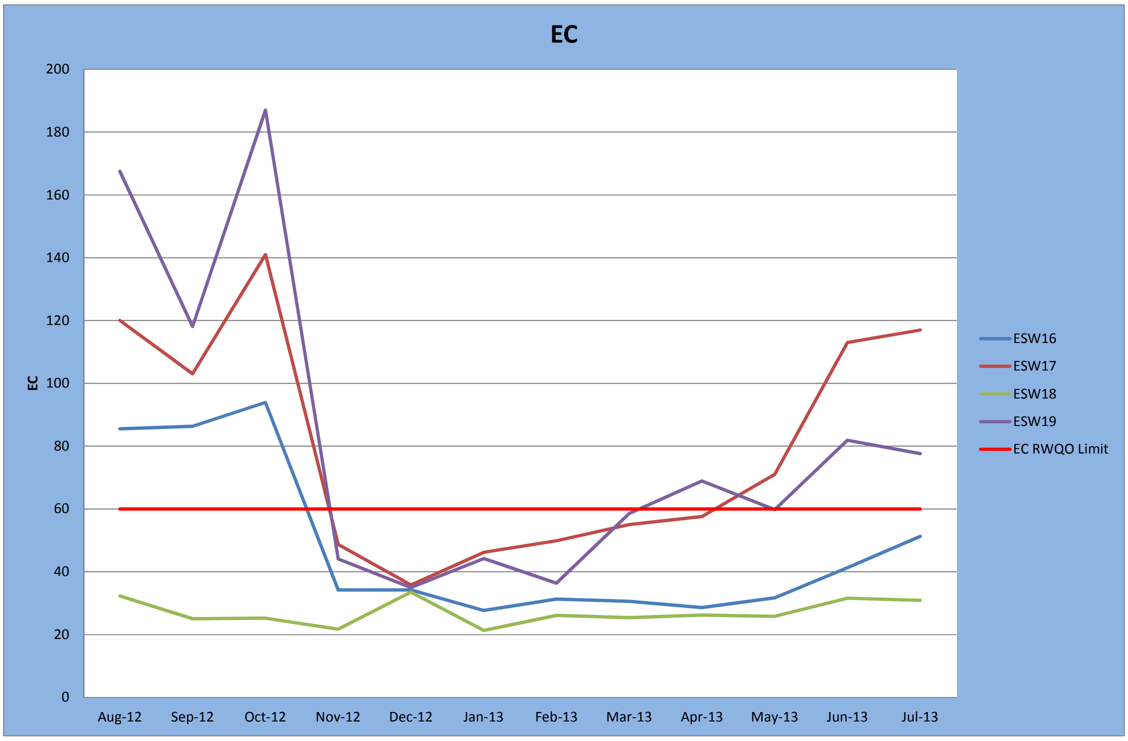


Figure 6.5.4(l) Time series graphs for EC

6.5.4.7. <u>Ecoli and Total Coliforms</u>

Escherichia coli (*e.coli*) is normally found in the gastrointestinal tracts of both humans and animals, and often is responsible for diarrheal diseases. The interim RWQO for the MU 8 for *e.coli* is 130 per 100 ml.

The current study shows high counts of *e.coli* along the Olifants River, Vlakkuilen and Viskuile Rivers, as well as around the project area, which may be attributed to cattle farming in the area.

Total coliforms are used to estimate microbial growth in water treatment processes. There are no interim RWQO specified for MU 8, however the South African Water Quality Guidelines for domestic use (2nd Edition 1996) indicates that >20 counts /100 ml would cause significant and increasing risk of infectious disease transmission.

The current study shows high counts of Total coliforms when comparing the results in **Table 6.5.3(b)** to South African Water Quality Guidelines for domestic use (2nd Edition 1996) along the Olifants River, Vlakkuilen and Viskuile Rivers, as well as around the project area, which may be attributed to cattle farming in the area.

Analysis of the other constituents in **Table 6.5.3(b)** indicates the following for catchment MU 8:

- In both pans (ESW01, ESW02) elevated concentrations of TDS, Chloride (Cl), Fluoride (F), Calcium (Ca), Magnesium (Mg) and Sodium (Na) were observed. These elevated concentrations may be due to farming activities in the area.

- In pan (ESW01) elevated concentrations of Potassium (K) were observed, which may be due to farming activities in the area.
- Around the Elders mine boundary, elevated levels of TDS, Chloride (Cl), Fluoride (F), Calcium (Ca), Sodium (Na) and Magnesium (Mg) were observed. These elevated concentrations may be due to a combination of mining activities in the area, as well as farming activities.

6.5.5 Biomonitoring

Biomonitoring has been assessed in a separate specialist report.

6.5.6 Water authority

The water authority is the Department of Water and Sanitation, Mpumalanga Region.

6.5.7 Wetlands

The surface water study does not include the delineation of sensitive areas such as wetlands. These are addressed in the wetlands specialist reports.

6.6 Surface water users

Water downstream of the site, up to the Witbank Dam, is primarily used for agricultural and livestock watering purposes, as well as mining.

A survey was conducted of surface water use in the area through a surface water use survey (by telephonic interviews, e-mail and post). In general, response to the survey was poor, with a low percentage return of questionnaires and/or inability to reach the participants to conduct telephonic interview. The outcome of the survey is indicated in **Table 6.6(a)**.

In addition to the surface water use survey, the Department of Water Affairs' WARMS Office in Nelspruit was approached to obtain information on abstraction water uses registered with the Department. A summary of the information for quaternary catchment B11A as obtained in November 2012, is provided in **Table 6.6(b)**. According to the Department's records, a total of 3 395 058 m^3/annum is abstracted for the purposes of crop irrigation, livestock watering and mining.

During the surface water use survey, the following comments were raised regarding water resources in the area:

- Water in the Olifants River is polluted. Impact from Sudor coal on the water quality of the Olifants River catchment was raised as a concern by the farmers in the area.
- Water quality in the river is critical for livestock watering.

Table 6.6(a) Surface water use survey

Farm name	Name of owner	Surface water use							
		Crops		Livestock		Human consumption		Recreational	Other
RE/3 of Middelkraal 50 IS, Ptn 2 of Schoonvlei 52 IS, Ptns 3,9-12 of Elandsfontein 75 IS	Mr Nic Britz	None		Cattle (700), sheep (250)	Olifants River and earth dams	None (from boreholes)		None	
Ptn 8 of Kleinfontein 49 IS	Mr Otto Myburgh			Cattle (250-300)	Olifants River	Domestic use (5 families)	Spring	None	
Ptn 4, 7, 8 of Elandsfontein 75 IS; RE and Ptn 1of Vlakkuilen 76 IS; Ptn 1 of Geluk 226 IS; Ptn 22 of Schurvekop 227 IS; Ptns 3, 13 of Halfgewonnen 190 IS	Anglo Operations Ltd and SC Schoeman (leased by Mr Johan Engelbrecht)	46 ha under centre pivot. Mainly fodder for cattle. Sometimes maize	Source: River and dam	Cattle (1100)	Source: River and dam	None		None	

Table 6.6(b) Abstraction of surface water in quaternary catchment B11A according to the DWA's WARMS registration system (November 2012)

Quaternary catchment B11A	m^3/annum
Water uses	
Irrigation	3 017 428
Livestock watering	17 630
Mining	360 000
Water resource	
Bankspruit	452 020
Unnamed dam	306 710
Unnamed dam/river:	145 480
Fountain	2 000
Klein Olifants River:	640 500
Various dams	257 250
Mooivlei dam	110 975
Olifants River	927 430
Tributary of Olifants River	448 760
Vlaklaagte Dam	35 533
Wasserman Dam	68 400

7. CONSIDERATION OF ALTERNATIVES

In accordance with Section 50(d) of the Mineral and Petroleum Resources Development Regulations, GN R527, under the Mineral and Petroleum Resources Development Act (2002) (MPRDA), as well as Section 32(2)(f) of the Environmental Impact Assessment (EIA) Regulations R385, dated April 2006 under the National Environmental Management (1998) (NEMA), the alternatives considered in terms of minimising the impacts on surface water and the overall water balance are discussed in this section.

Various alternatives were evaluated in terms of the overall water management, including the following issues:

7.1 Clean water management

The clean catchment draining towards the dirty areas on the mine will be diverted around to both minimise the generation of contaminated water, as well as maximise the clean runoff draining to the natural system. In all layout alternatives, the volume of clean runoff has been maximised.

7.2 Minimising the generation of dirty water

All storm water generated on the site is considered dirty and will be directed to the PCDs at the mine infrastructure area.

- Infrastructure areas: The footprint of the dirty water areas have been minimised.
- Mining methodologies: Opencast and underground mining were considered. Opencast mining was ruled out, due to the environmental sensitivity of the Elders site, particularly the Viskuile and Vlakkuilen wetland systems. By ruling out opencast mining methods, the mine water make has been minimised.

  The underground is to be mined by bord and pillar methods. High extraction mining was ruled out due to the severe impact on the topography and therefore the highly sensitive wetland systems, as well as the high water make associated with high extraction mining. High factors of safety will be employed on the pillars to minimise the risk of subsidence / collapse and ensure that the mine water make is kept to a minimum.

7.3 Maximising the reuse of dirty water

This was a priority consideration from the start of mine planning. A water treatment plant is planned that will treat dirty water generated on the mine to supply all of the mine's potable and process water requirements. In the early years when the water make is expected to be too low to meet the mine's water demand, the make-up will be supplied from Goedehoop Colliery's dirty water system. In this way the reuse of dirty water will be maximised.

7.4 Implementing treatment where required

Numerous treatment options were considered when developing the water management strategy to ensure that contaminated water would not be released to the environment more than once in 50 years (a 2% or lower risk of spill, as required by GNR 704). These included consideration various treatment plant sizes, coupled with provision of storage both on surface and in the workings. Treatment plant sizes from 2.5 Mℓ/day to 10 Mℓ/day were considered, with emergency storage facilities up to 250 Mℓ in capacity. The selected option of a WTP starting at 0.5 Mℓ/day and expanding first to 2.5 Mℓ/day and later 5.0 Mℓ/day treatment capacity at the shaft area, with discharge of surplus treated water to the environment, coupled with storage in the underground workings for extreme rainfall events, was considered the most practicable and cost effective solution.

7.5 Alternatives in terms of process development

These are detailed in the main EMP document.

7.6 Water pipeline alternative options considered

The raw water pipeline from Elders to Block 20 will follow the conveyor route within the conveyor servitude. The pipeline will be an HDPE pipeline buried at least 1m below ground level or a galvanised mild steel pipeline that will either be mounted on the overland conveyor trestles or supported on concrete plinths at wetland crossings.

The type of support at wetland crossings will depend on the sequence and scheduling of construction of the overland conveyor and the pipeline. If the construction schedule allows the simultaneous construction of both the overland conveyor and the pipeline, the pipeline will be mounted on the conveyor at crossings but should there be a need for the pipeline to be constructed before the overland conveyor then the pipeline will have to be supported on concrete plinth at all wetland crossings.

The existing pipeline between Goedehoop Colliery Block 20 to Goedehoop Colliery Block 8 will be re-installed and will be attached to the re-established conveyor.

8. ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION MEASURES

8.1 Introduction

In order to quantify the potential impacts, the general format of the assessment is to first assess the impact assuming no mitigation measures are applied. In some instances, these impacts could not result without extreme or unlawful practices, such as discharging all of the affected water from the mining facilities into the river system. However, this provides a basis for the "worst case" scenario, from which mitigation measures can be evaluated (such as containment or treatment for example). The residual impact after implementation of the mitigation measures is then assessed and indicated.

As required by the MPRDA, cumulative impacts are also assessed as and where this is practical.

The format of the impact assessment is as follows:

- Section 8.2: The impact assessment methodology and rating system is described.
- Section 8.3: The nature of the various activities is described in terms of the phases of the project, from construction through to post closure.
- Section 8.4: The activities are assessed, detailing the potential impacts, proposed mitigation and residual impact over the full life cycle of the project.
- Section 8.5: The proposed mitigations are summarised to form a summarised water management plan.

8.2 Impact assessment methodology and rating system

The rating of impacts was done according to an impact rating and assessment process provided by the lead environmental consultant, SRK Consulting. The methodology is outlined as follows, as detailed in the terms of reference supplied by SRK:

The impact significance rating system is presented in and involves four parts:

- Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/population and duration.
- Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A.
- Part C: Use the matrix to determine the impact significance rating which is a function of the impact consequence rating (from Part B) and the probability of occurrence and
- Part D: Define the confidence level.

The impact significance rating system is summarised in the Table overleaf.

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE *Use these definitions to define the consequence in Part B*		
Impact characteristics	**Definition**	**Criteria**
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor+	Minor improvement; change not measurable; or threshold never exceeded
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction
	Major+	Substantial improvement; within or better than the threshold; or favourable publicity
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years
SPATIAL SCALE OR POPULATION	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE/ POPULATION		
			Site or Local	**Regional**	**National/ international**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)	**Definite**	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

PART D: CONFIDENCE LEVEL		
High	Medium	Low

8.3 Activities to be undertaken at the proposed underground mine that could potentially affect surface water

The following activities will be undertaken during the various phases of the proposed Elders project:

8.3.1 Construction phase

This phase will commence when the construction contractors establish on site and will end on full commissioning of all of the mine infrastructure.

Activities to be undertaken that will potentially impact on surface water include the following:

- General construction activities:
  - Civil works
  - Movement of materials and equipment
  - Servicing of construction vehicles and equipment.
- Construction of various infrastructure
  - Shaft complex roads and parking
  - Administration building (Shaft offices)
  - Control room/medical facility, proto building
  - Change house
  - Ventilation fans and associated infrastructure
  - Fire tanks
  - Surface silo
  - Stone dust silo
  - Pollution control dams
  - Sewage treatment plant
  - Water treatment plant
  - Topsoil stockpile
  - Overburden stockpile
  - Engineering/Mining /general store
  - Paint/Oil/Gas store yard
  - LDV Wash Bay
  - LDV Wash Bay
  - Bus shelter
  - Carports
  - Covered shaft waiting area
  - Lamp and crush room building
  - Salvage yard
  - Fencing
  - Washbay and oil separator
  - Security and access control
  - Brake test ramp
  - Crusher
  - Outdoor yard Substation
  - Bulk fuel store
  - General and Hazardous waste facilities
  - Green room covered assembly
  - Assembly point open area
  - Cable repair workshop
  - Banksman Cabin
- Construction of water management infrastructure:
  - Clean and dirty water canals
  - Sediment traps/ silt traps

   - o Pollution control dams
   - o Pump stations and pipelines.
   - o Bulk water supply tank
   - o Fire water pump station
   - o Fire storage tank
   - o Elevated water tank
- Construction of sewage treatment plants
- Construction of water treatment plants and associated facilities
- Two 22kV powerlines
- Water Pipelines
- Conveyor belt
- Construction of roads
   - o Existing R35 alignment
   - o Access and internal roads
   - o Main substation access road
   - o 22KV outdoor road

8.3.2 Operational Phase

This phase commences on removal of first coal, and will overlap with the construction phase. The operational phase will end when the Elders underground mining reaches the end of its LOM, and mining activities cease.

The purpose of the proposed Elders Colliery project is to mine coal, utilising underground mining methods, and then to convey the coal to Goedehoop Colliery for processing. The activities that can impact on surface water include the following:

- Underground shaft area
- Transport of coal to Goedehoop Colliery
- Loading and unloading of coal
- Offices, change house, laundry and ablution facilities
- Workshops, offices
- Wash bays
- Operation and maintenance of the water management system, including sediment management and management of the water levels in the Pollution Control Dams, which will include water make from the underground workings, and the storage of this water underground.
- Cleaning, repair and maintenance activities along roads and conveyor.
- Dust and fire suppression water management.
- Sewage treatment plants
- Water treatments plant and associated waste facilities
-

8.3.3 Decommissioning Phase

This phase starts at the end of the operational phase, and involves the closing down of the proposed Elders Colliery project. In theory, this phase ends when the site obtains Closure from the authorities, but may include a period where there is no activity on the site other than monitoring prior to Closure being obtained. Note that Closure refers to the point at which the State assumes responsibility for the liabilities associated with the site and issues the proponent with a Closure Certificate. This acceptance is in turn based on the proponent providing an acceptable financial provision to meet any future costs, and the attainment of various closure objectives set for the site.

Activities expected for this period include:

- Civil works and materials movement
- Closure of the mine operations, dismantling and removal of machinery and mine surface infrastructure
- Closing of shafts
- Removal or cleaning of the coal handling infrastructure
- Removal and cleaning of the product and waste handling infrastructure
- Rehabilitation of the footprints of the mine's surface infrastructure
- Removal or cleaning of dirty water facilities. In some instances, dirty water dams (for example) may be retained if a suitable use for them exists post-closure, e.g. containing decant water make.

8.3.4 Post closure

This phase will commence when the site has obtained Closure. It has no defined end, with the State managing the post closure impacts related to the site. However, should the authorities deem that the proponent has not correctly defined the residual impacts, the proponent could also be required to address future impacts even after a Closure Certificate has been issued.

Activities expected for this period include:

- Monitoring of aspects such as surface and ground water quality.

8.4 Surface water impact assessment and mitigation measures

The activities are discussed below in terms of the nature of the activity that could potentially impact on surface water, the nature of the impact if not mitigated, possible mitigations and post mitigation impact.

Note that cumulative impacts are not addressed in the tables in Sections 8.4.1 to 8.4.3, but are noted in Section 8.5.

8.4.1 Construction Phase

8.4.1.1. <u>Impact on surface water quality</u>

The construction phase impacts on surface water quality are detailed in **Impact Tables C1** to **C3**.

8.4.1.2. <u>Impact on surface water quantity – catchment yield and flow rates</u>

The construction phase impacts on surface water quantity are detailed in **Impact Table C4**.

8.4.2 Operational Phase

8.4.2.1. Impact on surface water quality

The operational phase impacts on surface water quality are detailed in **Impact Tables O1** to **O11**.

8.4.2.2. Impact on surface water quantity – catchment yield

The operational phase impacts on surface water quantity are detailed in **Impact Table O11** to **O14**.

8.4.3 Decommissioning and Closure Phases

8.4.3.1. Impact on surface water quality

The decommissioning and closure phase impacts on surface water quality are detailed in **Impact Tables D1** to **D3**.

8.4.3.2. Impact on surface water quantity – catchment yield

During decommissioning and closure the affected areas will be rehabilitated to generate clean runoff and will be restored to free draining conditions. Until the water management infrastructure is decommissioned the impact on catchment yield will remain as per the Operational Phase.

8.4.4 Post Closure Residual Impacts

8.4.4.1. Impact on surface water quality

Post closure the site will be rehabilitated, grassed and made free draining. All contaminated materials will have been removed from the site. The impact on water quality is detailed in **Impact Table PC1**.

8.4.4.2. Impact on surface water quantity – catchment yield

Post closure all areas will be rehabilitated and made free draining. There will therefore be no impact on catchment yield.

Impact C1 **Pre-construction and construction Phase – mine surface infrastructure and conveyor – Impact on surface water quality**

PHASE	PRE-CONSTRUCTION AND CONSTRUCTION PHASE
ACTIVITY	**Mine surface infrastructure and conveyor**
	Construction camps, construction works, movement of materials and construction equipment
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

Note that due to the relatively small footprint of the mine surface infrastructure and conveyor, as well as the similar nature of the construction phase impacts, all construction activities are assessed together.

During the construction phase topsoil will be stripped and civil works, in the form of earthworks and terracing will be undertaken as part of the preparation of the area for the construction of infrastructure such as roads, change house, wash bays, offices, workshops, crushers, water treatment plant, sewage treatment plant, etc., including the conveyor. Construction equipment will be mobile on the site.

Impacts may arise from:

- Erosion of soils during rainfall events, with elevated suspended solids in the runoff water.
- Resultant elevated suspended solids in the watercourses, as well as sedimentation in the watercourses.
- Hydrocarbon spillages from fuel storage, servicing areas or construction equipment itself, with resultant elevated hydrocarbon concentrations in runoff water and watercourses.

The Olifants River catchment is considered a stressed water resource in terms of both the quantity of water in the system and the quality of the water. It also forms the main water supply for the Witbank area (from the Witbank Dam), as well as for irrigation water further downstream (from the Loskop Dam). Any impact on the quantity or quality of water in the system has the potential to affect the quality and assurance of supply to the community and agriculture.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*

MANAGEMENT MEASURES

The following mitigation measures will be implemented:

- The footprint of disturbed areas will be minimised.
- “No-go” zones will be delineated for construction plant and personnel.
- Appropriate storm water management measures will be implemented, including the temporary diversion of upstream run-off from the construction and laydown areas.
- Surface water management measures, such as storm water canals, sediment traps and PCDs are to be constructed first to ensure that runoff and dirty water spills are contained.
- Servicing of construction vehicles will take place only in dedicated areas that are equipped with drip trays.
- Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil.
- Spill-sorb or a similar product will be kept on site, and used to clean up hydrocarbon spills in the event that they should occur.
- Erosion protection measures will be implemented at steep areas.
- A waste management plan will be developed for the construction phase.
- An appropriate sewage management strategy will be implemented during the construction phase.
- Water quality monitoring will be undertaken downstream of the construction areas, before and during construction where practical, in order to detect any increase in suspended solids or turbidity.
- If erosion is evident, or the water quality monitoring indicates an increase in suspended solids, water management around the construction areas will be reviewed.

PHASE	PRE-CONSTRUCTION AND CONSTRUCTION PHASE						
ACTIVITY	**Mine surface infrastructure and conveyor**						
	Construction camps, construction works, movement of materials and construction equipment						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, **see Section 8.5**.							

Impact C2 Pre-construction and construction Phase – Removal of material from the initial boxcut and incline shaft – Impact on surface water quality

PHASE	**PRE-CONSTRUCTION AND CONSTRUCTION PHASE**
ACTIVITY	**Initial boxcut and incline shaft development**
	Removal of material from the boxcut and incline shaft
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

The construction phase is considered to end once carbonaceous material, in the form of the coal seam, is exposed within the boxcut and incline shaft. However, much of the overburden removed prior to the exposing of coal has the potential to contain some carbonaceous material.

The boxcut will be excavated selectively, any overburden material contaminated with acidifying carbonaceous material will be excavated and transported to the existing mineral residue disposal facility at the Goedehoop South Mine complex.

The excavated hard material that is clean will be stockpiled to the south of the inclined shaft and later used to backfill the mine shaft at mine closure. This material will remain in the stockpiles for the duration of mining until closure.

Impacts may arise from:

- Erosion during rainfall events, resulting in increased turbidity and suspended solids in the runoff water, reporting to the local watercourses.
- Deposition of sediments in the local watercourses, impacting on the aquatic ecology.
- Overburden stockpiles will potentially contain carbonaceous material, with the potential to affect downstream watercourses by increasing sulphate and TDS concentrations.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*

MANAGEMENT MEASURES

The following mitigation measures will be implemented:

- Surface water management measures, such as storm water canals, sediment traps and PCDs are to be constructed first to ensure that runoff and dirty water spills are contained.
- The storm water runoff from the overburden stockpile will be caught in a clean water cut off channel. The channel will convey the water to a silt trap from where it will discharge into the proposed clean water cannel at the office area and conveyed into the veld.
- Prior to discharge to the veld, the water quality from overburden stockpile channel will be assessed and and pumped to the PCD if not suitable for discharge to the environment.
- Water quality monitoring will be undertaken downstream of the construction areas before and during construction, where practical, in order to detect any increase in suspended solids or turbidity.

IMPACT AFTER MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*

CUMULATIVE IMPACT

Cumulative impacts not assessed here, see **Section 8.5**.

Impact C3 **Pre-construction and construction Phase – Dewatering of water ingress to boxcut and incline shaft – Impact on surface water quality**

PHASE	**PRE-CONSTRUCTION AND CONSTRUCTION PHASE**						
ACTIVITY	**Initial boxcut and incline shaft development**						
	Dewatering of water ingress to boxcut and incline shaft						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
Water that enters the boxcut and incline shaft excavations, both from groundwater seepage and direct rainfall, is expected to be largely clean. However, there is a possibility that this water makes contact with carbonaceous and pyritic materials. The water quality from the boxcut and incline shaft is therefore likely to be slightly to moderately impacted in terms of sulphate, TDS and suspended solids. Impacts may arise from: • Discharge of the potentially impacted water to the environment, with a resultant increase in sulphate and TDS concentrations in the natural watercourses. • Deposition of sediments in the local watercourses, impacting on the aquatic ecology.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • The maximum volume of water expected to be generated at the start of mining at the boxcut in 2018 is likely to be around 167 m^3/day during the summer period. The water will be contained at the site, in the PCD, for re-use after pre-treatment in dust suppression on haul roads, and as construction water, if the quality is suitable. The water will not be discharged. • Surface water management measures, such as storm water canals, sediment traps and PCDs are to be constructed first to ensure that runoff and dirty water spills are contained • A Water Use Licence for the dewatering of groundwater encountered during mining will be applied for, including the reuse of this water for dust suppression.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see **Section 8.5**.							

Impact C4 **Pre-construction and construction Phase – mine surface infrastructure, boxcut area and conveyor – Impact on surface water quantity**

PHASE	**PRE-CONSTRUCTION AND CONSTRUCTION PHASE**						
ACTIVITY	**Mine surface infrastructure, incline shaft, boxcut area and conveyor**						
	Construction camps, construction works, movement of materials and construction equipment, excavation of boxcut and incline shaft						
ASPECT	Water Quantity – containment of runoff from the site						
IMPACT DEFINITION	Reduction in catchment yield						
IMPACT DESCRIPTION AND EVALUATION							
Note that due to the relatively small footprint of the mine surface infrastructure at the shaft complex and conveyor, as well as the similar nature of the construction phase impacts, all construction activities are assessed together. During construction, prior to the commissioning of the pollution control dam, surface runoff will be released to the catchment once sediment has settled out. The water management infrastructure will be constructed first to enable the containment of dirty water generated during the remainder of the construction period. Impacts may arise from: • Containment of contaminated runoff water emanating from the site, including the mine infrastructure area with no release to the catchment. The duration of the potential impacts is therefore medium term. Although runoff from dirty areas will be contained (see management measures below) and the probability of impact is definite, its significance has still been assessed as very low on the basis of the very small area that will be contained.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • The aerial extent of the disturbed and potentially contaminated areas will be kept to the demarcated construction footprint. • Areas where dirty construction activities are carried out (e.g. servicing areas and workshops, fuel storage areas, waste storage areas) will be minimised and surrounded by bunds. • Clean upslope runoff will be diverted around construction activities.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see **Section 8.5**.							

Impact O1 **Operational Phase – Mine water discharge – Impact on surface water quality**

PHASE	**OPERATIONAL PHASE**
ACTIVITY	**Mine water discharge**
	Discharge of mine water to the natural watercourses
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

It is important to note that the mine water balance assessment undertaken in Section 5 is aimed at ensuring that the mine does not spill water during the operational phase, except for very extreme events related to floods in excess of at least the 1:50 year event. The water management measures detailed in Sections 4 and 5 are mitigation measures, focusing primarily on the treatment and reuse of water.

However, to merely indicate that the mine will not spill dirty water does not allow an assessment of the potential impact of non-compliance with the mitigation measures proposed. In order to assess the impact without mitigation, this impact assessment assumes that all dirty water is discharged to the catchment, where after detail is provided on how this will be prevented, and the impact after management is then assessed.

The water balance modeling indicates that the mine will have an average water surplus over the LOM of approximately 910 m^3/day, after reuse on site.

The assumed water quality used in this assessment is given in the table below (as estimated by JMA Consulting):

Parameter	Most likely operational quality	Possible high concentration
pH	6.1 to 8.1	5.5
TDS	800 to 110 mg/l	6500 mg/l
SO_4	350 to 800 mg/l	4500 mg/l

The potential impact on in-stream aquatic life and downstream users is assessed as follows:

The potential impact on aquatic life or downstream users of water within the rivers is highly dependent on the pH of the water discharged. This is because acidic conditions will result in mobilisation of metals, and this would be a major contributing factor to the potential toxicity of the water. Based on the assumption that the water is unlikely to be acidic during the operational phase, the following is predicted:

- It is possible that metals such as Fe and Al, will be present in significantly elevated concentrations (values of <1 to 10 mg/l and <1 to 5 mg/l predicted respectively).
- An increase in electrical conductivity and overall salinity such that the water is unfit for potable use, as well as informal drinking.
- Sulphate levels could be significantly elevated to the point that there is a risk of developing diarrhoea in infants that may drink the water. Miscarriages in cattle will also be possible at the higher levels of around 4500mg/l.
- SAR (Sodium Adsorption Ratio) levels may be impacted on, the Target Water Quality Range <= 2.0mg/l. it is possible that the SAR levels will be significantly elevated, making the water unsuitable for irrigation without some form of mitigation, with Na levels of around 45 mg/l , but possibly as high as 250 mg/l, predicted.

The potential impact in terms of salt loading on dams is assessed as follows:

The salt loading within the Witbank catchment is critical, particularly in terms of sulphate. Based on an average surplus water make of some 910 m^3/day, and a sulphate concentration of around 4500 mg/l (the worst case predicted by JMA for the operational period), the mine could generate an average of 4.1 tonnes SO_4 per day.

<table>
<tr><td>PHASE</td><td colspan="7">OPERATIONAL PHASE</td></tr>
<tr><td rowspan="2">ACTIVITY</td><td colspan="7">Mine water discharge</td></tr>
<tr><td colspan="7">Discharge of mine water to the natural watercourses</td></tr>
<tr><td>ASPECT</td><td colspan="7">Water Quality – discharge of contaminated water</td></tr>
<tr><td>IMPACT DEFINITION</td><td colspan="7">Pollution of surface water resources</td></tr>
<tr><td colspan="8">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Major</td><td>Long term</td><td>Regional</td><td>High</td><td>Definite</td><td>High</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="8">The mine water balance will be managed as detailed in Sections 4 and 5. These measures will include the following:
• Containment of all dirty water generated on the mine in a lined PCD, sized to have a risk of spill of 2% or less in any one year.
• Provision of a water treatment plant to treat a maximum of 5.0 Ml/day of dirty water generated at the mining operations.
• Treatment of excess dirty water for reuse at the Elders operations, including supply of domestic and service water requirements.
• Water will be treated to achieve both drinking water standards (SANS241:2011) and the interim RWQO for the Olifants River. Surplus treated water that cannot be reused in the operations will be discharged to the Olifants River.
• Excess water that cannot be treated or reused will be pumped to storage in underground compartments at around 2025, when storage becomes available at Elders 2 Seam underground sections. Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the 2 Seam, surplus water will be stored in the underground workings at Elders. The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.
• Provision of water management facilities with a risk of spill that is lower than 2% in any one year.
• A surface water quality monitoring programme will be implemented, as detailed in Section 11, to detect any impacts.
• A water balance monitoring programme will be implemented, as detailed in Section 11, to enable calibration of the water balance.</td></tr>
<tr><td colspan="8">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Moderate</td><td>Medium term</td><td>Regional</td><td>Medium</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="8">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

Impact O2 **Operational Phase – Mine surface infrastructure area (incline shaft area, workshops, offices and related infrastructure) – Impact on surface water quality**

PHASE	**OPERATIONAL PHASE**
ACTIVITY	**Mine Surface Infrastructure** Access shaft area, workshops, offices and related infrastructure
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

The mine surface infrastructure will be constructed at the start of mining and will remain in place for the duration of mining.

The wash bays, offices, and workshop areas have the potential to generate poor quality runoff due to contact of the water with coal, hydrocarbons and waste material.

Impacts associated with the incline shaft area would be as a result of runoff entering the pits and coming in contact with carbonaceous material.

Impacts may arise from:

- Contaminated storm water runoff, as well as wash down water and hydrocarbon spills that discharge from the site, with resultant deterioration in water quality within the Olifants River catchment, associated with increased suspended solids, hydrocarbons (oils and greases), siltation of carbonaceous materials, increase in salinity and potential decrease in pH in the watercourses.
- Contaminated seepage from the overburden stockpiles, if it contains carbonaceous material, with potentially elevated sulphate and TDS.
- Leakage of contaminated water from pipelines, poorly maintained storm water channels, sumps, sediment traps and oil skimmers, etc.
- Erosion at the clean canal discharge points could result in the formation of erosion gullies on surface, with elevated suspended solids in the runoff water, potentially impacting on the water quality in the watercourses in terms of suspended solids and deposition of silt.
- Increase in sulphate, turbidity, suspended solids and TDS due to runoff entering the pits and becoming contaminated.
- Runoff coming into contact with carbonaceous material in and around the access shaft.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Major	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*High*

MANAGEMENT MEASURES

The following mitigation measures will be implemented:

- All facilities with the potential to generate dirty storm water runoff, effluent or washdown water will be located within the designated dirty water area.
- Clean runoff will be diverted around the designated dirty areas by means of cut-off canals, sized to accommodate at least the 1:50 year peak flow event.
- Adequate erosion protection will be provided at the clean canal discharge locations.
- All spills will be contained within dedicated bunded areas (at wash bays, workshops, waste handling areas, etc.).
- Both general and hazardous wastes will be stored in skips until removed from the site. The skips in turn will be located under cover, in bunded areas, to prevent ingress of direct rainfall.
- There will be capacity to store a maximum of 132 m^3 of general waste in waste bins during the life of the project. The phasing of the bins is planned as follows:
  - During the construction phase: 6 x 6 m^3 bins
  - During the operational phase: 22 x 6 m^3 bins.
- The storage period will be less than 90 days before removal from the site by an appropriately licensed waste removal contractor and disposed of at a licensed general waste facility.

PHASE	OPERATIONAL PHASE
ACTIVITY	**Mine Surface Infrastructure**
	Access shaft area, workshops, offices and related infrastructure
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

- Hazardous waste will be stored according to the applicable regulations under the National Environmental Management: Waste Act (Act 59 of 2008) and the DWS Minimum Requirements.
- The storage area will, as a minimum, be paved with concrete, covered and provided with bunds and drainage facilities to collect and contain any spills or adversely affected runoff.
- Waste oil will be stored in drums in a bunded storage area.
- Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil.
- All contaminated runoff and spills that escape bunded areas will be collected and contained in the PCD.
- All pipeline routes will be inspected regularly to enable early detection of leaks.
- All storm water and wash down water will be collected in the PCD.
- Washdown and waste water from the workshops will be passed through oil skimmers before discharging to the storm water system for containment in the PCD and eventual treatment for reuse, or pumping to underground storage.
- An inspection and maintenance plan will be implemented on the storm water system to ensure that all oil skimming and sediment handling facilities are maintained and that storm water canals and pipelines remain unblocked and free flowing – monthly inspections will be carried out.
- Spill-sorb or a similar type product must be kept on site and used to clean up hydrocarbon spills in the event that they should occur.
- Contain all dirty water from the shaft area.
- A surface water quality monitoring programme will be implemented to detect any impacts.

IMPACT AFTER MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Medium term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*

CUMULATIVE IMPACT

Cumulative impacts not assessed here, see Section 8.5.

Impact O4 Operational Phase – Ablution facilities and sewage treatment plant – Impact on surface water quality

PHASE	**OPERATIONAL PHASE**						
ACTIVITY	**Ablution facilities and sewage treatment plant**						
	Handling, disposal and treatment of sewage						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
Water from the ablution facilities will contain organic matter, which is high in nitrogen and could therefore cause eutrophication if enters the water resource. The sewage treatment plant will be located adjacent to the PCD. During operations the treated effluent from the sewage treatment plant will be discharged into the Olifants River. Impacts may arise from: • Discharge of untreated sewage into the watercourse. • Discharge of treated water not meeting the specified discharge standards into the watercourse.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Medium term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • All domestic waste water will be treated in the sewage treatment plant. • The sewage water will be treated in the plant to acceptable effluent standards. • Sludge will be deposited in drying beds within the designated dirty water area and removed by a licensed waste contractor. • An inspection and maintenance plan will be implemented to ensure that the sewage treatment plant always operates within specification. • A surface water quality monitoring programme will be implemented to detect any impacts.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Medium term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact O5 Operational Phase – Pollution control dams – Impact on surface water quality

PHASE	**OPERATIONAL PHASE**						
ACTIVITY	**Pollution control dams**						
	Storage of polluted water						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
The water in the pollution control dams will be of poor quality, with potential to impact on the downstream water resources, primarily in terms of increased salinity (particularly sulphate) and potentially reduced pH if there are spillages or leaks from the dams. Impacts may arise from: • Inadequate sizing or lining system on the dams. • Poor maintenance resulting in loss of storage capacity due to sediment build-up in the dams							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Major	*Long term*	*Regional*	***High***	***Possible***	***High***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • The pollution control dams will be engineered to have sufficient capacity to limit the risk of spill to less than 2% in any one year. ▪ In line with best practice, the PCDs will be operated as empty as possible at all times to ensure that sufficient storm water retention capacity is available at all times. ▪ In the event that there is insufficient available capacity in the main PCD during extreme rainfall conditions, excess storm water will be pumped to the Elders underground storage compartments. • The pollution control dams will be equipped with geomembane liners to minimise leakage of contaminated water to the surface or ground water systems. • The lining system on the PCDs will include a sub-surface drainage layer to detect any leakages, as well as to prevent the build-up of hydrostatic pressure beneath the geomembrane liner. Water collected in the sub-surface drainage system will be discharged to a sump and pumped back into the PCD. • An inspection and maintenance plan will be implemented to ensure that the dams are kept in good working order and to monitor sediment build-up. When sediment levels reach a pre-determined level, sediment will be removed to ensure that sufficient storm water storage capacity is maintained at all times. • A surface water quality monitoring programme will be implemented to detect any impacts.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact O6 **Operational Phase – Dust and fire suppression – Impact on surface water quality**

<table>
<tr><td>PHASE</td><td colspan="7">OPERATIONAL PHASE</td></tr>
<tr><td rowspan="2">ACTIVITY</td><td colspan="7">Dust and fire suppression</td></tr>
<tr><td colspan="7">Dust and fire suppression with contaminated water</td></tr>
<tr><td>ASPECT</td><td colspan="7">Water Quality – discharge of contaminated water</td></tr>
<tr><td>IMPACT DEFINITION</td><td colspan="7">Pollution of surface water resources</td></tr>
<tr><td colspan="8">IMPACT DESCRIPTION AND EVALUATION</td></tr>
<tr><td colspan="8">Dust and fire suppression systems will be provided along haul roads and the conveyor. These will involve spraying of water onto coal handling areas, as well as a deluge system in case of fire. This water will become contaminated once it comes into contact with the coal.
Impacts may arise from:
• Spillage of dust suppression or fire water to the watercourses or adjacent pans, with resultant deterioration in water quality, in terms of elevated salinity, particularly sulphate.</td></tr>
<tr><td colspan="8">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Minor</td><td>Short term</td><td>Site</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="8">The following mitigation measures will be implemented:
• All dust and fire suppression will take place within the designated dirty water areas.
• Excess water will therefore drain via the dirty storm water system to the PCD and will be pumped back to the water treatment plant for reuse in the mining operations.</td></tr>
<tr><td colspan="8">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Minor</td><td>Short term</td><td>Site</td><td>Low</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="8">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

Impact O7 Operational Phase – Operation of water treatment plant – Impact on surface water quality

<table>
<tr><td colspan="2">PHASE</td><td colspan="6">OPERATIONAL PHASE</td></tr>
<tr><td colspan="2" rowspan="2">ACTIVITY</td><td colspan="6">Water treatment plant</td></tr>
<tr><td colspan="6">Operation of the water treatment plant, treatment of contaminated mine water</td></tr>
<tr><td colspan="2">ASPECT</td><td colspan="6">Water Quality – discharge of contaminated water</td></tr>
<tr><td colspan="2">IMPACT DEFINITION</td><td colspan="6">Pollution of surface water resources</td></tr>
<tr><td colspan="8">IMPACT DESCRIPTION AND EVALUATION</td></tr>
<tr><td colspan="8">Water will be drawn from the PCD and treated in the water treatment plant (WTP) for reuse in the mining operations, with surplus being discharged to the Olifants River.
The WTP will comprise a combination of filtration and RO.
Impacts may arise from:
• Spillage of chemical additives, which could result in deterioration of water quality in the watercourses.
• Spillage of the water treatment waste products, in the form of brine and gypsum to the receiving environment.
• Discharge of water that does not meet the discharge standards, or untreated water during upset conditions at the WTP.</td></tr>
<tr><td colspan="8">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Major</td><td>Long term</td><td>Regional</td><td>High</td><td>Possible</td><td>High</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="8">The following mitigation measures will be implemented:
• The WTP will be isolated within a designated dirty water area. All runoff and spills from the treatment plant will be collected in a sump, from which water will be pumped to the PCD.
• All chemicals and additives will be stored in dedicated bunded areas, where any spills will be contained.
• An inspection and maintenance plan will be implemented to ensure that the water treatment plant always operates within specification.
• A surface water quality monitoring programme, will be implemented to detect any impacts.
• Discharge water quality will be continuously monitored for early detection of discharge water quality problems.
• Should upset conditions occur, or poor discharge water quality be detected, the WTP discharge will be directed to the PCD.</td></tr>
<tr><td colspan="8">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Minor</td><td>Long term</td><td>Site</td><td>Medium</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="8">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

Impact O8 **Operational Phase – Handling and storage of brine and gypsum – Impact on surface water quality**

PHASE	**OPERATIONAL PHASE**
ACTIVITY	**Water treatment plant**
	Handling and storage of brine and gypsum
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

The proposed water treatment plant will generate both liquid waste (brine), and solid waste in the form of a gypsum sludge.

Impacts may arise from:

- Spillage of brine and gypsum onto the ground surface.
- Inadequate lining systems, or leakage from the liners at the gypsum drying bed.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*

MANAGEMENT MEASURES

The following mitigation measures will be implemented:

- Initially one brine dam will be constructed, with a second to be constructed at a later stage, as the WTP's treatment capacity is increased.
- The brine dams will be lined with 300mm compacted clayey layer with a 1.5 mm thick HPDE geomembrane above and below a 6 mm hi-drain, to minimise seepage of contaminated water to the groundwater system. The brine dams will also be equipped with a leak detection sump.
- The gypsum pads will be paved with concrete. The concrete slabs will be underlain by a 1.5 mm thick HDPE geomembrane liner. The gypsum pad will be provided with concrete bunds to ensure no storm water runoff from the area. The storm water will be directed to a sump at the lower end of the gypsum area, from where water will be directed to the brine dam via a sloping pad and concrete lined channel.
- Gypsum will be removed from the site on a regular basis. This will occur in a timely manner to prevent overloading of the gypsum drying pad.
- Removal from site of gypsum will be undertaken by an appropriately licensed waste removal contractor.
- Disposal of gypsum will be at a licensed hazardous waste disposal facility, such as Holfontein Landfill.
- The gypsum pad will be bunded to prevent clean storm water from entering the pad and to contain all storm water generated on the pad itself. Storm water from the pad will be collected in a sump and pumped to the PCD.
- An inspection and maintenance plan will be implemented to ensure that the pipelines and dams are kept in good working order.
- A surface water quality monitoring programme will be implemented to detect any impacts. The WTP will be isolated within a designated dirty water area. All runoff and spills from the treatment plant will be collected in a sump, from which water will be pumped to the PCD.

IMPACT AFTER MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*

CUMULATIVE IMPACT

Cumulative impacts not assessed here, see Section 8.5.

Impact O9 **Operational Phase – Discharge of treated water from the water treatment plant – Impact on surface water quality**

PHASE	OPERATIONAL PHASE						
ACTIVITY	**Water treatment plant**						
	Discharge of treated water to the Olifants River						
ASPECT	Water Quality – discharge of treated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
Water will be drawn from the PCD and treated in the water treatment plant (WTP), with surplus treated water discharged to the Olifants River. The water treatment plant will have the capacity to treat up to 5.0 Mℓ/day. The release of surplus treated water into the catchment will influence the water quality of the receiving resource and erosion may occur at the discharge point. The baseline water quality shows that the Olifants River is already heavily impacted. The quality of water should therefore improve due to dilution effects.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • Erosion protection measures at the discharge point • The quality of the water discharged will be closely monitored to ensure that it falls within the specified RWQO at all times.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact O10 **Operational Phase – Conveyance of coal – Impact on surface water quality**

PHASE	**OPERATIONAL PHASE**
ACTIVITY	**Conveyance of coal**
	Transport of coal by road and conveyor from Elders operation Goedehoop Colliery
ASPECT	Water Quality – spillage of contaminated water and coal particulates
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

Transport of coal by road has the potential to impact on watercourses and general runoff quality, primarily due to spillage of coal from overloaded trucks, as well as contaminated water from the load boxes of the trucks on inclines.

Transport of coal by conveyor has the potential to impact on watercourses and general runoff quality, primarily due to spillage of coal, as well as contaminated water from the belt itself and at transfer stations.

Impacts may arise from:

- Spillage of water from truck load boxes.
- Dripping of water from the conveyor belt at low points, as well as spillage at transfer stations.
- Spillage of coal at transfer, on-loading and offloading stations.
- Wind-blown dust at transfer stations settling on the adjacent surface and in watercourses.
- Storm water runoff coming into contact with these emissions would suffer a deterioration in water quality, with increased salinity, particularly sulphate.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long Term*	*Site*	***Medium***	***Definite***	***Medium***	-	*High*

MANAGEMENT MEASURES

The following mitigation measures will be implemented:

- The belt drive and transfer infrastructure at either end of the conveyor will be paved with concrete, bunded to prevent run-on of clean water and to contain dirty runoff.
- Loading and offloading of trucks will take place only within the designated dirty water areas and Goedehoop.
- Conveyors will be rotated at the either end to ensure that the dirty side faces upwards at all times.
- Belt scrubbers will be provided at either end to clean the belt to prevent carbonaceous material from being dropped along the route.
- The conveyor will be completely enclosed at the bridge crossing to prevent any spillage of water or coal into the watercourses.
- Watercourse crossings will be designed to accommodate at least the 1:100 year event without overtopping.
- Dust suppression will be employed at the either end of the conveyor to minimise dust emissions.
- A shroud will be provided along the entire conveyor length, on the upwind side, to prevent rain from falling directly onto the conveyor and to protect it from wind.
- Loading of trucks will be carefully controlled to ensure that overloading will not take place.
- Truck load boxes will be covered with tarpaulins to prevent spillage of coal from the backs of trucks during transport.
- Monitoring will be implemented downstream of all watercourse crossings along the conveyor route.

IMPACT AFTER MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*

CUMULATIVE IMPACT

Cumulative impacts not assessed here, see Section 8.5.

Impact O11 Operational Phase – Dirty water pipeline from Goedehoop Colliery – Impact on surface water quality

PHASE	**OPERATIONAL PHASE**						
ACTIVITY	**Dirty water pipeline** Pumping of water from Goedehoop Colliery to Elders Colliery as make-up water						
ASPECT	Water Quality – spillage of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
The dirty water pipeline from Goedehoop Colliery to the Elders Colliery has the potential to impact on surface water through leaks and spillages. The pipe will either be buried or mounted to the conveyor structure. If buried, detection of leaks will be difficult. Impacts may arise from: • Damage to the pipeline or deterioration of joints, causing leaks of dirty water, with a resultant deterioration in water quality, with increased salinity, particularly sulphate.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Major	*Long Term*	*Regional*	***High***	***Possible***	***High***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • The pipe will be pressure tested before commissioning backfilling the trench to ensure that all joints are properly sealed. • The pipe will be encased in concrete at all watercourse crossings (if buried) to minimise the risk of damage in the case of erosion due to flood events. • Monitoring will be implemented downstream of all watercourse crossings to detect any impacts.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact O12 Operational Phase – Consequence of extreme floods – Impact on surface water quality and quantity

<table>
<tr><td colspan="2">PHASE</td><td colspan="6">OPERATIONAL PHASE</td></tr>
<tr><td colspan="2" rowspan="2">ACTIVITY</td><td colspan="6">Elders mining operation</td></tr>
<tr><td colspan="6">All activities</td></tr>
<tr><td colspan="2">ASPECT</td><td colspan="6">Flooding of mine or mine infrastructure during extreme flood events</td></tr>
<tr><td colspan="2">IMPACT DEFINITION</td><td colspan="6">Impact on mining operation</td></tr>
<tr><td colspan="8">IMPACT DESCRIPTION AND EVALUATION</td></tr>
<tr><td colspan="8">GNR 704 stipulates that no mine workings may be placed within the 1:50 year floodline and no mine residue deposits or stockpiles may be placed within the 1:100 year floodline, or a distance of 100 m from any watercourse, whichever is the greater.
The majority of the mine infrastructure, including the incline shaft, workshops, offices and related infrastructure will be located well outside the 1:100 year floodlines. However, the conveyor, its service road, as well as the power lines and water supply pipeline from Goedehoop Colliery will cross watercourses along the conveyor route.
Extreme floods could cause damage to the conveyor, power line, access road and pipeline, with consequent impacts on surface water quality, as well as production at the mine.</td></tr>
<tr><td colspan="8">IMPACT BEFORE MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Moderate</td><td>Long term</td><td>Site</td><td>Medium</td><td>Unlikely</td><td>Medium</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">MANAGEMENT MEASURES</td></tr>
<tr><td colspan="8">The following mitigation measures will be implemented:
• With the exception of the conveyor, conveyor service road, power lines and pipeline from Goedehoop, no mine infrastructure will be located within the 1:100 year floodline of any water course.
• The conveyor will be elevated at least 1 m above the 1:100 year flood level at all watercourse crossings.
• The water supply pipeline from Goedehoop Colliery will be either buried at least 1 m deep and encased in concrete at all watercourse crossings, or mounted onto the conveyor structure.
• The conveyor service road will cross the watercourses by means of low-level crossings. These will be designed to withstand the flow velocities expected during extreme floods with minimal damage.</td></tr>
<tr><td colspan="8">IMPACT AFTER MANAGEMENT</td></tr>
<tr><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>SIGNIFICANCE</td><td>+ / -</td><td>Confidence</td></tr>
<tr><td>Minor</td><td>Medium term</td><td>Site</td><td>Low</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="8">CUMULATIVE IMPACT</td></tr>
<tr><td colspan="8">Cumulative impacts not assessed here, see Section 8.5.</td></tr>
</table>

Impact O13 Operational Phase – Elders mining operation – Impact on surface water quantity

PHASE	OPERATIONAL PHASE
ACTIVITY	**Elders mining operation**
	Isolation of dirty catchment
ASPECT	Water Quantity – containment of runoff from the site
IMPACT DEFINITION	Reduction in catchment yield

IMPACT DESCRIPTION AND EVALUATION

The loss in yield associated with mining at the Elders operation will be primarily due to the mine infrastructure area, which will be isolated from the catchment, as well as potential ingress to shallow underground workings below the Viskuile and Vlakkuilen wetland system.

Loss of yield to the watercourses:

The potential loss of yield to the watercourses is quantified in the following table:

Location	Catchment area (km^2)	MAR Pre-mining ($m^3 x10^6$)	Loss in MAR ($m^3 x10^6$)	MAR during operations ($m^3 x10^6$)	Percentage reduction (%)
Elders Mine Infrastructure (Offices, workshops, etc.) access shaft	0.83	0.03	0.03	0	100
Viskuile and Vlakkuilen Rivers upstream of Olifants River	392.3	17.16	0.39* (Max at end of LOM)	16.77	2.27
Mineral rights area	58.7	2.57	0.47	2.10	18.29
Olifants River downstream of mineral rights area	1070	46.81	0.47	46.34	1.00
Witbank Dam	3 579	125	0.47	124.53	0.38
Loskop Dam	12185	384	0.47	383.53	0.12

* Note: * Conservatively estimated by JMA Consulting

** The runoff calculations are not accurate to two decimal places. However, the values remain indicative of the magnitude of the impact.

It is evident from the table above that the impact on surface water yield to the watercourses is Moderate.

Note that the impact assessment below is based on a worst case loss to the wetland, as indicated by JMA consulting.

IMPACT ON WATERCOURSES

Impact before management

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*Medium*

Management measures

The site layout has been designed to minimise the dirty footprint, and therefore to minimise the impact on the catchment yield.

A water treatment plant will be provided, which will treat excess mine water make to discharge quality, which will be returned to the Olifants River.

PHASE	OPERATIONAL PHASE						
ACTIVITY	**Elders mining operation**						
	Isolation of dirty catchment						
ASPECT	Water Quantity – containment of runoff from the site						
IMPACT DEFINITION	Reduction in catchment yield						
Impact after management							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Long term*	*Site*	***Low***	***Definite***	***Low***	-	*Medium*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see **Section 8.5**.							

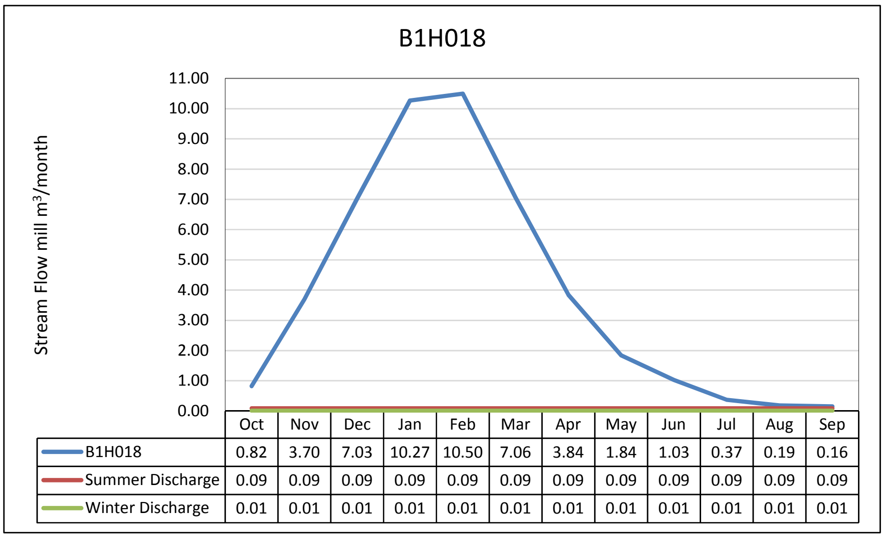
Impact O14 Operational Phase – Water treatment plant – Impact on surface water quantity

PHASE	OPERATIONAL PHASE
ACTIVITY	**Water treatment plant**
	Discharge of treated water to the Olifants River
ASPECT	Water Quantity – discharge of treated water
IMPACT DEFINITION	Alteration of flow patterns in watercourses

IMPACT DESCRIPTION AND EVALUATION

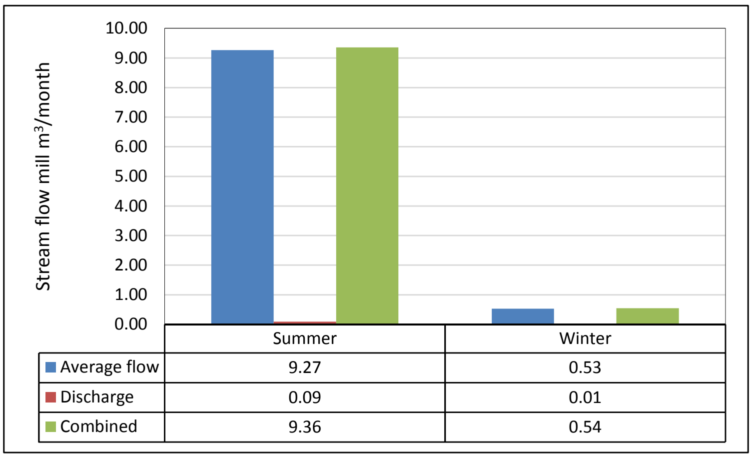
The discharge of treated water to the river system will result in a net increase in the flow of water in the Olifants River. While this has a net positive impact on the availability of water in the system, it has the potential to negatively impact on the aquatic ecology by changing the seasonal flow patterns in the river system.

The water make at the Elders Colliery will be seasonal, with a consequent strong seasonality in the discharge of treated water to the Olifants River (as illustrated in Section 5). The magnitude of the expected summer and winter discharges of treated water during the last year of mining (i.e. the year of maximum water make) have been compared with the natural stream flow in the Olifants River at DWS flow gauging station B1H018, located approximately 7 km downstream of the mine. This is illustrated in the figures below.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
B1H018	0.82	3.70	7.03	10.27	10.50	7.06	3.84	1.84	1.03	0.37	0.19	0.16
Summer Discharge	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Winter Discharge	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Average stream flow measured in the Olifants River



	Summer	Winter
Average flow	9.27	0.53
Discharge	0.09	0.01
Combined	9.36	0.54

Contribution of treated water discharge to the flow in the Olifants River

PHASE	**OPERATIONAL PHASE**						
ACTIVITY	**Water treatment plant**						
	Discharge of treated water to the Olifants River						
ASPECT	Water Quantity – discharge of treated water						
IMPACT DEFINITION	Alteration of flow patterns in watercourses						
The net percentage increase in flow during summer amounts to some 1.0% and in winter to around 2.7%. The net increase in MAR amounts to 1.4%. The potential impacts to the ecology of the river systems due to the discharge of treated water falls outside the scope of this surface water assessment, and will be assessed as part of the aquatic ecology and wetland assessments.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*
MANAGEMENT MEASURES							
No mitigation as increase in yield is positive.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact D1 **Decommissioning and Closure Phase – General decommissioning and rehabilitation – Impact on surface water quality**

PHASE	**DECOMMISSIONING AND CLOSURE PHASE**						
ACTIVITY	**Elders operation**						
	Construction camps, construction (demolition) works, movement of materials and construction equipment						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
Impacts resulting from general rehabilitation and decommissioning works will be similar to those during the construction phase, with rehabilitation earthworks and movement of construction equipment on the site. Impacts may arise from: • Erosion of soils during rainfall events, with elevated suspended solids in the runoff water. • Resultant elevated suspended solids in the watercourses, as well as sedimentation in the watercourses and the adjacent pans. • Hydrocarbon spillages from fuel storage, servicing areas or construction equipment itself, with resultant elevated hydrocarbon concentrations in runoff water, watercourses and the adjacent pans. • Contaminated soils below the stockpiles area may have a long term impact in terms of leaching contaminants to the ground and surface water systems. These impacts are expected to be relatively small, with the resultant impact post decommissioning being positive in comparison with the operational phase.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • The footprint of disturbed areas will be minimised. • “No-go” zones will be delineated for construction plant and personnel – particularly in close proximity and within the catchment areas of the pans. • The storm water management measures, including the PCD will be decommissioned last, to ensure adequate storm water management during the rehabilitation phase. • Servicing of construction vehicles will take place only in dedicated areas that are equipped with drip trays. • Bunded containment and settlement facilities will be provided for hazardous materials, such as fuel and oil. • Spill-sorb or a similar type product will be kept on site and used to clean up hydrocarbon spills in the event that they should occur. • Erosion protection measures will be implemented at steep areas. • A waste management plan will be developed for the construction phase, which will include the handling of contaminated materials / soils found on site. • All traces of hydrocarbons and residual waste will be removed before infrastructure is demolished. • All coal will be removed from the stockpiles prior to rehabilitation. • Contaminated soils will be excavated and placed on the discard facilities prior to their rehabilitation, or removed from site by an appropriately licensed waste contractor. • An appropriate sewage management strategy will be implemented during the decommissioning phase, including decommissioning of the sewage treatment plant as late as possible in the process. • Water quality monitoring will be undertaken downstream of the construction areas, before and during construction where practical, in order to detect any increase in suspended solids or turbidity. • If erosion is evident or the water quality monitoring indicates an increase in suspended solids, water management around the construction areas will be reviewed.							

PHASE	DECOMMISSIONING AND CLOSURE PHASE						
ACTIVITY	**Elders operation**						
	Construction camps, construction (demolition) works, movement of materials and construction equipment						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact D2 **Decommissioning and Closure Phase – Water management infrastructure and pollution control dams – Impact on surface water quality**

PHASE	**DECOMMISSIONING AND CLOSURE PHASE**						
ACTIVITY	**Water management infrastructure and pollution control dams**						
	Decommissioning and rehabilitation of water management infrastructure						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
The water management berms and canals isolate active areas from the catchment by diverting upslope clean runoff around the active areas and containing runoff generated on the active areas. These can only be removed once the area has been rehabilitated, but may result in increased erosion if not properly planned. The PCD will be used to contain affected runoff and from the mine infrastructure area until such time as the area becomes clean. Impacts may arise from: • Erosion of soils during rainfall events, with elevated suspended solids in the runoff water. • Resultant elevated suspended solids in the watercourses, as well as sedimentation in the watercourses and the adjacent pans. These impacts are expected to be relatively small, with the resultant impact post decommissioning being positive in comparison with the operational phase.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	*Short term*	*Regional*	***Medium***	***Possible***	***Medium***	-	*High*
MANAGEMENT MEASURES							
The following mitigation measures will be implemented: • This infrastructure will be decommissioned and rehabilitated last. • Refer to Impact D1 for general management measures.							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see Section 8.5.							

Impact D3 **Decommissioning and Closure Phase – Mine water balance – Impact on surface water quality**

PHASE	**DECOMMISSIONING AND CLOSURE PHASE**						
ACTIVITY	**Mine water balance**						
	Recovery of water levels and possible decant						
ASPECT	Water Quality – discharge of contaminated water						
IMPACT DEFINITION	Pollution of surface water resources						
IMPACT DESCRIPTION AND EVALUATION							
Once the mining has ceased and the incline shaft have been backfilled and re-shaped dewatering will cease and water levels will begin to recover in the workings. The underground workings will not fill to decant level during the decommissioning phase.							
IMPACT BEFORE MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Moderate	Medium term	Regional	***Medium***	***Definite***	***Medium***	-	High
MANAGEMENT MEASURES							
Mitigation measures will include the following: • The incline shaft will be sealed, backfilled and made free draining. • The underground will be left to fill to a pre-determined environmental safe level (below decant level) before active water level management is implemented. • Monitoring of water levels in the mine and the associated water quality is committed to. This will allow both calibration of the post mining water quality and water volumes. • The water level in the workings will be actively managed to ensure it remains below the decant elevation. • The water treatment plant will be decommissioned within 3 years of mine closure. Thereafter the water make from underground workings will be managed such that it will be allowed to fill up through natural recharge to a pre-determined environmental safe level below decant level. • The rise of water will be closely monitored to ensure that the environmental safe level is not exceeded and that appropriate extraction works and treatment facilities are constructed in time to treat the surplus water once the environmental safe level is reached. The water will then be actively maintained at or below the environmental safe level. • A detailed decant management plan will be developed at mine closure. Ultimately water treatment solutions, either passive or active, will be implemented. • Monitoring of the water table rebound will continue post-closure and the modelling updated to quantify the long-term impacts. If necessary, the management measures should be revised based on the modelling results. •							
IMPACT AFTER MANAGEMENT							
Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	Medium term	Site	***Low***	***Possible***	***Low***	-	High
CUMULATIVE IMPACT							
Cumulative impacts not assessed here, see **Section 8.5**.							

Impact PC1 Post Closure – Potential for acid mine drainage (AMD) and poor quality leachate – Impact on surface water quality

PHASE	DECOMMISSIONING AND CLOSURE PHASE
ACTIVITY	**Potential for decant of AMD**
	Decant of mine water make
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

IMPACT DESCRIPTION AND EVALUATION

Post closure, the infrastructure areas will have been rehabilitated and made free draining.

Two aspects have been considered here, namely, the volume of decant that could be generated, and the potential quality of decant.

If the water levels in the underground workings are not controlled, the potential time to decant is estimated as follows:

The rate of recharge to the mine areas is expected to vary, with groundwater inflows reducing as the water level increases within the mine due to a reduced hydraulic gradient towards the mined out areas. However, for the purposes of the calculation, recharge rates are assumed to be relatively constant over the period from cessation of dewatering until (without mitigation) decant reaches the potential decant level. The output from the calculations is given in the table below, based on an average recharge rate of around 2600 m^3/day at the underground workings.

Post closure decant assessment under Average rainfall conditions

Mining section	Average recharge rate (m^3/day)	Flooding Rate (m^3/annum)	Volume to decant level ($m^3 x10^6$)	Approximate time to flood (years)
Elders underground	2 600	949 000	**48.72**	35-42

Note: Decant elevations and decant times are provisional, and will be confirmed as models are calibrated with actual inflows.

If the decant is not managed (as detailed below), there could be an impact on both the downstream catchment and the downstream dams.

This impact is quantified following the discussion of the potential decant qualities.

It is considered valuable to assess the potential sulphate loading of the mine on the catchment. This assessment is based on the assumption that the entire water make were to be discharged to the catchment.

The water balance at closure indicates that an average water make in the order of 2600 m^3/day can be expected. Using the expected post closure sulphate concentrations (from JMA Consulting) of 4500 mg/l, this equates to around 11.7 tonnes SO_4 per day, or around 4270 tonnes SO_4 per year.

The estimates given above are proposed to be refined over the life of mine as follows:

- On-going sampling and monitoring of parameters important to the final water quality and water volumes.
- Quantification and verification of the groundwater model, the water balance model, and the geochemical model.
- Evaluation and reassessment of alternative options for the final water use and required associated water quality, together with the technologies required to achieve the required quality.

IMPACT BEFORE MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Major	Long Term	Regional	***High***	***Definite***	***High***	-	High

PHASE	**DECOMMISSIONING AND CLOSURE PHASE**
ACTIVITY	**Potential for decant of AMD**
	Decant of mine water make
ASPECT	Water Quality – discharge of contaminated water
IMPACT DEFINITION	Pollution of surface water resources

MANAGEMENT MEASURES

Mitigation measures will include the following:

- The incline shaft will be backfilled, rehabilitated and made free-draining.
- Monitoring of water levels in the mine and the associated water quality is committed to. This will allow both calibration of the post mining water quality and water volumes.
- The water level in the workings will be actively managed to ensure it remains below the decant elevation.
- The water treatment plant will be decommissioned within 3 years of mine closure. Thereafter the water make from underground workings will be managed such that it will be allowed to fill up through natural recharge to a pre-determined environmental safe level below decant level.
- The rise of water will be closely monitored to ensure that the environmental safe level is not exceeded and that appropriate extraction works and treatment facilities are constructed in time to treat the surplus water once the environmental safe level is reached. The water will then be actively maintained at or below the environmental safe level.
- A detailed decant management plan will be developed at mine closure. Ultimately water treatment solutions, either passive or active, will be implemented.
- Monitoring of the water table rebound will continue post-closure and the modelling updated to quantify the long-term impacts. If necessary, the management measures should be revised based on the modelling results.

IMPACT AFTER MANAGEMENT

Magnitude	Duration	Scale	**Consequence**	**Probability**	**SIGNIFICANCE**	+ / -	Confidence
Minor	Long term	Regional	***Medium***	***Unlikely***	***Low***	-	High

CUMULATIVE IMPACT

Cumulative impacts not assessed here, see **Section 8.5**.

8.5 Cumulative impacts

The proposed Elders Colliery project's area of surface disturbance will be very small in relation to the other activities in the area that could potentially impact on surface water. Such activities include other mining operations both upstream and downstream of Elders Colliery. There are numerous coal mines in the Olifants River catchment, with mining being most intensive downstream of the Elders. In addition, surrounding agricultural activities also potentially impact on the water quality and quantity in the catchment.

In terms of the Significance on Socio-economic and Biodiversity aspects, impacts would be due to the deterioration of water quality, as discussed in the impact assessment, that would result in health impacts in local communities, as well as reductions in certain plant and animal species that are sensitive to elevated sulphates and pH, etc.

The impact, if not mitigated, is considered HIGH. Mitigation would include a social management plan and biodiversity management plan to be put in place (which will be covered by the respective specialists), together with the mitigation measures detailed in this document. After mitigation, would be considered MEDIUM to LOW.

The cumulative impact of the Elders mining operation, with the mitigation measures described in the impact assessment, is therefore considered to be small in relation to the current and anticipated future activities in the area. The cumulative impact of all of the coal mines in the area has, however, resulted in a regional crisis in terms of water quality and quantity. Every new mine contributes to the further reduction and / or deterioration of the water resources in the Mpumalanga region and it is essential that good water management be implemented at the Elders operations to prevent further contributions to the existing impacts in the catchment.

The treatment and discharge of clean water at the Elders Colliery will have a positive impact on both surface water quality and quantity. The annual flow in the Olifants River will be increased by an estimated 1.4% through the discharge of treated water. This will help to mitigate the loss of yield during the operational period, but also the loss of yield due to other mining and agricultural activities in the catchment. In addition, the good quality of the water will have a dilution effect (albeit a small one), potentially improving the water quality in the Olifants River.

8.6 Impact assessment summary tables

A summary of the impact assessment is shown in **Tables 8.6(a)**.

Table 8.6(a) Summary of impacts

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
PRE-CONSTRUCTION AND CONSTRUCTION PHASE										
Mine surface infrastructure and conveyor	Construction camps, construction works, movement of materials and construction equipment	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*
Initial boxcut and incline shaft development	Removal of material from the boxcut and incline shaft	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Local*	***Low***	***Unlikely***	***Low***	-	*High*
	Dewatering of water ingress to boxcut and incline shaft	Water quality	Before Management							
			Moderate	*Short term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Mine surface infrastructure , incline shaft, boxcut area and conveyor	Construction camps, construction works, movement of materials and construction equipment, excavation of boxcut and incline shaft	Water Quantity	Before Management							
			Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*
			After Management							
			Minor	*Medium term*	*Regional*	***Low***	***Definite***	***Low***	-	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
OPERATIONAL PHASE										
Mine water discharge	Discharge of mine water to the natural watercourse	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*High*
			After Management							
			Moderate	*Medium term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
Mine surface infrastructure	Access shaft area, workshops, offices and related infrastructure	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*High*
			After Management							
			Moderate	*Medium term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*
Ablution facilities and sewage treatment plant	Handling, disposal and treatment of sewage	Water quality	Before Management							
			Moderate	*Medium term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Medium term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Pollution control dams	Storage of polluted water	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Possible***	***High***	-	*High*
			After Management							
			Moderate	*Short term*	*Regional*	***Medium***	***Unlikely***	***Low***	-	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
Dust and fire suppression	Dust and fire suppression with contaminated water	Water quality	Before Management							
			Minor	*Short term*	*Site*	***Low***	***Possible***	***Low***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Water treatment plant	Operation of the water treatment plant, treatment of contaminated mine water	Water quality	Before Management							
			Major	*Long term*	*Regional*	***High***	***Possible***	***High***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*
Water treatment plant	Handling and storage of brine and gypsum	Water quality	Before Management							
			Moderate	*Long term*	*Local*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*
Water treatment plant	Discharge of treated water to the Olifants River	Water quality	Before Management							
			Moderate+	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
			After Management							
			Moderate+	*Long term*	*Regional*	***High***	***Possible***	***High***	+	*High*
Conveyance of coal	Transport of coal by road (initially) and conveyor from Elders operation Goedehoop Colliery	Water quality	Before Management							
			Moderate	*Long Term*	*Site*	***Medium***	***Definite***	***Medium***	-	*High*
			After Management							
			Minor	*Long term*	*Site*	***Medium***	***Unlikely***	***Low***	-	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
Dirty Water Pipeline	Pumping of water from Goedehoop Colliery to Elders Colliery as make-up water	Water quality	Before Management							
			Major	*Long Term*	*Regional*	***High***	***Possible***	***High***	-	*High*
			After Management							
			Moderate	*Long term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
Consequence of extreme floods	Flooding of mine or mine infrastructure during extreme flood events	Water quality and quantity	Before Management							
			Moderate	*Long term*	*Site*	***Medium***	***Unlikely***	***Medium***	-	*High*
			After Management							
			Minor	*Medium term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Elders Operation	Isolation of dirty catchment – Impact on watercourses	Water quantity	Before Management							
			Moderate	*Long term*	*Regional*	***High***	***Definite***	***High***	-	*Medium*
			After Management							
			Minor	*Long term*	*Site*	***Low***	***Definite***	***Low***	-	*Medium*
Water Treatment Plant	Discharge of treated water to the Olifants River	Water quantity	Before Management							
			Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*
			After Management							
			Minor	*Long term*	*Regional*	***Medium***	***Definite***	***Medium***	+	*High*

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
DECOMMISSIONING AND CLOSURE PHASE										
General decommissioning and rehabilitation	Construction camps, construction (demolition) works, movement of materials and construction equipment	Water quality	Before Management							
			Moderate	*Short term*	*Site*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Water management infrastructure	Decommission-ing and rehabilitation of water management infrastructure	Water quality	Before Management							
			Moderate	*Short term*	*Regional*	***Medium***	***Possible***	***Medium***	-	*High*
			After Management							
			Minor	*Short term*	*Site*	***Low***	***Unlikely***	***Low***	-	*High*
Mine water balance	Recovery of water levels and possible decant	Water quality	Before Management							
			Moderate	Medium term	Regional	***Medium***	***Definite***	***Medium***	-	High
			After Management							
			Minor	Medium term	Site	***Low***	***Possible***	***Low***	-	High

Activity	Description	Aspect	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ / -	Confidence
POST CLOSURE PHASE										
Potential for acid mine drainage (AMD) and poor quality		Water quality	Before Management							
			Major	Long Term	Regional	***High***	***Definite***	***High***	-	High
			After Management							
			Minor	Long term	Regional	***Medium***	***Unlikely***	***Low***	-	High

9. FINANCIAL PROVISION

For the operational phase, the water management costs are included in the infrastructure costs in most respects, including pollution control dams and the associated storm water canals, pumps and pipes.

At closure these facilities will be demolished and removed and the area will be rehabilitated. The cost related to this will be included in the overall closure costing.

Post closure the area will be rehabilitated and will not generate dirty runoff. The water treatment plant will be decommissioned within 3 years of mine closure. Thereafter the water make from underground workings will be managed such that it will be allowed to fill up through natural recharge to a pre-determined environmental safe level below decant level.

The rise of water will be closely monitored to ensure that the environmental safe level is not exceeded and that appropriate extraction works and treatment facilities are constructed in time to treat the surplus water once the environmental safe level is reached. The water will then be actively maintained at or below the environmental safe level.

A detailed decant management plan will be developed at mine closure. Ultimately water treatment solutions, either passive or active, will be implemented.

Monitoring of the water table rebound will continue post-closure and the modelling updated to quantify the long-term impacts. If necessary, the management measures should be revised based on the modelling results.

10. SUMMARISED WATER MANAGEMENT PLAN

In Section 8, mitigation measures have been indicated to manage the impacts assessed. These measures need to be incorporated into an Integrated Water and Waste Management Plan (IWWMP) that can be used to implement, audit and measure the performance of the water management measures detailed in the EMP.

This section is intended to only provide inputs on key aspects of the water management plan.

10.1 Construction Phase

10.1.1 Key issues and objectives

- To prevent contamination of surface water runoff from the cleared construction site areas.
- To minimise erosion in the construction site areas and to minimise siltation in the adjacent water courses and pans.
- To ensure that the required water management infrastructure is constructed in time.

10.1.2 Key strategies

Areas where impacts in terms of construction activities could occur are listed below:

- Timing of construction activities. As far as is practically possible, construction should take place during the dry winter months.
- Construction of water management measures.
  - The upstream diversions should be constructed first to minimise the flow of water across the construction site.
  - The construction of the dirty water management measures should be completed prior to commissioning and operation.
- Construction of the materials handling areas.
  - The run of mine stockpiles will be located within the dirty water area.
- Control of suspended solids. Should wet conditions occur during construction, suspended solids in the watercourses and pans must be monitored and silt traps must be provided on construction areas, should suspended solids be detected.

10.1.3 Monitoring

Monitoring of water quality has been undertaken as part of the baseline surface water assessment. Monitoring will continue through the construction and operational phases. A monitoring programme for the entire Elders Colliery is detailed in Section 11.

10.1.4 Knowledge gaps

Final design of the infrastructure and water management measures has still to be completed. The adequacy of the measures detailed in this document will be reviewed in the final designs and updated in the Water Use License application.

10.2 Operational Phase

10.2.1 Key issues and objectives

- To minimise the impact on catchment yield
- To identify and control surface runoff that may be affected by the planned activities, as well as the water balance associated with the conveyor and to ensure that the risk of spilling this water into the clean catchment is:
    - In line with licensing requirements
    - In line with legislative requirements
    - Commensurate with the risks to downstream users associated with any spillage. This is taken currently at a 2% or lower risk in any one year, or the 1:50 year flood occurrence.
- To prevent clean runoff from upstream / upslope areas from spilling into the dirty water systems for flood events up to at least the 1:50 year recurrence interval.
- To ensure adequate monitoring so that the objectives of the water management system can be met.

10.2.2 Key strategies

The key management strategy is to keep clean water clean and to minimise the generation of dirty water. This is to be achieved by diverting runoff from clean catchments around the dirty areas and minimising the extent of dirty areas as far as is practical. Clean and dirty water systems will be designed and managed to have a risk of spill of 2% or less.

- Minimising loss of catchment yield:

  The footprint of the infrastructure areas will be kept to a minimum and is very small in relation to the Olifants River catchment.

  The loss of this yield is dependent on the on-site management and planning activities, including the following:
    - Placement of upstream diversion berms/ canals so that the maximum volume of upstream runoff can be diverted around the infrastructure areas.
    - Minimising the dirty water footprint of the mining and infrastructure areas.
    - Investigating and implementing water conservation and demand management, together with maximising recycling and reuse strategies on the site.
    - Implementation of a water flow, pumping and dam water level monitoring programme to enable calibration of the water balance model and efficient management of the site water balance.
- Managing the generation of dirty water

  Provision has been made to collect, store and reuse dirty water generated by the mining activities. The proponent has committed to having a 2% or lower risk of spilling in any one year and the water balance modelling has been shown that the planned PCD has adequate capacity to ensure that this level of risk can be achieved.

  The risk of spilling is a function of adequate storage capacity, balanced against the reuse of water and storage in the underground workings.

  In line with best practice, the PCDs will be operated as empty as possible at all times to ensure that sufficient storm water retention capacity is available at all times.

In the event that there is insufficient available capacity in the PCDs during extreme rainfall conditions, excess storm water will be pumped to storage compartments in the Elders underground workings when this becomes available around 2025.

Ongoing calibration of the water balance is required to ensure that the estimations in terms of water make-up, water shortages and storage requirements are evaluated during the life of the mine. Key strategies to address these issues involve:

- Monitoring of water volumes pumped and stored
- Documentation of any problems in reusing dirty water, such as operational difficulties
- Ongoing rainfall monitoring
- Management of water pumped/ draining into the pollution control dams, including documentation of water volumes abstracted for use in the mining operations
- Adjustment for any changes in process or infrastructure layout, where these could affect the water balance
- Ongoing monitoring of water levels within the pollution control dams, as well as any spillages
- Ongoing monitoring of water volumes imported from Goedehoop Colliery.
- Ongoing monitoring of all water used on the site, for domestic, process, dust suppression, fire suppression, etc.

All of the above highlight the fact that the water management will be a dynamic and ongoing process, aimed at ensuring compliance with legal requirements and good environmental practice over the life of mine.

10.2.3 Monitoring

The objective of the surface water monitoring system is to ensure that the water management systems perform according to specifications, to act as a pollution early warning system, to check compliance with license requirements and for reporting purposes. The objective of these systems will be achieved if there is no impact (attributable to the Elders Colliery) on the downstream environment.

Monitoring requirements are detailed in Section 11.

10.2.4 Knowledge gaps

The water balance is at this stage based largely on theoretical modelling of the hydrological aspects and theoretical production values/ parameters obtained from the mine designers (Hatch). Monitoring of inflows, water use volumes and dam water levels will therefore be an important input to calibration of the water balance model and to ensuring that the risks associated with the water management system are adequately defined. Key variables to be monitored are detailed in Section 10.2.2 above.

10.3 Decommissioning

10.3.1 Key issues and objectives

- To rehabilitate the mine infrastructure areas to ensure that they are free-draining and that runoff from these areas is clean

- To limit the risk of increased erosion on site and downstream, relating to areas being rehabilitated and consequently impacting on water quality
- To ensure that the area is decommissioned and rehabilitated “from the inside out”, thereby preventing spillage of any dirty water or waste in the process.

10.3.2 Key strategies

- Dismantling and removal of the mine infrastructure
- Removal of all carbonaceous material and other contaminants / waste materials from the site
- Shaping and grassing of the mine infrastructure areas
- Erosion protection:

  The general area is vulnerable to erosion. During rehabilitation, the areas where grass has not yet been established will be monitored to ensure that there is not excessive erosion prior to the grass establishing, and where necessary additional erosion protection such as the use of dump rock or repair of gullies will be undertaken until such time that the rehabilitated surfaces can be shown to be sustainable.

10.3.3 Monitoring

Monitoring during decommissioning will be based on the operational phase monitoring, adapted to suit the final works to be implemented during this phase. However, in terms of surface water this will be primarily downstream of the area, as for the operational phase.

10.3.4 Knowledge gaps

The final land use for the site is not certain at this stage. This may influence the rehabilitation strategy.

10.4 Post Closure

10.4.1 Key issues and objectives

- To manage the rehabilitated area post closure.

10.4.2 Key strategies

The key strategy is to ensure that the rehabilitation in terms of shaped land form and vegetation cover is maintained in the long term to ensure long term sustainability of the rehabilitated area. Management of decant water will be required. The water levels will be monitored and maintained at an environmentally safe level by pumping to a treatment plant.

10.4.3 Monitoring

Monitoring post closure will be undertaken only where required to prove the sustainability of the site. In terms of surface water, this relates primarily to managing the surface topography (monitoring for erosion), and water quality downstream of the site.

10.4.4 Knowledge gaps

The final land use for the site is not certain at this stage. The required post closure water management measures and monitoring may be influenced by the final land use.

11. MONITORING AND AUDITING

The objective of the surface water monitoring system is to ensure that the water management systems perform according to specifications, to act as an early warning system for pollution, to check compliance with license requirements and for reporting purposes. The objectives of these systems will be achieved if there is no impact (attributable to the proposed Elders Colliery) on the in-stream and downstream fitness for use criteria.

11.1 Water quality monitoring

11.1.1 Monitoring locations

In order to detect impacts attributable to an activity, water quality monitoring would usually be carried out upstream and downstream of the site. Portions of the proposed mine (mine infrastructure, the shaft area and the conveyor belt) drain either directly or via minor, unnamed tributaries to the Olifants River. A large portion of the proposed underground workings will be beneath the Vlakkuilen and Viskuile Rivers. Surface water quality monitoring will therefore be required on the minor tributaries, the Olifants River and the Vlakkuilen and Viskuile Rivers.

The proposed monitoring locations for Elders Colliery are shown in **Figure 11.1.1(a)**. The locations are described in **Table 11.1.1(a)**.

Table 11.1.1(a) Details of surface water quality monitoring locations

Monitoring location	Description	Co-ordinate
EP 01	At the Pan downstream	X : 2903338.084 Y: -45540.273
EP 02	At the Pan upstream to the east of the Vlakkuilen River	X: 2906949.854 Y: -48297.872
EP 03	Along the proposed conveyor	X: 2902117.05 Y: - 45590.70
EP 04	Along the proposed conveyor	X: 2897645.516 Y: -41030.847
EP 05	Along the proposed conveyor	X: 2898000.461 Y: -41194.103
EP 06	Along the proposed conveyor	X: 2899037.59 Y: -41772.36
EP 07	Along the proposed conveyor	X: 2899712.86 Y: -42270.93
EP 08	Along the proposed conveyor	X: 2900809.37 Y: -43413.53
EP 09	Along the Olifants River downstream of the workings	X: 2901166.105 Y: -46197.032
EP 10	Along Vlakkuilen River upstream of the workings	X: 2908368.320 Y: -46231.212
EP 11	Along Viskuile River upstream of the workings	X: 2908923.838 Y: -50076.867

Monitoring location	Description	Co-ordinate
EP 12	Along Viskuile River upstream of the workings	X: 2907434.531 Y: -50872.659
EP 13	Along Viskuile River upstream of the workings	X: 2906258.18 Y: -49398.56
EP 14	Along Viskuile River downstream of the workings	X: 2903065.150 Y: -48122.063
EP 15	Tributary of the Olifants River upstream of the workings	X: 2903038.933 Y: -51425.841
EP 16	Along the Olifants River upstream of the workings.	X: 2901478.832 Y: -49424.521
EP 17	Along the Olifants at Goedehoop Block 20	X: 2894236.23 Y: -40240.60
EP 18	Along a tributary of the Vlakkuilen River	X: 2906159.72 Y: -46213.53
EP 19	Along the Olifants River, near the discharge point of the sewage treatment plant and PCD	X: 2903075.46 Y: -47820.79
EP 20	At the PCD overflow outlet	X: 2903092.18 Y: -47818.69
EP 21	Along conveyor	X: 2888633.25 Y: -40977.65
EP 22	Along conveyor	X: 2890165.35 Y: -40767.16
EP 23	Along conveyor	X: 2890808.08 Y: -40919.46

Legend

- Conveyor
- Mine Boundary
- Extent of Underground Mining
- EP04 Monitoring Points (2013)

COORDINATE SYSTEM CLARKE 1880 LO29 Surface water quality monitoring locations		
	Y	X
EP01	-45540.27	2903338.08
EP02	-48297.87	2906949.85
EP03	-45590.70	2902117.05
EP04	-41030.85	2897645.52
EP05	-41194.10	2898000.46
EP06	-41772.36	2899037.59
EP07	-42270.93	2899712.86
EP08	-43413.53	2900809.37
EP09	-46197.03	2901166.11
EP10	-46231.21	2908368.32
EP11	-50076.87	2908923.84
EP12	-50872.66	2907434.53
EP13	-49398.56	2906258.18
EP14	-48122.06	2903065.15
EP15	-51425.84	2903038.93
EP16	-49424.52	2901478.83
EP17	-40240.60	2894236.23
EP18	-46213.53	2906159.72
EP19	-47820.79	2903075.46
EP20	-47818.69	2903092.18
EP21	-40977.65	2888633.25
EP22	-40767.16	2890165.35
EP23	-40919.46	2890808.08

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WATER QUALITY MONITORING LOCATIONS AT ELDERS

Figure 11.1.1(a)

11.1.2 Water quality sampling and analysis

The frequency of sampling and analysis is detailed in **Table 11.1.2(a)**.

Table 11.1.2(a) Surface water quality sampling and analysis

Location	Constituent	Frequency
All Locations	pH Electrical Conductivity (EC) Total Dissolved Solids (TDS) Alkalinity as $CaCO_3$ Ammonia as N Nitrate as N Ortho-Phosphate as P Chloride as Cl Sulphate as SO_4 Sodium as Na Potassium as K Calcium as Ca Magnesium as Mg Aluminium as Al (total and dissolved) Iron as Fe (total and dissolved) Manganese as Mn (total and dissolved) Zinc as Zn (total and dissolved) Boron as B (total) Fluoride as F Antimony as Sb (total) Molybdenum as Mo (total) Lead as Pb (total) Mercury as Hg (total) Chromium (total) Selenium (total)	Monthly
EP 19	Total coliforms and *E. coli*	Monthly
EP 01 EP 03 EP 09 EP 10 EP 13 EP 15 EP 17 EP 20	Full elemental ICP scan (Al, Sb, As, Ba, Be, B, Br, Cd, Cs, Cr, Co, Cu, Fe, Pb, Li, La, Mn, Hg, Mo, Ni, Se, Ag, Sr, Te, Sn, Ti, Tl, W, U, V, Zn) Total coliforms and *E. coli*	Quarterly

Samples will be grab samples, which will include:

- Filtered and unfiltered samples
- Acid preservation of samples for metals analysis.

All samples will be analysed by an accredited laboratory.

11.2 Water quantity monitoring (water balance monitoring)

For efficient management of water on the site, a good understanding of the site water balance will be required. To achieve this, the following monitoring will be needed:

- Rainfall – to be measured daily on the site
- Evaporation – this is not essential but would be useful for calibration of the water balance model
- Dam water levels – to be measured weekly
- Flows – including the following, to be measured weekly:
  - Make-up water drawn from all systems (raw water and potable water)
  - Water pumped from the mine workings
  - Water pumped to storage in the mine workings
  - Inflows to the Pollution Control Dams
  - Water pumped from the Pollution Control Dams
  - Water treated
  - Brine generation
  - Gypsum generation and moisture content
  - Service water pumped to the underground workings
  - Dust suppression water
  - Sewage volumes.

11.3 Data management and reporting

11.3.1 Monthly

The monthly report is an internal report which is used to keep records of changing water qualities at the site. The report will include:

- Sites that are sampled
- Water qualities for the relevant constituents
- Dam levels and flow rates on site
- Highlight significant issues that require immediate corrective/ preventative action.

11.3.2 Quarterly

The quarterly report may be submitted to DWS and consists of the following components:

- Brief compliance assessment description
- Brief description of monitoring actions performed
- Dam water level status report
- Highlight significant issues that require immediate corrective/ preventative action
- Historical and present source chemistry report
- Time dependent graphs for the relevant water quality variables.

11.3.3 Annually

The annual report consists of all the active environmental components, and for the chapter on surface water, the following components should be included:

- System audit
  - Statutory/ regulatory requirements
  - Monitoring infrastructure
  - Data captured
  - Information generation
  - Management of system liquids
- Data audit
  - Verification of data
  - Compliance interpretation using SANS 241 Drinking Water Standard and management unit objectives or water use licence requirements
  - Setting of new objectives or recommendation of corrective measures
  - Historical and present source chemistry report
  - Dam level status report.

11.4 Performance assessment/ audit

Annual audits should be carried out to determine the effectiveness of the water management systems that are in place. These should include a GNR 704 audit.

12. EMERGENCY AND REMEDIATION PROCEDURE

This section is detailed in the main EMP.

13. CONCLUSION

The water balance modelling indicates the following:

- The currently planned PCD capacity of 45 000 m^3 with a treatment capacity of 2.5 Mℓ/day, increasing to 5.0 Mℓ/day not later than 2023, is sufficient to prevent spillage for average rainfall.
- During long term extreme rainfall events, alternative storage will need to be provided in the period prior to 2025, when the 2 Seam mining is completed and the 2 Seam becomes available for storage. It is currently planned to pump the surplus water to Goedehoop Colliery.
- Prior to 2025, surplus water resulting from extreme rainfall that cannot be treated for discharge or reused or stored at the Elders underground workings, will be pumped to the Goedehoop Colliery Return Water Dam. Should the opportunity to create underground storage compartments arise during the mining of the 2 Seam, surplus water will be stored in the underground workings at Elders. The water balance for Goedehoop Colliery indicates that there will be sufficient storage available on the mine to accommodate the surplus water from Elders.
- Legal compliance in terms of the NWA and GNR 704 can therefore be achieved with the currently proposed water management strategy.

The water balance will need to be refined as the mine design develops and the results presented here should be viewed as preliminary, for input to the mine design process.

The following conclusions can be drawn from the surface water study:

- All dirty water generated on the site will be directed to the PCD and reused in the mining operations, with surplus treated water being discharged to the Olifants River.
- Surface water impacts from the site can be effectively mitigated by applying best practice water management principles.
- The success of surface water impact management will be judged on the basis of successful prevention of spills from the site.

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Tolmay Hopkins Pr Sci Nat

Michael Palmer Pr Eng
for Jones & Wagener

28 October 2015

Documentsource: C:\Alljobs\D202\2015 REPORT\SW\Rev 0\D202_10_REP_00_r0_mvmp_Elders_SWReport_20151028.docx
Document template: C184mm02_ConveyorBaselineReport_July2011.dot

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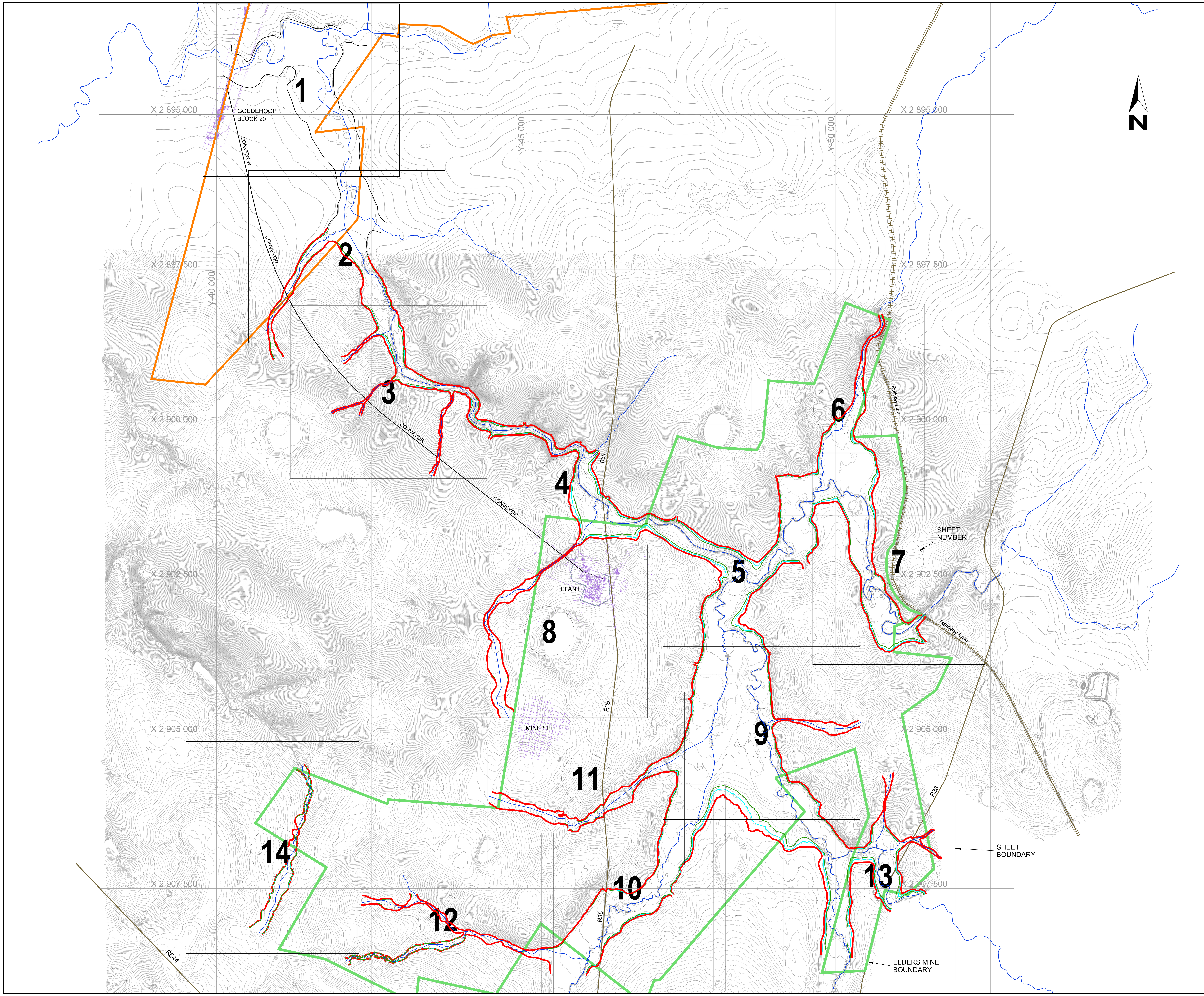
Appendix A

FLOODLINE DRAWINGS



NOTES

1. FLOODLINE DETERMINED USING SURVEY DATA PROVIDED BY THE CLIENT.
2. ACCURACY OF FLOODLINE IS COMMENSURATE WITH ACCURACY AND RESOLUTION OF MAPPING DATA USED.
3. THESE FLOODLINES ARE NOT CERTIFIED.

LEGEND

- 1 : 200 YEAR FLOODLINE
- 1 : 100 YEAR FLOODLINE
- 1 : 50 YEAR FLOODLINE
- 1 : 100 YEAR FLOODLINE : GOEDEHOOP BLOCK 20 - BY OTHERS
- ELDERS MINE BOUNDARY
- GOEDEHOOP MINE BOUNDARY
- 1m CONTOURS
- 5m CONTOURS
- RIVER COURSE
- PROVINCIAL ROAD
- RAILWAY LINE

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid | Projection: Lo 29

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ELDERS PROJECT
FLOODLINE DETERMINATION

GENERAL ARRANGEMENT

Drawing No / Tekening Nr: D202-02-001

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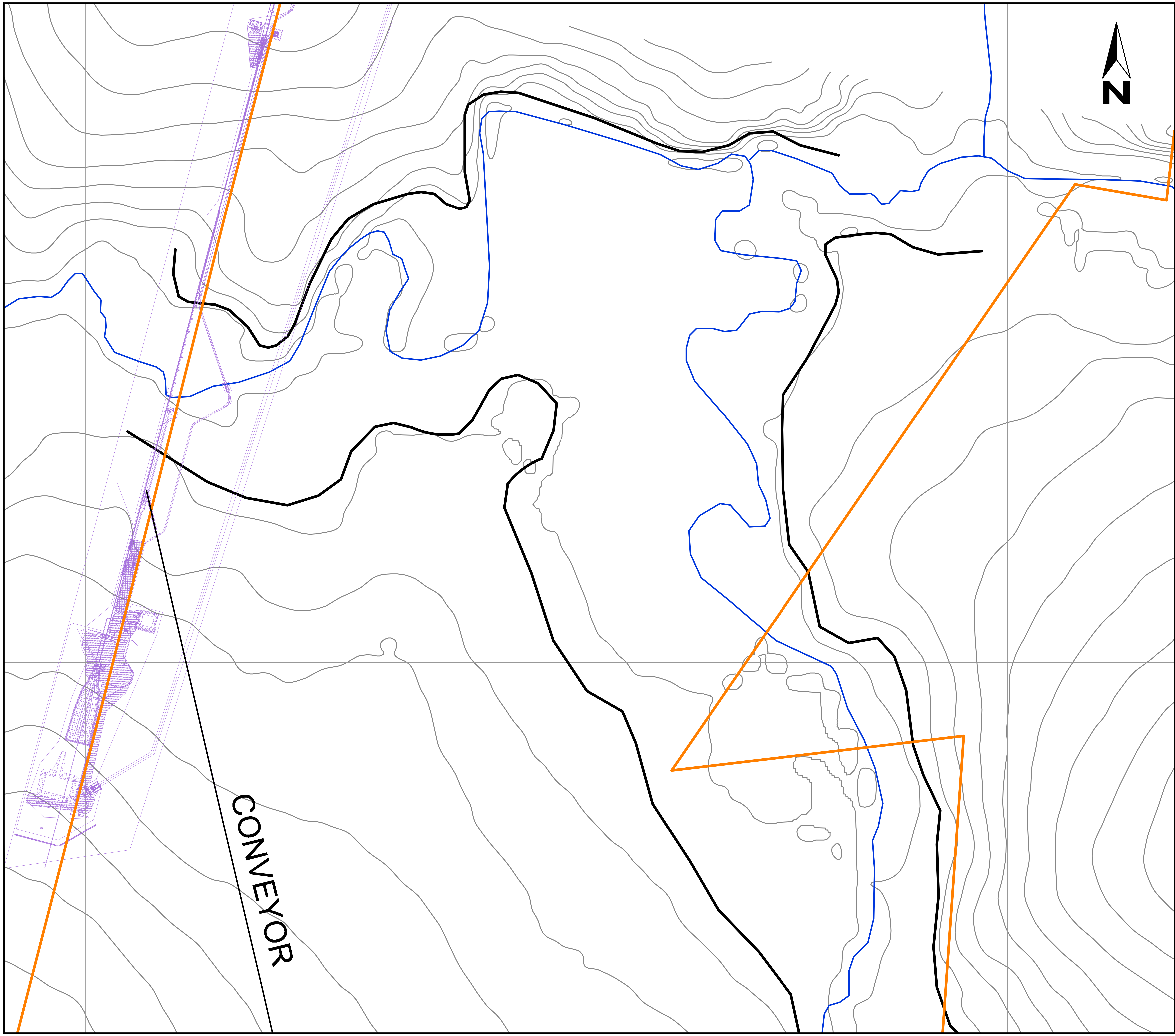

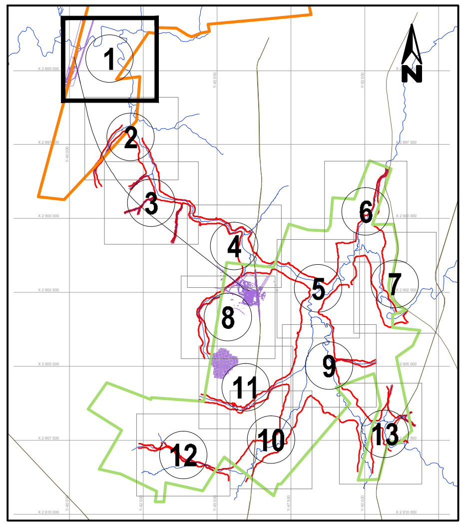

KEY PLAN

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SITE LAYOUT
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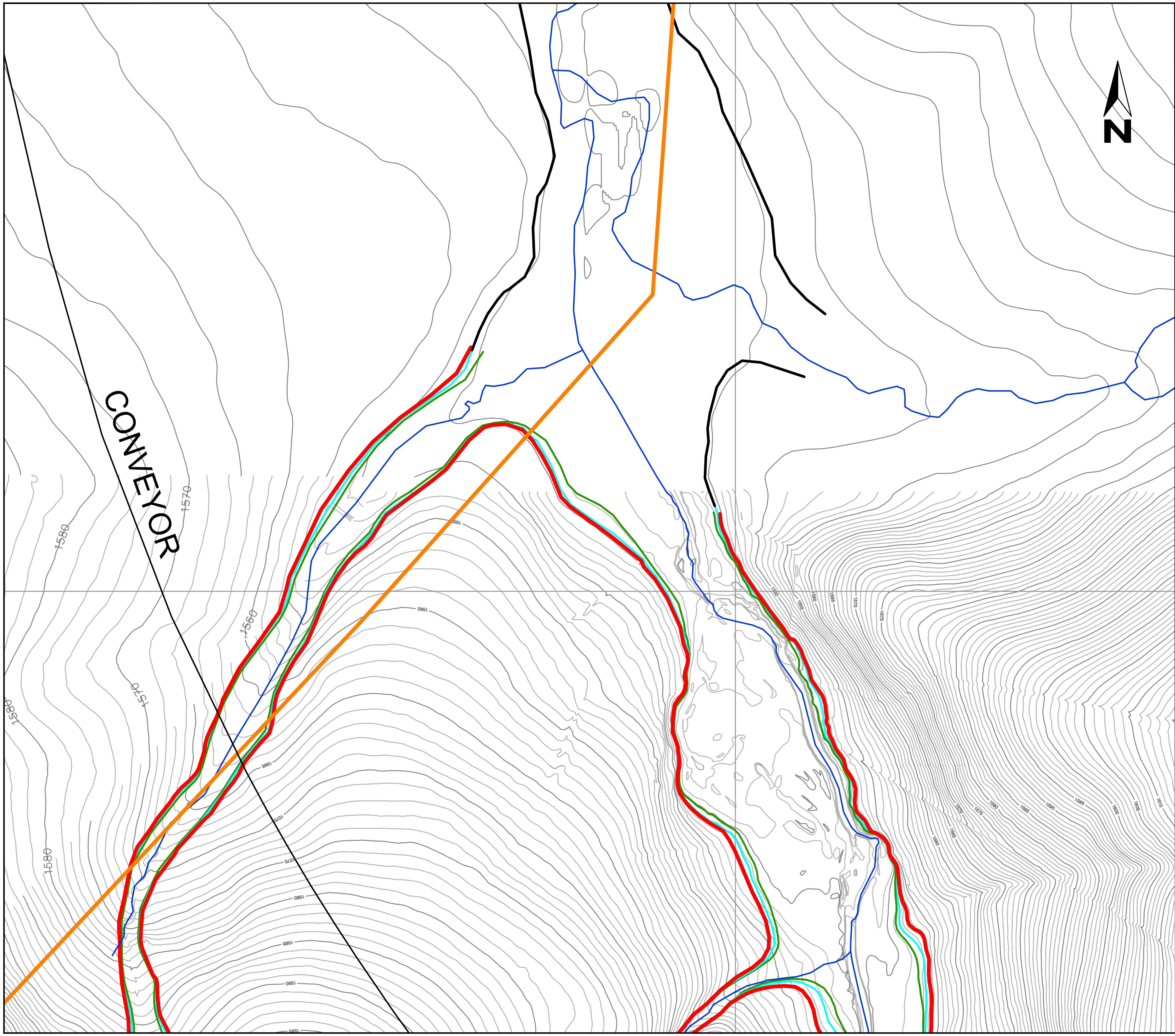

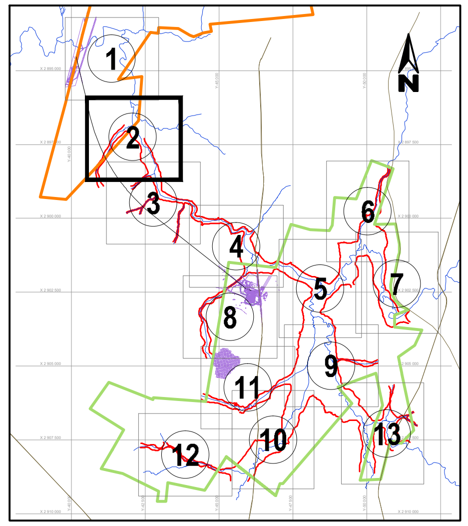

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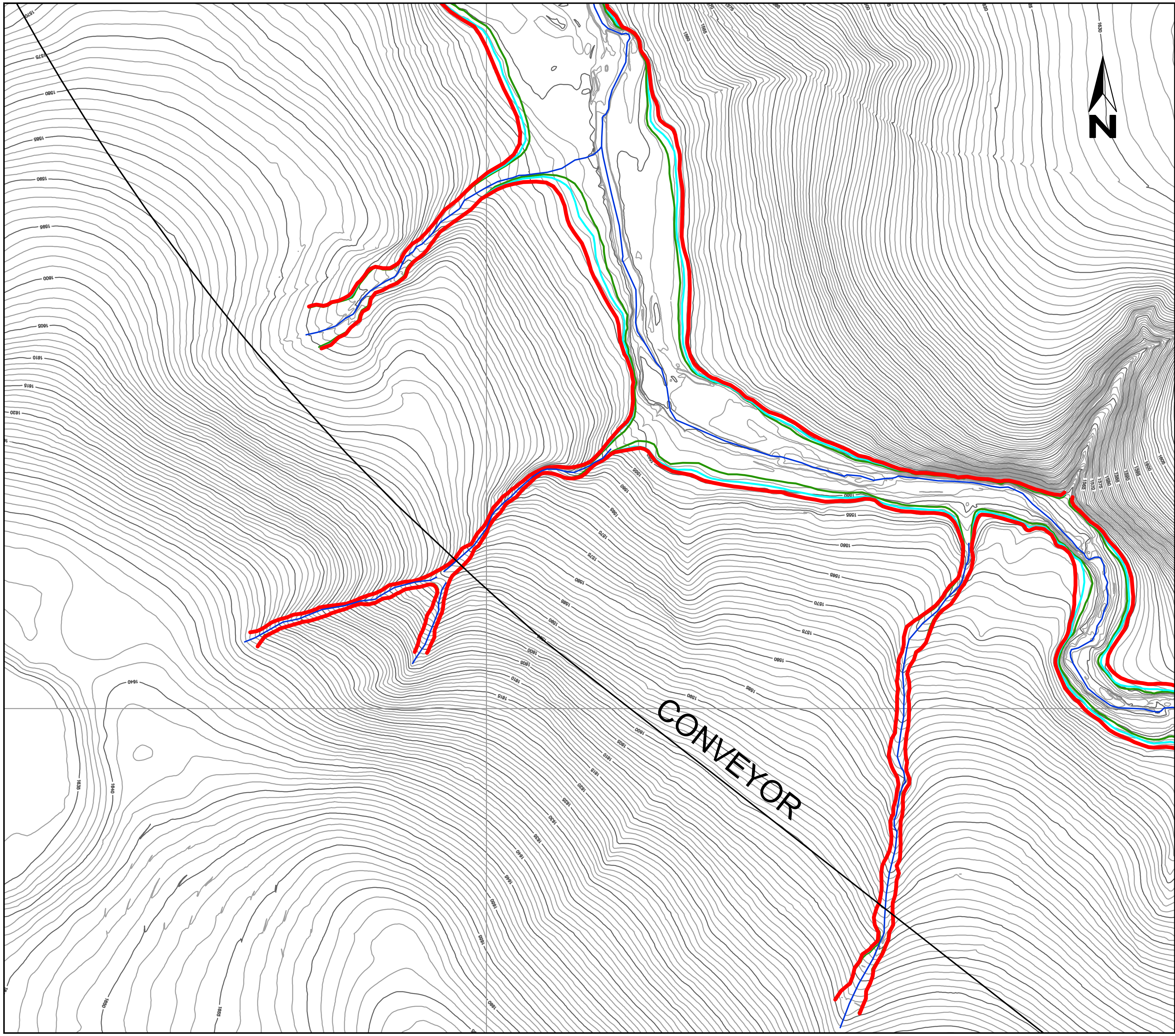

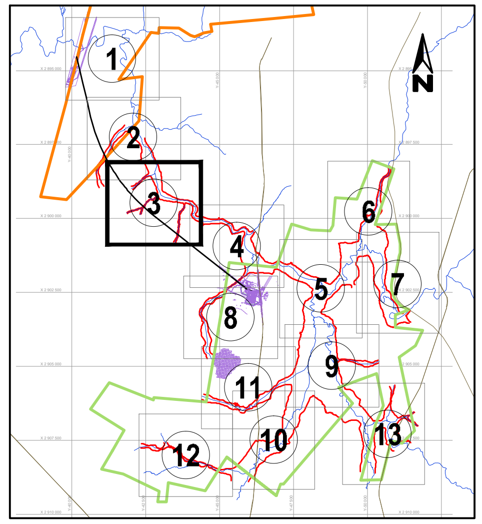

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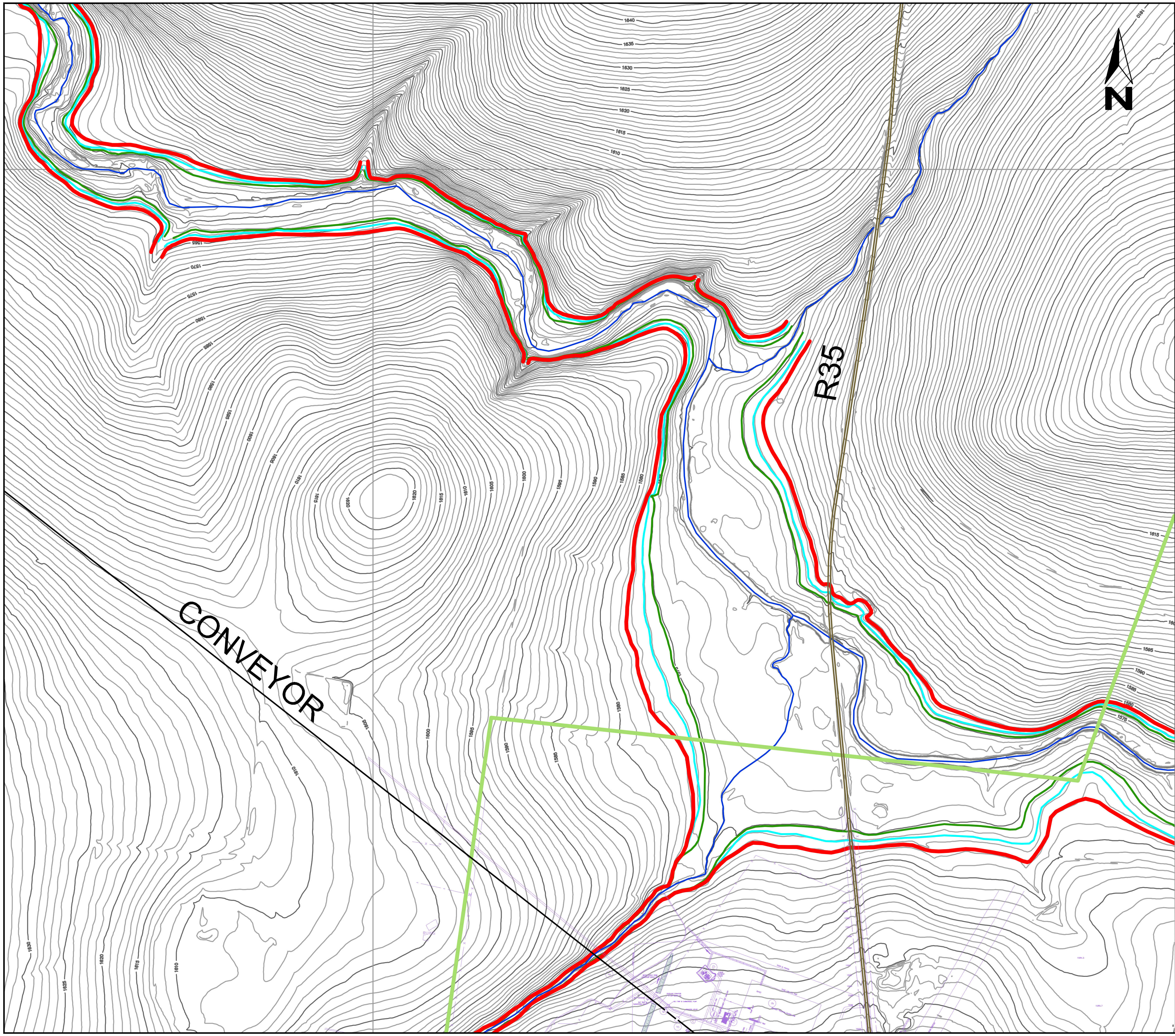
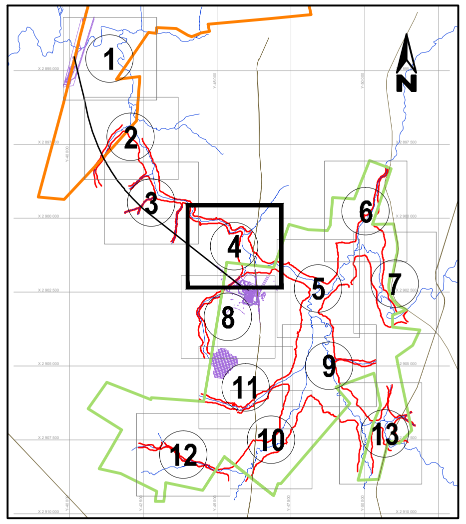
Drawing No / Tekening Nr: D202-02-004

Revision / Hersiening: A A1





KEY PLAN

NOTES

1. FLOODLINE DETERMINED USING SURVEY DATA PROVIDED BY THE CLIENT.
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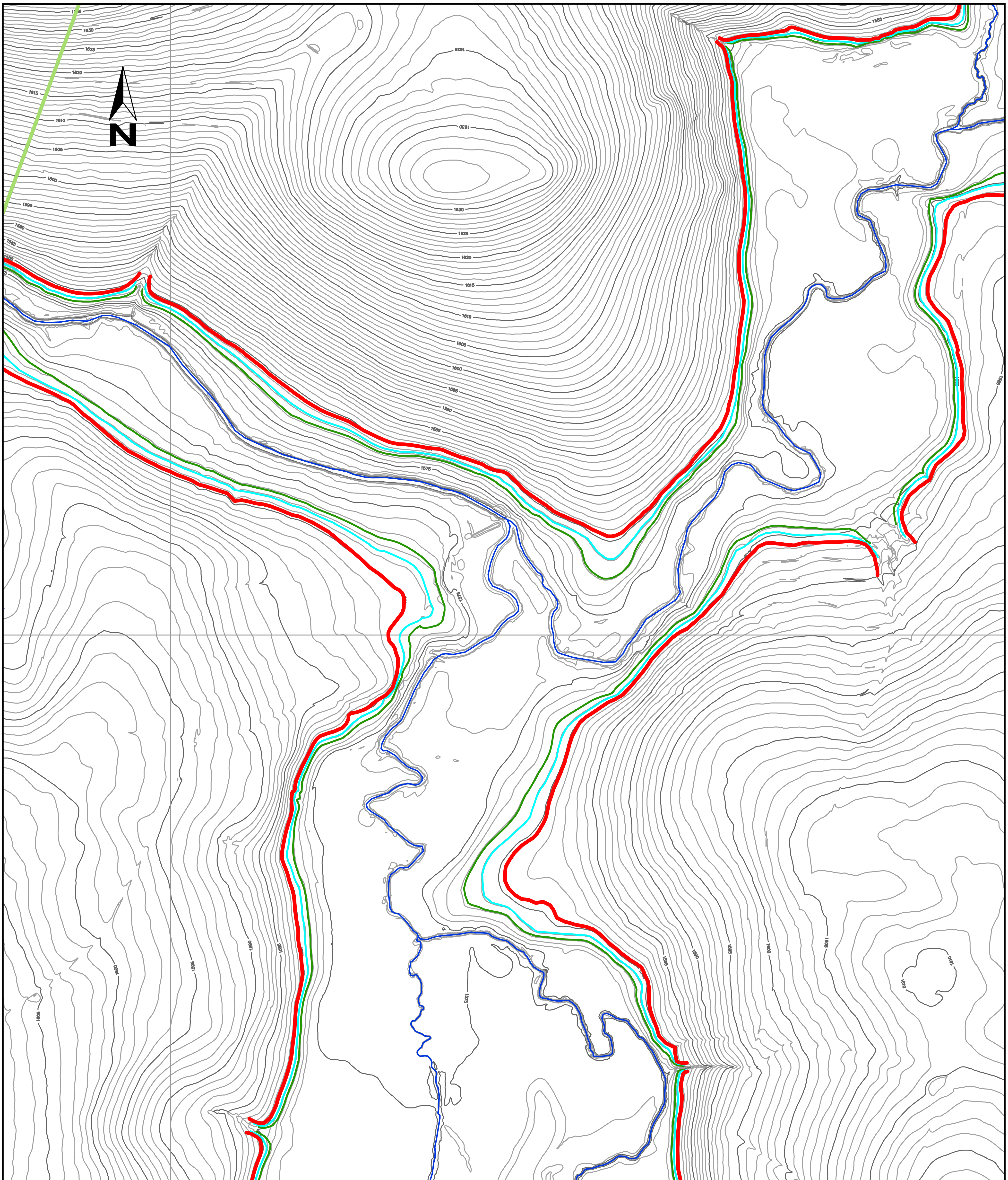
- GOEDEHOOP MINE BOUNDARY
- 1m CONTOURS
- 5m CONTOURS
- RIVER COURSE
- PROVINCIAL ROAD
- RAILWAY LINE

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid	Projection: Lo 29		
Jones & Wagener Consulting Civil Engineers Tel. (011) 519-0200 Fax. (011) 519-0201 e-mail post@jaws.co.za 59 Bevan Road P.O. Box 1434 Rivonia 2128	Drawn Geteken	HUNTLY	4.12.2012
	Designed Ontwerp	MOODLEY	DEC 2012
	Checked Nagesien	HEDIYIH	18.12.2012
Pr Eng 20120181 M Palmer Date	Approved Goedgekeur		
Client Klient SRK CONSULTING	Scale Skaal	1 : 5 000	
ELDERS PROJECT FLOODLINE DETERMINATION SITE LAYOUT SHEET 4 OF 13	Drawing No Tekening Nr D202-02-005		
	Revision Hersiening	A	A1



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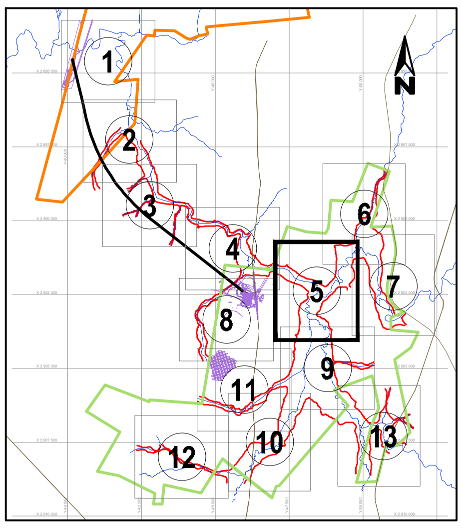

KEY PLAN

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid

Projection: Lo 29

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Drawn Geteken	HUNTLY	4.12.2012
Designed Ontwerp	MOODLEY	DEC 2012
Checked Nagesien	HEDIYIH	18.12.2012
Approved Goedgekeur		

Pr Eng 20120181 M Palmer Date

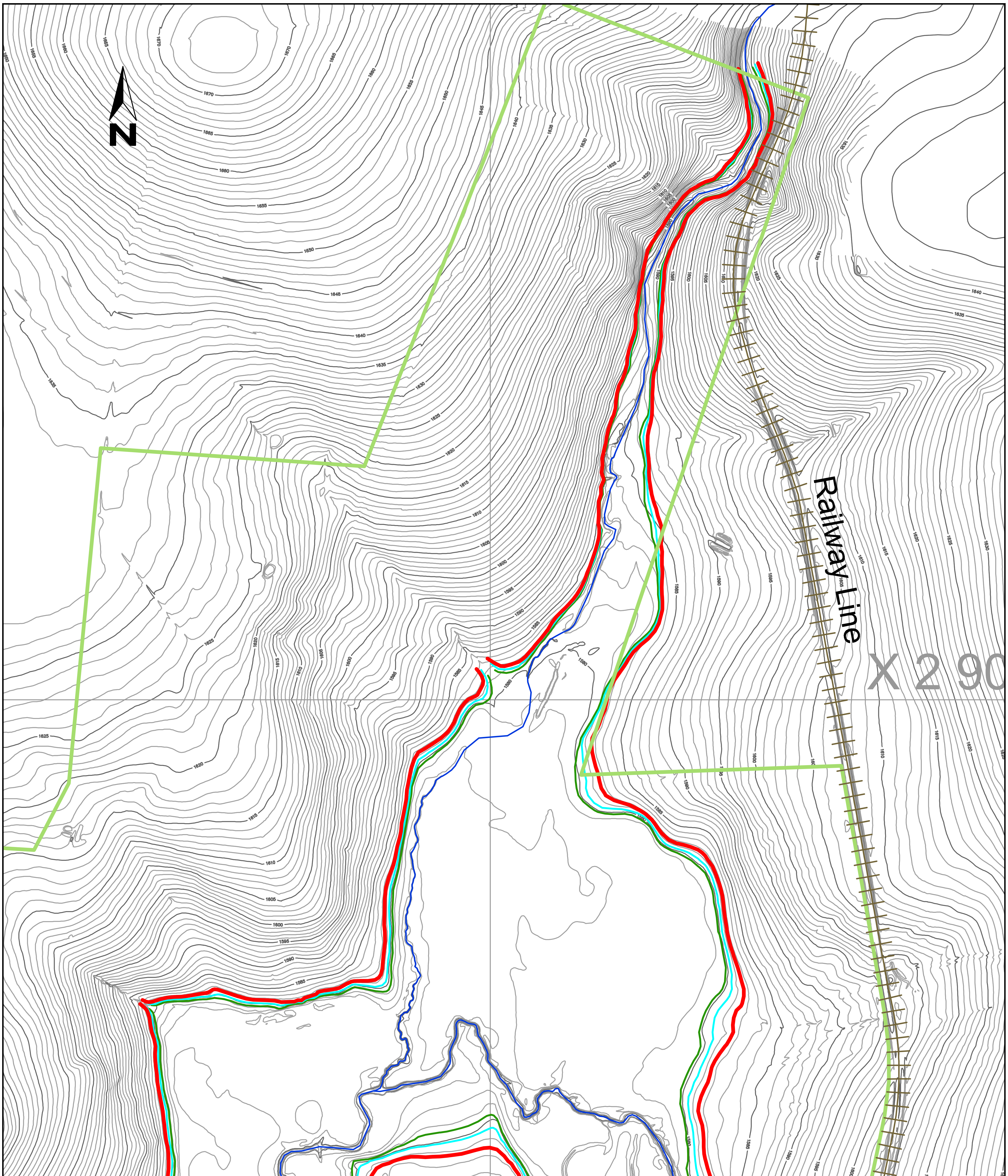
Client Klient SRK CONSULTING

Scale Skaal 1 : 5 000

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 5 OF 13

Drawing No Tekening Nr D202-02-006

Revision Hersiening A A1



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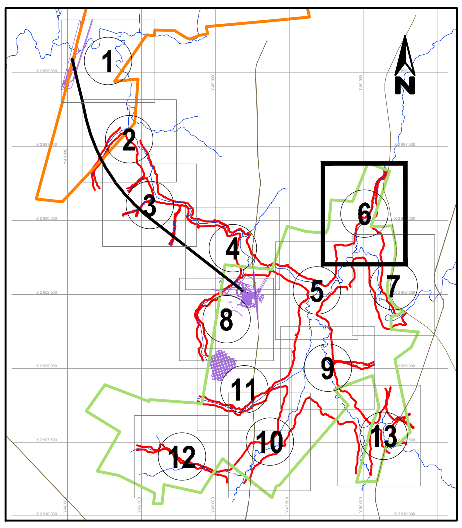

KEY PLAN

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid | Projection: Lo 29

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Drawn Geteken	HUNTLY	4.12.2012
Designed Ontwerp	MOODLEY	DEC 2012
Checked Nagesien	HEDIYIH	18.12.2012
Approved Goedgekeur		

Pr Eng 20120181 M Palmer Date

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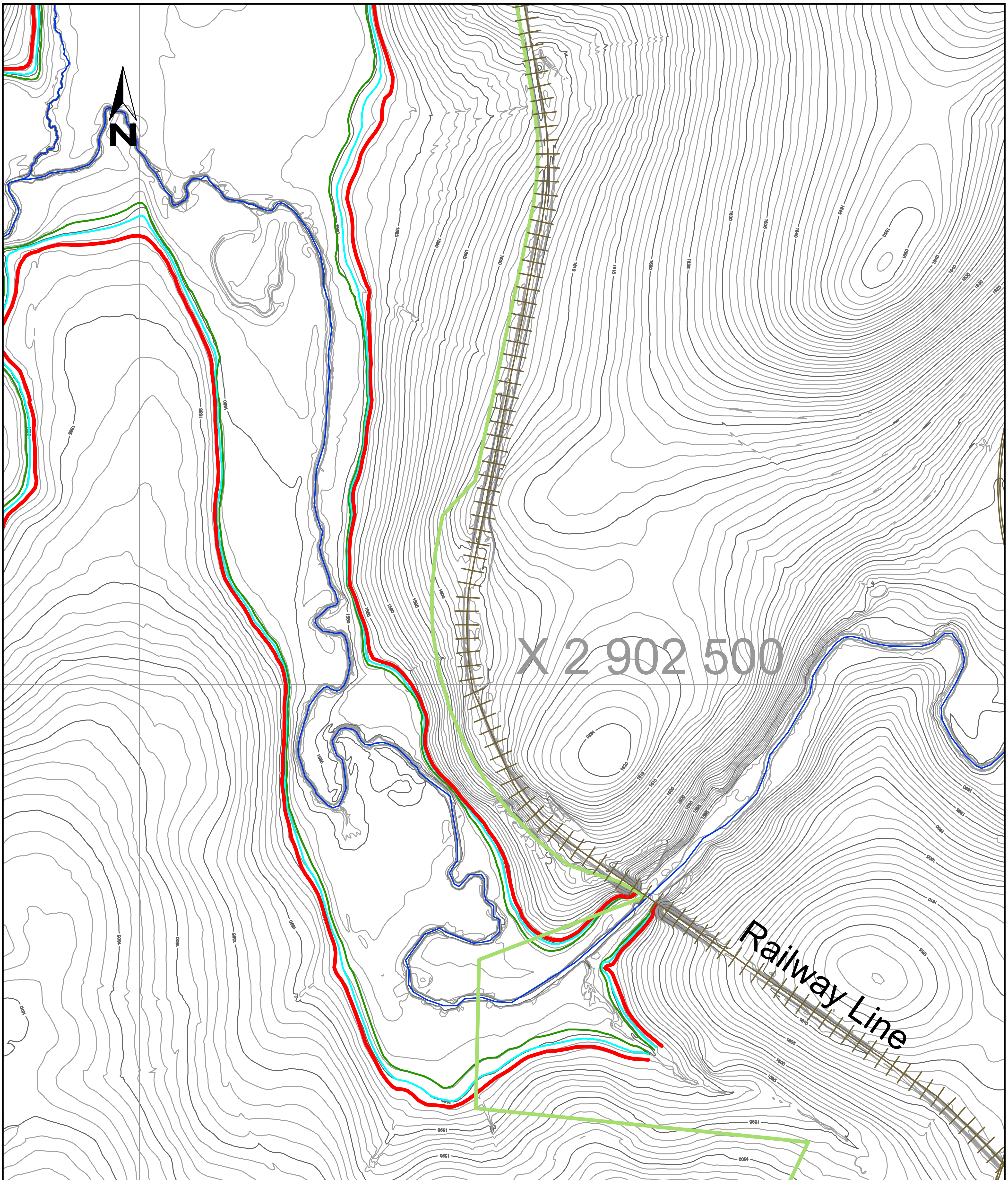
Scale Skaal 1 : 5 000

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 6 OF 13

Drawing No Tekening Nr D202-02-007

Revision Hersiening A A1



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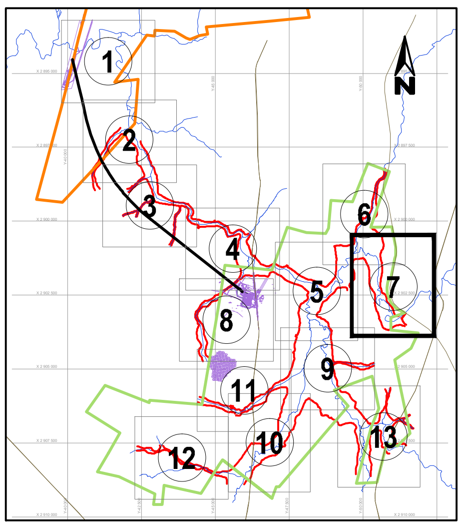
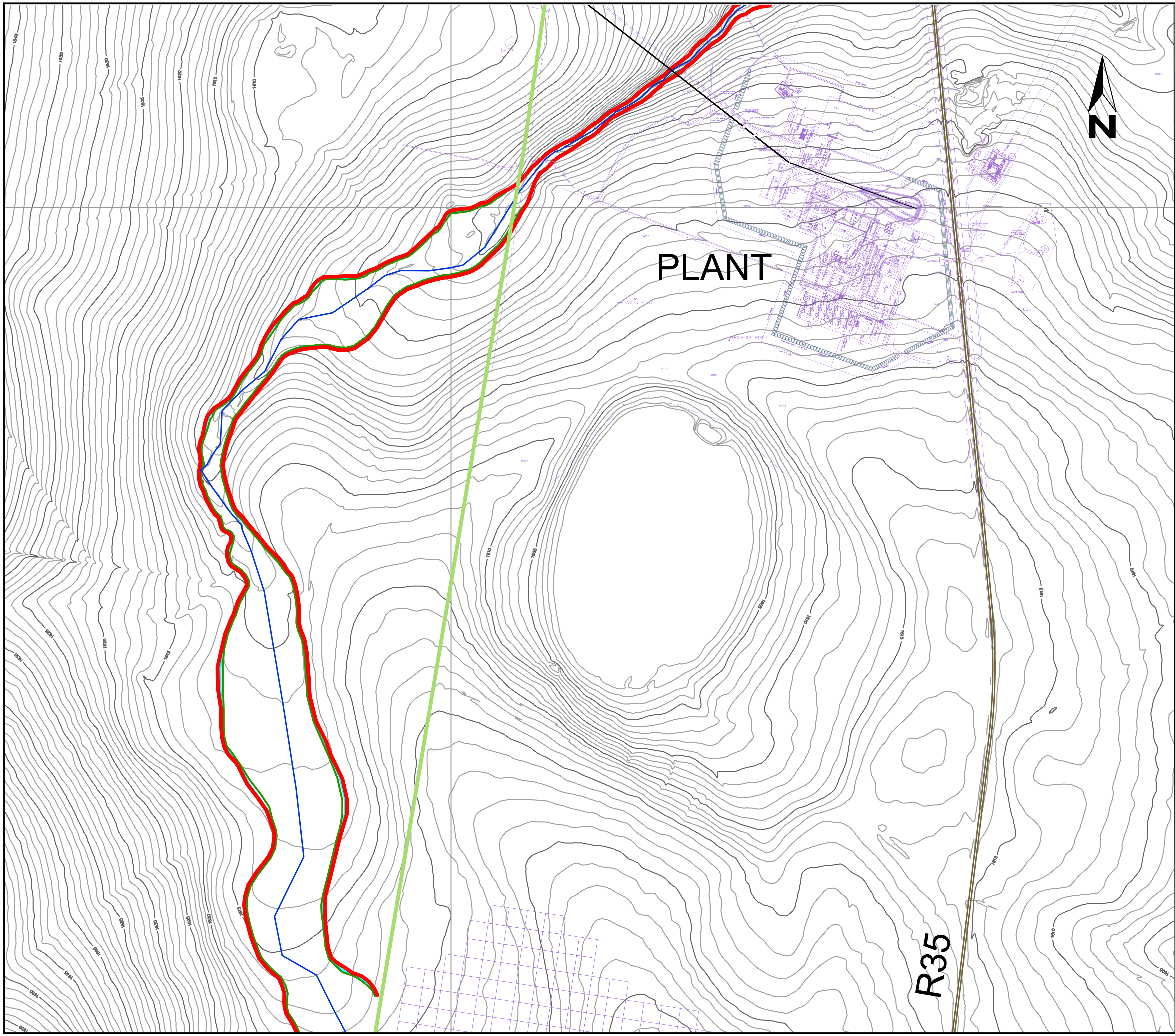


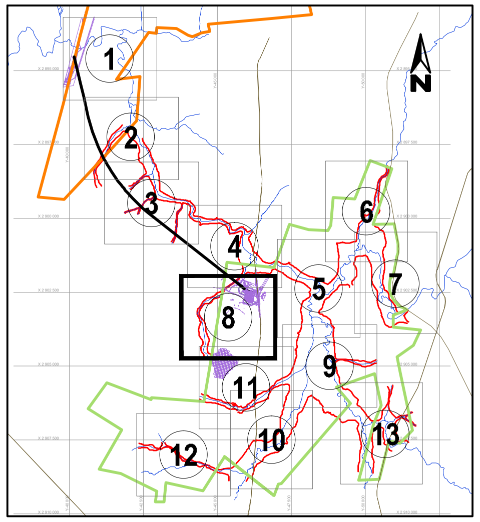
KEY PLAN

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid		Projection:	Lo 29
Jones & Wagener Consulting Civil Engineers Tel. (011) 519-0200 Fax. (011) 519-0201 e-mail post@jaws.co.za 59 Bevan Road P.O. Box 1434 Rivonia 2128		Drawn Geteken	HUNTLY	4.12.2012
		Designed Ontwerp	MOODLEY	DEC 2012
		Checked Nagesien	HEDIYIH	18.12.2012
Pr Eng 20120181	M Palmer	Date	Approved Goedgekeur	
Client Kliënt	SRK CONSULTING	Scale Skaal	1 : 5 000
ELDERS PROJECT FLOODLINE DETERMINATION SITE LAYOUT SHEET 7 OF 13		Drawing No Tekening Nr	D202-02-008
		Revision Hersiening	A	A1





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Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid
Projection: Lo 29

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Drawn / Geteken	HUNTLY	4.12.2012
Designed / Ontwerp	MOODLEY	DEC 2012
Checked / Nagesien	HEDIYIH	18.12.2012
Approved / Goedgekeur		

Pr Eng 20120181 M Palmer Date

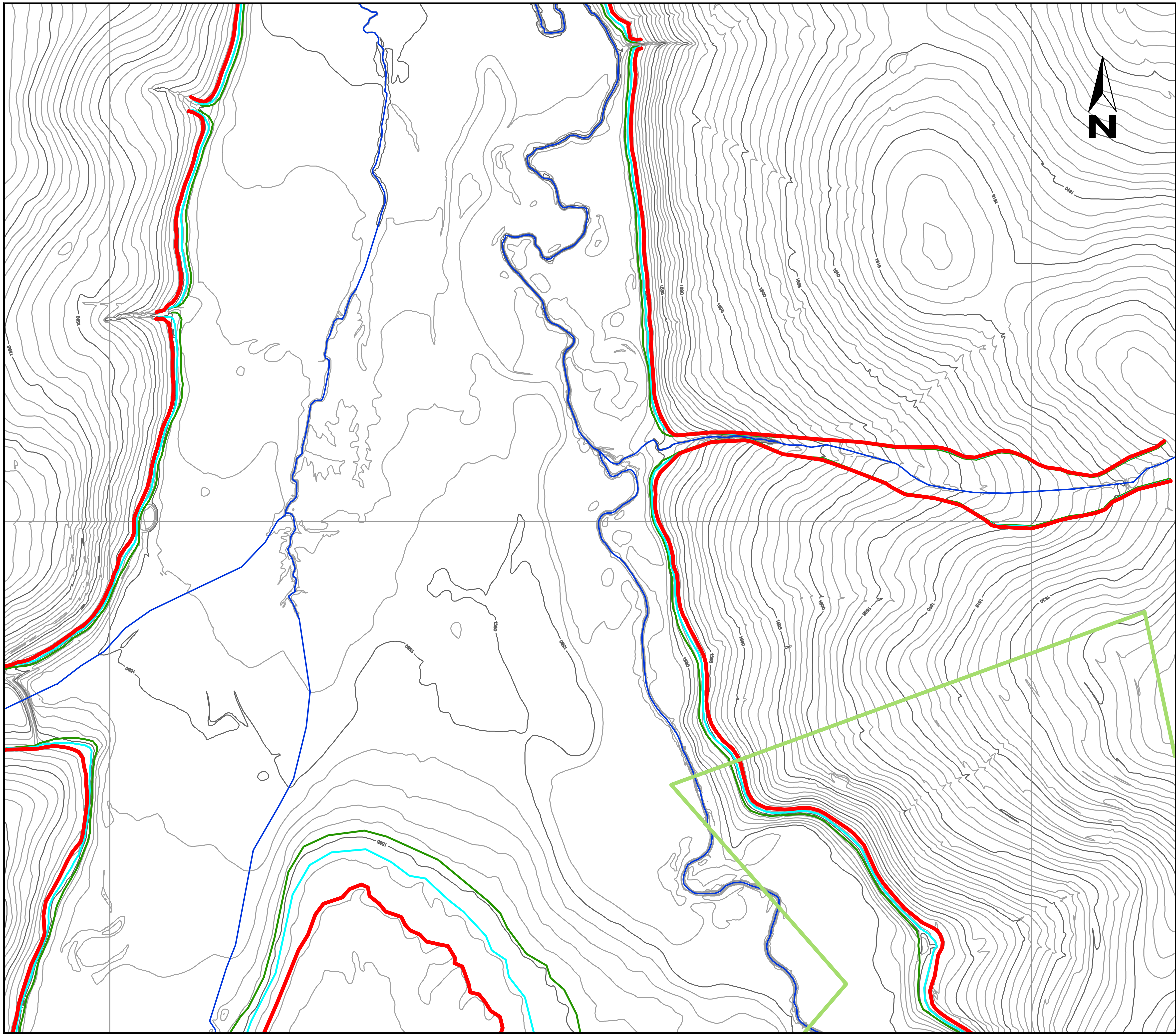
Client / Klient: SRK CONSULTING

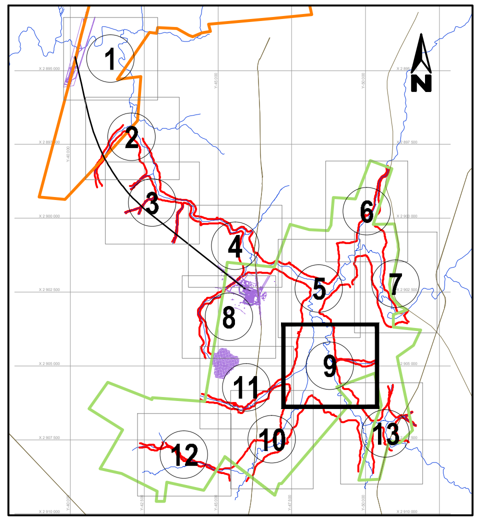
Scale / Skaal: 1 : 5 000

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 8 OF 13

Drawing No / Tekening Nr: D202-02-009

Revision / Hersiening: A — A1





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Approved / Goedgekeur		

Pr Eng 20120181 M Palmer Date

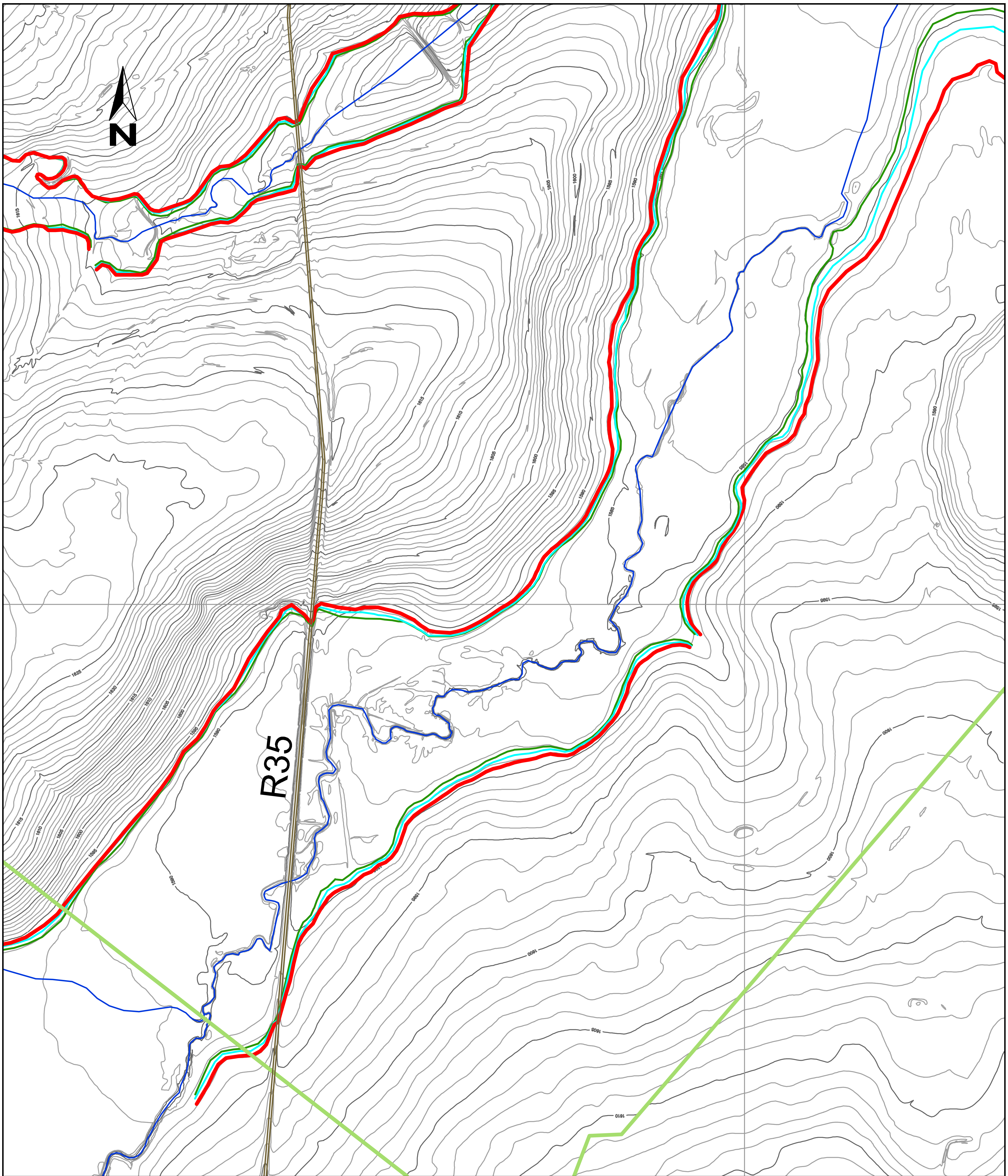
Client / Kliënt: SRK CONSULTING

Scale / Skaal: 1 : 5 000

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 9 OF 13

Drawing No / Tekening Nr: D202-02-010

Revision / Hersiening: A | A1



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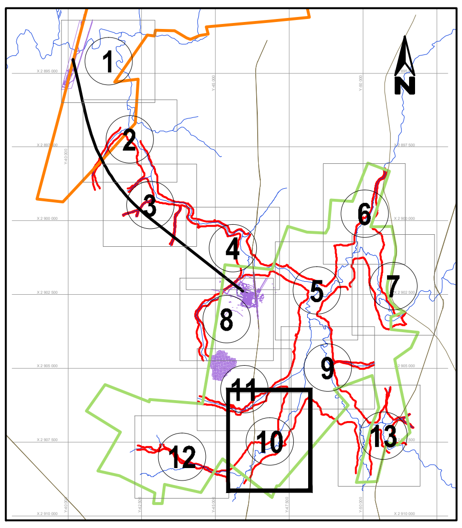

KEY PLAN

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid

Projection: Lo 29

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Drawn / Geteken	HUNTLY	4.12.2012
Designed / Ontwerp	MOODLEY	DEC 2012
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Approved / Goedgekeur		

Pr Eng 20120181 M Palmer Date

Client / Klient: SRK CONSULTING

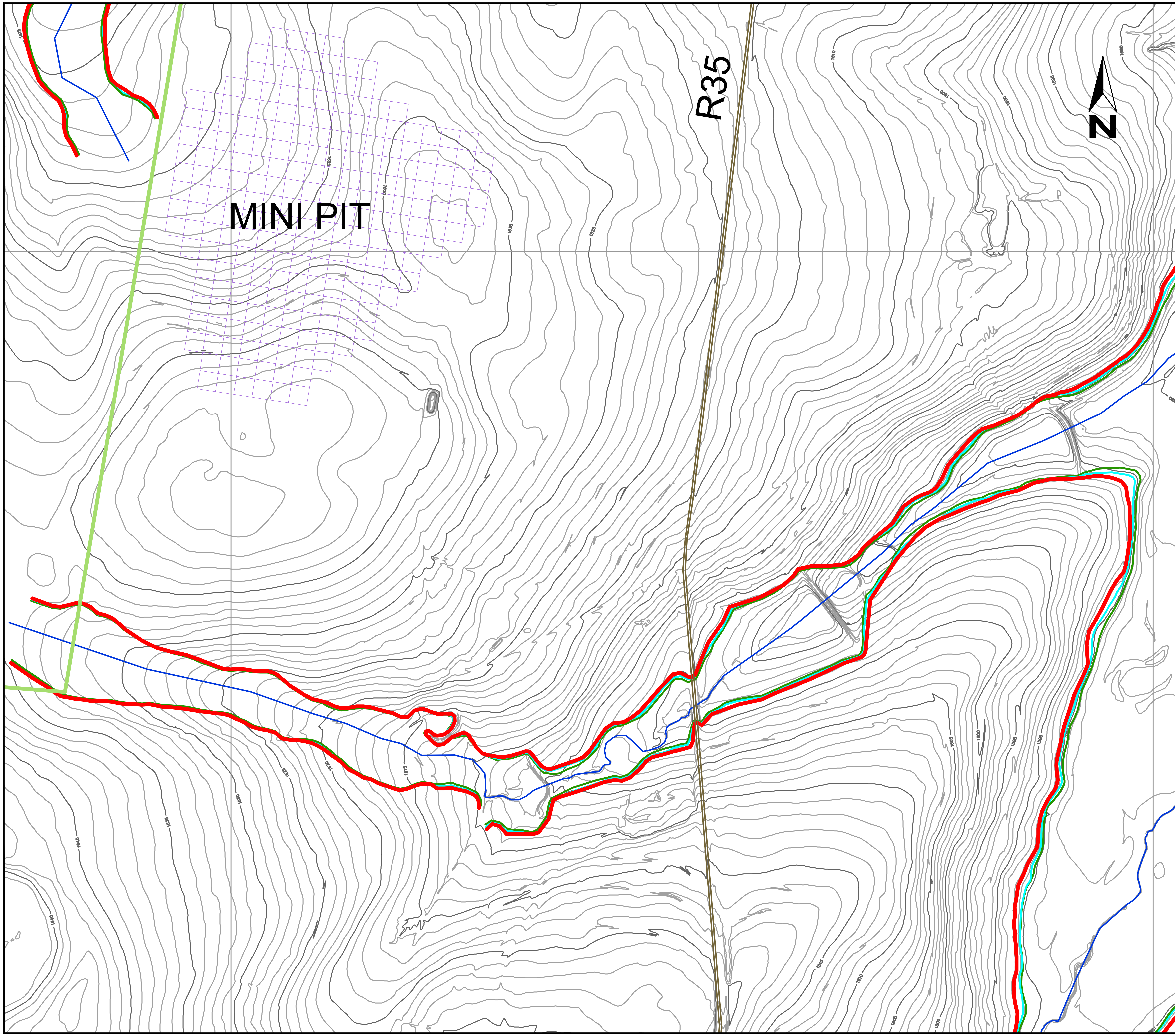
Scale / Skaal: 1 : 5 000

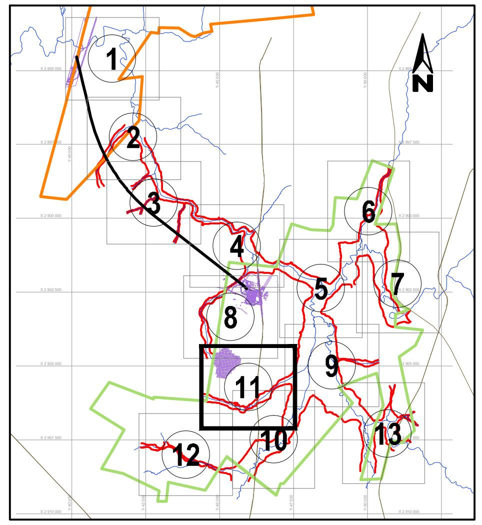
ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 10 OF 13

Drawing No / Tekening Nr: D202-02-011

Revision / Hersiening: A

A1





KEY PLAN

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Rev.	Revision / Hersiening	Name	Date	Approved
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Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid		Projection: Lo 29	
Jones & Wagener Consulting Civil Engineers Tel. (011) 519-0200 Fax. (011) 519-0201 e-mail post@jaws.co.za 59 Bevan Road P.O. Box 1434 Rivonia 2128		Drawn / Geteken	HUNTLY	4.12.2012
		Designed / Ontwerp	MOODLEY	DEC 2012
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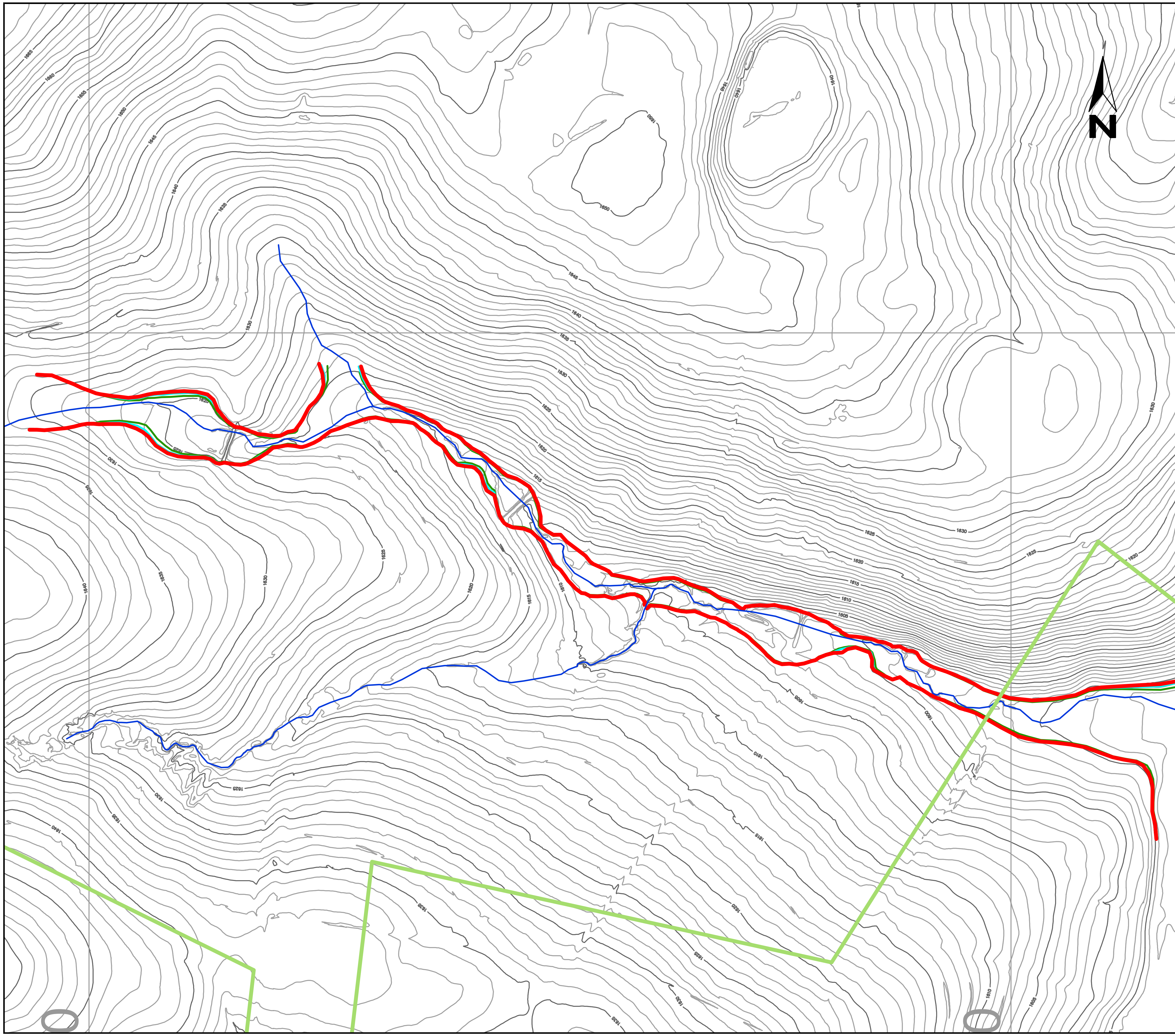
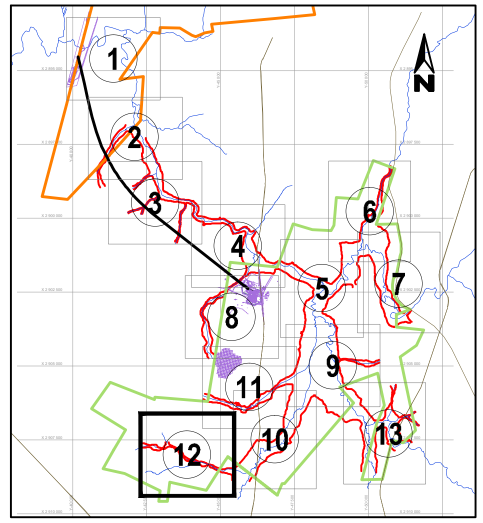
Pr Eng 20120181 M Palmer	Date	Approved / Goedgekeur		
Client / Klient: SRK CONSULTING		Scale / Skaal	1 : 5 000	

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 11 OF 13

Drawing No / Tekening Nr: D202-02-012

Revision / Hersiening: A | A1





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A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

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Approved Goedgekeur		

Pr Eng 20120181 M Palmer Date

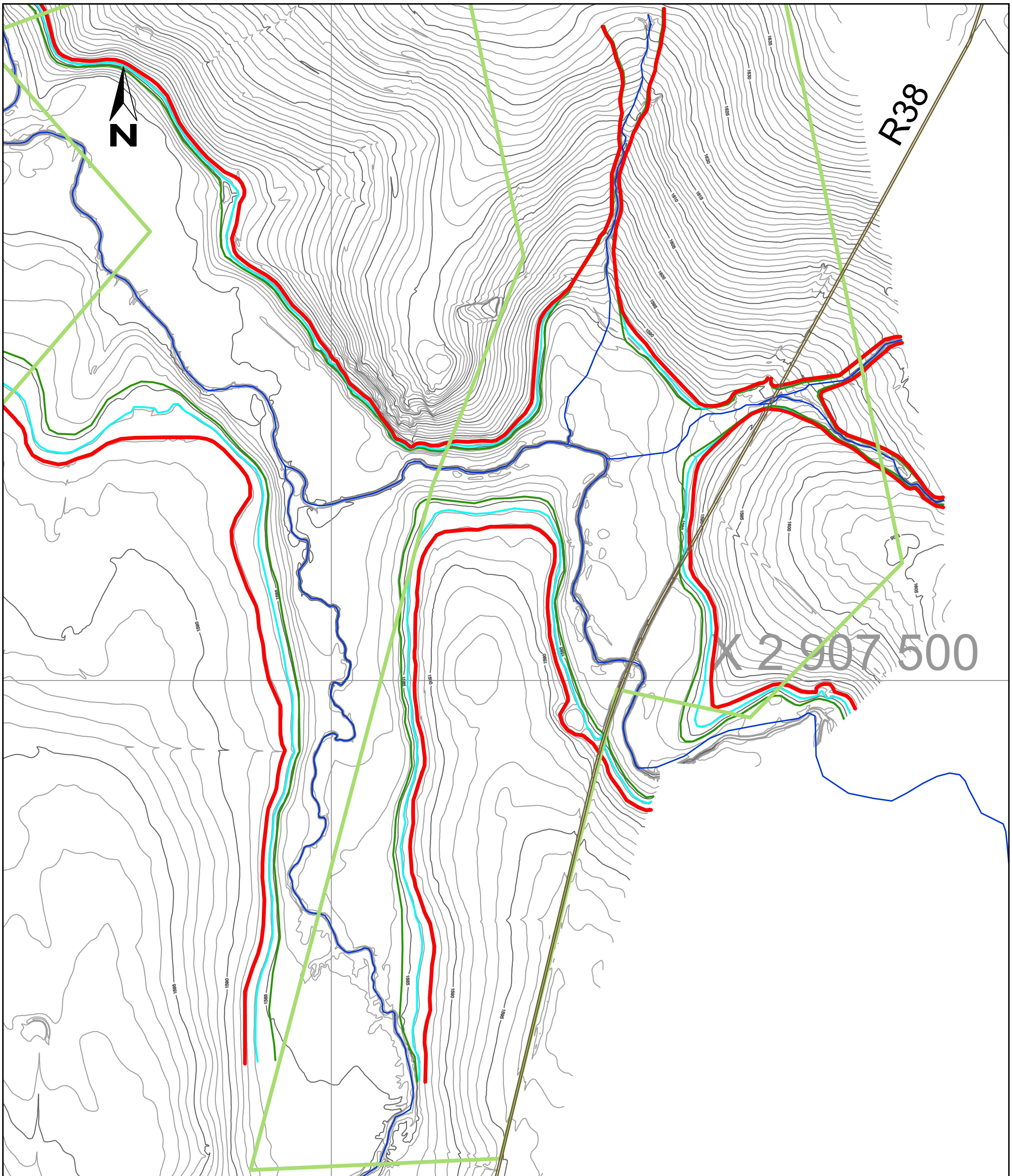
Client Klient: SRK CONSULTING

Scale Skaal: 1 : 5 000

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 12 OF 13

Drawing No Tekening Nr: D202-02-013

Revision Hersiening: A | A1



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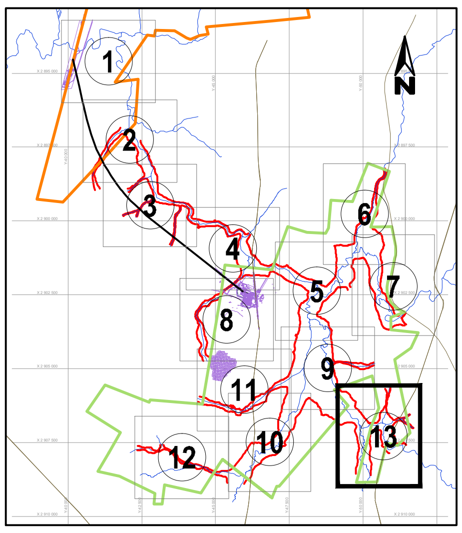

KEY PLAN

Rev.	Revision / Hersiening	Name	Date	Approved
A	ISSUED FOR APPROVAL			

Reference Drawings / Verwysingstekeninge

Co-ordinate System: CLARKE 1880 Spheroid		Projection:	Lo 29
Jones & Wagener Consulting Civil Engineers		Drawn Geteken	HUNTLY	4.12.2012
Tel. (011) 519-0200 Fax. (011) 519-0201 e-mail post@jaws.co.za	59 Bevan Road P.O. Box 1434 Rivonia 2128	Designed Ontwerp	MOODLEY	DEC 2012
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Pr Eng 20120181 M Palmer	Date	Approved Goedgekeur		
Client Klient SRK CONSULTING		Scale Skaal	1 : 5 000	

ELDERS PROJECT
FLOODLINE DETERMINATION
SITE LAYOUT
SHEET 13 OF 13

Drawing No / Tekening Nr: D202-02-014

Revision Hersiening: A | A1

Appendix B

WATER QUALITY RESULTS

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 9893
Project: GMS-Elders Ungerground

Date of certificate: 04 October 2012
Date accepted: 26 September 2012
Date completed: 03 October 2012
Revision: 0

Lab no:				102949	102950	102951	102952	102953	102954	102955
Date sampled:				26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-9	ESW-10	ESW-11	ESW-12
	Analyses	**Unit**	**Method**							
A	pH	pH	CSM 20	9.21	9.63	7.03	8.89	8.29	8.65	7.25
A	Electrical conductivity (EC)	mS/m	CSM 20	450.00	1761.00	20.28	113.70	67.30	91.60	85.90
A	Total dissolved solids (TDS)	mg/l	CSM 26	2487	9522	119	836	422	599	596
A	Total alkalinity	mg/l	CSM 01	737.24	1515.72	55.41	164.46	107.61	156.25	144.23
A	Chloride (Cl)	mg/l	CSM 02	490.90	3240.71	15.92	29.24	21.39	49.34	38.52
A	Sulphate (SO_4)	mg/l	CSM 03	635.06	1882.67	30.27	460.50	200.74	267.50	300.65
A	Nitrate (NO_3) as N	mg/l	CSM 06	0.502	<0.057	0.109	0.142	0.264	0.069	0.105
A	Ammonium (NH_4) as N	mg/l	CSM 05	0.101	0.258	0.017	0.019	0.017	0.022	0.019
A	Ortophosphate (PO_4) as P	mg/l	CSM 04	1.038	3.963	0.055	0.037	<0.025	<0.025	<0.025
A	Fluoride (F)	mg/l	CSM 08	19.520	20.390	0.292	0.700	0.411	0.364	0.413
A	Calcium (Ca)	mg/l	CSM 30	140.36	21.01	14.11	66.53	75.58	55.85	68.03
A	Magnesium (Mg)	mg/l	CSM 30	100.90	35.15	6.60	54.52	22.13	48.63	40.38
A	Sodium (Na)	mg/l	CSM 30	650.24	3379.45	13.97	119.08	31.95	76.36	52.48
A	Potassium (K)	mg/l	CSM 30	7.28	32.78	4.13	6.69	5.47	7.52	9.16
A	Aluminium (Al)	mg/l	CSM 31	1.321	0.231	0.280	0.240	0.543	0.380	0.166
A	Iron (Fe)	mg/l	CSM 31	0.443	<0.006	1.195	0.489	0.500	0.618	1.638
A	Manganese (Mn)	mg/l	CSM 31	0.303	0.143	0.806	0.255	0.575	0.181	5.87
A	Zinc (Zn)	mg/l	CSM 31	0.091	0.019	0.331	0.139	0.086	0.042	0.111
A	Lead (Pb)	mg/l	CSM 31	<0.001	<0.001	0.029	0.014	0.006	0.007	<0.001
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	0.09	0.14	<0.008	0.02	<0.008	<0.008	<0.008
N	Molybdenum (Mo)	mg/l	CSM 32	0.063	0.220	0.007	0.010	0.009	0.008	0.010
N	Antimony (Sb)	mg/l	CSM 36	0.012	0.011	0.028	0.023	0.018	0.006	<0.001
N	Balancing	%	CSM 26	98.86	96.64	96.98	98.03	98.21	98.66	96.44

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Results reported against the limit of quantification.

HHausen

Laboratory Manager: H. Holtzhausen

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 9893
Project: GMS-Elders Ungerground

Date of certificate: 04 October 2012
Date accepted: 26 September 2012
Date completed: 03 October 2012
Revision: 0

Lab no:				102956	102957	102958	102959	102960	102961	102962
Date sampled:				26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12	26-Sep-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-13	ESW-14	ESW-15	ESW-16	ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**							
A	pH	pH	CSM 20	8.85	7.83	8.71	8.04	8.18	7.64	8.03
A	Electrical conductivity (EC)	mS/m	CSM 20	51.00	29.57	69.90	86.30	103.00	25.03	118.10
A	Total dissolved solids (TDS)	mg/l	CSM 26	271	185	411	573	734	141	849
A	Total alkalinity	mg/l	CSM 01	220.74	123.13	208.80	225.32	209.71	35.46	100.14
A	Chloride (Cl)	mg/l	CSM 02	22.87	6.50	46.21	47.56	28.01	19.76	17.62
A	Sulphate (SO_4)	mg/l	CSM 03	16.03	40.78	101.54	205.02	355.88	48.56	509.42
A	Nitrate (NO_3) as N	mg/l	CSM 06	0.154	0.353	0.172	0.218	0.318	0.253	0.344
A	Ammonium (NH_4) as N	mg/l	CSM 05	<0.015	0.016	<0.015	<0.015	0.073	0.055	<0.015
A	Ortophosphate (PO_4) as P	mg/l	CSM 04	0.032	<0.025	<0.025	0.035	<0.025	<0.025	<0.025
A	Fluoride (F)	mg/l	CSM 08	0.324	0.413	0.669	0.720	0.544	0.371	0.380
A	Calcium (Ca)	mg/l	CSM 30	31.87	37.29	37.45	50.07	64.37	13.56	89.61
A	Magnesium (Mg)	mg/l	CSM 30	32.59	15.18	32.79	41.68	40.04	7.72	46.80
A	Sodium (Na)	mg/l	CSM 30	31.73	7.64	60.67	85.46	112.84	20.44	117.41
A	Potassium (K)	mg/l	CSM 30	2.81	2.84	6.36	7.20	6.22	9.13	7.24
A	Aluminium (Al)	mg/l	CSM 31	0.384	0.407	0.172	0.154	0.723	0.117	0.644
A	Iron (Fe)	mg/l	CSM 31	1.575	0.842	0.735	0.624	0.680	0.705	1.306
A	Manganese (Mn)	mg/l	CSM 31	0.958	0.243	1.13	0.226	0.264	0.209	0.361
A	Zinc (Zn)	mg/l	CSM 31	0.590	0.012	0.035	0.041	0.031	0.015	0.045
A	Lead (Pb)	mg/l	CSM 31	0.009	0.002	0.004	0.035	<0.001	0.006	0.009
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.008	<0.008	<0.008	<0.008	0.03	<0.008	0.03
N	Molybdenum (Mo)	mg/l	CSM 32	0.008	0.009	0.007	0.012	0.011	0.006	0.009
N	Antimony (Sb)	mg/l	CSM 36	<0.001	0.019	0.020	0.023	0.019	0.019	0.022
N	Balancing	%	CSM 26	95.91	99.00	98.85	98.59	96.94	96.26	97.70

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HHausen

Laboratory Manager: H. Holtzhausen

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ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 9524
Project: GMS-Elders Ungerground

Date of certificate: 06 September 2012
Date accepted: 30 August 2012
Date completed: 06 September 2012
Revision: 0

Lab no:				100068	100069	100070	100071	100072	100073	100074
Date sampled:				30-Aug-12	30-Aug-12	30-Aug-12	30-Aug-12	30-Aug-12	30-Aug-12	30-Aug-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-9	ESW-10	ESW-12	ESW-13	ESW-15	ESW-16	ESW-17
	Analyses	**Unit**	**Method**							
A	pH	pH	CSM 20	9.09	8.52	8.11	8.67	8.40	8.52	8.05
A	Electrical conductivity (EC)	mS/m	CSM 20	78.10	48.40	29.21	53.10	82.70	85.50	120.00
A	Total dissolved solids (TDS)	mg/l	CSM 26	474	280	162	299	528	539	836
A	Total alkalinity	mg/l	CSM 01	245.53	236.59	107.23	235.11	352.13	245.98	146.76
A	Chloride (Cl)	mg/l	CSM 02	42.12	16.53	16.77	24.34	63.60	36.83	13.93
A	Sulphate (SO_4)	mg/l	CSM 03	114.61	17.06	21.35	30.24	70.93	172.41	477.40
A	Nitrate (NO3) as N	mg/l	CSM 06	0.602	0.582	0.672	0.640	0.602	0.646	0.614
A	Ammonium (NH4) as N	mg/l	CSM 05	0.023	0.064	0.138	0.045	0.125	0.203	0.388
A	Orthophosphate (PO4) as P	mg/l	CSM 04	<0.025	<0.025	0.282	<0.025	<0.025	0.038	0.050
A	Fluoride (F)	mg/l	CSM 08	0.946	0.592	0.466	0.301	0.570	0.711	0.258
A	Calcium (Ca)	mg/l	CSM 30	38.57	48.45	18.10	33.10	45.05	48.00	109.37
A	Magnesium (Mg)	mg/l	CSM 30	37.05	20.00	12.17	33.50	34.99	42.58	71.31
A	Sodium (Na)	mg/l	CSM 30	84.70	31.77	24.56	32.43	97.83	82.35	68.39
A	Potassium (K)	mg/l	CSM 30	8.26	3.32	3.89	3.03	3.57	7.60	6.70
A	Aluminium (Al)	mg/l	CSM 31	0.204	0.025	0.490	0.026	0.070	0.275	0.098
A	Iron (Fe)	mg/l	CSM 31	0.283	0.079	0.280	0.940	0.424	0.487	0.204
A	Manganese (Mn)	mg/l	CSM 31	0.509	0.728	0.269	1.68	1.07	0.552	0.632
A	Zinc (Zn)	mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	Lead (Pb)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
N	Molybdenum (Mo)	mg/l	CSM 32	0.010	0.010	0.007	0.006	0.009	0.011	0.012
N	Antimony (Sb)	mg/l	CSM 36	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
N	Balancing	%	CSM 26	98.01	99.47	100.00	99.45	95.81	99.32	95.64

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HHausen
Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	06 September 2012
Address:	53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128	**Date accepted:**	30 August 2012
Report no:	9524	**Date completed:**	06 September 2012
Project:	GMS-Elders Ungerground	**Revision:**	0

Lab no:				100075	100076
Date sampled:				30-Aug-12	30-Aug-12
Sample type:				Water	Water
Locality description:				ESW-18	ESW-19
	Analyses	**Unit**	**Method**		
A	pH	pH	CSM 20	7.85	8.22
A	Electrical conductivity (EC)	mS/m	CSM 20	32.30	167.50
A	Total dissolved solids (TDS)	mg/l	CSM 26	194	1113
A	Total alkalinity	mg/l	CSM 01	81.09	191.09
A	Chloride (Cl)	mg/l	CSM 02	35.17	29.23
A	Sulphate (SO_4)	mg/l	CSM 03	42.15	609.50
A	Nitrate (NO3) as N	mg/l	CSM 06	0.595	0.690
A	Ammonium (NH4) as N	mg/l	CSM 05	0.309	0.090
A	Orthophosphate (PO4) as P	mg/l	CSM 04	0.039	0.030
A	Fluoride (F)	mg/l	CSM 08	0.499	0.567
A	Calcium (Ca)	mg/l	CSM 30	14.34	98.36
A	Magnesium (Mg)	mg/l	CSM 30	8.96	72.58
A	Sodium (Na)	mg/l	CSM 30	33.63	179.94
A	Potassium (K)	mg/l	CSM 30	10.47	7.09
A	Aluminium (Al)	mg/l	CSM 31	0.010	0.173
A	Iron (Fe)	mg/l	CSM 31	0.311	0.187
A	Manganese (Mn)	mg/l	CSM 31	0.277	0.633
A	Zinc (Zn)	mg/l	CSM 31	<0.004	<0.004
A	Lead (Pb)	mg/l	CSM 31	<0.001	<0.001
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.01	0.03
N	Molybdenum (Mo)	mg/l	CSM 32	0.010	0.009
N	Antimony (Sb)	mg/l	CSM 36	<0.010	<0.010
N	Balancing	%	CSM 26	95.14	95.79

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10823
Project: GMS-Elders Underground

Date of certificate: 30 November 2012
Date accepted: 26 November 2012
Date completed: 30 November 2012
Revision: 0

Lab no:				111090	111091	111092	111093	111094	111095	111096
Date sampled:				21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-7	ESW-9	ESW-10	ESW-11
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	CSM 31	1.90	3.29	<0.003	<0.003	2.05	<0.003	0.021
A	Iron (Fe)	mg/l	CSM 31	0.579	1.63	2.35	1.07	1.32	0.677	0.474
A	Manganese (Mn)	mg/l	CSM 31	0.772	0.671	1.25	<0.001	0.233	2.03	0.977
A	Zinc (Zn)	mg/l	CSM 31	0.653	0.629	<0.002	<0.002	0.006	<0.002	<0.002
A	Lead (Pb)	mg/l	CSM 31	0.046	0.010	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	0.252	0.179	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	CSM 32	0.156	0.105	0.009	0.007	0.011	0.010	0.017
N	Antimony (Sb)	mg/l	CSM 36	0.051	0.015	<0.001	<0.001	<0.001	<0.001	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico
Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10823
Project: GMS-Elders Underground

Date of certificate: 30 November 2012
Date accepted: 26 November 2012
Date completed: 30 November 2012
Revision: 0

Lab no:				111097	111098	111099	111100	111101	111102	111103
Date sampled:				21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17	ESW-18
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	CSM 31	3.24	2.12	0.038	2.16	2.22	2.07	0.027
A	Iron (Fe)	mg/l	CSM 31	1.80	1.74	<0.003	1.78	1.82	1.82	0.918
A	Manganese (Mn)	mg/l	CSM 31	0.679	0.436	0.013	0.464	0.471	0.835	0.180
A	Zinc (Zn)	mg/l	CSM 31	0.012	0.016	<0.002	0.011	0.008	0.034	<0.002
A	Lead (Pb)	mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004	0.006	<0.004
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	CSM 32	0.010	0.009	0.011	0.008	0.009	0.007	0.011
N	Antimony (Sb)	mg/l	CSM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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HHausen
Laboratory Manager: H. Holtzhausen

aquatico
Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	30 November 2012
Address:	53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128	**Date accepted:**	26 November 2012
Report no:	10823	**Date completed:**	30 November 2012
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				111104
Date sampled:				21-Nov-12
Sample type:				Water
Locality description:				ESW-19
	Analyses	**Unit**	**Method**	
A	Aluminium (Al)	mg/l	CSM 31	0.139
A	Iron (Fe)	mg/l	CSM 31	<0.003
A	Manganese (Mn)	mg/l	CSM 31	<0.001
A	Zinc (Zn)	mg/l	CSM 31	<0.002
A	Lead (Pb)	mg/l	CSM 31	<0.004
N	Mercury (Hg)	mg/l	CSM 35	<0.001
N	Boron (B)	mg/l	CSM 32	<0.003
N	Molybdenum (Mo)	mg/l	CSM 32	0.012
N	Antimony (Sb)	mg/l	CSM 36	0.003

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HHausen
Laboratory Manager: H. Holtzhausen

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ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10822
Project: GMS-Elders Underground

Date of certificate: 04 December 2012
Date accepted: 26 November 2012
Date completed: 04 December 2012
Revision: 0

	Lab no:			111075	111076	111077	111078	111079	111080	111081
	Date sampled:			21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			ESW-1	ESW-2	ESW-3	ESW-7	ESW-9	ESW-10	ESW-11
	Analyses	**Unit**	**Method**							
A	pH	pH	CSM 20	9.26	9.06	7.29	6.83	7.63	8.80	8.28
A	Electrical conductivity (EC)	mS/m	CSM 20	662	967	22.9	7.34	43.8	55.7	84.5
A	Total dissolved solids (TDS)	mg/l	CSM 26	3552	5828	105	<19.2	218	309	479
A	Total alkalinity	mg/l	CSM 01	702	700	60.9	<2.477	98.9	148	367
A	Chloride (Cl)	mg/l	CSM 02	785	2107	13.0	4.64	22.1	20.0	37.3
A	Sulphate (SO_4)	mg/l	CSM 03	963	996	15.7	6.52	59.8	89.1	48.2
A	Nitrate (NO_3) as N	mg/l	CSM 06	0.175	0.104	0.341	0.127	0.778	0.119	0.295
A	Ammonium (NH_4) as N	mg/l	CSM 05	3.21	1.05	0.225	0.138	0.404	0.049	0.077
A	Ortophosphate (PO_4) as P	mg/l	CSM 04	1.94	2.45	0.015	<0.008	0.035	<0.008	0.040
A	Fluoride (F)	mg/l	CSM 08	20.2	14.8	0.414	0.199	0.540	0.453	0.629
A	Calcium (Ca)	mg/l	CSM 30	20.6	18.8	15.7	1.10	24.2	55.4	52.5
A	Magnesium (Mg)	mg/l	CSM 30	15.2	12.2	7.70	0.823	16.8	20.1	46.8
A	Sodium (Na)	mg/l	CSM 30	1309	2223	10.7	2.64	27.4	29.6	66.4
A	Potassium (K)	mg/l	CSM 30	13.7	35.1	4.63	2.07	6.28	5.17	5.81
A	Aluminium (Al)	mg/l	CSM 31	0.125	0.352	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	CSM 31	0.402	0.488	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	1.37	<0.001
A	Zinc (Zn)	mg/l	CSM 31	0.017	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	CSM 31	0.005	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	0.213	0.160	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	CSM 32	0.150	0.086	0.007	0.004	0.009	0.007	0.010
N	Antimony (Sb)	mg/l	CSM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	CSM 26	98.03	97.70	98.57	95.78	99.52	95.83	99.70

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	04 December 2012
Address:	53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128	**Date accepted:**	26 November 2012
Report no:	10822	**Date completed:**	04 December 2012
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:			111082	111083	111084	111085	111086	111087	111088
Date sampled:			21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12	21-Nov-12
Sample type:			Water	Water	Water	Water	Water	Water	Water
Locality description:			ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17	ESW-18
Analyses	**Unit**	**Method**							
A pH	pH	CSM 20	7.39	7.45	7.84	7.50	7.57	7.27	7.74
A Electrical conductivity (EC)	mS/m	CSM 20	26.9	29.8	64.0	29.8	34.2	48.7	21.7
A Total dissolved solids (TDS)	mg/l	CSM 26	135	254	344	148	181	238	96
A Total alkalinity	mg/l	CSM 01	72.8	78.0	188	61.3	84.3	76.2	34.5
A Chloride (Cl)	mg/l	CSM 02	10.1	50.3	5.60	14.8	18.8	17.5	13.9
A Sulphate (SO_4)	mg/l	CSM 03	33.3	60.3	102	41.1	45.3	87.3	23.7
A Nitrate (NO_3) as N	mg/l	CSM 06	0.513	0.809	0.808	0.848	0.784	0.919	0.125
A Ammonium (NH_4) as N	mg/l	CSM 05	0.307	0.714	0.080	0.562	0.615	0.458	0.106
A Ortophosphate (PO_4) as P	mg/l	CSM 04	0.044	0.205	0.021	0.142	0.101	0.091	<0.008
A Fluoride (F)	mg/l	CSM 08	0.487	0.751	0.452	0.606	0.612	0.525	0.466
A Calcium (Ca)	mg/l	CSM 30	18.6	14.8	68.2	16.4	18.9	25.3	10.2
A Magnesium (Mg)	mg/l	CSM 30	11.6	9.28	26.3	10.1	12.1	14.0	5.90
A Sodium (Na)	mg/l	CSM 30	10.3	60.6	21.1	19.5	25.6	36.9	10.2
A Potassium (K)	mg/l	CSM 30	5.64	9.27	5.61	7.86	7.93	8.95	10.2
A Aluminium (Al)	mg/l	CSM 31	0.015	0.948	<0.003	0.490	0.148	0.121	0.013
A Iron (Fe)	mg/l	CSM 31	<0.003	0.527	<0.003	0.307	<0.003	<0.003	<0.003
A Manganese (Mn)	mg/l	CSM 31	0.313	<0.001	<0.001	<0.001	0.111	0.081	<0.001
A Zinc (Zn)	mg/l	CSM 31	<0.002	0.002	<0.002	0.006	0.003	0.004	<0.002
A Lead (Pb)	mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N Boron (B)	mg/l	CSM 32	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N Molybdenum (Mo)	mg/l	CSM 32	0.007	0.007	0.009	0.008	0.008	0.007	0.008
N Antimony (Sb)	mg/l	CSM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N Balancing	%	CSM 26	99.92	97.66	96.14	96.35	98.97	95.61	96.99

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HHausen

Laboratory Manager: H. Holtzhausen

Test Report

Client:	Groundwater Monitoring Services	**Date of certificate:**	04 December 2012
Address:	53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128	**Date accepted:**	26 November 2012
Report no:	10822	**Date completed:**	04 December 2012
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				111089
Date sampled:				21-Nov-12
Sample type:				Water
Locality description:				ESW-19
	Analyses	**Unit**	**Method**	
A	pH	pH	CSM 20	8.08
A	Electrical conductivity (EC)	mS/m	CSM 20	44.1
A	Total dissolved solids (TDS)	mg/l	CSM 26	220
A	Total alkalinity	mg/l	CSM 01	118
A	Chloride (Cl)	mg/l	CSM 02	14.6
A	Sulphate (SO_4)	mg/l	CSM 03	57.7
A	Nitrate (NO_3) as N	mg/l	CSM 06	0.122
A	Ammonium (NH_4) as N	mg/l	CSM 05	0.114
A	Ortophosphate (PO_4) as P	mg/l	CSM 04	0.017
A	Fluoride (F)	mg/l	CSM 08	0.518
A	Calcium (Ca)	mg/l	CSM 30	28.6
A	Magnesium (Mg)	mg/l	CSM 30	18.8
A	Sodium (Na)	mg/l	CSM 30	24.7
A	Potassium (K)	mg/l	CSM 30	4.41
A	Aluminium (Al)	mg/l	CSM 31	<0.003
A	Iron (Fe)	mg/l	CSM 31	<0.003
A	Manganese (Mn)	mg/l	CSM 31	<0.001
A	Zinc (Zn)	mg/l	CSM 31	<0.002
A	Lead (Pb)	mg/l	CSM 31	<0.004
N	Mercury (Hg)	mg/l	CSM 35	<0.001
N	Boron (B)	mg/l	CSM 32	<0.003
N	Molybdenum (Mo)	mg/l	CSM 32	0.010
N	Antimony (Sb)	mg/l	CSM 36	<0.001
N	Balancing	%	CSM 26	97.91

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10517
Project: GMS-Elders Underground

Date of certificate: 12 November 2012
Date accepted: 06 November 2012
Date completed: 12 November 2012
Revision: 0

Lab no:				108232	108233	108234	108235	108236	108237	108238
Date sampled:				24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-3	ESW-9	ESW-10	ESW-11	ESW-12	ESW-13
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	CSM 31	0.997	1.12	1.07	1.34	1.38	1.82	2.71
A	Iron (Fe)	mg/l	CSM 31	0.223	2.596	3.614	8.559	4.165	4.763	5.968
A	Manganese (Mn)	mg/l	CSM 31	0.004	0.792	0.240	0.756	0.063	2.03	2.59
A	Zinc (Zn)	mg/l	CSM 31	0.222	0.428	0.350	0.672	0.266	0.195	0.537
A	Lead (Pb)	mg/l	CSM 31	0.012	0.024	0.055	0.149	0.072	0.129	0.032
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	0.18	<0.008	0.02	0.01	<0.008	<0.008	<0.008
N	Molybdenum (Mo)	mg/l	CSM 32	0.116	0.008	0.008	0.006	0.012	0.011	0.015
N	Antimony (Sb)	mg/l	CSM 36	0.027	0.004	0.012	0.023	0.007	0.020	0.016

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10517
Project: GMS-Elders Underground

Date of certificate: 12 November 2012
Date accepted: 06 November 2012
Date completed: 12 November 2012
Revision: 0

	Analyses	Unit	Method					
Lab no:				108239	108240	108241	108242	108243
Date sampled:				24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12
Sample type:				Water	Water	Water	Water	Water
Locality description:				ESW-15	ESW-16	ESW-17	ESW-18	ESW-19
A	Aluminium (Al)	mg/l	CSM 31	3.09	0.594	0.428	0.346	0.658
A	Iron (Fe)	mg/l	CSM 31	2.776	1.243	2.243	1.036	0.887
A	Manganese (Mn)	mg/l	CSM 31	0.591	0.833	0.245	<0.001	0.028
A	Zinc (Zn)	mg/l	CSM 31	0.657	0.032	0.107	1.017	0.220
A	Lead (Pb)	mg/l	CSM 31	0.447	0.045	<0.001	0.018	0.040
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.008	0.01	0.07	<0.008	0.09
N	Molybdenum (Mo)	mg/l	CSM 32	0.011	0.009	0.014	0.008	0.011
N	Antimony (Sb)	mg/l	CSM 36	0.021	0.003	0.019	0.028	0.029

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10337
Project: GMS-Elders Underground

Date of certificate: 12 November 2012
Date accepted: 24 October 2012
Date completed: 12 November 2012
Revision: 0

Lab no:				106824	106825	106826	106827	106828	106829	106830
Date sampled:				24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-3	ESW-9	ESW-10	ESW-11	ESW-12	ESW-13
	Analyses	**Unit**	**Method**							
A	pH	pH	CSM 20	9.17	6.90	8.29	9.31	8.49	7.79	8.25
A	Electrical conductivity (EC)	mS/m	CSM 20	538	23.7	107	56.2	80.2	72.0	59.7
A	Total dissolved solids (TDS)	mg/l	CSM 26	3358	132	731	395	497	410	313
A	Total alkalinity	mg/l	CSM 01	856	50.5	153	98.3	225	198	270
A	Chloride (Cl)	mg/l	CSM 02	709	11.0	27.9	15.3	36.9	31.2	27.3
A	Sulphate (SO4)	mg/l	CSM 03	781	47.3	383	203	161	123	11.0
A	Nitrate (NO3) as N	mg/l	CSM 06	0.825	0.586	0.299	0.471	0.319	0.230	0.220
A	Ammonium (NH4) as N	mg/l	CSM 05	0.671	0.084	0.061	0.046	0.052	0.056	0.037
A	Ortophosphate (PO4) as P	mg/l	CSM 04	1.99	0.033	0.030	0.044	0.054	0.031	0.137
A	Fluoride (F)	mg/l	CSM 08	33.0	<0.183	0.368	0.204	0.267	0.365	0.271
A	Calcium (Ca)	mg/l	CSM 30	13.3	15.2	67.5	59.9	45.9	51.0	32.9
A	Magnesium (Mg)	mg/l	CSM 30	10.3	8.41	49.0	24.8	41.5	33.7	38.0
A	Sodium (Na)	mg/l	CSM 30	1283	13.0	103	26.9	69.5	44.5	38.7
A	Potassium (K)	mg/l	CSM 30	13.2	6.22	7.38	5.04	6.52	7.62	2.42
A	Aluminium (Al)	mg/l	CSM 31	0.249	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
A	Iron (Fe)	mg/l	CSM 31	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
A	Manganese (Mn)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004	0.195	<0.004
A	Lead (Pb)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	0.13	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008
N	Molybdenum (Mo)	mg/l	CSM 32	0.114	0.007	0.008	0.006	0.010	0.009	0.013
N	Antimony (Sb)	mg/l	CSM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	CSM 26	97.94	96.10	99.10	97.37	99.81	99.87	99.45

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, PO Box 1811, Rivonia, 2128
Report no: 10337
Project: GMS-Elders Underground

Date of certificate: 12 November 2012
Date accepted: 24 October 2012
Date completed: 12 November 2012
Revision: 0

Lab no:				106831	106832	106833	106834	106835
Date sampled:				24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12	24-Oct-12
Sample type:				Water	Water	Water	Water	Water
Locality description:				ESW-15	ESW-16	ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**					
A	pH	pH	CSM 20	8.47	7.73	8.29	7.75	8.28
A	Electrical conductivity (EC)	mS/m	CSM 20	75.5	93.9	141	25.2	187
A	Total dissolved solids (TDS)	mg/l	CSM 26	437	582	982	137	1416
A	Total alkalinity	mg/l	CSM 01	234	123	198	37.4	143
A	Chloride (Cl)	mg/l	CSM 02	43.9	52.8	40.0	24.5	22.7
A	Sulphate (SO4)	mg/l	CSM 03	103	267	500	42.6	846
A	Nitrate (NO3) as N	mg/l	CSM 06	0.232	0.244	0.333	0.335	0.245
A	Ammonium (NH4) as N	mg/l	CSM 05	0.168	0.068	0.123	0.156	0.028
A	Ortophosphate (PO4) as P	mg/l	CSM 04	0.045	0.031	0.034	0.028	0.033
A	Fluoride (F)	mg/l	CSM 08	0.578	0.218	0.394	0.323	<0.183
A	Calcium (Ca)	mg/l	CSM 30	38.4	55.3	79.6	12.5	122
A	Magnesium (Mg)	mg/l	CSM 30	37.4	42.2	49.4	7.63	66.6
A	Sodium (Na)	mg/l	CSM 30	66.3	78.3	186	16.8	265
A	Potassium (K)	mg/l	CSM 30	6.12	11.7	7.10	9.78	7.97
A	Aluminium (Al)	mg/l	CSM 31	<0.006	<0.006	<0.006	0.048	<0.006
A	Iron (Fe)	mg/l	CSM 31	<0.006	<0.006	<0.006	<0.006	<0.006
A	Manganese (Mn)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	CSM 31	<0.004	<0.004	<0.004	<0.004	<0.004
A	Lead (Pb)	mg/l	CSM 31	<0.001	<0.001	<0.001	<0.001	<0.001
N	Mercury (Hg)	mg/l	CSM 35	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	CSM 32	<0.008	<0.008	0.06	<0.008	0.08
N	Molybdenum (Mo)	mg/l	CSM 32	0.011	0.008	0.014	0.007	0.011
N	Antimony (Sb)	mg/l	CSM 36	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	CSM 26	99.54	98.00	97.49	97.38	95.20

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11829
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

Lab no:				119470	119471	119472	119473	119474	119475	119476
Date sampled:				01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-4	ESW-5	ESW-6	ESW-7
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	2.83	8.70	0.052	0.854	0.201	0.577	0.075
A	Iron (Fe)	mg/l	ALM 31	3.70	3.77	1.45	0.931	<0.003	1.06	0.012
A	Manganese (Mn)	mg/l	ALM 31	0.098	1.32	<0.001	0.977	<0.001	0.007	<0.001
A	Zinc (Zn)	mg/l	ALM 31	0.003	0.039	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	0.006	0.013	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.039	0.068	<0.003	0.007	0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.010	0.024	0.008	0.009	0.007	0.006	0.005
N	Antimony (Sb)	mg/l	ALM 36	0.050	0.014	0.040	0.012	0.019	0.020	0.045

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11829
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

Lab no:				119477	119478	119479	119480	119481	119482	119483
Date sampled:				01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-8	ESW-9	ESW-10	ESW-11	ESW-12	ESW-13	ESW-14
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	0.357	0.483	0.051	0.587	0.034	0.235	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.220	1.23	0.165	0.388	0.270	0.690	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.215	<0.001	0.029	0.136	0.384	2.70
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.005	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.004	0.011	0.009	0.008	0.012	0.007	0.011
N	Antimony (Sb)	mg/l	ALM 36	0.037	0.022	0.030	0.012	0.036	0.019	0.043

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11829
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

Lab no:				119484	119485	119486	119487	119488
Date sampled:				01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
Sample type:				Water	Water	Water	Water	Water
Locality description:				ESW-15	ESW-16	ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**					
A	Aluminium (Al)	mg/l	ALM 31	0.341	0.665	0.444	<0.003	0.317
A	Iron (Fe)	mg/l	ALM 31	0.736	1.18	1.29	2.01	0.740
A	Manganese (Mn)	mg/l	ALM 31	0.194	0.160	1.03	0.655	0.799
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.008	0.007	0.010	0.007	0.007
N	Antimony (Sb)	mg/l	ALM 36	0.025	0.014	0.026	0.071	0.023

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HHausen

Laboratory Manager: H. Holtzhausen

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T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11828
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

Lab no:				119451	119452	119453	119454	119455	119456	119457
Date sampled:				01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-4	ESW-5	ESW-6	ESW-7
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	7.71	8.53	7.45	7.68	7.77	7.00	6.68
A	Electrical conductivity (EC)	mS/m	ALM 20	63.6	225	20.4	41.4	31.0	14.4	7.26
A	Total dissolved solids (TDS)	mg/l	ALM 26	332	1210	96	216	150	67	25
A	Total alkalinity	mg/l	ALM 01	112	238	49.7	166	110	35.1	4.53
A	Chloride (Cl)	mg/l	ALM 02	61.2	443	7.77	3.36	1.56	1.13	1.41
A	Sulphate (SO_4)	mg/l	ALM 03	75.3	179	22.4	39.2	30.8	21.1	11.4
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017	0.277	<0.017	<0.017	<0.017	<0.017	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.796	0.186	0.048	0.015	0.006	0.127	0.073
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.315	2.16	0.018	0.040	0.015	0.026	0.008
A	Fluoride (F)	mg/l	ALM 08	1.32	4.03	0.473	0.463	0.363	0.351	0.134
A	Calcium (Ca)	mg/l	ALM 30	32.7	11.1	12.7	21.3	10.9	4.33	1.58
A	Magnesium (Mg)	mg/l	ALM 30	14.7	7.51	6.91	27.7	24.2	7.78	1.16
A	Sodium (Na)	mg/l	ALM 30	64.8	411	11.1	16.0	11.0	3.28	3.05
A	Potassium (K)	mg/l	ALM 30	13.9	10.4	4.91	8.99	5.22	7.56	3.25
A	Aluminium (Al)	mg/l	ALM 31	0.003	3.87	0.035	<0.003	0.132	0.091	0.037
A	Iron (Fe)	mg/l	ALM 31	<0.003	2.19	0.012	<0.003	<0.003	0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	0.618	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	0.008	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.036	0.062	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.007	0.009	0.007	0.007	0.006	0.005	0.005
N	Antimony (Sb)	mg/l	ALM 36	<0.001	0.005	0.006	0.001	0.003	<0.001	<0.001
N	Balancing	%	ALM 26	96.17	96.27	96.84	99.60	95.57	99.26	96.89

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HHausen
Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11828
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

	Lab no:			119458	119459	119460	119461	119462	119463	119464
	Date sampled:			01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			ESW-8	ESW-9	ESW-10	ESW-11	ESW-12	ESW-13	ESW-14
	Analyses	Unit	Method							
A	pH	pH	ALM 20	6.61	7.67	7.78	7.56	7.95	7.88	7.74
A	Electrical conductivity (EC)	mS/m	ALM 20	9.61	30.7	43.2	27.2	71.5	30.0	75.5
A	Total dissolved solids (TDS)	mg/l	ALM 26	38	157	236	135	367	150	405
A	Total alkalinity	mg/l	ALM 01	13.2	99.0	92.6	91.7	194	102	235
A	Chloride (Cl)	mg/l	ALM 02	1.77	8.56	29.8	4.40	49.2	7.43	13.7
A	Sulphate (SO_4)	mg/l	ALM 03	14.9	32.6	69.6	27.5	69.4	26.0	107
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.039	0.053	0.040	0.030	0.043	0.064	0.078
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.010	0.049	0.032	0.077	0.018	0.025	0.013
A	Fluoride (F)	mg/l	ALM 08	0.166	0.358	0.568	0.324	0.480	0.366	0.382
A	Calcium (Ca)	mg/l	ALM 30	1.98	18.9	19.8	16.3	45.0	21.6	74.5
A	Magnesium (Mg)	mg/l	ALM 30	1.59	13.7	16.3	14.1	36.1	12.4	31.6
A	Sodium (Na)	mg/l	ALM 30	7.10	18.9	35.9	13.8	41.5	16.2	34.0
A	Potassium (K)	mg/l	ALM 30	2.70	4.61	7.87	3.77	9.39	5.05	2.63
A	Aluminium (Al)	mg/l	ALM 31	0.193	<0.003	<0.003	0.021	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.16
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.004	0.009	0.007	0.006	0.008	0.006	0.007
N	Antimony (Sb)	mg/l	ALM 36	0.009	<0.001	0.010	0.003	<0.001	<0.001	0.007
N	Balancing	%	ALM 26	99.77	98.53	99.05	97.67	96.19	97.79	96.18

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11828
Project: GMS-Elders Underground

Date of certificate: 14 February 2013
Date accepted: 01 February 2013
Date completed: 14 February 2013
Revision: 0

Lab no:				119465	119466	119467	119468	119469
Date sampled:				01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13	01-Feb-13
Sample type:				Water	Water	Water	Water	Water
Locality description:				ESW-15	ESW-16	ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**					
A	pH	pH	ALM 20	7.98	7.59	7.61	7.37	7.69
A	Electrical conductivity (EC)	mS/m	ALM 20	35.2	27.7	46.2	21.3	44.2
A	Total dissolved solids (TDS)	mg/l	ALM 26	181	138	244	102	237
A	Total alkalinity	mg/l	ALM 01	120	88.3	113	38.0	103
A	Chloride (Cl)	mg/l	ALM 02	12.1	7.79	22.7	12.2	16.7
A	Sulphate (SO_4)	mg/l	ALM 03	32.1	26.1	70.4	29.4	79.3
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017	<0.017	0.285	<0.017	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.070	0.067	0.018	0.181	0.061
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.025	0.057	0.018	0.013	0.021
A	Fluoride (F)	mg/l	ALM 08	0.402	0.388	0.462	0.308	0.471
A	Calcium (Ca)	mg/l	ALM 30	23.8	17.5	30.8	9.89	28.9
A	Magnesium (Mg)	mg/l	ALM 30	14.7	12.5	19.0	6.71	17.4
A	Sodium (Na)	mg/l	ALM 30	20.1	16.4	25.8	13.9	26.5
A	Potassium (K)	mg/l	ALM 30	5.48	4.12	7.10	6.90	5.92
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	0.178	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.006	0.006	0.007	0.005	0.006
N	Antimony (Sb)	mg/l	ALM 36	<0.001	0.011	0.010	<0.001	0.011
N	Balancing	%	ALM 26	99.84	96.78	99.99	96.98	99.58

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11562
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 18 January 2013
Date completed: 28 January 2013
Revision: 0

Lab no:				117200	117201	117202	117203	117204	117205	117206
Date sampled:				14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-9	ESW-10
	Analyses	Unit	Method							
A	Aluminium (Al)	mg/l	ALM 31	2.67	13.9	0.069	1.24	0.051	0.545	0.003
A	Iron (Fe)	mg/l	ALM 31	1.49	6.10	7.75	2.66	0.586	1.05	0.683
A	Manganese (Mn)	mg/l	ALM 31	<0.001	2.18	1.24	0.339	<0.001	<0.001	0.957
A	Zinc (Zn)	mg/l	ALM 31	<0.002	1.16	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	0.060	0.181	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.218	0.078	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.199	0.035	0.012	0.012	0.013	0.015	0.016
N	Antimony (Sb)	mg/l	ALM 36	0.031	<0.001	0.027	<0.001	0.036	0.020	0.085

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11562
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 18 January 2013
Date completed: 28 January 2013
Revision: 0

	Analyses	Unit	Method							
Lab no:				117207	117208	117209	117210	117211	117212	117213
Date sampled:				14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13	14-Jan-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17
A	Aluminium (Al)	mg/l	ALM 31	0.196	0.059	0.417	<0.003	0.384	0.572	0.532
A	Iron (Fe)	mg/l	ALM 31	0.071	1.59	1.02	<0.003	0.938	1.21	1.81
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.586	<0.001	3.24	<0.001	<0.001	0.040
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.016	0.015	0.014	0.016	0.014	0.012	0.014
N	Antimony (Sb)	mg/l	ALM 36	0.021	0.051	0.018	0.040	0.012	0.010	0.018

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11562
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 18 January 2013
Date completed: 28 January 2013
Revision: 0

				117214	117215	117229
Lab no:				117214	117215	117229
Date sampled:				14-Jan-13	14-Jan-13	14-Jan-13
Sample type:				Water	Water	Water
Locality description:				ESW-18	ESW-19	ESW-8
	Analyses	**Unit**	**Method**			
A	Aluminium (Al)	mg/l	ALM 31	0.041	0.489	0.296
A	Iron (Fe)	mg/l	ALM 31	4.23	1.20	3.89
A	Manganese (Mn)	mg/l	ALM 31	1.23	<0.001	0.535
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.012	0.014	0.011
N	Antimony (Sb)	mg/l	ALM 36	0.029	0.016	0.011

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11461
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 14 January 2013
Date completed: 28 January 2013
Revision: 0

Lab no:				116395	116396	116397	116398	116399	116400	116401
Date sampled:				11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-8	ESW-7	ESW-9
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	9.00	8.27	7.47	6.67	6.69	6.77	7.92
A	Electrical conductivity (EC)	mS/m	ALM 20	734	207	24.2	9.88	9.57	6.52	36.0
A	Total dissolved solids (TDS)	mg/l	ALM 26	4467	1041	106	104	31	17	180
A	Total alkalinity	mg/l	ALM 01	803	240	56.8	66.3	14.3	<2.477	105
A	Chloride (Cl)	mg/l	ALM 02	748	329	5.75	2.99	1.83	<0.423	11.8
A	Sulphate (SO_4)	mg/l	ALM 03	1489	190	25.6	24.6	8.23	9.01	38.8
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.067	2.48	0.111	0.203	0.118	0.096	0.459
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.560	0.158	0.123	0.623	0.133	0.053	0.037
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	2.87	1.87	0.024	0.043	0.010	0.010	0.010
A	Fluoride (F)	mg/l	ALM 08	24.3	3.92	0.440	0.464	0.223	0.201	0.469
A	Calcium (Ca)	mg/l	ALM 30	42.1	16.8	14.2	8.39	1.86	0.852	24.6
A	Magnesium (Mg)	mg/l	ALM 30	20.3	7.72	6.63	15.0	1.42	0.639	14.8
A	Sodium (Na)	mg/l	ALM 30	1643	335	15.7	5.04	7.52	3.04	19.7
A	Potassium (K)	mg/l	ALM 30	18.0	11.2	3.59	6.75	1.37	1.59	5.74
A	Aluminium (Al)	mg/l	ALM 31	0.891	3.76	<0.003	0.059	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.250	2.50	0.144	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.193	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	0.041	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	1900	1900	12	3000	58	150	280
A	Total coliform	CFU/100ml	ALM 40	2500	3100	65	4500	200	300	710
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.144	0.070	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.118	0.007	0.003	0.008	0.006	0.010	0.010
N	Antimony (Sb)	mg/l	ALM 36	0.028	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.79	95.20	95.45	96.89	95.31	95.28	97.83

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HHausen

Laboratory Manager: H. Holtzhausen

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11461
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 14 January 2013
Date completed: 28 January 2013
Revision: 0

Lab no:				116402	116403	116404	116405	116406	116407	116408
Date sampled:				11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13	11-Jan-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.74	8.49	8.00	7.93	8.07	8.15	7.98
A	Electrical conductivity (EC)	mS/m	ALM 20	41.9	61.5	62.4	28.5	96.3	29.7	34.2
A	Total dissolved solids (TDS)	mg/l	ALM 26	215	321	339	139	614	147	170
A	Total alkalinity	mg/l	ALM 01	147	281	183	90.0	234	95.8	104
A	Chloride (Cl)	mg/l	ALM 02	11.1	7.92	36.6	6.21	18.6	7.52	10.5
A	Sulphate (SO_4)	mg/l	ALM 03	37.0	22.8	71.0	25.7	265	27.0	33.2
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.117	0.395	0.219	0.357	0.174	0.188	0.565
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.049	0.153	0.022	0.102	0.065	0.015	0.122
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.010	0.049	0.014	0.019	0.010	0.014	0.019
A	Fluoride (F)	mg/l	ALM 08	0.517	0.538	0.592	0.386	0.419	0.385	0.417
A	Calcium (Ca)	mg/l	ALM 30	35.0	38.1	40.3	20.9	99.2	21.6	24.2
A	Magnesium (Mg)	mg/l	ALM 30	15.4	35.2	27.1	11.5	42.3	12.0	13.8
A	Sodium (Na)	mg/l	ALM 30	23.2	44.6	41.4	14.2	45.4	15.1	18.4
A	Potassium (K)	mg/l	ALM 30	4.51	2.60	11.7	5.22	2.83	5.23	5.88
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.005
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	1.25	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	15	70	140	230	120	110	590
A	Total coliform	CFU/100ml	ALM 40	20	270	400	530	560	340	1600
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.011	0.014	0.012	0.011	0.012	0.009	0.009
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	99.16	96.71	99.07	96.45	98.95	97.74	97.49

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 11461
Project: GMS-Elders Underground

Date of certificate: 28 January 2013
Date accepted: 14 January 2013
Date completed: 28 January 2013
Revision: 0

Lab no:				116409	116410	116411
Date sampled:				11-Jan-13	11-Jan-13	11-Jan-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	7.79	7.27	7.88
A	Electrical conductivity (EC)	mS/m	ALM 20	35.8	33.5	35.0
A	Total dissolved solids (TDS)	mg/l	ALM 26	185	175	177
A	Total alkalinity	mg/l	ALM 01	91.9	22.1	99.9
A	Chloride (Cl)	mg/l	ALM 02	8.33	13.5	9.64
A	Sulphate (SO_4)	mg/l	ALM 03	58.8	89.1	45.0
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.317	0.434	0.431
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.043	0.209	0.080
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.013	0.020	0.021
A	Fluoride (F)	mg/l	ALM 08	0.426	0.335	0.372
A	Calcium (Ca)	mg/l	ALM 30	24.0	17.0	24.4
A	Magnesium (Mg)	mg/l	ALM 30	14.2	10.4	15.1
A	Sodium (Na)	mg/l	ALM 30	18.6	20.2	16.3
A	Potassium (K)	mg/l	ALM 30	5.61	11.0	5.59
A	Aluminium (Al)	mg/l	ALM 31	0.011	<0.003	0.073
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.842	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	790	16	870
A	Total coliform	CFU/100ml	ALM 40	1500	180	1100
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.006	0.009	0.008
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	99.69	96.61	98.93

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HHausen

Laboratory Manager: **H. Holtzhausen**

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13147
Project: GMS-Elders Underground

Date of certificate: 26 April 2013
Date accepted: 22 April 2013
Date completed: 26 April 2013
Revision: 0

Lab no:				130182	130183	130184	130185	130186	130187	130188
Date sampled:				19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	3.88	2.31	0.175	0.052	0.102	0.234	0.426
A	Iron (Fe)	mg/l	ALM 31	2.03	1.20	1.94	0.163	0.661	0.418	0.638
A	Manganese (Mn)	mg/l	ALM 31	0.359	0.170	0.431	0.458	0.272	0.342	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.029	0.010	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.030	0.017	0.011	0.009	0.008	0.009	0.017
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	0.018	<0.001	0.039	0.039	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13147
Project: GMS-Elders Underground

Date of certificate: 26 April 2013
Date accepted: 22 April 2013
Date completed: 26 April 2013
Revision: 0

Lab no:				130189	130190	130191	130192	130193	130194	130195
Date sampled:				19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	0.177	0.797	0.155	0.047	<0.003	0.136	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.940	0.721	0.274	0.385	<0.003	1.06	0.322
A	Manganese (Mn)	mg/l	ALM 31	0.266	0.876	<0.001	0.137	0.009	0.019	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.008	0.008	0.012	0.008	0.008	0.008	0.007
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	0.010	<0.001	<0.001

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HHausen
Laboratory Manager: H. Holtzhausen

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T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	26 April 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	22 April 2013
Report no:	13147	**Date completed:**	26 April 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				130196	130197	130198
Date sampled:				19-Apr-13	19-Apr-13	19-Apr-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.307	0.671	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.120	0.299	0.204
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.010	0.008	0.011
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	0.071

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Laboratory Manager: H. Holtzhausen

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ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	26 April 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	22 April 2013
Report no:	13146	**Date completed:**	26 April 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				130165	130166	130167	130168	130169	130170	130171
Date sampled:				19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.79	8.31	7.21	8.20	7.09	6.55	8.12
A	Electrical conductivity (EC)	mS/m	ALM 20	204	159	49.8	28.7	8.76	12.7	32.9
A	Total dissolved solids (TDS)	mg/l	ALM 26	1360	934	274	151	26	43	171
A	Total alkalinity	mg/l	ALM 01	287	223	75.2	91.4	4.54	<2.477	112
A	Chloride (Cl)	mg/l	ALM 02	216	270	24.5	11.3	7.54	9.35	13.4
A	Sulphate (SO_4)	mg/l	ALM 03	506	194	117	37.5	5.57	15.0	33.9
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.818	0.602	0.474	0.266	0.265	1.37	0.313
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.164	0.930	0.495	0.143	<0.005	0.008	0.085
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	1.11	1.34	0.023	0.010	0.009	0.008	0.014
A	Fluoride (F)	mg/l	ALM 08	4.90	2.44	0.256	0.420	0.119	0.162	0.285
A	Calcium (Ca)	mg/l	ALM 30	27.6	20.1	38.4	10.5	1.56	2.38	22.0
A	Magnesium (Mg)	mg/l	ALM 30	21.2	10.5	18.1	20.4	1.29	1.92	14.3
A	Sodium (Na)	mg/l	ALM 30	395	289	22.5	8.94	3.78	5.77	15.5
A	Potassium (K)	mg/l	ALM 30	16.2	12.8	7.28	6.45	2.73	6.28	4.13
A	Aluminium (Al)	mg/l	ALM 31	0.190	0.291	<0.003	<0.003	<0.003	0.036	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.022	0.090	<0.003	<0.003	0.006	0.071	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	21000	3800	2100	530	2700	15000	1800
A	Total coliform	CFU/100ml	ALM 40	32000	8200	4200	660	3700	32000	2200
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.018	0.006	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.016	0.009	0.008	0.007	0.006	0.005	0.013
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.34	95.04	99.19	96.42	96.85	99.49	95.24

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13146
Project: GMS-Elders Underground

Date of certificate: 26 April 2013
Date accepted: 22 April 2013
Date completed: 26 April 2013
Revision: 0

	Analyses	Unit	Method							
	Lab no:			130172	130173	130174	130175	130176	130177	130178
	Date sampled:			19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13	19-Apr-13
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
A	pH	pH	ALM 20	8.03	7.64	8.07	8.10	7.31	7.91	8.07
A	Electrical conductivity (EC)	mS/m	ALM 20	29.6	25.6	57.1	26.3	15.9	25.7	28.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	156	145	323	139	71	131	147
A	Total alkalinity	mg/l	ALM 01	112	50.5	243	96.4	32.0	87.7	110
A	Chloride (Cl)	mg/l	ALM 02	13.0	19.5	26.9	8.54	2.19	11.3	10.7
A	Sulphate (SO_4)	mg/l	ALM 03	22.6	47.1	40.8	23.8	25.5	22.7	20.4
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.344	0.329	0.255	0.261	0.955	0.312	0.260
A	Ammonium (NH_4) as N	mg/l	ALM 05	<0.005	<0.005	<0.005	3.20	0.236	0.232	0.325
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.016	0.056	0.016	0.012	0.047	0.028	0.022
A	Fluoride (F)	mg/l	ALM 08	0.313	0.220	0.396	0.588	0.312	0.310	0.357
A	Calcium (Ca)	mg/l	ALM 30	23.6	18.4	40.3	17.3	14.3	17.0	19.8
A	Magnesium (Mg)	mg/l	ALM 30	12.4	9.53	27.3	11.2	5.24	11.1	12.4
A	Sodium (Na)	mg/l	ALM 30	11.8	13.2	36.0	11.3	1.28	11.0	12.7
A	Potassium (K)	mg/l	ALM 30	4.99	5.88	5.17	4.52	1.93	4.39	4.44
A	Aluminium (Al)	mg/l	ALM 31	0.141	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.041	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	1700	4900	2800	35	570	2200	1700
A	Total coliform	CFU/100ml	ALM 40	4200	25000	3600	340	3700	7900	2900
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.007	0.007	0.006	0.008	0.006	0.006	0.003
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.45	96.96	95.62	98.19	97.90	95.58	95.31

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Client:	Groundwater Monitoring Services	**Date of certificate:**	26 April 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	22 April 2013
Report no:	13146	**Date completed:**	26 April 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				130179	130180	130181
Date sampled:				19-Apr-13	19-Apr-13	19-Apr-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	8.22	8.09	8.31
A	Electrical conductivity (EC)	mS/m	ALM 20	57.6	26.2	68.9
A	Total dissolved solids (TDS)	mg/l	ALM 26	316	132	429
A	Total alkalinity	mg/l	ALM 01	179	65.8	153
A	Chloride (Cl)	mg/l	ALM 02	28.6	20.1	21.8
A	Sulphate (SO_4)	mg/l	ALM 03	73.0	26.4	186
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.305	0.275	0.261
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.261	0.167	0.120
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.021	0.015	0.013
A	Fluoride (F)	mg/l	ALM 08	0.449	0.351	0.392
A	Calcium (Ca)	mg/l	ALM 30	39.1	12.5	50.8
A	Magnesium (Mg)	mg/l	ALM 30	26.2	8.69	31.2
A	Sodium (Na)	mg/l	ALM 30	34.9	15.5	40.1
A	Potassium (K)	mg/l	ALM 30	5.54	8.61	6.44
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.006	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
A	E.coli	CFU/100ml	ALM 40	63	7	40
A	Total coliform	CFU/100ml	ALM 40	90	26	66
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.008	0.006	0.007
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	98.48	95.22	96.17

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Results reported against the limit of detection.

HHausen

Laboratory Manager: **H. Holtzhausen**

aquatico Laboratories (Pty). Ltd.

T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12577
Project: GMS-Elders Underground

Date of certificate: 25 March 2013
Date accepted: 19 March 2013
Date completed: 25 March 2013
Revision: 0

	Analyses	Unit	Method	125457	125458	125459	125460	125461	125462	125463
	Date sampled:			19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
A	Aluminium (Al)	mg/l	ALM 31	5.43	3.67	<0.003	0.108	<0.003	0.068	0.096
A	Iron (Fe)	mg/l	ALM 31	3.99	3.08	0.045	0.991	0.506	0.641	0.799
A	Manganese (Mn)	mg/l	ALM 31	0.258	0.351	<0.001	0.192	<0.001	<0.001	0.255
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	0.004	0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.088	0.050	0.007	0.008	<0.003	<0.003	0.006
N	Molybdenum (Mo)	mg/l	ALM 32	0.036	0.017	0.013	0.008	0.009	0.007	0.010
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	0.014	<0.001	0.052	0.001	0.012

(Header row: Lab no.)

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12577
Project: GMS-Elders Underground

Date of certificate: 25 March 2013
Date accepted: 19 March 2013
Date completed: 25 March 2013
Revision: 0

Lab no:				125464	125465	125466	125467	125468	125469	125470
Date sampled:				19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	0.107	<0.003	0.028	0.079
A	Iron (Fe)	mg/l	ALM 31	0.330	<0.003	0.015	0.881	<0.003	0.518	0.891
A	Manganese (Mn)	mg/l	ALM 31	0.845	<0.001	0.732	0.338	0.527	0.227	0.301
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.011
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.004	<0.003	0.006	<0.003	0.006	0.014
N	Molybdenum (Mo)	mg/l	ALM 32	0.010	0.013	0.011	0.010	0.011	0.010	0.021
N	Antimony (Sb)	mg/l	ALM 36	0.012	0.014	0.010	<0.001	0.004	<0.001	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

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Client:	Groundwater Monitoring Services	**Date of certificate:**	25 March 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	19 March 2013
Report no:	12577	**Date completed:**	25 March 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				125471	125472	125473
Date sampled:				19-Mar-13	19-Mar-13	19-Mar-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	Aluminium (Al)	mg/l	ALM 31	0.122	<0.003	0.073
A	Iron (Fe)	mg/l	ALM 31	0.619	1.05	0.439
A	Manganese (Mn)	mg/l	ALM 31	0.858	0.272	0.500
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.008	0.008	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.009	0.010
N	Antimony (Sb)	mg/l	ALM 36	0.002	0.004	0.018

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HHausen
Laboratory Manager: H. Holtzhausen

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Client:	Groundwater Monitoring Services	**Date of certificate:**	25 March 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	19 March 2013
Report no:	12576	**Date completed:**	25 March 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				125440	125441	125442	125443	125445	125446	125447
Date sampled:				19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.44	8.23	7.67	7.71	7.10	7.15	7.92
A	Electrical conductivity (EC)	mS/m	ALM 20	197	152	79.8	20.2	6.71	9.90	37.5
A	Total dissolved solids (TDS)	mg/l	ALM 26	1143	809	515	91	18	31	178
A	Total alkalinity	mg/l	ALM 01	294	192	129	58.8	7.64	13.7	116
A	Chloride (Cl)	mg/l	ALM 02	167	263	10.1	5.51	3.53	7.61	13.5
A	Sulphate (SO_4)	mg/l	ALM 03	404	131	278	18.8	2.85	2.75	31.9
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.793	0.655	1.75	0.262	0.260	0.249	0.253
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.434	0.198	0.045	0.082	0.025	0.024	0.059
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	1.14	1.56	0.013	0.009	0.008	0.009	0.012
A	Fluoride (F)	mg/l	ALM 08	7.37	2.81	0.500	0.396	0.214	0.243	0.472
A	Calcium (Ca)	mg/l	ALM 30	14.2	10.3	78.5	6.99	1.24	2.17	24.3
A	Magnesium (Mg)	mg/l	ALM 30	7.62	7.11	32.8	13.0	0.894	1.70	15.3
A	Sodium (Na)	mg/l	ALM 30	351	264	31.2	5.17	3.41	6.41	17.4
A	Potassium (K)	mg/l	ALM 30	14.2	13.7	4.43	5.82	1.25	1.71	5.11
A	Aluminium (Al)	mg/l	ALM 31	5.27	1.90	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	2.95	3.02	<0.003	0.074	0.108	0.133	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.011	0.030	<0.001	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.087	0.046	0.005	0.006	<0.003	<0.003	0.006
N	Molybdenum (Mo)	mg/l	ALM 32	0.022	0.011	0.012	0.005	0.006	0.004	0.008
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.20	96.36	95.72	98.98	97.15	99.78	99.20

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12576
Project: GMS-Elders Underground

Date of certificate: 25 March 2013
Date accepted: 19 March 2013
Date completed: 25 March 2013
Revision: 0

	Lab no:			125444	125448	125449	125450	125451	125452	125453
	Date sampled:			19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13	19-Mar-13
	Sample type:			Water	Water	Water	Water	Water	Water	Water
	Locality description:			ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	7.94	8.42	7.70	7.86	7.77	7.97	7.76
A	Electrical conductivity (EC)	mS/m	ALM 20	43.1	63.4	64.4	25.7	57.0	27.8	30.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	205	322	325	124	296	139	151
A	Total alkalinity	mg/l	ALM 01	170	241	228	92.9	203	100	113
A	Chloride (Cl)	mg/l	ALM 02	9.25	15.6	26.3	6.48	5.80	9.54	11.2
A	Sulphate (SO_4)	mg/l	ALM 03	20.5	51.8	44.4	18.5	67.1	20.8	20.6
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.292	0.236	0.241	0.228	0.318	0.250	0.287
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.067	0.046	0.028	0.056	0.046	0.054	0.077
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.009	0.013	0.014	0.016	0.009	0.013	0.014
A	Fluoride (F)	mg/l	ALM 08	0.534	0.419	0.584	0.320	0.405	0.337	0.390
A	Calcium (Ca)	mg/l	ALM 30	36.4	36.8	40.3	16.9	53.1	19.2	20.5
A	Magnesium (Mg)	mg/l	ALM 30	16.8	33.7	29.5	10.6	24.7	11.9	12.8
A	Sodium (Na)	mg/l	ALM 30	15.1	35.6	38.8	10.4	21.4	12.3	13.6
A	Potassium (K)	mg/l	ALM 30	3.65	2.66	7.51	4.63	1.32	4.69	4.14
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.286	<0.001	0.415	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.004	<0.003	0.006	<0.003	0.006	0.007
N	Molybdenum (Mo)	mg/l	ALM 32	0.007	0.010	0.010	0.006	0.008	0.007	0.021
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	97.83	98.76	99.55	96.33	99.93	97.20	95.42

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HHausen

Laboratory Manager: H. Holtzhausen

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Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12576
Project: GMS-Elders Underground

Date of certificate: 25 March 2013
Date accepted: 19 March 2013
Date completed: 25 March 2013
Revision: 0

Lab no:				125454	125455	125456
Date sampled:				19-Mar-13	19-Mar-13	19-Mar-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	7.75	7.69	7.95
A	Electrical conductivity (EC)	mS/m	ALM 20	55.0	25.4	58.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	246	120	295
A	Total alkalinity	mg/l	ALM 01	136	50.5	107
A	Chloride (Cl)	mg/l	ALM 02	18.3	13.4	18.5
A	Sulphate (SO_4)	mg/l	ALM 03	56.2	33.6	110
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.339	0.319	0.250
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.206	0.165	0.056
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.012	0.009	0.009
A	Fluoride (F)	mg/l	ALM 08	0.454	0.377	0.421
A	Calcium (Ca)	mg/l	ALM 30	32.3	13.5	35.7
A	Magnesium (Mg)	mg/l	ALM 30	23.1	8.55	21.9
A	Sodium (Na)	mg/l	ALM 30	28.3	12.6	36.2
A	Potassium (K)	mg/l	ALM 30	5.57	7.40	6.69
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.027	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.033	<0.001	0.090
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.006	0.007	0.007
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.007	0.008
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.15	99.94	96.83

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Results reported against the limit of detection.

HHausen
Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12223
Project: GMS-Elders Underground

Date of certificate: 06 March 2013
Date accepted: 27 February 2013
Date completed: 06 March 2013
Revision: 0

Lab no:				122711	122712	122713	122714	122715	122716	122717
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	1.13	5.04	<0.003	0.356	<0.003	0.005	0.181
A	Iron (Fe)	mg/l	ALM 31	0.030	3.38	2.34	2.78	0.199	1.50	1.06
A	Manganese (Mn)	mg/l	ALM 31	1.22	0.692	3.67	0.480	<0.001	0.151	0.291
A	Zinc (Zn)	mg/l	ALM 31	<0.002	0.060	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.200	0.069	<0.003	0.010	<0.003	<0.003	0.007
N	Molybdenum (Mo)	mg/l	ALM 32	0.083	0.014	0.013	0.014	0.008	0.011	0.012
N	Antimony (Sb)	mg/l	ALM 36	0.089	<0.001	0.059	0.024	0.075	0.087	0.064

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12223
Project: GMS-Elders Underground

Date of certificate: 06 March 2013
Date accepted: 27 February 2013
Date completed: 06 March 2013
Revision: 0

Lab no:				122718	122719	122720	122721	122722	122723	122724
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	0.127	0.113	0.177	0.133
A	Iron (Fe)	mg/l	ALM 31	0.571	<0.003	0.910	1.48	0.043	1.52	1.26
A	Manganese (Mn)	mg/l	ALM 31	1.02	0.150	1.68	0.664	2.21	0.578	0.467
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.005	<0.003	0.006	<0.003	0.009	0.008
N	Molybdenum (Mo)	mg/l	ALM 32	0.015	0.019	0.015	0.012	0.018	0.015	0.015
N	Antimony (Sb)	mg/l	ALM 36	0.080	0.059	0.067	0.062	0.081	0.048	0.049

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Results reported against the limit of detection.

HHausen
Laboratory Manager: H. Holtzhausen

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12223
Project: GMS-Elders Underground

Date of certificate: 06 March 2013
Date accepted: 27 February 2013
Date completed: 06 March 2013
Revision: 0

				122725	122726	122727
Lab no:				122725	122726	122727
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	Aluminium (Al)	mg/l	ALM 31	0.298	<0.003	0.211
A	Iron (Fe)	mg/l	ALM 31	1.10	2.07	1.10
A	Manganese (Mn)	mg/l	ALM 31	0.906	0.481	0.680
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.008	0.010	0.007
N	Molybdenum (Mo)	mg/l	ALM 32	0.014	0.011	0.012
N	Antimony (Sb)	mg/l	ALM 36	0.047	0.080	0.051

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12222
Project: GMS-Elders Underground

Date of certificate: 06 March 2013
Date accepted: 27 February 2013
Date completed: 06 March 2013
Revision: 0

Lab no:				122694	122695	122696	122697	122698	122699	122700
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.51	8.25	7.39	8.23	7.39	7.03	8.07
A	Electrical conductivity (EC)	mS/m	ALM 20	394	185	50.7	29.1	6.71	9.16	29.9
A	Total dissolved solids (TDS)	mg/l	ALM 26	2415	1102	301	139	20	32	158
A	Total alkalinity	mg/l	ALM 01	586	198	103	112	4.20	17.1	108
A	Chloride (Cl)	mg/l	ALM 02	494	385	15.1	10.8	5.14	6.29	13.5
A	Sulphate (SO_4)	mg/l	ALM 03	664	196	129	8.70	4.37	3.37	20.1
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.291	0.759	0.262	0.299	0.300	0.252	0.706
A	Ammonium (NH_4) as N	mg/l	ALM 05	1.76	0.287	0.098	0.087	0.014	0.014	0.072
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	1.53	1.79	0.014	0.013	<0.008	0.011	0.019
A	Fluoride (F)	mg/l	ALM 08	14.9	3.63	0.505	0.550	0.290	0.264	0.472
A	Calcium (Ca)	mg/l	ALM 30	20.0	13.7	46.7	12.9	1.25	2.03	23.5
A	Magnesium (Mg)	mg/l	ALM 30	12.5	8.34	21.0	23.0	0.904	1.66	14.3
A	Sodium (Na)	mg/l	ALM 30	838	361	23.4	8.14	3.91	7.52	15.2
A	Potassium (K)	mg/l	ALM 30	19.3	14.6	2.61	6.55	1.16	0.769	5.11
A	Aluminium (Al)	mg/l	ALM 31	0.158	0.570	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.315	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	2.40	<0.001	<0.001	0.019	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.167	0.068	<0.003	0.010	<0.003	<0.003	0.005
N	Molybdenum (Mo)	mg/l	ALM 32	0.082	0.030	0.012	0.011	0.007	0.008	0.010
N	Antimony (Sb)	mg/l	ALM 36	0.070	<0.001	0.046	0.001	0.046	0.042	0.036
N	Balancing	%	ALM 26	98.35	95.19	99.86	95.15	97.24	96.96	98.05

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HHausen

Laboratory Manager: H. Holtzhausen

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 12222
Project: GMS-Elders Underground

Date of certificate: 06 March 2013
Date accepted: 27 February 2013
Date completed: 06 March 2013
Revision: 0

Lab no:				122701	122702	122703	122704	122705	122706	122707
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.08	8.51	7.60	7.75	7.86	7.87	7.61
A	Electrical conductivity (EC)	mS/m	ALM 20	38.7	66.0	64.1	27.1	67.0	28.3	31.3
A	Total dissolved solids (TDS)	mg/l	ALM 26	198	357	317	126	350	131	150
A	Total alkalinity	mg/l	ALM 01	145	275	223	99.5	231	101	114
A	Chloride (Cl)	mg/l	ALM 02	10.2	18.8	30.1	8.67	11.8	10.1	11.8
A	Sulphate (SO_4)	mg/l	ALM 03	25.6	40.1	32.0	8.20	71.4	9.13	12.0
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.425	0.285	0.329	0.311	0.524	0.262	0.262
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.074	0.075	0.035	0.055	0.108	0.053	0.137
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.010	0.017	0.012	0.019	<0.008	0.014	0.021
A	Fluoride (F)	mg/l	ALM 08	0.496	0.495	0.587	0.355	0.395	0.379	0.410
A	Calcium (Ca)	mg/l	ALM 30	38.3	45.2	42.6	20.2	66.5	20.9	23.6
A	Magnesium (Mg)	mg/l	ALM 30	17.0	40.3	30.3	12.1	31.2	12.5	14.3
A	Sodium (Na)	mg/l	ALM 30	14.3	43.3	39.3	11.4	27.3	12.3	14.5
A	Potassium (K)	mg/l	ALM 30	4.20	3.31	7.62	4.78	1.81	4.60	4.76
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.469	<0.001	1.12	<0.001	0.106	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.003	<0.003	0.005	<0.003	0.004	0.006
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.013	0.011	0.009	0.012	0.008	0.011
N	Antimony (Sb)	mg/l	ALM 36	0.038	0.008	0.037	0.038	0.035	0.028	0.033
N	Balancing	%	ALM 26	96.45	95.55	95.78	96.60	95.32	96.07	96.52

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	06 March 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	27 February 2013
Report no:	12222	**Date completed:**	06 March 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				122708	122709	122710
Date sampled:				27-Feb-13	27-Feb-13	27-Feb-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	7.64	7.39	7.57
A	Electrical conductivity (EC)	mS/m	ALM 20	49.9	26.1	36.4
A	Total dissolved solids (TDS)	mg/l	ALM 26	248	139	180
A	Total alkalinity	mg/l	ALM 01	115	30.5	87.8
A	Chloride (Cl)	mg/l	ALM 02	23.4	15.1	20.0
A	Sulphate (SO_4)	mg/l	ALM 03	65.4	60.5	45.4
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.416	0.306	0.345
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.248	0.098	0.225
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.010	0.010	0.014
A	Fluoride (F)	mg/l	ALM 08	0.485	0.356	0.459
A	Calcium (Ca)	mg/l	ALM 30	33.7	14.6	22.9
A	Magnesium (Mg)	mg/l	ALM 30	20.7	8.83	13.9
A	Sodium (Na)	mg/l	ALM 30	28.5	12.3	17.6
A	Potassium (K)	mg/l	ALM 30	6.44	8.91	6.61
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	1.06	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.306	<0.001	0.290
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.006	0.009	0.005
N	Molybdenum (Mo)	mg/l	ALM 32	0.012	0.009	0.008
N	Antimony (Sb)	mg/l	ALM 36	0.037	0.022	0.026
N	Balancing	%	ALM 26	95.26	98.84	99.03

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13938
Project: GMS-Elders Underground

Date of certificate: 27 June 2013
Date accepted: 24 June 2013
Date completed: 27 June 2013
Revision: 0

Lab no:				136446	136447	136448	136449	136450	136451	136452
Date sampled:				21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-8	ESW-9	ESW-10	ESW-11
	Analyses	Unit	Method							
A	Aluminium (Al)	mg/l	ALM 31	2.61	6.47	0.028	<0.003	0.027	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	4.25	1.65	0.071	0.251	0.330	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.126	0.229	<0.001	0.008	1.17	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	0.104	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.213	0.069	<0.003	<0.003	0.005	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.609	0.032	0.011	0.011	0.016	0.014	0.014
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	0.005	<0.001	0.016	0.012

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HHausen

Laboratory Manager: H. Holtzhausen

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13938
Project: GMS-Elders Underground

Date of certificate: 27 June 2013
Date accepted: 24 June 2013
Date completed: 27 June 2013
Revision: 0

Lab no:				136453	136454	136455	136456	136457	136458	136459
Date sampled:				21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17	ESW-18
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	<0.003	0.036	0.051	<0.003	0.009	<0.003	0.006
A	Iron (Fe)	mg/l	ALM 31	0.992	0.543	0.170	0.448	0.396	<0.003	2.03
A	Manganese (Mn)	mg/l	ALM 31	0.351	0.250	0.271	0.321	0.035	0.181	0.338
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	0.012	0.005
N	Molybdenum (Mo)	mg/l	ALM 32	0.014	0.013	0.011	0.012	0.011	0.018	0.017
N	Antimony (Sb)	mg/l	ALM 36	0.018	<0.001	0.011	<0.001	<0.001	0.016	0.021

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Client:	Groundwater Monitoring Services	**Date of certificate:**	27 June 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	24 June 2013
Report no:	13938	**Date completed:**	27 June 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				136460
Date sampled:				21-Jun-13
Sample type:				Water
Locality description:				ESW-19
	Analyses	**Unit**	**Method**	
A	Aluminium (Al)	mg/l	ALM 31	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001
N	Boron (B)	mg/l	ALM 32	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.014
N	Antimony (Sb)	mg/l	ALM 36	0.011

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13937
Project: GMS-Elders Underground

Date of certificate: 27 June 2013
Date accepted: 24 June 2013
Date completed: 27 June 2013
Revision: 0

Lab no:				136431	136432	136433	136434	136435	136436	136437
Date sampled:				21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-8	ESW-9	ESW-10	ESW-11
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	9.14	8.69	7.16	7.67	8.22	8.06	8.57
A	Electrical conductivity (EC)	mS/m	ALM 20	1479	209	28.2	9.41	39.9	44.6	75.3
A	Total dissolved solids (TDS)	mg/l	ALM 26	11427	1389	157	34	209	243	449
A	Total alkalinity	mg/l	ALM 01	1793	292	22.2	15.3	100	192	274
A	Chloride (Cl)	mg/l	ALM 02	2034	417	23.0	2.83	16.8	7.52	36.0
A	Sulphate (SO_4)	mg/l	ALM 03	4400	309	67.1	8.65	57.6	31.0	90.6
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017	0.218	0.713	<0.017	<0.017	0.056	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.360	0.114	0.125	0.037	0.095	0.082	0.050
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	1.35	2.07	0.016	0.011	0.011	0.010	0.009
A	Fluoride (F)	mg/l	ALM 08	22.3	4.46	0.148	0.172	0.313	0.429	0.289
A	Calcium (Ca)	mg/l	ALM 30	35.6	14.5	16.1	1.46	27.0	48.3	42.0
A	Magnesium (Mg)	mg/l	ALM 30	86.5	13.1	10.6	1.31	17.3	17.0	49.5
A	Sodium (Na)	mg/l	ALM 30	3721	438	22.0	9.36	22.8	20.3	61.0
A	Potassium (K)	mg/l	ALM 30	52.4	18.3	3.44	1.50	6.59	3.14	4.77
A	Aluminium (Al)	mg/l	ALM 31	0.052	6.34	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	3.29	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	0.041	<0.001	<0.001	1.02	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.161	0.064	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.504	0.016	0.011	0.007	0.011	0.013	0.014
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	96.08	95.14	96.55	95.64	96.75	99.03	96.84

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Results reported against the limit of detection.

HHausen

Laboratory Manager: **H. Holtzhausen**

aquatico
Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13937
Project: GMS-Elders Underground

Date of certificate: 27 June 2013
Date accepted: 24 June 2013
Date completed: 27 June 2013
Revision: 0

Lab no:				136438	136439	136440	136441	136442	136443	136444
Date sampled:				21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13	21-Jun-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17	ESW-18
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.17	8.10	8.12	8.56	8.41	8.58	8.19
A	Electrical conductivity (EC)	mS/m	ALM 20	58.1	30.9	19.9	51.6	41.3	113	31.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	341	192	103	275	209	855	136
A	Total alkalinity	mg/l	ALM 01	231	100	71.3	170	115	180	59.7
A	Chloride (Cl)	mg/l	ALM 02	28.6	14.5	1.25	22.0	16.5	21.7	23.0
A	Sulphate (SO_4)	mg/l	ALM 03	58.4	52.1	20.6	55.4	51.6	490	30.2
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017	0.164	0.271	0.072	<0.017	<0.017	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.090	0.093	0.068	0.063	0.068	0.107	0.047
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.009	0.010	0.009	0.009	0.010	0.009	0.008
A	Fluoride (F)	mg/l	ALM 08	0.395	0.263	0.229	0.274	0.307	0.313	0.353
A	Calcium (Ca)	mg/l	ALM 30	42.5	24.8	19.5	35.4	26.5	97.6	11.9
A	Magnesium (Mg)	mg/l	ALM 30	29.7	15.4	9.02	23.6	17.2	60.1	8.16
A	Sodium (Na)	mg/l	ALM 30	37.1	18.3	6.64	30.1	22.0	69.7	19.1
A	Potassium (K)	mg/l	ALM 30	6.08	6.32	2.17	6.34	6.51	8.12	6.93
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.087	<0.001	0.142	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	0.006	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.012	0.009	0.009	0.008	0.010	0.011	0.016
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	97.53	99.37	96.41	99.85	99.81	95.07	95.49

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HHausen
Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13937
Project: GMS-Elders Underground

Date of certificate: 27 June 2013
Date accepted: 24 June 2013
Date completed: 27 June 2013
Revision: 0

Lab no:				136445
Date sampled:				21-Jun-13
Sample type:				Water
Locality description:				ESW-19
	Analyses	**Unit**	**Method**	
A	pH	pH	ALM 20	8.53
A	Electrical conductivity (EC)	mS/m	ALM 20	81.9
A	Total dissolved solids (TDS)	mg/l	ALM 26	543
A	Total alkalinity	mg/l	ALM 01	150
A	Chloride (Cl)	mg/l	ALM 02	31.1
A	Sulphate (SO_4)	mg/l	ALM 03	260
A	Nitrate (NO_3) as N	mg/l	ALM 06	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.059
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.008
A	Fluoride (F)	mg/l	ALM 08	0.430
A	Calcium (Ca)	mg/l	ALM 30	51.7
A	Magnesium (Mg)	mg/l	ALM 30	35.5
A	Sodium (Na)	mg/l	ALM 30	58.5
A	Potassium (K)	mg/l	ALM 30	15.3
A	Aluminium (Al)	mg/l	ALM 31	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001
N	Boron (B)	mg/l	ALM 32	0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.011
N	Antimony (Sb)	mg/l	ALM 36	<0.001
N	Balancing	%	ALM 26	95.06

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HHausen

Laboratory Manager: H. Holtzhausen

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Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13584
Project: GMS-Elders Underground

Date of certificate: 27 May 2013
Date accepted: 22 May 2013
Date completed: 27 May 2013
Revision: 0

				133193	133194	133195	133196	133197	133198	133199
Lab no:				133193	133194	133195	133196	133197	133198	133199
Date sampled:				22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	4.13	6.57	<0.003	0.040	<0.003	<0.003	0.014
A	Iron (Fe)	mg/l	ALM 31	2.18	4.35	0.721	0.529	<0.003	0.325	0.278
A	Manganese (Mn)	mg/l	ALM 31	0.600	0.636	0.484	0.322	<0.001	<0.001	0.045
A	Zinc (Zn)	mg/l	ALM 31	0.017	1.12	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	0.191	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.130	0.098	<0.003	0.019	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.091	0.023	0.007	0.009	0.007	0.006	0.011
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	0.020	0.013	0.022	0.013	0.018

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HHausen
Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13584
Project: GMS-Elders Underground

Date of certificate: 27 May 2013
Date accepted: 22 May 2013
Date completed: 27 May 2013
Revision: 0

Lab no:				133200	133201	133202	133203	133204	133205	133206
Date sampled:				22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	0.158	<0.003	1.17	0.044
A	Iron (Fe)	mg/l	ALM 31	0.075	<0.003	0.611	0.762	<0.003	1.62	0.499
A	Manganese (Mn)	mg/l	ALM 31	0.107	<0.001	0.199	0.133	0.517	0.594	0.103
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	1.80	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	0.007	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.012	0.009	0.008	0.013	0.011	0.010
N	Antimony (Sb)	mg/l	ALM 36	0.025	0.015	0.015	<0.001	0.020	<0.001	0.003

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HHausen

Laboratory Manager: H. Holtzhausen

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Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13584
Project: GMS-Elders Underground

Date of certificate: 27 May 2013
Date accepted: 22 May 2013
Date completed: 27 May 2013
Revision: 0

	Analyses	Unit	Method			
Lab no:				133207	133208	133209
Date sampled:				22-May-13	22-May-13	22-May-13
Sample type:				Water	Water	Water
Locality description:				ESW-17	ESW-18	ESW-19
A	Aluminium (Al)	mg/l	ALM 31	0.022	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.141	1.40	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.337	0.540	0.127
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.006	<0.003	0.004
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.006	0.008
N	Antimony (Sb)	mg/l	ALM 36	0.010	0.004	0.024

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13583
Project: GMS-Elders Underground

Date of certificate: 27 May 2013
Date accepted: 22 May 2013
Date completed: 27 May 2013
Revision: 0

Lab no:				133176	133177	133178	133179	133180	133181	133182
Date sampled:				22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-1	ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	9.08	8.80	7.34	8.83	7.83	7.67	8.00
A	Electrical conductivity (EC)	mS/m	ALM 20	394	183	30.8	29.4	7.02	8.44	35.4
A	Total dissolved solids (TDS)	mg/l	ALM 26	2335	1193	182	184	25	34	216
A	Total alkalinity	mg/l	ALM 01	493	226	35.5	90.4	13.8	14.2	117
A	Chloride (Cl)	mg/l	ALM 02	499	350	26.1	14.3	1.05	7.41	18.1
A	Sulphate (SO_4)	mg/l	ALM 03	692	292	79.0	55.8	6.14	5.18	56.6
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.054	0.461	0.268	0.257	0.038	0.018	0.142
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.045	0.076	0.112	0.070	0.071	0.069	0.099
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	1.16	2.32	0.018	0.014	0.013	0.013	0.013
A	Fluoride (F)	mg/l	ALM 08	13.7	3.68	0.169	0.430	0.120	0.124	0.343
A	Calcium (Ca)	mg/l	ALM 30	21.5	14.6	19.6	14.3	1.29	1.35	26.3
A	Magnesium (Mg)	mg/l	ALM 30	15.1	15.9	10.7	21.5	1.11	1.19	16.6
A	Sodium (Na)	mg/l	ALM 30	778	346	20.7	15.3	4.69	8.13	21.0
A	Potassium (K)	mg/l	ALM 30	20.4	34.3	3.90	8.24	1.85	1.79	6.59
A	Aluminium (Al)	mg/l	ALM 31	0.548	6.37	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	0.261	4.22	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.440	0.232	<0.001	<0.001	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	0.046	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.104	0.074	<0.003	0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.063	0.014	0.007	0.006	0.004	0.003	0.009
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	96.83	95.05	95.93	99.19	96.19	96.55	96.15

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Results reported against the limit of detection.

HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 13583
Project: GMS-Elders Underground

Date of certificate: 27 May 2013
Date accepted: 22 May 2013
Date completed: 27 May 2013
Revision: 0

Lab no:				133183	133184	133185	133186	133187	133188	133189
Date sampled:				22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13	22-May-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-10	ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.34	8.68	8.24	8.11	8.41	8.19	8.12
A	Electrical conductivity (EC)	mS/m	ALM 20	42.8	64.4	51.9	28.1	79.3	29.9	31.7
A	Total dissolved solids (TDS)	mg/l	ALM 26	265	417	338	175	563	177	195
A	Total alkalinity	mg/l	ALM 01	204	262	209	89.3	295	82.4	104
A	Chloride (Cl)	mg/l	ALM 02	13.6	32.9	31.1	13.9	28.5	16.9	18.2
A	Sulphate (SO_4)	mg/l	ALM 03	37.7	88.5	70.9	50.5	173	50.1	49.7
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.347	0.030	0.060	0.079	0.153	0.051	0.045
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.668	0.075	0.079	0.098	0.058	0.160	0.148
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.014	0.013	0.014	0.017	0.015	<0.008	<0.008
A	Fluoride (F)	mg/l	ALM 08	0.525	0.235	0.306	0.267	0.353	2.11	0.333
A	Calcium (Ca)	mg/l	ALM 30	43.5	42.7	41.5	20.8	90.0	21.7	24.2
A	Magnesium (Mg)	mg/l	ALM 30	19.9	42.5	28.1	12.9	41.8	13.8	15.2
A	Sodium (Na)	mg/l	ALM 30	21.1	48.4	33.4	16.0	48.4	16.8	18.6
A	Potassium (K)	mg/l	ALM 30	5.26	4.63	7.35	6.89	3.59	6.24	6.35
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	<0.001	<0.001	<0.001	0.291	<0.001	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.008	0.011	0.008	0.005	0.008	0.006	0.007
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	96.22	98.89	95.84	95.73	99.10	97.49	97.19

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Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Test Report

Client:	Groundwater Monitoring Services	**Date of certificate:**	27 May 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	22 May 2013
Report no:	13583	**Date completed:**	27 May 2013
Project:	GMS-Elders Underground	**Revision:**	0

	Lab no:			133190	133191	133192
	Date sampled:			22-May-13	22-May-13	22-May-13
	Sample type:			Water	Water	Water
	Locality description:			ESW-17	ESW-18	ESW-19
	Analyses	**Unit**	**Method**			
A	pH	pH	ALM 20	8.28	8.17	8.28
A	Electrical conductivity (EC)	mS/m	ALM 20	71.0	25.8	59.8
A	Total dissolved solids (TDS)	mg/l	ALM 26	512	147	408
A	Total alkalinity	mg/l	ALM 01	166	64.1	142
A	Chloride (Cl)	mg/l	ALM 02	27.2	24.5	27.2
A	Sulphate (SO_4)	mg/l	ALM 03	235	33.4	172
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.069	0.108	<0.017
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.177	0.133	0.172
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	<0.008	<0.008	<0.008
A	Fluoride (F)	mg/l	ALM 08	0.325	0.301	0.405
A	Calcium (Ca)	mg/l	ALM 30	57.8	12.5	46.0
A	Magnesium (Mg)	mg/l	ALM 30	36.1	8.97	29.5
A	Sodium (Na)	mg/l	ALM 30	49.5	19.1	39.9
A	Potassium (K)	mg/l	ALM 30	7.02	9.26	7.11
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.028	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.200	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.005	<0.003	0.004
N	Molybdenum (Mo)	mg/l	ALM 32	0.009	0.005	0.008
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.41	95.26	96.04

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HHausen

Laboratory Manager: H. Holtzhausen

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 14279
Project: GMS-Elders Underground

Date of certificate: 31 July 2013
Date accepted: 23 July 2013
Date completed: 31 July 2013
Revision: 0

Lab no:				139625	139626	139627	139628	139629	139630	139631
Date sampled:				23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-2	ESW-3	ESW-6	ESW-7	ESW-8	ESW-9	ESW-10
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	9.73	0.839	0.079	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	5.32	8.65	1.60	0.003	3.16	0.123	0.568
A	Manganese (Mn)	mg/l	ALM 31	0.309	1.47	0.772	<0.001	0.074	<0.001	1.83
A	Zinc (Zn)	mg/l	ALM 31	<0.002	1.20	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	0.019	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.274	0.008	0.004	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.439	0.026	0.018	0.018	0.012	0.018	0.015
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

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ilac-MRA sanas Testing Laboratory T0374

Test Report

Client:	Groundwater Monitoring Services	**Date of certificate:**	31 July 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	23 July 2013
Report no:	14279	**Date completed:**	31 July 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				139632	139633	139634	139635	139636	139637	139638
Date sampled:				23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17
	Analyses	**Unit**	**Method**							
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	0.079	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	0.873	0.839	0.544	0.449	<0.003	0.015
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.278	1.52	1.44	1.03	<0.001	0.223
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.021	0.017	0.018	0.018	0.018	0.015	0.014
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 14279
Project: GMS-Elders Underground

Date of certificate: 31 July 2013
Date accepted: 23 July 2013
Date completed: 31 July 2013
Revision: 0

Lab no:				139639	139640
Date sampled:				23-Jul-13	23-Jul-13
Sample type:				Water	Water
Locality description:				ESW-18	ESW-19
	Analyses	**Unit**	**Method**		
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	2.16	0.150
A	Manganese (Mn)	mg/l	ALM 31	0.490	0.096
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.014	0.018
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 14278
Project: GMS-Elders Underground

Date of certificate: 31 July 2013
Date accepted: 23 July 2013
Date completed: 31 July 2013
Revision: 0

Lab no:				139609	139610	139611	139612	139613	139614	139615
Date sampled:				23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-2	ESW-3	ESW-6	ESW-7	ESW-9	ESW-8	ESW-10
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.81	6.50	8.25	7.50	8.21	7.37	7.94
A	Electrical conductivity (EC)	mS/m	ALM 20	256	28.5	46.3	5.97	44.9	9.37	44.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	1460	166	255	19	253	34	255
A	Total alkalinity	mg/l	ALM 01	295	40.4	161	8.71	127	14.6	207
A	Chloride (Cl)	mg/l	ALM 02	440	28.1	26.7	<0.423	20.7	4.50	10.3
A	Sulphate (SO_4)	mg/l	ALM 03	328	60.6	51.9	6.26	68.8	7.02	27.8
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.352	0.250	0.224	0.170	0.208	0.276	0.248
A	Ammonium (NH_4) as N	mg/l	ALM 05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	1.92	0.074	0.011	0.010	0.011	0.011	0.010
A	Fluoride (F)	mg/l	ALM 08	3.80	0.170	0.464	0.071	0.280	0.099	0.276
A	Calcium (Ca)	mg/l	ALM 30	16.5	18.3	17.0	1.16	34.8	1.85	56.1
A	Magnesium (Mg)	mg/l	ALM 30	12.5	11.0	33.1	0.875	19.5	1.25	16.2
A	Sodium (Na)	mg/l	ALM 30	447	20.6	20.1	3.84	25.9	9.37	17.8
A	Potassium (K)	mg/l	ALM 30	34.8	2.96	8.59	1.46	6.39	1.36	2.69
A	Aluminium (Al)	mg/l	ALM 31	9.73	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	5.32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.085	0.474	<0.001	<0.001	<0.001	1.57
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	0.274	0.008	0.004	<0.003	<0.003	<0.003	<0.003
N	Molybdenum (Mo)	mg/l	ALM 32	0.439	0.026	0.015	0.009	0.012	0.008	0.012
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.98	98.10	95.86	98.05	99.45	96.29	99.99

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0374

Client:	Groundwater Monitoring Services	**Date of certificate:**	31 July 2013
Address:	53 Bevan Road, Woodmead, Rivonia, 2128	**Date accepted:**	23 July 2013
Report no:	14278	**Date completed:**	31 July 2013
Project:	GMS-Elders Underground	**Revision:**	0

Lab no:				139616	139617	139618	139619	139620	139621	139622
Date sampled:				23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13	23-Jul-13
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				ESW-11	ESW-12	ESW-13	ESW-14	ESW-15	ESW-16	ESW-17
	Analyses	**Unit**	**Method**							
A	pH	pH	ALM 20	8.65	8.12	8.03	8.25	8.41	8.27	8.20
A	Electrical conductivity (EC)	mS/m	ALM 20	80.3	60.1	51.4	78.6	63.2	51.3	117
A	Total dissolved solids (TDS)	mg/l	ALM 26	454	354	297	487	378	302	972
A	Total alkalinity	mg/l	ALM 01	294	246	207	294	258	182	188
A	Chloride (Cl)	mg/l	ALM 02	34.7	31.3	26.0	25.7	32.9	25.8	20.4
A	Sulphate (SO_4)	mg/l	ALM 03	79.0	53.1	43.1	108	58.4	60.0	566
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.258	0.280	0.800	0.263	0.376	0.299	0.272
A	Ammonium (NH_4) as N	mg/l	ALM 05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.031	0.011	0.011	0.016	0.012	0.011	0.011
A	Fluoride (F)	mg/l	ALM 08	0.179	0.326	0.287	0.296	0.323	0.342	0.291
A	Calcium (Ca)	mg/l	ALM 30	47.5	49.1	48.6	91.2	51.8	41.9	126
A	Magnesium (Mg)	mg/l	ALM 30	51.4	31.1	26.1	37.9	32.8	24.7	69.4
A	Sodium (Na)	mg/l	ALM 30	60.1	36.4	23.6	44.1	40.8	32.7	68.5
A	Potassium (K)	mg/l	ALM 30	4.17	5.32	4.58	2.94	5.27	6.45	8.03
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	<0.001	0.177	1.35	1.03	0.800	<0.001	0.058
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.017	0.014	0.013	0.018	0.014	0.013	0.014
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N	Balancing	%	ALM 26	95.64	98.52	99.31	95.75	99.09	99.55	96.93

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HHausen

Laboratory Manager: H. Holtzhausen

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Groundwater Monitoring Services
Address: 53 Bevan Road, Woodmead, Rivonia, 2128
Report no: 14278
Project: GMS-Elders Underground

Date of certificate: 31 July 2013
Date accepted: 23 July 2013
Date completed: 31 July 2013
Revision: 0

Lab no:				139623	139624
Date sampled:				23-Jul-13	23-Jul-13
Sample type:				Water	Water
Locality description:				ESW-18	ESW-19
	Analyses	**Unit**	**Method**		
A	pH	pH	ALM 20	8.90	8.40
A	Electrical conductivity (EC)	mS/m	ALM 20	30.9	77.6
A	Total dissolved solids (TDS)	mg/l	ALM 26	176	546
A	Total alkalinity	mg/l	ALM 01	84.4	164
A	Chloride (Cl)	mg/l	ALM 02	29.7	27.8
A	Sulphate (SO_4)	mg/l	ALM 03	33.5	251
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.269	0.276
A	Ammonium (NH_4) as N	mg/l	ALM 05	<0.005	<0.005
A	Ortophosphate (PO_4) as P	mg/l	ALM 04	0.015	0.065
A	Fluoride (F)	mg/l	ALM 08	0.288	0.419
A	Calcium (Ca)	mg/l	ALM 30	16.5	61.6
A	Magnesium (Mg)	mg/l	ALM 30	10.7	38.4
A	Sodium (Na)	mg/l	ALM 30	25.3	60.4
A	Potassium (K)	mg/l	ALM 30	8.78	7.16
A	Aluminium (Al)	mg/l	ALM 31	<0.003	<0.003
A	Iron (Fe)	mg/l	ALM 31	<0.003	<0.003
A	Manganese (Mn)	mg/l	ALM 31	0.083	<0.001
A	Zinc (Zn)	mg/l	ALM 31	<0.002	<0.002
A	Lead (Pb)	mg/l	ALM 31	<0.004	<0.004
N	Mercury (Hg)	mg/l	ALM 35	<0.001	<0.001
N	Boron (B)	mg/l	ALM 32	<0.003	0.009
N	Molybdenum (Mo)	mg/l	ALM 32	0.012	0.016
N	Antimony (Sb)	mg/l	ALM 36	<0.001	<0.001
N	Balancing	%	ALM 26	96.32	98.36

A = Accredited N= Not accredited O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine
Results marked 'Not SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory.
This test report shall not be reproduced except in full, without written approval of the laboratory.
Measurement of uncertainty available on request for all methods included in the SANAS Schedule of Accreditation.
Results reported against the limit of detection.

HHausen
Laboratory Manager: H. Holtzhausen

Appendix G10: Socio-Economic Specialist Study

Elders Social Baseline and Impact Assessment Report

Report Prepared for

Anglo American Inyosi Coal

Report Number 484436/SIA

Report Prepared by

srk consulting

September 2015

Elders Socio-Economic Baseline and Impact Assessment Report

Anglo American Inyosi Coal

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SRK Project Number 484436

September 2015

Compiled by:

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Authors: Andrew Hart, Adel Malebana

Peer Reviewed by:

Anita Bron
Principal social scientist

Executive Summary

This report presents the social baseline and impact assessment for the proposed Elders Coal Mine also known as the Elders Colliery, owned by Anglo Operations (Pty) Ltd (AOL). It draws on and updates the socio-economic impact assessment studies that were conducted since 2007, including the socio-economic baseline study undertaken as part of the Socio-Economic Assessment Toolbox (SEAT) 3 process and the Social Impact Assessment (SIA) of 2013.

In January 2013, the environmental authorisation process for the proposed Elders Colliery commenced, which included a Draft Scoping Report (May 2013), a Final Scoping Report (August 2013) and the associated stakeholder engagement (application reference number: 17/2/3 GS-154). Subsequent to the approval of the Final Scoping Report in 2013 the project description was reassessed. Consequently, the project was placed on hold and the AOL project team undertook a detailed investigation to assess the feasibility of the project. As a result the application lapsed.

A new application process is now undertaken under the 2014 National Environmental Management Act (NEMA) regulations. The current mine plans incorporate the following (explained in more detail in section 1.4 of this report):

- Underground mining;
- Mining of No. 2 and 4 Seam by means of board and pillar mining methods using Continuous Miners;
- Box cut and associated surface infrastructure;
- New overland conveyor belt (10 km) to Block 20; and,
- Upgrading existing conveyor belt (8 km) from Block 20 to Goedehoop Colliery.

SRK Consulting, an independent consultant, has been appointed by AOL to complete an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed project. As part of the EIA a socio-economic baseline and impact assessment study has to be undertaken to establish and develop a baseline from which to predict, assess and monitor social impacts associated with the proposed project. The purpose of the socio-economic baseline is to assist in developing an understanding of the communities potentially affected by the proposed project. This information will assist with identifying socio-economic impacts, and designing appropriate mitigation measures required to manage potential negative project impacts and enhance opportunities. The objectives of the study are therefore:

- Identification of the project's zone of influence and the directly and indirectly communities within these zones of influence;
- Profiling the affected communities in terms of demographic, employment, education, health, welfare, and living standards and the description of local systems of governance, jurisdiction and administration;
- Identification of existing major social infrastructure in the affected communities that may have relevance to the proposed mining development and its possible impacts (i.e. schools, hospitals, clinics, religious facilities, water sources, power supply, transport systems, etc.);
- Developing an understanding of the local economy of the nearby towns in the project area. An important component of this exercise will be the identification of possible procurement opportunities and links with the project;
- Establishing the current extent of natural resource utilisation in the vicinity of the project, including the type of resources and when and where they are used;

- Gain an in-depth understanding of the socio-economic issues raised by local communities and key informants regarding the project. Determine the main development challenges identified by local communities;
- Identification and assessment of potential direct, indirect and cumulative social, cultural and economic effects (both impacts and opportunities) of the project on communities, populations and vulnerable groups;
- Prioritisation of human rights risks and alignment with the United Nations (UN) Guiding Principles on Business and Human Rights, to ensure that harm to people is prevented through ongoing stakeholder engagement based on communication, assessments of risks, integrating and acting on identified risks, as well as tracking progress; and,
- Development of sustainable and contextually appropriate measures to manage impacts and to realise development opportunities.

It has been established that approximately 1 000 employment opportunities will be created during the construction phase of the Elders Colliery project. The construction phase for the boxcut and conveyor belt will be approximately 18 months. Employment figures for the operational phase are expected to ramp up from 378 in 2018 to 564 in 2022. It is expected that most of these opportunities will be sourced from Goedehoop Colliery when it reaches its closure.

Elders Colliery falls under the Govan Mbeki Local Municipality (GMLM) within Gert Sibande District Municipality (GSDM) in Mpumalanga Province. This socio-economic study has been broken into distinct Zones of Influence (ZoI), referred to as the Primary, Secondary and Tertiary ZoI. There are several towns and communities within the ZoI which will all be impacted on in various ways by the Elders project.

The Primary ZoI includes the following communities and stakeholders as a result of their proximity to the Project infrastructure.

- The Vlakkuilen Community is approximately between 2.0 and 4.4 km from the proposed box cut and 4.0 km from the main shaft complex[1]. This community is comprised of 24 households, and was previously required to relocate and make way for the Elders opencast mine. Engagement with this community regarding relocation started in 2007 until 2013 when the cut-off date was determined. However, current mine plans indicate that this community does not require to be relocated.
- The Middelkraal Community is located 4.3 km from the Elders mining complex. This community, comprising of 18 households, was relocated by Umcebo Mine in 2007, and is now adjacent to the Elders Colliery on the farm Middelkraal.

Bethal, Emzinoni and the Goedehoop Town/ Mahlathini informal settlement were identified as falling within the Secondary ZoI. Bethal and Emzinoni fall within the GMLM, while Goedehoopn Town and Mahlathini fall within the Steve Tshwete Local Municipality. It is anticipated that these communities may face changes due to their location on the R35, a main corridor between the Elders colliery and these settlements. Lastly, the Tertiary ZoI includes Kriel and Thubelihle, both located in the Emalahleni Local Municipality (ELM). They have been included due to their relative locations to the mine lease area and mining infrastructure and the potential changes the project may bring to these settlements. Although these settlements are much closer to the project site than Bethal and Emzinoni from a distance point of view, Bethal is closer from an access point of view, using the R35 as the main access road.

[1] There are two households considered a part of the Vlakkuilen Community that reside within 2 km of the proposed conveyor belt.

Primary data for the socio-economic baseline study was collected during five site visits, which took place in April 2011, July and September 2012, January 2013 and September 2015. Various data collection tools were used such as focus group meetings, key informant interviews and household surveys for the Vlakkuilen community.

The GMLM comprises six departments, all of which account to the Office of the Municipal Manager. These departments are: Corporate Services; Technical and Engineering Services; Finance; Public Safety; Environment and Tourism; and Health and Community Services.

Taking cognisance of the political, national, provincial, and district policies and plans, the following Key Performance Areas (KPAs) were identified by the GMLM:

- Governance and Stakeholder Participation;
- Physical Infrastructure and Energy Efficiency;
- Services and Customer Care;
- Economic Growth and Development;
- Safety and Environment;
- Social and Community Development;
- Institutional Transformation; and,
- Financial Sustainability.

The key findings of the social baseline study include the following:

The GMLM is characterised by high population growth rates, especially in migration from other provinces in South Africa and also areas outside the country. It has been noted from key stakeholder interviews that some of the migration is related to mining activities within the Municipality.

Delivery of services such as water, sanitation and refuse removal is poor. Minimal health facilities and poor access to such facilities remain a growing cause for concern for the area, as the population continues to grow due to mining related in-migration.

Unemployment in the area is very high, with the majority of households dependent on government grants, particularly pension, disability and child support grants. It has been noted during focus group meetings and key informant interviews that renting out of backrooms is another major source of income for the households. 47% of individuals in the Secondary ZoI, particularly Bethal and Emzinoni, do not earn any monthly income and this places these households in a vulnerable position and increases the responsibility on the few income earners. While the income levels are fairly similar, Bethal does have more income earners over R3 200.00 per month while the majority of income earners in Emzinoni earn under R1 600.00 per month.

Levels of education and skills in the area are very poor, and this can be attributed to high levels of poverty, unemployment, and the remoteness of some of the rural schools. Wazana Primary School, which used to provide primary education to the learners at Vlakkuilen has now been closed and as a result, learners travel by bus to The Friedman Primary School at Blinkwater farm, which is 25 km away. Learners at Middelkraal attend schools in Bethal and Hendrina, approximately 20 km away. The Department of Education (DoE) provides school transport for all learners at Vlakkuilen and Middelkraal.

Access to health services is available for households living in surrounding towns and townships. However, the communities within the Primary ZoI rely on a mobile clinic that visits the farms once a month. Usually these mobile clinics are not reliable, and sometimes do not have enough resources such as medicines. Under these circumstances, communities within the Primary ZoI have to travel to

Bethal and Emzinoni to access medical care at a cost of R20 per single trip. Monthly statistics at Emzinoni Clinic indicate high overcrowding in these facilities, and the shortage of resources to accommodate the need.

The following drivers of social change and impacts have been identified during the course of this study, and these are classified into pre-construction, construction, operation, and closure.

Table ES1 provides a summary of impacts identified during the course of this study, while cumulative impacts are provided in Table ES2. Cumulative impacts are those that may arise due to the effects of the proposed Elders Colliery combined with those of the existing social conditions, or the combined effects of other projects as well as Elders on the existing social conditions.

Table ES1: Summary of Impacts and Management Measures

Driver of social change	Impact	Project phase	Impact significance before management	Proposed management measures	Impact significance post management
Stakeholder Engagement	SE1: Improved relations with local communities and stakeholders	Preconstruction, Construction and Operations	Low +	• Detail life of mine stakeholder consultation in a Stakeholder Engagement Plan (SEP), this management plan should be made available to communities should they request it[2]; • Providing proactive feedback to the communities regarding project developments particularly around employment opportunities; • Include affected communities in the decision making processes of the project, particularly around potential Corporate Social Investment (CSI) opportunities, and Social and Labour (SLP) projects; • Ensure that all stakeholder engagement includes women, youth and vulnerable groups; • Provide regular and transparent feedback to the Vlakkuilen and Middelkraal communities specifically; • Discuss and manage issues, concerns, changes and impacts related to the project; • Monitor and implement the Grievance Management Mechanism; • Involve Local Ward Councillors and keep them informed about project developments, and included in all stakeholder engagement processes. Their involvement will assist with the successful development of relationships between the mine, the municipality and the communities; • Regularly consult with local government through the GMLM around issues of community development, employment, co-operation and project activities; • Where possible AOL should align their CSI initiatives and SLP projects with the GMLM Integrated Development Plan (IDP) with the goal of improving both sustainability and feasibility (this would only occur once the mine was operational); • All engagement and consultation should follow established protocols; and, • Durable participatory and consultative structures should be in place pre-closure to mitigate the impacts of closure.	Medium +

[2] A copy of the current SEP is included in the draft EIA that is available for public comment

Driver of social change	Impact	Project phase	Impact significance before management	Proposed management measures	Impact significance post management
	SE2: Unmet expectations of the Vlakkuilen community regarding relocation and changing mine plans	Pre-Construction	High -	• Continue the discussions with and planning for the livelihoods restoration for the Vlakkuilen community; • Ensure the community and Ward Councillor are informed about the project progress; and, • Monitor and implement the Grievance Management Mechanism.	Low -
Expectations for local opportunities	EO1: Unmet expectations from communities within the Primary ZoI to benefit from economic opportunities and improved living conditions	Construction and Operations	Medium -	• Compile and implement the management measures detailed in the SLP, as well as Impact SE1 and SE2; • Prioritise the employment of the communities residing within the Primary ZoI for semi-skilled and unskilled job opportunities during construction; • Enforce the contractor management plan, especially relating to local recruitment and procurement; • Plan for the up-skilling of the people (particularly the youth) within the Primary ZoI prior to construction, to prepare them for potential job opportunities at Elders and at other mines; and, • Assist, where possible, with building the capacity of local government to provide social services to the communities within the Primary ZoI.	Low -
	EO2: Increased pressure on social services and infrastructure, and an increase in social pathologies and social disruptions due to influx of people and construction workers, resulting in spontaneous settlements	Construction and Operations	Medium -	• Develop a clear and concise employment and recruitment policy that prioritizes local recruitment; • Identify and support community development programmes that address challenges raised by population influx and spontaneous settlement; • Enforce the Anglo American Contractor Management Plan, which should in addition address accommodation, living standard, transport and health and safety standards of contractors; • Enforce the Anglo American principles regarding employee and contractor behaviour; • Continuously monitor the housing and living conditions of employees receiving living out allowances; • Support local government capacity for integrated development planning; • Develop a strategy to address issues related to and potentially enhanced by project-induced influx. This strategy will be developed in order to clearly define how AOL, in conjunction with local government and relevant stakeholders, intend to manage the impacts caused by influx where possible;	Low -

Driver of social change	Impact	Project phase	Impact significance before management	Proposed management measures	Impact significance post management
				• Compile and implement the community health and safety initiatives of the Community Health and Safety Plan (CHSP), such as education and awareness programs that address social pathologies in neighbouring communities through established government departments; and, • Monitor employee and contractor compliance with company policy regarding alcohol and substance abuse.	
Employment and associated benefits	EB1: Employment and Income	Construction	Low +	• Develop a clear and concise employment policy prioritizing local employment; • Implement vocational training programs to promote local workforce capacity as per the Labor and Human Resources Plan (LHRP); • Employ local workers if qualified applicants with the appropriate skills are available. Formalize this policy in company Human Resources guidelines and contractors' agreements; • Purchase goods and services at a local level, if available. Formalize this policy in company purchasing guidelines and contractors' agreements; • Work closely with the local communities before and during the project to identify and communicate required skills and resources that the local community could provide; • Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programs; • Prepare a detailed vocational training program in consultation with the local community to be implemented during the construction phase; and, • Through the stakeholder engagement process ensure that expectations are managed around employment opportunities and practices.	Medium +
	EB1: Employment and Income	Operations	Medium +	• Develop a clear and concise employment policy prioritizing local employment; • Implement vocational training programs to promote local workforce capacity as per the Labor and Human Resources Plan (LHRP). • Employ local workers if qualified applicants with the appropriate skills are available. Formalize this policy in company HR guidelines and contractors' agreements; • Purchase goods and services at a local level, if available. Formalize	Medium +

Driver of social change	Impact	Project phase	Impact significance before management	Proposed management measures	Impact significance post management
				this policy in company purchasing guidelines and contractors' agreements; • Work closely with the local communities before and during the project to identify and communicate required skills and resources that the local community could provide; • Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programs; • Prepare a detailed vocational training program in consultation with the local community to be implemented during the operations phase; and, • Through the stakeholder engagement process ensure that expectations are managed around employment opportunities and practices.	
	EB2: Dissatisfaction over Employment Opportunities and Conditions of Procurement	Construction and operations	Medium -	• Develop a clear and concise employment policy prioritizing local employment; • Employ staff from across community groups and the Project area and keep recruitment and employment records, distributing short-term opportunities to as many as possible; and, • Develop a SLP that considers integrated development of communities impacted by the Project.	Low -
	EB3: Improved employment and enterprise development opportunities through skills development and capacity building initiatives	Construction	Low +	• In order to promote skills development and capacity building initiatives to both employees and the broader population and, in particular amongst youth, the SLP should focus on enterprise development and capacity building; • Furthermore, AOL's closure plan will aim to reinforce the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods; and, • Develop a clear and concise employment policy prioritizing local employment.	Medium +
		Operations	Medium +	• Implement and monitor the SLP; • Develop a clear and concise employment policy prioritizing local employment; and, • Develop a closure plan which will aim to reinforce the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods.	Medium +

Driver of social change	Impact	Project phase	Impact significance before management	Proposed management measures	Impact significance post management
		Closure and Post Closure	High -	• Develop and implement the LHRP that addresses the impacts associated with retrenchment, job losses and reduced demand for local goods and services; and, • Develop a closure plan which will aim to reinforce the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods.	Medium -
Social investment	CSR1: Improved infrastructure in the study area due to social investment activities	Construction, Operation, Closure and Post Closure	Low +	• Implement management and enhancement measures as per the SLP.	Medium +
Mine revenue	MR1: Increased direct revenue to local government		Low +	• AOL should participate and report according to the Extractive Industries Transparency Initiative (EITI) principles and guidelines.	Low +

Key

(green)	Low
(amber)	Medium
(red)	High

Table ES2: Summary of Cumulative Impacts

Cumulative Impacts	Rating
Some of the positive cumulative impacts identified for the Elders Colliery are: • Secure jobs, incomes and social security; • Increased disposable income among employees and local multipliers; • Local business opportunities arising from procurement of goods and services; • Use of external suppliers due to depressed local economy, leading to export of funds and skills development; • Increase in business confidence and attraction of investors; and, • Increased involvement of and cooperation with local government.	+🡡
Some of the negative cumulative impacts identified for the Elders Colliery are: • Social division over limited jobs and perceived preferential access; • Demand for housing, with impacts on markets (construction, resale, and rental); • Increased demand for privately and publicly provided social services; • Social division over limited jobs and perceived preferential access; and, • Increased risk of communicable diseases with influx of workers and opportunity seekers.	-🡣

Key

-🡣	A downward, negative arrow, indicates that the current situation will deteriorate due to either to cumulative impacts or the no action scenario
+🡡	An upward, positive arrow, indicates that the trend/impact will continue to improve (i.e. a positive overall impact of a cumulative nature)

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Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by Anglo Operations (Pty) Ltd (AOL). SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

Acronyms and Abbreviations

AOL	Anglo Operations Limited
CBO	Community Based Organisations
CDP	Community Development Plan
CHSP	Community Health and Safety Plan
CSI	Corporate Social Investment
CSR	Corporate Social Responsibility
DoE	Department of Education
EIA	Environmental Impact Assessment
EITI	Extractive Industries Transparency Initiative
ELM	Emalahleni Local Municipality
EMP	Environmental Management Plan
GDP	Gross Domestic Product
GMLM	Govan Mbeki Local Municipality
GPS	Global Positioning System
GSDM	Gert Sibande District Municipality
HIV/AIDS	Acquired immune deficiency syndrome or acquired immunodeficiency syndrome
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IFC	International Finance Corporation
KPA	Key Performance Area
Km	Kilometer
LED	Local Economic Development Plan
LHRP	Labour and Human Resources Plan
MPRDA	Mineral and Petroleum Resources Development Act No. 28 of 2002
NDM	Nkangala District Municipality
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
NSDP	National Spatial Development Perspective
PGDS	Provincial Growth and Development Strategy
PS	Performance Standard
RDP	Reconstruction and Development Programme
SADC	Southern Africa Development Community
SDF	Spatial Development Framework
S&EIA	Social and Environmental Impact Assessment

SEAT	Socio-Economic Assessment Toolbox
SEP	Stakeholder Engagement Plan
SERO	Socio-economic Review and Outlook
SIA	Social Impact Assessment
SLP	Social and Labour Plan
SRK	SRK Consulting (Pty) Ltd
Stats SA	Statistics South Africa
TB	Tuberculosis
UN	United Nations
UNGP	United Nations Guiding Principles
VCT	Voluntary Counseling and Testing
VIP	Ventilation Improved Pit latrine
WB	World Bank
WBG	World Bank Group

1 Introduction

1.1 Background

This report presents the social baseline and impact assessment for the proposed Elders Coal Mine also known as the Elders Colliery, owned by Anglo Operations (Pty) Ltd (AOL). It draws on and updates the socio-economic impact assessment studies that were conducted since 2007, including the socio-economic baseline study undertaken as part of the Socio-Economic Assessment Toolbox (SEAT) 3 process and the Social Impact Assessment (SIA) of 2013.

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A new application process is now undertaken under the 2014 National Environmental Management Act (NEMA) regulations. The current mine plans incorporate the following (explained in more detail in section 1.4 of this report):

- Underground mining;
- Mining of No. 2 and 4 Seam by means of board and pillar mining methods using Continuous Miners;
- Box cut and associated surface infrastructure;
- New overland conveyor belt (10 km) to Block 20; and,
- Upgrading existing conveyor belt (8 km) from Block 20 to Goedehoop Colliery.

SRK Consulting, an independent consultant, has been appointed by AOL to complete an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed project. As part of the EIA, a socio-economic baseline and impact assessment study have to be undertaken to establish and develop a baseline from which to predict, assess and monitor social impacts associated with the proposed project.

This report presents the findings of the socio-economic baseline and impact assessment, compiled using secondary data collected during a desktop study, and primary research data gathered during focus group meetings and key informant interviews held in 2012 and September 2015.

1.2 Geographical Context

The closest towns to the proposed development are Bethal/Emzinoni, in the Govan Mbeki Local Municipality (GMLM) and Kriel/Thubelihle in the Emalahleni Local Municipality (ELM) (Table 1-1). Other nearby towns within a 50 km radius of the mine includes Trichardt, Secunda, Embalenhle, Kinross and Evander. Access to the Elders Colliery project area is from the R35 provincial road between Middelburg and Bethal (Figure 1-1).

Table 1-1: Elders Colliery in relation to adjacent towns

Town	Approximate distance and direction in terms of the project area (line of sight)
Kriel/ Thubelihle	12 km west
Bethal/Emzinoni	20 km south
Hendrina	30 km north west
Middelburg	47 km north
Emalahleni	55 km north north west

Source: SRK Consulting, Elders specialists terms of reference, 2015

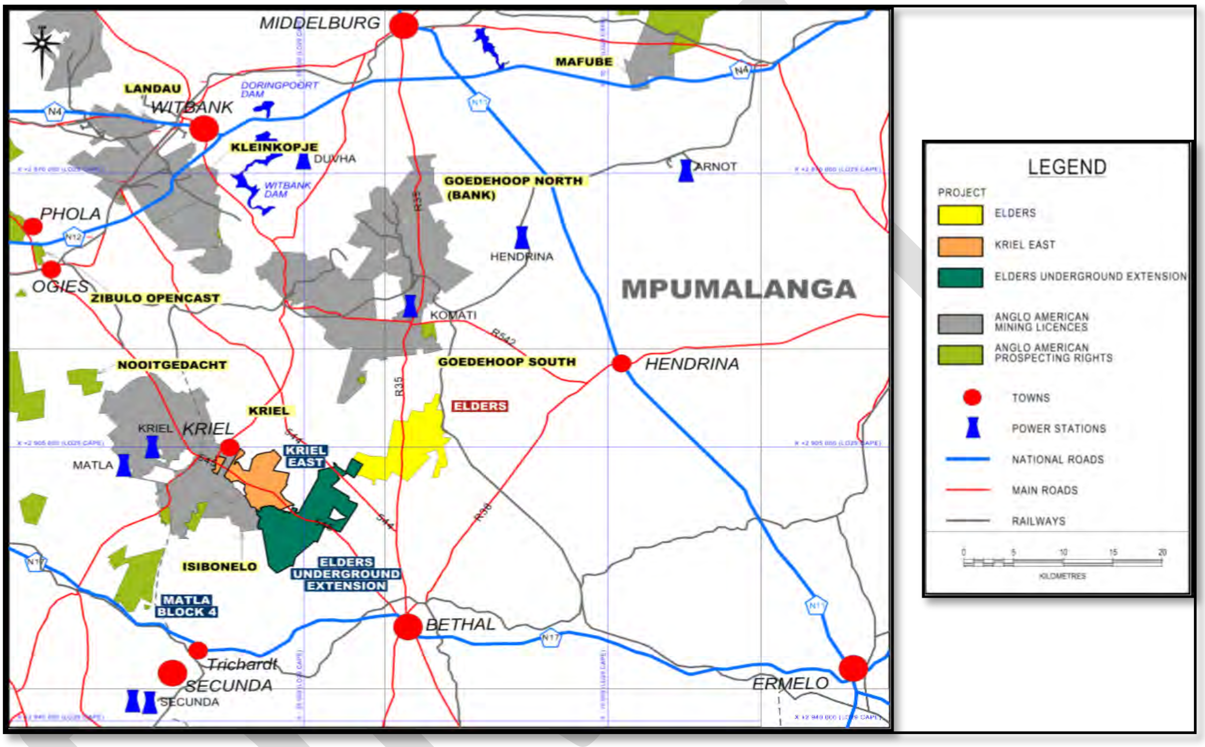

Figure 1-1: Regional locality map of Elders Colliery

Source: SRK Consulting, Elders specialists terms of reference, 2015

1.3 Scope and Purpose of the Report

The purpose of the socio-economic baseline is to assist in developing an understanding of the communities potentially affected by the proposed project. This information will assist with identifying socio-economic impacts, and designing appropriate mitigation measures required to manage potential negative Project impacts and enhance opportunities. The objectives of the study are therefore:

- Identification of the project's zone of influence and the directly and indirectly affected communities within these zones of influence;
- Profiling the affected communities in terms of demographics, employment, education, health, welfare, and living standards;
- Providing a description of local systems of governance, jurisdiction and administration;

- Identification of existing major social infrastructure in the affected communities that may have relevance to the proposed mining development and its possible impacts (i.e. schools, hospitals, clinics, religious facilities, water sources, power supply, transport systems, etc.);
- Developing an understanding of the local economy of the nearby towns in the project area. An important component of this exercise will be the identification of possible procurement opportunities and links with the project;
- Establishing the current extent of natural resource utilisation in the vicinity of the Project, including the type of resources and when and where they are used;
- Gain an in-depth understanding of the socio-economic issues raised by local communities and key informants regarding the project. Determine the main development challenges identified by local communities;
- Identification and assessment of potential direct, indirect and cumulative social, cultural and economic effects (both impacts and opportunities) of the project on communities, populations and vulnerable groups;
- Prioritisation of human rights risks and alignment with the United Nations (UN) Guiding Principles on Business and Human Rights, to ensure that harm to people is prevented through ongoing stakeholder engagement based on communication, assessments of risks, integrating and acting on identified risks, as well as tracking progress; and,
- Development of sustainable and contextually appropriate measures to manage impacts and to realise development opportunities.

1.4 Project Information

1.4.1 Project Infrastructure and Activities

For this project, AOL is planning to extend coal reserves located in the GMLM which falls under the Gert Sibande District Municipality (GSDM) in the Mpumalanga Province. The proposed Elders Colliery, situated approximately 18 km from the existing Goedehoop Colliery is comprised of an underground mine. Box and pillar mining will be used, meaning that existing underground coal will be used as pillars to support the underground roof, which will later be removed.

A small box cut operation and associated infrastructure in the vicinity of the proposed shaft will be the access to the mine. A box cut is a small opening to the underground mine, until it reaches a place where it is safe to develop a slope to the mine. A shaft, or entrance hole, will be close by to remove stale air from underground. Coal will be transported via a new overland conveyor belt to Block 20 at Goedehoop, where an existing overland conveyor belt to Goedehoop Mine will be upgraded to transport the coal (Figure 1-2).

Infrastructure associated with the underground mine shaft complex

- Roads
    - Access roads: access from the R35 will be via a new intersection incorporating the existing Sudor Mine road;
    - Internal roads: will be used within the shaft complex; and
    - Service roads: will include roads from the shaft area to the substation, water treatment plant and water storage tanks. As these will be gravel roads, measures to reduce dust will be implemented, such as sprinkling water.

- Powerlines: to supply power during construction and initial mining stages. During the operation of the mine, power might be supplied by a new Eskom powerline.
- Pipelines: to transport potable, dirty and sewage water to various water supply and containment or treatment plants.
- Topsoil stockpile: this is the top layer of soil that will be stripped from the shaft complex area, and it will be used to construct a berm diverting water around the complex.
- Overburden stockpile: this is the material that lies above a coal seam or ore body, and can be contaminated or uncontaminated. The uncontaminated (clean) overburden will be stockpiled and later used to backfill the mine shaft at mine closure, whereas the contaminated overburden will be transported to a registered waste disposal facility at the Goedehoop Mine Complex.
- Solid waste: general waste such as domestic waste, paper and scrap steel will be temporarily stored in skips within the complex and later disposed of at a licenced municipal facility. Hazardous waste will however be temporarily stored in specialised containers and will be disposed of at a licenced hazardous waste facility.
- Water management facilities:
  - Pollution Control Dams: Two Pollution Control Dams will be constructed to contain polluted water generated in the shaft area;
  - Sewerage Treatment Plant: This will be developed to treat sewage for the employees at the underground mine. Sewer water reticulation piping shall be used to collect waste from the waste water generating points to the treatment plants, where effluent will be treated quality suitable for release into the environment; and,
  - Water Treatment Plant: water for industrial and potable use will be obtained from Block 8 and pumped into the pollution control dam.

Infrastructure associated with the conveyor route servitude

- Conveyor belt: a conveyor belt will be constructed within the conveyor route servitude to transport coal from Elders Colliery to Goedehoop Block 20. A conveyor belt is a continuous moving belt made of fabric, rubber, or metal used for transporting objects from one place to another;
- Access roads: Access from the R35 to the silo and conveyor service route will be via a new intersection that incorporates the existing Sudor Mine road;
- Service roads: these are gravel roads that will run adjacent to the conveyor belt for its entire route. Measures to reduce dust on these roads will be implemented such as sprinkling of water;
- Powerlines: two overhead powerlines will be constructed within the conveyor route servitude from Block 20 to Elders Colliery; and,
- Pipelines: raw water will be transported from Block 8 to the Elders Colliery Pollution Control Dams using pipelines that will be constructed along the conveyor route.

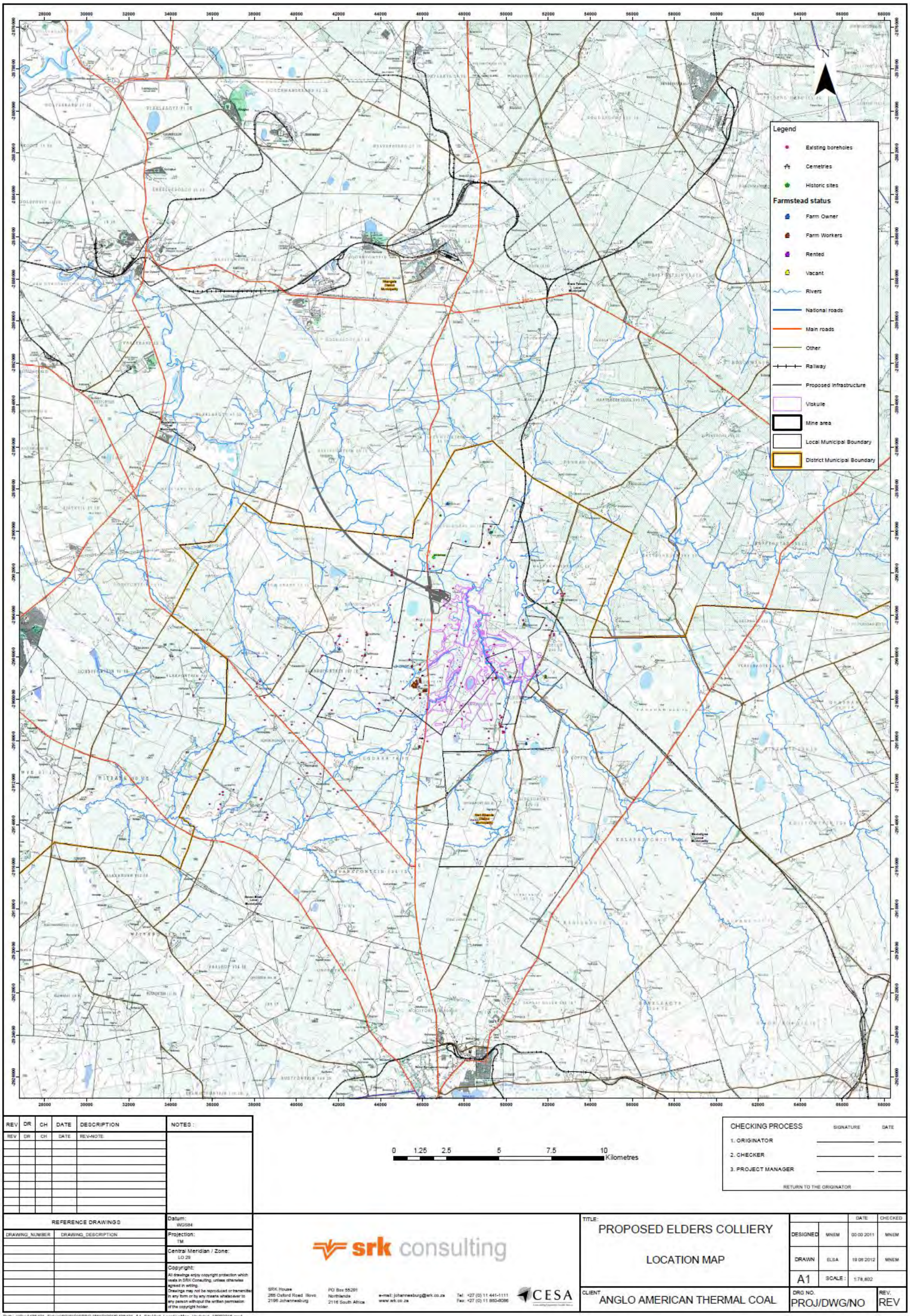

Figure 1-2: Elders Colliery site layout

1.4.2 Project Employment Features

It has been established that approximately 1 000 employment opportunities will be created during the construction phase of the Elders Colliery project. The construction phase for the boxcut and conveyor belt will be approximately 18 months. It is assumed that the construction phase will be developed by a specialist contractor. Contractors will be required to comply with Anglo American Contractor social management plans, which will include local employment and procurement as one of the key performance indicators.

Information relating to employment figures for the Elders Colliery during the operational phase is as per Table 1-2 below:

Table 1-2: Elders Colliery employment figures during operations

Category	2018	2019	2020	2021	2022
Professionally qualified and experienced specialist and middle management	130	136	142	142	142
Skilled technicians and academically qualified workers, junior management, supervisors	114	132	142	142	142
Semi-skilled and discretionary decision making	134	203	280	280	280
Total	**378**	**471**	**564**	**564**	**564**

Source: Elders Social and Labour Plan, 2015

At the time of writing this report, the percentage between new employees and those who will be transferred from Goedehoop Colliery was not known as yet. AOL has committed to sourcing some of these opportunities locally as far as practically possible, taking into consideration that potential employees will have to pass psychometric tests to measure their suitability for the job, based on their personality characteristics and aptitude as part of the adjudication process. Minimum requirements for employment based on the AOL recruitment policy are Grade 12 /or a Grade 10 with an existing operating license to operate vehicles and machinery in a mine. Where contractors will be used, the general labour will probably come from local communities, and skilled labour will be sourced locally where possible (within the 50 km radius).

1.4.3 Employee Housing and Living Conditions

While there was no information available about employee housing for the Elders Project, the Elders Social and Labour Plan (SLP 2015) mentions that *"Elders Colliery will abide by the Anglo American strategy and vision of home ownership which strives at moving away from housing provision entirely and ensuring that employees are accommodated in their own formal accommodation located within the metropolitan frameworks of the regions where new and existing operations are based".*

Table 1-3 below reflects the housing allowances provided by AAC to its employees in a quest to encourage homeownership. SRK's experience in conducting SIAs has however shown that due to the lack of skills and education locally, most of the employment opportunities are accessed by people who do not live and do not have an established housing unit close to the mines. As a result, most of these employees would probably rent rooms in the surrounding townships. Discussions with key informants and site visits to Bethal and Emzinoni confirmed that renting out of backrooms is a popular form of household income[3].

[3] SRK Consulting, September 2015

Table 1-3: Anglo American South Africa housing allowances

Employee grade	2014 RATES
Mid management and professionally qualified	R 8 786
Skilled and technical	R 7 531
Junior Management and semi-skilled	R 6 175
Senior-skilled	R 6 175
Skilled	R 6 175

Source: Elders Social and Labour Plan, 2015

1.4.4 Land Use and Land Ownership

Economic displacement refers to the loss of productive assets (including land and crops), usage rights or livelihood capacities as a result of acquisition and transformation of land for Project purposes. The Project will not require a large amount of land due to being an underground mine. Land will be required for the construction of the mini-pit, berms and the shaft complex and associated infrastructure such as the conveyor belt. Currently all the land required for the construction of the mine is owned by AOL and leased to a commercial farmer, Mr Engelbrecht and the lease agreement is in the process of being renegotiated and finalised[4].

The land currently carries approximately 1 400 cattle, and grain is cultivated on sections of it. Approximately 30 ha of cultivated land will be lost as a result of the project. An additional 10-20 ha might be lost, depending on the impact of dust on the crops. A bruto loss in the range of R500 000 is expected as a result of the 30 ha loss of land. The loss of 30-50 ha worth of income can be absorbed by the lessee, and will not impact on employees' jobs, provided that this impacted area does not increase. The lease agreement allows both parties the opportunity to exit the agreement, should the conditions in the agreement not be met in a satisfactory manner.

The main concerns from the lessee's point of view are the potential impact of the mine activities on water quality and quantity (ground water and surface water). A reduction in water quantity will negatively impact on the grazing land available and/or the quality of grazing, and the quality of water provided to cattle cannot be compromised. The assumption is that Anglo will be monitoring water quality and quantity closely as per the recommendations in the relevant specialist studies, and will take the responsibility for implementing the mitigation measures required should water quantity and quality be compromised as a result of the mine activities, including blasting.

[4] Telephonic discussion between Mr Engelbrecht and Ms Bron from SRK Consulting on 7 October 2015

2 Methodology

2.1 Zones of Influence

The socio-economic baselines study has been broken into distinct categories consistent with the Primary and Secondary Zone of Influence (ZoI) as per the SEAT 3 document. The ZoI is the area within which a project has impacts or influence, these impacts can be either direct physical impacts or induced or interactive impacts. Typically the social ZoI is unique to each project and is larger than the actual project footprint (i.e. the mine lease area, or land used for mining and infrastructure).

For the Elders project the social ZoI has been delineated as follows:

- **The Primary Zone of Influence** - In terms of the proposed Elders Colliery, the primary ZoI includes the 'footprints' of areas immediately adjacent to the primary and service infrastructure of the mine. This includes the Vlakkuilen and Middelkraal Communities, which are within the primary ZoI.
- **The Secondary Zone of Influence** - This ZoI includes Bethal and Emzinoni which are both located in the GMLM. It is anticipated that Bethal and Emzinoni will both experience impacts from the proposed development. Furthermore, due to the location of the mining operation future activities and interaction will be focused upon the GMLM. The Mahlathini informal settlement, located 10 km from the proposed infrastructure, also falls within this ZoI.
- **The Tertiary Zone of Influence** - This ZoI includes Kriel and Thubelihle, both located in the ELM. It is also anticipated that both Kriel and Thubelihle might experience changes and impacts due to their proximity to the proposed mine.

All of the ZoI have been developed with the assistance of SEAT 3 Tool 2A. However due to the nature of the project, they have been structured to reflect both the socio-economic environment of the project and the potential impacts.

2.1.1 Towns and Communities within the Identified Zones of Influence

As discussed in Section 2.1, the socio-economic study has been broken into distinct zones of influence. Within these zones there are several towns and communities which will all be impacted on in various ways by the Elders project.

The Primary ZoI includes the following communities and stakeholders as a result of their proximity to the Project infrastructure (Table 2-1):

- The Vlakkuilen Community is approximately between 2.0 and 4.4 km from the proposed box cut and 4.0 km from the main shaft complex[5]; and,
- The Middelkraal Community is located 4.3 km from the Elders mining complex.

For the geographical location of this community refer to Figure 1-1.

[5] There are two households considered to be part of the Vlakkuilen community that reside within 2 km of the proposed conveyor belt

Table 2-1: Settlements identified in the Primary ZoI

No.	Settlement	Distance from Box Cut	Distance from Shaft Complex
1	Vlakkuilen	Between 2.0 and 4.4 km	4.5 km
2	Middelkraal	4.3 km	4.3 km

Bethal, Emzinoni and the Goedehoop Town/ Mahlathini informal settlement were identified as falling within the Secondary ZoI. All are within the GMLM. It is anticipated that these communities may face changes due to their location on the R35, a main corridor between the Elders colliery and these settlements (Table 2-2).

Table 2-2: Settlements identified in the Secondary ZoI

No.	Settlement	Distance from Box cut	Distance from Shaft Complex
1	Bethal	20 km	22 km
2	Emzinoni	24 km	26 km
3	Mahlathini Informal settlement[6]	16 km	14 km

The Tertiary ZoI includes Kriel and Thubelihle, both located in the ELM (Table 2-3). They have been included due to their relative locations to the mine lease area and mining infrastructure and the potential changes the project may bring to these settlements. Although these settlements are much closer to the project site than Bethal and Emzinoni from a distance point of view, Bethal is closer from an access point of view, using the R35 as the main access road.

Table 2-3: Settlements identified in the Tertiary ZoI

No.	Settlement	Distance from Box cut	Distance from Shaft Complex
1	Kriel	17.5 km	18 km
2	Thubelihle	16 km	16 km

[6] Mahlathini informal settlement falls within the conveyor belt's Primary ZoI, and is assessed as part of the Hope 4 SIA

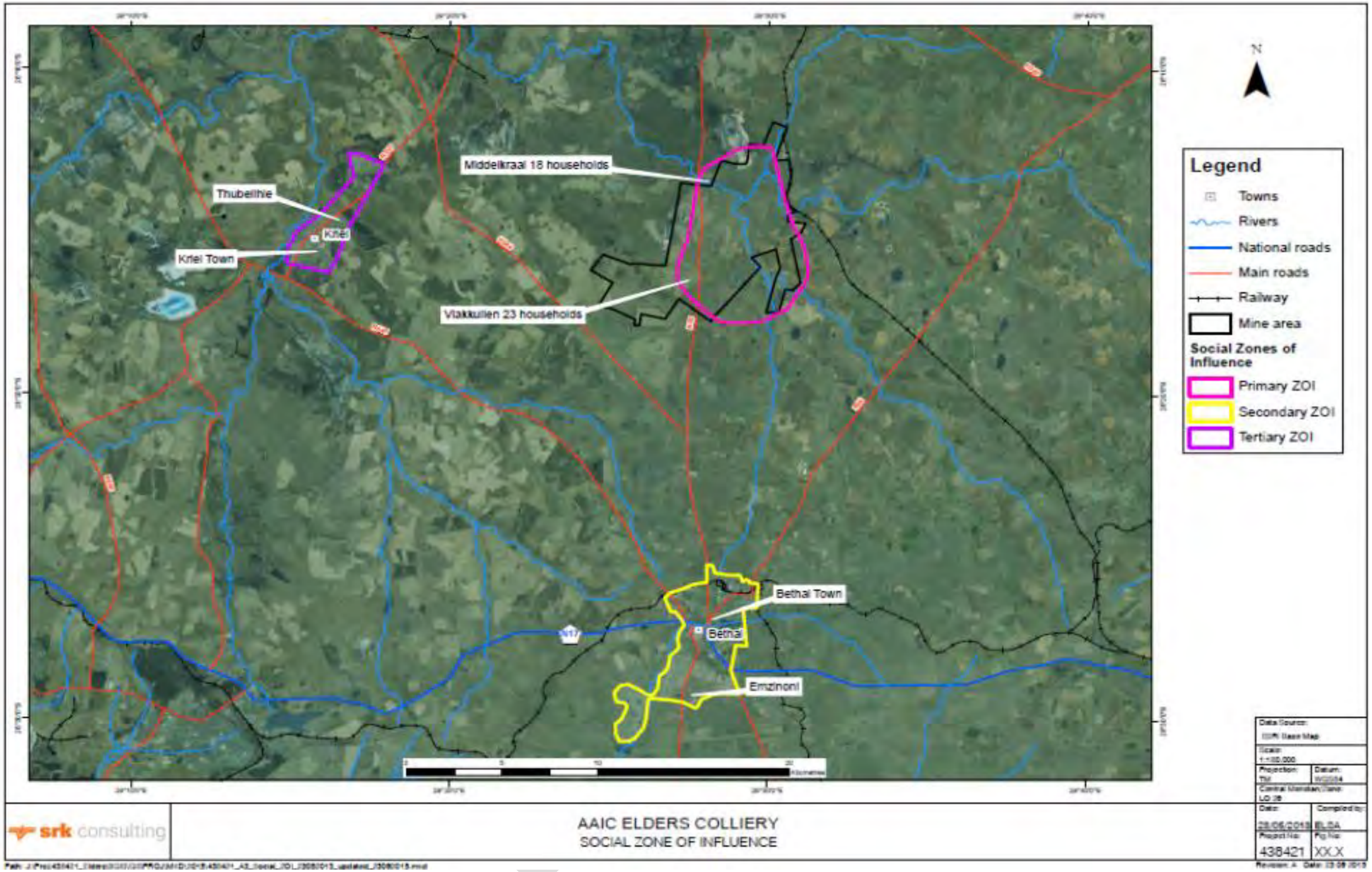

Figure 2-1: Elders Colliery Zone of Influence map

2.2 Primary Data Collection

Primary data for the socio-economic baseline study was collected during five site visits, which took place in April 2011, July and September 2012, January 2013 and September 2015. Various data collection tools were used. These tools are described below.

2.2.1 Focus Groups

Focus groups provide valuable insight and community information that is not generally available from secondary sources. In 2012, focus group interviews with women, men and youth were held in Vlakkuilen, Kriel and Thubelihle. Focus groups were not held in Bethal and Emzinoni as they would not provide a fair and representative view of these communities due to their size; furthermore, recent secondary data was available on these communities.

Participants for the focus groups were chosen/ selected randomly. The number of people present in the various focus groups is presented in Table 2-4.

Table 2-4: Focus group meetings in 2012

Town/Settlement	Women	Men	Youth
Vlakkuilen	15	8	-
Kriel[7]	10	8	12
Thubelihle	12	11	18
Sub total	**37**	**27**	**30**
Total	**94**		

Participants for the focus group discussions in 2015 were sourced from each of the wards represented in Bethal and Emzinoni area (Wards 15, 22, 26, 24, 27). While arrangements for the focus groups were made with the ward councillors a week before the focus group meetings, only two men, two women and one youth representative attended the focus group discussions respectively. These are therefore regarded as interviews, as opposed to focus groups.

A further focus group meeting was held with the Middelkraal community members on 16 September 2015. This focus group was made up of seven men above 35, four women above 35 and eight youth (3 males and 5 females). The interviews were conducted by SRK in the predominant language spoken in the area, i.e. Zulu.

2.2.2 Key Informant Interviews

Individual semi-structured interviews were conducted in 2012 and 2015 with several key stakeholders, including government officials, health workers, Community Based Organisations (CBOs) and teachers. These key informants were selected in order to provide insight into areas such as education, health, government, employment, etc. The list of informants for the interviews were is included in Table 2-5 below. The key stakeholder interviews were conducted by SRK in Zulu or English.

[7] Focus groups in Kriel and Thubelihle were held in April 2011 for the Kriel Colliery SIA. The information has been used in this report

Table 2-5: Key informant interviews conducted in 2012 and 2015

Community	Key Informant (2012)	Key informant (2015)
Vlakkuilen	Ward Councillor (Ward 15)	Ward Councillor (Ward 15)
	Wazana Primary School	None- Wazana Primary School is closed
	Resettlement Working Group	None
Bethal/ Emzinoni	Ward Councillor (Ward 27)	Ward Councillors (Wards 15, 22, 26, 24, 27)
	Bethal Hospital	Bethal Hospital
	Siyati Clinic	SEAD Clinic
	Mzinoni Secondary School	Bethal Education Circuit Office
	Ikhwezi Primary School	
		Bethal Police Station
		Bethal Department of Social Development
		Sesifikile Youth Development Centre
Thubelihle[8]	Ward Councillors (Ward 25)	None
	Thubelihle Clinic	
	Sbongamandla Secondary School	
Kriel	Sakhimfundo Trading and Project	
	Kriel High School	
	Local Ward councillors (Ward 26)	
	Phumelela Home Base Care	

2.2.3 Household Survey

In September 2012 a household survey was done with 23 households (100% sample) in the Vlakkuilen community. The census component of the household survey gathered information on demographics, services, health, education, income, employment and social structures. The household surveys in 2012 were focused on the development of the Resettlement Action Plan for this community, with the intention that the community would be required to relocate and make way for the project. However, with the changes in the mine plan and footprint for Elders, relocation of the Vlakkuilen Community is no longer required.

Household information for the Vlakkuilen community was updated from 15 to 19 September 2015. The purpose of the updates was to draw a comparison between the socio-economic information of the 23 households in Vlakkuilen between 2012 and 2015 to assist AOL to develop livelihoods restoration plans for the community to enable development where they are currently established.

A household survey was not conducted for the Middelkraal community, as per AOL's request, in order not to create expectations of relocation.

2.2.4 Stakeholder Engagement Meetings

At a local level, information from Interested and Affected Parties (I&APs) was collected (from the stakeholder engagement meetings held between June 2012 and July 2015). Key socio-economic issues identified during these meetings are tabulated in Table 2-6 below:

[8] Key informant interviews in Kriel and Thubelihle were held in April 2011 for the Kriel Colliery SIA. Information for this report has been drawn from this source

Table 2-6: Stakeholders' key concerns raised in 2013 and 2015

2013	2015
Alleged lack of communication by AOL regarding progress, feedback or changes to mine planning	Conflicts between farm owners and farmworkers residing on the farms regarding the grazing carrying capacity
No compensation for losses has been made to farmers, their families and workers	Potential increase of crime due to influx of people into the area and the development of informal settlements
Preferential employment and skills development opportunities for local communities	Absence of a proper platform to register complaints
Preferential small business opportunities for local communities, especially the youth	Potential subsidence due to underground mining activities
Potential for increased traffic along the R35 during construction	Lack of feedback regarding concerns raised in the past

Source: SRK Consulting Comments and Response Report, 2015

2.2.5 Data Analysis

Qualitative thematic analysis was used to analyse the focus group and key stakeholder data. GPS readings were used to produce maps.

2.3 Secondary Data

The proposed Elders Colliery has a history dating back to 2005. For this reason there have been numerous studies, including EIAs and an SIA completed by DPR Projects in 2005, and updated by SRK Consulting in 2012. These documents together with reports, papers and government documents including 2011 census data and current Integrated Development Plans (IDPs) have been drawn upon in the development of this SIA. The SEAT report completed for Kriel Colliery in 2011 has also been drawn upon where necessary. These sources were accessed through AOL, government web pages and Statistics South Africa (Stats SA). This data is referenced throughout the text and in the reference section of this report.

2.4 Assumptions and Limitations

It is assumed that:

- No substantial changes will take place in the study area between the data collection and the submission of the report;
- Interviewees responded truthfully to questions posed as part of the social baseline study;
- Interpretation and translation of interviews and discussions accurately reflect the meaning of the interviewees' responses; and,
- Information about all relevant stakeholders has been included in the study.

Limitations include:

- Key informant and focus group meetings were not held at Kriel and Thubelihle;
- Secondary data sources, including statistical data, are limited and sometimes outdated; and,
- The focus group discussions generated estimates and patterns rather than exact figures.

3 Legal and Regulatory Framework

This section provides an overview of South African regulations pertinent to this study, together with applicable international standards and guidelines.

3.1 South African Legislation

This section provides an overview of South African regulations pertinent to this study, together with applicable international standards and guidelines including the Performance Standards of the International Finance Corporation (IFC).

3.1.1 The Constitution

The Constitution of the Republic of South Africa, 1996, protects occupiers of land in two important areas:

- Section 25(6) states that a person or community whose tenure of land is legally insecure as a result of past racially discriminatory laws or practices, is entitled either to tenure which is legally secure or to comparable redress; and,
- Section 184 (1) of the Constitution, established the Human Rights Commission, which aims to:

  (a) promote respect for human rights and a culture of human rights;

  (b) promote the protection, development and attainment of human rights; and,

  (c) monitor and assess the observance of human rights in the Republic.

Chapter 7 of the Constitution of South Africa provides municipalities with the mandate and the right to govern, on its own initiative, the local government affairs of its community, subject to national and provincial legislation. The national or a provincial government may not compromise or impede a municipality's ability or right to exercise its powers or perform its functions. It further states the objects of local government as follows:

- To provide democratic and accountable government for local communities;
- To ensure the provision of services to communities in a sustainable manner;
- To promote social and economic development;
- To promote a safe and healthy environment; and,
- To encourage the involvement of communities and community organisations in the matters of local government.

3.1.2 National Environmental Management Act No. 52 of 2003

The function of the NEMA is to provide co-operative and environmental governance by establishing principles for decision-making on matters affecting the environment.

An EIA is a requirement of the Act, and is required to provide "...*a description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity"* (NEMA, Part 2, Section 23 (d)).

An assessment of the manner in which the proposed activity may affect the social, economic and cultural aspects of the environment will be informed by stakeholders through the consultation process. Specifically, for the SIA, discussions aimed to elicit the following information from I&APs as required by the Department of Mineral Resources as part of the application for environmental authorisation:

- How the proposed activities will impact on them or their socio-economic conditions;
- Provide written responses stating their suggestions to mitigate the anticipated impacts of each activity;
- Provide information on current land uses and their location within the area under consideration; and,
- Mitigate the potential impacts on their socio-economic conditions to make proposals as to how the potential impacts on their infrastructure can be managed avoided or remedied.

3.1.3 Social and Labour Plan

The SLP is a key component of the new order mining right in South Africa. The objectives of an SLP are:

- To promote economic growth and mineral and petroleum resources development;
- To promote employment and advance social and economic welfare;
- To contribute to the transformation of the mining industry by ensuring that holders of mining rights contribute towards the socio-economic development of the areas in which they operate, as well as the areas from which the majority of their workforce is sourced; and,
- To utilise and expand the existing skills base for the empowerment of Historically Disadvantaged South Africans and to serve the community.

These objectives indicate that a key outcome of an SLP should be socio-economic growth and development in the areas in which operations occur, as well as in labour sending areas.

3.1.4 Extension of Security of Tenure Act No. 62 of 1997

This Act provides the conditions under which persons may be evicted from using or occupying a piece of land: *"To provide for measures with State assistance to facilitate long-term security of land tenure; to regulate the conditions of residence on certain land; to regulate the conditions on and circumstances under which the right of persons to reside on land may be terminated; and to regulate the conditions and circumstances under which persons, whose right of residence has been terminated, may be evicted from land; and to provide for matters connected therewith".*

Although this law is not likely to be applicable, it is summarised in the event that it does become relevant to the project. An occupier's right of residence may be terminated on lawful grounds by a Land Claims Court or a magistrate's court (the "Court") within whose area of jurisdiction the land in question is situated. If the Court finds such termination is just and equitable the Court will make an order for the eviction based on the following criteria:

- The period that the occupier has resided on the land in question;
- The fairness of the terms of any agreement between the parties;
- Whether suitable alternative accommodation is available;
- The reason for the proposed eviction; and,
- The balance of interests of the owner, the occupier and the remaining occupiers of the land.

A Court shall determine a just and equitable date on which the occupier shall vacate the land and determine the date in which an eviction order may be carried out if the occupier has not vacated the land. When a Court makes an order for an eviction, the Court shall order the owner to:

- Pay compensation for the structures erected and improvements made by the occupier and any standing crops planted by the occupier;
- Pay any outstanding wages and outstanding amounts that are due in terms of the Basic Conditions of Employment Act No. 3 of 1983, the Labour Relations Act or the Wage Act No. 5 of 1957;
- Allow occupiers to demolish structures and improvements erected or made by the occupier and to remove materials salvaged; and,
- Enable occupiers to tend crops until they are ready for harvesting, and then to harvest and remove them.

No order for eviction may be executed without the authority of an order of a competent court. The Court shall not grant an order for eviction unless compensation has been paid. Compensation shall be contemplated by the court as being just and equitable.

3.1.5 Mine Health and Safety Act No. 29 of 1996

Regulation 17(7) a) of the Mine Health and Safety Act states that the employer must take reasonable measures that:

- No mining operations are carried out within a horizontal distance of 100m from reserve land, buildings, roads, railways, dams, waste dumps, or any infrastructure whatsoever including such structures beyond the mining boundaries, or any surface, which it may be necessary to protect in order to prevent any significant risk, unless a lesser distance has been determined safe by risk assessment and all restrictions and conditions determined in terms of the risk assessment are complied with.

Regulation 17(8) of the Mine Health and Safety Act states that

- No person may erect, establish or construct any buildings, roads, railway, dams, waste dumps, reserve land, excavations or any other structures whatsoever within a horizontal distance of 100m from workings, unless a lesser distance has been determined safe by a risk assessment or a professional geotechnical specialist and the determined restrictions and conditions are implemented.

3.1.6 National Heritage Resource Act No. 25 of 1999

This Act provides for the protection of all archaeological sites. Section 35 of the Act provides protection to all archaeological material and sites older than 100 years. Section 36 protects graves which are older than 60 years and outside of an official cemetery. Section 38 of the Act defines the categories of development for which the responsible heritage resources authority must be notified.

3.2 International Standards and Guidelines

3.2.1 United Nations Guiding Principles on Business and Human Rights[9]

Human rights are rights inherent to all human beings, whatever the nationality, place of residence, sex, national or ethnic origin, colour, religion, language, or any other status. International human

[9] Source: United Nations Guiding Principles on business and human rights, 2011

rights law lays down obligations of Governments to act in certain ways or to refrain from certain acts, in order to promote and protect human rights and fundamental freedoms of individuals or groups.

The United Nations Guiding Principles (UNGP) on business and human rights were developed by the Special Representative of the Secretary-General on the issue of human rights and transnational corporations and other business enterprises. These guiding principles should be implemented in a non-discriminatory manner, with particular attention to the rights and needs of, as well as the challenges faced by, individuals from groups or populations that may be at heightened risk of becoming vulnerable or marginalized, and with due regard to the different risks that may be faced by women and men.

The UNGPs give the responsibility for the protection of human rights to the state and corporates individually, but also provides for measures to implement should the human rights be violated. These are summarized below:

a) The State responsibility to protect human rights

States must protect against human rights abuse within their territory and/or jurisdiction by third parties, including business enterprises. This requires taking appropriate steps to prevent, investigate, punish and redress such abuse through effective policies, legislation, regulations and adjudication.

In meeting their duty to protect human rights, States should:

- Enforce laws that are aimed at, or have the effect of, requiring business enterprises to respect human rights, and periodically to assess the adequacy of such laws and address any gaps;
- Ensure that other laws and policies governing the creation and ongoing operation of business enterprises, such as corporate law, do not constrain but enable business respect for human rights;
- Provide effective guidance to business enterprises on how to respect human rights throughout their operations;
- Encourage, and where appropriate require, business enterprises to communicate how they address their human rights impacts.
- States should set out clearly the expectation that all business enterprises domiciled in their territory and/or jurisdiction respect human rights throughout their operations.

b) The Corporate responsibility to respect human rights

Business enterprises should avoid infringing on the human rights of others and should address adverse human rights impacts with which they are involved.

As a result, businesses are required to:

- Avoid causing or contributing to adverse human rights impacts through their own activities, and address such impacts when they occur;
- Seek to prevent or mitigate adverse human rights impacts that are directly linked to their operations, products or services by their business relationships, even if they have not contributed to those impacts.

In order to meet their responsibility to respect human rights, business enterprises should have in place policies and processes appropriate to their size and circumstances, including:

- A policy commitment to meet their responsibility to respect human rights;
- A human rights due diligence process to identify, prevent, mitigate and account for how they address their impacts on human rights;

- Processes to enable the remediation of any adverse human rights impacts they cause or to which they contribute.

c) Remediation

As part of their duty to protect against business-related human rights abuses, States must take appropriate steps to ensure, through judicial, administrative, legislative or other appropriate means, that when such abuses occur within their territory and/or jurisdiction those affected have access to effective remedy.

This could be achieved through the following ways:

- Taking appropriate steps to ensure the effectiveness of domestic judicial mechanisms when addressing business-related human rights abuses, including considering ways to reduce legal, practical and other relevant barriers that could lead to a denial of access to remedy.
- Providing effective and appropriate non-judicial grievance mechanisms, alongside judicial mechanisms, as part of a comprehensive State-based system for the remedy of business-related human rights abuse.
- Consider ways to facilitate access to effective non-State based grievance mechanisms dealing with business related human rights harms.

Anglo American Social Way (section 3.3.1) recognises that effective social performance is intrinsically linked with respect for human rights, and is set on avoiding, preventing, mitigating and, where appropriate, remediating adverse human rights impacts through human rights due diligence, and has a Human Rights Policy that formalises these commitments. Through this Human Rights Policy, Anglo American accepts and supports the corporate responsibility to respect human rights and actively seek to avoid involvement with human rights abuses. It also aims to identify, assess and minimise potential adverse human rights impacts that are caused by the operations, or that the operation contributes to. Anglo American also recognise that host governments have a duty to protect the human rights of everyone within their jurisdiction and, will, where appropriate, work with states to build their capacity in support of that objective.

3.2.2 The International Finance Corporation's Performance Standards

The International Finance Corporation's (IFC) Performance Standards (PS) on Social and Environmental Sustainability were adopted in 2006 and updated in 2012. The PS's are applied by the IFC to manage project social and environmental risks and impacts, and to enhance and promote development opportunities through selective private sector funding. Other financial institutions may also choose to apply the PS to their own projects in emerging markets. Banks subscribing to the Equator Principles require compliance to the PS. The PS establishes standards and guidelines that the client is to meet throughout the life of a project.

PS 1 – Assessment and Management of Environmental and Social Risks and Impacts describes the IFC's requirements to ensure the management of social and environmental performance throughout the life of a project. The key requirements are:

- To identify and evaluate environmental and social risks and impacts of the project.
- To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment.
- To promote improved environmental and social performance of clients through the effective use of management systems.

- To ensure that grievances from affected communities and external communications from other stakeholders are responded to and managed appropriately.
- To promote and provide means for adequate engagement with affected communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.
- The IFC's PS 1 GN109 further requires the establishment of a grievance procedure, which should provide for an accessible channel to receive communications from the public. The mechanism should not impede access to judicial or administrative remedies. Client will inform the affected communities about the mechanism in the course of the stakeholder engagement process

The objectives of the grievance mechanism will be to:

- Receive and facilitate resolution of affected communities' concerns and grievances about the client's environmental and social performance.
- Seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate and readily accessible, and at no cost and without retribution to the party that originated the issue or concern.

PS 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with PS 1. Standards 2 to 8 are listed below.

PS 4 recognises that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. This PS addresses Client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups. The main objectives of PS 4 are as follows:

- To anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances.
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected communities.

PS 5, The *Anglo Social Way* requires that "all resettlement exercises must be properly resourced and meet or exceed the requirements set out in the IFC's PS 5 on Land Acquisition and Involuntary Resettlement". Specifically, the IFC's PS 5 states the following basic principles in terms of resettlement:

- To avoid, or at least minimize, involuntary resettlement wherever feasible by exploring alternative project designs.
- To mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by:
    - Providing compensation for loss of assets at replacement cost; and,
    - Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- To improve or at least restore the livelihoods and standards of living of displaced persons.
- To improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

The objective of the assessment is therefore to determine the potential for physical and economic displacement and land access complications as a result of the project footprint. The findings of this exercise will be used to inform the design layout and option selection of the proposed infrastructure to avoid or minimize economic and physical displacement and land access complications. Economic displacement refers to the loss of land used for livelihoods; land access complications means difficulty in reaching agricultural land that was previously accessible.

PS 6 provides for the protection of ecosystem services. Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services.

PS 8 recognises the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this PS aims to ensure that clients protect cultural heritage in the course of their project activities. In addition, the requirements of this PS on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity. Objectives are:

- To protect cultural heritage from the adverse impacts of project activities and support its preservation; and,
- To promote the equitable sharing of benefits from the use of cultural heritage.

3.3 Anglo American Policies and Guidelines

3.3.1 Anglo American Social Way

The Anglo Social Way Version 2, 2014, defines Anglo American's governing framework for social performance at their operations throughout the entire lifecycle of project activities; from exploration through project development, construction and commissioning, operation, closure and post-closure. The Anglo Social Way social performance principles are as follows:

- To deliver a lasting positive contribution to communities socioeconomic benefit from the development of natural resources;
- To manage risks and impacts through avoidance, prevention, mitigation and, where appropriate, remediating such impacts;
- To respect human rights demonstrated through the Human Rights Policy and the endorsement of the UNGPs;
- To engage with affected and interested stakeholders in a transparent manner to ensure that they are able to express their views on positive opportunities, risks, adverse impacts as well as prevention and mitigation measures. Effective engagement and participation allows us to consider and respond to stakeholders' views in a proactive way;
- To empower vulnerable and marginalised groups; and,
- To integrate social performance within relevant operational processes.

Underpinning this vision are four core principles:

- Engage respectfully with host communities throughout the project cycle, and be accountable to stakeholders;

- Host communities should experience a lasting benefit from the presence of Anglo American operations and Anglo must seek to maximise the benefits flowing from an operation in addition to traditional social investment; and,
- Take the necessary steps to spread the application of good practice, and to learn from negative social impacts, complaints, incidents, audit findings and other non-conformances to prevent their recurrence. In addition, put in place appropriate mechanisms for handling and resolving grievances.

Of relevance to the SIA are the following principles:

- Identify, profile and analyse affected communities and other stakeholders or groups, in particular those who may be disadvantaged or particularly vulnerable to adverse impacts;
- Ensure that all engagement is respectful of community conventions, customs and gender considerations, while also ensuring inclusion of under-represented, vulnerable and marginalised groups;
- Provide relevant and appropriately communicated information to help affected communities and other interested stakeholders understand the potential and actual impacts associated with Anglo American's activities;
- Ensure that the views of affected communities and other interested stakeholders, including those of vulnerable and marginalised groups, are incorporated into Anglo American decision-making as appropriate; and,
- Recognising that effective social performance is intrinsically linked with respect for human rights, which means avoiding, preventing, mitigating and, where appropriate, remediating adverse human rights impacts through human rights due diligence.

3.3.2 Environmental Way

Anglo has developed a suite of Environmental Performance Standards that cover key management areas contained in the Anglo American Environment Way, Version 1, 2009. These standards contain mandatory, high-level requirements set at corporate level. They support the Anglo environmental vision, principles and policy, and outline the required approach to avoiding or minimising the potential adverse environmental impacts associated with mining activities. The performance standard relevant to this SIA is the Social and Environmental Impact Assessment (S&EIA).

The S&EIA performance standard's purpose is to ensure that all Anglo American projects proactively consider social and environmental matters in their planning and decision-making. Some of the key principles underpinning the S&EIA performance standard are:

- Stakeholder engagement: Give local communities that may be affected by adverse impacts of the project access to relevant information on the purpose, nature, scale, and duration of the proposed activities, and opportunities to express their views on the impacts and mitigation measures.
- Identification and selection of alternatives: Use the S&EIA process to examine alternatives, including the 'no project' option, and document the rationale for selecting the preferred option(s).
- Social and environmental characterisation / description: Use sufficiently accurate, detailed and current data to describe and characterise the pre-mining baseline social and environmental conditions within the project's zone(s) of influence, taking into consideration the identification of land owners, socio-economic status of the communities, presence of Indigenous Peoples and/or other vulnerable individuals or groups etc.;

- Risk/Impact Assessment: Using existing, recognised methods, adopt a systematic and structured approach to identify, predict and evaluate the significance of potential impacts. All potential impacts should be subject to a conceptual (scoping) assessment and then, as appropriate, to full impact assessment.

3.3.3 Socio-Economic Assessment Toolbox

The Anglo American SEAT is intended to improve an operation's understanding of their socio-economic impacts, both positive and negative, to build a more structured dialogue with stakeholders, to create greater internal capacity in the management of social issues, and to be a step forward in transparency and local accountability (Anglo America, 2007).

The core objectives of SEAT (2012) include the following:

- Provide guidance and support for achieving full compliance with Anglo America's Social Way;
- Identify key social and economic impacts and issues that need to be managed and thereby improve risk management;
- Assess existing social performance initiatives and identify where improvements are required;
- Facilitate the capturing and sharing of best practice across Anglo American operations;
- Improve each operation's understanding of the full range of local stakeholders, their views and interests;
- Provide guidance in developing and updating annual Stakeholder Engagement Plans, and increase trust and goodwill among host communities; and,
- Support sustainable socio-economic development of their host communities.

The SEAT document provides seven tools required to assess socio-economic impacts. These are:

- Introduction to profiling the Anglo American operation;
- Introduction to the profiling and engagement tools;
- Introduction to the impact identification and assessment tool;
- Introduction to the social performance management tools;
- Introduction to the socio-economic benefit delivery tools;
- Introduction to developing a social management plan; and,
- Introduction to SEAT reporting.

Tools 2A and 3A are of particular relevance to this baseline and impact assessment.

Tool 2A: Profiling the local area - This tool -aims to assist in building an understanding of the local area as well as national and regional issues that influence local conditions. The baseline information gathered should:

- Build a socio-economic profile of the local area that can be monitored and updated over time, and be used to benchmark changes and impacts in the local area;
- Confirm socio-economic issues and impacts associated with the operation;
- Identify risks that need to be managed (to the community and operation); and,
- Identify the main development issues and opportunities in the local area.

Tool 3A: Developing a Stakeholder Engagement Plan (SEP) - The main objective of Tool 3A is to assist in identifying the positive and negative impacts of an operation. According to SEAT there are two main ways in which this can be achieved:

- The first is through engagement, whereby stakeholders comment on what they perceive to be an operation's impact (positive and negative); and,
- The second is through an examination of impacts by internal stakeholders.

Both of these methods will be used in developing this report, and identifying potential negative and positive impacts associated with the project.

***Tool 4D: Resettlement Planning and Implementation* -** This tool aims to provide guidance on resettlement planning and implementation. Specifically, this tool aims to highlight the risks and complexities associated with resettlement and to outline best practice principles to manage these issues.

4 Overview of the Mpumalanga Province

This section of the report provides an overview of the Mpumalanga Province. The main focus of this section is to provide a context for the primary, secondary and tertiary zones of influence. A baseline of the province is also important as the construction of the mine may create impacts on a provincial level.

4.1 Background

The Mpumalanga Province is made up of three district municipalities which are in turn divided into 18 local municipalities. The province has a population of approximately 4 039 939 people (Census 2011). Table 4-1 below provides the structure of this population.

Table 4-1 : Population structure of the Mpumalanga Province

Population Group	Male	Female	Total
Black	1 781 368	1 880 850	3 662 219
White	151 557	152 038	303 595
Coloured	18 149	18 462	36 611
Indian/Asian	16 165	11 753	27 917
Other*	6 817	2 780	9 597
Total	1 974 055	2 065 883	**4 039 939**

Source: South African Census, 2011

*Other refers to people who chose not to put themselves into one of the above categories

In the mid-1990s Mpumalanga Province had one of the fastest growing economies in South Africa. Although it is one of the less populated and second smallest of the provinces, Mpumalanga has the fourth largest economy, based largely on the rich natural resources of the area. However, as with the rest of the SA economy, this growth rate has slowed down considerably. The population of 2.6 million in 1996 has grown to over 4 million today, now representing approximately 8% of the South African population (South African Census, 2011).

4.2 Provincial Economy

The main industrial and manufacturing activities in Mpumalanga include iron, steel, stainless steel, petrochemicals and chemical products, agricultural products, mining, power generation, timber and wood products and food processing. The potential for further development in these sectors, as well as tourism is considerable. The favourable location of the province enhances its development potential with the Maputo Corridor linking the province to Maputo in Mozambique, the close proximity to the substantial Gauteng market and the rail and road infrastructure allowing access to ports at Durban and Richards Bay.

It is estimated that Mpumalanga contributed some R217.9 billion in current prices to the Gross Domestic Product (GDP) of South Africa in 2011. According to estimates, Mpumalanga's contribution was the fifth largest among the nine provinces and registered a marginal decrease from a 6.9% contribution in 1996, to 6.6 % in 2011. At the start of the period under review, the economic growth of the province, as measured by real GDP growth, was higher than the national rate. However, the provincial economy has not outperformed the national economy in terms of GDP growth since 1999.

The average annual growth rate for the country and Mpumalanga over the period 1996 to 2011 was 3.2% and 2.7%, respectively. Current concerns about the global economy have resulted in lower growth forecasts in 2012 for South Africa and Mpumalanga of 2.6 % and 2.3%, respectively. The annual average growth rates for South Africa and Mpumalanga, from 2011 to 2016 are forecasted at 3.8% and 3.5%, respectively. The National Development Plan targets average national GDP growth of over 5% up to 2030. According to expectations, Gert Sibande is expected to record annual average growth of 4.0% from 2011-2016 followed by Nkangala (3.4%) and Ehlanzeni (3.2%) (Socio-economic Review and Outlook of Mpumalanga (SERO), November 2012).

4.3 Inflation

The September 2012 inflation rate of Mpumalanga (6.3%) was the second highest among the nine provinces and higher than the national rate of 5.5% in September 2012. Mpumalanga's inflation rate was higher than the upper limit of the inflation target zone of 6% for the first time since June 2012 (SERO, November 2012).

The main determinants of inflation in Mpumalanga are based on their respective weightings are price changes in food and non-alcoholic beverages, housing and utilities, transport as well as miscellaneous goods and services. These four broad determinants, in terms of the weighting, contribute more than 70% to the level of inflation and inflation movements in Mpumalanga (SERO, November 2012).

4.4 Labour Statistics

The Mpumalanga Province has a labour force of approximately 1.34 million individuals. This has grown by approximately 60 000 at the end of the third quarter of 2012 than a year earlier. This is predominantly due to migrant workers. Despite this growth in the labour force the Province has an estimated unemployment rate of 26.6%.

Mining, manufacturing and community services are the biggest contributors to employment with 40.5%, 12.6% and 11.7% respectively. Given the number of new coal mines planned in the western part of Mpumalanga, hopes to decrease unemployment in the Province rests almost exclusively on the coal-mining sector. Total employment in Mpumalanga constituted 6.8% of employment in the country (South African Census, 2011).

4.5 Education and Literacy

Education and literacy levels are key indicators of development in a population. Education attainment levels as well as access to education facilities are also important indicators to take into account.

The Province's education system continues to underperform, however has seen some improvement since 2009. Statistics from the Provincial Department of Education (DoE) shows that Mpumalanga was the worst performing province at Matric level during the 2009 – 2010 academic years. Of the 54 000 matriculants who wrote their final Matric exams in 2009, only 47.9% passed (Mpumalanga Provincial Government). This has however improved with a 56.8% pass rate in 2010, 64.8% in 2011 and 70% at the end of 2012.

The Mpumalanga Province still suffers with the second highest illiteracy rate in the country for people aged 20 and older. The Mpumalanga DoE estimated this to be as much as 27.5%. Much of this underperformance in education has been attributed to high levels of poverty, unemployment, unqualified educators and to the remoteness of some of the rural schools.

4.6 Health

Healthcare facilities in the province face numerous challenges. According to the Primary Health Care survey, these facilities have a slow turn-around time in obtaining laboratory tests for illnesses such as Tuberculosis (TB). In addition, their medical personnel are unevenly distributed across the province, and they are often under-equipped, sometimes lacking essential tools to perform the most basic of tasks. These challenges are exacerbated by the perceived influx of patients from border countries (i.e. Mozambique and Swaziland). The province has a total of 243 clinics and community home based care centres and 25 hospitals.

According to the South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey, HIV/AIDS prevalence in the province has increased from 14.1% in 2002 to 15.4% in 2008, which is the second highest in the country after KwaZulu Natal. While statistics are not available for 2012/13 it is estimated that the prevalence is could have increased to over 16%.

4.7 Housing

The Mpumalanga Province has approximately 1 075 488 households (South African Census, 2011) with an average household size of 4 people. While housing structures are varied, 79% of households in the province are modern housing constructed from brick on a separate stand or farm. Approximately 15% of housing in the province is still informal and/or traditional structures.

4.8 Provincial Growth and Development Strategy

A Provincial Growth and Development Strategy (PGDS) is a strategic and integrated provincial development plan that provides direction and scope for province-wide development programmes and projects, within the context of a long-term perspective and taking into consideration resources available and constraints.

Furthermore, a PGDS provides a spatially referenced framework for both public and private sector investment, indicating areas of opportunity and development priorities and enabling intergovernmental alignment.

In essence then, the PGDSs are aimed at providing strategic directives to District and Local Municipalities in formulating their more detailed IDPs, and Spatial Development Frameworks (SDF). It is thus essential that the issues and directives emanating from PGDSs be compatible with the vision, priority areas, and guidelines of SDFs of Local and District municipalities.

Mpumalanga has identified six priority areas of intervention as part of the PGDS, namely:

- Economic Development (i.e. investment, job creation, business and tourism development and Small and Medium Enterprise development);
- Infrastructure Development (i.e. urban/rural infrastructure, housing and land reform);
- Human Resource Development (i.e. adequate education opportunities for all);
- Social Infrastructure (i.e. access to full social infrastructure);
- Environmental Development (i.e. protection of the environment and sustainable development); and,
- Good Governance (i.e. effective and efficient public sector management and service delivery) (Mpumalanga Provincial Growth and Development Strategy).

5 The Primary Zone of Influence

5.1 Overview

As defined in Section 2.1, the Primary ZoI for the Elders project includes communities and stakeholders who could be directly impacted by the construction of the mine. This includes the Vlakkuilen and Middelkraal communities. It is not currently anticipated that surrounding farms will be significantly impacted, however, should the Project description change this will have to be re-evaluated.

The information for the Vlakkuilen community draws on information from the household census conducted in 2012 and 2015 to provide characteristics of the affected households. The information for Middelkraal community was gathered from secondary sources, site observations and a focus group discussion on 15 September 2015.

5.2 Vlakkuilen Community

5.2.1 Location

The Vlakkuilen community is predominantly located on the southern portion of the Hirsaw Estate; two households are detached from the main community and reside on the northern side of the estate. The Hirsaw Estate is located along the R35 national road between Bethal and the Goedehoop Colliery in the GMLM. Refer to Figure 1-1 for the location of the Vlakkuilen community and Figure 1-2 for the location of the individual households included in the census.

5.2.2 Demography

Demographic data for the Vlakkuilen Community has been drawn from the household census conducted in September 2012 and revised in 2015. This data provides an accurate reflection of the population and structure of the community.

5.2.3 Population Structure

The Vlakkuilen Community is a rural community with a total population of **127 people living in 23 households**. This gives an average household size of 5.5 people, reflecting the norm for rural agricultural households in South Africa. During the 2015 household surveys, 37% of the population were children below the age of 18, whereas 10% of the population was made up of pensioners above the age of 65.

5.2.4 Population Growth

The Vlakkuilen community was not growing significantly in 2012, with only one birth reported between September 2011 and September 2012. However, there seemed to be some growth taking place between September 2014 and 2015, with six new births recorded during this time. Furthermore, due to in-migration being controlled by the farmer and the rural nature of the community population growth is restricted. In 2015, only one household indicated having a person renting from them.

5.2.5 Education

Wazana Primary School

Wazana Primary School was the only school at Vlakkuilen and was closed in December 2014. Nine learners who were registered at the school were transferred to The Friedman Primary School on the farm Blinkwater. This school is 25 km from Vlakkuilen. The DoE is providing learners with transport to and from school on a daily basis. The Friedman Primary School is registered with the DoE and receives food for their feeding programme and teaching aids such as text books.

The school infrastructure is limited to three multi-graded classrooms, i.e. one classroom for grades 1, 2 and 3, another classroom for grades 4 and 5 and the last classroom for grades 6 and 7. There is also one kitchen where food is prepared for learners. Sanitation facilities are limited to two Ventilated Improved Pit (VIP) latrines. The school is currently not electrified.

Communication with the headmistress of The Friedman Primary School on 18 September 2015 revealed the following challenges regarding the transportation of learners from Vlakkuilen by the Department:

- The school buses pick up leaners earlier than usual and learners have to walk about 500m to get to the R35 where the bus stops;
- The school buses pick up the learners from school very late on many occasions and by this time the educators have already left and the children are left unsupervised during this time;
- The Department is sometimes irregular with organising transport. At the beginning of term 3 learners from Vlakkuilen could not come to school for 6 weeks because the Department did not pay for the school bus;
- Due to the long travelling time, learners are mostly tired by the time they get to school, and tired when they get home and this affects their school work; and,
- There is also no secondary school in Vlakkuilen, and as a result, learners have to travel to Bethal/Emzinoni, approximately 25 km away. Refer to Section 6.5 for additional detail on schools in Bethal and Emzinoni).

5.2.6 Health

There is no clinic in the Vlakkuilen Community. A mobile clinic visits the community once a month to distribute basic medication. For more serious complications and child birth people from the community generally travel to Bethal and Emzinoni where there clinics, a hospital and doctors. There is no public transport to Bethal and Emzinoni, as a result, people depend on lifts to get to these places, and pay R20 single trip. In cases of a health emergency, hired transport to get to heath facilities could cost up to R150.

5.2.7 Employment, Livelihoods and Income

As is the case in many rural farming areas of South Africa, the Vlakkuilen community is characterised by high levels of unemployment. During the household census affected households indicated that they are suffering as a result, particularly with issues such as food security and electricity costs.

Income

It was established during the 2012 and 2015 census surveys that the primary source of income for the majority of households was social grants, mainly pension and child support grants. The monthly household income is a useful variable to consider because it brings to light the fact that although households are comprised of individual members of the community, income earning individuals are not spread equally throughout these households. Low or no income makes a household more vulnerable to the impacts that resettlement can pose.

The average monthly income for the Vlakkuilen community in 2015 is **R3 394.00**. During the 2015 census only one household reported having no income, while the highest monthly household income was R11 820.00.

Agriculture

Most of the households in Vlakkuilen have small vegetable gardens where they grow small amounts of subsistence vegetables; however, there was no evidence of cultivated vegetables at the time of the 2015 household surveys.

Livestock

Only one household in the Vlakkuilen community is involved in commercial agricultural activities. The business is comprised of 50 pigs, 38 cattle, 15 goats, 200 chickens and crop farming. Two family members work for the business; however two more people are employed seasonally. The table below provides a breakdown of the numbers of livestock currently in the community.

Table 5-1: Livestock in the Vlakkuilen community

Type of Livestock	Total number in the community*
Cattle	203
Goats	63
Sheep	46
Pigs	50
Chickens	531
Ducks	69
Turkeys	16

Source: Vlakkuilen Household Survey, 2015

5.2.8 Housing

Primary Structures

Housing in the Vlakkuilen community is varied in both construction type and size. There are the original houses constructed by the farm owner, these are generally constructed using brick and cement with asbestos roofing.

The second type of housing is more informal structures constructed using corrugated iron sheeting. These houses are generally constructed by extended family members who do not have the funds to build a more formal structure.

There are also a couple of traditional structures in the community built using mud, stone and wood. Two households in the community currently reside within the Wazana Primary School.

Table **5-2** below provides a breakdown of the typical housing structures in the community.

Table 5-2: Housing types in the Vlakkuilen community

Type of Housing	Characteristics
Modern Housing 	• Modern construction methods • Clay brick, steel framed windows, asbestos roofing • Constructed by the farm owner • All electrified • Some have flushing toilets inside the house
Informal Housing 	• Poorly constructed using cheap material • Predominantly constructed from corrugated iron • Not all are electrified • Generally very small
Traditional Housing 	• Constructed using traditional methods • Materials include mud blocks, stone, wood, traditional plaster and corrugated iron • These structures are not electrified

* Two households currently reside within what was the Wazana Primary School, which is now closed.

Additional Structures

All of the households in the Vlakkuilen community have constructed additional structures on their properties. These structures range in size, material and uses. Most households have constructed additional sleeping quarters, mainly for extended family. Other structures include garages, cattle kraals, chicken coups, toilets, kitchens and spiritual huts.

5.2.9 Land Tenure

Households in the Vlakkuilen community do not have formal title deeds to their properties however they are protected under the Land Reform (Labour Tenants) Act 3 of 1996. This is based on the fact that the community has lived and worked on the farm for over twenty years.

5.2.10 Infrastructure and Services

The importance of establishing the level of services provided to the community at present is important in the SIA process for a number of reasons. Firstly, it provides a comprehensive baseline of the potentially affected community. Secondly, it allows for more comprehensive mitigation measures and community development opportunities to be developed in the area of service delivery.

Transport

Due to the rural and remote nature of the Vlakkuilen Community, linked to towns such as Bethal via the R35 national road, transport is a serious issue for the community. During the census survey it was often mentioned that transport made up a significant percentage of a households monthly costs.

Typically people use lifts costing between R15 and R20 single trip for personal transport to and from Bethal and other places of interest.

Refuse Removal

During the household census, affected households were asked how they disposed of their refuse. As there is no municipal refuse removal service, all households indicated that they either burned or buried it. While this is a simple and cost effective solution for the community it could potentially lead to unhygienic conditions which might impact on household members' health.

Sanitation

The availability and access to sanitation services is an important social service, and can often be an indicator of a community's social wellbeing. Sanitation services in the Vlakkuilen community are varied. Some households, particularly the older farm houses, have flushing toilets with septic tanks, however the majority of the community make use of self-built unventilated pit latrines.

Water

Water in the Vlakkuilen community is supplied by a groundwater borehole which is pumped to storage tanks via a windmill. There is also a pump operated by a generator that pumps water out of the Olifants River, however this is often in a state of disrepair and not a reliable source.

Households have standpipes in their yards to access the water from the borehole. It is reported by the community that the water sources are generally reliable and the quality is acceptable for human and animal consumption.

Electricity

The availability of electricity as an energy source is vitally important as households utilise it for both cooking and lighting. Some of the key points regarding electricity provision in Vlakkuilen are:

- Of the households, 11 have access to municipal electricity;
- Electricity is purchased on a pre-paid basis;
- The primary household structure/s are connected, additional structures, such as storerooms, are either connected informally (extension cords or homemade connections) or do not have electricity; and,
- The most common complaint regarding electricity is that it is very expensive.

5.2.11 Cultural Sites (including graves)

No sites of cultural significance or graves were identified during the household census in 2012 and 2015. In 2009, as a component of the proposed resettlement, 324 graves were exhumed and relocated to Kriel, Bethal and Verena. These graves were moved in anticipation that the community would be moved as well. According to the GMLM by-laws relating to cemeteries, all new graves must reside in an official cemetery. Following this the community has been burying their deceased in these locations, mostly in Emzinoni, Bethal.

5.3 Middelkraal Community

5.3.1 Location

The Middelkraal community is made up of 18 households located on the northern side of the Olifants River. This community was relocated in 2007 from the Kleinfontein farm by Umcebo Mining, currently known as Glencore, to make way for the Middelkraal Mine.

5.3.2 Education

There is no school in Middelkraal and as a result learners travel to neighbouring townships such as Emzinoni and Hendrina. The Department of Education is responsible for transporting learners to and from school on a daily basis at no cost to the learners. Some of the children at Middelkraal used to attend Wazana Primary School at Vlakkuilen, which has since been closed and learners taken to the Friedman Primary School.

5.3.3 Health

There is no clinic in the Middelkraal Community. The community members travel to Vlakkuilen (8.4 km away) to access a mobile clinic once a month. The mobile clinic distributes basic medication and attends to chronic conditions from the community. For more serious complications and child birth people from the community generally travel to Govan Mbeki Clinic and Bethal Hospital, ± 20 km away.

5.3.4 Employment, Livelihoods and Income

The Middelkraal community is characterised by high levels of unemployment. During the focus group discussions in September 2015, households indicated that they were suffering as a result, particularly with issues such as food security and electricity costs. It was difficult to determine exact employment levels of the community, however, most of the community members mentioned that they depended on government grants such as pensions, disability and child support for their livelihoods

5.3.5 Agriculture

While there were small pieces of land allocated for agriculture, there was no evidence of any crop farming activities at Middelkraal. Focus group discussions with the Middelkraal community revealed that the community members collectively owned the following livestock (Table 5-3):

Table 5-3: Livestock in the Middelkraal community

Livestock	Number
Cattle	± 250
Chickens	± 1000
Goats	80
Sheep	40
Ducks	30
Geese	5
Turkeys	2
Horse	1

Source: Middelkraal focus group meeting, September 2015

Community members complained about the contamination of the Olifants River, the source of water for their livestock, and that livestock were dying as a result.

5.3.6 Housing

Primary Structures

Houses in the Middelkraal community are all similar 77m² five roomed houses, made of cement bricks and corrugated iron sheets within a 400m² plots. The houses are supplied with electricity, water and sewerage. These houses were built by Glencore, previously known as Umcebo, following the relocation of the community from Kleinfontein farm in 2007. As part of the relocation agreement with Umcebo Mining, residents had to pay for their own electricity and water and maintain their own houses after initial problems were addressed (SRK focus group discussions, 2015).

Additional Structures

The majority of the households in the Middelkraal community have constructed additional structures on their properties mostly using corrugated iron sheeting or cement bricks. These structures range in size, material and uses. Focus group discussions at Middelkraal have revealed that the community members used to rent out informal structures to the Middelkraal Mine (Umbeco Mine) employees as a source of household income before it was closed. It is possible that the same trend can occur should the Elders mine be developed. However, the community members did not mention any influx of people into the area as a result of mining activities, apart from accessing rental housing. Table 5-4

Table 5-4: Housing types in the Middelkraal community

Type of Housing	Characteristics
Formal house built by Umcebo (Glencore) 	• Modern construction methods • Clay brick, steel framed windows, corrugated iron roofing • Constructed by Umcebo mine • All electrified
Informal backyard house built by owners 	• Poorly constructed using cheap material • Predominantly constructed from corrugated iron or mud • Not all are electrified • Generally very large

5.3.7 Land Tenure

Allegedly, households in the Middelkraal community were promised title deeds for their properties when they were relocated. However, gathered from discussions with some members of the community, they still had received their title deeds. There are also allegations of intimidation by surrounding land owners in terms of their ownership of the land, and that they did not have any legal rights to the land as a result of not having title deeds. This issue has resulted in frustration and lack of trust of mining in general, and expectations that other mines should take responsibility for these legacy issues are evident.

5.3.8 Infrastructure and Services

Transport

Due to the rural and remote nature of the Middelkraal Community, which is linked to towns such as Bethal via the R35 national road, transport is a serious issue for the community. Typically people use lifts for personal transport, at a cost of between R15 and R20 single trip to Bethal.

Refuse Removal

Households at Middelkraal were asked how they disposed of their refuse. As there is no municipal refuse removal service, all households indicated that they either burned or buried their waste.

Water

Water in the Middelkraal community is supplied by groundwater boreholes, which is pumped to storage tanks via a windmill. Households have standpipes in their yards to access the water from the borehole. It was reported that the water sources were generally unreliable and the quality of water was not acceptable for human and animal consumption due to the sewage flowing into the Olifants River.

Sanitation

All houses at Middelkraal were provided with internal flushing toilets with septic tanks. However, with the shortage of water in the area, these toilets are mostly not working, resulting in blockages in the houses and an unhealthy environment. As a result, most of the households have constructed pit latrines outside their houses.

Electricity

Households at Middelkraal use prepaid electricity for lighting, and use wood and coal for cooking and heating. Most of the households complained about the costs of electricity and the lack of access to wood and coal in Middelkraal, as compared to Kleinfontein, where they easily had access to these.

5.3.9 Cultural Sites (including graves)

No sites of cultural significance or graves were observed during the site visit. According to the GMLM by-laws relating to cemeteries, all new graves must reside in an official cemetery. The closest cemeteries to the Middelkraal Community are at Emzinoni.

5.4 Mahlathini Community

Mahlathini, located approximately 1 km from Hope Village (Portion 7 of Goedehoop 46-IS and small section located on Portion 9 of Goedehoop 46-IS) has been in existence for more than a decade and has grown considerably since 2005. This informal township is not recognised by the local authority. It can be assumed that the settlement came about due to an influx of jobseekers looking for employment at the mines, power stations and related industries in the area. It is estimated that approximately 800 people reside at Mahlathini and the Steve Tshwete LM does not regard it as a legal informal settlement. Services are limited and unemployment and illiteracy levels are high. The settlement experiences increasing social problems relating to alcohol and drug abuse and crime. Residents own in the region of 400 to 500 cattle and cattle graze on private land and servitudes without permission, management or control[10].

[10] Geovicon Environmental, 2015: Goedehoop South Colliery, Proposed No 4 Seam Project Draft SIA

6 Secondary Zone of Influence

6.1 Overview

The Secondary ZoI includes the towns of Bethal and Emzinoni which both fall within the Govan Mbeki Local Municipality (GMLM). It is anticipated that both of these communities will be affected by both induced and interactive impacts due to the construction of the mine and their location on the R35 transport corridor. Furthermore, as the Elders Colliery falls within the GMLM they will primarily focus their relationship building, corporate investment, and SLP within this municipality. Apart from focus group and key informant interviews, this information has been sourced from the GSDM and GMLM IDP documents, 2012-2017.

6.2 Geographic Context of the Govan Mbeki Local Municipality

The GMLM is located in South-Western Mpumalanga and is one of seven local municipalities in the GSDM. The other municipalities include Albert Luthuli, Dipaleseng, Lekwa, Mkhondo, Msukaligwa and Pixley ka Isaka-Seme (refer to Figure 6-1).

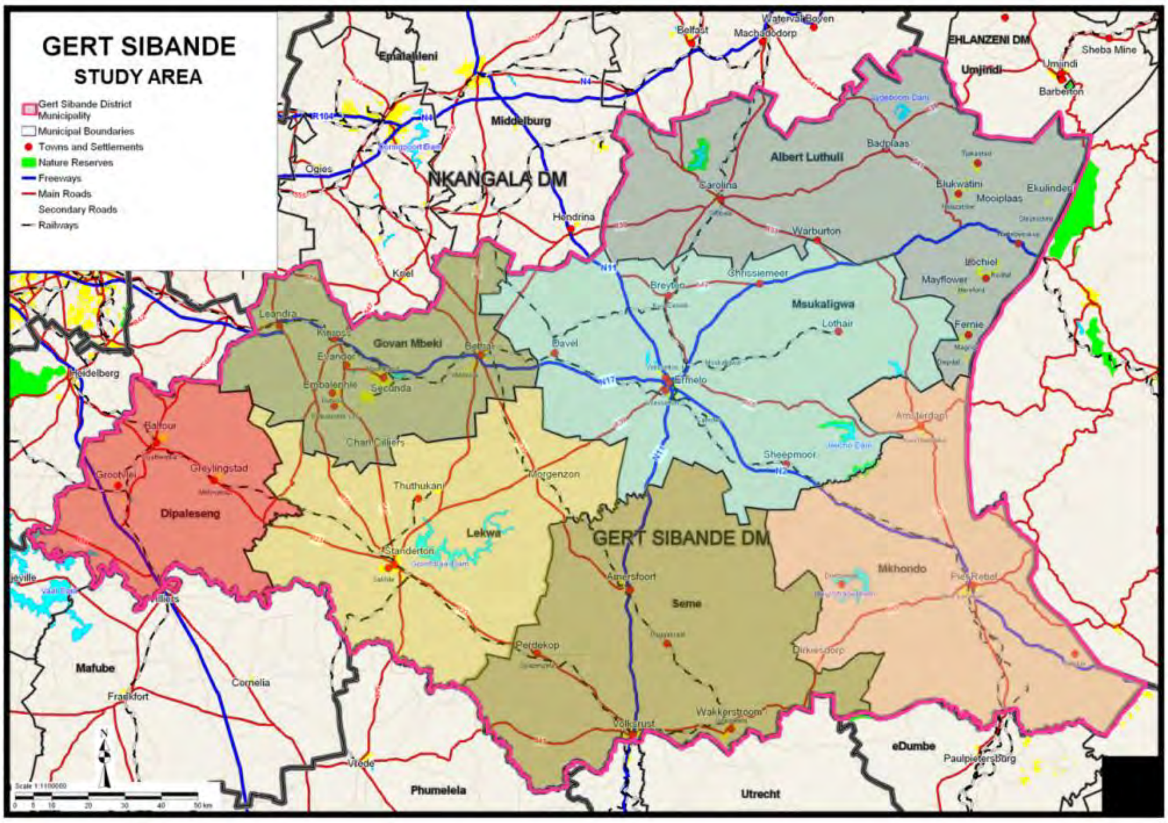

Figure 6-1: Location of the GMLM within the GSDM

Source: GSDM IDP, 2012-2017

6.3 Political Context

6.3.1 Structure of the Govan Mbeki Local Municipality

The GMLM comprises six departments, all of which account to the Office of the Municipal Manager. These departments are: Corporate Services; Technical and Engineering Services; Finance; Public Safety; Environment and Tourism; and Health and Community Services.

The elected municipal council is the ultimate IDP decision-making authority within the GMLM and is supported by the following structures in order to promote participatory democracy:

- IDP representative forum;
- Municipal Manager;
- IDP Steering Committee; and,
- Sub Steering Committees (Departmental projects, programmes, etc).

6.3.2 Key Performance Areas

Taking cognisance of the political, national, provincial, and district policies and plans, the following Key Performance Areas (KPAs) were identified by the GMLM, IDP Review, April 2012:

- Governance and Stakeholder Participation;
- Physical Infrastructure and Energy Efficiency;
- Services and Customer Care;
- Economic Growth and Development;
- Safety and Environment;
- Social and Community Development;
- Institutional Transformation; and,
- Financial Sustainability.

6.3.3 Municipal Challenges

Some of the key challenges and opportunities that require both macro and more localised responses are listed below:

- Resource Management (water shortages, energy constraint, fuel consumption) and the compelling need to embrace alternative means of energy;
- Climate change and associated natural disasters;
- Increasing prominence of Information Technology as a driver of both new communications, movement patterns and resource management; and,
- Bridging the gap between the rich and poor. GMLM IDP Review, April 2012.

6.4 Demography

6.4.1 Population Structure

Govan Mbeki Local Municipality

The age and gender composition of the population is a key determinant of population change and dynamics. Age distribution is an important indicator of both current and future needs regarding education, health care for children and elderly, employment opportunities for those in the economic age group and provision of social services such as pensions to those in need.

The population of the GMLM was estimated at 294 538 in 2011 (Statistics South Africa, Census 2011) representing 83 874 households at an average of 3.3 people per household. Table 6-1 below provides a breakdown of the total population.

Table 6-1: Population structure of the GMLM

Age Group	Black African		White		Coloured		Indian/Asian		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
0-7	19731	19927	2623	2581	351	373	310	275	46 171
8-18	22518	22351	3446	3286	387	376	345	339	53 048
19-35	46638	37154	6466	6229	774	722	923	698	99 604
36-50	21336	20857	5281	5298	512	400	432	402	54 518
51-65	10375	10057	4537	4107	286	208	292	221	30 083
66-74	1503	2413	903	1 135	39	43	45	55	6 136
75+	825	1 505	459	823	3	28	31	38	3 712
Total	**237 190**		**47 176**		**4 502**		**4 406**		**294 538***

*1 264 respondents did not categorise themselves into any of the above groups
Source: Stats SA, Census 2011

The major urban areas in the GMLM include Secunda and Bethal. Both of these urban centres are located along the N17/N2 corridor which runs from east to west through the municipality. Other towns and townships include Leandra/Leslie, eMbalenhle, eMzinoni, Trichardt, Evander, Kinross, Charl Cilliers and Lebohang.

Bethal and Emzinoni

Bethal accounts for approximately 6.3% of the municipality's population with 18 690 people while Emzinoni accounts for approximately 9.3% with a population of 27 515 people. The table below provides a breakdown of this population structure.

Table 6-2: Population structure of Bethal and Emzinoni

Age Group	Bethal		Emzinoni	
	Male	Female	Male	Female
0-7	1 177	1 219	2 391	2 351
8-18	1 579	1 544	2 890	2 852
19–35	3 174	2 475	4 390	4 251
36-50	2 051	1 901	2 224	2 564
51-65	1 200	1 200	1 185	1 415
66-74	252	371	211	396
75+	175	270	111	227
Total	**18 690**		**27 515**	

Source: Stats SA, Census 2011

6.4.2 Population Growth and Migration

Govan Mbeki Local Municipality

The GMLM has experienced an average population growth rate of 9.5% per annum since 2007 to 2011. This is significantly higher than the current national average of 0.5%. This rapid growth is due partly to natural population growth but also because of in migration of job seekers.

Since 2007 the GMLM has experienced a growing in migration each year. This can predominantly be attributed to people in search of employment opportunities in the mining and power generation sectors and the influx of migrants from Zimbabwe and Mozambique. The majority of migrants to the GMLM are men from outside of South Africa, other areas of Mpumalanga and Gauteng. The table below provides a breakdown of the number of migrants to the GMLM since 2007, where they come from and their gender.

Table 6-3: Migration into the GMLM

	2007		2008		2009		2010		2011	
	M	F	M	F	M	F	M	F	M	F
Western Cape	-	-	1	1	1	-	1	-	1	-
Eastern Cape	-	-	1	-	1	-	6	5	-	-
Northern Cape	2	-	-	1	-	-	-	1	-	-
Free state	3	1	3	1	-	-	1	-	-	-
KwaZulu-Natal	5	1	11	5	6	5	5	3	6	7
North West	4	2	2	1	-	6	1	-	-	-
Gauteng	28	6	31	22	38	24	32	14	28	12
Mpumalanga	52	24	74	32	65	43	39	32	37	30
Limpopo	8	2	4	1	4	-	2	1	1	-
Outside SA	**276**	**164**	**358**	**193**	**458**	**244**	**515**	**321**	**772**	**467**
Sub-total	377	198	485	258	573	322	602	378	845	516
Grand Total	**575**		**743**		**895**		**980**		**1 361**	

Source: Stats SA, Census 2011

Bethal and Emzinoni

In line with the municipal growth rate, Bethal and Emzinoni have also both experienced an increased growth rate since 2007. Both communities, Bethal in particular, are also experiencing an influx of migrants from outside of South Africa. Table 6-4 below provides a breakdown of the number of migrants into each community.

Table 6-4: Migration into Bethal and Emzinoni

	2007		2008		2009		2010		2011	
	Beth	Emzi	Beth	Emzi	Bethal	Emzi	Beth	Emzi	Beth	Emzi
Western Cape	-	-	2	-	-	-	-	-	-	-
Eastern Cape	-	-	-	-	-	-	-	2	-	-
Northern Cape	-	-	1	-	-	-	-	-	-	-
Free state	-	1	-	-	-	-	-	-	-	-
KwaZulu-Natal	2	-	6	2	-	-	-	-	-	-
North West	-	-	-	-	1	-	1	-	-	-
Gauteng	1	1	7	5	5	5	5	5	6	-
Mpumalanga	5	3	8	7	7	2	7	5	6	5
Limpopo	1	-	-	-	-	-	-	-	1	-
Outside SA	**22**	**25**	**45**	**29**	**82**	**31**	**62**	**29**	**56**	**46**
Total	**31**	**30**	**69**	**43**	**95**	**38**	**75**	**41**	**69**	**51**

Source: Stats SA, Census 2011

It is alleged that the influx of people into the area is mostly associated with mining activity in the GMLM. Discussions with key informants have revealed that most households in Emzinoni are reliant on rental income for their livelihoods, which ranges from R500 to R2000 per outside room. The local mines providing living out allowances to their employees contribute to this situation.

Figure 6-2: Rental housing in Emzinoni

6.5 Education and Literacy

6.5.1 State of Education in Govan Mbeki Local Municipality

Education and literacy levels are key indicators of development in a population. Education attainment levels as well as access to education facilities are also important indicators to take into account. From a GMLM point of view the education system continues to deteriorate. GMLM has seen a decrease in the matric pass rate from 71% in 2011 to 64% in 2012.

Municipal statistics from Statistics South Africa (2011) show that about 18% of the GMLM residents aged 20 and above were functionally illiterate, with no schooling at all and a few with some primary education.

Statistics show that in 2011 only 7,9% of the population of GMLM had no schooling (a decline from 16.5% in 2001) and within the same period 44.0% of the population 20+ had matric and higher (an increase from 28,7% in 2001) while functional literacy[11] stands at 83.1% in 2001 (an increase from 69.0% in 2001). Much of this underperformance has been attributed to high levels of poverty, unemployment, unqualified educators and to the remoteness of some of the rural schools.

Shortfalls of schools are greater in low income areas such as Lebohang, eMzinoni and eMbalenhle. Average teacher/pupil ratios are 1:36 in primary schools and 1:34 in secondary schools. Schools in previously disadvantaged townships and rural areas are poorly equipped in comparison with those in previous white urban areas. The two tertiary institutions are a satellite campus of Vaal Triangle Technikon, and the Evander Technical College.

On the positive side however, the following points can be highlighted for GMLM over a 10 year period from 2001 to 2011:

- The percentage of the population with no schooling decreased from 26% in 2001 to 8% in 2011 (this is partly due to the migration of educated people in to the area and improved access to schooling);
- Compared to the other local municipalities within GSDM, GMLM has the lowest number of people who do not have any education at all;
- The percentage of people who completed secondary school increased from 27% in 2001 to 34% in 2011; and,
- The percentage of people with post matric qualifications in GMLM increased from 16% in 2001 to 31% in 2011.

6.5.2 State of Education in Bethal and Emzinoni

Education Levels

Education levels are slightly better in Bethal than in the GMLM with the exception of tertiary education which is lower than the municipal average. Emzinoni however displays higher levels of people with no education when compared to the GMLM. The table below provides a breakdown of the highest levels of education attained in Bethal and Emzinoni.

Table 6-5: Education levels in Bethal and Emzinoni

Highest Level of Education Attained	Percentage of Population	
	Bethal	Emzinoni
No education	4.6	10.4
Primary School	25.4	34.2
Secondary School	59.5	53.8
Certificate/Diploma (without matric)	0.5	0.1
Tertiary Education	9.9	1.5

Source: Stats SA, Census 2011

[11] The Institute for Statistics sees functional literacy as a level of reading, writing and calculation skills sufficient in the particular community in which an individual lives (www.oxfordbibliographies.com)

Education Infrastructure

Bethal currently has 4 schools (2 primary, 1 secondary and 1 special school) while Emzinoni has 11 schools (7 primary, 3 secondary and 1 combined). These schools, particularly in Emzinoni, are under resourced; however key informant meetings revealed that parents were generally happy with the level of education their children were receiving. Table 6-6 below provides an overview of the schools in Bethal and Emzinoni in 2012 and 2015.

Table 6-6: Schools in Bethal and Emzinoni

Name of School	Type of School	Town/Area	Number of Learners (2013)	Number of Teachers (2013)	Number of Learners (2015)	Number of Teachers (2015)
Alpheus D Nkosi	Secondary	Emzinoni	1320	50	979	43
Bethal Private	Primary	Bethal	245	11	Not available	Not available
Enkundleni	Combined Farm School	Kafferstad	Not available	Not available	202	8
H.M. Swart	Primary	Bethal	595	26	542	19
Hoogenhout	Secondary	Bethal	699	41	720	31
Ikhethelo	Secondary	Emzinoni	950	31	1326	41
Ikhwezi	Primary	Emzinoni	768	18	776	22
Imbekezelo	Primary	Emzinoni	1007	24	725	25
Jim van Tonder	Special School	Bethal	Not available	Not available	Not available	Not available
Langelihle	Primary	Emzinoni	1140	33	1001	33
Langelihle 2	Primary	Emzinoni				
MD Coovadia	Combined	Emzinoni	639	14	704	21
Mzinoni	Secondary	Emzinoni	825	33	1321	36
Sakhisizwe	Primary	Emzinoni	844	21	1548	46
Thandanani	Primary	Emzinoni	1065	27	1092	31
Vukanini	Primary	Emzinoni	669	21	538	Not available
TOTAL			**10 766**	**352**	**11 474**	**356**

Source: Bethal Circuit Office, 2015

From the above table it can be determined that there was a teacher to learner ratio of 1:19 in Bethal, and 1:34 in Emzinoni in 2013. This has now changed to 1:35 in Bethal and remains 1:34 in Emzinoni in 2015. The fact that the teacher learner ratio in Emzinoni remains unchanged from 2013 to 2015 conflicts with the information received from key informants that overcrowding in schools has been increasing over the years.

Key informant interviews have also highlighted the following challenges relating to the provision of education in the area, especially in Emzinoni.

- Potential for overcrowding could increase in secondary schools in Emzinoni- especially with the Department of Education's plan to convert one of these high schools into a Maths and Science Academy. This means that all the other learners in this school will be absorbed by the two remaining high schools and further increase the problem;
- Poor resources in schools, especially in terms of learning support materials and connectivity;

- Lack of recreational facilities in schools in Emzinoni;
- Lack of managerial capacity in schools and in the school governing bodies; and,
- High teenage pregnancies and drug and alcohol abuse among learners.

6.6 Health

6.6.1 State of Health in Govan Mbeki Local Municipality

As of 1 April 2012, the GSDM as opposed to the GMLM, is responsible for the provision of health care in the municipality. This process is line with the trend throughout the province whereby the district municipalities have become responsible for health services.

Within the urban areas of the GMLM population groups generally have good basic health with low HIV/AIDS prevalence rates. A large percentage of families living in formal urban areas have access to medical aid and rely on private sector medical services.

People living in rural and informal settlements generally have poor access to basic health care, and are heavily dependent on Government and employers to provide basic health needs. There are high HIV/AIDS prevalence rates among this group. Poor living conditions, and inaccessibility of basic health facilities contributes to the poor health profile.

The HIV prevalence rate in the GMLM was estimated at 30.9% in 2009, (GMLM IDP 2012), which is significantly higher than the provincial average of 24% (the national average is 17%-18%[12]). HIV prevalence rate according to the District Health Information Systems (excluding pregnant women) stood at 33.0% in 2011 (a decrease from 35.3% in 2010). Key informant interviews have indicated that GMLM has the highest HIV rate in GSDM.

GMLM currently has 11 clinics, three community health centres and two hospitals. There are also four mobile clinics within the municipality.

6.6.2 Municipal Health Services

The GSDM has made progress in ensuring the health and safety of its community through provision of municipal health services by extending these services to areas that were previously not covered, through established and well-functioning forums which coordinate services delivery, planning and implementation of target program and intervention.

Key issues that are addressed at Local Municipalities pertaining to Municipal Health Services include:

- Access to safe drinking water;
- Access to safe sanitation;
- Management of safe food access, distribution and sale;
- Waste management services;
- Management and control of medical and hazardous waste; and,
- Minimisation and control of environmental pollution and environmental health risk.

The following will be the key strategic approach to improve Municipal Health service delivery:

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[12] Source: 3rd South African National HIV Communication Survey 2012 (NCS)

- Regulatory Services (development & review of By-Laws, District Health Plans);
- Compliance Monitoring and Enforcement;
- Awareness and Capacity Building;
- Community and Stakeholder Mobilisation;
- Inter-sectoral collaboration and partnership; and,
- Surveillance of high risk communities, environmental health risk areas (GSDM IDP 2012/13 – 2016/17).

6.6.3 Health Infrastructure in Bethal and Emzinoni

Currently Bethal has one hospital and the Govan Mbeki Clinic. Emzinoni has two clinics namely Emzinoni Clinic (8 hour facility) and SEAD Clinic (12 hour facility). Patients are allowed to go to any clinic of their choice for medical attention. All the clinics refer patients to Bethal Hospital for complicated health issues and hospitalisation where necessary.

For more remote rural farmworker communities residing within Ward 15 of the GMLM, a mobile clinic visits every month. However, these clinics have been said to be unreliable and not properly resourced. Alternatively, community members go to the Govan Mbeki Clinic and Bethal Hospital, 20 km away, where healthcare services are free of charge for the patients.

6.6.4 Health Status in Bethal and Emzinoni

Some of the main ailments experienced in 2012, particularly among the elderly, included high blood pressure, diabetes and arthritis. There were a few incidents of malnutrition reported in Emzinoni. The table below provides an overview of the health issues commonly experienced by men women and children in Bethal and Emzinoni in 2012.

Table 6-7: Common health issues in Bethal and Emzinoni

Town/Settlement	Men	Women	Children
Bethal	Hypertension, asthma, tuberculosis	Diabetes, arthritis, hypertension, tuberculosis	Influenza, asthma, diarrhoea
Emzinoni	Hypertension, tuberculosis, diabetes	Diabetes, arthritis, hypertension, tuberculosis, sexually transmitted diseases	Influenza, malnutrition

Source: Key Informant Interviews, 2012

These issues have not changed drastically from 2012 to 2015. However, it has been gathered from key informant interviews in 2015 that hypertension, diabetes, TB, including multi-drug resistant TB, HIV/AIDS and Sexually Transmitted Diseases were the most prevalent in Bethal and Emzinoni. All the clinics do offer HIV Counselling and Testing free of charge. See **Table 6-8** for the health statistics at Emzinoni Clinic from January 2015 to June 2015.

Table 6-8: Health statistics of Emzinoni Clinic

Month	Monthly Statistics	New TB Infections	HIV Statistics on antiretroviral treatment
January 2015	2177	35	441
February 2015	1814	50	534
March 2015	1814	50	534
April 2015	2329	21	567
May 2015	2036	69	601
June 2015	2144	59	652
Total number (6 months)	12 314	284	3 329
Monthly Average	**2 052**	**47**	**555**

Source: Key informant interview, 2015

It can be seen from the table above that the HIV statistics are escalating on a monthly basis, and this could potentially mean that the rate of new infections is increasing. If not properly managed, this will cause more overcrowding in the current facilities, and further issues regarding resourcing in these facilities.

Overcrowding in health facilities, shortage of staff members and lack of resources have been cited as key health challenges by key informants interviewed.

6.7 Housing

6.7.1 Housing in Govan Mbeki Local Municipality

The GMLM is the main housing provider, which provides low cost housing schemes and human settlement related programmes funded by the national Department of Human Settlement. The GMLM is identifying for the purpose of acquisition 3800 ha to be purchased to accommodate growth in the GMLM for 2011-2017 (based on economic growth of 3%).

Adequate housing remains a serious challenge for the municipality. The GMLM IDP reports that there are 29 478 households without access to formal housing. The housing backlog is estimated at approximately 58 000 units, including 18 887 in situ developments (formal stands), and over 34 000 backyard dwellers (over the age of 18). The 2011 stats indicate that there were 23 365 informal housing units within the GMLM, the majority of these are at Embalenhle.

6.7.2 Housing in Bethal and Emzinoni

Housing in Bethal is predominantly formal housing with only a very small percentage of informal dwellings. Emzinoni is also predominantly formal housing however there is also a large percentage of informal dwellings. Emzinoni is one of the communities within the GMLM that has been prioritised for the construction of Reconstruction and Development Programme (RDP) housing. The table below provides a breakdown of the housing situation in Bethal and Emzinoni in 2012.

Table 6-9: Housing in Bethal and Emzinoni

Type of Housing	Bethal	Emzinoni
Formal	5 167 (96.4%)	5 099 (62.8%)
Traditional	18 (0.3%)	15 (0.2%)
Informal	176 (3.3%)	3 009 (37.1%)
Total	**5 361**	**8 122**

Source: Stats SA, Census 2011

It was noted during the site visits and discussions with key informants in 2015 that the township of Emzinoni has been experiencing growth over the past years. The reasons cited for the growth included mining developments in the area and the farmworker households from the surrounding farms who buy plots to move away from the farms. Due to the lack of security of tenure on farms and poor relationships between the farmers and the farmworkers, most of the farmworkers were reportedly starting to move away from these farms to establish their housing in established townships such as Emzinoni. The following types of houses were identified in Emzinoni.

Table 6-10: Types of housing at Emzinoni

	Self-built formal house extended by the household
	RDP house built by the municipality to improve the quality of houses and curb the development of informal housing
	Backyard rental housing usually rented out to migrant workers working in the different mines in the area and foreigners who want to establish their businesses in the area, especially spaza shops
	Informal settlements developing on a separate piece of land in Emzinoni

6.8 Infrastructure and Services

This section describes the services (water, sanitation and energy) and infrastructure (transport and communication) in the GMLM and more specifically in Bethal and Emzinoni.

6.8.1 Water Supply

Govan Mbeki Local Municipality

All urban areas in the GMLM are fully reticulated in terms of potable water supply, however informal settlements are still lacking. According to municipal estimates, approximately 40% of households have piped water inside the dwelling, while another 40% of households have piped water in the yard. Communities in the rural and peri-urban areas do not have access to piped potable water supply and use borehole water.

Most of GMLM is situated in the catchments of the Blesbokspruit and Watervaal Rivers which are in the Upper Vaal Water Management Area as well as the catchments of Olifants and Rietspruit which are in the Olifants River WMA. Rand Water supplies GMLM with all its treated bulk water requirements from the Suikerbosrand Water treatment Plant (GMLM WSDP, 2011).

Bethal and Emzinoni

Currently 67.5% of households in Bethal have access to piped water inside their households, while 31.5% have access to piped water in their yard. The situation in Emzinoni is not as good with only 37.5% of households having piped water into their households and 52.2% with piped water in their yards. 8.5% of households in Emzinoni still access their water from communal standpipes.

The GMLM has estimated they will spend 1.82 million over a five year period upgrading water supply in Emzinoni. No budget has been set aside for Bethal.

6.8.2 Sanitation

Govan Mbeki Local Municipality

Access to adequate sanitation is one of GMLM's primary focuses. The municipality understands that adequate sewage and disposal facilities are directly linked to health and welfare. As such, the number of households with access to flushing toilets has increased from 50% in 2001 to 90% in 2011. Currently all formal stands in urban areas, with the exception of Eendracht, have access to waterborne sewerage. Sewage is outsourced to Sasol in Secunda. Table 6-11 provides an overview of sanitation levels in the GMLM.

Table 6-11: Sanitation facilities in the GMLM

Type	2007 (% of households)	2011 (% of households)
Flush toilets connected to a sewage system or septic tank	50	90
Pit toilets with ventilation	7	3
Pit toilet without ventilation	23	2
Bucket toilet system	7	0.6
None	11	1.3

Source: Statistics South Africa 2007 and 2011

Bethal and Emzinoni

Sanitation facilities in Bethal are generally good with approximately 97% of households having access to flushing toilets. Despite this the GMLM has estimated it will spend R31.7 million on the upgrading of the Bethal sewerage system over the next 5 years. The situation is Emzinoni is not as good, the most concerning fact being that 7.8% of households reported not having access to any toilet facilities. The GMLM has estimated they will spend R4.5 million over the next 5 years on the provision of sanitation services in Emzinoni. Table 6-12 below provides a breakdown of the sanitation facilities in Bethal and Emzinoni.

Table 6-12: Sanitation facilities in Bethal and Emzinoni

Type	Bethal	Emzinoni
Flush toilets connected to a sewage system or septic tank	97%	76%
Pit toilets with ventilation	0.2%	5.4%
Pit toilet without ventilation	0.2%	4.7%
Bucket toilet system	0.2%	4.5%
None	0.8%	7.8%

Source: Stats SA, Census 2011

6.8.3 Energy

Govan Mbeki Local Municipality

Eskom is the primary bulk provider of electricity in the GMLM, and the Wildebees and Sol substations supply the towns in the GMLM. Approximately 90% of households within the Municipality have access to electricity. The power networks in Evander, Trichardt and Bethal are degraded and require upgrading. Additional bulk capacity is required in most areas. Recommendations apart from expanding capacity include the moving of certain substations, strengthening existing cables and installing new cables (GMLM IDP 2012). Table 6-13 provides a breakdown of the predominant sources of energy used in the GMLM.

Table 6-13: Sources of energy in the GMLM

Source of Energy	2007 (% of households)	2011 (% of households)
Electricity	57	90
Gas	0.3	0.2
Candles and paraffin	47	8.9

Source: GMLM IDP 2012

The usage of electricity as the predominant source of energy has increased significantly from 57% in 2007 to 90% of households in 2011. As a result, electricity remains the most used item for cooking, lighting and heating. Similarly, the use of candles and paraffin has also decreased from 47% in 2007 to 8.9% in 2011.

Bethal and Emzinoni

From the table below it is clear to see that electricity is the dominant source of energy in both Bethal and Emzinoni for cooking, heating and lighting. However, charcoal is also frequently used, particularly in Emzinoni for cooking and heating. This is mainly due to households not being able to afford electricity or not being connected to the municipal supply.

Table 6-14: Sources of energy in Bethal and Emzinoni

Energy Source	Bethal			Emzinoni		
	Cooking	Heating	Lighting	Cooking	Heating	Lighting
Electricity	83%	70.2%	96.6%	57.6%	49.8%	84.6%
Gas	4.4%	6.2%	<1%	1.4%	1.9%	<1%
Paraffin	1.4%	<1%	<1%	3.1%	1.5%	<1%
Candles	-	-	2.3%	-	-	14.1%
Wood	<1%	<1%	-	<1%	<1%	-
Charcoal	10.7%	21.3%	-	34.8%	46.1%	-
Solar	<1%	<1%	<1%	<1%	<1%	<1%

Source: Stats SA, Census 2011

6.8.4 Transport

Govan Mbeki Local Municipality

Public transport in the GMLM is road based and centres on bus and minibus taxi transport. Rail services are exclusively dedicated to freight. The Gert Sibande's Integrated Transport Plan (2012-2016) identified a total of 9 taxi ranks in the GMLM. Formal taxi ranks exist in Secunda, Lebohang, Evander, eMbalenhle and Bethal, however these taxi ranks do not have surfaced areas, shelters or ablutions. Bus transport is primarily rendered on a contract basis to Sasol Mines. The Department of Public Works provides transport for school children.

The GSDM SDF states that generally, the maintenance of roads remains a major challenge due to the damage caused by the heavy vehicles used to transport coal to Eskom's power stations. One of the challenges facing the municipality is to continuously maintain roads and pave or tar gravel roads.

Bethal and Emzinoni

Bethal is situated on the N17/N2 corridor which runs east to west through the municipality. For this reason Bethal experiences a high volume of large trucks moving through the town.

Transport in Bethal and Emzinoni, as in the rest of the municipal area, is road based. Roads in Bethal are tarred and generally in decent condition. There are several informal taxi ranks in the town which are utilised as the predominant source of transport. Emzinoni also has a tarred central road network, however the majority of this is in poor condition. The secondary roads are dirt which are susceptible to erosion during heavy rainfall. Taxis, as in Bethal, are the primary source of transport, at a cost of R10 per trip from Emzinoni to Bethal.

Figure 6-3: Transport in Bethal and Emzinoni

6.9 Local Economy and Livelihood Strategies

6.9.1 Levels and Areas of Employment

Govan Mbeki Local Municipality

Traditionally the GMLM has employed people predominantly in the mining and manufacturing (including Sasol) industries. This trend continues today with Sasol employing approximately 8 600 people in its non-coal mining operations and 6 800 people in coal mining, while sub-contractors providing services for Sasol account for a total of approximately 7 000 jobs. Industries such as commercial agriculture does not account for a large percentage of employment largely due to the sustainability of employment being threatened by increasing mechanisation. The distribution of employment by industry in the GMLM is summarised below.

Table 6-15: Employment sectors in the GMLM

Sector	Percentage of workforce employed	
	2001	2010
Agriculture, hunting, forestry and fishing	4.8	3.0
Mining and quarrying	**21.5**	**21.8**
Manufacturing	**22.9**	**18.2**
Electricity, gas and water supply	0.7	0.6
Construction	3.9	5.3
Wholesale and retail trade	**20.9**	**21.0**
Transport, storage and communication	3.8	4.3
Financial, insurance, real estate and business services	3.5	5.4
Community, social and personal services	10.2	12.2
Private households	7.7	8.1

Source: GMLM and Mpumalanga Department of Finance

The unemployment rate in the GMLM touches almost all segments of the population including men, women, and youth. This may be attributed to the lack of skills, low levels of literacy and an undiversified local economy. People who obtain skills outside those required by mining and electricity companies are less likely to find adequate employment. Unemployment in the GMLM predominantly affects the black population, and particularly the women. Unemployment is high in previously disadvantaged urban areas such as eMbalenhle, eMzinoni, Lebohang, and informal settlements around towns. Table 6-16 below provides a breakdown of the employment levels in the GMLM according to race and gender.

Table 6-16: Employment levels in the GMLM

Racial Group	Black		White		Indian/Asian		Coloured	
Gender	Male	Female	Male	Female	Male	Female	Male	Female
Economically active population[13]	63 352	47 365	14 657	10 611	1 466	728	1 316	894
Number of unemployed	14 985	18 298	564	900	60	78	129	147
Unemployment rate[14] (%)	**23.7%**	**38.6%**	**3.8%**	**8.5%**	**4.1%**	**10.7%**	**9.8%**	**16.4%**

Source: Stats SA, Census 2011

Bethal and Emzinoni

Employment in Bethal and Emzinoni follows a similar trend to that of the GMLM. Black women are particularly vulnerable to unemployment in both in Bethal and Emzinoni with unemployment rates of 38.4% and 43.6% respectively. Table 6-17 below provides a breakdown of the employment levels in both Bethal and Emzinoni.

Table 6-17: Employment levels in Bethal and Emzinoni

	Racial Group	Gender	Employed	Unemployed	Unemployment Rate
Bethal	Black	Male	2 387	612	20.4%
		Female	1 443	900	38.4%
	White	Male	1 580	82	4.9%
		Female	1 107	137	11.1%
	Coloured	Male	43	14	24.6%
		Female	34	10	29.4%
	Indian/Asian	Male	113	10	8.1%
		Female	56	10	15.2%
Emzinoni	**Racial Group**	**Gender**	**Employed**	**Unemployed**	**Unemployment Rate**
	Black	Male	4 441	1 574	26.2%
		Female	3 034	2 347	43.6%
	White	Male	15	3	16.7%
		Female	7	-	0%
	Coloured	Male	30	11	26.8%
		Female	16	13	44.8%
	Indian/Asian	Male	33	2	5.7%
		Female	-	-	-

Source: Stats SA, Census 2011

[13] The economically active population includes people from 15 to 64 years of age who are either employed or unemployed and who are seeking employment

[14] The unemployment rate refers to the percentage of the work force that is unemployed but is willing and able to work and actively seeking employment

Of the employed population in Bethal and Emzinoni, 76.4% of black males and 69.2% of black females are employed in the formal sector. The majority of these jobs are in the mining, manufacturing industries and farming.

Only 11.2% of the total employed population is employed in the informal sector while 12% of the total employed population are employed by private households.

Lack of employment has been cited by all key informants and focus groups as the most prevalent socio-economic issue in the area.

6.9.2 Agriculture

Govan Mbeki Local Municipality

Subsistence and small scale farming is not widely practiced in the GMLM. Some households have expressed a willingness to farm however as most households live in either peri-urban or urban areas it is often difficult for people to acquire lands parcels.

Within the GMLM, the majority of available land is used for large scale commercial agriculture, despite this the industry only accounts for 8.7% of the districts Gross Value Added. The petrochemical industry is the main contributor to municipal output. Labour intensity has reduced in the agriculture industry due to mechanisation; therefore it represents only 3.0 % of employment.

Cattle and sheep farming is practiced on a large scale in the GMLM, however small scale animal husbandry is not common. This is again due to the per-urban and urban nature of the majority of settlements.

Bethal and Emzinoni

While Bethal is traditionally an agricultural town with large scale maize, sorghum, sunflower and potato farms in the area, the industry is not a significant employer due to mechanisation of the industry, as in the rest of the municipal area, and the growth of the coal mining industry which has resulted in large scale land acquisition.

The only agriculture occurring in Emzinoni is small scale subsistence gardens. Livestock farming seems to be evident in Emzinoni, with cattle, pigs, goats and chickens roaming around the township. While there is a designated private area for keeping the livestock within the township, most of the livestock were observed roaming the streets of Emzinoni. Some of the key informants indicated that the livestock belonged to households that have been relocated from farms with no plans made for keeping the livestock.


Figure 6-4: Agricultural activities at Emzinoni

6.9.3 Income

Govan Mbeki Local Municipality

The GMLM is one of the wealthier local municipalities within the GSDM with an average per capita income higher than that of the GSDM and Mpumalanga as a whole. Despite this 37% of the population still live below the poverty line. The table below provides an overview of the income levels in the GMLM.

Table 6-18: Income levels in the GMLM

Development Indicator (2010)	GMLM	GSDM	Mpumalanga
Poverty Rate	37.1%	49.2%	45.6%
Per capita income per year	R37 880.00	R25 769.00	R26 623.00
% of households below R3 500p/m	40.7%	49.9%	46.9%

Source: GMLM IDP, 2012-2017

Bethal and Emzinoni

In both Bethal and Emzinoni 47% of individuals do not earn any monthly income; this places these households in a vulnerable position and increases the responsibility on the few income earners. While the income levels are fairly similar, Bethal does have more income earners over R3 200.00 per month while the majority of income earners in Emzinoni earn under R1 600.00 per month. The figure below provides a breakdown of the individual monthly income in Bethal and Emzinoni.

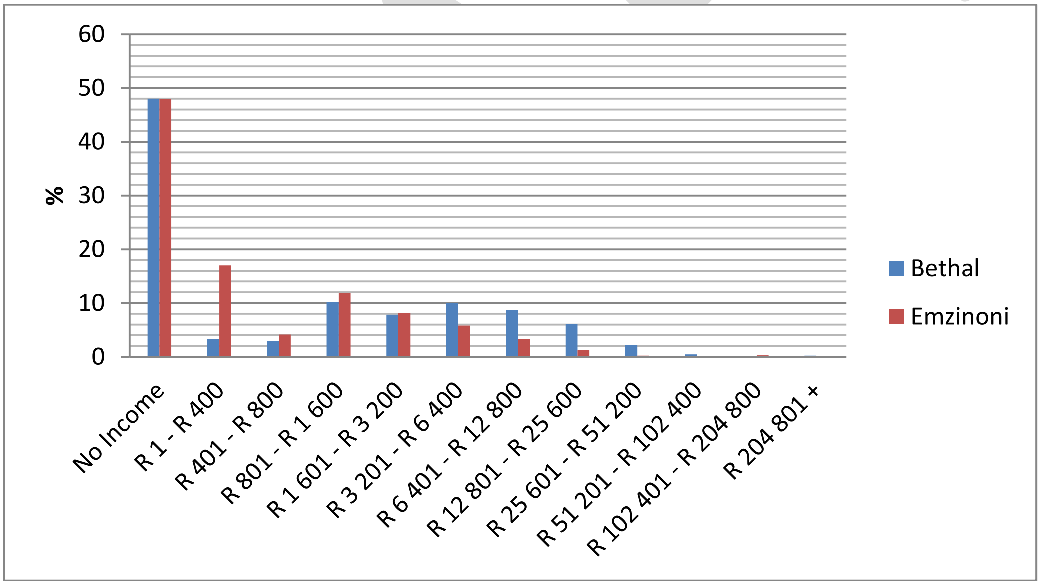

Figure 6-5: Individual monthly income in Bethal and Emzinoni

Source: Stats SA, Census 2011

6.10 Local Social Dynamics

6.10.1 Culture

The population of the GMLM is predominantly Zulu, making up over 60% of the overall population. Other ethnic groups include Swazi, Venda and Ndebele. No intra-ethnic conflicts were reported in the area and people generally seem to live peacefully among each other. There were isolated reports of resentment against some foreign nationals who own shops in the area, particularly in Emzinoni in 2012.

Religion continues to play a very strong role in the communities. The dominant religion is Christianity with the majority of the population belonging to the Zion Christian Church. It was reported during focus group discussions that church attendance was always good and that religious leaders played an important role within the community.

6.10.2 Youth

The majority (68%) of the GMLM population is under 35 years of age. This large contingent of the population is largely unemployed and a general sense of frustration is apparent due to the lack of job opportunities. The need for employment is the number one comment in all public meetings held in the GMLM.

The GMLM has expressed the need for improved education and post matric education and training in order to make the youth more employable and possibly diversify the economy away from the current dominant industries.

While the youth stand to benefit from the growing mining industry in the GMLM, should they not be employed there is also potential for them to be further removed from the workforce increasing their vulnerability and disillusionment.

A key informant discussion with Emzinoni youth in September 2015 highlighted the following key issues - while only one person was interviewed representing the youth, these issues are similar to those raised by other key informants:

- Unemployment and lack of skills from high drop-out rates in local schools;
- No skills assessment has been conducted in Emzinoni to confirm if there are mine related skills in the area;
- Tensions between local youth and outsiders regarding competition for jobs;
- Shortage of further education and training colleges and tertiary institutions in the area, making access for post matriculants difficult;
- High rate of alcohol, drug abuse and related crimes due to high unemployment rates and lack of extra mural activities in the area; and,
- SLP projects from current mines are not being implemented and are ineffective in improving the living conditions of Emzinoni.

The key informants from the Sesifikile Youth Development Centre were also interviewed on 2 September 2015. The Department of Social Development in Bethal established the Sesifikile Youth Development Centre in 2011 as a Non-Profit Organisation to assist youth with services to improve their chances of studying further or accessing job opportunities. The centre is open to all the youth in Emzinoni and services provided are free. The objectives of the centre are as follows:

- Provide information to the youth regarding education and training opportunities;

- Provide access to computers, printing, faxing, internet and email services for typing and sending CVs or job applications;
- Provide life skills workshops to the youth, (alcohol and drug abuse);
- Train the youth on entrepreneurship skills;
- Train the youth on basic computer literacy; and;
- Provide career guidance workshops to the youth.

It was also established with the centre that there is a database of unemployed people that can be shared with industries looking for skills in Emzinoni.

6.10.3 Social Problems, Conflict and Crime

There are nine police stations and three magistrate's courts operating in the GMLM area. Crime statistics reported to each station are provided below (reported cases per 100 000).

Table 6-19: Crime statistics within the GMLM

Town	2005	2010
Bethal	238	189
Charl Cilliers	43	28
Embalenhle	1727	1219
Emzinoni	409	428
Evander	235	185
Kinross	213	132
Leslie	719	445
Secunda	559	58
Trichard	209	90
Total	**1 814**	**1 244**

Source: GMLM 2012-2015 IDP

There seem to be a decline in the number of contact crimes from 2005 (1 814) to 2010 (1 244). While the highest crime rates are at Embalenhle in 2005, there has also been some decline in these figures in 2010.

Bethal and Emzinoni

There are two police stations in the project area, namely Bethal Police Station responsible for the town of Bethal, surrounding farms and mines; and Emzinoni Police Station responsible for Emzinoni. Key informant interviews at Bethal and Emzinoni Police stations have revealed the following key concerns in the area.

Table 6-20: Safety situation in Bethal and Emzinoni

<table>
<tr><th></th><th>Bethal Police Station</th><th>Emzinoni Police Station</th></tr>
<tr><td>Prevalent crimes in the area</td><td>• Shoplifting;
• Vehicle jamming;
• Assault and common house burglaries
• Drug abuse (especially nyaope and dagga);
• Shortage of human and physical resources to deal with crime in the area. There are only 2 vehicles per shift in Bethal;
• Influx of new people into the area causing a stress to the facilities; and,
• Mining related crimes are theft of copper cables, truck tyres and diesel.</td><td>• House burglaries, especially during the winter months;
• Drug abuse due to unemployment and poverty;
• Shortage of human and physical resources to deal with crime in the area; and,
• Influx of new people into the area causing a stress to the facilities.</td></tr>
<tr><td>Key concerns and challenges</td><td>• Crime in the area is increasing due to poverty and unemployment.</td><td>• Influx of people into the area but no upgrading of services to deal with the growth- result in added pressure on police services.</td></tr>
<tr><td>Strategies in place to address challenges</td><td colspan="2">• Youth desk crime prevention strategy to educate the youth about crime and the consequences thereof;
• School based crime prevention to educate children in schools about crime;
• Rural safety involving farm owners and workers and teaching them how to prevent themselves from being victims of crime;
• Neighbourhood watches and Community Policing Forums in all communities; and,
• South African Police Service stakeholders' forum[15] established to control crime in the area.</td></tr>
</table>

Source: Key informant interviews, 2015

[15] The Forum includes local farm owners, police, community policing forums and the youth

7 Tertiary Zone of Influence

7.1 Overview

The Tertiary ZoI includes the town of Kriel (including Thubelihle). They have been included due to their proximity to the proposed Elders Colliery, (12 km west of the project). Where possible distinct information for Thubelihle has been provided, however this is not possible for all areas as it is sometimes grouped together with Kriel. It is anticipated that both of these communities will experience induced and interactive impacts due to the construction of the mine. These impacts will predominantly relate to potential employment, influx, and inflation. These impacts are discussed in detail in Section 8.

Both Kriel and Thubelihle are within the ELM and therefore an overview of the municipality has been provided to create a baseline and a context.

7.2 Geographic Context

The ELM is one of six local municipalities within the Nkangala District Municipality (NDM). Other municipalities are Victor Khanye Local Municipality, Steve Tshwete Local Municipality, Emakhazeni Local Municipality, Thembisile Hani Local Municipality and Dr J S Moroka Local Municipality.

The ELM is situated on the Highveld in Mpumalanga and covers approximately 2 677 square kilometres (km). The local municipality consists of a number of towns, including Balmoral, Clewer, Coalville, Hlalanikahle, Kendal, Kriel, Kwaguqa, Lynnville, Matla, Minnaar, New Largo, Ogies, Paxton, Phola, Rietspruit, Thubelihe, Van Dyksdrift and Wilge, with eMalahleni City (Witbank) being one of the major urban concentrations in NDM and Mpumalanga as a whole. While the municipality can be described as rural with large farms and dispersed urban centers there is a significant industrial, power generation and coal mining sector present.

7.3 Political Context

7.3.1 Local Government structure

The municipal council comprises 31 councillors - 16 of which are elected by their respective wards, and the remaining 15 are appointed by elected political candidates. Each of the 16 ward councillors are supported by a team of ten local residents who assist councillors with day to day activities. In addition, the 31 councillors are mandated to elect six executive committee members. While the Mayor serves as the chairperson of the executive committee, the remaining five executive members are chairpersons of five standing committees which include:

- Finance;
- Corporate Services;
- Technical Services;
- Community Services; and,
- Integrated Planning and Economic Development.

7.3.2 Municipal Challenges

The main challenges facing the municipality can be divided into two main categories. These are:

- **Organisational challenges**: These relate to the inability of the local municipality to retain skilled employees. Larger municipalities and private sector businesses usually offer bigger packages to lure employees away from ELM. The second challenge is linked to the first one in that the inability to retain skilled employees leads to high staff turnover, which in turn affects service delivery. Interviews are said to be organised on a monthly basis to fill the gap caused by the staff turnover.
- **Operational challenges**: the lack of equipment in the municipality also tends to affect service delivery. For instance, roads, sanitation and educational facilities are not serviced on a regular basis.

7.4 Demography

7.4.1 Population Structure

The ELM has a population of **395 466** people. Table 7-1 provides an overview of the demographic structure of the ELM.

Table 7-1: Demographic structure of ELM

Age Group	Black African		White		Coloured		Indian/Asian		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
0-7	25 344	25 402	3 377	3 149	561	529	240	215	58 971
8-18	27 249	27 552	4 504	4 238	681	632	266	265	65 501
19-35	68 177	52 981	7 895	7 720	1 168	1 015	908	452	141 271
36-50	31 951	27 676	7 036	6 932	603	628	448	331	75 866
51-65	15 479	12 731	5 875	5 804	326	358	169	161	40 998
66-74	1 894	2 656	1 609	1 814	57	85	38	34	8 216
75+	931	1 647	744	1 198	22	53	10	23	4 643
Total	**321 668**		**61 893**		**6 717**		**3 562**		**395 466***

*1 626 respondents did not categorise themselves into any of the above race groups

Source: Stats SA, Census 2011

The biggest segment of the population in the ELM is aged between 19 and 35 (35.7%). Also apparent from the above table is the fact that the size of the population is a decreasing function of the average age group. In other words, the older the segment group, the smaller the size of the segment group. This is particularly prevalent among the black population in the ELM.

The overwhelming majority of the local population can be classified as Black African (81.3%) and Whites, Coloureds and Indian/Asians represent 15.7%, 1.7% and 0.9% respectively.

In 2011 Thubelihle had a population of 14 938 (47.6% female, 42,4% male) and Kriel had a population of 9 187 (46.8% female and 53.2% male).

7.4.2 Migration

Migration into the ELM since 2007 has been steadily growing, with a spike in 2011. The majority of people migrating to the ELM originate from outside of South Africa, with the majority being male. It is assumed that these migrants have come to the ELM in search of employment and/or improved infrastructure and services. This level of migration will increase the pressure on the municipality to provide services and on local companies to provide employment. Table 7-2 below provides an overview of the number and origin of migrants into the ELM.

Table 7-2: Migration into the ELM

	2007		2008		2009		2010		2011	
	M	F	M	F	M	F	M	F	M	F
Western Cape	-	1	3	1	6	1	2	-	2	-
Eastern Cape	6	9	5	2	7	-	4	5	4	3
Northern Cape	-	-	1	-	9	5	1	-	-	2
Free state	3	-	2	-	6	2	3	2	-	2
KwaZulu-Natal	6	3	16	8	10	6	3	1	1	1
North West	10	3	4	1	10	-	4	1	2	-
Gauteng	64	32	96	39	68	24	55	27	32	16
Mpumalanga	120	63	143	94	141	86	80	57	62	49
Limpopo	10	4	9	4	5	3	5	1	7	-
Outside SA	**573**	**275**	**832**	**380**	**819**	**464**	**1 000**	**546**	**1 449**	**841**
Sub-total	791	392	1 113	530	1 082	590	1 159	641	1 559	914
Grand Total	**1 183**		**1 643**		**1 672**		**1 800**		**2 473**	

Source: Stats SA, Census 2011

7.5 Education and Literacy

7.5.1 State of Education in Emalahleni Local Municipality

The level of education in the ELM in comparison with other local municipalities in the NDM is relatively good. The municipality recorded the lowest percentage of people without any schooling (5.5%) in the NDM. Functional literacy rate (people aged 20 and over who completed grade 7) was estimated at 83.7 %, and the ELM also recorded the highest percentage of residents that completed secondary school 58,8 % in the NDM. Table 7-3 below provides an overview of the highest levels of education achieved in the ELM.

Table 7-3: Education levels in the ELM

Highest Level of Education Attained	Percentage of Population
	ELM
No education	5.5
Primary School	27.3
Secondary School	58.8
Certificate/Diploma (without matric)	0.6
Tertiary Education	7.7

Source: Stats SA, Census 2011

7.5.2 State of Education in Kriel and Thubelihle

Education Levels

Education levels in Kriel are good compared to the municipal average, particularly regarding people with no schooling and tertiary education. Only 0.3% of the population do not have any education while 24.9% have tertiary education. The situation in Thubelihle is not as good, with only 1.8% of the population having tertiary education. Table 7-4.

Table 7-4: Education levels in Kriel and Thubelihle

Highest Level of Education Attained	Percentage of Population	
	Kriel	Thubelihle
No education	0.3	8.1
Primary School	25.7	34.6
Secondary School	57.0	55.8
Certificate/Diploma (without matric)	0.9	0.1
Tertiary Education	24.9	1.8

Source: Stats SA, Census 2011

The literacy rate for isiZulu in Kriel and Thubelihle is considered to be high. Respondents estimated that the majority of the population was literate in isiZulu (70% to 80% of people can read and write isiZulu); but that the literacy rate for English is low (less than 50% of the population could read and write English).

Education Infrastructure

Focus group meetings with women revealed that the local population of Kriel and Thubelihle have access to a number of schools, which are situated close to the residential areas, and as such learners do not have to travel long distances to attend school.

Overall, the majority of school-going children attend school with an estimated school attendance well over 95%. The quality of education is said to be acceptable in all schools. Table 7-5 below provides an overview of the schools that are utilised by Kriel and Thubelihle.

Table 7-5: Schools in Kriel and Thubelihle

Community	School	Level	Number of Learners	Number of Teachers
Thubelihle	Bonginhlanhla	Primary	873	23
	Sibongamandla	Secondary	1 128	38
	Kwanala	Primary	736	22
Kriel	Kriel High	Secondary	1 006	42
	Merlin Park	Primary	876	26
	Kriel Park	Primary	459	17
	Onverwacht	Primary	611	21

Source: SRK survey, 2013

7.6 Health

7.6.1 State of Health in Emalahleni Local Municipality

Unlike Thembisile Hani and Dr JS Moroka local municipalities where healthcare is provided by the Provincial Department of Health, health services in the ELM are provided by the NDM. Some of the challenges faced by this healthcare system include:

- The infrequent visits by doctors to the clinics (including Kriel and Thubelihle);
- The inconsistent drug supply to healthcare facilities;
- Budgetary constraints; and,
- The high staff turnover of doctors and nurses.

ELM has four hospitals and 18 clinics. According to the ELM IDP, these hospitals are sufficient in terms of the hospital-to-population ratio, however, there is a shortfall of approximately 10 clinics in the municipality. A number of mobile clinics also operate in the area, which largely service the rural population.

7.6.2 Health Infrastructure in the Kriel and Thubelihle

Residents in Kriel and Thubelihle have access to three health facilities. These facilities include Thubelihle Clinic, Kriel Clinic and Ga-Nala Clinic. Patients do not pay any consultation fees at any of these clinics.

Women in focus group meetings rated the quality of healthcare provision at these clinics as either “average” or “bad”. The reasons provided for these ratings include lack of available medicines, the aging infrastructure, staff shortages and the restricted operating hours. For example, Thubelihle Clinic operates from 07:00 AM until 16:00 PM, and is closed on weekends.

For more serious ailments that cannot be treated at the clinics, patients are generally either referred to a hospital in Emalahleni or Bethal Hospital.

7.6.3 State of Health in Kriel and Thubelihle

A number of ailments affect the population in both Kriel and Thubelihle; however the most prevalent ailments and diseases include high blood pressure, diabetes and TB. It was difficult to determine the extent of HIV/AIDS infection in the area but respondents at focus group interviews did indicate that it was high. Table 7-6 below provides a breakdown of the common ailments in men, women and children.

Locals use a mixture of traditional and conventional medicine to treat these illnesses. In general, respondents confirmed that traditional healers (known locally as Sangomas) are consulted, however their influence is decreasing. It was reported that they charge between R100 and R200 per consultation.

Table 7-6: Common health problems in Kriel and Thubelihle

Town/Settlement	Men	Women	Children
Kriel	Diabetes	Diabetes, HIV/AIDS and other sexually transmitted diseases, high blood pressure, cervical, breast and skin cancer	Sinuses, asthma, diarrhoea and HIV/AIDS
Thubelihle	High blood pressure, HIV/AIDS, diabetes, cancers and tuberculosis	High blood pressure, HIV/AIDS, diabetes, cancers and tuberculosis	Nutrition related illnesses, HIV/AIDS and flu

Source: Focus group interviews, 2012

7.7 Housing

7.7.1 State of Housing in Emalahleni Local Municipality

Adequate housing remains a serious challenge for the municipality. The ELM IDP (2012-2013) reports that there are 39 informal settlements in the area and that the municipality needs about R2.8 billion to meet the housing backlogs. Most of these informal settlements are situated in Kwa-Guqa, which has approximately 10 500 informal houses.

7.7.2 State of Housing in Kriel and Thubelihle

Housing in Kriel is generally modern, the majority having been constructed in the 1970s to house mine employees. There are a few informal houses developing on the outskirts of the town, particularly to the south-west. Housing in Thubelihle is predominantly formal housing (including RDP), only 13.7% of housing is informal, however this is on the rise due to influx into the area.

Table 7-7: Housing in Kriel and Thubelihle

Type of Housing	Kriel	Thubelihle
Formal	2 425 (95.2%)	3 971 (83.8%)
Traditional	17 (0.7%)	120 (2.5%)
Informal	104 (4.1%)	650 (13.7%)
Total	**2 546**	**4 741**

Source: Stats SA, Census 2011

7.8 Infrastructure and Services

This section describes the services (water, sanitation and energy) and infrastructure (transport and communication) in the ELM, Kriel and Thubelihle.

7.8.1 Water Supply

Emalahleni Local Municipality

The ELM IDP states that the service infrastructure in the municipality is approximately 15 years old and in need of refurbishment. There are currently 31,969 households that do not have sufficient access to water reticulation and the municipality's current source of water, the Emalahleni Dam, is only sustainable during the wet season. During the dry season, water shortages often occur.

To compensate for this shortfall, the municipality has undertaken various projects and is investigating the following options:

- Recycling approximately 30 million litres per day of sewage effluent;

- Supplying industry with processed industrial water from various treatment works;
- Purchasing the Doornpoort Dam;
- Possible support from the Middleburg Dam; and,
- The transfer of Bruspruit water treatment works from Water Affairs to Emalahleni.

According to ELM these plans will go a long way to guaranteeing a sufficient supply of water in the municipality.

Kriel and Thubelihle

The majority of houses in Kriel have access to piped water in the house, while only 0.7% of households do not have access to piped water. The situation is not as good in Thubelihle with only 44.8% of households having piped water inside the household while 6.1% do not have access to piped water.

Table 7-8: Sources of water in Kriel and Thubelihle

Source of Water	Kriel	Thubelihle
No access to piped water	0.7%	6.1%
Piped water inside the house	81.9%	44.8%
Piped water in the yard	17.1%	47.6%
Communal standpipe	0.3%	1.6%

Source: Stats SA, Census 2011

Residents in Kriel expressed their concerns over the quality of the water they received and commented that people often got sick from drinking it. Although the quantity of water was said to be sufficient, its quality was also described in focus group meetings with women as “bad”. They also mentioned that people accessed water using two sources, municipal water and boreholes. The latter category of water usage was more prominent in farms than in urban areas.

7.8.2 Sanitation

Emalahleni Local Municipality

Access to adequate sanitation is one of ELM’s primary focus areas. The municipality understands that adequate sewage and disposal facilities are directly linked to people’s welfare. As such, the number of households with access to flushing toilets has steadily increased since 2001. The number of flushing toilets connected to a sewage system increased from about 52 100 in 2001 to over 82 000 in 2011. Despite this improvement the number of people using non-ventilated pit latrines remains high as does the amount of people without any sanitation facilities. Table 7-9 provides the list of toilet types with their respective numbers.

Table 7-9: Sanitation facilities in ELM between 2001 and 2011

Type	2001	2007	2011
Flush toilets connected to a sewage system	52 153	61 023	82 482
Flush toilets with a septic tank	789	2 063	2 389
Dry toilets	0	1 974	2 412
Pit toilets with ventilation	839	4 842	3 812
Pit toilet without ventilation	14 097	28 828	24 223
Chemical toilets	653	626	844
Bucket toilet system	1 171	114	726
None	5 215	6 072	2 987

Source: ELM IDP 2012 and Stats SA, Census 2011

Kriel and Thubelihle

Sanitation facilities in Kriel are better than the municipal average with 97.5% of households having access to flushing toilets connected to a sewerage system. The remaining households either make use of flushing toilets connected to a septic tank or a VIP latrine.

The situation in Thubelihle is also relatively good with 89% of households having access to flushing toilets connected to either a sewerage system or septic tank. The remaining households make use of pit latrines (VIP and non-VIP). Only 1.8% of houses in Thubelihle do not have any sanitation facilities. Table 7-10 below provides a detailed breakdown of the sanitation facilities in Kriel and Thubelihle.

Table 7-10: Sanitation facilities in Kriel and Thubelihle

Type	Kriel	Thubelihle
Flush toilets connected to a sewage system or septic tank	**97.5%**	**89.6%**
Pit toilets with ventilation	0.9%	3.8%
Pit toilet without ventilation	-	3.8%
Bucket toilet system	-	0.2%
None	-	1.8%

Source: Stats SA, Census 2011

7.8.3 Energy

Emalahleni Local Municipality

As in the GMLM, Eskom is the primary electricity supplier of electricity in the ELM. Electricity is the dominant energy source in the municipality for cooking, heating and lighting. Paraffin and coal are important sources of energy for cooking and heating, while candles are used extensively for lighting. Alternative energy sources such as solar power remains underutilised.

Table 7-11: Energy sources and uses in the ELM

Energy Source	ELM		
	Cooking	Heating	Lighting
Electricity	**70.8%**	**71.6%**	**73.4%**
Gas	2.3%	2.8%	<1%
Paraffin	21.5%	5.4%	2.5%
Candles	-	-	23.3%
Wood	1.6%	4.8%	-
Charcoal	3.5%	15.1%	-
Solar	<1%	<1%	<1%

Source: Stats SA, Census 2011

Kriel and Thubelihle

In Kriel electricity is the dominant source of energy for cooking, heating and lighting. While electricity remains the primary source of energy in Thubelihle as well, alternative sources such as paraffin and coal are used for cooking and heating and candles for lighting. The cost of electricity was noted as the main reason why households in Thubelihle would sometimes revert to using alternative sources of energy. Table 7-12 below provides an overview of the sources and uses of energy in Kriel and Thubelihle.

Table 7-12: Energy sources for cooking and lighting at Kriel and Thubelihle

Energy Source	Kriel			Thubelihle		
	Cooking	Heating	Lighting	Cooking	Heating	Lighting
Electricity	97.6%	90.8%	99%	80.8%	68.3%	87.4%
Gas	1.1%	3.3%	<1%	1.4%	1.5%	<1%
Paraffin	<1%	<1%	<1%	6.8%	4.1%	<1%
Candles	-	-	<1%	-	-	11.1%
Wood	<1%	<1%	-	1.7%	2.3%	-
Charcoal	<1%	4.3%	-	8.9%	24.9%	-
Solar	<1%	<1%	<1%	<1%	<1%	<1%

Source: Stats SA, Census 2011

7.8.4 Transport

The ELM IDP 2012-2013 states that major road refurbishments need to be undertaken throughout the municipality. Some of the constraints regarding transport infrastructure and services the municipality is faced with include:

- The formalisation of the taxi industry;
- The construction of drop-offs and loading zones in the area;
- The lack of an Integrated Transport Plan; and,
- The insufficient funding to meet transport needs.

In focus group meetings with men and women in Kriel and Thubelihle, it was stated that community members commute to neighbouring towns for a variety of reasons. These reasons include shopping, doctor appointments, family visits, banking and access to municipal services such as the police and Home Affairs. The places most visited by the respondents include eMalahleni (Witbank), Secunda and Bethal. The main source of transport is taxis, while shorter distances are covered on foot.

7.8.5 Communication

Televisions and radios are almost exclusively the community's source of news and information. They have access to a number of local television and radio shows. National and local newspapers are readily available in the area. Cell phones are the primary way for people to communicate with the majority of households in both Kriel and Thubelihle owning at least one cell phone. All three major networks cover the area.

7.9 Local Economy and Livelihood Strategies

7.9.1 Areas of Employment

Emalahleni Local Municipality

Mining, agriculture, power generation and the manufacturing industries are the largest employers in the ELM. There are currently more than 22 collieries within the municipal radius, making mining the largest employer. Power stations, such as Kendal, Matla, Duvha and Ga-Nala are all within the ELM and are also significant local employers.

While the agricultural sector has traditionally, and still is, a significant industry in the municipality, increasing mechanisation and the purchasing of land by mining companies and has seen this sector of the economy shrink as an area of employment.

Industry and the manufacturing sector are growing rapidly in the municipality, with large companies such as Evraz Highveld Steel and Vanadium Limited, employing significant amounts of people.

7.9.2 Employment Levels

Opportunities for formal employment in the ELM are low. People who participated in the focus group meetings emphasized that unemployment was the biggest problem facing local communities. To overcome the high unemployment rate, government has implemented a number of short-term employment generating activities. Local residents have witnessed a sharp increase in short-term employment opportunities in the following areas: road works, water pipeline construction between power stations and municipal employment opportunities; however these are only temporary positions.

Establishing privately owned businesses is another way local entrepreneur's combat unemployment. Some of the privately owned businesses include: barbershops, car washing businesses, local vendors and mechanics. Participants in focus group meetings said that local entrepreneurs are faced with the following constraints:

- Lack of skills;
- Lack of training facilities;
- Nepotism and bribery in the large companies' recruitment processes;
- Lack of opportunities for local residents; and,
- Homogeneous business environment focused on mining and electricity generation.

The table below provides an overview of the unemployment levels in the ELM.

Table 7-13: Unemployment levels in the ELM

Racial Group	Black		White		Indian/Asian		Coloured	
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Economically active population	95 833	67 450	17 904	12 953	1 399	595	1 599	1 407
Number of unemployed	22 072	26 331	1 040	1 514	97	106	394	422
Unemployment rate (%)	**23.1%**	**39.1%**	**5.8%**	**11.7%**	**6.9%**	**17.8%**	**24.6%**	**29.9%**

Source: Stats SA, Census 2011

Kriel and Thubelihle

Employment levels in Kriel and Thubelihle are similar to those experienced throughout the ELM. Thubelihle has particularly high unemployment rates among black women which is a trend throughout Mpumalanga. The table below provides a breakdown of the unemployment situation in Kriel and Thubelihle.

Table 7-14: Unemployment levels in Kriel and Thubelihle

	Racial Group	Gender	Employed	Unemployed	Unemployment Rate
Kriel	Black	Male	1 457	254	14.8%
		Female	636	381	37.5%
	White	Male	884	97	9.9%
		Female	484	135	21.8%
	Coloured	Male	59	2	3.3%
		Female	26	7	21.2%
	Indian/Asian	Male	46	2	4.2%
		Female	13	2	13.3%
Thubelihle	**Racial Group**	**Gender**	**Employed**	**Unemployed**	**Unemployment Rate**
	Black	Male	3 122	1 250	28.6%
		Female	1 570	1 720	52.3%
	White	Male	25	3	10.7%
		Female	17	8	32.0%
	Coloured	Male	15	-	0%
		Female	5	2	28.6%
	Indian/Asian	Male	5	5	50%
		Female	-	3	100%

Source: Stats SA, Census, 2011

7.9.3 Income

Emalahleni Local Municipality

Individual monthly income in the ELM is higher than in both the NDM and Mpumalanga. A high percentage of individuals reported that they do not earn any monthly income, indicating both a high unemployment rate and a high level of dependency on household income earners. The figure below provides a breakdown of individual monthly income in the ELM.

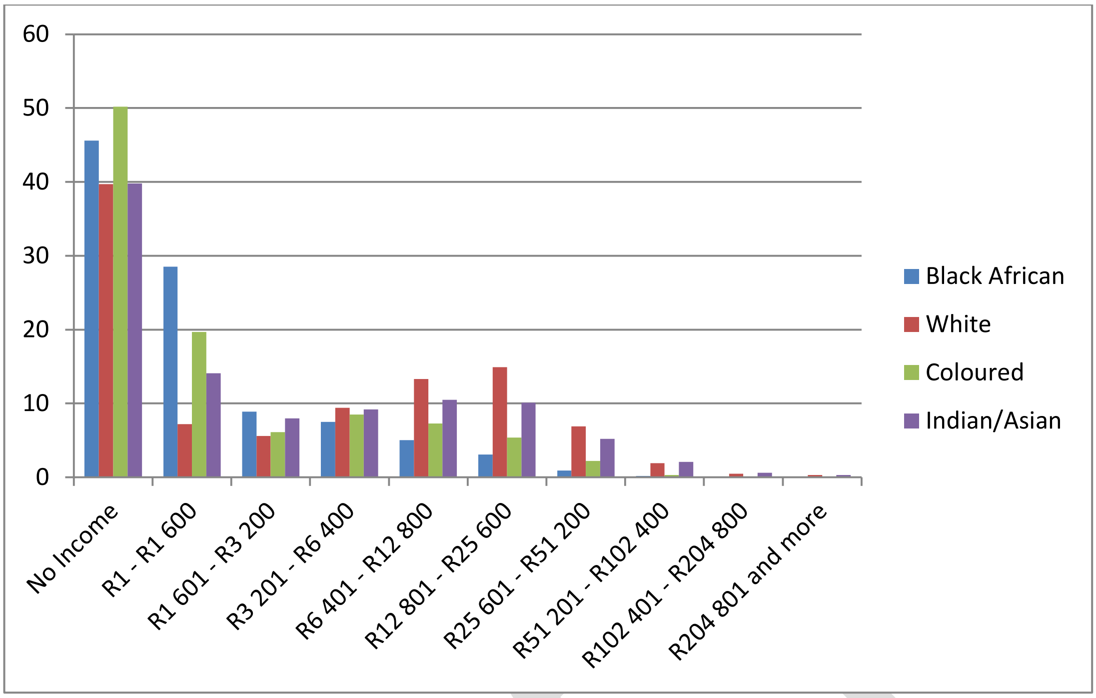

Figure 7-1: Individual monthly income in the ELM

Source: Stats SA, Census 2011

Kriel and Thubelihle

Income levels in Kriel and Thubelihle are similar to those in the ELM. 48% and 45% of individuals in Kriel and Thubelihle do not earn any monthly income. Despite the similarities in the two communities, higher incomes are generally experienced in Kriel. Figure 7-2 below provides a breakdown of the individual monthly incomes in Kriel and Thubelihle.

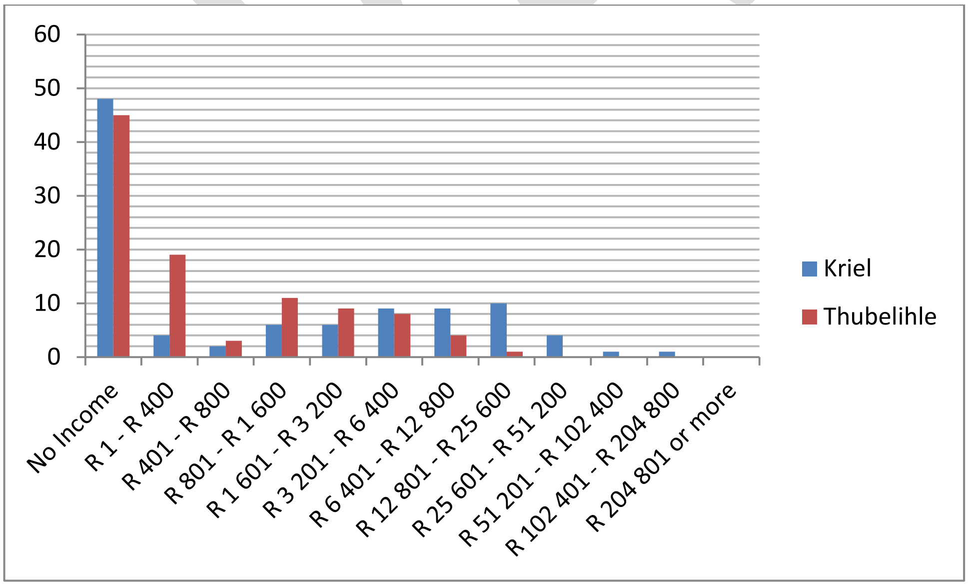

Figure 7-2: Individual monthly income in Kriel and Thubelihle

Source: Stats SA, Census 2011

7.10 Local social dynamics

7.10.1 Culture

The ELM is made up of numerous ethnic groups with the predominant group being Zulu (39.9% of the ELM population). The other significant ethnic/language groups include Afrikaans (15.5%), Sepedi (11.6%), Ndebele (9.2%) and SiSwati (6.1%).

Even though Christianity is the dominant religion in the area, many also combine Christianity with traditional African beliefs. The branches of Christianity found in the project area include the Ethiopian Church of South Africa, the Roman Catholic Church, the Anglican Church, the Methodist Church, and the Zulu Congregation Church.

Religion and religious leaders play a very important role in the community. According to the respondents, religion shows people how to live ethically and religious leaders guide and support people to live principled lives. Some of their responsibilities include counselling, conflict resolution, facilitation of religious ceremonies and decision making.

7.10.2 Youth

Youth in both Kriel and Thubelihle were defined as people between the ages of 18 and 35. As members of the community, young people are expected to go to school, find employment in order contribute to household expenses and assist younger and older people.

During focus group meetings at Thubelihle in 2011, young people were concerned about the increasing number of young girls getting married. They attributed this occurrence to the need for young girls to find a way to survive. Very often salaried men, reportedly those working for mining companies, offer relatively large sums of money to a potential suitor’s family in order to have the family’s blessings.

Even though young people sometimes make and are willing to make decisions, the right to decide on household issues are chiefly reserved to parents or older people. Often, the ability to make decisions is dependent on the contribution young people make to the household budget. The more they contribute, the more they are able to participate in the household decision-making process.

The youth in the study area were also concerned about the lack of job opportunities. They are often unable to follow vocational training programmes because no such opportunities are available to them. As such, young people report that they do what they can in order to survive.

Not many youth organisations exist in the area and those that are in place are government sponsored. Love Life is proactive in the area. In addition to providing HIV/AIDS awareness campaigns to young people, they also provide similar programmes to the whole community. Other local initiatives include Future Minds Centres and New Life Centres. While the former focuses on improving the standard of living for residents, the latter focuses on peer education on HIV/AIDS.

On the whole, young people are in need of extramural activities. Not much is currently being provided by way of work opportunities either. The following development challenges were identified by the youth:

- High unemployment rate;
- Lack of recreational facilities;
- Lack of funding for potential entrepreneurial activities;
- Alcoholism;
- Teenage pregnancies and early marriages;

- Nepotism;
- Drug abuse;
- Prostitution; and,
- Crime.

7.10.3 Social Problems, Conflict and Crime

According to the information collected from the focus group meetings, crime was by far the number one cause for concern for the communities in the study area. The chief contributor to the high crime was said to be the level of unemployment. The other was drug abuse. Some of the offences committed include break-ins, car theft, armed robberies, rape, shoplifting and drug dealing.

To prevent this, communities have established a number of Community Policing Forums. During focus group meetings many respondents agreed that this was an effective way to combat crime in the area.

8 Socio-economic Impact Assessment

8.1 Introduction

The impact assessment takes into account the available baseline data collected for the proposed Elders Colliery (for baseline data refer to Sections 4-7 of this report). The overall project EIA examines how the project will lead to a measurable difference in the quality of the environment and the quality of life of the impacted individuals and communities. The impacts of the project construction and operation activities as well as impacts that persist post-closure were considered for the following socio-economic parameters:

- Population and demographic movements;
- Strengthened community organization and local institutions through increased cooperation and engagement;
- Land and natural resources;
- Health;
- Social services and infrastructure;
- Economy, work and livelihoods;
- Social conflict and vulnerable groups;
- Cultural heritage; and,
- Traffic and transportation.

8.2 Methodology

8.2.1 Identification and Definition of Impacts

The impact assessment has been conducted in an integrated manner that considers the links between the socio-economic components with the biophysical components of the environment. The assessment moves through the following steps:

- **Issue identification** - evaluate the ‘aspects’ arising from the project description and ensure that all issues in their area of expertise have been identified;
- **Impact definition** - positive and negative impacts associated with these issues (and any others not included) are defined – the definition statement includes the activity (source of impact), aspect and receptor as well as whether the impact is direct, indirect or cumulative. Fatal flaws are also identified at this stage; and,
- **Impact evaluation** – this is not a purely objective and quantitative exercise. It has a subjective element, often using judgement and values as much as science-based criteria and standards. The need therefore exists to clearly explain how impacts have been interpreted so that others can see the weight attached to different factors and can understand the rationale of the assessment.

8.2.2 Impact Significance Rating

Practicable management measures have been recommended based on the impact identified. These measures aim to avoid, and if avoidance is not possible, then reduce, restore, compensate/offset negative impacts, enhance positive impacts and assist Project design. The impact significance rating system is presented in

Table 8-1 and involves four parts:

Part A: Defines impact consequence using the three primary impact characteristics: magnitude, spatial scale and duration;

Part B: Uses the matrix to determine a rating for impact consequence based on the definitions identified in Part A;

Part C: Uses the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence; and,

Part D: Defines the confidence level.

Table 8-1: Method for rating the significance of impacts

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE *Use these definitions to define the consequence in Part B*		
Impact characteristics	**Definition**	**Criteria**
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor+	Minor improvement; change not measurable; or threshold never exceeded
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction
	Major+	Substantial improvement; within or better than the threshold; or favourable publicity
SPATIAL SCALE OR POPULATION	Site or local	Study area, as defined in this report
	Regional	Immediate focus areas: Bethal, Emzinoni, Kriel and Thubelihle
	National/ International	Nationally or beyond
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE/ POPULATION		
			Site or Local	**Regional**	**National/ international**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)	**Definite**	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

PART D: CONFIDENCE LEVEL		
High	Medium	Low

Notes: + denotes a positive impact and alternative colours will be used for the significance ratings

Using the matrix, the significance of each described impact is initially rated. This rating assumes that the management measures inherent in the Project design are in place.

8.2.3 Management Recommendations and Post Management Significance

Practicable **management measures** are recommended with the focus primarily on avoidance, and if avoidance is not possible, then to reduce, restore, compensate/offset negative impacts, and to enhance positive impacts and assist Project design.

The significance of impacts has then been re-assessed with assumed management measures in place ("after management"). Specialists also recommended and described appropriate monitoring and review programs to track the efficacy of management measures. These are included in the EMP.

8.3 Socio-Economic Impacts

This chapter summarizes the most salient social and economic impacts associated with the project, all requiring intervention and management or enhancement.

It is important to note that the significance rating of an impact is not the only criterion used to identify where priorities for management lie. Management measures are determined based on good international and sector practice together with the ratings of the impacts.

For the socio-economic impact assessment, a pre-construction phase has been included in some areas as mitigation/enhancement of impacts such as resettlement and employment needs to commence in the pre-construction phase of the project.

The impacts in this section have been grouped according to the cause of the impact, or the driver. For example, the driver will be the mine requiring land for infrastructure development, the impact of this land take may be physical displacement. The potential impact drivers include the following:

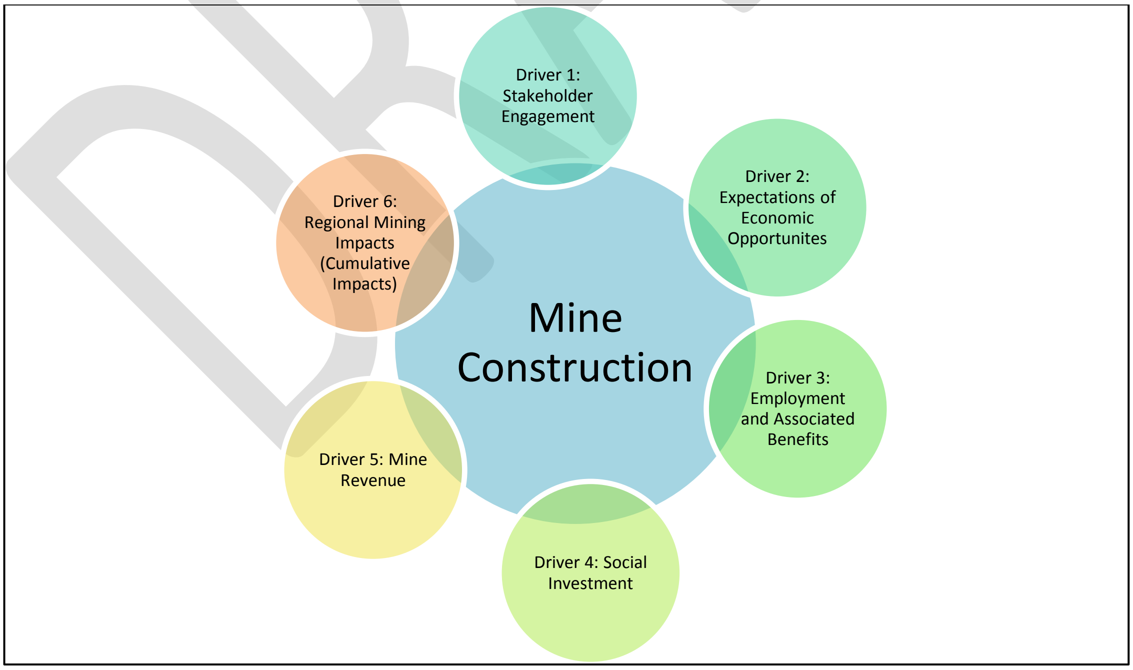

Figure 8-1: Impact drivers

8.3.1 Driver 1: Stakeholder Engagement

The construction of the Elders Colliery will require extensive public consultation and stakeholder engagement, particularly in the pre-construction and construction phases of the Project. Various stakeholders from communities to local government will be extensively consulted. This stakeholder engagement will be a driver for the following positive impacts.

Impact SE1: Improved relations with local communities and stakeholders

Impact Description

AOL has developed a relationship with the Vlakkuilen Community dating back to 2005 when original consultation commenced. It is important for this relationship to continue, especially if the community will not be relocating as per previous mine plans. Transparent and regular consultation with local communities, such as Vlakkuilen, will not only prevent potential future conflict but will also benefit the community and improve AOL's social license to operate.

The Middelkraal community, relocated in 2007 by Umcebo Mine, has not previously been considered as the primary zone of influence by Elders. However, since the changes to the mine footprint, they are the neighbouring community to the Elders project and closest to the infrastructure. As a result, it is important that Elders Colliery starts engaging regularly with this community to ensure that they are well appraised about all issues pertaining to the mine development.

Impact Rating

Pre-Construction, Construction and Operations

<table>
<tr><th></th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>+ /-</th><th>Confidence</th></tr>
<tr><td>Before Management</td><td>Minor</td><td>Medium-term</td><td>Site/ Local</td><td>Low</td><td>Possible</td><td>Low+</td><td>+</td><td>High</td></tr>
<tr><td colspan="9">Management Measures:
Detail life of mine stakeholder consultation in a SEP, this management plan should be made available to communities should they request it ;
Providing proactive feedback to the communities regarding project developments particularly around employment opportunities;
Include affected communities in the decision making processes of the project, particularly around potential Corporate Social Investment (CSI) opportunities, and SLP projects;
Ensure that all stakeholder engagement includes women, youth and vulnerable groups;
Provide regular and transparent feedback to the Vlakkuilen and Middelkraal communities specifically;
Discuss and manage issues, concerns, changes and impacts related to the project;
Monitor and implement the Grievance Management Mechanism;
Involve Local Ward Councillors and keep them informed about project developments, and included in all stakeholder engagement processes. Their involvement will assist with the successful development of relationships between the mine, the municipality and the communities;
Regularly consult with local government through the GMLM around issues of community development, employment, co-operation and project activities;
Where possible AOL should align their CSI initiatives and SLP projects with the GMLM IDP with the goal of improving both sustainability and feasibility (this would only occur once the mine was operational);
All engagement and consultation should follow established protocols; and,
Durable participatory and consultative structures should be in place pre-closure to mitigate the impacts of closure.
</td></tr>
<tr><td>After Management</td><td>Moderate</td><td>Medium-term</td><td>Site/ Local</td><td>Medium</td><td>Definite</td><td>Medium+</td><td>+</td><td>High</td></tr>
</table>

Impact SE2: Unmet expectations for the relocation of the Vlakkuilen community and loss of social license due to changes in mine planning

Impact Description

In 2007 an ESIA and EMP was completed for the proposed project but not submitted to the authorities for approval. During the assessment 23 households located on Vlakkuilen 76 IS were identified for potential physical displacement resulting from strip mining (i.e. open cast mine).

Due to the anticipated construction of the opencast pit, it was unavoidable that the Vlakkuilen Community would have to be resettled. Resettlement activities began in 2007, including the following:

- AOL purchasing the Hirsaw Livestock Estate, on which the Vlakkuilen Community is located,
- AOL engaged with the Vlakkuilen community regarding the potential resettlement;
- An individual household census and asset inventory was conducted by B/Sure Rural Management Consultants with 23 affected households;
- A representative committee was elected by the community; and,
- In 2009, 324 graves were exhumed and relocated to Bethal, Kriel and Verena.

Subsequently additional consultations, including a census and asset inventory, were conducted in 2012 following the revised Project description. In 2014, the mine plans were revised again and it was confirmed that the Vlakkuilen community does not need to relocate at all. Due to the cut-off date that was determined as October 2012, this community was not allowed to make any improvements on their properties and as a result, were living in houses that were not maintained due to the looming resettlement that never happened since 2007. This resulted in some community members being unhappy, having their expectations for a better life elsewhere not fulfilled and grievances relating to their family graves which were relocated and are now far from them. If not properly managed, this could potentially impact on relations and subsequently social license to operate for Elders Colliery.

Impact rating

Pre-Construction

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+ /-	Confidence
Before Management	*Major*	*Long-term*	*Site/Local*	***High***	***Definite***	***High -***	-	*High*
Management Measures: • Continue the discussions with and planning for the livelihoods restoration for the Vlakkuilen community; • Ensure the community and Ward Councillor are informed about the project progress; and, • Monitor and implement the Grievance Management Mechanism.								
After Management	*Moderate*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low-***	-	*High*

8.3.2 Driver 2: Expectations of Economic Opportunities and Improved Living Conditions

The development of a mine and related infrastructure, such as roads, power lines, and telecommunications, inevitably leads to increased influx, and, in some circumstances, to spontaneous settlements. Project-induced influx is usually fuelled by people attempting to benefit from perceived employment opportunities, improved infrastructure, and access to a range of social services.

Impact EO1: Unmet expectations from communities within the Primary ZoI to benefit from economic opportunities and improved living conditions

Impact description

It has been established in the baseline studies that the communities within the Primary ZoI have limited skills and education levels to assist them in accessing any potential job opportunities from the Elders Colliery. This is also coupled with high unemployment rates as well as high levels of poverty. Being the closest communities to the mine, there are expectations that the development of the mine will improve their living conditions in terms of employment and poverty alleviation. However, due to the fact that most of the local community members would not have the required skills and education levels required for these employment opportunities, people from outside of the project area might be well suited for these opportunities. Similarly, expectations for improved living conditions such as provision of water, sanitation and other services could potentially also be directed at the mine, which is ideally not responsible for service delivery. Having established during the focus group meetings that the Middelkraal community is distancing itself from local government due to them being a private landowner, it is possible that the mine would be expected to play the role of government in local service delivery. If these expectations are not met, they could result in a negative impact on the mine's social licence to operate, leading to poor relationships between the mine and these communities.

<table>
<tr><th></th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>+/-</th><th>Confidence</th></tr>
<tr><td>Before Management</td><td>Major</td><td>Medium</td><td>Site/Local</td><td>Medium</td><td>Possible</td><td>Medium -</td><td>-</td><td>Medium</td></tr>
<tr><td colspan="9">Management Measures:
Compile and implement the management measures detailed in the SLP, as well as Impact SE1 and SE2;
Prioritise the employment of the communities residing within the Primary ZoI for semi-skilled and unskilled job opportunities during construction;
Enforce the contractor management plan, especially relating to local recruitment and procurement;
Plan for the up-skilling of the people (particularly the youth) within the Primary ZoI prior to construction, to prepare them for potential job opportunities at Elders and at other mines; and,
Assist, where possible, with building the capacity of local government to provide social services to the communities within the Primary ZoI.</td></tr>
<tr><td>After Management</td><td>Moderate</td><td>Short-term</td><td>Site/Local</td><td>Low</td><td>Possible</td><td>Low -</td><td>-</td><td>Medium</td></tr>
</table>

Impact EO2: Increased pressure on social services and infrastructure, and an increase in social pathologies and social disruptions due to influx of people and construction workers, resulting in spontaneous settlements

Impact Description

The development of a substantial mining project can mean a high public profile even before project activities commence. Such speculation raises expectations of, and interest in, the potential benefits of a project (IFC, 2009). The pattern of influx generally reflects expectation levels. It is possible that as potential jobseekers and contractors start moving into the project area in expectation of economic benefits from the project, spontaneous settlements could develop to cater for their housing needs. It was established however, that Elders Colliery plans to bus in their construction workers into the project area daily to avoid them having to settle permanently in the area.

While it is unlikely that the jobseekers could establish their housing within the Primary ZoI (Vlakkuilen and Middelkraal), it is likely that Emzinoni, and Mahlathini within the Secondary ZoI and Thubelihle in the Tertiary ZoI might experience a further growth of informal housing, It is anticipated that influx and opportunistic settlement will peak during the construction phase of the mine when demand for unskilled local labour is at its highest. Engagements with key informants in 2015 have raised influx of mineworkers into the area as a concern, mostly in relation to the competition for services. On the other hand, the renting out of backyard shacks and rooms in Emzinoni provides for income for the households. It was also gathered during focus group meetings at Middelkraal that the households also used to rent out outside rooms to the employees of Middelkraal (Umcebo) Mine, before it was closed in June 2015. However, it seems as if the employees have now vacated the area, suggesting that influx for construction workers may be temporary. It is therefore possible that should there be a need for housing of employees close to the project area, this community will continue to earn incomes from renting out their outside rooms. However, this will only be for the construction period of 18 months, after which it is assumed that the construction workers will move to potential new areas of development in the region.

The development of spontaneous settlements could potentially lead to an increase in the current social pathologies currently experienced, particularly prostitution and alcohol abuse, due to the presence of construction workers. Influx is already occurring in these settlements. It has been confirmed through discussions with key informants in 2015 that these social pathologies have been increasing in the area. While there will be no contractor laydown areas it is anticipated that construction workers will frequent Bethal, Emzinoni, Kriel and Thubelihle.

Towns in the area such as Bethal and Kriel and more specifically Thubelihle and Emzinoni are currently stretched to provide adequate healthcare and education. Many schools are understaffed and lack sanitation facilities, teaching materials (including textbooks and desks), while local clinics and hospitals are also under resourced.

An influx of people into the area will increase the demand for existing services and infrastructure that are already under pressure to deliver adequate services to the local population. This impact, if not adequately managed, will exacerbate and worsen poor service delivery in the area.

With the levels of unemployment in the area being so high, there is also a potential for the communities within the Primary ZoI (Vlakkuilen and Middelkraal) to rent out backrooms to mine contractors and employees to make additional income. Middelkraal households have provided accommodation to mine workers on the Middelkraal Mine (Umbeco). Vlakkuilen has not experienced an influx, despite the announcement of the Elders project since as early as 2005. These communities already have limited access to services, and the rental income gained will further reduce access to these resources.

It is currently assumed that a construction camp will not be established on site. However, should a construction camp be required, AOL should develop a Construction Management Plan that would address issues relating to housing and living conditions, transportation, as well as health and safety of construction workers.

Impact Rating

Construction and operation

<table>
<tr><th></th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>+ /-</th><th>Confidence</th></tr>
<tr><td>Before Management</td><td>Moderate</td><td>Short-term</td><td>Site/Local</td><td>Low</td><td>Definite</td><td>Medium -</td><td>-</td><td>Medium</td></tr>
<tr><td colspan="9">Management Measures:

Develop a clear and concise employment and recruitment policy that prioritizes local recruitment;
Identify and support community development programmes that address challenges raised by population influx and spontaneous settlement;
Enforce the Anglo American Contractor Management Plan, which should in addition address accommodation, living standard, transport and health and safety standards of contractors;
Enforce the Anglo American principles regarding employee and contractor behaviour;
Continuously monitor the housing and living conditions of employees receiving living out allowances;
Support local government capacity for integrated development planning;
Develop a strategy to address issues related to and potentially enhanced by project-induced influx. This strategy will be developed in order to clearly define how AOL, in conjunction with local government and relevant stakeholders, intend to manage the impacts caused by influx where possible;
Compile and implement the community health and safety initiatives of the Community Health and Safety Plan (CHSP), such as education and awareness programs that address social pathologies in neighbouring communities through established government departments; and,
Monitor employee and contractor compliance with company policy regarding alcohol and substance abuse.
</td></tr>
<tr><td>After Management</td><td>Moderate</td><td>Short-term</td><td>Site/Local</td><td>Low</td><td>Possible</td><td>Low -</td><td>-</td><td>Medium</td></tr>
</table>

8.3.3 Driver 3: Employment and Associated Benefits

Impact EB1: Employment and Income

Impact Description

Employment and a secure income provides many socio-economic benefits to employees and their dependents, including:

- Improved material wealth and standard of living;
- Enhanced potential to invest in and improve access to social services such as education, health services, etc. (which may be provided directly by the company to employees and/or employees may now have the funds to pay for these services); and,
- Employment and training of unskilled workers facilitates skills development and improves the future employment prospects of such workers.

Secure wage employment can also contribute towards a sense of independence, freedom, and pride, and it may promote a good work ethic.

The mine will create various types of employment:

- *Direct[16] employment for the workforce:* The project will require positions involving low to medium-skilled activities as well as those with specialized tasks. Local workers will be recruited to fill these roles where possible. If certain technical skill sets are unavailable locally, workers will be recruited from outside areas.
    - The **construction phase**, which is expected to begin in April 2015, is expected to generate approximately 1 000 temporary jobs at the mine. AOL will require contractors to prioritize local employment based on competency and job availability.
    - The **operation phase** is expected to create jobs in mining and administration for approximately eight years that will reduce once mining ceases and stockpiles are treated for a further seven years. Again, AOL will promote local employment where feasible.
- *Indirect employment at the supplier companies (procurement):* Local companies are likely to perform services such as earthworks, road construction, transportation and catering. The extent of indirect employment and income that will be created through the outsourcing of services to local contractors is difficult to determine at this stage but has the potential to be significant, and will receive priority attention.
- *Induced employment:* The income created through direct and indirect employment will create down-stream income if the money is used to buy goods and services at a local level (i.e., the multiplier effect). Many of the employees and suppliers, and hence beneficiaries of income generated, will be locally based and not highly mobile, and a significant portion of their income is thus likely to be spent at a local level. The increase in demand for goods and services locally will also induce new businesses to open.

[16] The ICMM defines the various employment categories as follows in the Mining: Partnership for Development Toolkit:

- Direct employment by the operation includes those staff that are on the payroll and any contractors permanently based on site
- Indirect employment comprises off-site contractor employees working for the operation (i.e. those staff on the contractors' payrolls who are employed to fulfill contracts at the operation), employees working at the operation's suppliers and at any contractor's suppliers or subcontractors whose employment is attributable to business generated by the operation; and employment generated in the region by (community) social investment activities, including local business development, in which the mining operation is a participant
- Induced or "multiplier" employment in local communities generated by the spending of direct and indirect employees, such as employment in local businesses and services (e.g., shops, transport and public services)

Impact Rating

Construction

The local employment generated or sustained during the construction phase is expected to have an impact of moderate magnitude and short-term duration. It is also expected to impact at a local scale as it is likely that earnings will benefit extended family and commercial networks.

Local employment benefits may be further increased by sourcing as many goods and services as possible from within the study area. However, due to technical requirements and constrained local supply that limit procurement options, the scope to expand local employment and procurement is limited.

<table>
<tr><th></th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>SIGNIFICANCE</th><th>+ /-</th><th>Confidence</th></tr>
<tr><td>Before Management</td><td>Moderate</td><td>Short-term</td><td>Site/Local</td><td>Low</td><td>Possible</td><td>Low +</td><td>+</td><td>Medium</td></tr>
<tr><td colspan="9">Management Measures:
• Develop a clear and concise employment policy prioritizing local employment;
• Implement vocational training programs to promote local workforce capacity as per the Labor and Human Resources Plan (LHRP);
• Employ local workers if qualified applicants with the appropriate skills are available. Formalize this policy in company Human Resources guidelines and contractors’ agreements;
• Purchase goods and services at a local level, if available. Formalize this policy in company purchasing guidelines and contractors’ agreements;
• Work closely with the local communities before and during the project to identify and communicate required skills and resources that the local community could provide;
• Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programs;
• Prepare a detailed vocational training program in consultation with the local community to be implemented during the construction phase; and,
• Through the stakeholder engagement process ensure that expectations are managed around employment opportunities and practices.</td></tr>
<tr><td>After Management</td><td>Major</td><td>Short-term</td><td>Site/Local</td><td>Medium</td><td>Definite</td><td>Medium +</td><td>+</td><td>Medium</td></tr>
</table>

Operations

During operations, it is expected that a smaller number of people will be employed. Furthermore, where possible, skilled labour will be moved from Goedehoop Colliery to Elders in an attempt to reduce retrenchments as operations close. As such, the local employment generated during the operation phase is expected to have an impact of medium magnitude and medium-term duration and to impact at a local scale. Local employment benefits may be further increased by implementing the management measures listed below, although the rating is not expected to change further.

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Moderate*	*Medium-term*	*Site/Local*	***Medium***	***Possible***	***Medium +***	+	*Medium*
Management Measures: • Develop a clear and concise employment policy prioritizing local employment; • Implement vocational training programs to promote local workforce capacity as per the Labor and Human Resources Plan (LHRP); • Employ local workers if qualified applicants with the appropriate skills are available. Formalize this policy in company Human Resources guidelines and contractors' agreements; • Purchase goods and services at a local level, if available. Formalize this policy in company purchasing guidelines and contractors' agreements; • Work closely with the local communities before and during the project to identify and communicate required skills and resources that the local community could provide; • Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programs; • Prepare a detailed vocational training program in consultation with the local community to be implemented during the construction phase; and, • Through the stakeholder engagement process ensure that expectations are managed around employment opportunities and practices.								
After Management	*Moderate*	*Medium-term*	*Site/Local*	***Medium***	***Definite***	***Medium +***	+	*Medium*

Impact EB2: Dissatisfaction over employment opportunities and conditions of procurement

Impact Description

While it is expected that a small portion of the local population might be able to benefit from direct and indirect employment opportunities at the proposed Elders Colliery, the majority will not benefit and will therefore continue living off alternative methods, such as social grants, rental income, small-scale commerce etc. Many of these activities are expected to yield a lower and more uncertain income than that associated with mine employment.

It is generally perceived that people who will benefit most from mining employment are those with the highest levels of education and experience, leaving behind those with the lowest education qualifications.

The employment of only a small portion of the population at the mine is thus likely to lead to increased economic disparity in the project area and the potential marginalization of people not employed at the mine. The latter might find that they cannot maintain the same living standard as people who are employed or access existing or new services and facilities that are either exclusive to mine workers or become too expensive to unemployed people.

Mining can also contribute to the marginalization of specific groups within a community, specifically the poorly educated and women (particularly those with children). Increasing economic disparity and marginalization of groups within a community can contribute to a number of changes, such as:

- Diminished social cohesion as some members of the community can afford more goods and/or adopt different lifestyles;
- A change in social values away from community centered-values towards individual-centered values;

- A change in local power structures in line with earning power;
- Lower population health, as economic inequality has been identified as a major determinant of differing levels of health status (Barnett, Pearce and Moon, 2004); and,
- A change in family structures such as a rise in single parenting or later marriage.

Besides generating inequality within a community, mining can also create inequality between communities, as those situated closest to the mines are typically targeted for employment. Communities that are more remote from the mine are typically a much lower priority for mine employment (Gibson and Klinck, 2005).

Impact Rating

Construction and Operations

Due to the potential generation of local employment opportunities, and the relative absence of alternative and complementary employment, it is expected that economic disparity will increase. It is expected to have a negative impact of major intensity for the short term at a local level.

The implementation of mitigation measures aimed at reducing the inequality generated by mine employment and increasing the access to benefits generated by mining is expected to reduce the magnitude of the impact to moderate.

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Major*	*Short-term*	*Site/Local*	***Medium***	***Definite***	***Medium -***	-	*Medium*
Management Measures: • Develop a clear and concise employment policy prioritizing local employment; • Employ staff from across community groups and the Project area and keep recruitment and employment records, distributing short-term opportunities to as many as possible; and, • Develop an SLP that considers integrated development of communities impacted by the Project.								
After Management	*Moderate*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low -***	-	*Medium*

Impact EB3: Improved employment and enterprise development opportunities through skills development and capacity building initiatives

Overview

It is recommended that employees of AOL, particularly unskilled workers employed during the construction and operations phase of the Project, should receive skills development and training. Alternatively, AOL can support local government in their skills development and training programmes. Skills development and capacity building initiatives will improve opportunities for future employment and enterprise development. Although a majority of the population has received secondary education, many people in the project area are still illiterate and lack employable skills.

AOL, in partnership with local government, can help develop and implement skills development and training programs that target both their employees and the broader population, which aim to stimulate enterprise development and meet local economic demands. Skills development and capacity building is fundamental to sustainable development and poverty alleviation in the area, and particularly amongst the youth.

Construction

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Moderate*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low +***	+	*Medium*
Management Measures: • In order to promote skills development and capacity building initiatives to both employees and the broader population and, in particular amongst youth, the SLP should focus on enterprise development and capacity building; • Furthermore, AOL's closure plan will aim to reinforce the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods; and, • Develop a clear and concise employment policy prioritizing local employment.								
After Management	*Major*	*Short-term*	*Site/Local*	***Medium***	***Definite***	***Medium +***	+	*Medium*

Operations

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Moderate*	*Medium-term*	*Site/Local*	***Medium***	***Possible***	***Medium +***	+	*High*
Management Measures: • Implement and monitor the SLP; • Develop a clear and concise employment policy prioritizing local employment; and, • Furthermore AOL's closure plan should aim at reinforcing the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods.								
After Management	*Major*	*Medium-term*	*Site/Local*	***Medium***	***Definite***	***Medium +***	+	*High*

Closure and Post closure

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Major*	*Long-term*	*Site/Local*	***High***	***Definite***	***High -***	-	*High*
Management Measures: • Develop and implement the LHRP that addresses the impacts associated with retrenchment, job losses and reduced demand for local goods and services; and, • Develop a closure plan which will aim to reinforce the objectives of the SLP by reducing the reliance on AOL for employment by promoting skills transfer to enable alternative livelihoods.								
After Management	*Moderate*	*Long-term*	*Site/Local*	***Medium***	***Definite***	***Medium -***	-	*High*

8.3.4 Driver 4: Corporate Social Responsibility and Social and Labour Plans

Corporate Social Responsibility (CSR) and SLPs are some of key ways in which large scale mining operations can make a difference to local communities. These could be the driver of various positive impacts in the project area.

Impact CSR1: Improved infrastructure in the study area due to social investment activities

Impact Description

CSR and SLP initiatives have the potential to promote and support community development, capacity building and empowerment, which includes job creation, skills and SMME development and infrastructure development. Elders Colliery CSR activities have the potential to improve the quality of life of those living in the project area. The development and implementation of these activities requires consultation with local development partners including local government, Non-Governmental Organisations (NGOs), and CBOs.

It is anticipated that the majority of AOL's initial CSR budget will be spent through the SLP. Following construction the focus may move towards improving infrastructure in the project area. The impact will be most significant during the operations phase of the mine, when the CSR programme is fully operational. While benefits will cease with mine closure, sustainable projects and infrastructure will endure post closure.

Impact Rating

Construction, Operations, Closure and Post Closure

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Minor*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low +***	+	*Medium*
Management Measures: • Implement management and enhancement measures as per the SLP.								
After Management	*Moderate*	*Short-term*	*Site/Local*	***Low***	***Definite***	***Medium +***	+	*Medium*

8.3.5 Driver 5: Mine Revenue

Impact MR1: Increased direct revenue to local government

Impact Description

Increased taxes and revenue from the mine will flow into national government, which in turn should flow down into the local municipality. This increased revenue should help to improve the service delivery of the local government and also aid in the successful implementation of various IDP projects. The government is expected to derive revenue from the mining operation through:

- The various forms of taxes and duties that are applicable to mining companies, including import duty, mineral royalties, corporate tax, coal exports and value added tax. However, the value of these revenue streams cannot be determined at present due to the high uncertainty associated with the various determinants of future government revenue.
- The proposed Elders Colliery mini pit is expected to treat some 90 000 tons per month while the underground shaft complex will have a production rate of 4 500 kilo tonnes per annum. Sized coal will be transported to Goedehoop for processing and sale.

Impact Rating

Construction

During construction, income to the government is mostly expected to result from import duties as well as taxes on locally procured services and goods. The construction phase is expected to have a minor (positive) impact of short term duration and local scale (due to the relatively limited contribution) on government revenue.

This impact is one of the downstream socio-economic effects directly resulting from the operation of the mine and mitigation of this impact is very difficult. However, AOL should practice transparent reporting of all of their taxes and revenue in line with the Extractive Industries Transparency Initiative (EITI).

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Minor*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low +***	+	*Medium*
Management Measures: • AOL will participate and report according to the EITI principles and guidelines.								
After Management	*Minor*	*Short-term*	*Site/Local*	***Low***	***Possible***	***Low +***	+	*Medium*

Operations

During operations, income to the government is mostly expected to result from royalties, dividends and duties and taxes paid on locally procured services and goods. The operations phase is expected to have a medium (positive) impact of medium-term duration and local scale (due to the relatively limited contribution) on government revenue.

Government income is determined by tax regimes and world market prices for commodities. As such, no mitigation measures are recommended for this impact.

	Magnitude	Duration	Scale	Consequence	Probability	SIGNIFICANCE	+ /-	Confidence
Before Management	*Moderate*	*Medium-term*	*Site/Local*	***Medium***	***Definite***	***Medium +***	+	*Medium*
Management Measures: • AOL will participate and report according to the EITI principles and guidelines.								
After Management	*Moderate*	*Medium-term*	*Site/Local*	***Medium***	***Definite***	***Medium +***	+	*Medium*

8.3.6 Driver 6: Regional Mining Impacts (Cumulative Impacts)

Cumulative impacts are those that may arise due to the effects of the proposed Elders Colliery combined with those of the existing social conditions, or the combined effects of other projects as well as Elders on the existing social conditions. Socio-economic cumulative impacts include issues such as influx, land take and employment opportunities. These will be considered further in the Table 8-2 below.

The following comprise the objectives of this cumulative impact assessment:

- To assess the effect of other existing projects on Elders Colliery's significant impacts; and,
- To assess the cumulative impacts of Elders and other existing and future projects in the area.

This assessment is based on an assumption that the mines in and around the study area will continue to be developed. While this development scenario is the main focus of this chapter, consideration is also given to a 'no action' scenario.

Recommendations are offered in support of management of the identified cumulative impacts. These recommendations would ideally be implemented by a collaboration of stakeholders including local government, other mining companies operating in the project area and NGOs.

Table 8-2: Summary of the probable future trends in the Project's impacts when the cumulative consequences of other projects are taken into account

Socio-Economic Components and Impacts	Cumulative Impact		No Action Scenario	
	Direction of trend	**Discussion**	**Direction of trend**	**Discussion**
Secure jobs, incomes and social security	+↑	The realization of several projects in the area in addition to the Elders Project will significantly augment the positive socio-economic consequences, and accelerate the reversal of the economic downturn. As the local economy grows in size, infrastructure and services will improve, the tax base will grow, the financial viability of state/ local authority services will improve leading to further infrastructure upgrading. The capacity of local professionals and skilled workers will develop and the economy will become more sophisticated. This will reduce reliance on imports of materials, equipment and people. The potentially socially divisive need to bring in employees from outside of the area should thus decline, and movement of monies out of the local economy should reduce in the long term (although this may be countered by global economic trends towards free flow of profits and capital). The only potentially negative consequence is related to the increased demand for housing and infrastructure, exacerbated by continued influx of employment seekers. There may be a point at which demand outstrips supply, and it will take time for the effect to return to the positive side of the baseline.	-↓	Presently the mining industry is emerging from a period of reduced production. Should no new projects proceed to full implementation, socio-economic decline in the area may continue. With none of the predicted positive outcomes of Elders and other developments being realized, it will be extremely difficult for local government to generate sufficient revenues to improve infrastructure and services.
Increased disposable income among employees and local multipliers	+↑		-↓	
Local business opportunities arising from procurement of goods and services	+↑		-↓	
Use of external suppliers due to depressed local economy, leading to export of funds and skills development.	-↓		-↓	
Increase in business confidence and attraction of investors	+↑		-↓	
Increased involvement of and cooperation with local government	+↑		-↓	
Demand for housing, with impacts on markets (construction, resale, and rental)	-↓		-↓	
Increased demand for privately and publicly provided social services	-↓		-↓	
Payment for services by income earners, improving viability of providers	+↑		-↓	
Local improvements to roads, power and other infrastructure	+↑		-↓	
Income to government through payment of taxes	+↑		-↓	
Community capacity building through social programs	+↑		-↓	

Socio-Economic Components and Impacts	Cumulative Impact		No Action Scenario	
	Direction of trend	**Discussion**	**Direction of trend**	**Discussion**
Assistance to vulnerable groups through social programs	+↑		-↓	
Increased access to social and health facilities	+↑		-↓	
Increased role for NGOs and CBOs	+↑		-↓	
Social division over limited jobs and perceived preferential access	-↓		0	
Nuisance and danger to proximate communities	-↓	Mitigation measures to be employed by all operators	0	No Project development = no impact, no change from baseline.
Increased risk of communicable diseases with influx of workers and opportunity seekers	-↓	Increasing economic activity will draw migrants to the area, creating a more culturally and socially dynamic situation, which tends to result in increased prevalence of communicable diseases such as HIV/AIDS.	-↓	It is difficult to predict the spread of communicable diseases such as HIV/AIDS in the area with no further development. Since trends of communicable diseases are upwards, other mining companies are currently operating in the area, and no development will see ongoing decline in public services, it can be deduced that the likely trend would be an increase in the local prevalence of communicable diseases, but with a high degree of uncertainty.

Key

+↑	An upward, positive arrow, indicates that the trend/impact will continue to improve (i.e. a positive overall impact of a cumulative nature)
-↓	A downward, negative arrow, indicates that the current situation will deteriorate due to either to cumulative impacts or the no action scenario

9 Way Forward

The proposed Elders Colliery is situated in an area of the Mpumalanga Province characterised by large industries, commercial agriculture and large scale mining, predominantly in the coal sector. Despite this industrial development local communities have not seen the direct benefits and are generally underdeveloped and characterised by high levels of poverty and unemployment. This situation is increasingly creating a social environment characterised by frustration and resentment towards mining companies. A new mine, such as the Elders Colliery, can present further challenges, however, if properly managed the benefits of such a development can be profound.

Although the proposed Elders Colliery is relatively remotely located, through careful management and mitigation, AOL management will have the opportunity to promote development and capacity building in the area. This will only be achievable and sustainable if AOL work as closely as possible with local and district municipalities in the development and implementation of projects and initiatives. Through careful and informed design, integration and implementation of management plans such as the SLP and CHSP, AOL can proactively promote development and mitigate negative impacts before they arise. These management plans should take into account current development plans in the area, such as municipal IDPs, as well as the needs of local communities.

Overall, the anticipated socio-economic impact of the proposed Elders Colliery is positive. Where negative impacts are present, sustainable and practical mitigation measures are available. Importantly, all mitigation, mine design and development should be done in a consultative and participatory environment that promotes inclusiveness and transparency.

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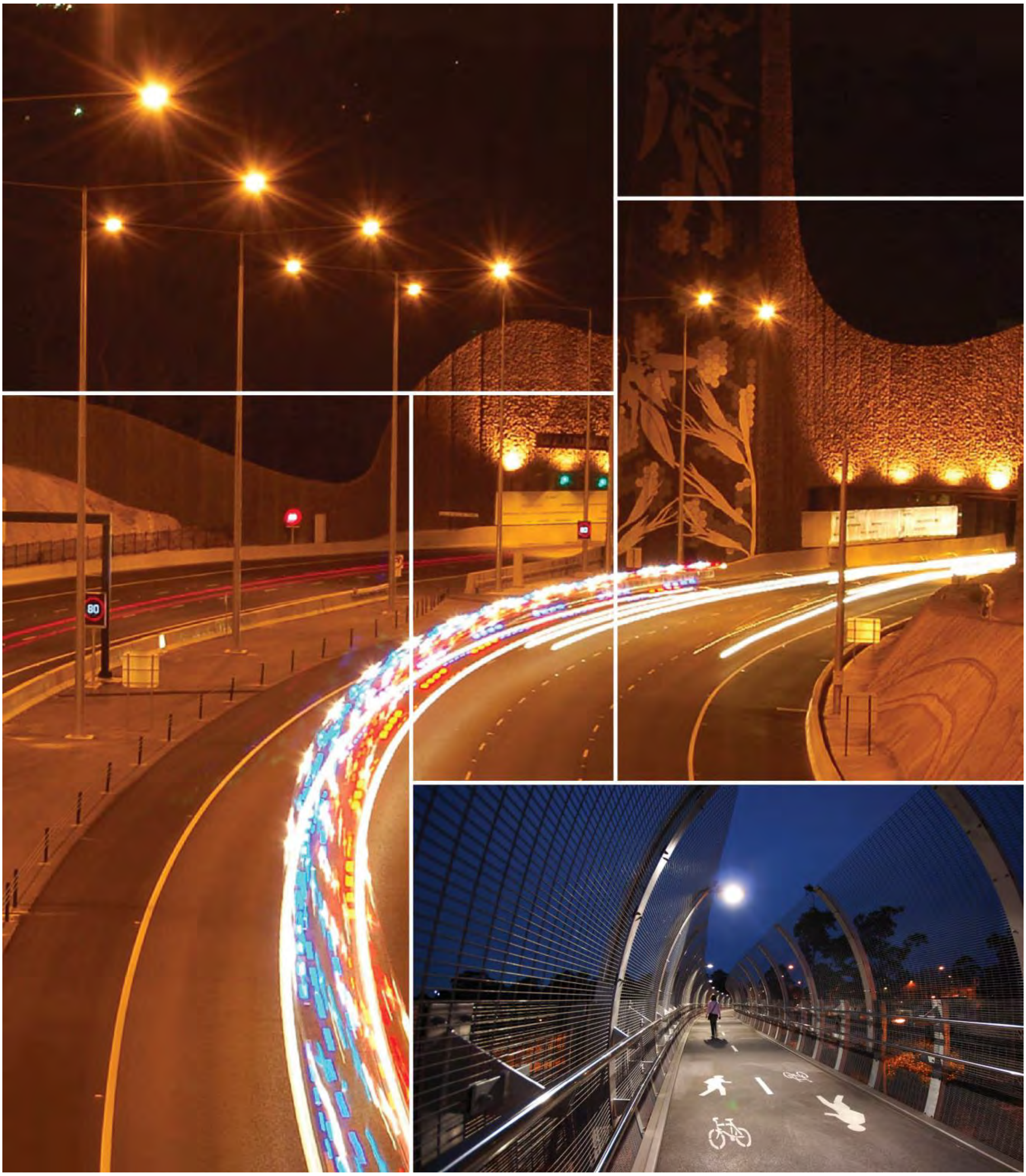
Appendix G11: Traffic Impact Assessment



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Elders Colliery EMP

Traffic Impact Assessment for the Proposed Elders Colliery EMP in Mpumalanga

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Contents

Figures

Tables

1 Introduction

SRK Consulting South Africa (Pty) Ltd has appointed Aurecon SA (Pty) Ltd to revise the Traffic Impact Assessment for the proposed Elders Colliery EMP located in Mpumalanga which was previously done in January 2014.

Anglo Operations (Pty) Limited (AOL) submitted an environmental authorisation application to the Mpumalanga Department of Mineral Resources (DMR) for the proposed project on 16 July 2015 and subsequently a Scoping Report and Environmental Management Programme (EMPr) was submitted. The environmental authorisation for the proposed Elders Colliery is pending.

AOL is planning several changes to the proposed project and subsequently requires an amendment to the environmental authorisation. The proposed changes involve a change in mine plan, block plan and an additional transport method for mined coal.

The new mine plan entails the underground mining of the No. 4 coal seam first, by means of bord and pillar mining methods, making use of continuous miners and shuttle cars. Further planning will be undertaken to the mine the No. 2 coal seam following the completion of mining the No. 4 seam. Access to the coal seam will be gained by developing a boxcut of 4 ha, reducing the boxcut footprint. Due to the decrease in size of the boxcut, the surface infrastructure layout has been adjusted. In addition, a stone dust silo, bins and high masts have been included in the block plan.

In summary, the following changes to the project has been made:

- Underground mining of No. 4 coal seam first
- Change in block plan layout, changes include:
  - Smaller boxcut (4 ha)
  - Ventilation shaft outside boxcut (but adjacent)
  - Stone dust silo
  - Coal storage bins
  - Road layout change
  - 22kV power line layout change
  - Run of mine/interburden stockpile
- Transporting of ore via trucks to an existing treatment facility

Due to the addition of the transporting of coal option, the purpose of this specialist traffic and transportation study is to estimate the daily peak hour volume of traffic that the proposed mining operations are likely to generate, assess the impact of this additional traffic on the surrounding road network and if no road exists, to assess the impact of this traffic on the new roads to be constructed and make recommendations for mitigation or improvements.

2 Site Location

The proposed Elders Colliery is located primarily east of the provincial road R35 approximately 47km to the south of Middelburg, approximately 55km to the southeast of eMalahleni, and approximately 20km north of Bethal. Kriel is located approximately 12km to the east of the site. Access to the Colliery will be an intersection with the R35.

The Elders Colliery area falls within the boundaries of two district municipalities and two local municipalities. They are the Nkangala District Municipality and the Steve Tshwete Local Municipality; and the Gert Sibande District Municipality and Govan Mbeki Local Municipality.

The locality map of the project site is shown in Figure 1 below.

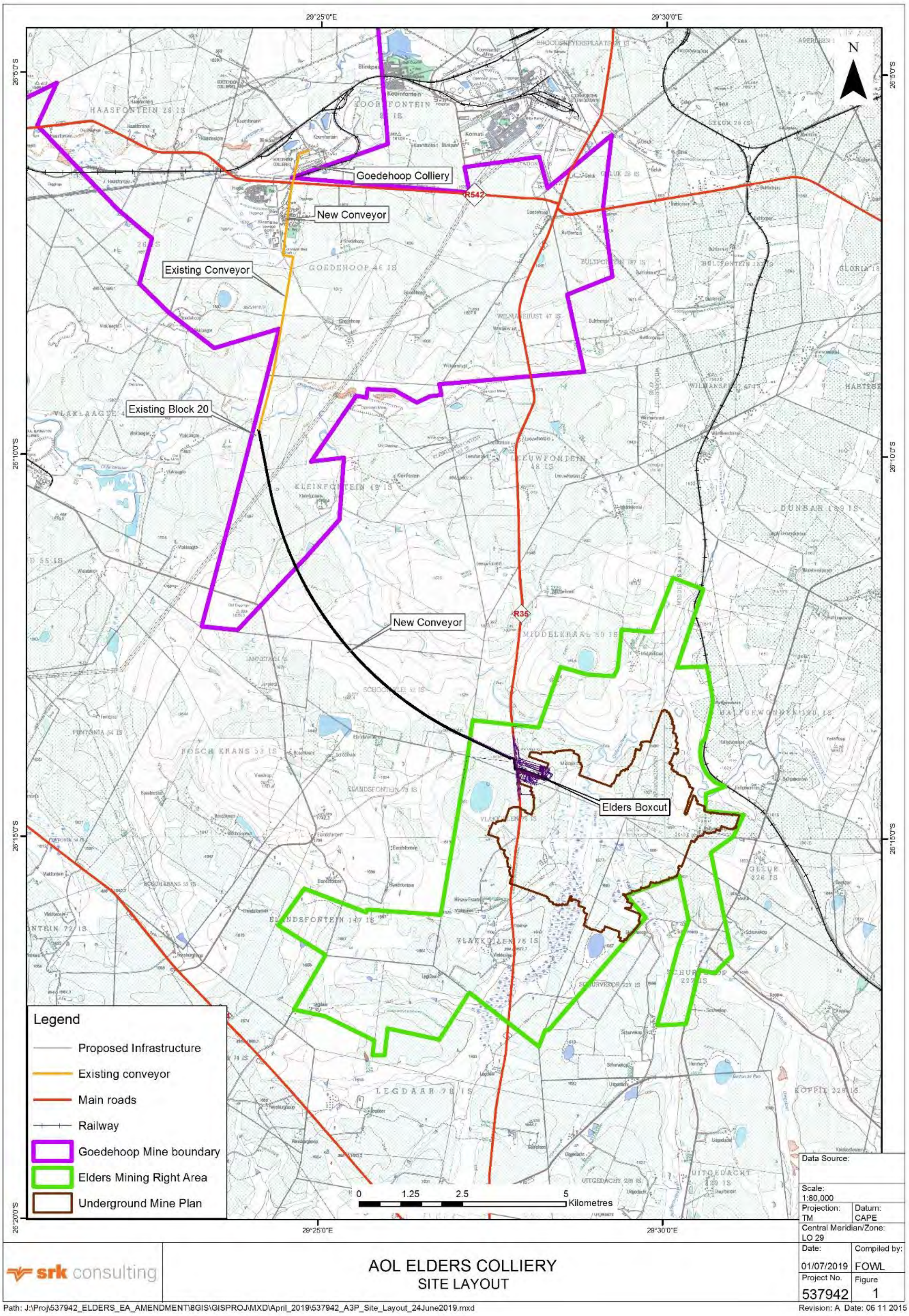


Figure 1: Locality Sketch

3 Assessment Scenarios

The selection of the assessment years is based on the Technical Methods for Highways (TMH) 16 Manual for Traffic Impact Assessments and Site Traffic Assessments. The following assessment years will be analysed in this Site Traffic Assessment.

- Existing Traffic conditions: This scenario will analyse the existing traffic conditions (2019) on the road network surrounding the Elders Colliery with current road geometry.
- Base Year Traffic plus Elders Colliery construction traffic: This scenario will analyse the existing traffic conditions (2019) on the road network surrounding the Elders Colliery plus the construction traffic as generated due to the construction of the new mine shaft with current road geometry.
- Design Year Traffic conditions: The design year is the year in which the Elders Colliery is completely developed and operating at full capacity. This is expected to be in 3 years' time. However, the operations of the mine are estimated to be 14 years. Therefore, this scenario will analyse the 10-year background traffic volumes plus the fully operational Elders Colliery generated traffic volumes on the surrounding road network in the year 2029. Any road upgrades currently underway in the area will also be completed, hence they will be included in the analysis.

The scenarios mentioned above therefore analyse the worst-case traffic conditions at each scenario.

4 Overview of Relevant Legislation and Standards

The specialist traffic and transportation study has been undertaken in accordance with the following legislation and standards where applicable:

- Minerals and Petroleum Resources Development Act (MPRDA, Act 28 of 2002)
- National Environmental Management Act (NEMA, Act 107 of 1998) and amendments
- National Water Act (NWA, Act 36 of 1998)
- Conservation of Agricultural Resources Act 43 of 1983
- Environment Conservation Act 73 of 1989
- National Environmental Management: Biodiversity Act 10 of 2004
- National Environmental Management: Air Quality Act 39 of 2004
- National Environmental Management: Waste Act 59 of 2008
- Mine Health and Safety Act 29 of 1996
- National Heritage Resources Act 25 of 1999
- Health Act 63 of 1977
- Local bylaws
- The National Road Traffic Act 93 of 1996

In addition, this specialist traffic and transportation study has also referred to the following guideline documents:

- TMH 16 Volume 1, South African Traffic Impact and Site Traffic Assessment Manual, 2012.
- TMH 16 Volume 2, South African Manual for Traffic Impact and Site Traffic Assessment Standards and Requirements Manual, 2014.
- TMH 17 South African Trip Data Manual
- Southern African Road Safety Manual (National Department of Transport 1999) which gives guidelines and the methodology to undertake a road safety assessment of existing roads.
- Southern African Development Community Road Traffic Signs Manual (South African Department of Transport)

5 Site Investigation

The map of the road network most likely to be affected by this proposed development is provided below followed by a description of the roads.

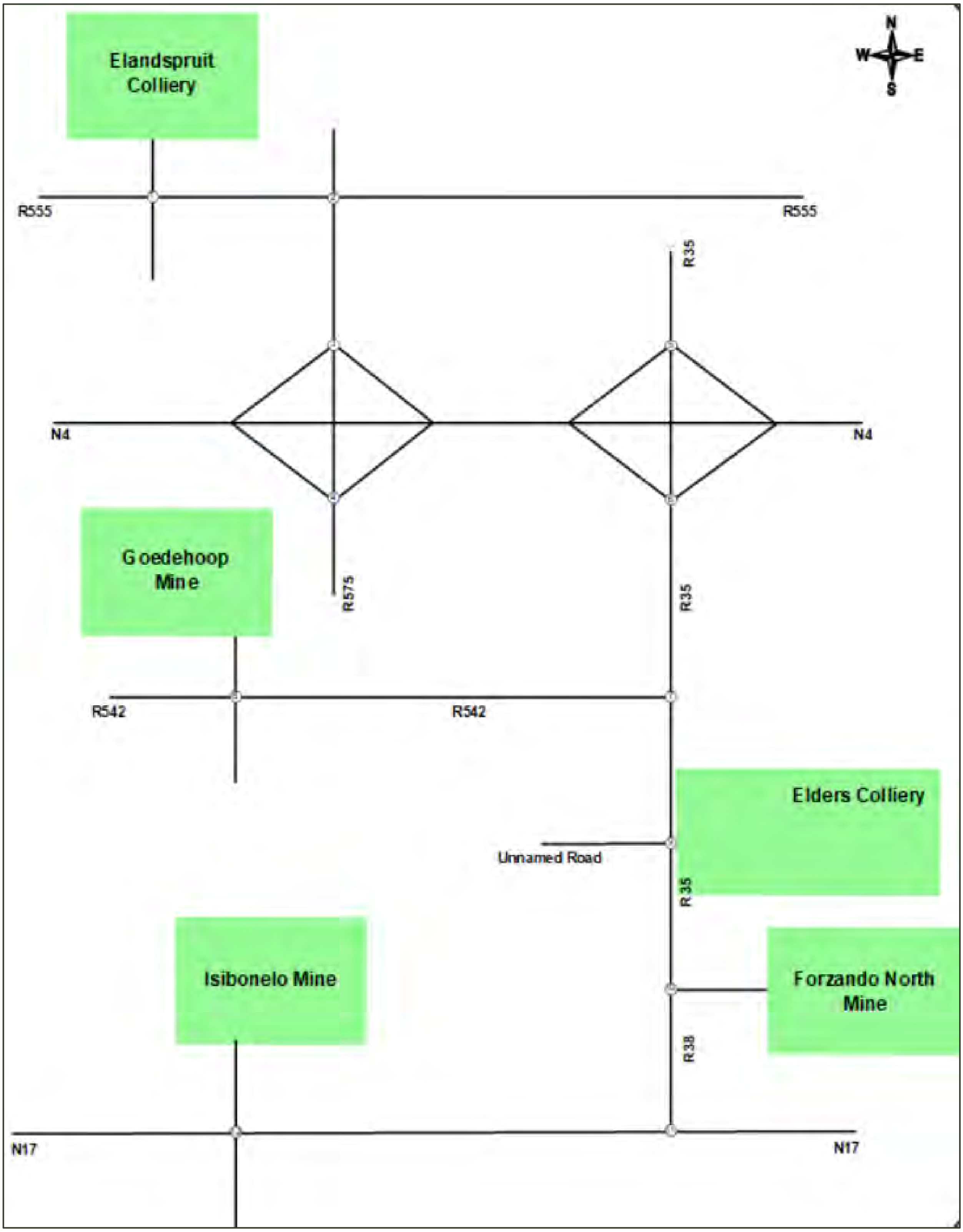
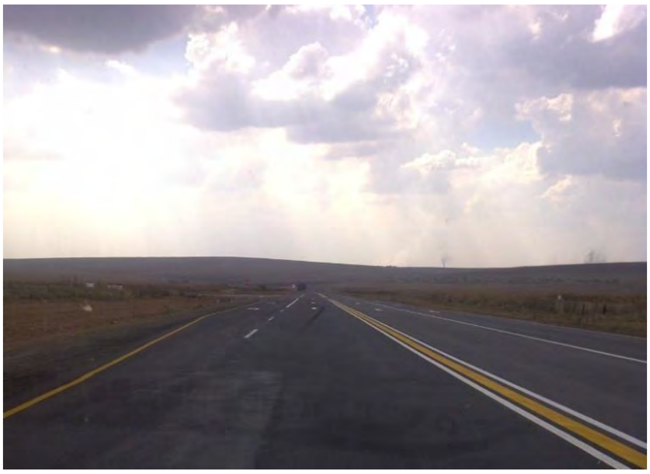


Figure 2: Road Network

5.1 R35

The R35 road is in excellent condition with very good geometry. The road is a single carriageway with 3,5m lanes in both directions and 1,5m hard shoulders. Sight distance is in excess of 200m at the Elders Colliery access point. Signage is good and the speed limit varies between 60-100km/h. The road edge was well maintained, and the grass was cut short in the road reserve. No adverse safety conditions were observed.



R35

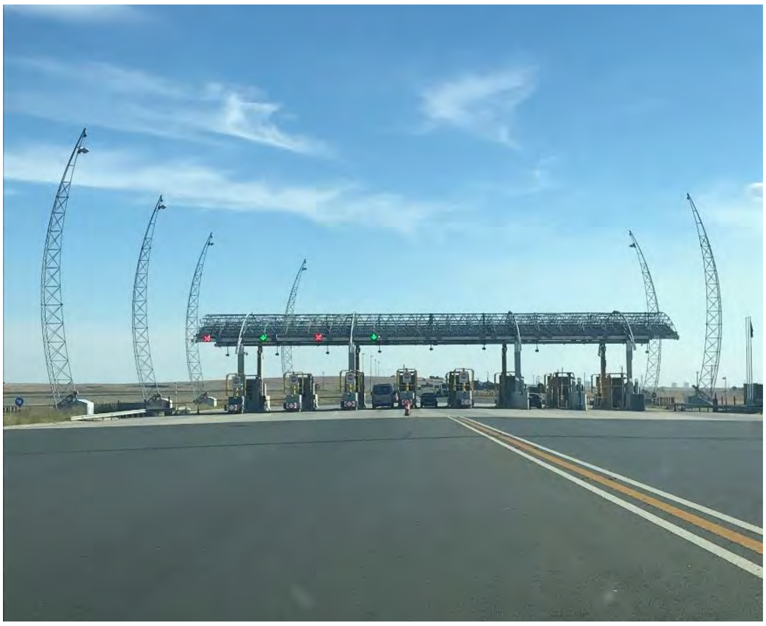
5.2 R542

The R542 is a single carriageway road with a single 3.5m lane in each direction having grassed shoulders on both sides. Sight distance is excellent however the road surface conditions vary from good to poor with evidence of significant road repairs and potholes together with severe rutting at the road edges. The indicated speed limit is 100km/h and reduces to 60km/h on approach to the intersection with the R35. No adverse safety conditions were observed.

R542

5.3 N17

The N17 road is in excellent condition with very good geometry. The road is a single carriageway with 3,7m lanes in both directions and 1,5m hard shoulders. Signage is good, and the speed limit varies between 100-120km/h. The road edge was well maintained, and the grass was cut short in the road reserve. No adverse safety conditions were observed. The Trichardt Toll Plaza is located on the N17 on the way to Isibonelo Mine.



Trichardt Toll Plaza on N17

5.4 N4

The N4 road is in excellent condition with very good geometry. The road is a dual carriageway with 3,7m lanes in both directions and 1,5m hard shoulders. Signage is good, and the speed limit varies between 100-120km/h. The road edge was well maintained, and the grass was cut short in the road reserve. No adverse safety conditions were observed.

N4

5.5 R575

The R575 is a single carriageway road with a single 3.5m lane in each direction with 1.5m hard shoulders on both sides. Sight distance is good however the road surface conditions vary from good to poor with evidence of significant road repairs and potholes together with severe rutting at the road edges. The indicated speed limit is 80km/h. No adverse safety conditions were observed.

R575

5.6 R555

The R542 is a single carriageway road with a single 3.5m lane in each direction having grassed shoulders on both sides. Climbing lanes are provided for steep segments. Sight distance is good, however the road surface conditions vary from good to poor with evidence of significant road repairs and potholes together with severe rutting at the road edges. The indicated speed limit is between 60-80km/h. No adverse safety conditions were observed.

R555

6 Traffic Counts

The potential maximum impact of the proposed Elders Colliery will be during the weekday AM and PM peak hours when background traffic is the highest. The existing traffic volumes on the surrounding road network were obtained from classified traffic counts undertaken by Bala Survey and Research at the following intersections:

1. R555 / Road to Elandspruit Colliery
2. R555 / R575
3. R575 / N4 North Ramp
4. R575 / N4 South Ramp
5. R35 / N4 North ramp
6. R35 / N4 South ramp
7. R35 / R542 North
8. R542 / Goedehoop Mine Access
9. R35 / Unnamed Road
10. R35 / Road to Forzando North Mine
11. N17 / Moses Kotane / R38
12. N17 / Road to Isibonelo Mine

The traffic counts were undertaken from 06:00 to 18:00 recording all vehicles by vehicle type and movement in 15-minute intervals. An analysis of the traffic counts revealed that the AM peak hour at these intersections occurs from 06:30 to 07:30 and the PM peak hour occurs from 16:15 to 17:15, both of which are typical peak period times for town centre and semi-rural environments.

The traffic count locations are shown in Figure 3 below. The 4 transport routes between Elders mine and processing plants are shown in Figure 4. The existing peak hour traffic volumes on the surrounding road network are shown in Figure 5 below.

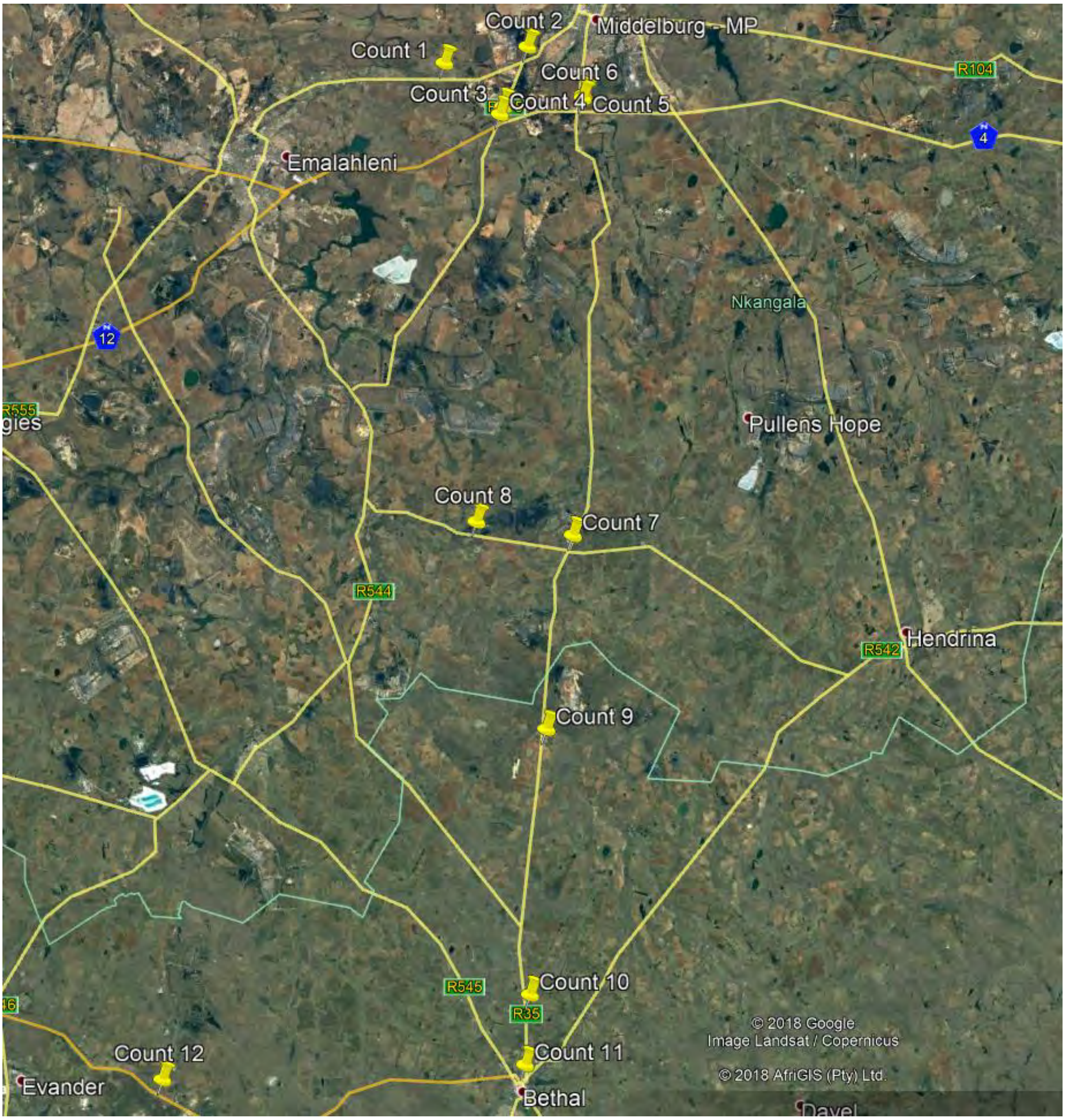


Figure 3: Traffic count locations

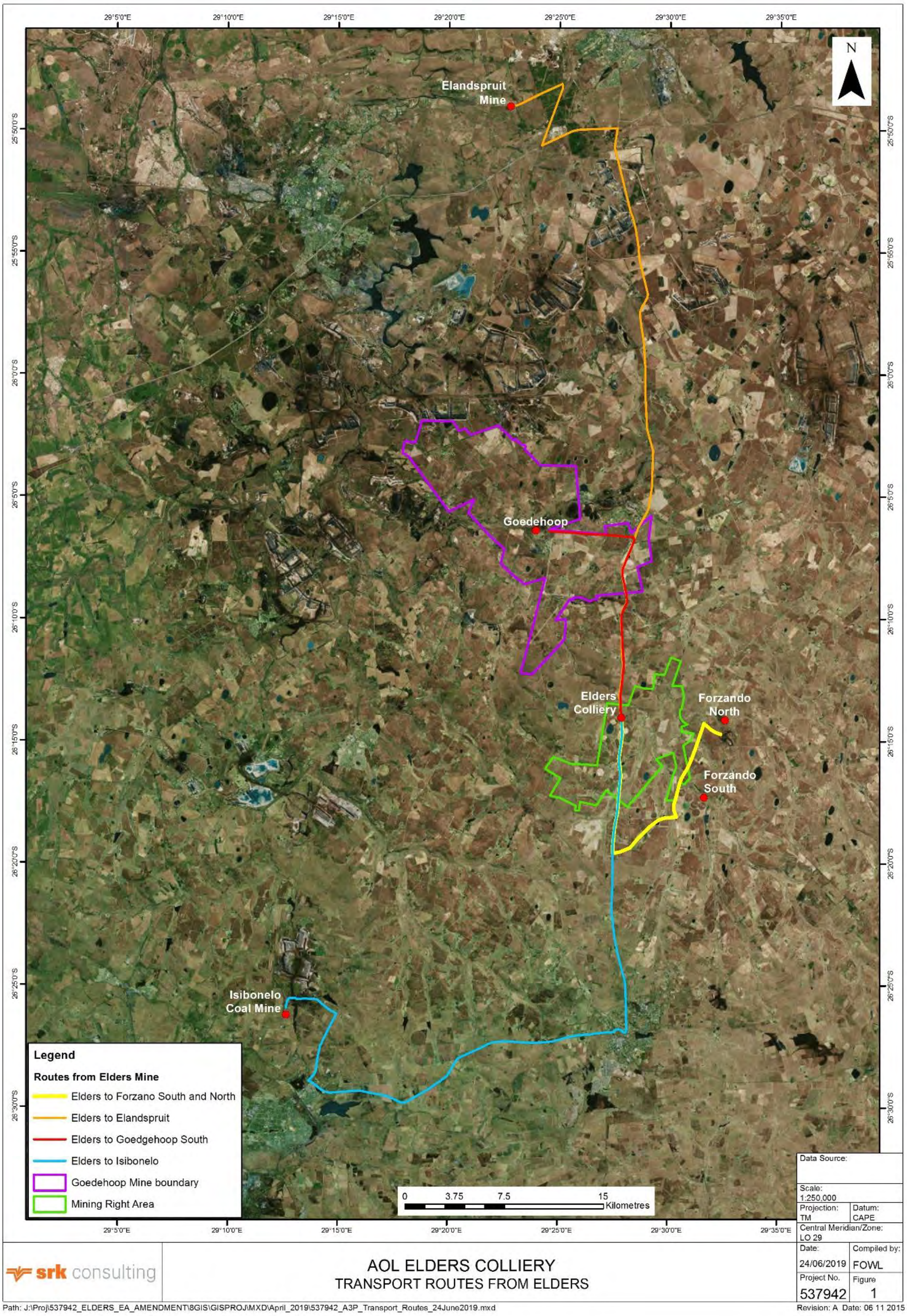


Figure 4: Transport routes to processing plants

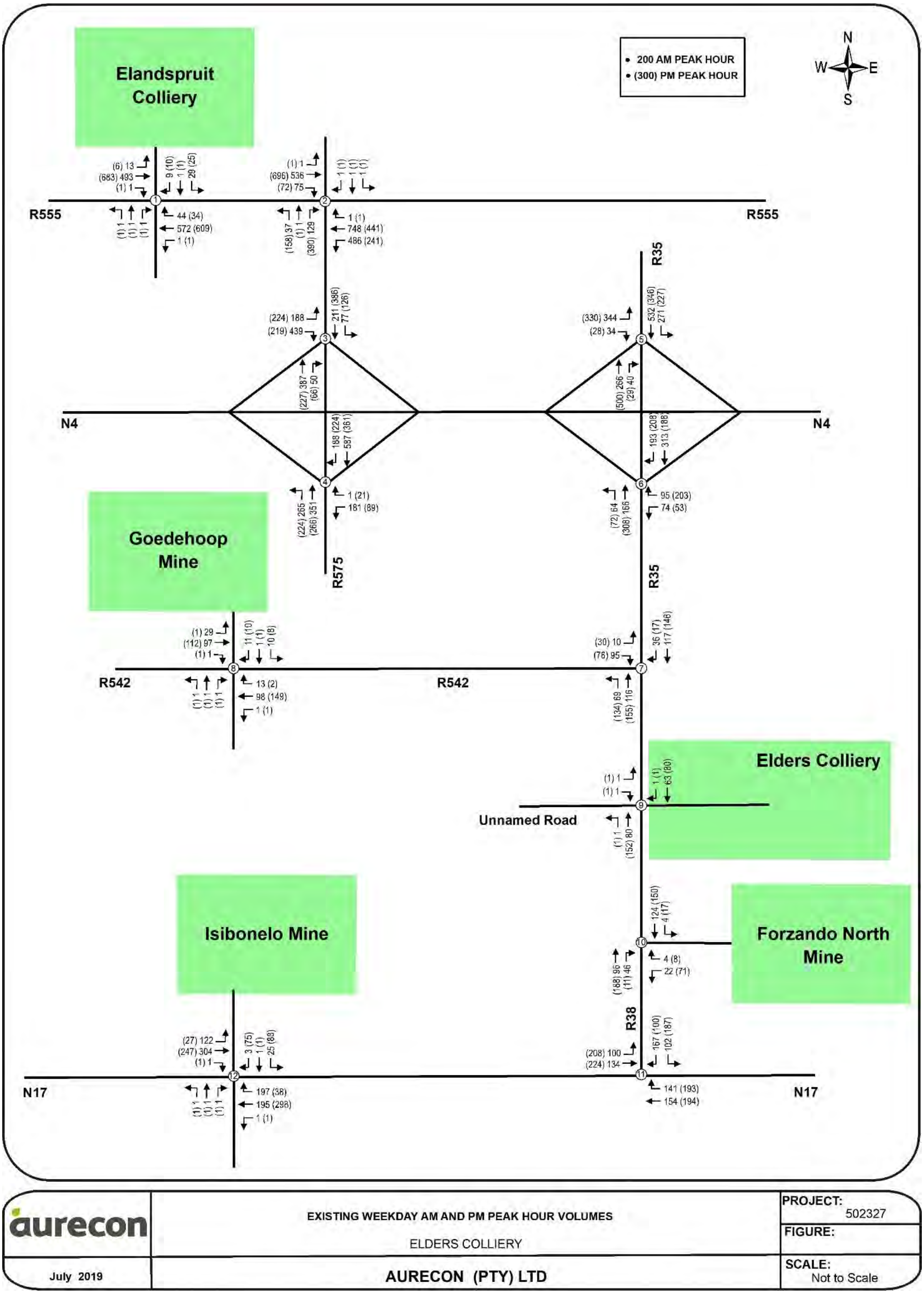


Figure 5: Existing Traffic Volumes

6.1 Method of Analysis

The Signalised & unsignalized Intersection Design and Research Aid (SIDRA) computer software was used to analyse the traffic conditions at the affected intersections. The underlying objective of intersection analysis is to quantify the performance of an intersection with regard to specified traffic volumes and environmental conditions. This traffic operational performance can be measured in terms of ‘Level of Service’ (LOS). Six levels of service exist, ranging from A to F.

LOS A represents the best operating conditions (free-flow conditions and no delay or congestion) whereas LOS F represents the worst, (breakdown conditions with congestion and very high delays). LOS D is deemed the minimum acceptable level of service.

The legend hereafter is used to depict the LOS of each movement at the intersections.

LOS A: No delay or congestion

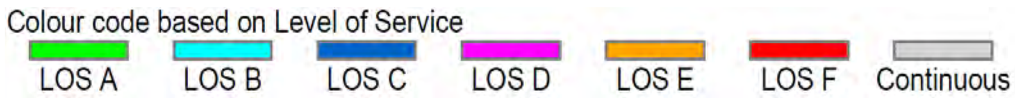
LOS B: Negligible delay or congestion

LOS C: Low delay or congestion

LOS D: Some delay or congestion

LOS E: Moderate delay or congestion

LOS F: Congestion and very high delays

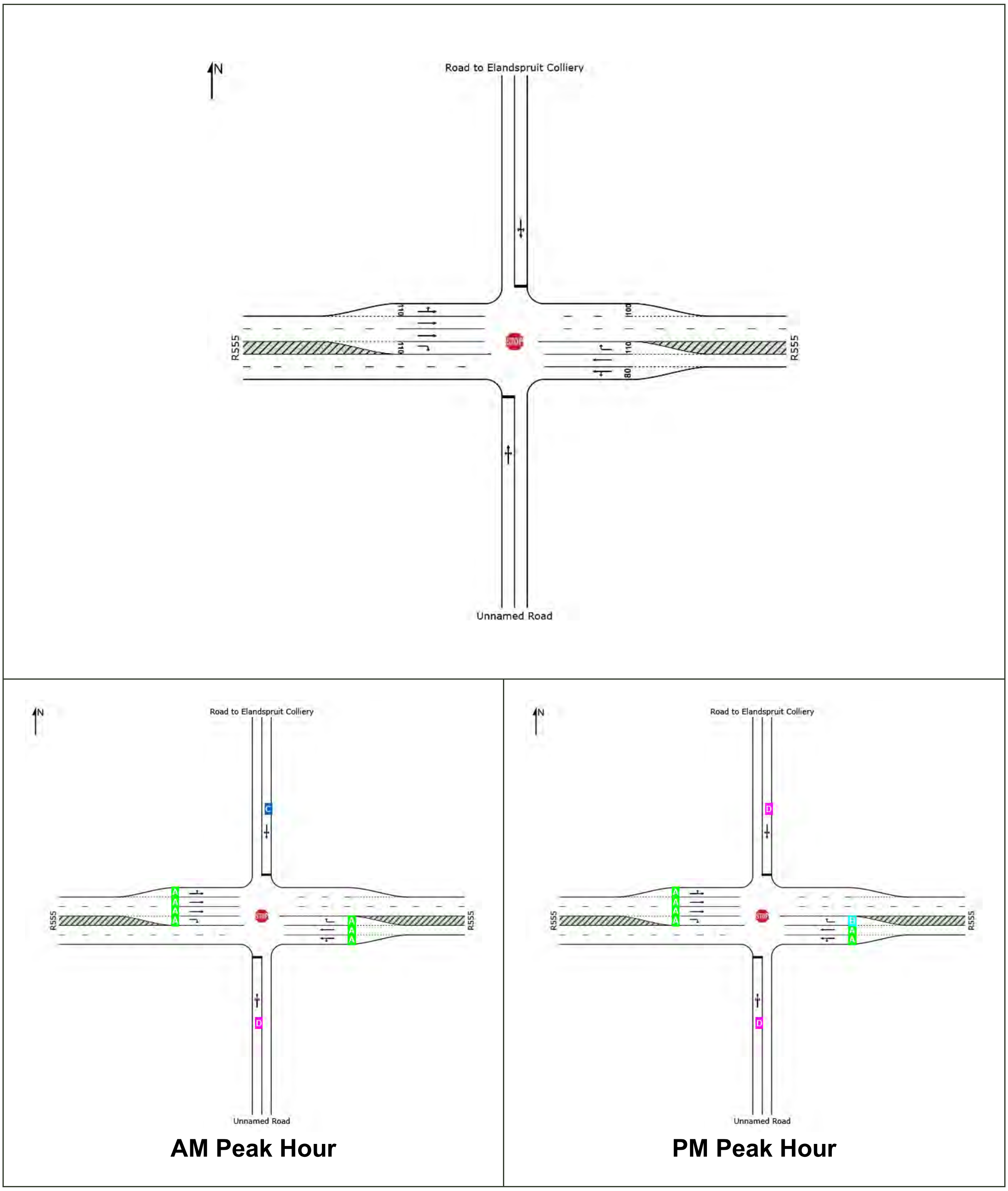


The results of these analyses are presented below with the details contained in Appendix B to this report.

7 Existing Analysis

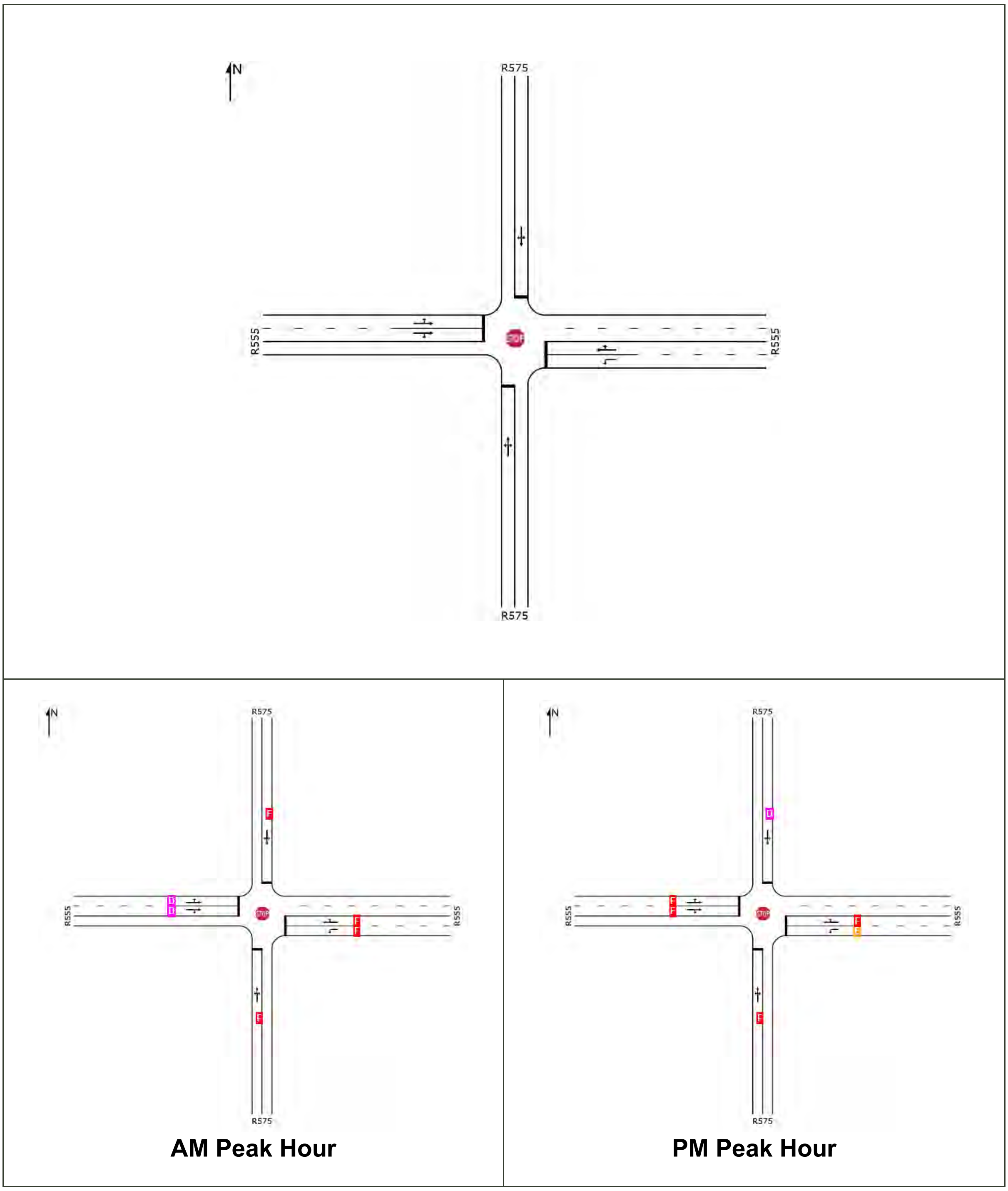
This section will analyse the existing traffic conditions on the road network and does not include additional mine generated traffic. The traffic congestion issues if any are pre-existing.

7.1 R555 / Road to Elandspruit Colliery Intersection



From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

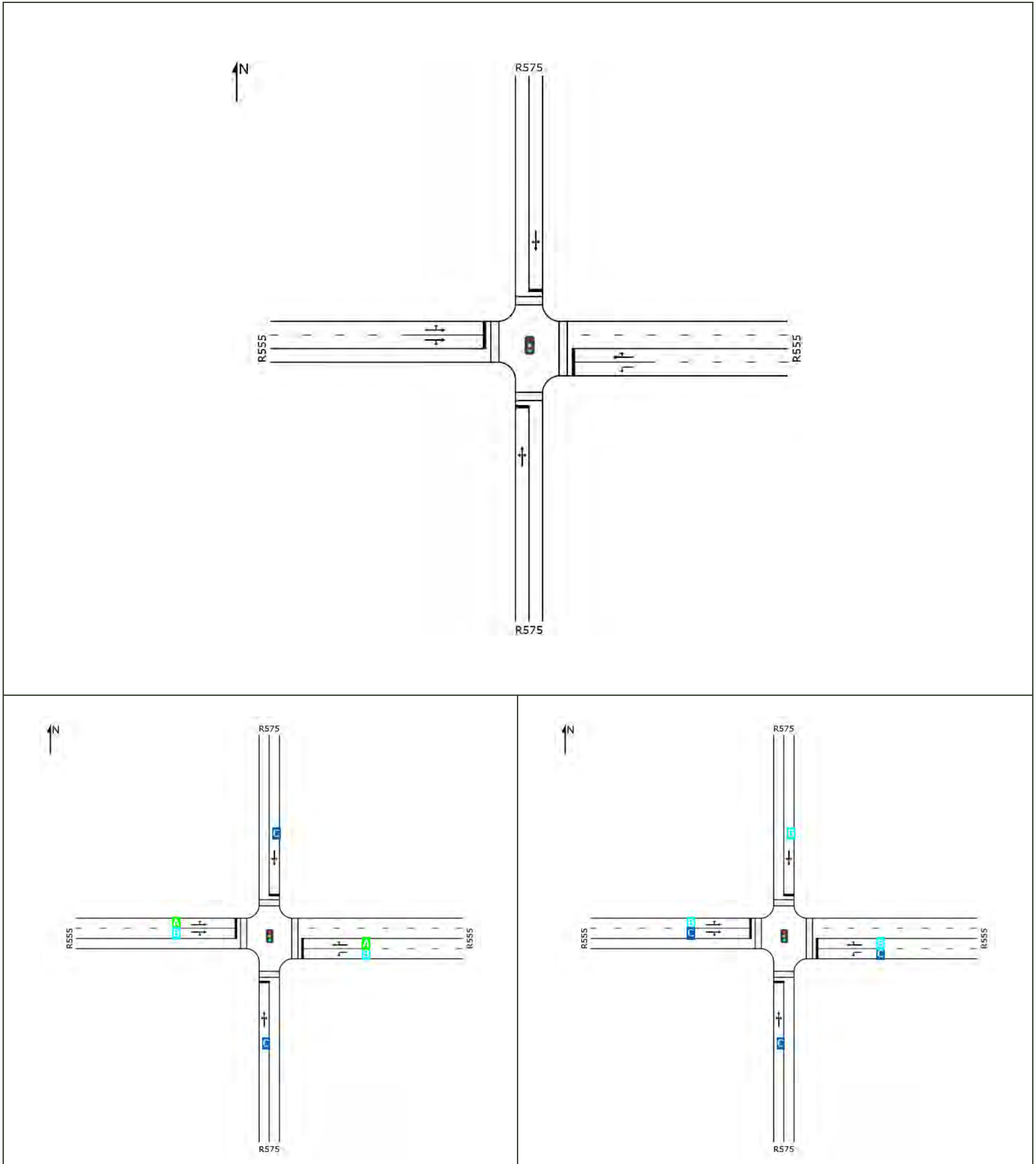
7.2 R555 / R575 Intersection



From the SIDRA results, it is evident that this intersection currently experiences congestion during the peak hours. Upgrades are required to this intersection even before adding the mine generated traffic. The road authority is responsible for these upgrades. The upgrade required is tested below.

R555 / R575 Intersection - Upgraded

The road authority is responsible for these upgrades as it is an existing traffic congestion requirement.



AM Peak Hour

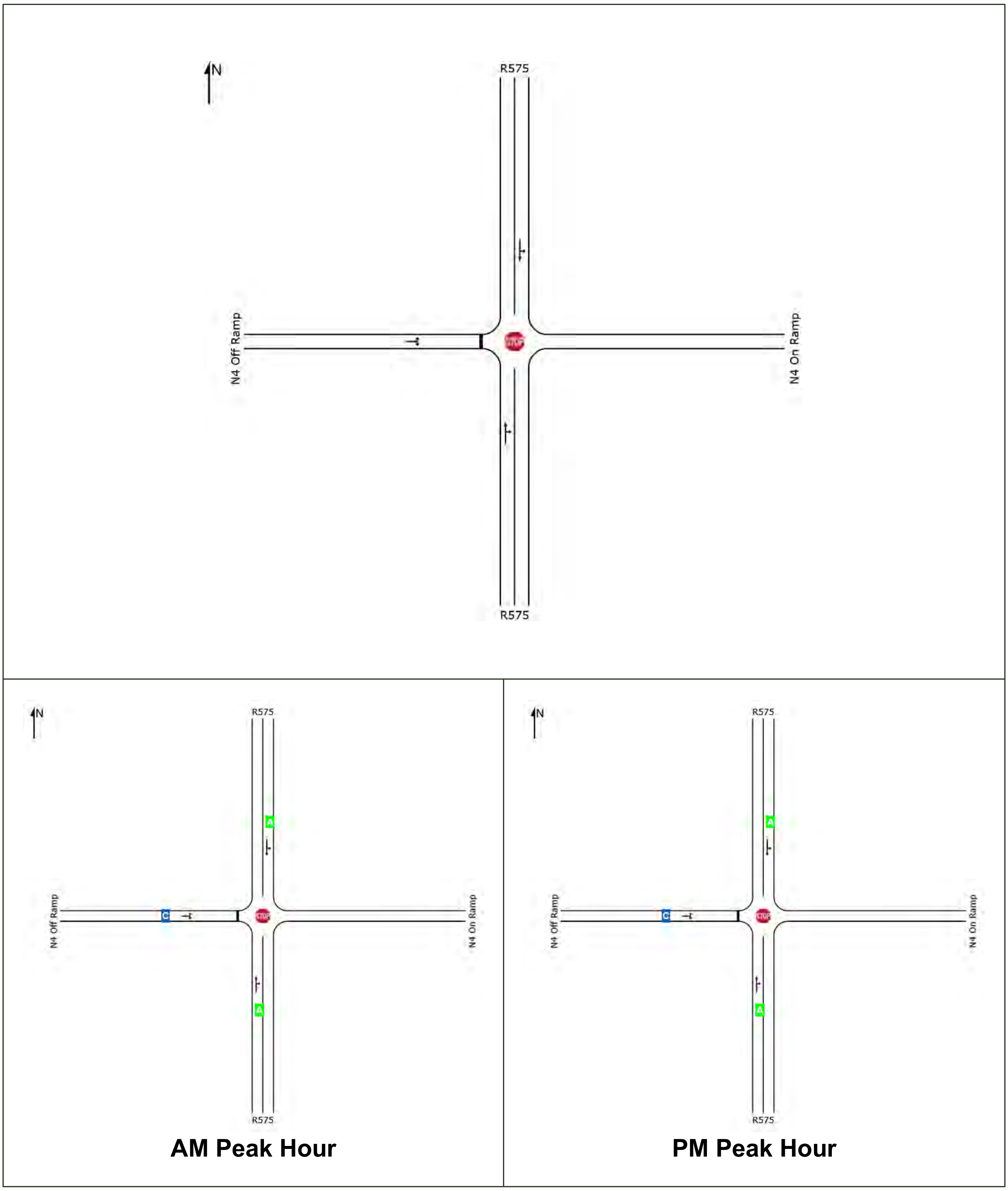
PM Peak Hour

The following upgrades were recommended for this intersection:

- Upgraded to a signalized intersection

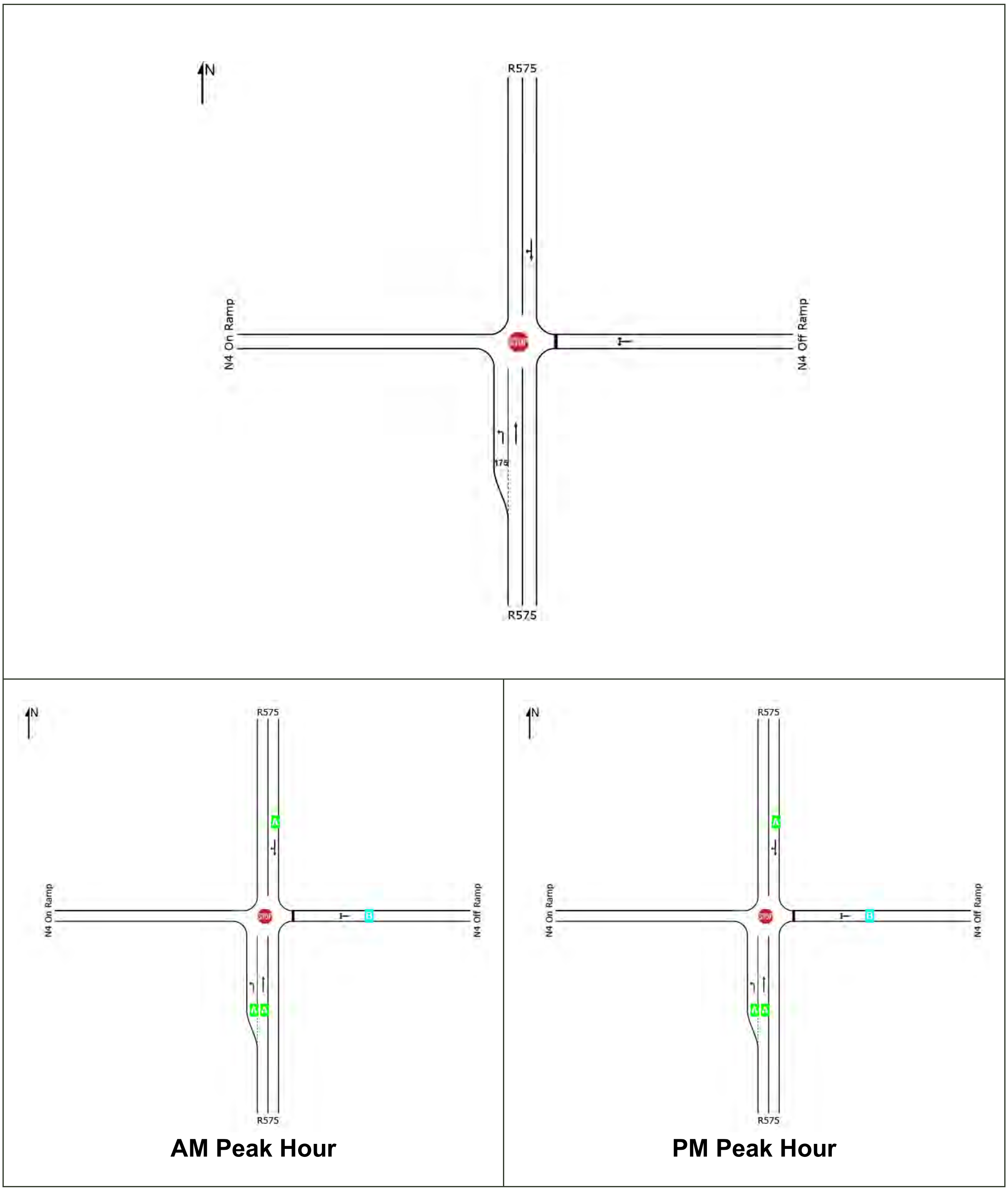
From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours once the upgrade above is implemented. It is to be noted that this intersection can only be signalized once the warrants are met.

7.3 R575 / N4 North Ramp Intersection



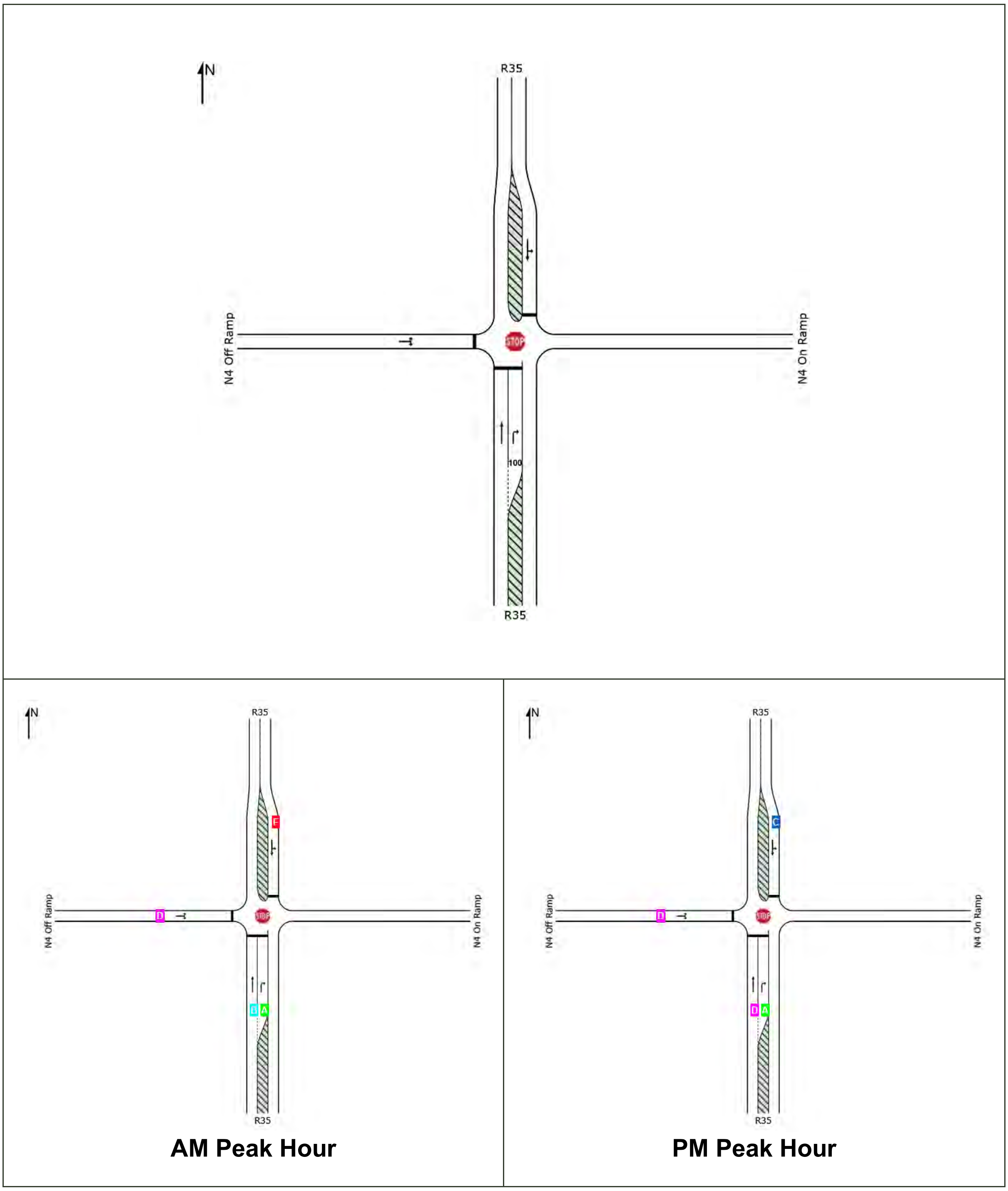
From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

7.4 R575 / N4 South Ramp Intersection



From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

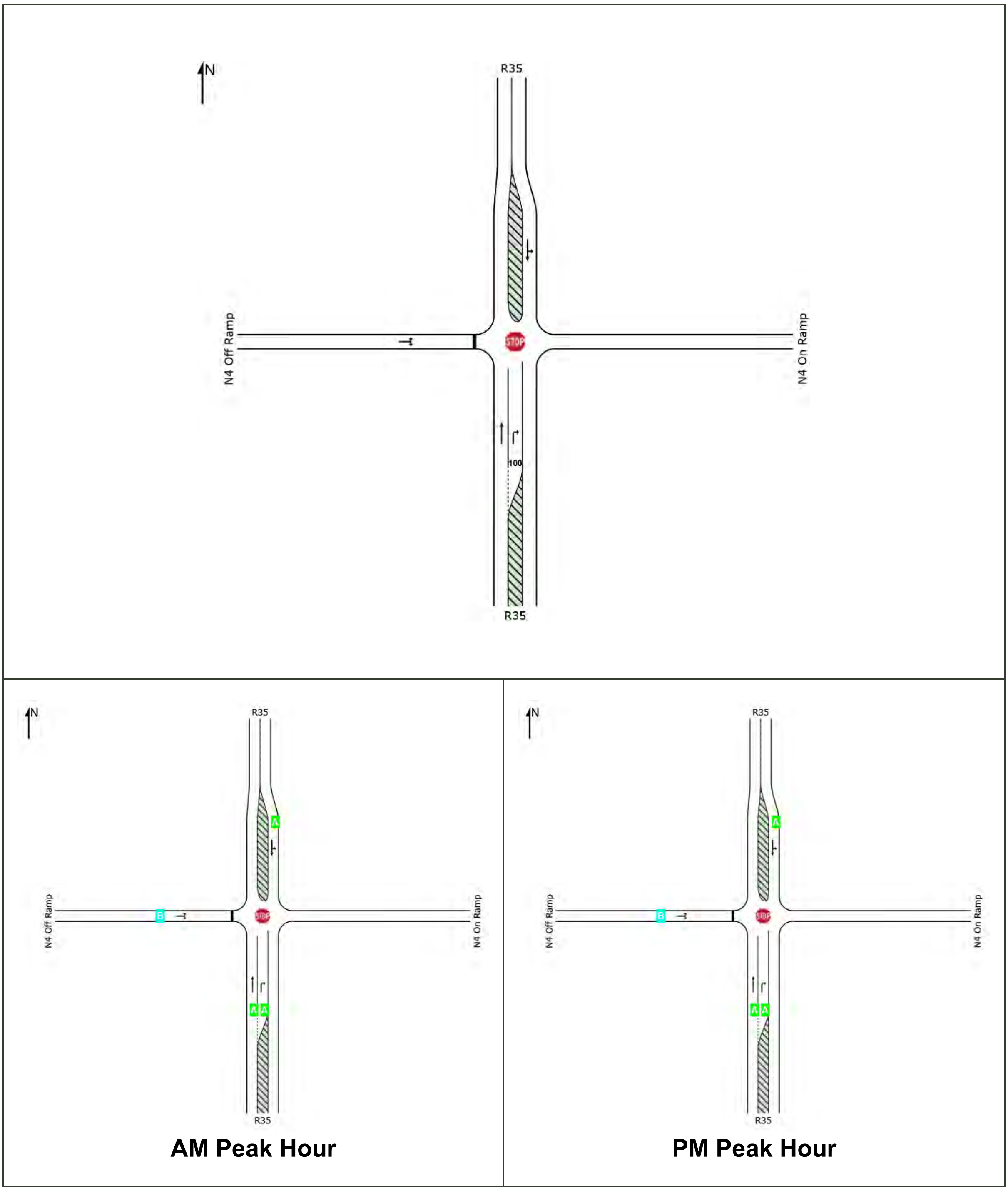
7.5 R35 / N4 North Ramp Intersection



From the SIDRA results, it is evident that this intersection currently experiences congestion during the peak hours. Upgrades are required to this intersection even before adding the mine generated traffic. The road authority is responsible for these upgrades. The upgrade required is tested below.

R35 / N4 North Ramp Intersection - Upgraded

The road authority is responsible for these upgrades as it is an existing traffic congestion requirement.

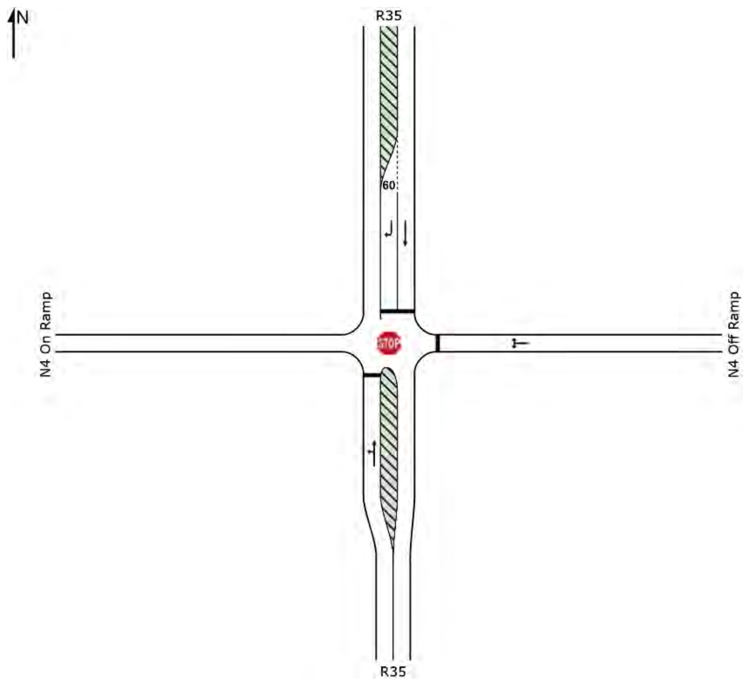


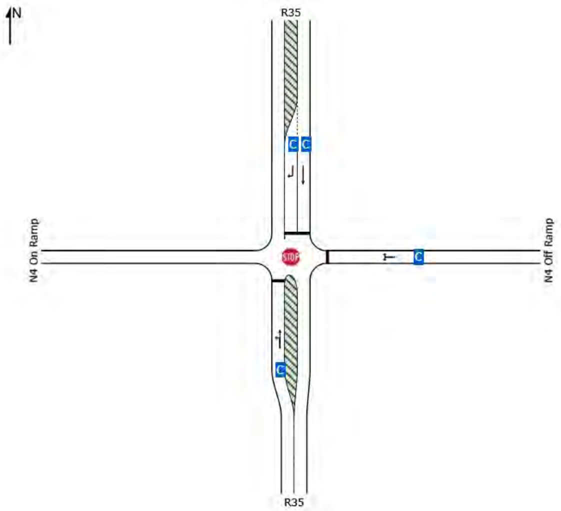
The following upgrades are required for this intersection:

- North and South Approach: Remove stop control

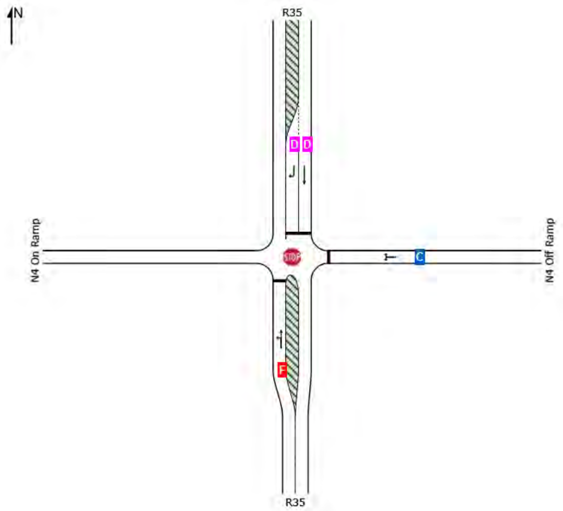
From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours once the upgrade above is implemented.

7.6 R35 / N4 South Ramp Intersection





AM Peak Hour

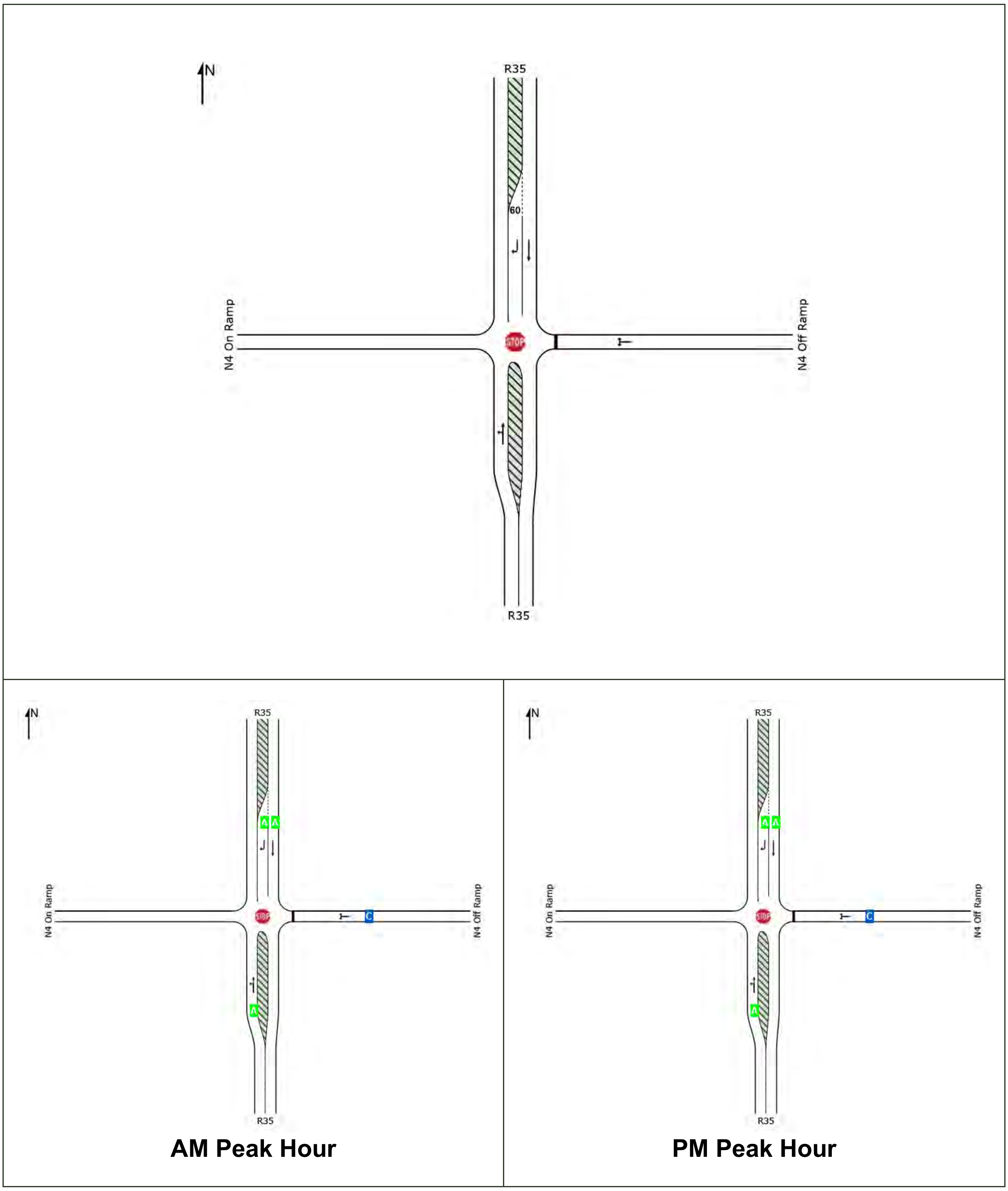


PM Peak Hour

From the SIDRA results, it is evident that this intersection currently experiences congestion during the peak hours. Upgrades are required to this intersection even before adding the mine generated traffic. The road authority is responsible for these upgrades. The upgrade required is tested below.

R35 / N4 South Ramp Intersection - Upgraded

The road authority is responsible for these upgrades as it is an existing traffic congestion requirement.

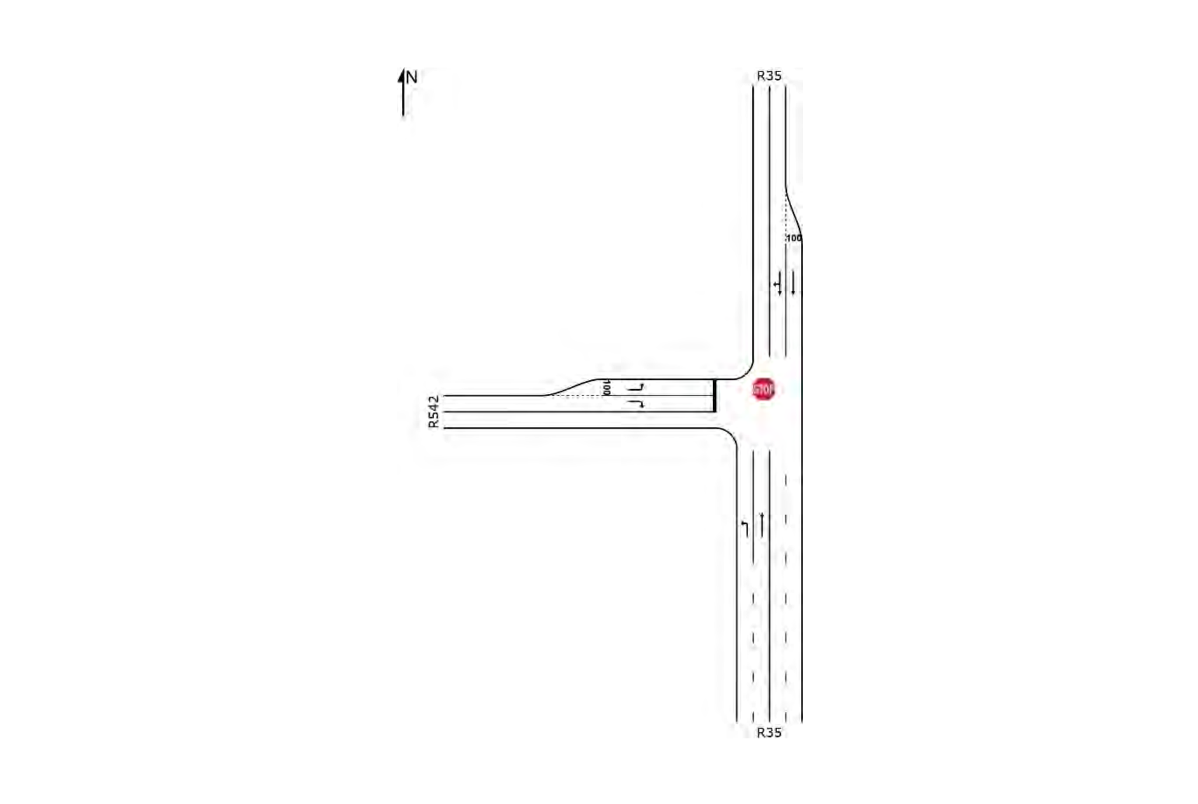


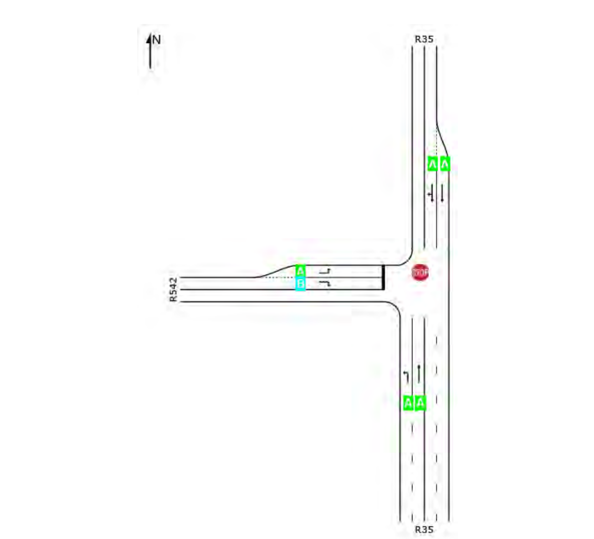
The following upgrades are required for this intersection:

- North and South Approach: Remove stop control

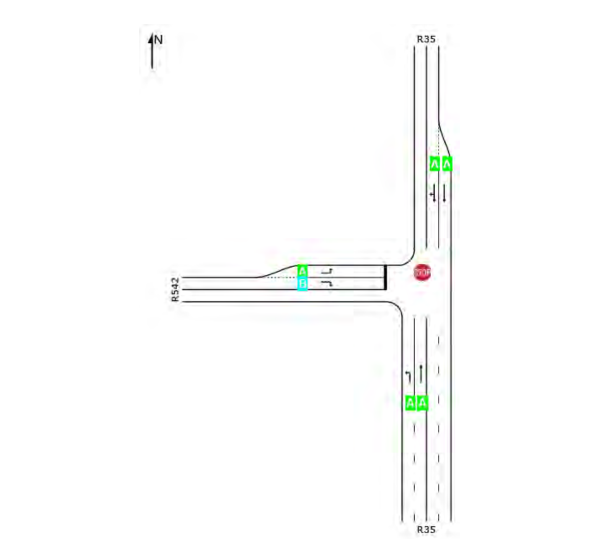
From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours once the upgrade above is implemented.

7.7 R35 / R542 North Intersection





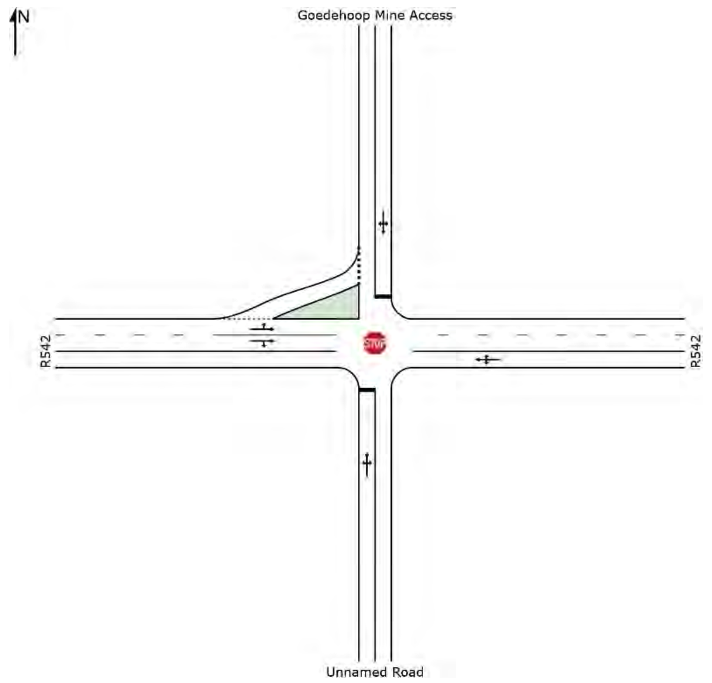
AM Peak Hour

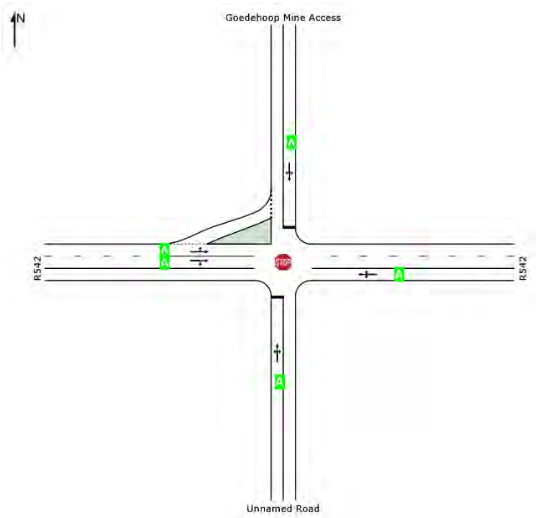


PM Peak Hour

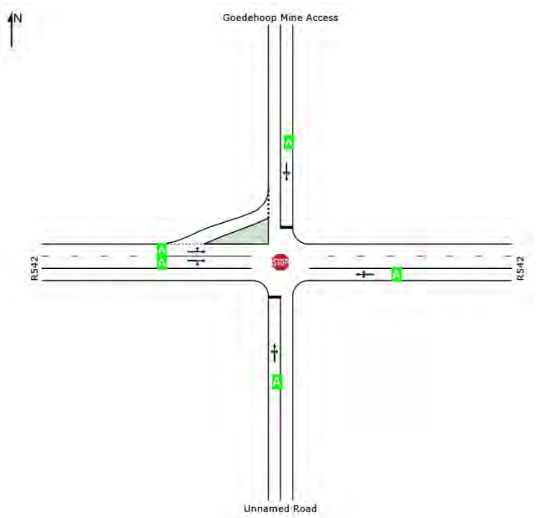
From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

7.8 R542 / Goedehoop Mine Access Intersection





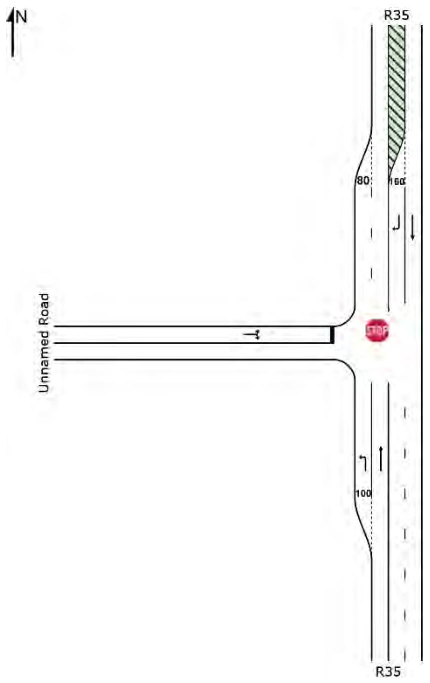
AM Peak Hour

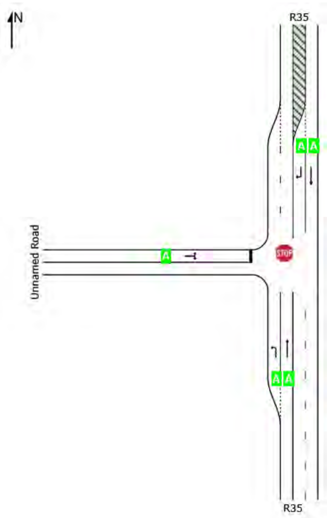


PM Peak Hour

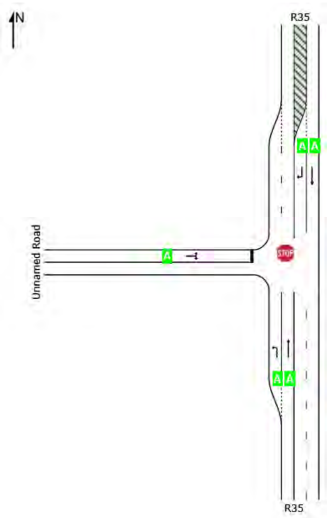
From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

7.9 R35 / Unnamed Road Intersection





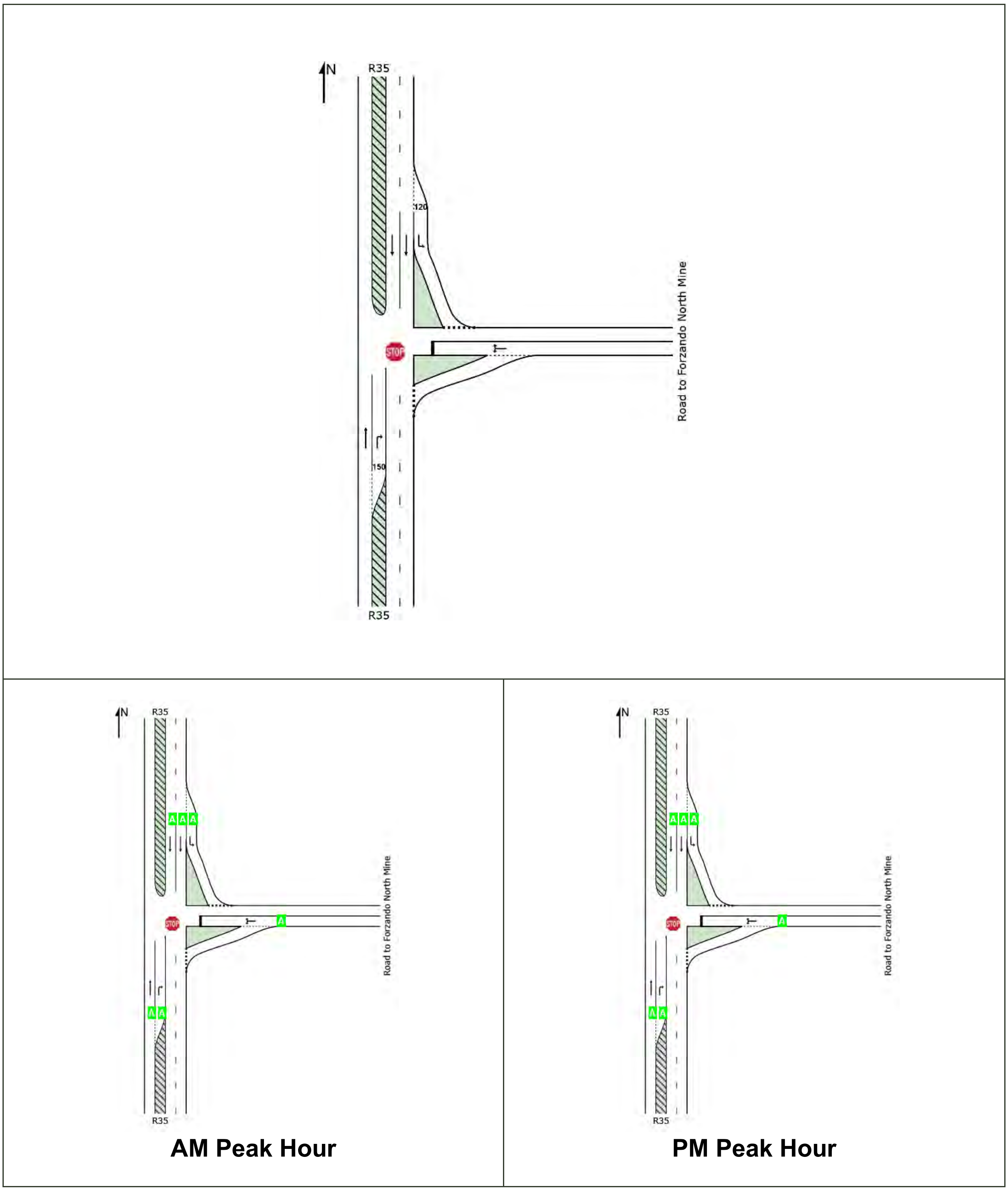
AM Peak Hour



PM Peak Hour

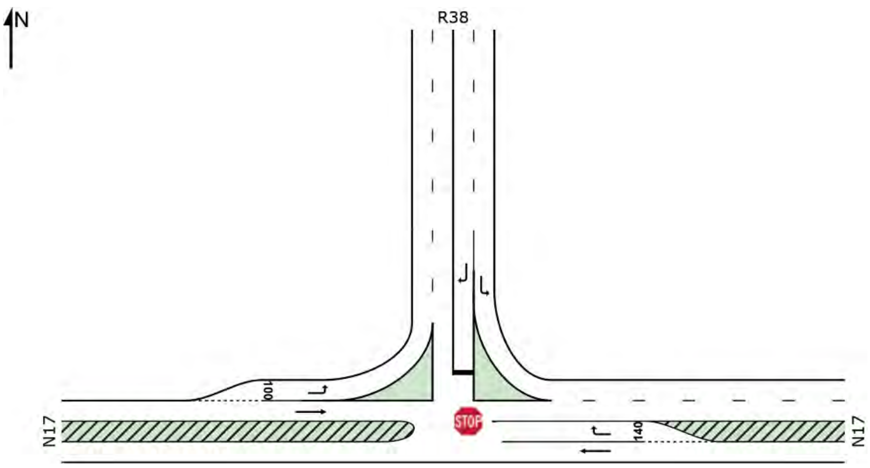
From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

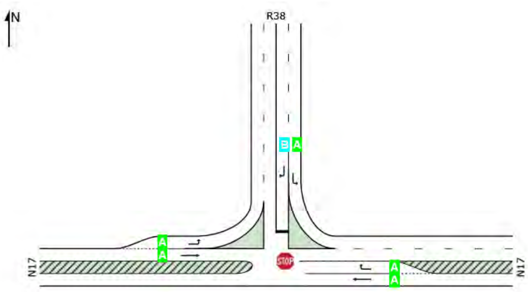
7.10 R35 / Road to Forzando North Mine Intersection



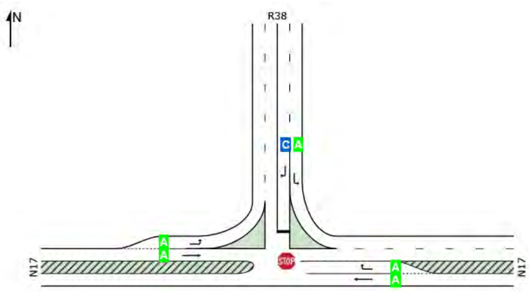
From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

7.11 N17 / Moses Kotane / R38 Intersection





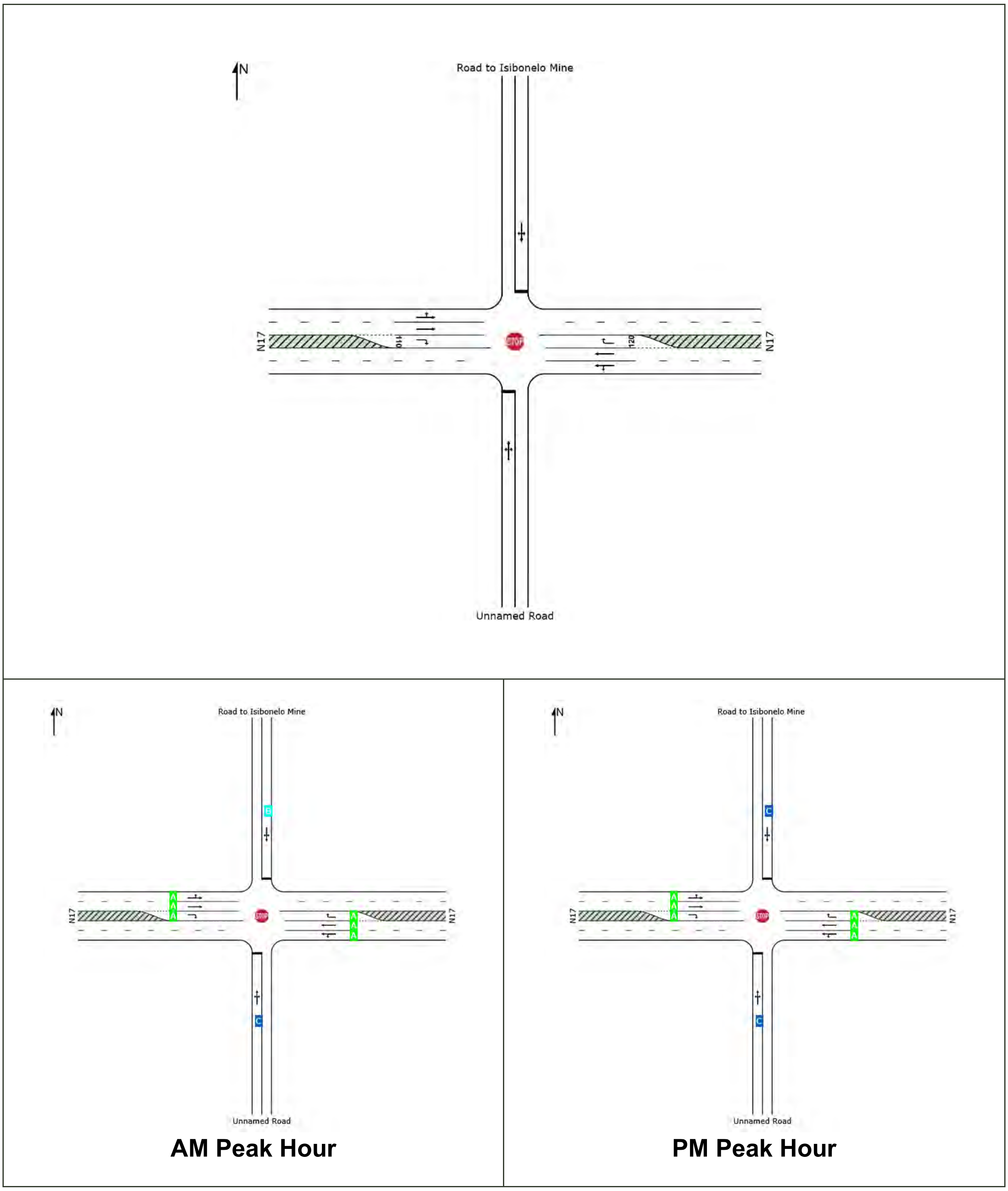
AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

7.12 N17 / Road to Isibonelo Mine Intersection



AM Peak Hour

PM Peak Hour

From the SIDRA results, it is evident that this intersection currently operates at acceptable levels of service during the peak hours.

8 Summary of Existing Traffic Analysis

The table below summarises the existing traffic analysis without adding mine generated traffic. The responsibility of upgrades where required lies with the road authority as these are required due to pre-existing traffic congestion.

Summary of existing Traffic Analysis			
Intersection	**Upgrade needed (Yes/No)**	**Upgrade type**	**Responsibility**
R555 / Road to Elandspruit Colliery Intersection	No	-	-
R555 / R575 Intersection	Yes	Upgraded to a signalized intersection	Road Authority
R575 / N4 North Ramp Intersection	No	-	-
R575 / N4 South Ramp Intersection	No	-	-
R35 / N4 North Ramp Intersection	Yes	North and South Approach: Remove stop control	Road Authority
R35 / N4 South Ramp Intersection	Yes	North and South Approach: Remove stop control	Road Authority
R35 / R542 North Intersection	No	-	-
R542 / Goedehoop Mine Access Intersection	No	-	-
R35 / Unnamed Road Intersection	No	-	-
R35 / Road to Forzando North Mine Intersection	No	-	-
N17 / Moses Kotane / R38 Intersection	No	-	-
N17 / Road to Isibonelo Mine Intersection	No	-	-

Table 1: Summary of existing traffic analysis

Analysis in the sections to follow will be carried out such that the above-mentioned road upgrades have been implemented by the road authority. This is done in order to determine which upgrades are needed, if any, that are a result of mine generated traffic.

9 Existing plus Elders Colliery Construction Traffic Analysis

This scenario will analyse the existing traffic conditions (2019) on the road network surrounding the Elders Colliery plus the construction traffic as generated due to the construction of the Elders Colliery with current road geometry. Length of construction will be approximately 2 years.

The mine will have two access points. The main access intersection will form a 4-way intersection with the R35. This will be for mine workers and visitors. Approximately 600m north of this access will be an access used by the haulage trucks. This will be a T-junction with the R35. The construction phase will only analyse the main access. The operational phase will analyse both access points.

9.1 Trip Generation

The proposed Elders Colliery will generate additional traffic on the surrounding road network during the construction phase which will consist of construction workers and construction vehicles.

9.2 Construction Workers

The construction of the Elders Colliery will require a construction workforce as following which will be employed for an estimated 2 years which is estimated to be the length of the construction period:

- Skilled workers: 30
- Unskilled workers: 300
- Total construction workers: 330

The unskilled workers will be transported to and from the mine via buses with a vehicle occupancy of 60 persons per vehicle. The workers origins are expected as follows:

- Bethal (40%), Middelburg (35%) Witbank (15%) Kriel (10%)

The skilled workers will utilise private vehicles with an occupancy rate of 1.5 persons per vehicle. Both these categories of workers are expected to generate peak period vehicle trips. Therefore, this means that 300 workers will use buses and 30 workers will utilise private vehicles to go to the mine in the AM peak hour and return in the PM peak hour.

This equates to 5 bus trips (15 equivalent car units) and 20 vehicle trips into the mine in the AM peak hour and out of the mine in the PM peak hour.

*Note: 1 bus = 3 equivalent car units

9.3 Construction Vehicles

The construction activities at the proposed Elders Colliery will generate additional heavy vehicle traffic on the surrounding road network as a result of the construction vehicles travelling to and from the mine transporting equipment and construction materials. It is envisaged that the delivery vehicles will be deployed from their origins in the morning. The expected arrival times of these vehicles will fall outside of the traditional AM peak hour in. Similarly, these vehicles will leave for their origins before the PM peak hour to be back in time.

A maximum of 8 delivery trucks will deliver material to site each day. Therefore, the impact of the heavy construction vehicles on the external road network is expected to be negligible during the peak hours.

In addition, light vehicles and earth moving equipment will travel within the mine. These construction vehicles will not travel on the public road and hence will have little or negligible impact on the surrounding road network.

The summary of the construction traffic is shown in Table 2 and Figure 6 below.

		AM PEAK HOUR		**PM PEAK HOUR**	
	Equivalent Number of Peak Hour Passenger Car Unit Trips				
	Total Two Way	IN	OUT	IN	OUT
Construction Workers vehicles	35	35	0	0	35
Construction Vehicles	Negligible				
Total Vehicles per Hour	**35**	**35**	**0**	**0**	**35**

Table 2: Total ECU's for the Construction Phase

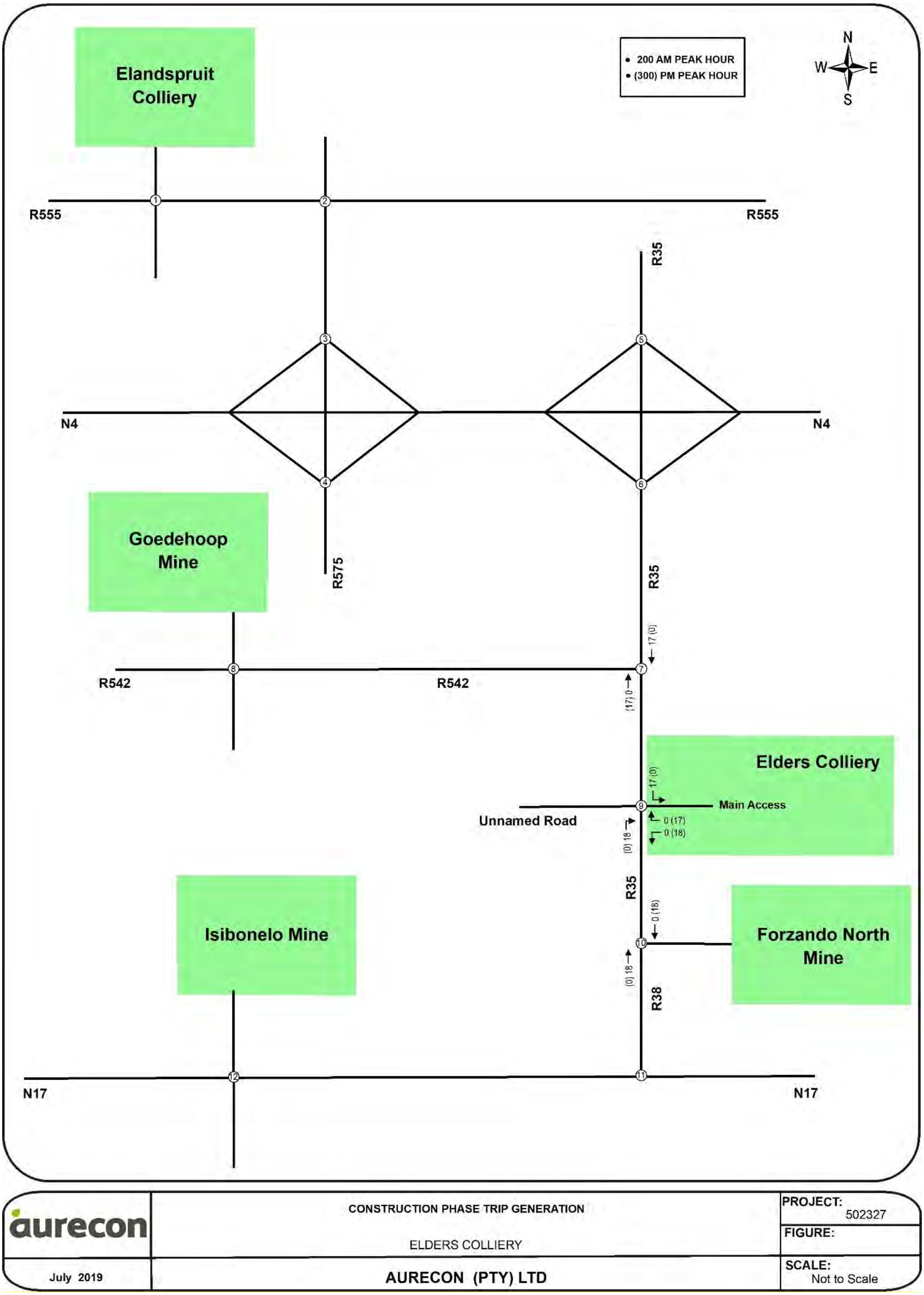
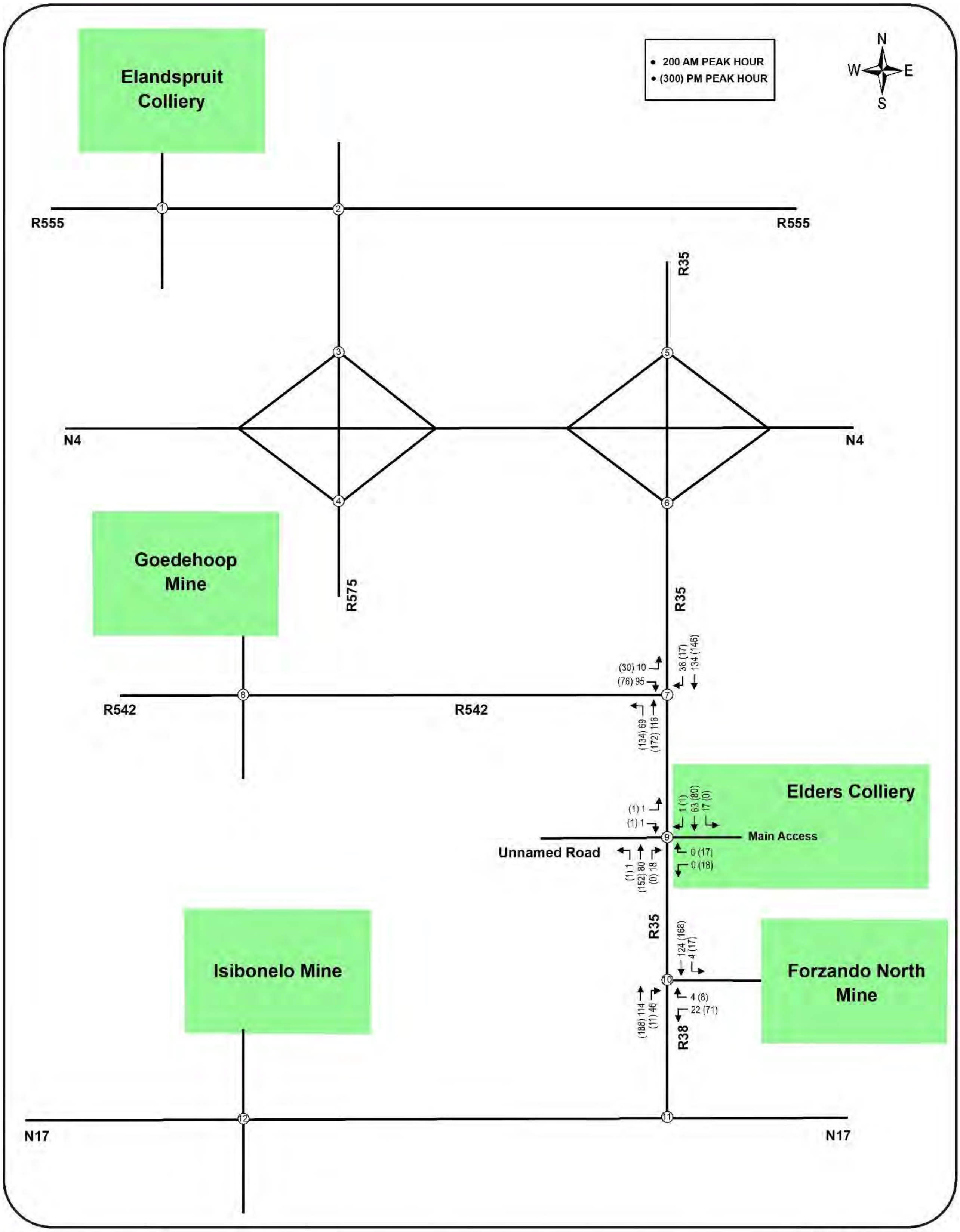


Figure 6: Construction Phase Generated Traffic Volumes

9.4 Base Year plus Construction Traffic Volumes

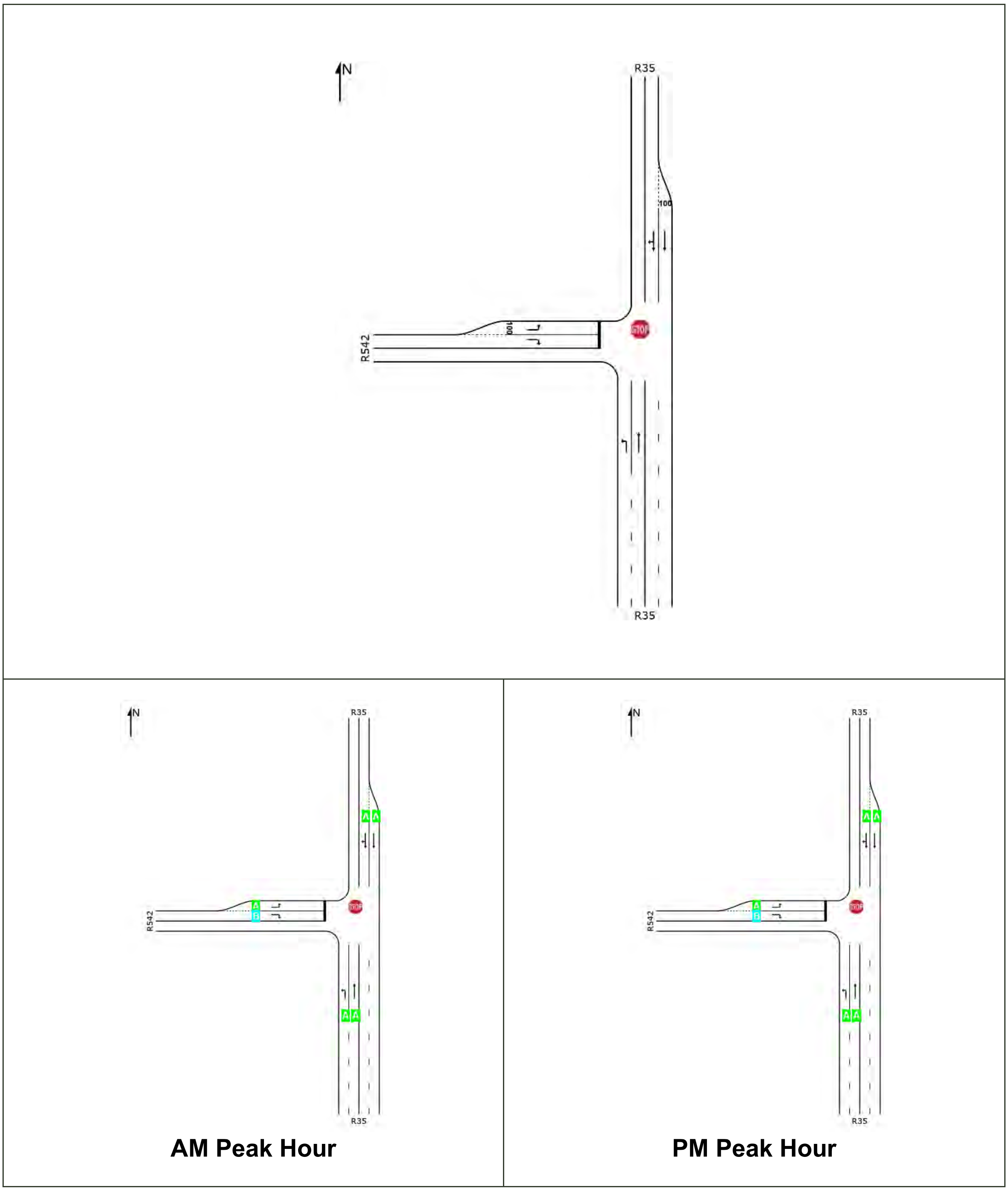
Figure 7 below shows the traffic volumes expected to be generated in the construction phase of the development plus the existing background traffic volumes. The volumes are very low during the peak hours hence only the intersections adjacent to the proposed Colliery will be analysed.



aurecon	BASE YEAR SCENARIO PLUS CONSTRUCTION PHASE TRIP GENERATION ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

Figure 7: Base Year plus Construction Phase Generated Traffic Volumes

9.5 R35 / R542 North Intersection

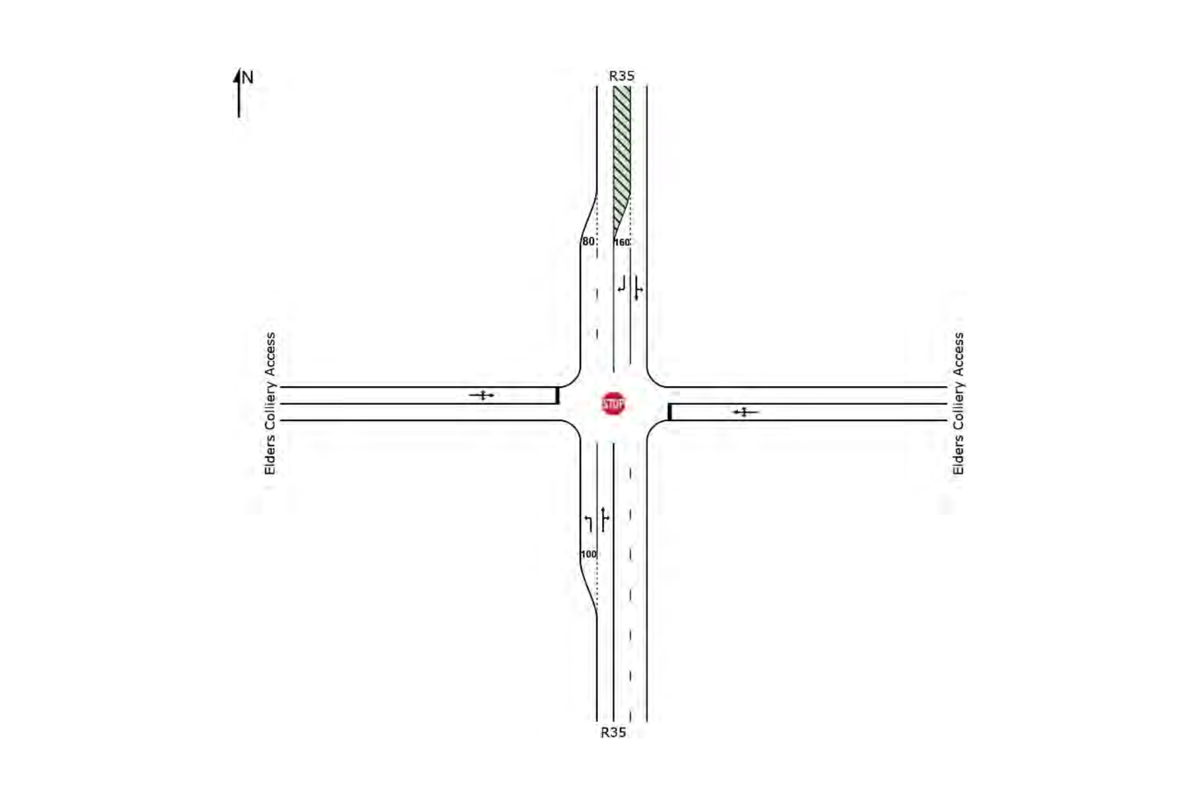


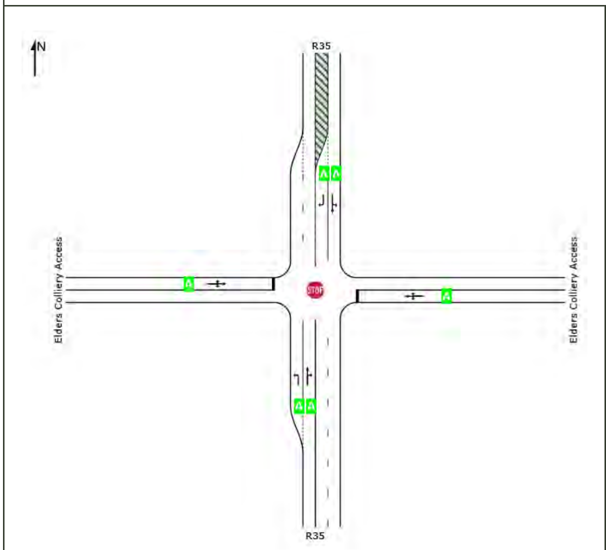
AM Peak Hour

PM Peak Hour

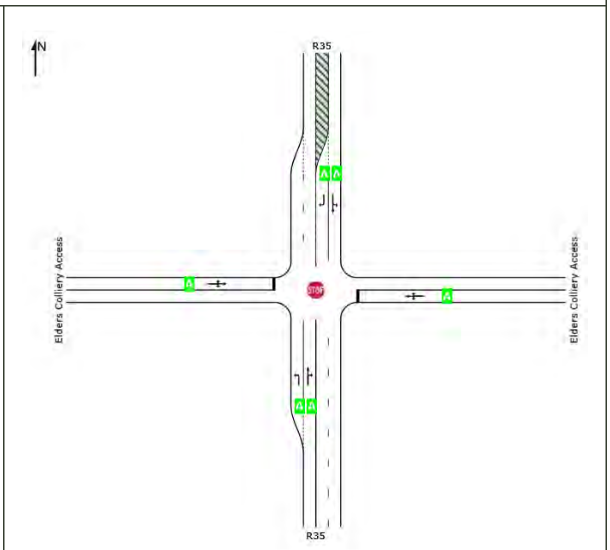
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

9.6 R35 / Elder Colliery Access Intersection



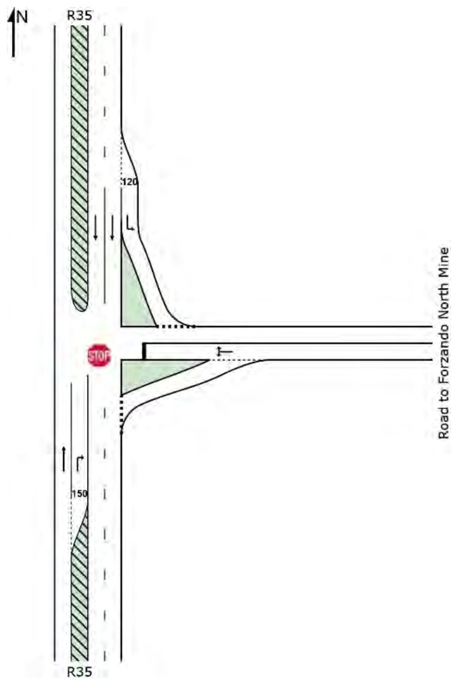


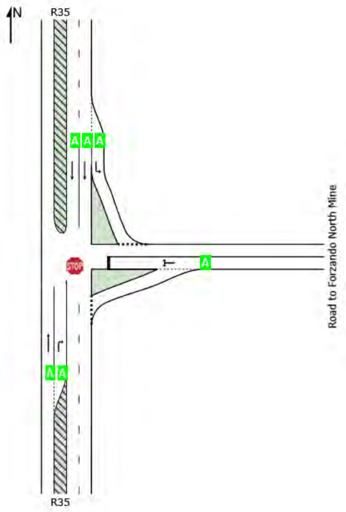
AM Peak Hour



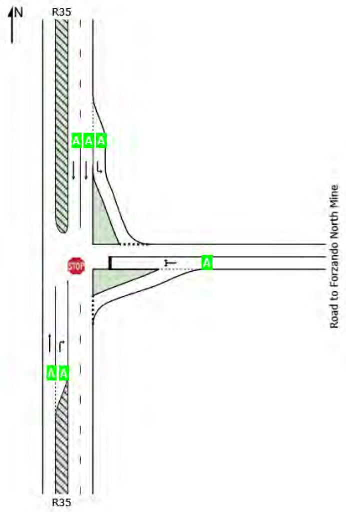
PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.





AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

10 Elders Colliery Operational Traffic

The operational phase of the proposed Elders Colliery extension will consist of traffic that is generated by employees as well as haulage vehicles. This phase will be carried out for approximately 14 years.

10.1 Employees

The operations of the Elders Colliery will require a workforce which will be employed for an estimated 14 years which is estimated to be the length of the operational period. The employees will utilise the main access on the R35.

The table below summarises the peak hour vehicles generated by the employees.

Summary of vehicles generated by Employees				
	Total	Managers	Miners	
Employees (Full Time Equivalents)	300	100	200	
Managers to utilise private car, Miners to utilise buses Private car vehicle occupancy: 1.5 people/car Bus occupancy: 60 people / bus 1 bus = 3 equivalent car units				
Private vehicles	67 vehicles two way in peak hour			
Buses	4 (12 ecu's two way in peak hour)			
Total	79 vehicles in peak hour.			
In Out ratio 75:25				
	AM In	**AM Out**	**PM In**	**PM Out**
Volume of vehicles	59	20	20	59

Table 3: Peak Hour Vehicles Generated by Employees

10.2 Heavy Delivery Vehicles

Raw material will be transported from the Elders Colliery to a processing plant. There are four options:

1. Goedehoop Mine
2. Isibonelo Mine
3. Elandspruit Colliery
4. Forzando North Mine

The haulage delivered to each processing plant can vary. Therefore, in order to calculate the maximum traffic impact, the analysis will be carried out such that all raw material from the proposed Elders Colliery will be transported to one of the processing plant options.

Therefore 4 different routes will be analysed in this section as follows:

1. Route 1: Elders Colliery to Goedehoop Mine
2. Route 2: Elders Colliery to Isibonelo Mine
3. Route 3: Elders Colliery to Elandspruit Colliery
4. Route 4: Elders Colliery to Forzando North Mine

Summary of vehicles generated by Delivery Trucks				
Number of trucks per day to the destination processing plant:	**185 trucks**			
Equivalent car units =	**555 vehicles per day**			
For a round trip =	**1110 vehicles per day two way**			
The trucks to operate 20 hours of a day	**1110/20 = 56**			
Therefore, peak hour volume two way:	56 vehicles two way			
In Out ratio 50:50				
	AM In	**AM Out**	**PM In**	**PM Out**
Volume of vehicles	28	28	28	28

Table 4: Peak Hour Haulage Vehicles Volumes

The operational trip generation along each of the four routes mentioned above is shown in Figures 8, 9, 10 and 11 below.

10.3 Elders Colliery Traffic Volumes for Each Route

The traffic volumes generated above are schematically presented below for each route.

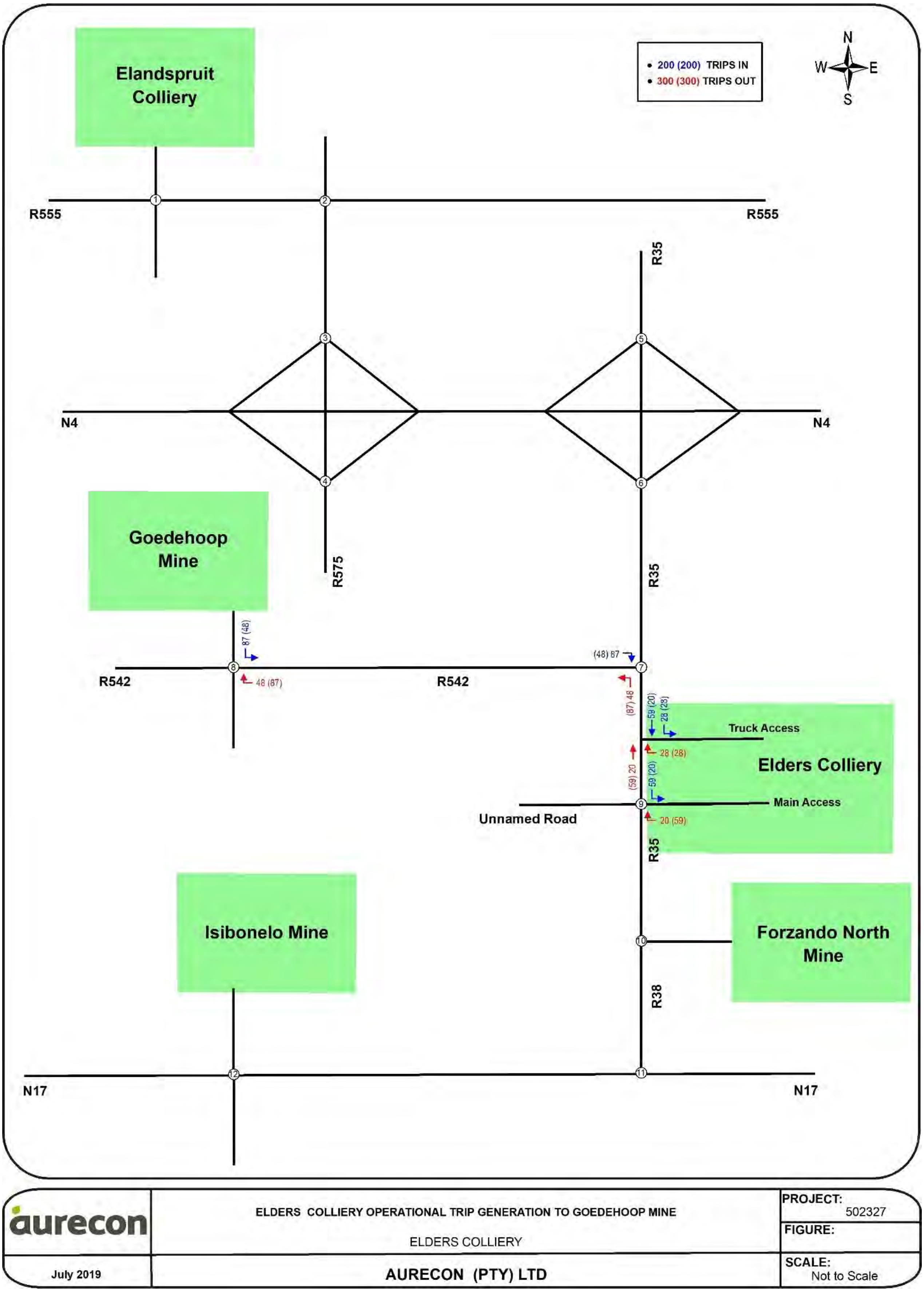
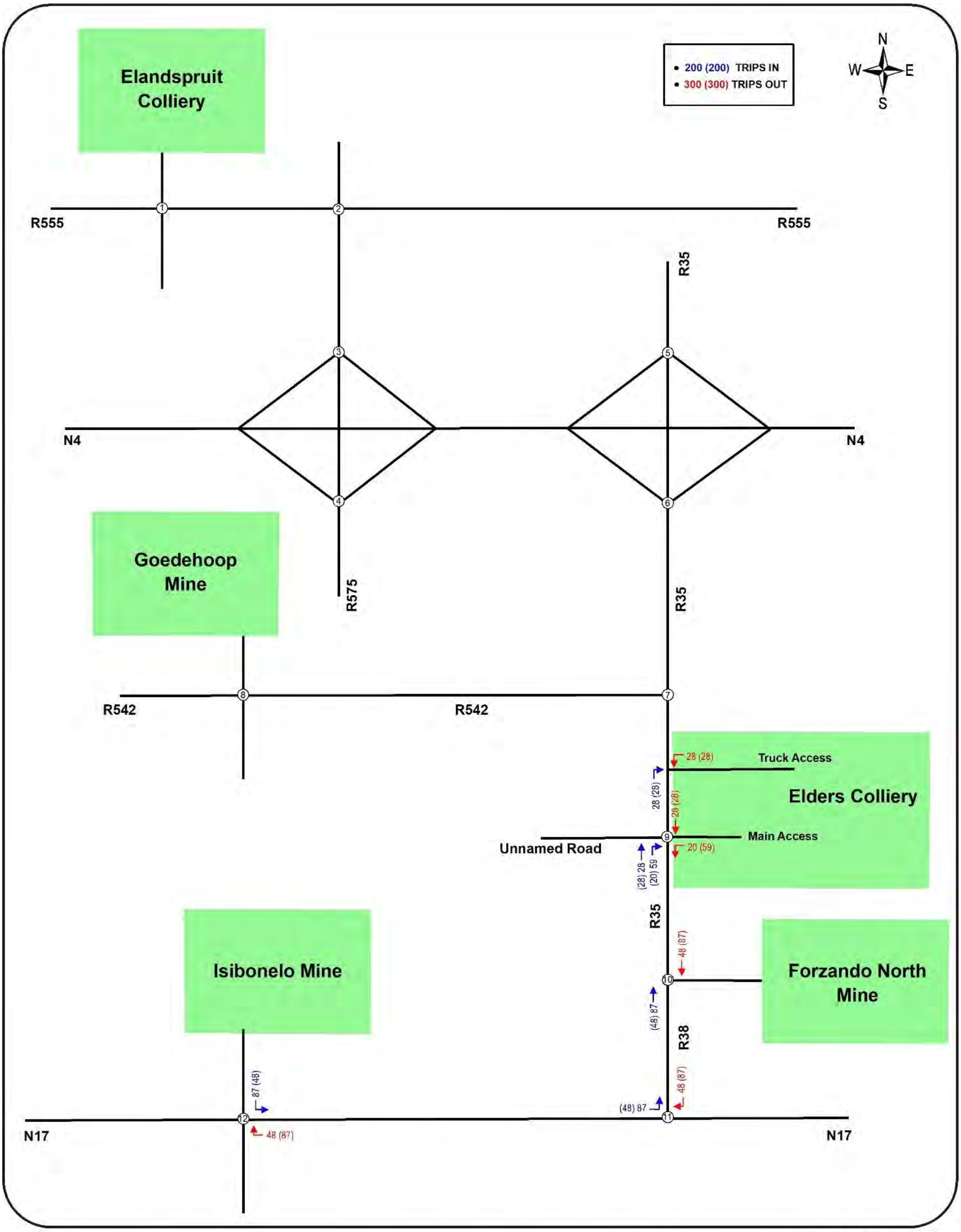
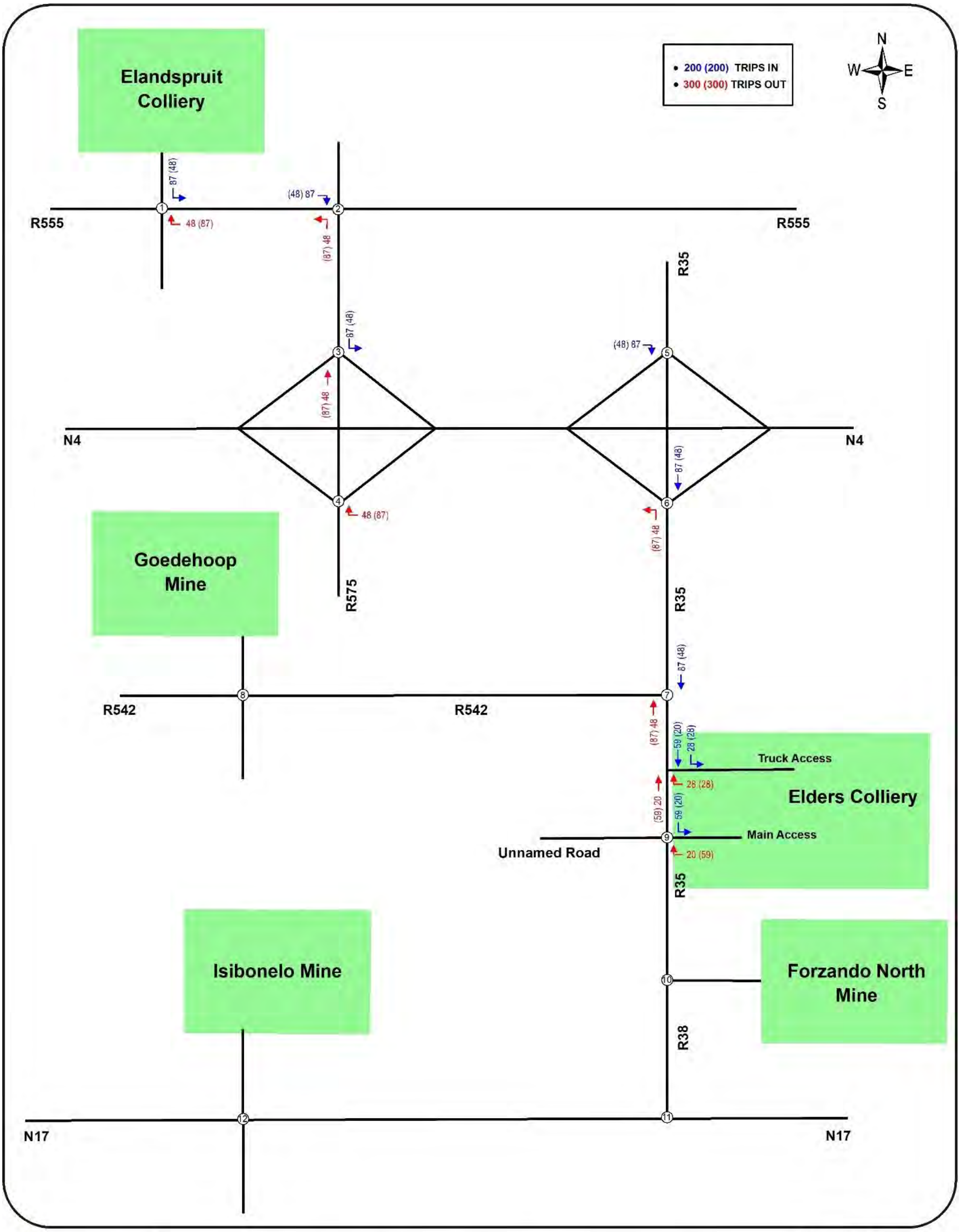


Figure 8: Elders Colliery Operational Trip Generation to Goedehoop Mine



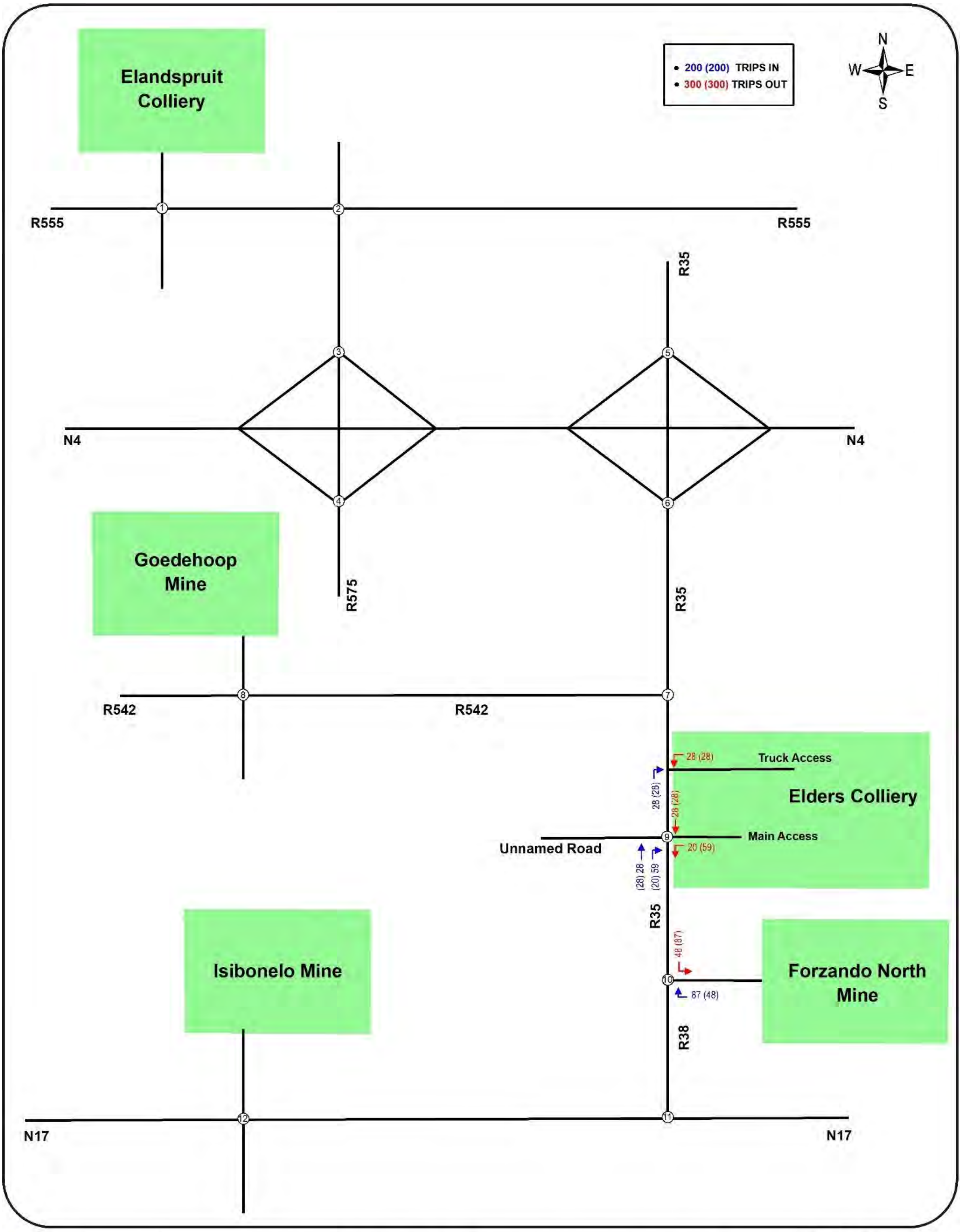
aurecon	ELDER COLLIERY OPERATIONAL TRIP GENERATION TO ISIBONELO MINE ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

Figure 9: Elders Colliery Operational Trip Generation to Isibonelo Mine



aurecon	ELDER COLLIERY OPERATIONAL TRIP GENERATION TO ELANDSPRUIT COLLIERY ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

Figure 10: Elders Colliery Operational Trip Generation to Elandspruit Colliery



aurecon	ELDER COLLIERY OPERATIONAL TRIP GENERATION TO FORZANDO NORTH MINE ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

Figure 11: Elders Colliery Operational Trip Generation to Forzando North Mine

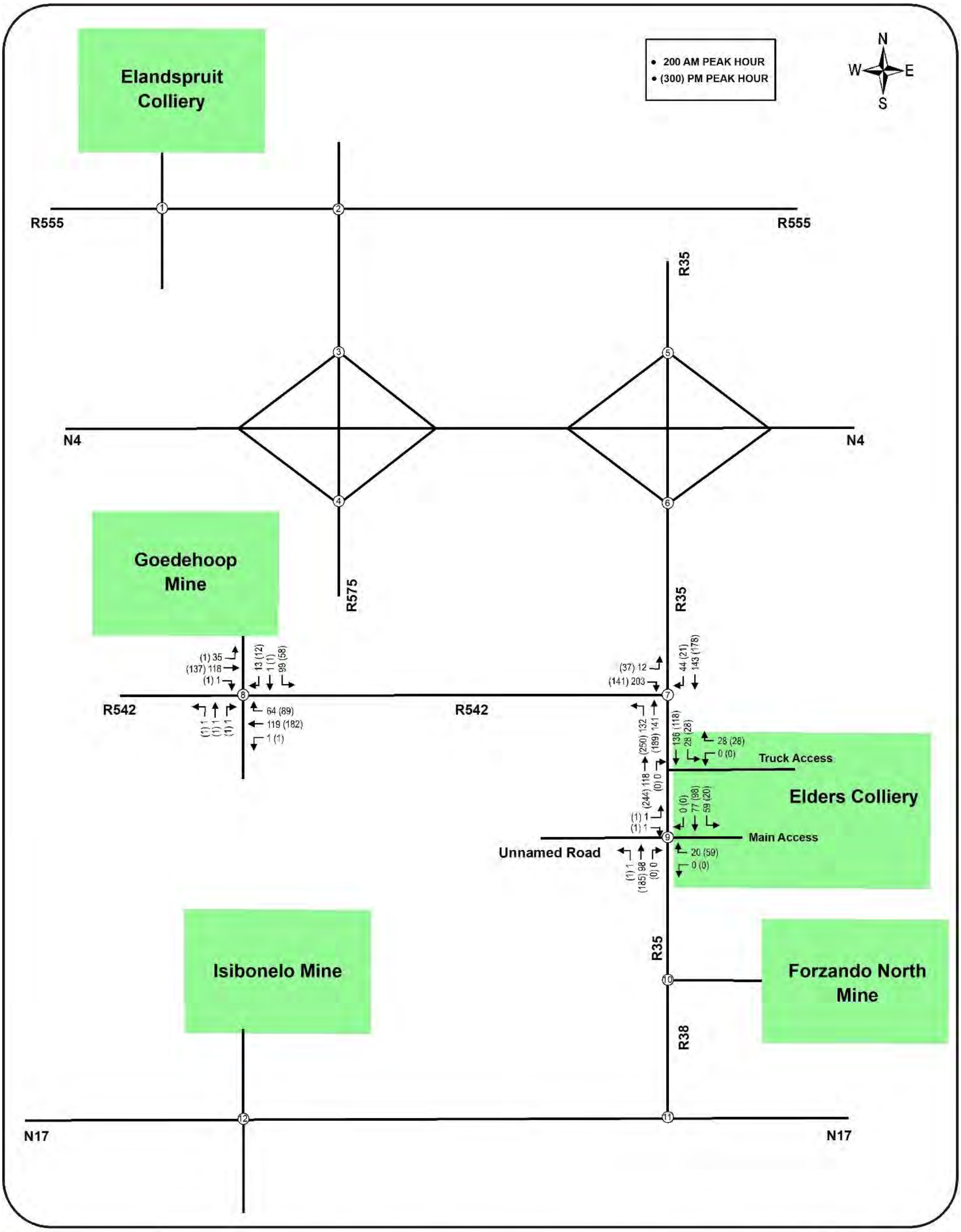
11 Elders Colliery to Goedehoop Mine Analysis

For assessing the 10-year design horizon, the existing background traffic needs to be factored up by a specified growth rate from 2019 to 2029. A growth rate of 2.0% is used.

This section will analyse the 10-year background traffic volumes plus the traffic volumes generated by the Elders Colliery if all haulage is to utilise the Goedehoop processing plant. This traffic will use the R35 and the R542 to get to and from the Elders Colliery. Based on this route only the following intersections will be analysed in this section:

- R35 / R542 North
- R542 / Goedehoop Mine Access
- R35 / Elders Colliery Main Access
- R35 / Elder Colliery Truck Access

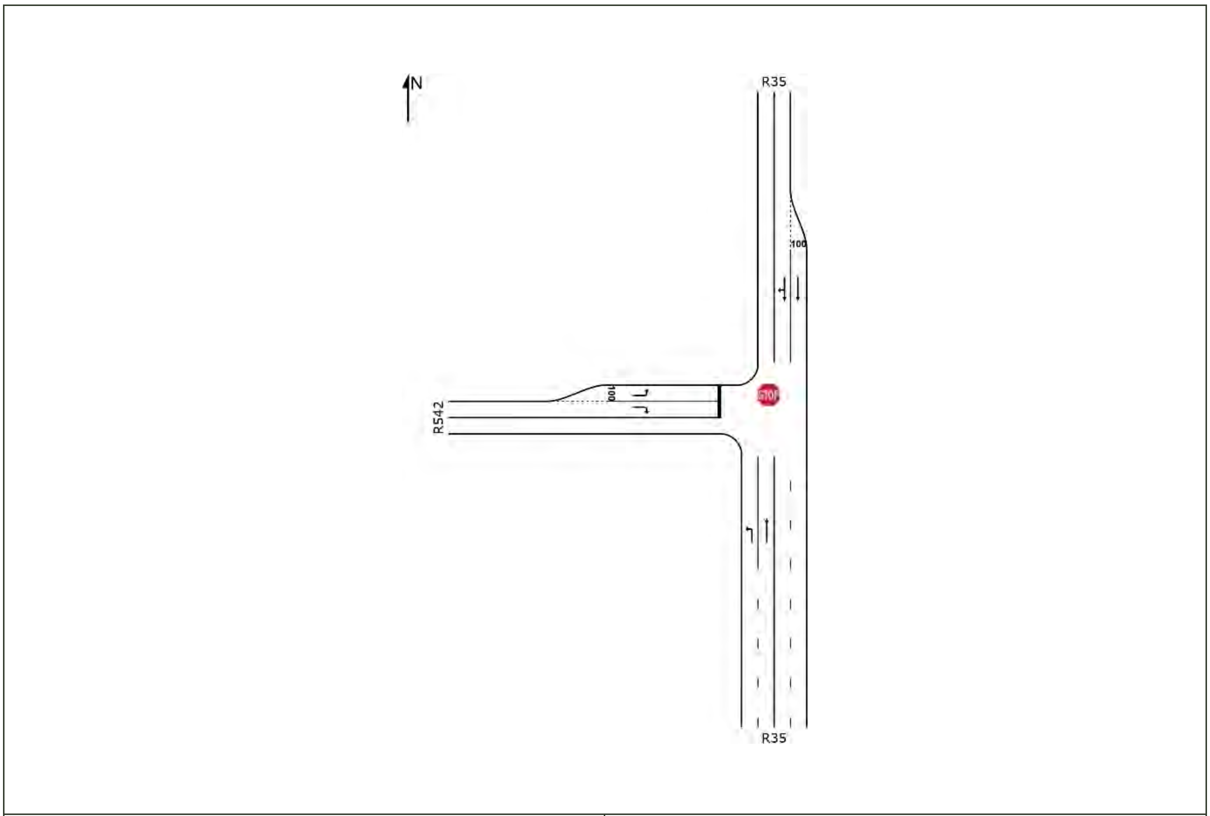
The 10-year background traffic volumes plus the Elders Colliery operational trip generation to the Goedehoop Mine is shown in Figure 12 below.

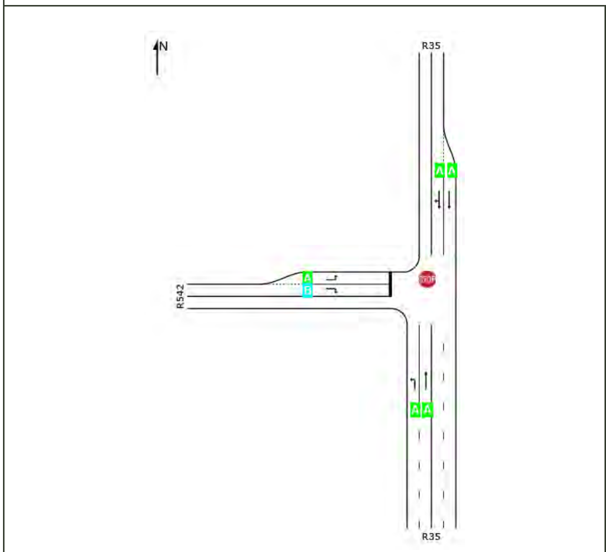


aurecon	HORIZON YEAR SCENARIO PLUS ELDERS COLLIERY TRIP GENERATION TO GOEDEHOOP MINE ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

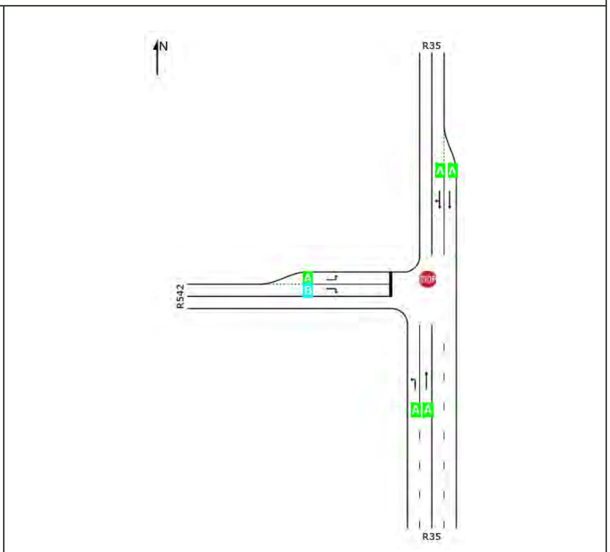
Figure 12: Horizon Year plus Elders Colliery Operational Trip Generation to Goedehoop Mine

11.1 R35 / R542 North Intersection





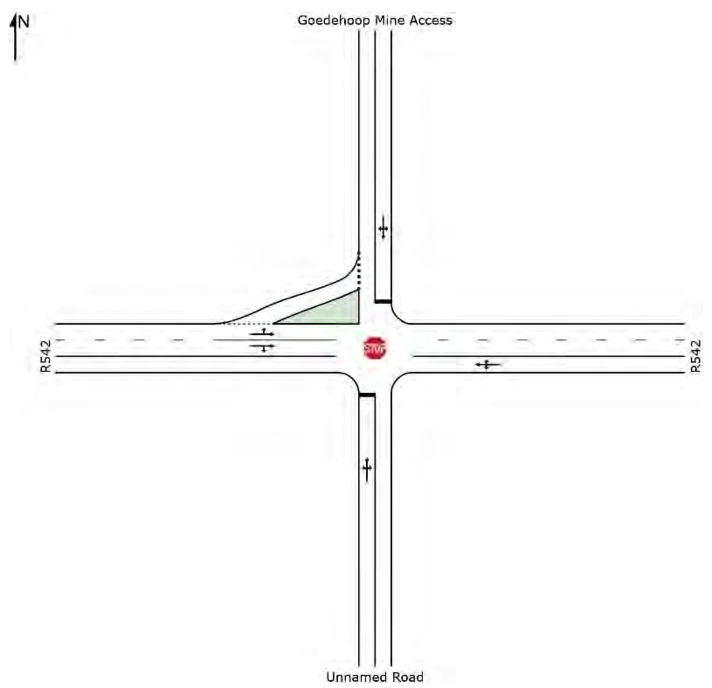
AM Peak Hour

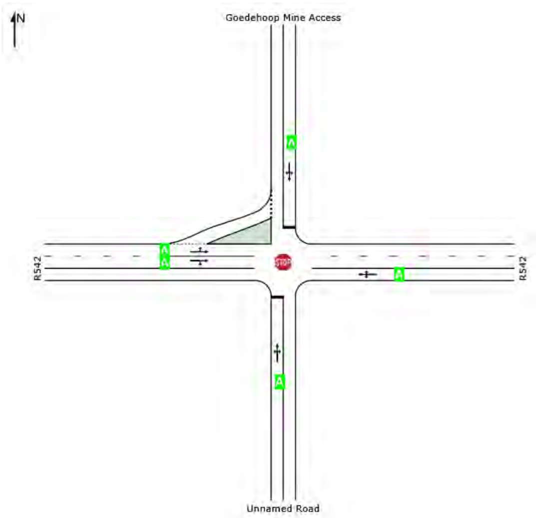


PM Peak Hour

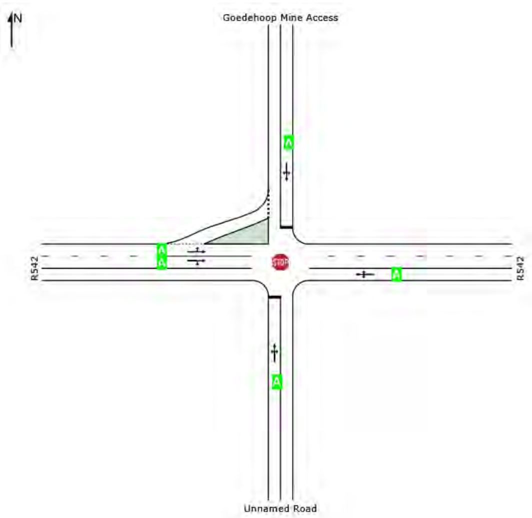
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

11.2 R542 / Goedehoop Mine Access Intersection





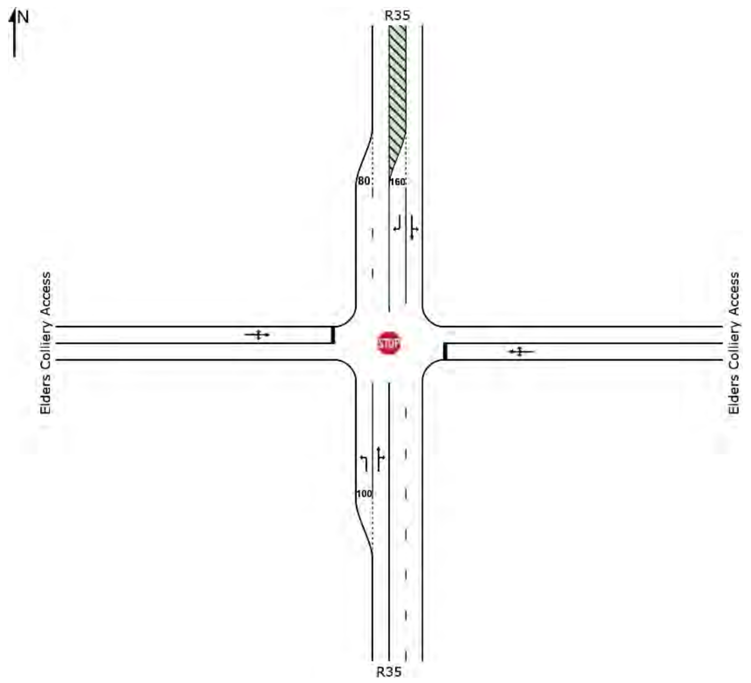
AM Peak Hour

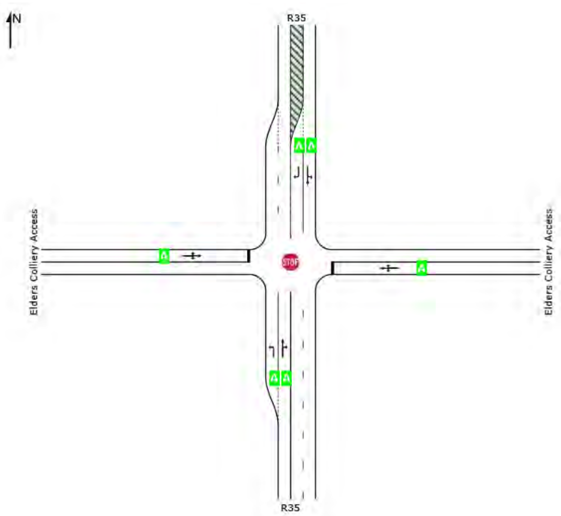


PM Peak Hour

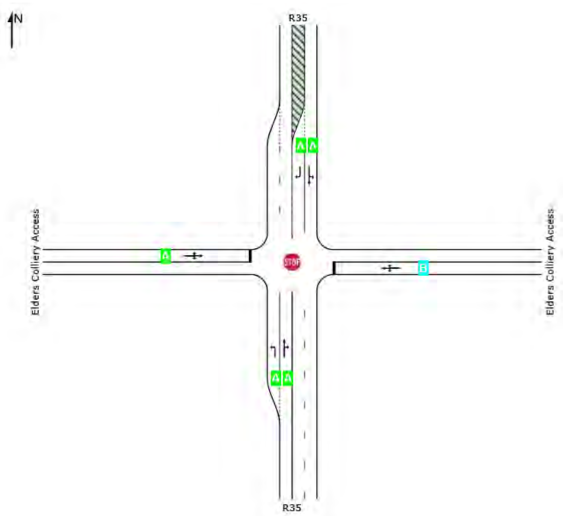
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

11.3 R35 / Elder Colliery Access Intersection





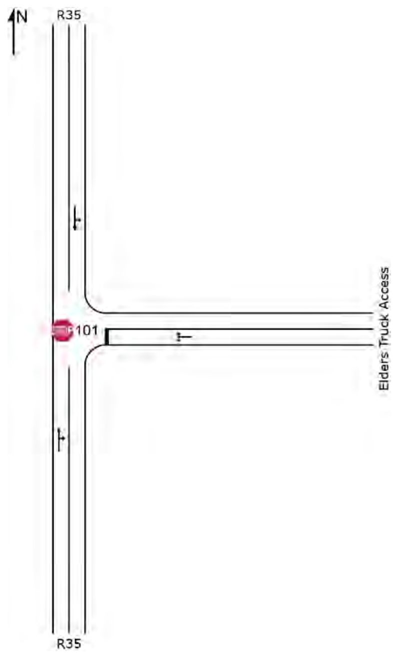
AM Peak Hour

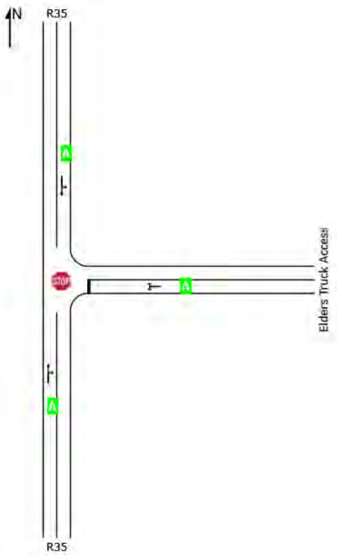


PM Peak Hour

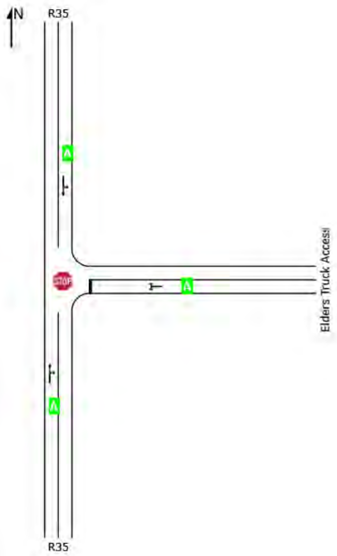
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

11.4 R35 / Elder Colliery Truck Access Intersection





AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

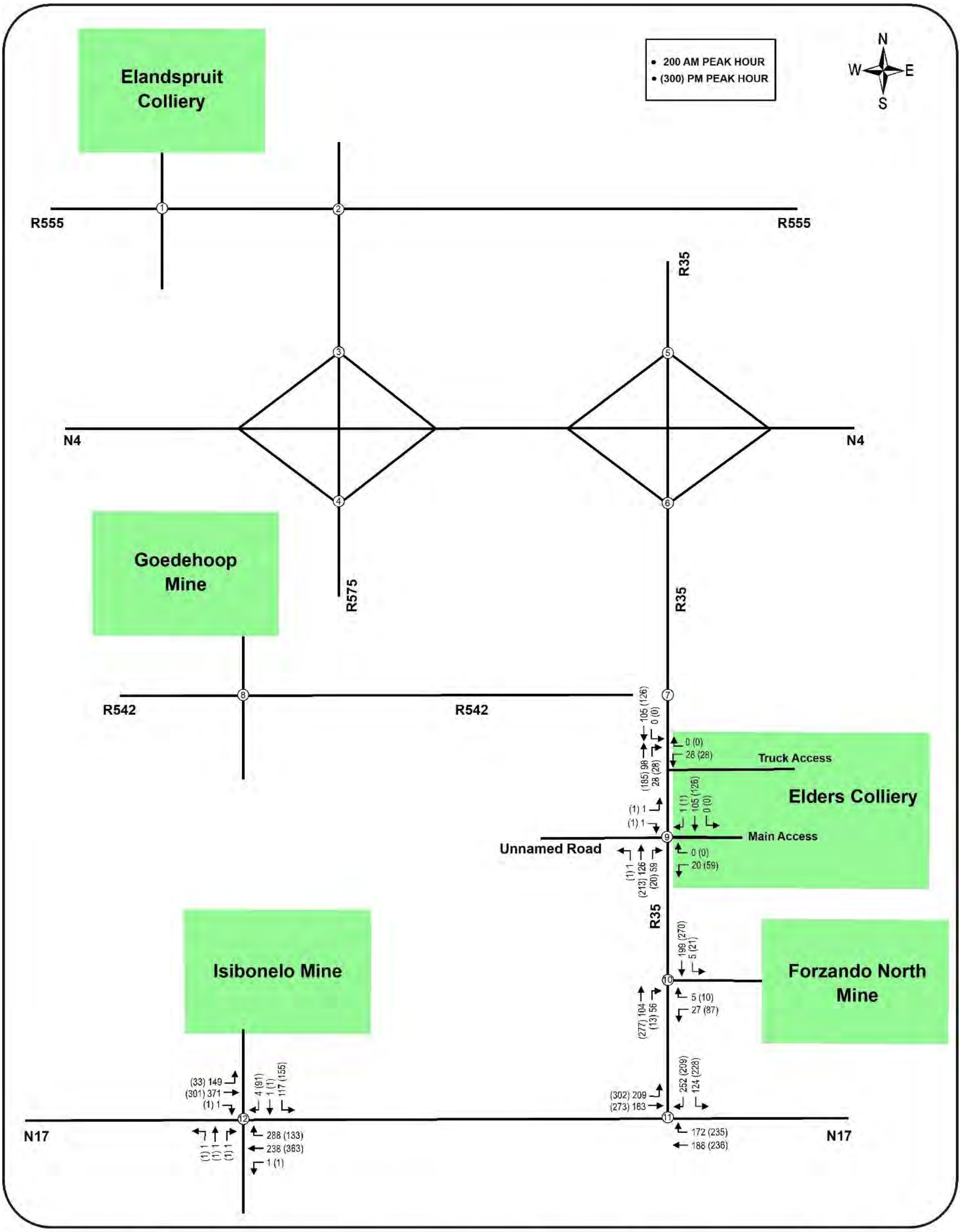
12 Elders Colliery to Isibonelo Mine Analysis

For assessing the 10-year design horizon, the existing background traffic needs to be factored up by a specified growth rate from 2019 to 2029. A growth rate of 2.0% is used.

This section will analyse the 10-year background traffic volumes plus the traffic volumes generated by the Elders Colliery if all haulage is to utilise the Isibonelo processing plant. This traffic will use the R35, the R38 and the N17 to get to and from the Elders Colliery. Based on this route only the following intersections will be analysed in this section:

- R35 / Elders Colliery Main Access
- R35 / Elders Colliery Truck Access
- R35 / Road to Forzando North Mine
- N17 / Moses Kotane / R38
- N17 / Road to Isibonelo Mine

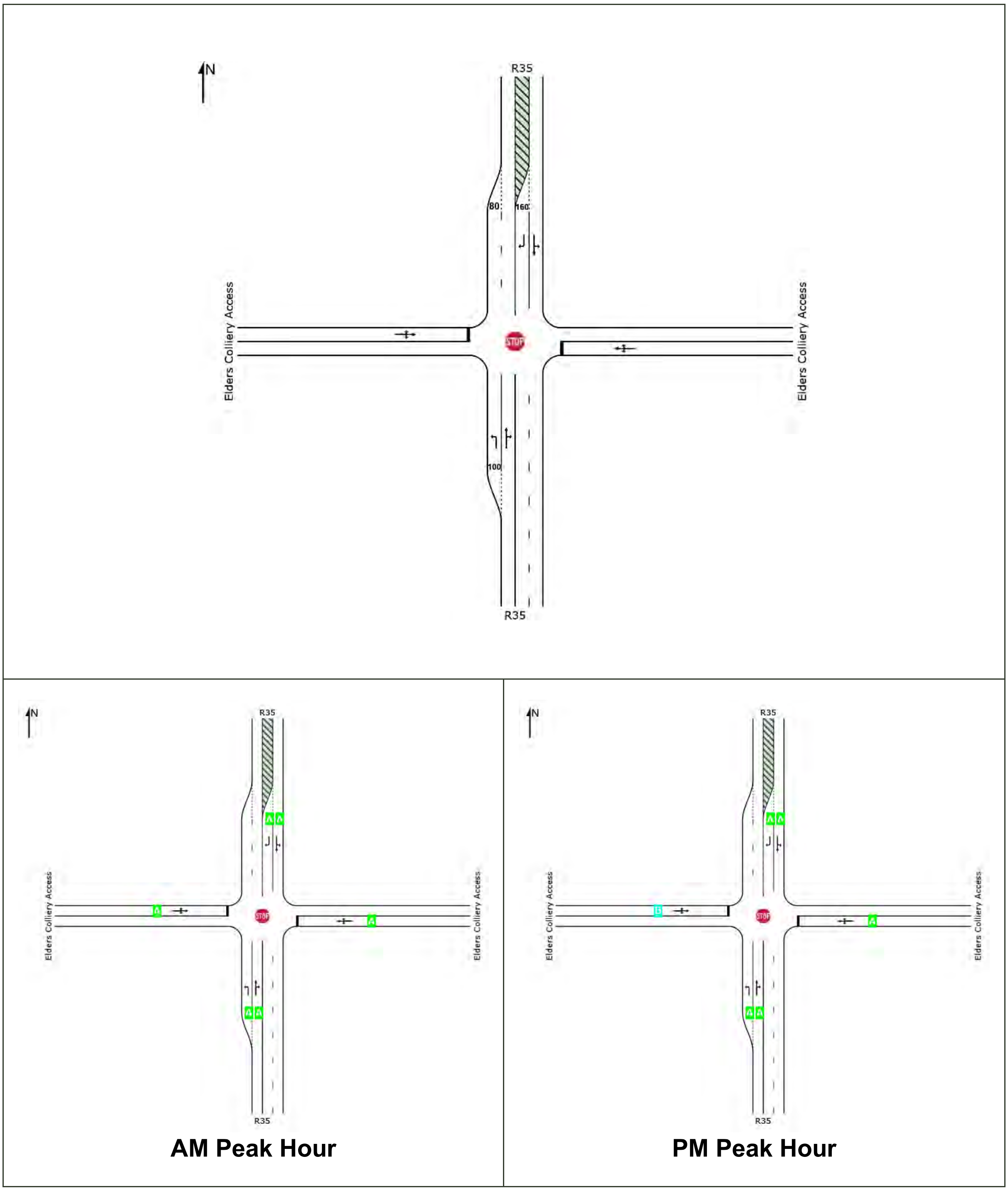
The 10-year background traffic volumes plus the Elders Colliery operational trip generation to the Isibonelo Mine is shown in Figure 13 below.



aurecon	HORIZON YEAR SCENARIO PLUS ELDERS COLLIERY TRIP GENERATION TO ISIBONELO MINE ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

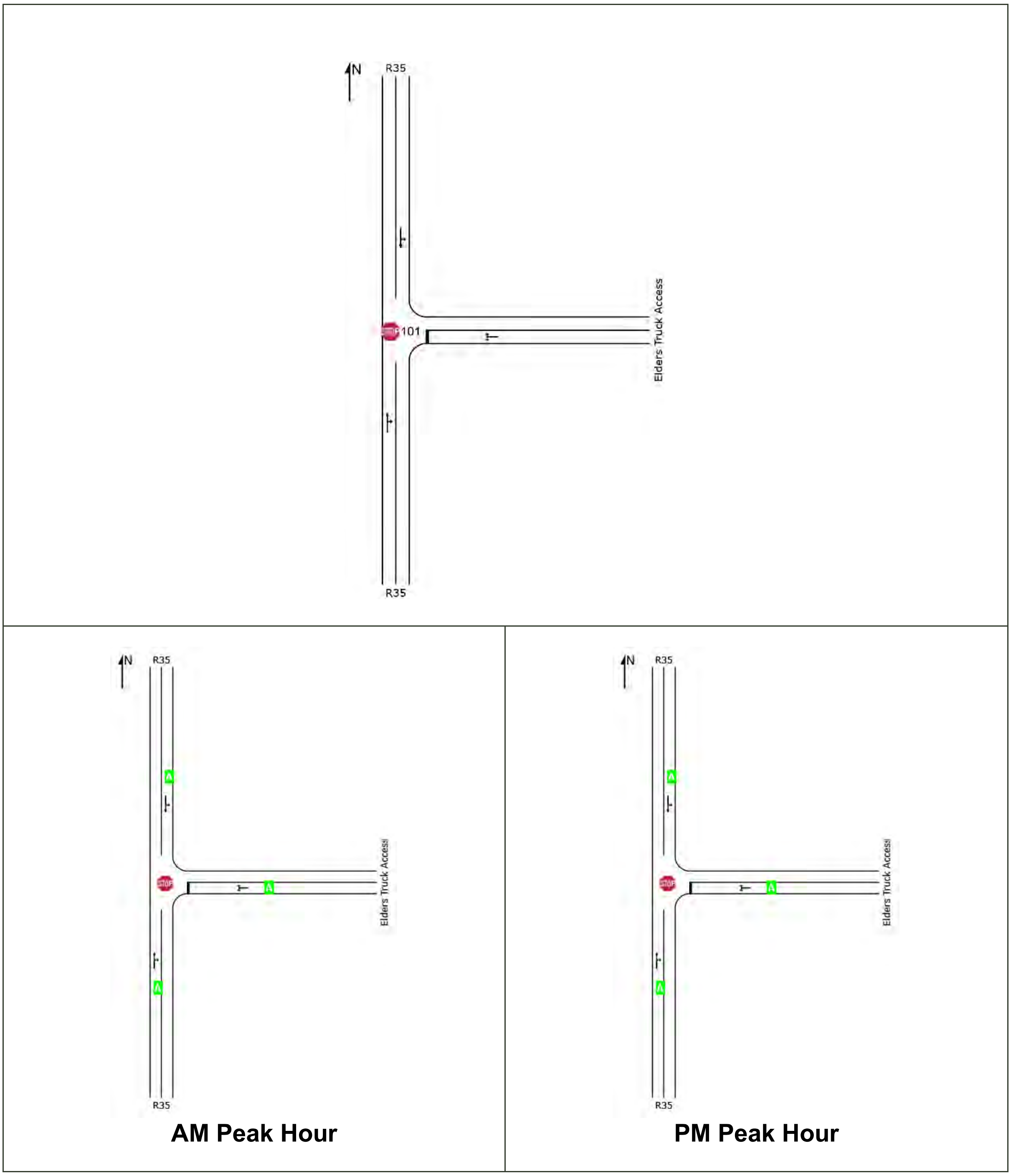
Figure 13: Horizon Year plus Elders Colliery Operational Trip Generation to Isibonelo Mine

12.1 R35 / Elder Colliery Access Intersection



From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

12.2 R35 / Elder Colliery Truck Access Intersection

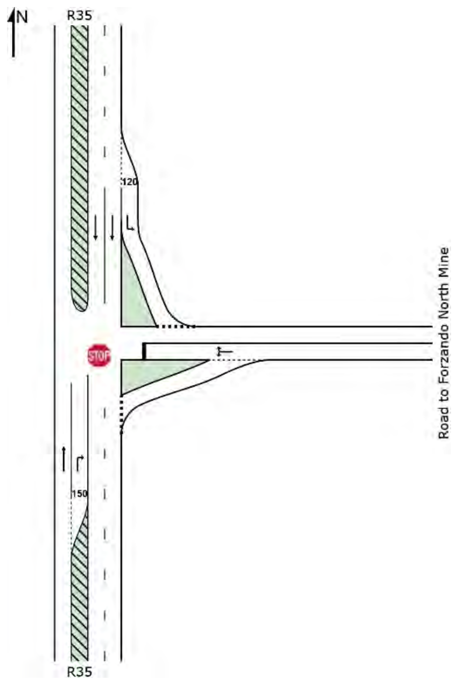


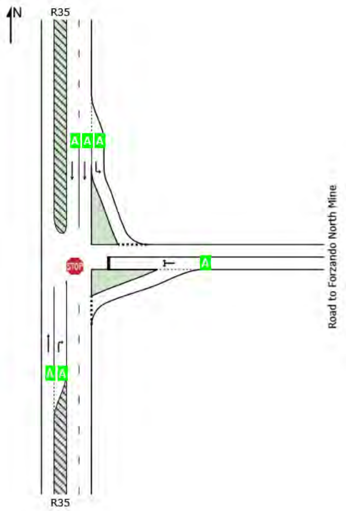
AM Peak Hour

PM Peak Hour

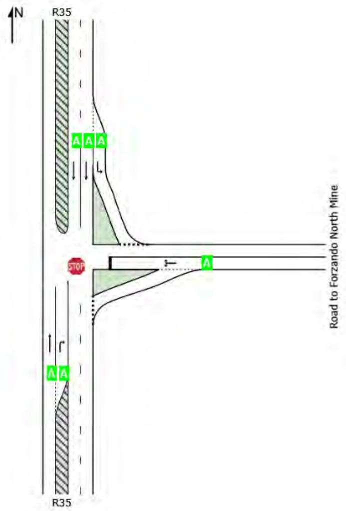
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

12.3 R35 / Road to Forzando North Mine Intersection





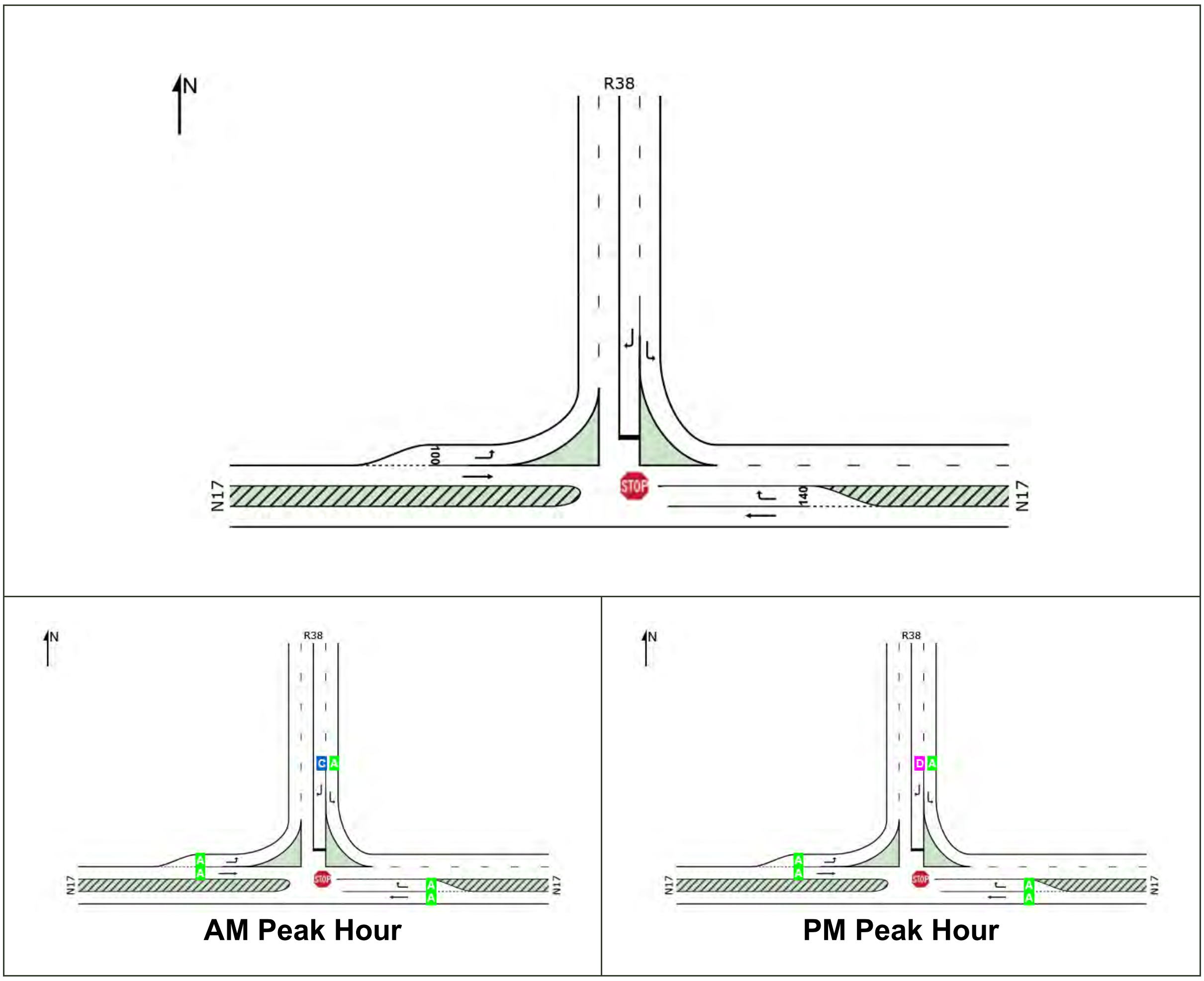
AM Peak Hour



PM Peak Hour

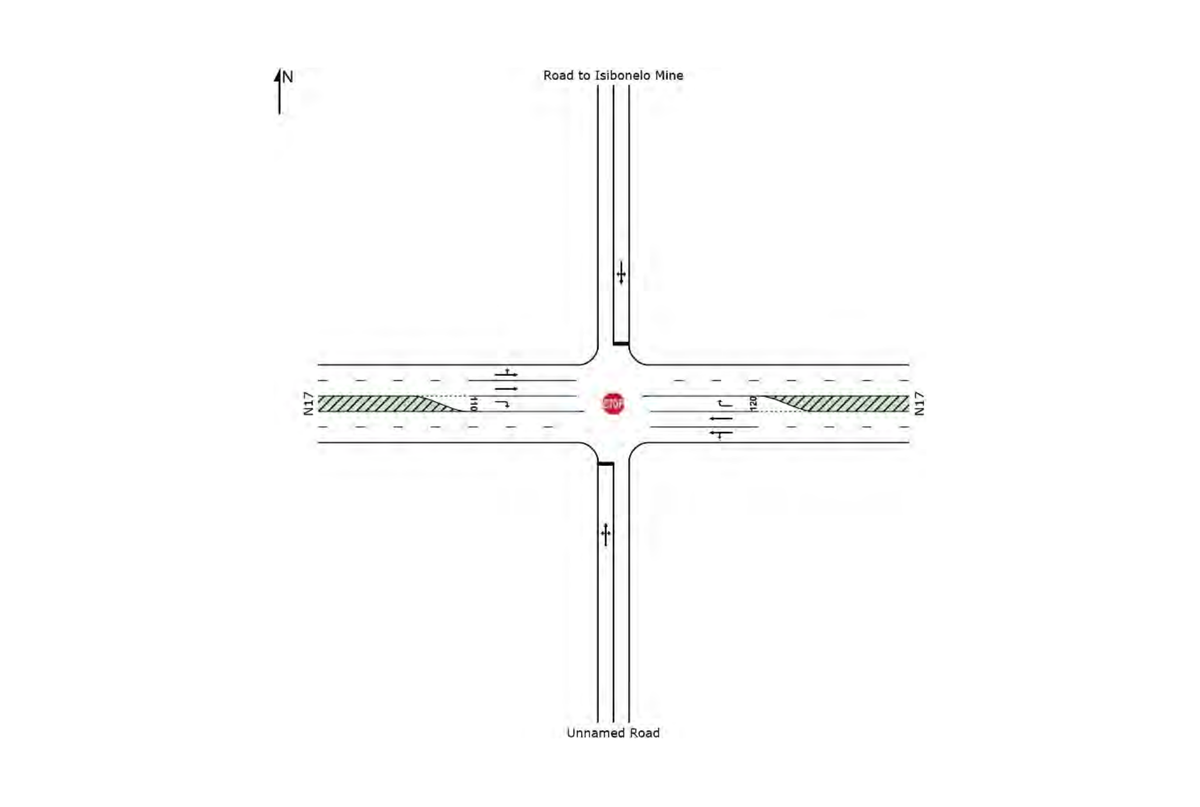
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

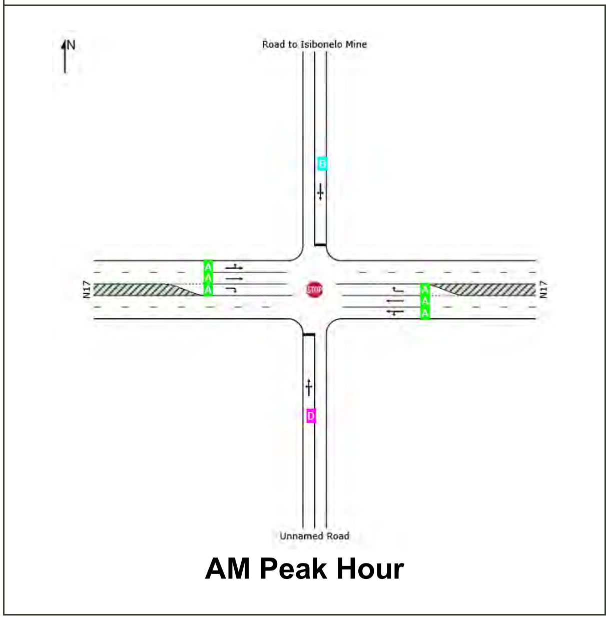
12.4 N17 / Moses Kotane / R38 Intersection

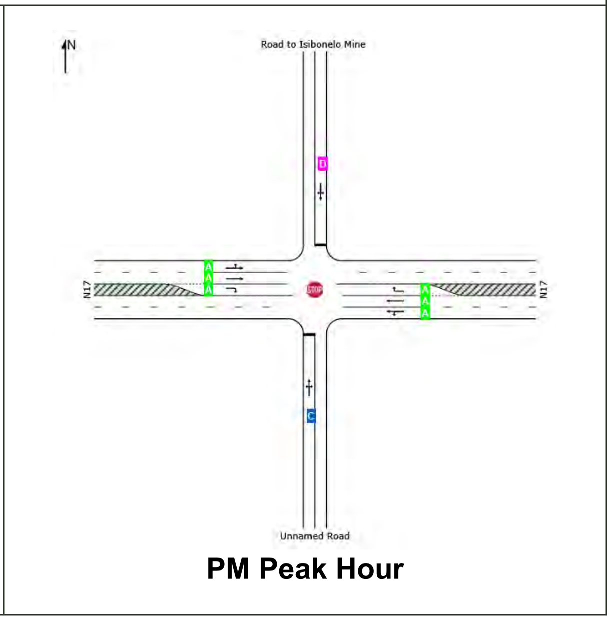


From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

12.5 N17 / Road to Isibonelo Mine Intersection







From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

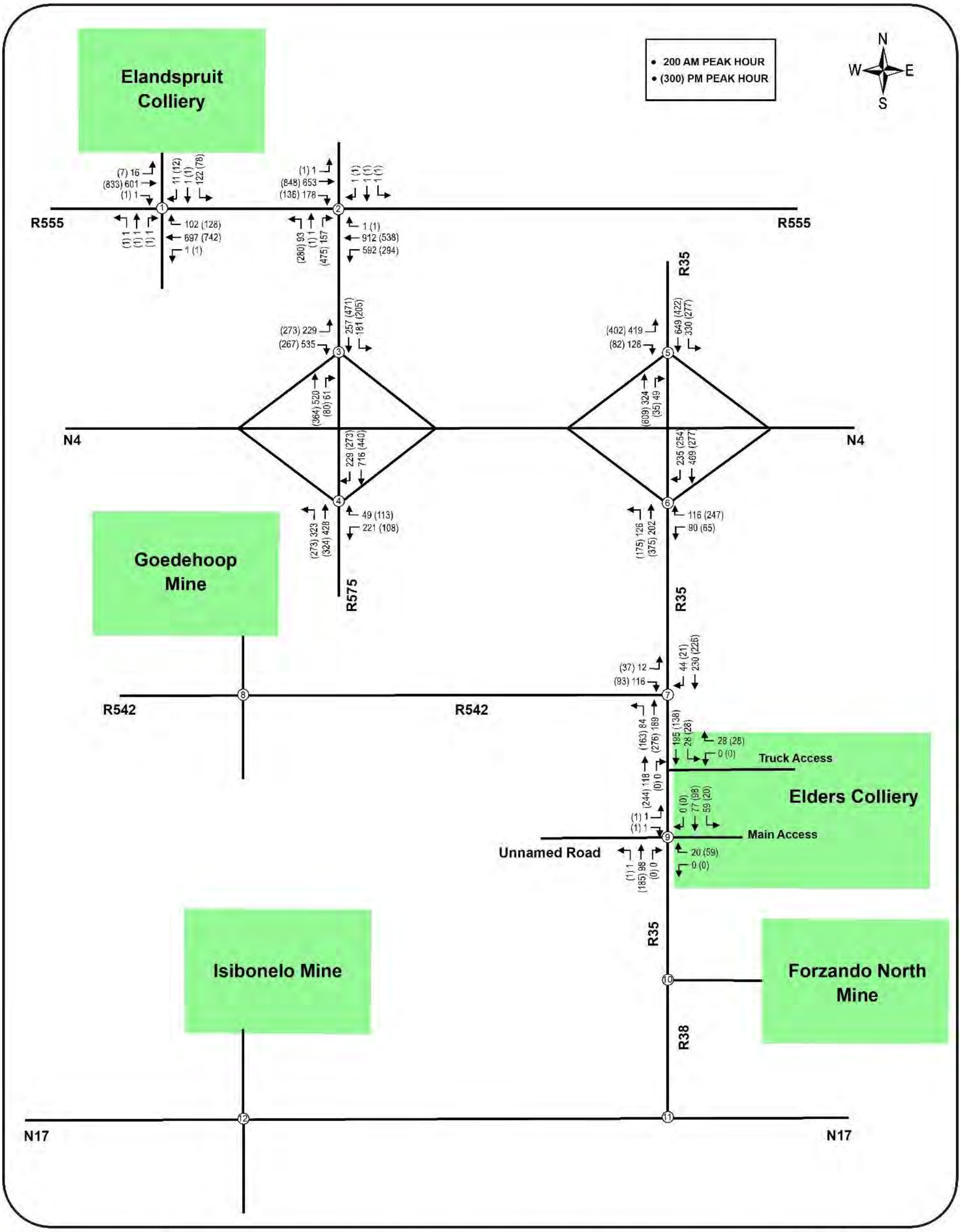
13 Elders Colliery to Elandspruit Colliery Analysis

For assessing the 10-year design horizon, the existing background traffic needs to be factored up by a specified growth rate from 2019 to 2029. A growth rate of 2.0% is used.

This section will analyse the 10-year background traffic volumes plus the traffic volumes generated by the Elders Colliery if all haulage is to utilise the Elandspruit processing plant. This traffic will use the R35, the N4, the R575 and the R555 to get to and from the Elders Colliery. Based on this route only the following intersections will be analysed in this section:

- R555 / Road to Elandspruit Colliery
- R555 / R575
- R575 / N4 North Ramp
- R575 / N4 South Ramp
- R35 / N4 North Ramp
- R35 / N4 South Ramp
- R35 / R542 North
- R35 / Elder Colliery Main Access
- R35 / Elder Colliery Truck Access

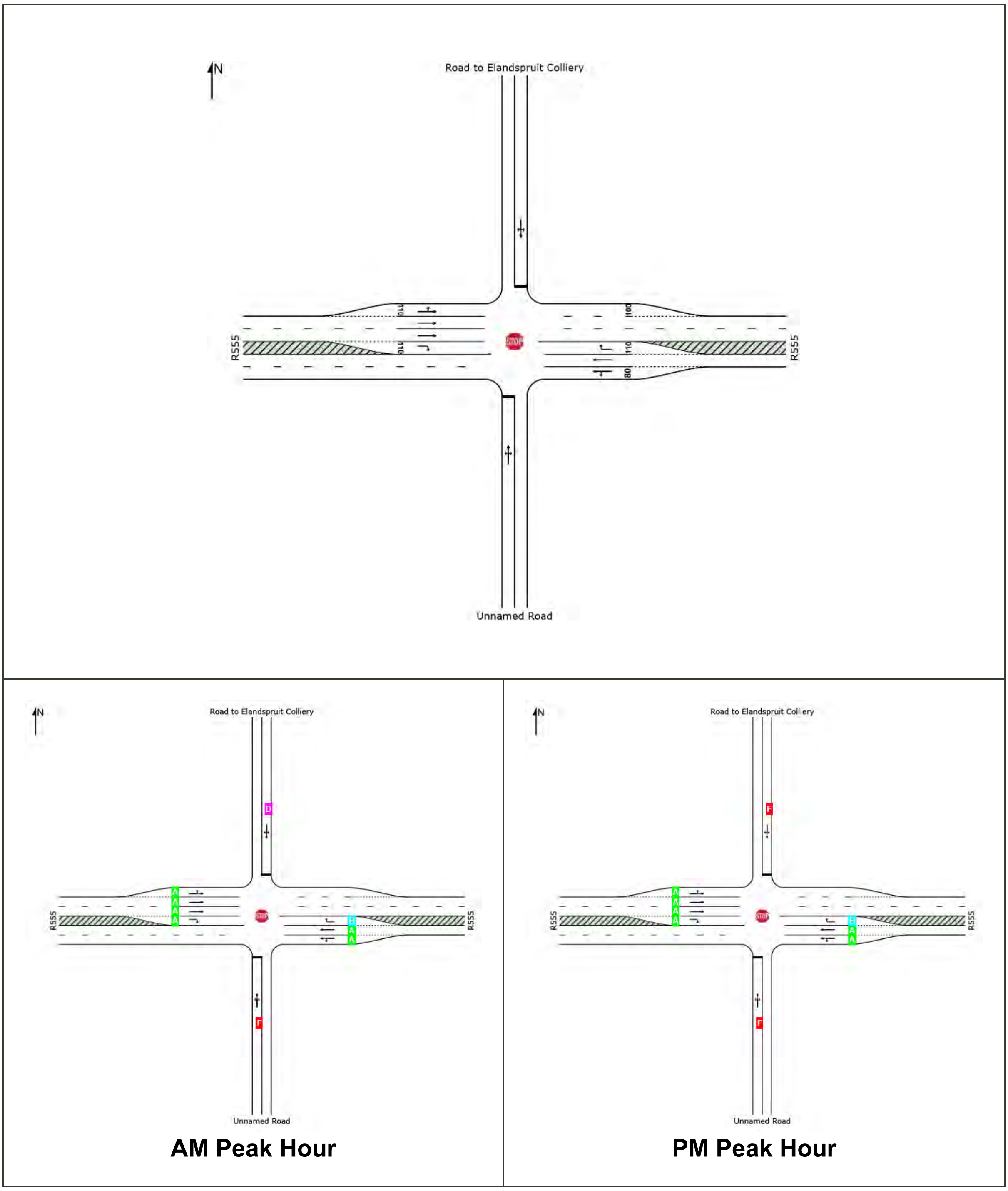
The 10-year background traffic volumes plus the Elders Colliery operational trip generation to the Elandspruit Colliery is shown in Figure 14 below.



aurecon	HORIZON YEAR SCENARIO PLUS ELDERS COLLIERY TRIP GENERATION TO ELANDSPRUIT COLLIERY ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

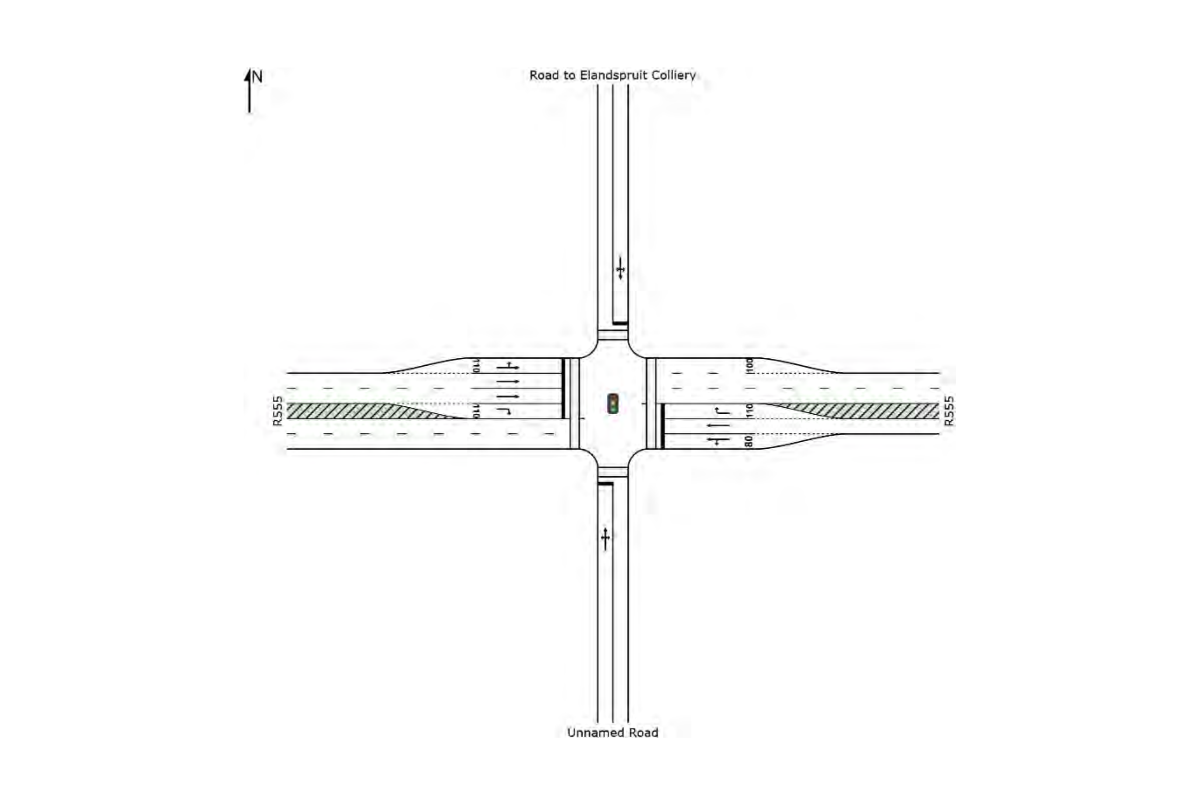
Figure 14: Horizon Year plus Elders Colliery Operational Trip Generation to Elandspruit Colliery

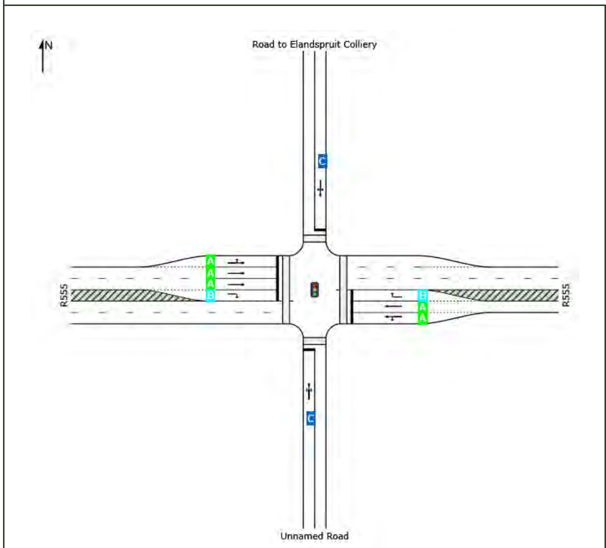
13.1 R555 / Road to Elandspruit Colliery Intersection



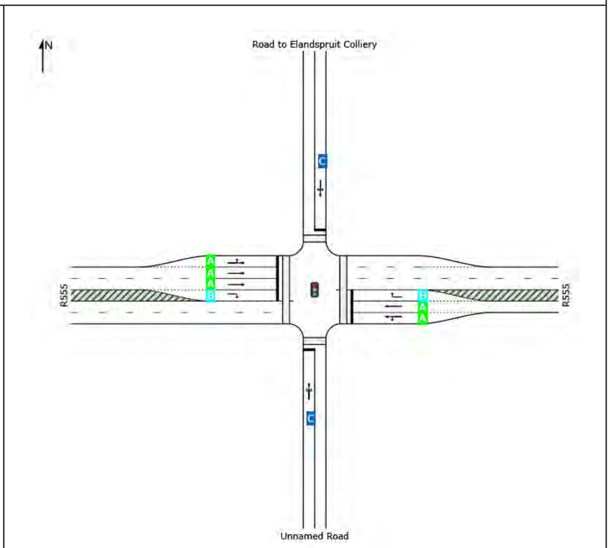
From the SIDRA results, it is evident that this intersection will experience congestion during the peak hours in the future horizon year. The congestion is due to the increase of background traffic as well as due to the mine generated traffic. Upgrades are required to this intersection as shown below. The cost of the upgrades are to be shared between latent developments, the road authority as well as the Elders Mine.

R555 / Road to Elandspruit Colliery Intersection - Upgraded





AM Peak Hour



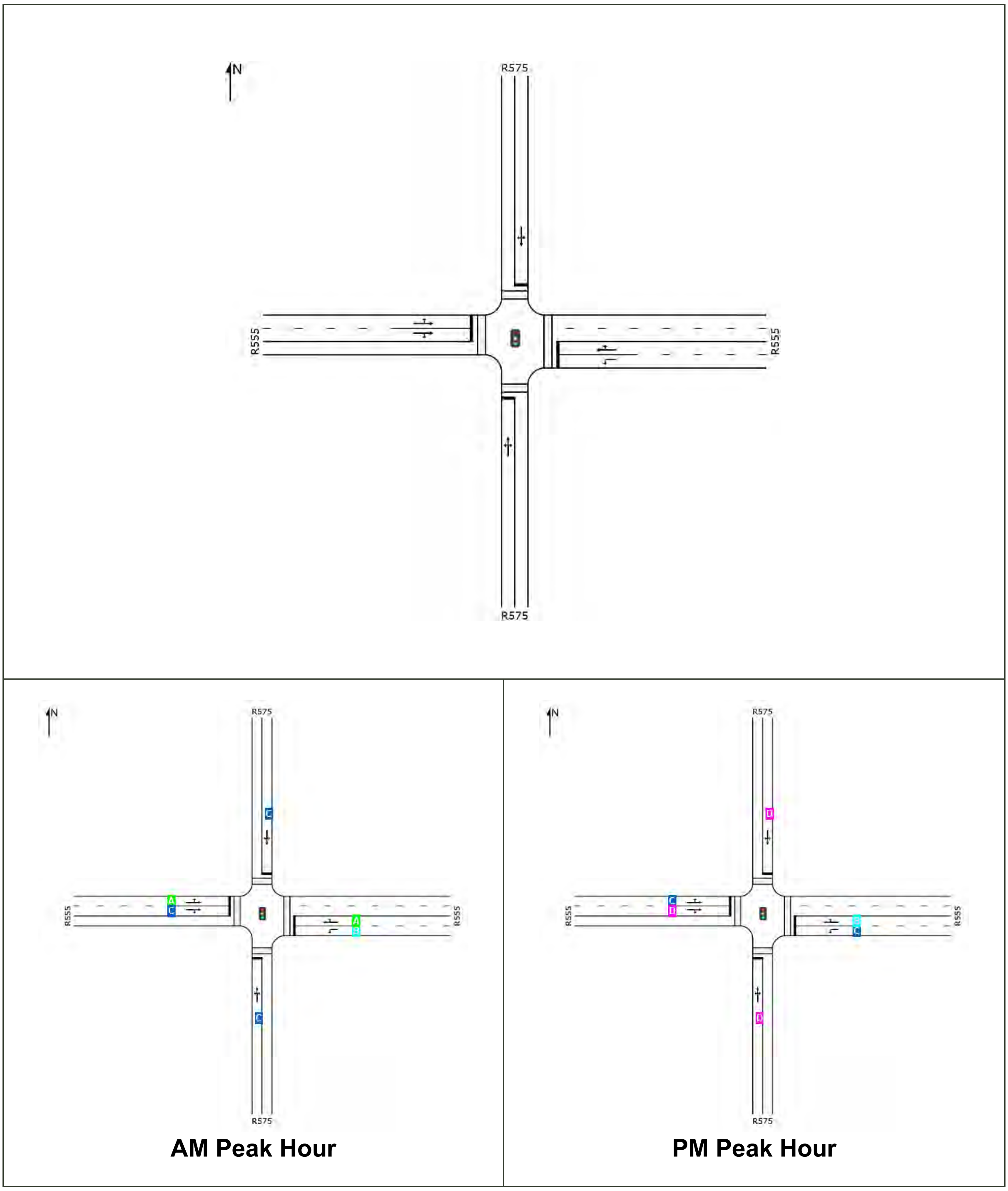
PM Peak Hour

The following upgrades are recommended for this intersection:

- Upgraded to a signalized intersection

From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours. It is to be noted that this intersection may only be signalized once the traffic signal warrants are met.

13.2 R555 / R575 Intersection

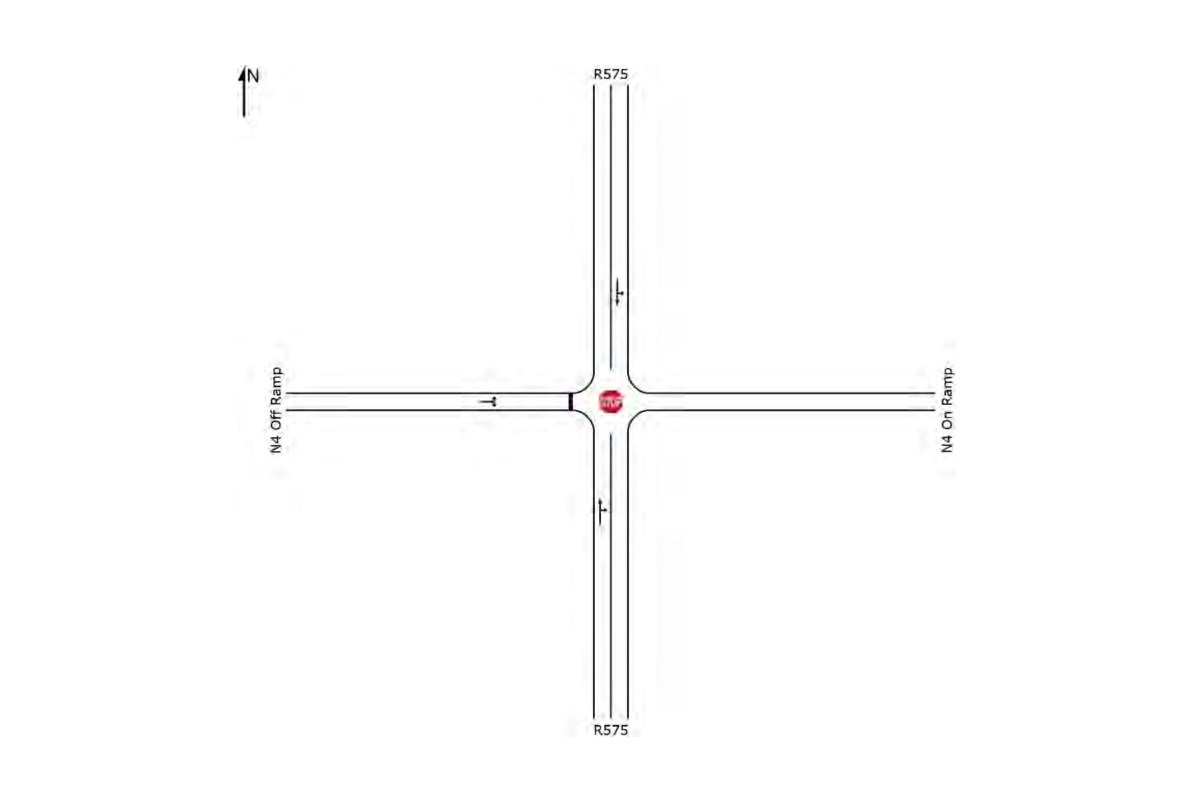


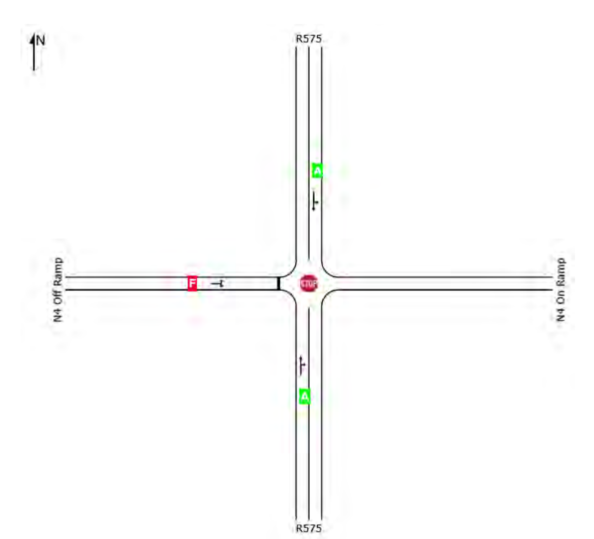
AM Peak Hour

PM Peak Hour

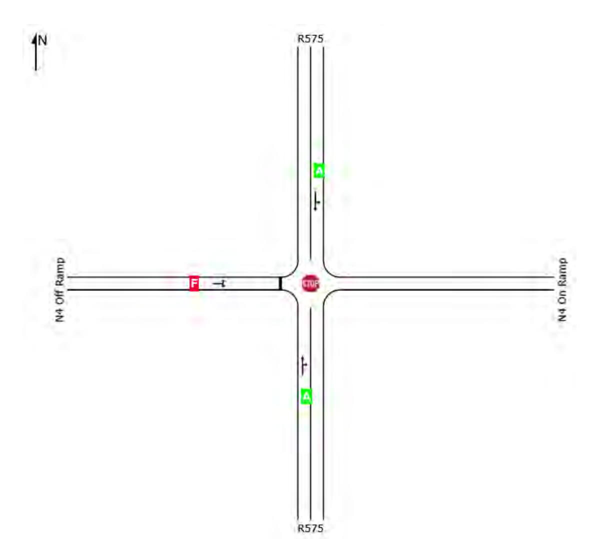
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

13.3 R575 / N4 North Ramp Intersection





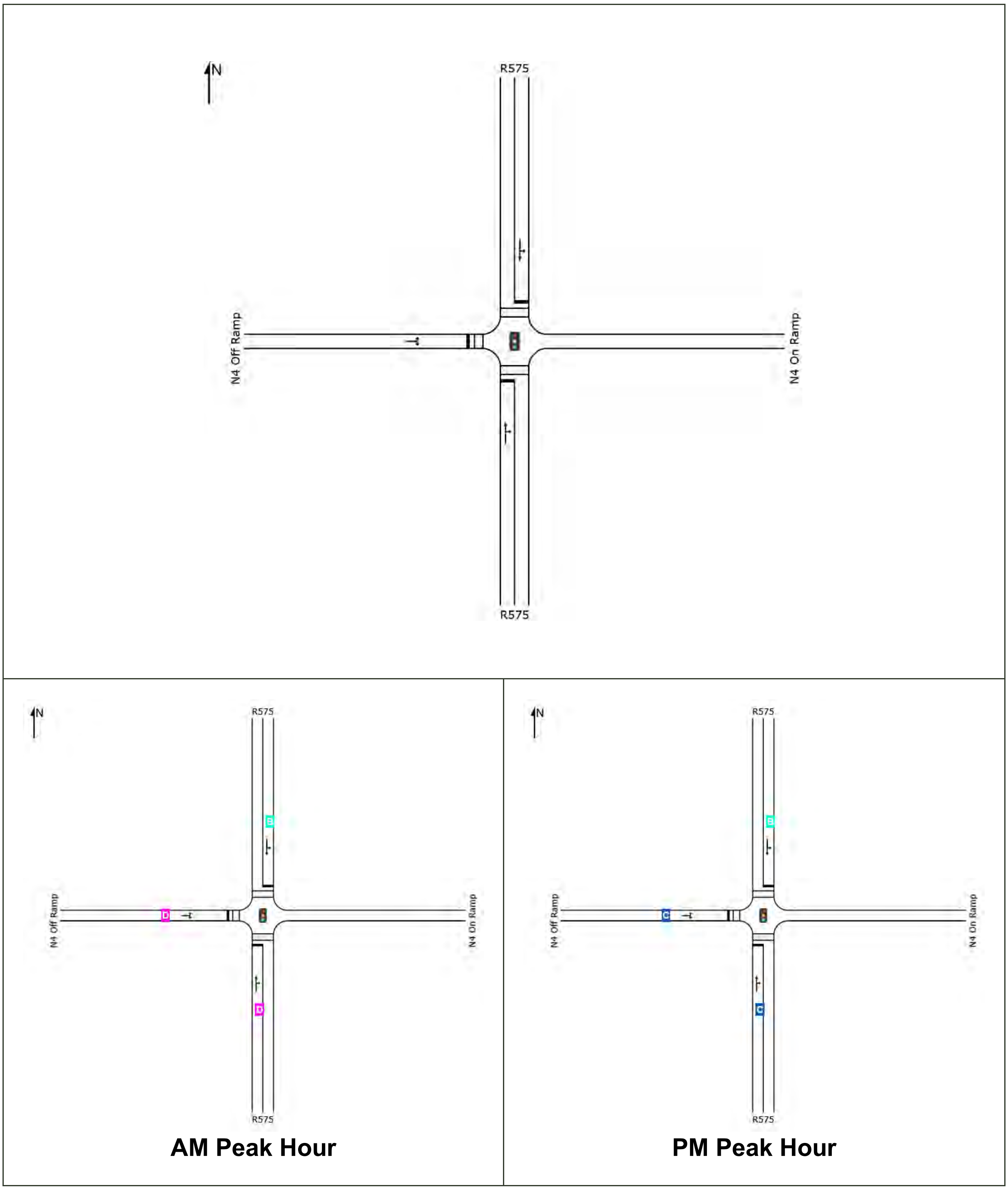
AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will experience congestion during the peak hours in the future horizon year. The congestion is due to the increase of background traffic as well as due to the mine generated traffic. Upgrades are required to this intersection as shown below. The cost of the upgrades are to be shared between latent developments, the road authority as well as the Elders Mine.

R575 / N4 North Ramp Intersection - Upgraded

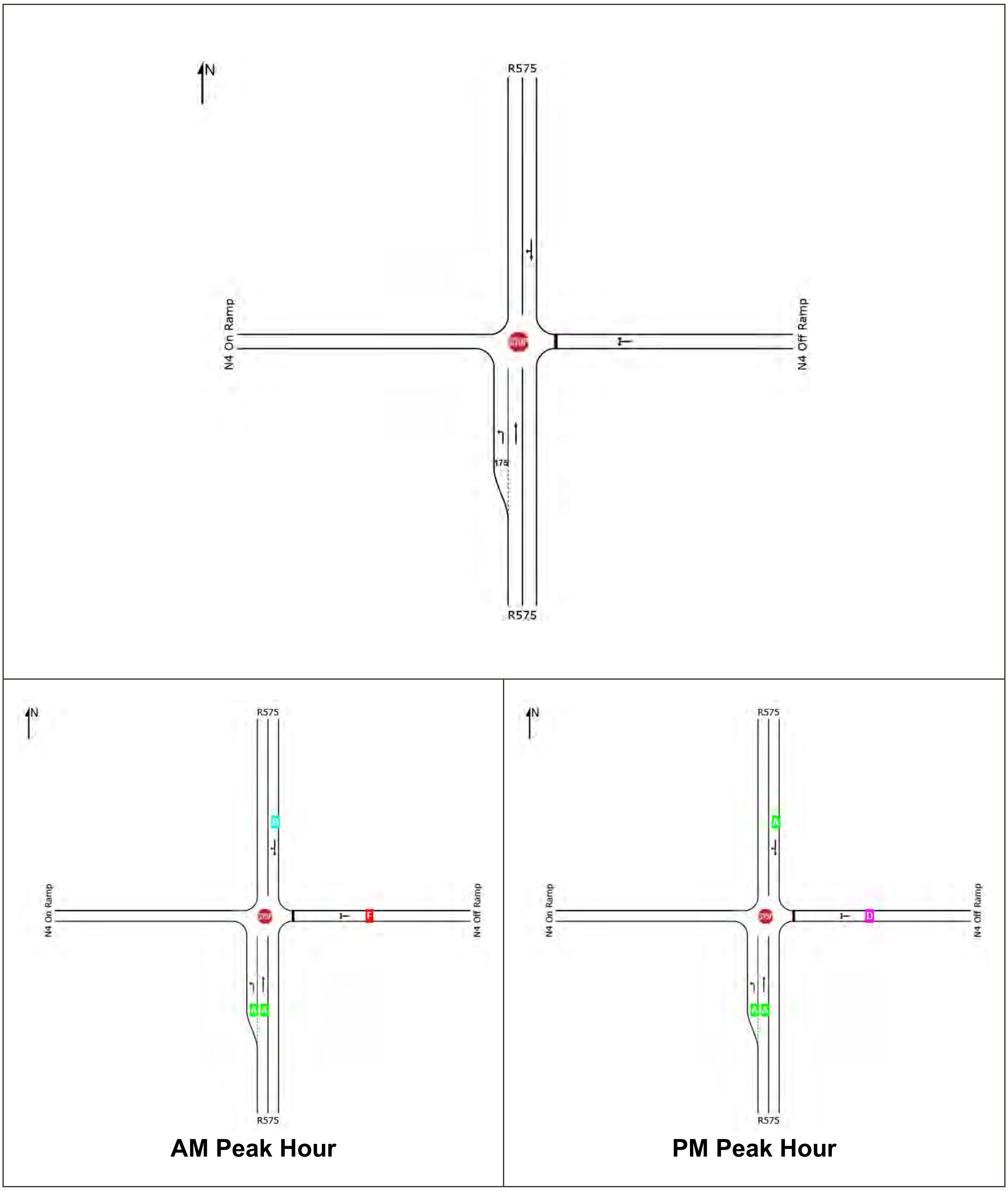


The following upgrades are recommended for this intersection:

- Upgraded to a signalized intersection

From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours. It is to be noted that this intersection may only be signalized once the traffic signal warrants are met.

13.4 R575 / N4 South Ramp Intersection

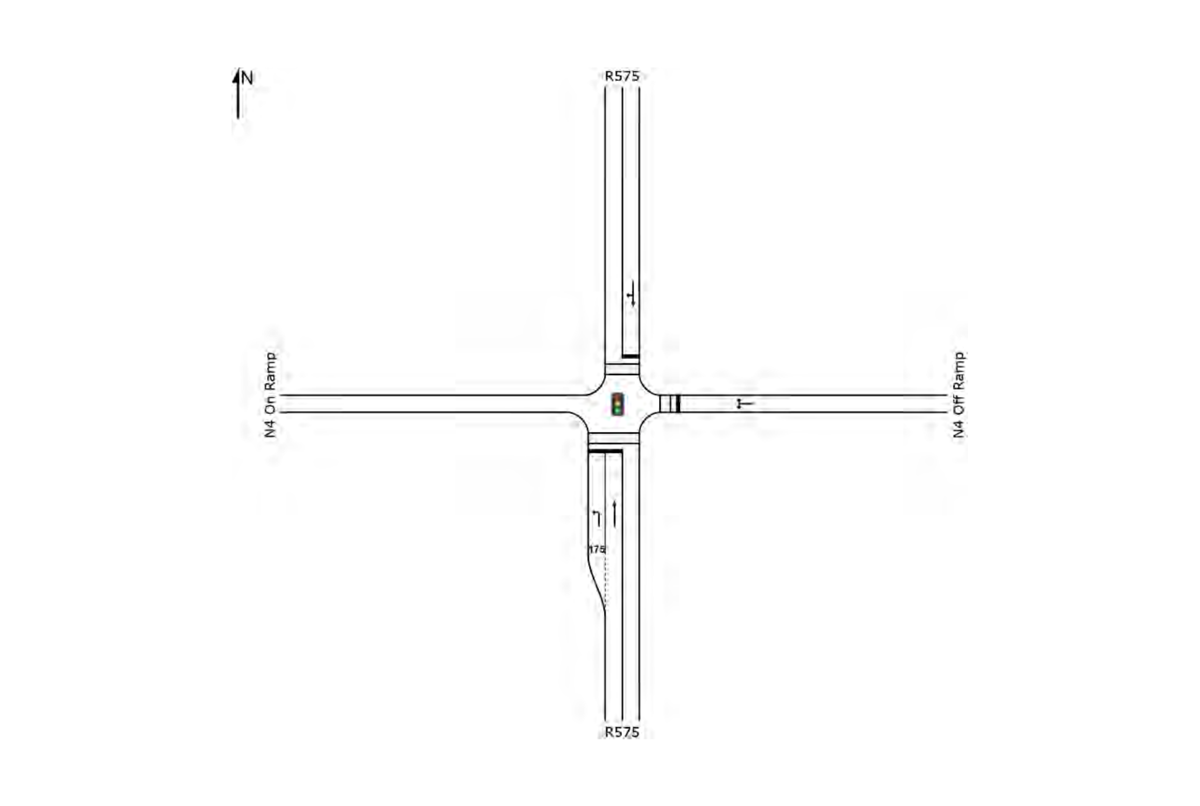


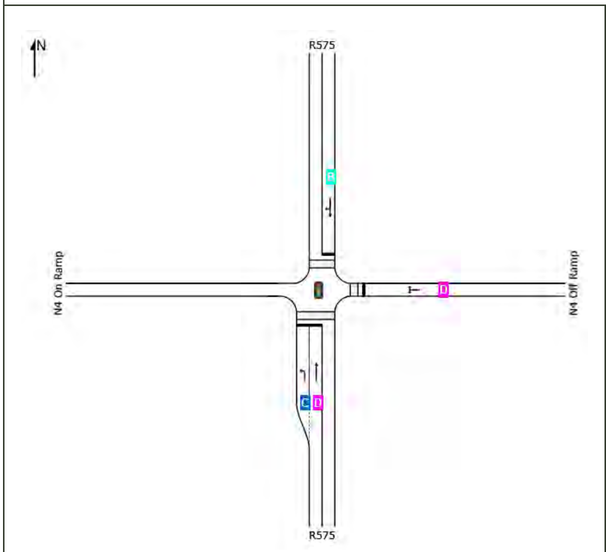
AM Peak Hour

PM Peak Hour

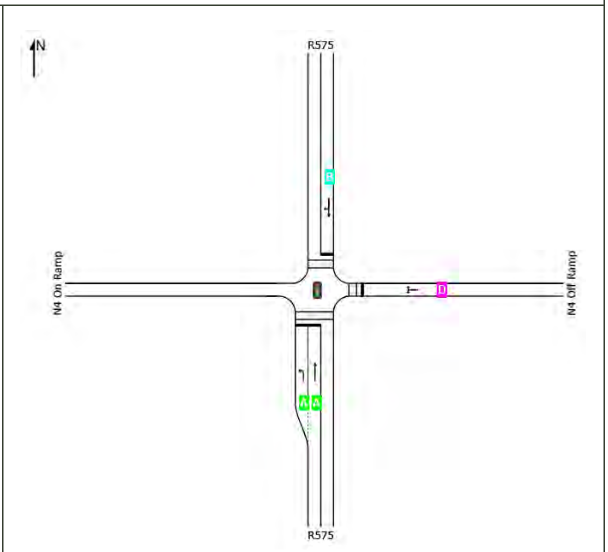
From the SIDRA results, it is evident that this intersection will experience congestion during the peak hours in the future horizon year. The congestion is due to the increase of background traffic as well as due to the mine generated traffic. Upgrades are required to this intersection as shown below. The cost of the upgrades are to be shared between latent developments, the road authority as well as the Elders Mine.

R575 / N4 South Ramp Intersection - Upgraded





AM Peak Hour



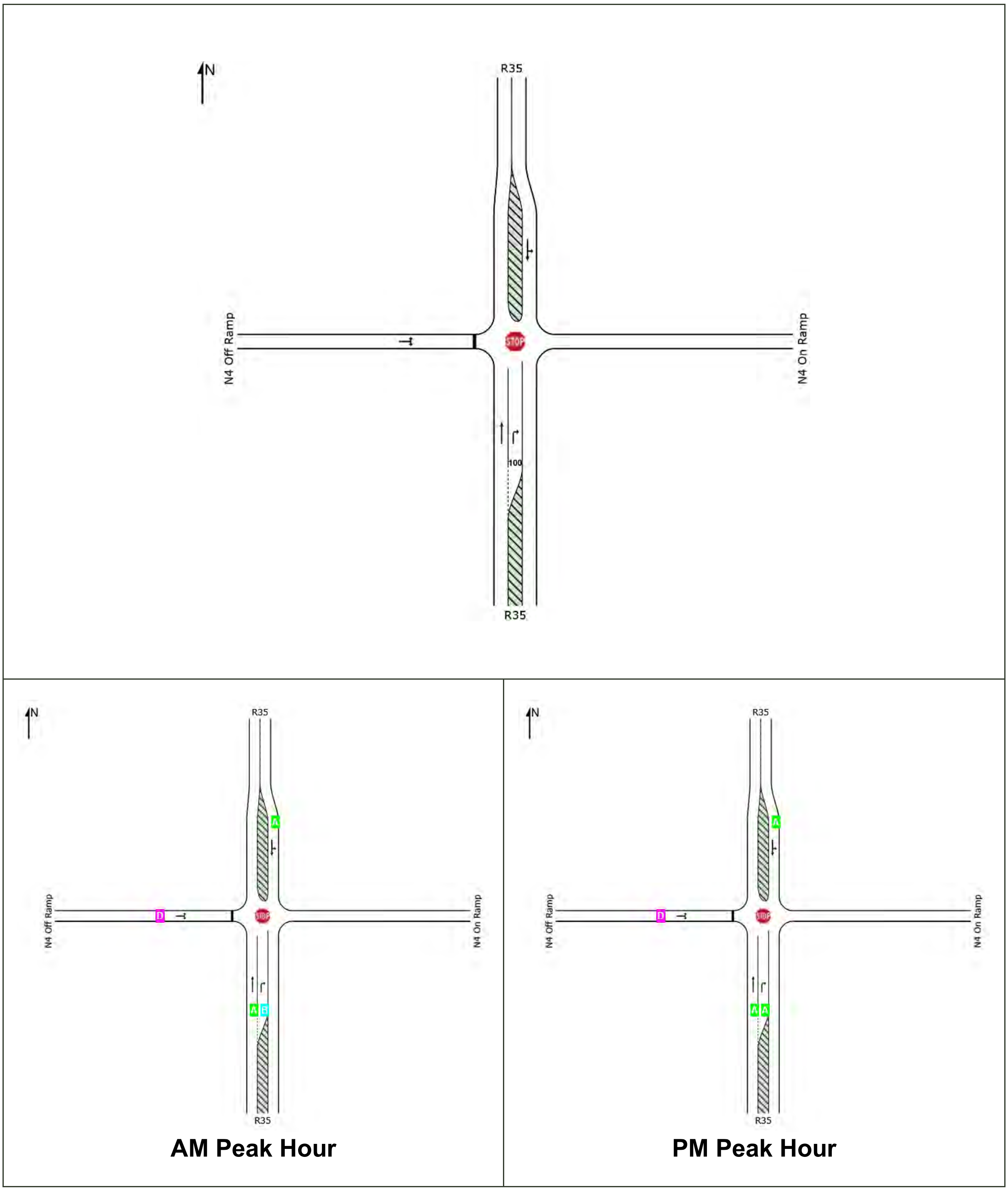
PM Peak Hour

The following upgrades are recommended for this intersection:

- Upgraded to a signalized intersection

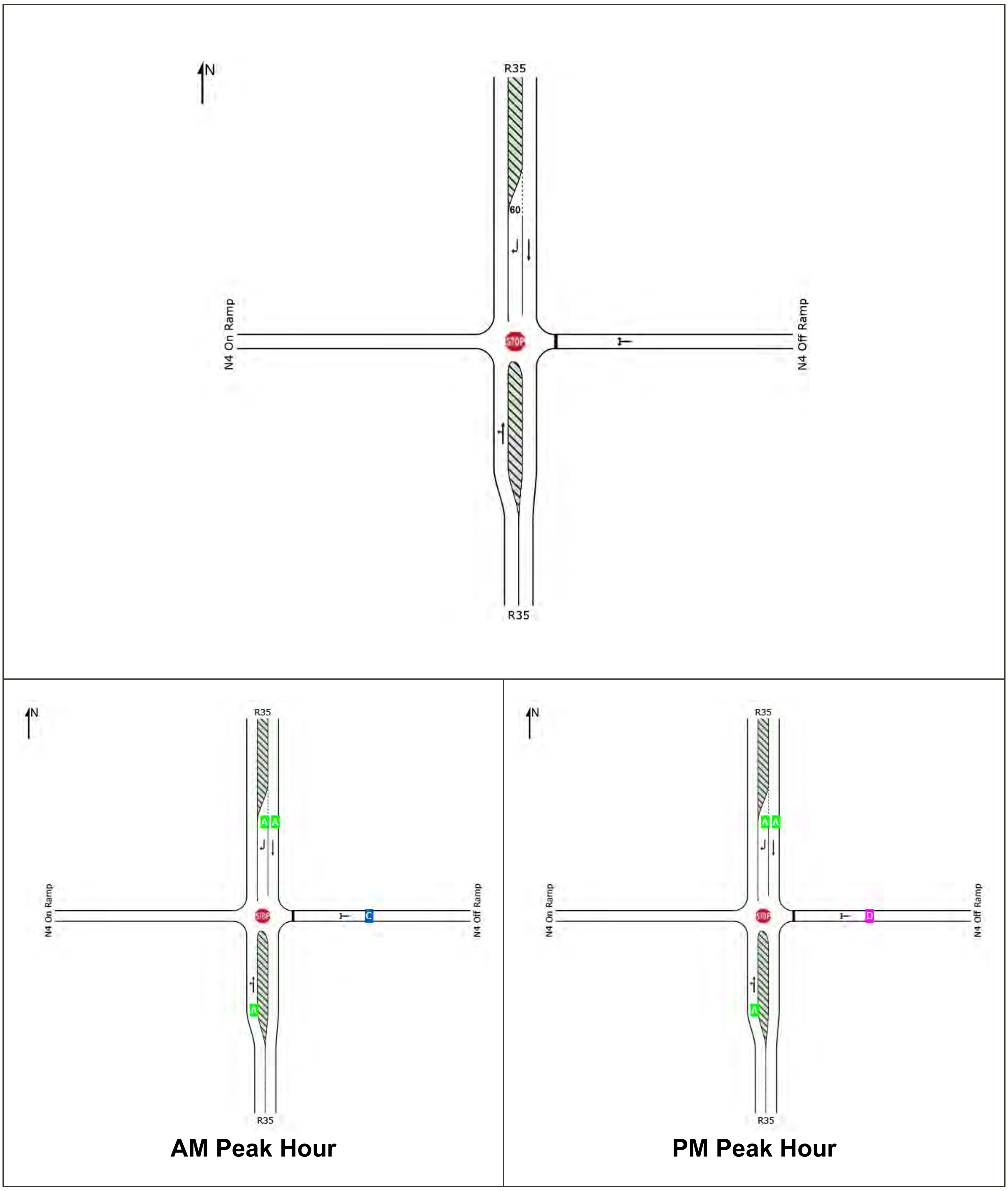
From the SIDRA results, it is evident that this upgraded intersection will operate at acceptable levels of service during the peak hours. It is to be noted that this intersection may only be signalized once the traffic signal warrants are met.

13.5 R35 / N4 North Ramp Intersection



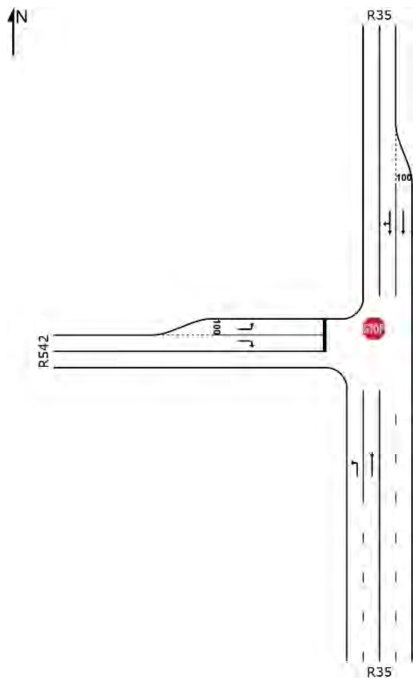
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

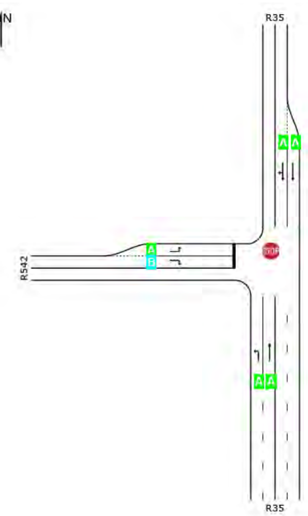
13.6 R35 / N4 South Ramp Intersection



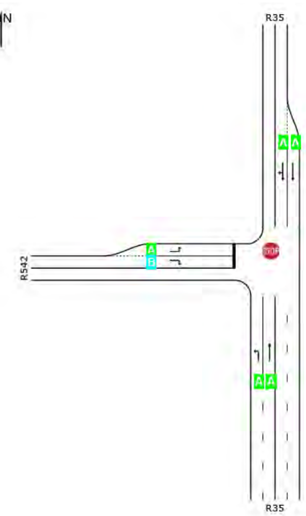
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

13.7 R35 / R542 North Intersection





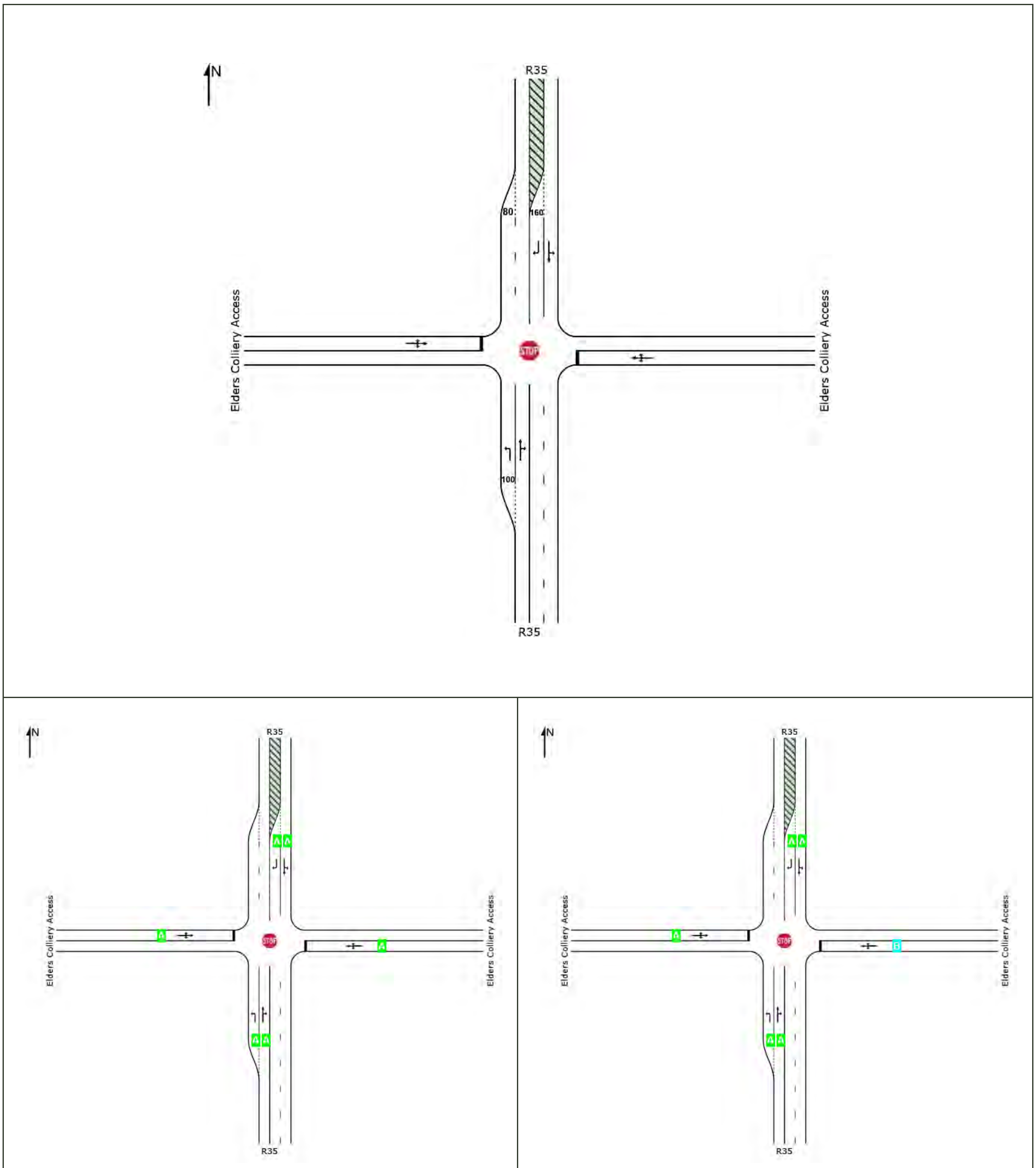
AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

13.8 R35 / Elder Colliery Access Intersection

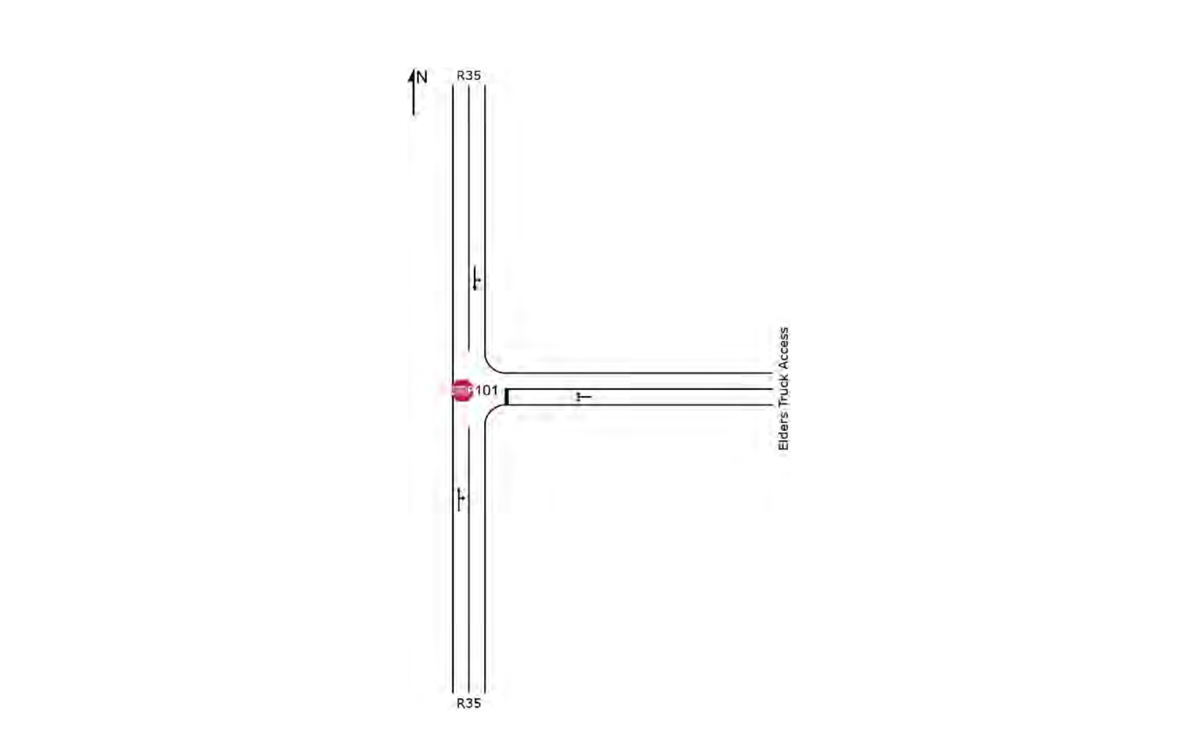


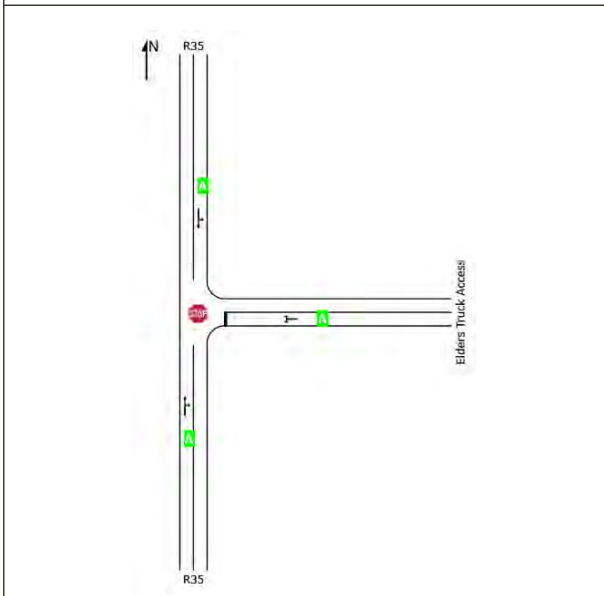
AM Peak Hour

PM Peak Hour

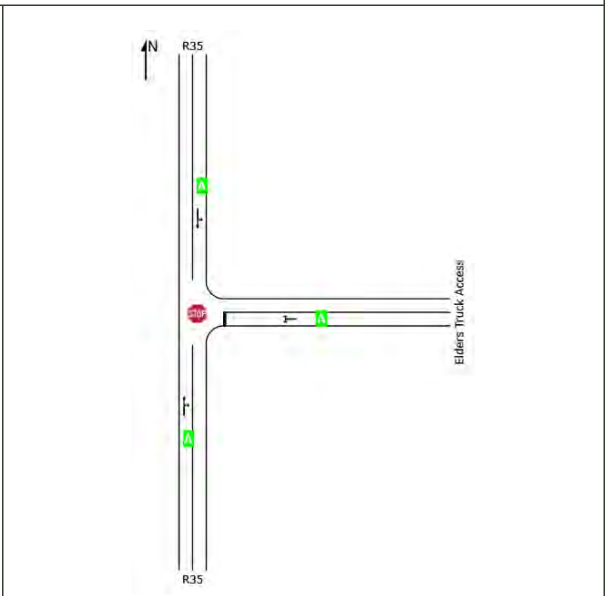
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

13.9 R35 / Elder Colliery Truck Access Intersection





AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

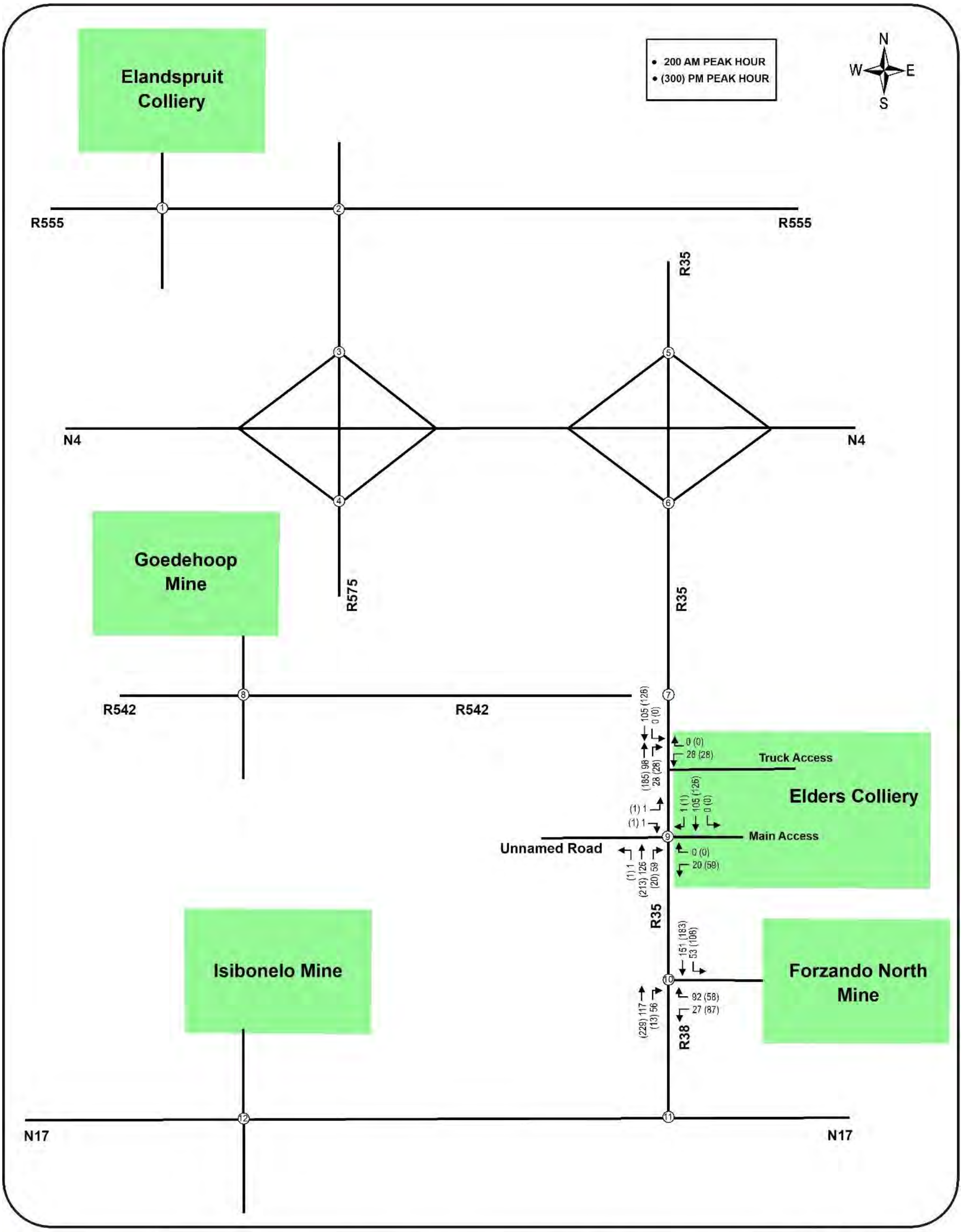
14 Elders Colliery to Forzando North Mine Analysis

For assessing the 10-year design horizon, the existing background traffic needs to be factored up by a specified growth rate from 2019 to 2029. A growth rate of 2.0% is used.

This section will analyse the 10-year background traffic volumes plus the traffic volumes generated by the Elders Colliery if all haulage is to utilise the Forzando North processing plant. This traffic will use the R35 to get to and from the Elders Colliery. Based on this route only the following intersections will be analysed in this section:

- R35 / Elder Colliery Main Access
- R35 / Elder Colliery Truck Access
- R35 / Road to Forzando North Mine

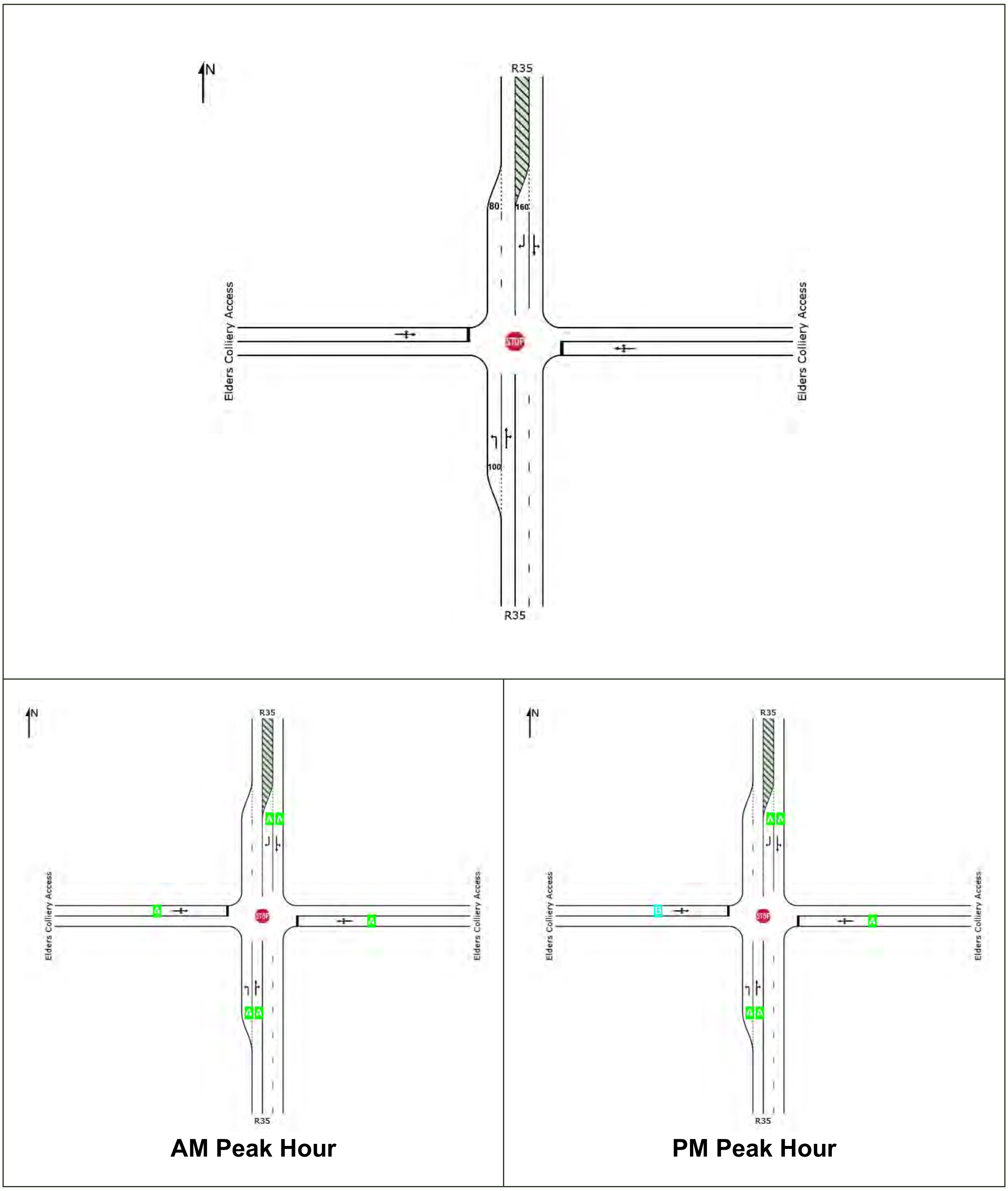
The 10-year background traffic volumes plus the Elders Colliery operational trip generation to the Forzando North Mine is shown in Figure 15 below.



aurecon	HORIZON YEAR SCENARIO PLUS ELDERS COLLIERY TRIP GENERATION TO FORZANDO NORTH MINE ELDERS COLLIERY	PROJECT: 502327 FIGURE:
July 2019	AURECON (PTY) LTD	SCALE: Not to Scale

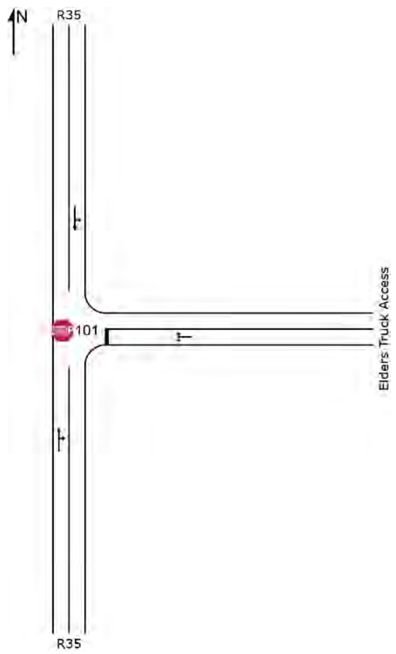
Figure 15: Horizon Year plus Elders Colliery Operational Trip Generation to Forzando North Mine

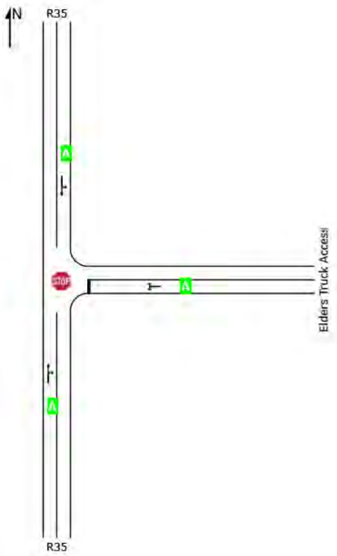
14.1 R35 / Elder Colliery Access Intersection



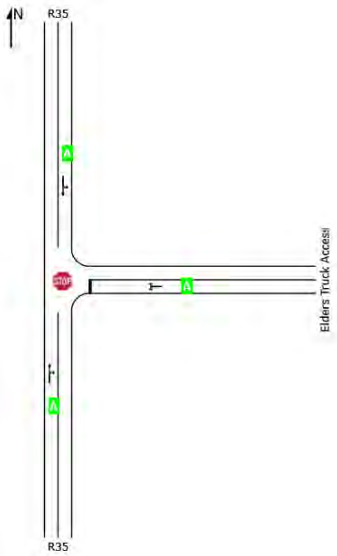
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

14.2 R35 / Elder Colliery Truck Access Intersection





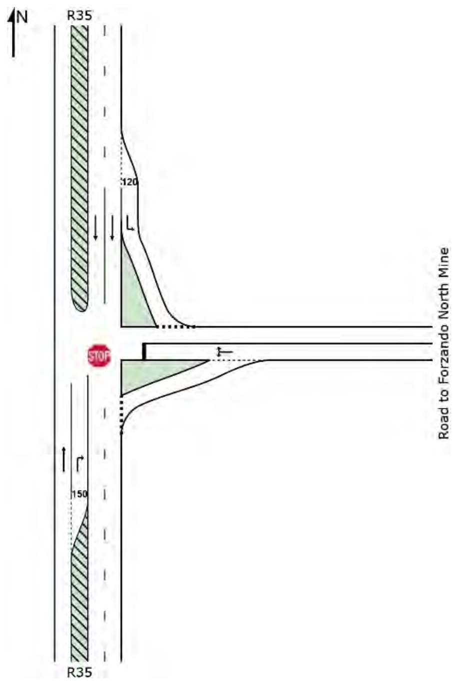
AM Peak Hour

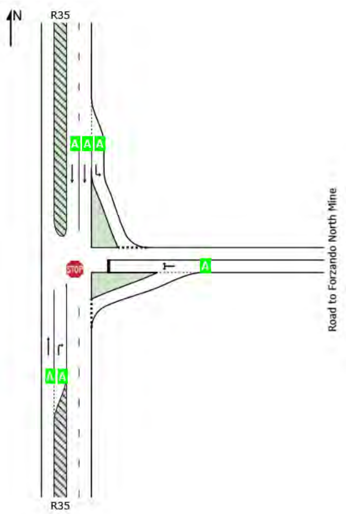


PM Peak Hour

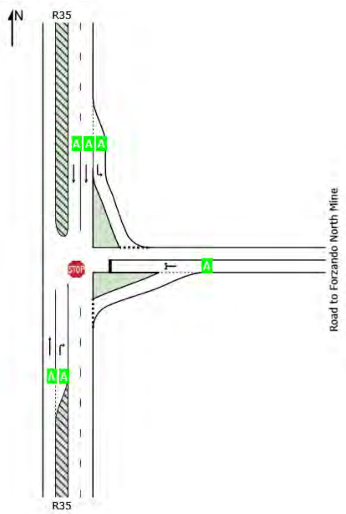
From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

14.3 R35 / Road to Forzando North Mine Intersection





AM Peak Hour



PM Peak Hour

From the SIDRA results, it is evident that this intersection will operate at acceptable levels of service during the peak hours.

15 Road Safety

Based on observation during the site visit, the road safety conditions along the roads in the study area are generally acceptable during the day when visibility is good and smaller vehicles are able to overtake the heavy vehicles fairly safely. During the night visibility is poor on roads that no street lighting has been provided.

The vehicle speeds and driver behaviour within the study area are generally good based on observation during the site visit, with the occasional vehicle exceeding the speed limit. There is signage displaying the maximum permissible speed and advanced warning signs for the presence of slower moving heavy vehicles on these sections of road.

16 Public Transport & Pedestrians

Negligible pedestrians and no cyclists were observed on the road network in the immediate vicinity of the Elders Colliery project area. There is thus very little conflict between pedestrians and traffic along the roads in the vicinity of the mine. There will be negligible pedestrians generated by Elders Colliery project area as the mine workers will be transported to and from the mine on buses. Pedestrian activity will not pose a road safety threat on any of the roads surrounding the project area.

17 Risk / Impact Assessment

The envisaged impacts of the proposed construction and operation of the Elders Mine on the surrounding road network are quantitatively evaluated in this chapter of the study. The purpose of this evaluation is to assign relative significance to the predicted impacts associated with the project and to determine the manner in which these impacts are to be avoided, mitigated or managed, if need be.

17.1 Impact on the Existing Traffic Conditions

The construction and operations of the proposed Elders Mine will generate additional traffic on the surrounding road network within the study area. The existing road network is operating at well below its capacity even during the critical AM and PM commuter peak periods. As such, the road network has sufficient capacity to handle the low volume of additional traffic that will be generated by the proposed construction and operations.

Activity	Additional traffic generated on the road network							
Project Phase	Construction, operation through to close-out							
Impact Summary	The additional traffic generated on the external road network will decrease the capacity of the road network and increase delays.							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Regional	Medium	Definite	Medium	-	Medium
Management Measures	The TIA has analysed all critical intersection with the mine generated traffic. Intersection upgrades are to be provided as recommended in this TIA. The upgrade of the intersections will provide additional capacity on the road network.							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Regional	Medium	Definite	Medium	-	Medium

17.2 Impact on Existing Pedestrians and Cyclists

The additional traffic that will be generated by the construction and the operation activities of the proposed Elders Mine will have a minimal impact on the existing space available for pedestrians and cyclists. There is no major conflict between pedestrians and vehicles within the study area. The additional traffic volumes will not result in any conflict.

There will be negligible pedestrians or cyclists generate by the proposed Elders mine. The unskilled construction workers will travel to and from the mine in contracted transport services and be picked and dropped off at the mine. The skilled workers will travel to the proposed site by private vehicles. It is unlikely that many of the workers will commute to work on foot.

Activity	Pedestrians and cyclists generated by the mine							
Project Phase	Construction, operation through to close-out							
Impact Summary	Conflict between pedestrians and vehicular traffic							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Site	Medium	Definite	Unlikely	-	Low
Management Measures	The TIA has analysed all critical intersection with the mine generated traffic. Intersection upgrades are to be provided as recommended in this TIA. The upgrade of the intersections will provide additional capacity on the road network.							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Site	Medium	Definite	Unlikely	-	Low

17.3 Impact on the Condition of the Surrounding Road Network

The haulage trucks to and from Elders and the processing plants will have a minor impact on the condition of the road network. Currently, the existing road network varied from poor to good condition. The volume of traffic proposed to be generated by the mine is low. Majority of the of the surrounding industries are also generating heavy traffic on the local road network.

The road network will be able to carry the additional volumes of heavy traffic that will be generated by the proposed mine. Hence, the impact of the additional heavy vehicle traffic on the existing condition of the road network is expected to be low.

Activity	Additional heavy vehicles generated on the road network impacting road condition.							
Project Phase	Construction, operation through to close-out							
Impact Summary	The additional heavy vehicles generated on the external road network will impact the road surface condition of the road network.							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Regional	Medium	Definite	Possible	-	Medium
Management Measures	The road authority is to provide maintenance and rehabilitation on all roads.							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq.**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long	Regional	Medium	Definite	Possible	-	Medium

18 Recommendations

The infrastructure upgrade requirements for the scenarios analysed in this TIA are summarised in Table 5 below:

Scenario	Intersection	Upgrade Required	Responsibility
Existing Analysis without any Development Traffic	R555 / R575	Signalized	Road Authority
	R35 / N4 North Ramp	Assign north and south approaches as major roads	Road Authority
	R35 / N4 South Ramp	Assign north and south approaches as major roads	Road Authority
Base Year plus Construction Traffic	No upgrades required		
Horizon Year plus Elders Colliery Operational Traffic to Goedehoop Mine	No upgrades required		
Horizon Year plus Elders Colliery Operational Traffic to Isibonelo Mine	No upgrades required		
Horizon Year plus Elders Colliery Operational Traffic to Forzando North Mine	No upgrades required		
Horizon Year plus Elders Colliery Operational Traffic to Elandspruit Colliery	R555 / Road to Elandspruit Colliery	Signalized	Cost share between Elders, Road Authority and surrounding latent developments
	R575 / N4 North Ramp	Signalized	
	R575 / N4 South Ramp	Signalized	

Table 5: Infrastructure Upgrade Requirements

19 Conclusions

SRK Consulting South Africa (Pty) Ltd have appointed Aurecon SA (Pty) Ltd to prepare a Traffic Impact Assessment as part of the EIA for the Elders Colliery, situated on the R35 in Mpumalanga.

The following can be noted from this Traffic Assessment:

- Existing traffic conditions on the four routes investigated vary from very good traffic operating conditions to high traffic congestion. Therefore, infrastructure upgrades will be required for intersections currently experiencing congestion. These upgrades are required due to existing traffic volumes and the responsibility is with the relevant road authority to implement.
- Upon analysing the intersections with the recommended upgrades, intersections operate well and have additional capacity.
- A high percentage of heavy vehicles operate on the surrounding road network due to the many mining activities taking place.
- The base year with construction traffic analysis shows all intersections operate at a good LOS. No upgrades will be needed to accommodate construction traffic.
- The 10-year with development scenario was tested for each route and the results of the analysis indicated:
    - No upgrades needed for the routes to Goedehoop, Isibonelo and Forzando North processing plants.
    - Upgrades will be needed along the route to Elandspruit Colliery.
- Pedestrian activity is very low and will not pose road safety hazard.

From a traffic and transportation perspective, the Elders Colliery project can be supported, provided the recommendations above are adhered to.

Appendices

Appendix A
Traffic Counts

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECITON OF R555 AND ROAD TO ELANDSPRUIT COLLIERY

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	ROAD TO ELANDSPRUIT COLLIERY															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
06:15 - 06:30	6	0	0	1	7	0	0	0	0	0	6	0	0	0	6	13
06:30 - 06:45	8	3	0	1	12	0	0	0	0	0	4	0	0	0	4	16
06:45 - 07:00	6	0	0	0	6	0	0	0	0	0	4	0	0	0	4	10
07:00 - 07:15	5	0	1	0	6	0	0	0	0	0	1	0	0	0	1	7
07:15 - 07:30	4	0	1	0	5	0	0	0	0	0	0	0	0	0	0	5
07:30 - 07:45	5	0	4	1	10	0	0	0	0	0	0	0	0	0	0	10
07:45 - 08:00	0	1	1	1	3	0	0	0	0	0	1	0	0	0	1	4
08:00 - 08:15	1	1	1	0	3	0	0	0	0	0	0	0	0	0	0	3
08:15 - 08:30	0	0	0	1	1	0	0	0	0	0	3	0	0	0	3	4
08:30 - 08:45	3	0	2	1	6	0	0	0	0	0	0	0	0	0	0	6
08:45 - 09:00	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
09:00 - 09:15	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
09:30 - 09:45	2	0	2	0	4	0	0	0	0	0	1	0	0	0	1	5
09:45 - 10:00	5	0	3	0	8	0	0	0	0	0	1	0	0	0	1	9
10:00 - 10:15	2	0	3	0	5	0	0	0	0	0	1	0	0	0	1	6
10:15 - 10:30	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
10:30 - 10:45	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
10:45 - 11:00	4	0	2	0	6	0	0	0	0	0	0	0	0	0	0	6
11:00 - 11:15	2	0	2	0	4	0	0	0	0	0	0	0	2	0	2	6
11:15 - 11:30	6	0	7	0	13	0	0	0	0	0	0	0	1	0	1	14
11:30 - 11:45	3	0	2	0	5	0	0	0	0	0	0	0	0	0	0	5
11:45 - 12:00	5	1	2	0	8	0	0	0	0	0	0	0	0	0	0	8
12:00 - 12:15	4	0	2	0	6	0	0	0	0	0	0	0	0	0	0	6
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	3	0	1	0	4	0	0	0	0	0	4	0	0	0	4	8
12:45 - 13:00	1	0	1	0	2	0	0	0	0	0	0	0	1	0	1	3
13:00 - 13:15	2	1	2	0	5	0	0	0	0	0	2	0	1	0	3	8
13:15 - 13:30	2	0	1	0	3	0	0	0	0	0	0	0	0	0	0	3
13:30 - 13:45	1	0	2	0	3	0	0	0	0	0	0	0	0	0	0	3
13:45 - 14:00	3	0	3	0	6	0	0	0	0	0	0	0	1	0	1	7
14:00 - 14:15	5	0	1	0	6	0	0	0	0	0	2	0	0	1	3	9
14:15 - 14:30	3	0	1	0	4	0	0	0	0	0	3	1	0	0	4	8
14:30 - 14:45	3	0	1	0	4	0	0	0	0	0	1	0	0	0	1	5
14:45 - 15:00	10	0	0	0	10	0	0	0	0	0	2	0	0	0	2	12
15:00 - 15:15	6	0	1	0	7	0	0	0	0	0	0	0	0	0	0	7
15:15 - 15:30	7	0	1	0	8	0	0	0	0	0	0	0	0	0	0	8
15:30 - 15:45	5	0	1	0	6	0	0	0	0	0	0	0	0	0	0	6
15:45 - 16:00	5	1	0	2	8	0	0	0	0	0	0	0	0	0	0	8
16:00 - 16:15	8	0	1	0	9	0	0	0	0	0	3	0	0	0	3	12
16:15 - 16:30	8	0	0	1	9	0	0	0	0	0	3	0	1	0	4	13
16:30 - 16:45	6	0	0	0	6	0	0	0	0	0	2	0	1	0	3	9
16:45 - 17:00	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
17:00 - 17:15	7	0	0	0	7	0	0	0	0	0	3	0	0	0	3	10
17:15 - 17:30	4	0	0	0	4	0	0	0	0	0	2	0	2	0	4	8
17:30 - 17:45	2	0	0	0	2	0	0	0	0	0	2	0	0	0	2	4
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**177**	**8**	**52**	**9**	**246**	**0**	**0**	**0**	**0**	**0**	**52**	**1**	**10**	**1**	**64**	**310**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECITON OF R555 AND ROAD TO ELANDSPRUIT COLLIERY

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECITON OF R555 AND ROAD TO ELANDSPRUIT COLLIERY															
DATE:	12 HOUR COUNT ON WEDNESDAY 22 MAY 2019															
UNITS:	CLASSIFIED															

APPROACH FROM	EAST															TOTAL
NAME	R 555															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	100	2	10	3	115	2	1	0	0	3	118
06:15 - 06:30	0	0	0	0	0	111	1	6	0	118	0	0	0	0	0	118
06:30 - 06:45	0	0	0	0	0	150	4	7	1	162	0	10	0	0	10	172
06:45 - 07:00	0	0	0	0	0	106	4	9	1	120	0	2	3	0	5	125
07:00 - 07:15	0	0	0	0	0	155	2	12	0	169	10	4	0	1	15	184
07:15 - 07:30	0	0	0	0	0	107	1	13	0	121	9	5	0	0	14	135
07:30 - 07:45	0	0	0	0	0	140	4	22	6	172	3	0	1	0	4	176
07:45 - 08:00	0	0	0	0	0	77	4	16	5	102	4	0	2	0	6	108
08:00 - 08:15	0	0	0	0	0	76	4	15	0	95	10	0	2	0	12	107
08:15 - 08:30	0	0	0	0	0	100	4	24	1	129	4	0	0	0	4	133
08:30 - 08:45	0	0	0	0	0	95	2	18	1	116	4	0	2	0	6	122
08:45 - 09:00	0	0	0	0	0	82	0	14	1	97	3	0	0	0	3	100
09:00 - 09:15	0	0	0	0	0	59	0	22	0	81	4	0	0	0	4	85
09:15 - 09:30	0	0	0	0	0	114	1	7	1	123	3	0	8	0	11	134
09:30 - 09:45	0	0	0	0	0	87	0	16	0	103	1	0	3	0	4	107
09:45 - 10:00	0	0	0	0	0	76	1	8	0	85	3	0	0	0	3	88
10:00 - 10:15	0	0	0	0	0	99	3	32	0	134	4	0	2	0	6	140
10:15 - 10:30	0	0	0	0	0	58	0	10	0	68	0	0	2	0	2	70
10:30 - 10:45	0	0	0	0	0	100	0	20	1	121	4	0	3	0	7	128
10:45 - 11:00	0	0	0	0	0	70	1	23	0	94	2	0	1	0	3	97
11:00 - 11:15	0	0	0	0	0	67	0	16	1	84	4	0	0	0	4	88
11:15 - 11:30	0	0	0	0	0	81	4	18	1	104	5	0	0	0	5	109
11:30 - 11:45	0	0	0	0	0	70	2	14	0	86	1	0	3	0	4	90
11:45 - 12:00	0	0	0	0	0	63	1	9	1	74	2	0	0	0	2	76
12:00 - 12:15	0	0	0	0	0	87	4	18	1	110	6	0	4	0	10	120
12:15 - 12:30	0	0	0	0	0	70	1	19	0	90	2	0	3	0	5	95
12:30 - 12:45	0	0	0	0	0	91	2	18	1	112	3	0	2	0	5	117
12:45 - 13:00	0	0	0	0	0	57	1	15	0	73	3	0	1	0	4	77
13:00 - 13:15	0	0	0	0	0	73	2	22	0	97	1	0	3	0	4	101
13:15 - 13:30	0	0	0	0	0	72	1	19	0	92	3	0	2	0	5	97
13:30 - 13:45	0	0	0	0	0	75	1	23	1	100	4	0	1	0	5	105
13:45 - 14:00	0	0	0	0	0	112	3	20	1	136	5	0	1	0	6	142
14:00 - 14:15	0	0	0	0	0	100	4	10	0	114	2	0	1	0	3	117
14:15 - 14:30	0	0	0	0	0	85	2	20	0	107	3	0	0	0	3	110
14:30 - 14:45	0	0	0	0	0	84	2	19	3	108	2	0	0	0	2	110
14:45 - 15:00	0	0	0	0	0	110	3	22	0	135	5	0	0	0	5	140
15:00 - 15:15	0	0	0	0	0	95	1	8	1	105	4	0	0	1	5	110
15:15 - 15:30	0	0	0	0	0	253	9	41	4	307	7	0	0	1	8	315
15:30 - 15:45	0	0	0	0	0	88	3	13	2	106	9	2	0	1	12	118
15:45 - 16:00	0	0	0	0	0	41	0	6	0	47	0	0	0	0	0	47
16:00 - 16:15	0	0	0	0	0	80	2	24	1	107	2	0	3	0	5	112
16:15 - 16:30	0	0	0	0	0	98	3	17	2	120	3	0	0	0	3	123
16:30 - 16:45	0	0	0	0	0	137	5	12	0	154	5	0	0	0	5	159
16:45 - 17:00	0	0	0	0	0	139	2	27	3	171	10	0	2	0	12	183
17:00 - 17:15	0	0	0	0	0	132	8	24	0	164	13	0	0	1	14	178
17:15 - 17:30	0	0	0	0	0	96	2	15	0	113	7	0	0	0	7	120
17:30 - 17:45	0	0	0	0	0	148	3	12	0	163	10	0	0	0	10	173
17:45 - 18:00	0	0	0	0	0	128	3	21	1	153	0	0	1	0	1	154
TOTAL	**0**	**0**	**0**	**0**	**0**	**4694**	**112**	**806**	**45**	**5657**	**191**	**24**	**56**	**5**	**276**	**5933**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECITON OF R555 AND ROAD TO ELANDSPRUIT COLLIERY

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	R 555															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	4	0	1	1	6	60	1	5	0	66	0	0	0	0	0	72
06:15 - 06:30	0	0	0	0	0	83	3	3	0	89	0	0	0	0	0	89
06:30 - 06:45	4	0	0	0	4	115	6	4	0	125	0	0	0	0	0	129
06:45 - 07:00	5	0	0	0	5	157	3	7	1	168	0	0	0	0	0	173
07:00 - 07:15	1	0	0	0	1	83	1	3	0	87	0	0	0	0	0	88
07:15 - 07:30	3	0	0	0	3	109	4	0	0	113	0	0	0	0	0	116
07:30 - 07:45	3	0	0	0	3	92	5	8	0	105	0	0	0	0	0	108
07:45 - 08:00	3	0	0	0	3	108	4	10	0	122	0	0	0	0	0	125
08:00 - 08:15	1	0	0	0	1	74	1	16	0	91	0	0	0	0	0	92
08:15 - 08:30	1	0	0	0	1	82	4	16	0	102	0	0	0	0	0	103
08:30 - 08:45	0	0	1	0	1	100	2	20	1	123	0	0	0	0	0	124
08:45 - 09:00	2	0	2	0	4	134	4	17	0	155	0	0	0	0	0	159
09:00 - 09:15	1	0	0	0	1	45	1	9	0	55	0	0	0	0	0	56
09:15 - 09:30	1	0	0	0	1	84	4	11	0	99	0	0	0	0	0	100
09:30 - 09:45	0	0	0	0	0	74	1	15	0	90	0	0	0	0	0	90
09:45 - 10:00	1	0	0	0	1	135	1	14	0	150	0	0	0	0	0	151
10:00 - 10:15	1	0	2	0	3	62	2	20	0	84	0	0	0	0	0	87
10:15 - 10:30	2	0	2	0	4	81	0	12	0	93	0	0	0	0	0	97
10:30 - 10:45	0	0	1	0	1	81	0	20	0	101	0	0	0	0	0	102
10:45 - 11:00	1	0	1	0	2	73	2	14	0	89	0	0	0	0	0	91
11:00 - 11:15	1	0	1	0	2	65	3	10	0	78	0	0	0	0	0	80
11:15 - 11:30	3	0	0	0	3	61	2	22	0	85	0	0	0	0	0	88
11:30 - 11:45	0	0	1	0	1	77	4	23	0	104	0	0	0	0	0	105
11:45 - 12:00	3	0	0	0	3	78	2	26	0	106	0	0	0	0	0	109
12:00 - 12:15	2	0	0	0	2	96	3	23	0	122	0	0	0	0	0	124
12:15 - 12:30	0	0	0	0	0	62	0	13	1	76	0	0	0	0	0	76
12:30 - 12:45	3	0	0	0	3	120	2	32	1	155	0	0	0	0	0	158
12:45 - 13:00	1	0	0	0	1	67	1	12	2	82	0	0	0	0	0	83
13:00 - 13:15	0	0	0	0	0	103	3	20	0	126	0	0	0	0	0	126
13:15 - 13:30	1	0	0	0	1	78	5	17	1	101	0	0	0	0	0	102
13:30 - 13:45	0	0	0	0	0	69	1	16	0	86	0	0	0	0	0	86
13:45 - 14:00	1	0	0	0	1	47	2	11	1	61	0	0	0	0	0	62
14:00 - 14:15	3	0	0	0	3	83	3	22	1	109	0	0	0	0	0	112
14:15 - 14:30	2	0	0	0	2	113	5	12	0	130	0	0	0	0	0	132
14:30 - 14:45	1	0	0	0	1	83	3	13	0	99	0	0	0	0	0	100
14:45 - 15:00	2	0	0	0	2	115	2	18	3	138	0	0	0	0	0	140
15:00 - 15:15	1	0	1	0	2	96	1	17	0	114	0	0	0	0	0	116
15:15 - 15:30	8	0	1	0	9	87	2	13	1	103	0	0	0	0	0	112
15:30 - 15:45	1	0	0	0	1	43	1	12	0	56	0	0	0	0	0	57
15:45 - 16:00	1	0	0	1	2	166	5	23	0	194	0	0	0	0	0	196
16:00 - 16:15	3	0	1	0	4	100	2	20	0	122	0	0	0	0	0	126
16:15 - 16:30	0	0	0	0	0	136	5	19	0	160	0	0	0	0	0	160
16:30 - 16:45	1	0	0	0	1	138	3	14	1	156	0	0	0	0	0	157
16:45 - 17:00	2	0	0	0	2	184	2	13	0	199	0	0	0	0	0	201
17:00 - 17:15	3	0	0	0	3	147	5	16	0	168	0	0	0	0	0	171
17:15 - 17:30	0	0	1	0	1	110	4	17	0	131	0	0	0	0	0	132
17:30 - 17:45	3	0	0	0	3	136	2	11	0	149	0	0	0	0	0	152
17:45 - 18:00	1	0	0	0	1	30	0	5	0	35	0	0	0	0	0	36
TOTAL	**81**	**0**	**16**	**2**	**99**	**4522**	**122**	**694**	**14**	**5352**	**0**	**0**	**0**	**0**	**0**	**5451**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R555 AND R575

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R555 AND R575

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 545															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	4	1	6	0	11	0	0	0	0	0	19	4	0	0	23	34
06:15 - 06:30	5	0	2	0	7	0	0	0	0	0	27	5	1	0	33	40
06:30 - 06:45	6	0	7	0	13	0	0	0	0	0	18	1	1	0	20	33
06:45 - 07:00	4	0	5	0	9	0	0	0	0	0	29	1	0	3	33	42
07:00 - 07:15	7	1	4	0	12	0	0	0	0	0	34	4	6	2	46	58
07:15 - 07:30	1	0	2	0	3	0	0	0	0	0	24	2	3	1	30	33
07:30 - 07:45	9	0	8	0	17	0	0	0	0	0	36	1	3	3	43	60
07:45 - 08:00	9	0	17	0	26	0	0	0	0	0	21	0	4	2	27	53
08:00 - 08:15	8	1	4	0	13	0	0	0	0	0	18	0	0	0	18	31
08:15 - 08:30	5	0	17	0	22	0	0	0	0	0	30	0	6	0	36	58
08:30 - 08:45	6	0	6	0	12	0	0	0	0	0	32	0	1	3	36	48
08:45 - 09:00	7	0	8	0	15	0	0	0	0	0	23	3	1	0	27	42
09:00 - 09:15	16	0	10	0	26	0	0	0	0	0	26	3	0	0	29	55
09:15 - 09:30	11	0	10	0	21	0	0	0	0	0	13	0	0	0	13	34
09:30 - 09:45	5	0	12	0	17	0	0	0	0	0	6	0	0	0	6	23
09:45 - 10:00	8	0	8	0	16	0	0	0	0	0	9	0	37	0	46	62
10:00 - 10:15	8	0	7	0	15	0	0	0	0	0	11	0	13	0	24	39
10:15 - 10:30	8	0	3	0	11	0	0	0	0	0	8	0	4	0	12	23
10:30 - 10:45	4	0	13	0	17	0	0	0	0	0	4	0	0	0	4	21
10:45 - 11:00	6	0	7	0	13	0	0	0	0	0	6	0	14	0	20	33
11:00 - 11:15	10	0	8	0	18	0	0	0	0	0	12	0	14	0	26	44
11:15 - 11:30	9	0	17	0	26	0	0	0	0	0	38	0	15	0	53	79
11:30 - 11:45	0	0	3	0	3	0	0	0	0	0	2	0	7	0	9	12
11:45 - 12:00	2	0	8	0	10	0	0	0	0	0	14	0	4	0	18	28
12:00 - 12:15	9	0	6	0	15	0	0	0	0	0	37	0	4	0	41	56
12:15 - 12:30	6	0	7	0	13	0	0	0	0	0	23	0	4	2	29	42
12:30 - 12:45	3	0	2	0	5	0	0	0	0	0	30	0	3	0	33	38
12:45 - 13:00	9	0	12	0	21	0	0	0	0	0	45	0	4	0	49	70
13:00 - 13:15	11	0	10	0	21	0	0	0	0	0	36	1	0	1	38	59
13:15 - 13:30	5	0	6	0	11	0	0	0	0	0	40	1	0	0	41	52
13:30 - 13:45	12	0	16	0	28	0	0	0	0	0	45	4	2	2	53	81
13:45 - 14:00	10	1	6	0	17	0	0	0	0	0	17	0	1	0	18	35
14:00 - 14:15	11	0	6	0	17	0	0	0	0	0	36	4	3	0	43	60
14:15 - 14:30	10	1	8	1	20	0	0	0	0	0	41	0	3	0	44	64
14:30 - 14:45	22	2	11	0	35	0	0	0	0	0	32	2	3	0	37	72
14:45 - 15:00	13	0	10	0	23	0	0	0	0	0	106	0	3	2	111	134
15:00 - 15:15	29	0	11	0	40	0	0	0	0	0	70	0	6	1	77	117
15:15 - 15:30	18	1	12	0	31	0	0	0	0	0	47	0	8	3	58	89
15:30 - 15:45	28	2	11	0	41	0	0	0	0	0	118	0	3	0	121	162
15:45 - 16:00	26	2	6	0	34	0	0	0	0	0	65	2	11	0	78	112
16:00 - 16:15	36	2	15	0	53	0	0	0	0	0	72	3	2	1	78	131
16:15 - 16:30	33	0	12	1	46	0	0	0	0	0	114	1	3	3	121	167
16:30 - 16:45	23	0	7	0	30	0	0	0	0	0	82	0	3	7	92	122
16:45 - 17:00	37	0	16	1	54	0	0	0	0	0	112	0	3	1	116	170
17:00 - 17:15	20	0	8	0	28	0	0	0	0	0	59	0	0	2	61	89
17:15 - 17:30	29	0	10	0	39	0	0	0	0	0	58	0	0	2	60	99
17:30 - 17:45	11	0	6	0	17	0	0	0	0	0	58	0	4	0	62	79
17:45 - 18:00	9	0	2	0	11	0	0	0	0	0	25	0	0	0	25	36
TOTAL	**578**	**14**	**408**	**3**	**1003**	**0**	**0**	**0**	**0**	**0**	**1828**	**42**	**207**	**41**	**2118**	**3121**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R555 AND R575

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	R 555															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	84	5	0	4	93	177	0	10	2	189	0	0	0	0	0	282
06:15 - 06:30	92	3	4	5	104	243	3	9	4	259	0	0	0	0	0	363
06:30 - 06:45	117	1	5	2	125	124	1	9	1	135	0	0	0	0	0	260
06:45 - 07:00	148	4	2	2	156	219	4	8	2	233	0	0	0	0	0	389
07:00 - 07:15	108	3	3	0	114	165	3	10	0	178	0	0	0	0	0	292
07:15 - 07:30	87	1	2	1	91	187	0	14	1	202	0	0	0	0	0	293
07:30 - 07:45	84	2	0	0	86	153	7	17	4	181	0	0	0	0	0	267
07:45 - 08:00	42	0	0	0	42	139	3	13	1	156	0	0	0	0	0	198
08:00 - 08:15	33	2	3	0	38	107	4	8	2	121	0	0	0	0	0	159
08:15 - 08:30	35	0	1	0	36	84	1	15	1	101	0	0	0	0	0	137
08:30 - 08:45	41	0	1	0	42	131	2	22	2	157	0	0	0	0	0	199
08:45 - 09:00	46	1	2	0	49	84	1	12	0	97	0	0	0	0	0	146
09:00 - 09:15	28	0	1	0	29	57	2	12	1	72	0	0	0	0	0	101
09:15 - 09:30	32	0	0	1	33	34	3	8	0	45	0	0	0	0	0	78
09:30 - 09:45	17	0	16	0	33	132	2	2	0	136	0	0	0	0	0	169
09:45 - 10:00	17	0	4	1	22	56	1	11	1	69	0	0	0	0	0	91
10:00 - 10:15	20	0	2	0	22	72	6	20	0	98	0	0	0	0	0	120
10:15 - 10:30	24	0	0	1	25	53	1	9	0	63	0	0	0	0	0	88
10:30 - 10:45	26	0	2	0	28	95	0	9	0	104	0	0	0	0	0	132
10:45 - 11:00	23	0	3	1	27	61	0	14	0	75	0	0	0	0	0	102
11:00 - 11:15	26	0	0	1	27	83	3	10	0	96	0	0	0	0	0	123
11:15 - 11:30	29	0	0	0	29	49	2	10	1	62	0	0	0	0	0	91
11:30 - 11:45	25	0	2	0	27	76	1	10	-1	86	0	0	0	0	0	113
11:45 - 12:00	42	0	3	0	45	66	3	7	2	78	0	0	0	0	0	123
12:00 - 12:15	39	1	7	1	48	105	2	12	0	119	0	0	0	0	0	167
12:15 - 12:30	28	1	2	0	31	68	1	10	2	81	0	0	0	0	0	112
12:30 - 12:45	22	1	4	0	27	57	1	2	0	60	0	0	0	0	0	87
12:45 - 13:00	46	2	5	1	54	91	3	23	0	117	0	0	0	0	0	171
13:00 - 13:15	34	3	3	0	40	58	2	6	1	67	0	0	0	0	0	107
13:15 - 13:30	60	1	5	0	66	84	1	15	0	100	0	0	0	0	0	166
13:30 - 13:45	54	1	2	1	58	106	1	8	2	117	0	0	0	0	0	175
13:45 - 14:00	80	4	2	4	90	89	2	13	0	104	0	0	0	0	0	194
14:00 - 14:15	15	1	5	2	23	107	4	17	0	128	0	0	0	0	0	151
14:15 - 14:30	45	1	6	3	55	90	0	16	0	106	0	0	0	0	0	161
14:30 - 14:45	36	1	2	5	44	66	1	15	0	82	0	0	0	0	0	126
14:45 - 15:00	73	3	8	2	86	144	3	8	2	157	0	0	0	0	0	243
15:00 - 15:15	42	1	3	1	47	97	1	9	1	108	0	0	0	0	0	155
15:15 - 15:30	64	1	5	1	71	135	2	10	4	151	0	0	0	0	0	222
15:30 - 15:45	48	2	5	0	55	116	6	13	0	135	0	0	0	0	0	190
15:45 - 16:00	65	4	1	2	72	85	2	12	3	102	0	0	0	0	0	174
16:00 - 16:15	68	4	1	0	73	107	4	10	3	124	0	0	0	0	0	197
16:15 - 16:30	61	0	0	1	62	76	2	21	4	103	0	0	0	0	0	165
16:30 - 16:45	50	0	1	1	52	98	1	10	0	109	0	0	0	0	0	161
16:45 - 17:00	56	0	3	4	63	96	1	10	0	107	0	0	0	0	0	170
17:00 - 17:15	58	2	1	3	64	115	0	7	0	122	0	0	0	0	0	186
17:15 - 17:30	60	0	2	1	63	104	0	13	0	117	0	0	0	0	0	180
17:30 - 17:45	148	1	2	3	154	76	3	12	0	91	0	0	0	0	0	245
17:45 - 18:00	18	0	0	0	18	86	0	4	0	90	0	0	0	0	0	108
TOTAL	**2496**	**57**	**131**	**55**	**2739**	**4903**	**96**	**545**	**46**	**5590**	**0**	**0**	**0**	**0**	**0**	**8329**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R555 AND R575

DATE: 12 HOUR COUNT ON WEDNESDAY 22 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	R 555															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	42	4	2	2	50	15	0	6	0	21	71
06:15 - 06:30	0	0	0	0	0	95	5	4	2	106	23	0	1	0	24	130
06:30 - 06:45	0	0	0	0	0	126	7	1	0	134	14	0	4	1	19	153
06:45 - 07:00	0	0	1	0	1	128	5	3	2	138	17	0	7	0	24	163
07:00 - 07:15	0	0	0	0	0	136	3	9	11	159	15	0	2	0	17	176
07:15 - 07:30	0	0	0	0	0	93	3	7	2	105	11	1	3	0	15	120
07:30 - 07:45	0	0	0	0	0	104	4	4	0	112	4	0	7	0	11	123
07:45 - 08:00	0	0	0	0	0	115	4	5	2	126	13	0	7	0	20	146
08:00 - 08:15	0	0	0	0	0	62	4	5	1	72	10	0	5	0	15	87
08:15 - 08:30	0	0	0	0	0	92	3	12	0	107	12	0	1	0	13	120
08:30 - 08:45	0	0	0	0	0	66	1	8	2	77	12	0	9	0	21	98
08:45 - 09:00	0	0	0	0	0	87	2	2	1	92	4	1	3	0	8	100
09:00 - 09:15	0	0	0	0	0	66	2	7	1	76	9	0	10	0	19	95
09:15 - 09:30	0	0	0	0	0	78	4	6	0	88	11	0	11	0	22	110
09:30 - 09:45	0	0	0	0	0	101	0	6	0	107	10	0	19	0	29	136
09:45 - 10:00	0	0	0	0	0	57	2	3	0	62	4	0	16	0	20	82
10:00 - 10:15	0	0	0	0	0	79	1	8	0	88	4	0	6	0	10	98
10:15 - 10:30	0	0	1	0	1	55	0	2	0	57	5	0	4	0	9	67
10:30 - 10:45	0	0	0	0	0	95	0	13	1	109	7	0	9	0	16	125
10:45 - 11:00	0	0	0	0	0	61	1	6	0	68	4	0	4	0	8	76
11:00 - 11:15	0	0	0	0	0	81	3	6	0	90	3	0	8	0	11	101
11:15 - 11:30	0	0	0	0	0	70	2	18	0	90	8	0	16	0	24	114
11:30 - 11:45	0	0	0	0	0	68	2	8	1	79	9	0	9	0	18	97
11:45 - 12:00	0	0	0	0	0	63	2	10	1	76	10	0	13	0	23	99
12:00 - 12:15	0	0	0	0	0	58	2	9	0	69	2	0	10	0	12	81
12:15 - 12:30	0	0	1	0	1	94	1	14	1	110	9	0	5	0	14	125
12:30 - 12:45	0	0	0	0	0	26	0	2	0	28	0	0	0	0	0	28
12:45 - 13:00	0	0	0	0	0	78	1	14	2	95	4	0	9	0	13	108
13:00 - 13:15	0	0	0	0	0	59	2	10	0	71	11	0	4	0	15	86
13:15 - 13:30	0	0	0	0	0	57	1	11	0	69	4	0	7	0	11	80
13:30 - 13:45	0	0	1	0	1	85	3	11	1	100	5	1	12	0	18	119
13:45 - 14:00	0	0	0	0	0	52	2	6	1	61	3	0	10	0	13	74
14:00 - 14:15	0	0	0	0	0	98	0	11	4	113	7	1	23	0	31	144
14:15 - 14:30	0	0	0	0	0	56	3	5	0	64	5	0	5	0	10	74
14:30 - 14:45	0	0	0	0	0	88	6	5	0	99	5	0	12	1	18	117
14:45 - 15:00	0	0	2	0	2	108	3	4	2	117	5	0	4	0	9	128
15:00 - 15:15	0	0	0	0	0	97	3	9	0	109	2	0	11	0	13	122
15:15 - 15:30	0	0	0	0	0	46	0	6	1	53	5	0	4	0	9	62
15:30 - 15:45	0	0	0	0	0	150	3	9	1	163	3	0	11	0	14	177
15:45 - 16:00	0	0	2	0	2	114	4	7	1	126	5	0	13	1	19	147
16:00 - 16:15	0	0	0	0	0	146	2	14	1	163	3	1	9	0	13	176
16:15 - 16:30	0	0	0	0	0	93	3	4	0	100	3	0	3	0	6	106
16:30 - 16:45	0	0	0	0	0	193	4	10	1	208	16	0	10	1	27	235
16:45 - 17:00	0	0	0	0	0	160	1	13	0	174	5	1	14	0	20	194
17:00 - 17:15	0	0	0	0	0	195	2	16	1	214	9	1	9	0	19	233
17:15 - 17:30	0	0	0	0	0	154	7	13	0	174	10	0	12	0	22	196
17:30 - 17:45	0	0	0	0	0	124	1	14	0	139	5	1	10	0	16	155
17:45 - 18:00	0	0	0	0	0	74	1	11	1	87	4	0	2	0	6	93
TOTAL	**0**	**0**	**8**	**0**	**8**	**4425**	**119**	**383**	**47**	**4974**	**364**	**8**	**389**	**4**	**765**	**5747**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (NORTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	R 575															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	7	0	0	0	7	9	5	38	0	52	0	0	0	0	0	59
06:15 - 06:30	0	0	0	0	0	19	4	17	1	41	0	0	0	0	0	41
06:30 - 06:45	2	0	7	0	9	30	1	30	0	61	0	0	0	0	0	70
06:45 - 07:00	14	1	10	0	25	22	0	20	1	43	0	0	0	0	0	68
07:00 - 07:15	8	1	10	0	19	33	2	28	1	64	0	0	0	0	0	83
07:15 - 07:30	6	1	17	0	24	21	2	19	1	43	0	0	0	0	0	67
07:30 - 07:45	9	1	31	0	41	24	2	48	0	74	0	0	0	0	0	115
07:45 - 08:00	11	0	30	0	41	26	0	40	0	66	0	0	0	0	0	107
08:00 - 08:15	7	0	10	0	17	16	0	20	1	37	0	0	0	0	0	54
08:15 - 08:30	12	1	19	0	32	24	1	19	1	45	0	0	0	0	0	77
08:30 - 08:45	18	0	19	0	37	22	0	23	0	45	0	0	0	0	0	82
08:45 - 09:00	8	0	13	0	21	14	0	14	0	28	0	0	0	0	0	49
09:00 - 09:15	7	1	35	0	43	19	2	26	1	48	0	0	0	0	0	91
09:15 - 09:30	12	0	14	0	26	28	0	15	0	43	0	0	0	0	0	69
09:30 - 09:45	6	0	6	0	12	25	0	14	0	39	0	0	0	0	0	51
09:45 - 10:00	8	0	10	0	18	23	0	46	0	69	0	0	0	0	0	87
10:00 - 10:15	7	0	8	0	15	21	0	67	1	89	0	0	0	0	0	104
10:15 - 10:30	11	1	33	0	45	21	0	30	0	51	0	0	0	0	0	96
10:30 - 10:45	10	0	21	0	31	15	0	64	0	79	0	0	0	0	0	110
10:45 - 11:00	10	0	13	0	23	20	0	20	0	40	0	0	0	0	0	63
11:00 - 11:15	6	0	19	0	25	28	0	40	1	69	0	0	0	0	0	94
11:15 - 11:30	11	0	44	0	55	30	0	33	0	63	0	0	0	0	0	118
11:30 - 11:45	14	0	17	0	31	10	0	32	0	42	0	0	0	0	0	73
11:45 - 12:00	4	0	15	0	19	24	0	42	0	66	0	0	0	0	0	85
12:00 - 12:15	35	0	13	1	49	23	0	30	0	53	0	0	0	0	0	102
12:15 - 12:30	18	0	15	0	33	29	1	43	0	73	0	0	0	0	0	106
12:30 - 12:45	15	0	15	1	31	36	1	20	1	58	0	0	0	0	0	89
12:45 - 13:00	4	0	24	0	28	36	2	40	1	79	0	0	0	0	0	107
13:00 - 13:15	8	0	15	0	23	20	2	34	0	56	0	0	0	0	0	79
13:15 - 13:30	5	0	6	0	11	7	4	30	0	41	0	0	0	0	0	52
13:30 - 13:45	11	0	28	0	39	11	1	29	0	41	0	0	0	0	0	80
13:45 - 14:00	22	0	7	0	29	13	4	36	0	53	0	0	0	0	0	82
14:00 - 14:15	18	1	23	0	42	26	5	34	0	65	0	0	0	0	0	107
14:15 - 14:30	23	1	13	0	37	27	3	24	3	57	0	0	0	0	0	94
14:30 - 14:45	15	4	23	0	42	48	0	46	1	95	0	0	0	0	0	137
14:45 - 15:00	15	1	23	0	39	35	0	25	0	60	0	0	0	0	0	99
15:00 - 15:15	24	4	18	0	46	37	0	34	5	76	0	0	0	0	0	122
15:15 - 15:30	17	4	17	0	38	44	0	25	2	71	0	0	0	0	0	109
15:30 - 15:45	27	1	15	0	43	38	2	37	2	79	0	0	0	0	0	122
15:45 - 16:00	10	1	20	0	31	58	3	52	2	115	0	0	0	0	0	146
16:00 - 16:15	14	3	9	0	26	44	2	28	4	78	0	0	0	0	0	104
16:15 - 16:30	12	3	14	0	29	52	4	40	5	101	0	0	0	0	0	130
16:30 - 16:45	16	2	26	0	44	61	1	30	3	95	0	0	0	0	0	139
16:45 - 17:00	15	0	22	0	37	41	2	40	3	86	0	0	0	0	0	123
17:00 - 17:15	1	7	8	0	16	37	2	64	1	104	0	0	0	0	0	120
17:15 - 17:30	4	0	12	0	16	41	1	53	2	97	0	0	0	0	0	113
17:30 - 17:45	2	1	18	0	21	59	2	39	3	103	0	0	0	0	0	124
17:45 - 18:00	3	0	14	1	18	5	0	23	1	29	0	0	0	0	0	47
TOTAL	**542**	**40**	**799**	**3**	**1384**	**1352**	**61**	**1601**	**48**	**3062**	**0**	**0**	**0**	**0**	**0**	**4446**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (NORTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 575															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	57	3	13	1	74	7	0	0	0	7	81
06:15 - 06:30	0	0	0	0	0	65	2	14	1	82	1	0	0	0	1	83
06:30 - 06:45	0	0	0	0	0	67	1	4	1	73	1	1	7	1	10	83
06:45 - 07:00	0	0	0	0	0	87	4	3	2	96	14	0	2	1	17	113
07:00 - 07:15	0	0	0	0	0	116	0	6	1	123	8	1	3	1	13	136
07:15 - 07:30	0	0	0	0	0	81	4	9	1	95	6	1	3	0	10	105
07:30 - 07:45	0	0	0	0	0	52	2	3	0	57	9	1	7	0	17	74
07:45 - 08:00	0	0	0	0	0	11	0	2	0	13	11	0	8	0	19	32
08:00 - 08:15	0	0	0	0	0	26	1	8	0	35	7	2	6	0	15	50
08:15 - 08:30	0	0	0	0	0	6	0	7	1	14	12	0	4	0	16	30
08:30 - 08:45	0	0	0	0	0	9	0	4	0	13	18	0	8	0	26	39
08:45 - 09:00	0	0	0	0	0	8	0	7	0	15	8	0	8	0	16	31
09:00 - 09:15	0	0	0	0	0	14	1	14	0	29	7	1	8	0	16	45
09:15 - 09:30	0	0	0	0	0	15	0	10	0	25	12	0	11	0	23	48
09:30 - 09:45	0	0	0	0	0	20	0	14	0	34	6	0	9	0	15	49
09:45 - 10:00	0	0	0	0	0	11	2	17	1	31	8	0	9	0	17	48
10:00 - 10:15	0	0	0	0	0	22	2	10	0	34	7	0	11	0	18	52
10:15 - 10:30	0	0	0	0	0	9	0	6	0	15	11	0	9	0	20	35
10:30 - 10:45	0	0	0	0	0	17	0	15	3	35	10	0	22	1	33	68
10:45 - 11:00	0	0	0	0	0	15	0	9	0	24	10	0	9	0	19	43
11:00 - 11:15	0	0	0	0	0	17	1	8	0	26	6	0	10	0	16	42
11:15 - 11:30	0	0	0	0	0	3	0	13	0	16	11	0	12	0	23	39
11:30 - 11:45	0	0	0	0	0	6	0	14	0	20	14	0	13	0	27	47
11:45 - 12:00	0	0	0	0	0	22	1	31	1	55	4	0	9	1	14	69
12:00 - 12:15	0	0	0	0	0	16	0	24	0	40	7	1	7	0	15	55
12:15 - 12:30	0	0	0	0	0	18	0	10	1	29	10	0	8	0	18	47
12:30 - 12:45	0	0	0	0	0	8	0	9	2	19	12	0	12	0	24	43
12:45 - 13:00	0	0	0	0	0	26	3	27	0	56	4	0	9	0	13	69
13:00 - 13:15	0	0	0	0	0	22	4	90	0	116	8	0	9	0	17	133
13:15 - 13:30	0	0	0	0	0	30	1	78	1	110	7	0	11	0	18	128
13:30 - 13:45	0	0	0	0	0	13	4	27	3	47	3	0	8	0	11	58
13:45 - 14:00	0	0	0	0	0	19	3	13	1	36	5	0	9	1	15	51
14:00 - 14:15	0	0	0	0	0	20	0	19	6	45	4	0	12	0	16	61
14:15 - 14:30	0	0	0	0	0	15	0	26	1	42	5	0	8	0	13	55
14:30 - 14:45	0	0	0	0	0	13	1	21	0	35	9	0	9	0	18	53
14:45 - 15:00	0	0	0	0	0	24	1	24	0	49	7	0	7	0	14	63
15:00 - 15:15	0	0	0	0	0	5	1	19	2	27	9	1	9	0	19	46
15:15 - 15:30	0	0	0	0	0	21	0	26	2	49	4	0	8	1	13	62
15:30 - 15:45	0	0	0	0	0	10	0	26	3	39	7	0	11	0	18	57
15:45 - 16:00	0	0	0	0	0	21	2	13	1	37	6	0	11	0	17	54
16:00 - 16:15	0	0	0	0	0	32	0	20	0	52	5	0	18	0	23	75
16:15 - 16:30	0	0	0	0	0	24	0	33	1	58	6	0	8	0	14	72
16:30 - 16:45	0	0	0	0	0	27	1	18	0	46	5	0	12	0	17	63
16:45 - 17:00	0	0	0	0	0	29	2	22	1	54	7	1	13	0	21	75
17:00 - 17:15	0	0	0	0	0	38	1	28	2	69	6	0	8	0	14	83
17:15 - 17:30	0	0	0	0	0	47	1	31	3	82	5	0	7	0	12	94
17:30 - 17:45	0	0	0	0	0	31	1	10	1	43	3	0	7	0	10	53
17:45 - 18:00	0	0	0	0	0	22	0	11	0	33	4	0	5	0	9	42
TOTAL	**0**	**0**	**0**	**0**	**0**	**1287**	**50**	**866**	**44**	**2247**	**356**	**10**	**414**	**7**	**787**	**3034**

TRAFFIC SURVEY

CLIENT:	AURECON
SITE:	INTERSECTION OF N4 AND R575 (NORTH OF INTERCHANGE)
DATE:	12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS:	CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (NORTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	N4 OFF RAMP															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	8	0	3	0	11	0	0	0	0	0	104	0	0	0	104	115
06:15 - 06:30	33	0	6	0	39	0	0	0	0	0	114	0	2	0	116	155
06:30 - 06:45	18	0	4	0	22	0	0	0	0	0	110	0	2	0	112	134
06:45 - 07:00	57	2	12	0	71	0	0	0	0	0	127	4	2	0	133	204
07:00 - 07:15	41	1	7	0	49	0	0	0	0	0	114	1	0	0	115	164
07:15 - 07:30	35	1	10	0	46	0	0	0	0	0	78	0	1	0	79	125
07:30 - 07:45	22	0	46	0	68	0	0	0	0	0	87	1	3	0	91	159
07:45 - 08:00	15	0	18	0	33	0	0	0	0	0	40	1	1	0	42	75
08:00 - 08:15	23	0	13	1	37	0	0	0	0	0	63	2	0	0	65	102
08:15 - 08:30	26	0	5	0	31	0	0	0	0	0	36	0	1	0	37	68
08:30 - 08:45	24	0	10	0	34	0	0	0	0	0	30	2	3	0	35	69
08:45 - 09:00	12	0	9	0	21	0	0	0	0	0	27	0	1	0	28	49
09:00 - 09:15	5	0	3	0	8	0	0	0	0	0	45	0	3	0	48	56
09:15 - 09:30	17	0	9	0	26	0	0	0	0	0	28	0	3	0	31	57
09:30 - 09:45	11	0	13	0	24	0	0	0	0	0	31	0	0	0	31	55
09:45 - 10:00	14	0	7	0	21	0	0	0	0	0	42	0	0	1	43	64
10:00 - 10:15	8	0	16	0	24	0	0	0	0	0	55	0	0	0	55	79
10:15 - 10:30	14	0	11	0	25	0	0	0	0	0	41	0	4	0	45	70
10:30 - 10:45	26	0	24	0	50	0	0	0	0	0	30	0	0	0	30	80
10:45 - 11:00	10	0	10	0	20	0	0	0	0	0	37	0	0	0	37	57
11:00 - 11:15	7	0	18	0	25	0	0	0	0	0	38	0	2	0	40	65
11:15 - 11:30	6	0	9	0	15	0	0	0	0	0	32	0	0	0	32	47
11:30 - 11:45	4	0	8	1	13	0	0	0	0	0	38	0	0	0	38	51
11:45 - 12:00	15	0	22	0	37	0	0	0	0	0	28	0	0	0	28	65
12:00 - 12:15	12	0	16	0	28	0	0	0	0	0	30	0	0	0	30	58
12:15 - 12:30	9	1	19	0	29	0	0	0	0	0	36	1	1	0	38	67
12:30 - 12:45	15	0	7	0	22	0	0	0	0	0	31	1	3	0	35	57
12:45 - 13:00	16	1	10	0	27	0	0	0	0	0	43	0	3	0	46	73
13:00 - 13:15	9	0	10	0	19	0	0	0	0	0	25	1	4	0	30	49
13:15 - 13:30	14	1	9	0	24	0	0	0	0	0	31	0	3	0	34	58
13:30 - 13:45	6	0	7	0	13	0	0	0	0	0	36	0	3	0	39	52
13:45 - 14:00	12	0	14	0	26	0	0	0	0	0	10	0	0	0	10	36
14:00 - 14:15	15	0	9	0	24	0	0	0	0	0	44	0	4	0	48	72
14:15 - 14:30	6	0	5	0	11	0	0	0	0	0	38	0	2	0	40	51
14:30 - 14:45	9	0	14	0	23	0	0	0	0	0	61	3	1	0	65	88
14:45 - 15:00	12	0	17	0	29	0	0	0	0	0	21	3	11	0	35	64
15:00 - 15:15	8	0	12	4	24	0	0	0	0	0	26	1	1	0	28	52
15:15 - 15:30	10	0	3	0	13	0	0	0	0	0	44	3	4	0	51	64
15:30 - 15:45	8	0	3	0	11	0	0	0	0	0	39	0	2	0	41	52
15:45 - 16:00	14	0	15	1	30	0	0	0	0	0	33	2	2	0	37	67
16:00 - 16:15	15	0	6	0	21	0	0	0	0	0	27	3	1	1	32	53
16:15 - 16:30	36	0	15	0	51	0	0	0	0	0	44	0	2	1	47	98
16:30 - 16:45	43	0	16	0	59	0	0	0	0	0	53	0	12	0	65	124
16:45 - 17:00	24	0	22	0	46	0	0	0	0	0	38	0	0	0	38	84
17:00 - 17:15	24	0	43	1	68	0	0	0	0	0	68	0	1	0	69	137
17:15 - 17:30	21	0	27	1	49	0	0	0	0	0	51	1	1	0	53	102
17:30 - 17:45	4	0	17	1	22	0	0	0	0	0	77	2	2	0	81	103
17:45 - 18:00	9	0	16	0	25	0	0	0	0	0	14	0	0	0	14	39
TOTAL	**802**	**7**	**625**	**10**	**1444**	**0**	**0**	**0**	**0**	**0**	**2295**	**32**	**91**	**3**	**2421**	**3865**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)															
DATE:	12 HOUR COUNT ON TUESDAY 14 MAY 2019															
UNITS:	CLASSIFIED															
APPROACH FROM	NORTH															TOTAL
NAME	R 575															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	48	5	36	0	89	8	0	3	0	11	100
06:15 - 06:30	0	0	0	0	0	153	3	6	1	163	33	0	2	0	35	198
06:30 - 06:45	0	0	0	0	0	187	1	11	0	199	18	0	8	0	26	225
06:45 - 07:00	0	0	0	0	0	100	4	13	1	118	57	0	12	0	69	187
07:00 - 07:15	0	0	0	0	0	129	3	13	1	146	41	0	7	0	48	194
07:15 - 07:30	0	0	0	0	0	103	2	18	1	124	35	0	10	0	45	169
07:30 - 07:45	0	0	0	0	0	90	1	5	0	96	22	1	46	0	69	165
07:45 - 08:00	0	0	0	0	0	52	1	25	0	78	11	0	18	0	29	107
08:00 - 08:15	0	0	0	0	0	36	1	6	1	44	27	1	13	1	42	86
08:15 - 08:30	0	0	0	0	0	53	1	15	0	69	26	0	5	0	31	100
08:30 - 08:45	0	0	0	0	0	25	0	14	0	39	24	0	10	0	34	73
08:45 - 09:00	0	0	0	0	0	68	1	22	0	91	12	1	9	0	22	113
09:00 - 09:15	0	0	0	0	0	45	2	4	2	53	5	0	3	0	8	61
09:15 - 09:30	0	0	0	0	0	24	0	8	0	32	17	0	9	0	26	58
09:30 - 09:45	0	0	0	0	0	22	0	5	0	27	11	0	13	0	24	51
09:45 - 10:00	0	0	0	0	0	37	0	38	0	75	14	0	7	0	21	96
10:00 - 10:15	0	0	0	0	0	32	0	52	0	84	8	0	16	0	24	108
10:15 - 10:30	0	0	0	0	0	14	0	18	0	32	14	0	11	0	25	57
10:30 - 10:45	0	0	0	0	0	50	0	46	0	96	26	0	24	0	50	146
10:45 - 11:00	0	0	0	0	0	29	0	7	0	36	10	0	10	0	20	56
11:00 - 11:15	0	0	0	0	0	31	0	24	0	55	7	0	18	0	25	80
11:15 - 11:30	0	0	0	0	0	38	0	25	0	63	6	0	9	0	15	78
11:30 - 11:45	0	0	0	0	0	26	0	18	0	44	4	0	14	1	19	63
11:45 - 12:00	0	0	0	0	0	59	0	25	0	84	15	0	16	0	31	115
12:00 - 12:15	0	0	0	0	0	36	0	15	1	52	12	0	16	0	28	80
12:15 - 12:30	0	0	0	0	0	25	1	23	0	49	9	1	19	0	29	78
12:30 - 12:45	0	0	0	0	0	35	1	21	1	58	15	1	7	0	23	81
12:45 - 13:00	0	0	0	0	0	46	1	33	1	81	16	1	10	0	27	108
13:00 - 13:15	0	0	0	0	0	35	2	24	0	61	9	0	10	0	19	80
13:15 - 13:30	0	0	0	0	0	71	2	23	0	96	14	2	9	0	25	121
13:30 - 13:45	0	0	0	0	0	40	1	27	0	68	6	0	7	0	13	81
13:45 - 14:00	0	0	0	0	0	50	4	26	0	80	12	2	14	0	28	108
14:00 - 14:15	0	0	0	0	0	27	2	22	0	51	15	1	9	0	25	76
14:15 - 14:30	0	0	0	0	0	62	2	32	3	99	6	0	5	0	11	110
14:30 - 14:45	0	0	0	0	0	24	2	25	1	52	9	0	14	0	23	75
14:45 - 15:00	0	0	0	0	0	66	3	28	0	97	12	0	17	0	29	126
15:00 - 15:15	0	0	0	0	0	37	1	2	0	40	8	0	12	4	24	64
15:15 - 15:30	0	0	0	0	0	78	1	2	2	83	10	0	3	0	13	96
15:30 - 15:45	0	0	0	0	0	44	1	72	2	119	8	1	3	0	12	131
15:45 - 16:00	0	0	0	0	0	64	4	30	1	99	14	2	15	1	32	131
16:00 - 16:15	0	0	0	0	0	45	3	24	5	77	15	3	6	0	24	101
16:15 - 16:30	0	0	0	0	0	54	3	41	5	103	36	0	15	0	51	154
16:30 - 16:45	0	0	0	0	0	61	0	37	3	101	43	0	16	0	59	160
16:45 - 17:00	0	0	0	0	0	46	1	22	3	72	24	0	22	0	46	118
17:00 - 17:15	0	0	0	0	0	58	3	23	1	85	24	0	43	1	68	153
17:15 - 17:30	0	0	0	0	0	62	0	28	2	92	21	0	27	1	49	141
17:30 - 17:45	0	0	0	0	0	145	1	24	0	170	4	1	17	1	23	193
17:45 - 18:00	0	0	0	0	0	27	0	8	0	35	9	0	16	0	25	60
TOTAL	**0**	**0**	**0**	**0**	**0**	**2689**	**64**	**1066**	**38**	**3857**	**802**	**18**	**625**	**10**	**1455**	**5312**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 575															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	56	0	0	0	56	65	3	11	1	80	0	0	0	0	0	136
06:15 - 06:30	46	0	0	0	46	45	2	14	1	62	0	0	0	0	0	108
06:30 - 06:45	38	0	0	0	38	76	1	13	2	92	0	0	0	0	0	130
06:45 - 07:00	68	0	2	1	71	70	5	4	3	82	0	0	0	0	0	153
07:00 - 07:15	66	0	0	0	66	68	3	9	2	82	0	0	0	0	0	148
07:15 - 07:30	86	1	3	0	90	80	3	11	1	95	0	0	0	0	0	185
07:30 - 07:45	91	0	2	0	93	61	1	10	0	72	0	0	0	0	0	165
07:45 - 08:00	54	0	0	0	54	25	0	8	0	33	0	0	0	0	0	87
08:00 - 08:15	52	0	0	0	52	40	1	12	0	53	0	0	0	0	0	105
08:15 - 08:30	41	1	2	0	44	20	0	11	0	31	0	0	0	0	0	75
08:30 - 08:45	37	1	3	0	41	29	0	13	0	42	0	0	0	0	0	83
08:45 - 09:00	35	0	6	0	41	17	0	14	0	31	0	0	0	0	0	72
09:00 - 09:15	37	0	3	0	40	24	1	20	0	45	0	0	0	0	0	85
09:15 - 09:30	38	0	4	0	42	34	0	22	0	56	0	0	0	0	0	98
09:30 - 09:45	49	0	7	0	56	26	0	21	0	47	0	0	0	0	0	103
09:45 - 10:00	33	0	6	0	39	20	0	26	1	47	0	0	0	0	0	86
10:00 - 10:15	33	0	4	0	37	33	2	21	0	56	0	0	0	0	0	93
10:15 - 10:30	30	2	5	0	37	20	0	14	0	34	0	0	0	0	0	71
10:30 - 10:45	37	0	4	0	41	29	0	36	0	65	0	0	0	0	0	106
10:45 - 11:00	33	0	4	0	37	30	0	16	1	47	0	0	0	0	0	84
11:00 - 11:15	39	0	3	0	42	20	0	18	0	38	0	0	0	0	0	80
11:15 - 11:30	44	2	4	0	50	16	1	24	0	41	0	0	0	0	0	91
11:30 - 11:45	32	0	3	0	35	23	0	27	0	50	0	0	0	0	0	85
11:45 - 12:00	28	0	2	1	31	26	0	39	1	66	0	0	0	0	0	97
12:00 - 12:15	35	0	2	0	37	25	2	30	0	57	0	0	0	0	0	94
12:15 - 12:30	57	0	4	0	61	26	0	17	1	44	0	0	0	0	0	105
12:30 - 12:45	26	0	2	0	28	25	0	21	2	48	0	0	0	0	0	76
12:45 - 13:00	39	3	4	0	46	25	0	34	0	59	0	0	0	0	0	105
13:00 - 13:15	37	0	3	0	40	31	2	98	0	131	0	0	0	0	0	171
13:15 - 13:30	50	0	3	0	53	37	4	86	1	128	0	0	0	0	0	181
13:30 - 13:45	36	0	2	0	38	14	1	36	2	53	0	0	0	0	0	91
13:45 - 14:00	31	0	2	0	33	25	4	24	3	56	0	0	0	0	0	89
14:00 - 14:15	35	0	3	1	39	30	3	29	6	68	0	0	0	0	0	107
14:15 - 14:30	49	0	0	0	49	39	0	32	1	72	0	0	0	0	0	121
14:30 - 14:45	32	1	3	0	36	17	0	29	0	46	0	0	0	0	0	82
14:45 - 15:00	39	0	3	0	42	28	1	30	0	59	0	0	0	0	0	101
15:00 - 15:15	31	0	1	0	32	21	2	29	2	54	0	0	0	0	0	86
15:15 - 15:30	40	0	6	0	46	32	0	30	3	65	0	0	0	0	0	111
15:30 - 15:45	43	0	2	0	45	28	1	36	2	67	0	0	0	0	0	112
15:45 - 16:00	32	0	2	0	34	34	0	23	1	58	0	0	0	0	0	92
16:00 - 16:15	60	0	4	0	64	21	1	34	0	56	0	0	0	0	0	120
16:15 - 16:30	70	1	2	0	73	24	0	39	1	64	0	0	0	0	0	137
16:30 - 16:45	45	0	2	0	47	28	0	29	0	57	0	0	0	0	0	104
16:45 - 17:00	61	0	2	0	63	41	2	30	1	74	0	0	0	0	0	137
17:00 - 17:15	38	0	3	0	41	40	1	28	2	71	0	0	0	0	0	112
17:15 - 17:30	43	0	2	0	45	50	1	32	3	86	0	0	0	0	0	131
17:30 - 17:45	19	0	1	0	20	35	2	15	1	53	0	0	0	0	0	73
17:45 - 18:00	12	0	1	0	13	25	0	5	0	30	0	0	0	0	0	43
TOTAL	**2063**	**12**	**126**	**3**	**2204**	**1598**	**50**	**1210**	**45**	**2903**	**0**	**0**	**0**	**0**	**0**	**5107**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	N4 OFF RAMP															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	22	0	2	0	24	0	0	0	0	0	1	0	0	0	1	25
06:15 - 06:30	16	0	2	0	18	0	0	0	0	0	1	0	0	0	1	19
06:30 - 06:45	36	0	0	0	36	0	0	0	0	0	0	0	0	0	0	36
06:45 - 07:00	76	3	1	0	80	0	0	0	0	0	0	0	0	0	0	80
07:00 - 07:15	20	2	6	0	28	0	0	0	0	0	0	0	0	0	0	28
07:15 - 07:30	31	4	2	0	37	0	0	0	0	0	0	0	0	0	0	37
07:30 - 07:45	9	0	6	0	15	0	0	0	0	0	0	0	0	0	0	15
07:45 - 08:00	3	0	4	0	7	0	0	0	0	0	0	0	2	0	2	9
08:00 - 08:15	5	0	5	0	10	0	0	0	0	0	1	0	1	0	2	12
08:15 - 08:30	5	2	5	0	12	0	0	0	0	0	2	0	0	1	3	15
08:30 - 08:45	2	0	8	0	10	0	0	0	0	0	1	0	1	0	2	12
08:45 - 09:00	5	0	7	0	12	0	0	0	0	0	1	0	1	0	2	14
09:00 - 09:15	3	0	6	0	9	0	0	0	0	0	1	0	1	0	2	11
09:15 - 09:30	4	2	7	0	13	0	0	0	0	0	4	0	0	0	4	17
09:30 - 09:45	5	0	3	0	8	0	0	0	0	0	2	0	1	0	3	11
09:45 - 10:00	8	0	1	0	9	0	0	0	0	0	5	0	0	0	5	14
10:00 - 10:15	6	0	8	0	14	0	0	0	0	0	1	0	1	0	2	16
10:15 - 10:30	5	1	4	0	10	0	0	0	0	0	2	0	0	0	2	12
10:30 - 10:45	3	0	3	0	6	0	0	0	0	0	0	0	0	3	3	9
10:45 - 11:00	9	0	4	0	13	0	0	0	0	0	1	0	0	0	1	14
11:00 - 11:15	3	0	2	0	5	0	0	0	0	0	3	0	1	0	4	9
11:15 - 11:30	3	1	5	0	9	0	0	0	0	0	2	0	0	0	2	11
11:30 - 11:45	9	0	7	0	16	0	0	0	0	0	4	0	1	0	5	21
11:45 - 12:00	12	0	8	0	20	0	0	0	0	0	5	1	0	1	7	27
12:00 - 12:15	11	0	12	0	23	0	0	0	0	0	2	0	0	0	2	25
12:15 - 12:30	10	0	7	0	17	0	0	0	0	0	1	0	0	0	1	18
12:30 - 12:45	12	0	4	0	16	0	0	0	0	0	1	0	0	0	1	17
12:45 - 13:00	7	1	14	0	22	0	0	0	0	0	3	0	1	0	4	26
13:00 - 13:15	14	0	7	0	21	0	0	0	0	0	2	0	0	0	2	23
13:15 - 13:30	10	0	8	0	18	0	0	0	0	0	3	0	0	0	3	21
13:30 - 13:45	4	0	8	0	12	0	0	0	0	0	3	0	2	0	5	17
13:45 - 14:00	10	0	5	0	15	0	0	0	0	0	1	0	0	0	1	16
14:00 - 14:15	12	1	9	0	22	0	0	0	0	0	2	0	0	0	2	24
14:15 - 14:30	10	0	3	0	13	0	0	0	0	0	3	0	1	0	4	17
14:30 - 14:45	13	0	5	0	18	0	0	0	0	0	2	0	0	0	2	20
14:45 - 15:00	8	0	7	0	15	0	0	0	0	0	6	0	1	0	7	22
15:00 - 15:15	2	1	11	0	14	0	0	0	0	0	8	0	0	0	8	22
15:15 - 15:30	10	0	7	0	17	0	0	0	0	0	6	0	0	0	6	23
15:30 - 15:45	8	0	7	0	15	0	0	0	0	0	13	0	1	0	14	29
15:45 - 16:00	20	0	2	0	22	0	0	0	0	0	3	0	0	0	3	25
16:00 - 16:15	16	0	2	0	18	0	0	0	0	0	5	0	3	0	8	26
16:15 - 16:30	13	1	11	0	25	0	0	0	0	0	5	0	1	1	7	32
16:30 - 16:45	12	0	10	0	22	0	0	0	0	0	1	0	0	0	1	23
16:45 - 17:00	16	0	5	0	21	0	0	0	0	0	4	0	4	0	8	29
17:00 - 17:15	18	0	3	0	21	0	0	0	0	0	3	1	1	0	5	26
17:15 - 17:30	23	0	5	0	28	0	0	0	0	0	4	0	0	0	4	32
17:30 - 17:45	14	0	5	0	19	0	0	0	0	0	1	0	0	0	1	20
17:45 - 18:00	9	0	4	0	13	0	0	0	0	0	2	0	0	0	2	15
TOTAL	**582**	**19**	**267**	**0**	**868**	**0**	**0**	**0**	**0**	**0**	**121**	**2**	**25**	**6**	**154**	**1022**

TRAFFIC SURVEY

CLIENT:	AURECON
SITE:	INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)
DATE:	12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS:	CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT:	AURECON
SITE:	INTERSECTION OF N4 AND R35 (NORTH OF INTERCHANGE)
DATE:	12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS:	CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	19	0	5	0	24	87	0	13	0	100	0	0	0	0	0	124
06:15 - 06:30	13	0	5	0	18	65	0	26	1	92	0	0	0	0	0	110
06:30 - 06:45	55	0	4	0	59	68	4	37	3	112	0	0	0	0	0	171
06:45 - 07:00	73	2	4	0	79	109	1	26	1	137	0	0	0	0	0	216
07:00 - 07:15	70	2	10	0	82	131	2	21	0	154	0	0	0	0	0	236
07:15 - 07:30	48	0	3	0	51	117	0	11	1	129	0	0	0	0	0	180
07:30 - 07:45	72	1	3	0	76	141	1	23	1	166	0	0	0	0	0	242
07:45 - 08:00	40	0	5	0	45	113	0	18	0	131	0	0	0	0	0	176
08:00 - 08:15	40	0	7	1	48	124	0	20	0	144	0	0	0	0	0	192
08:15 - 08:30	44	0	3	0	47	98	0	17	1	116	0	0	0	0	0	163
08:30 - 08:45	29	0	2	0	31	53	2	9	0	64	0	0	0	0	0	95
08:45 - 09:00	36	0	7	0	43	93	0	25	1	119	0	0	0	0	0	162
09:00 - 09:15	48	0	1	0	49	110	0	22	0	132	0	0	0	0	0	181
09:15 - 09:30	33	0	6	0	39	107	0	29	2	138	0	0	0	0	0	177
09:30 - 09:45	23	0	5	0	28	81	0	13	0	94	0	0	0	0	0	122
09:45 - 10:00	43	1	5	0	49	106	2	28	0	136	0	0	0	0	0	185
10:00 - 10:15	18	0	6	1	25	69	0	16	0	85	0	0	0	0	0	110
10:15 - 10:30	31	0	0	0	31	98	1	21	0	120	0	0	0	0	0	151
10:30 - 10:45	17	1	3	0	21	51	0	9	0	60	0	0	0	0	0	81
10:45 - 11:00	29	0	4	0	33	85	0	26	0	111	0	0	0	0	0	144
11:00 - 11:15	52	0	10	2	64	98	0	14	0	112	0	0	0	0	0	176
11:15 - 11:30	16	0	3	0	19	48	0	12	0	60	0	0	0	0	0	79
11:30 - 11:45	35	0	4	0	39	85	0	19	0	104	0	0	0	0	0	143
11:45 - 12:00	20	0	3	0	23	62	0	16	0	78	0	0	0	0	0	101
12:00 - 12:15	37	0	1	0	38	83	0	14	1	98	0	0	0	0	0	136
12:15 - 12:30	29	0	4	0	33	89	0	24	0	113	0	0	0	0	0	146
12:30 - 12:45	43	2	4	1	50	112	1	16	2	131	0	0	0	0	0	181
12:45 - 13:00	30	1	3	0	34	57	1	25	0	83	0	0	0	0	0	117
13:00 - 13:15	45	1	2	0	48	69	1	15	1	86	0	0	0	0	0	134
13:15 - 13:30	25	0	1	0	26	73	2	12	3	90	0	0	0	0	0	116
13:30 - 13:45	45	1	3	0	49	117	2	30	1	150	0	0	0	0	0	199
13:45 - 14:00	54	0	3	0	57	83	2	19	0	104	0	0	0	0	0	161
14:00 - 14:15	41	1	3	2	47	88	0	23	3	114	0	0	0	0	0	161
14:15 - 14:30	39	1	2	2	44	96	0	15	0	111	0	0	0	0	0	155
14:30 - 14:45	43	1	2	1	47	80	11	23	1	115	0	0	0	0	0	162
14:45 - 15:00	29	0	3	1	33	70	2	18	1	91	0	0	0	0	0	124
15:00 - 15:15	49	0	4	2	55	85	5	18	2	110	0	0	0	0	0	165
15:15 - 15:30	44	2	3	1	50	88	1	24	2	115	0	0	0	0	0	165
15:30 - 15:45	35	0	1	1	37	77	0	17	0	94	0	0	0	0	0	131
15:45 - 16:00	37	0	5	0	42	67	0	12	0	79	0	0	0	0	0	121
16:00 - 16:15	42	0	3	0	45	113	0	31	0	144	0	0	0	0	0	189
16:15 - 16:30	51	1	0	0	52	92	0	20	1	113	0	0	0	0	0	165
16:30 - 16:45	44	0	3	0	47	21	1	16	1	39	0	0	0	0	0	86
16:45 - 17:00	102	1	2	0	105	64	2	15	1	82	0	0	0	0	0	187
17:00 - 17:15	15	1	5	2	23	91	1	18	2	112	0	0	0	0	0	135
17:15 - 17:30	46	0	6	3	55	90	1	10	0	101	0	0	0	0	0	156
17:30 - 17:45	3	0	2	0	5	3	0	6	0	9	0	0	0	0	0	14
17:45 - 18:00	6	0	4	0	10	3	0	6	0	9	0	0	0	0	0	19
TOTAL	**1838**	**20**	**177**	**20**	**2055**	**4010**	**46**	**898**	**33**	**4987**	**0**	**0**	**0**	**0**	**0**	**7042**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R35 (NORTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	6	0	17	0	23	9	0	17	0	26	49
06:15 - 06:30	0	0	0	0	0	10	5	15	1	31	9	0	4	0	13	44
06:30 - 06:45	0	0	0	0	0	33	3	11	3	50	3	0	4	1	8	58
06:45 - 07:00	0	0	0	0	0	51	5	1	1	58	7	1	9	0	17	75
07:00 - 07:15	0	0	0	0	0	82	2	12	2	98	4	0	8	0	12	110
07:15 - 07:30	0	0	0	0	0	44	4	9	3	60	1	0	2	0	3	63
07:30 - 07:45	0	0	0	0	0	59	2	5	1	67	4	0	6	0	10	77
07:45 - 08:00	0	0	0	0	0	58	1	8	0	67	1	0	1	0	2	69
08:00 - 08:15	0	0	0	0	0	55	4	11	0	70	4	0	4	0	8	78
08:15 - 08:30	0	0	0	0	0	43	0	17	1	61	3	0	5	0	8	69
08:30 - 08:45	0	0	0	0	0	32	0	4	0	36	0	0	3	0	3	39
08:45 - 09:00	0	0	0	0	0	71	0	7	0	78	4	0	5	0	9	87
09:00 - 09:15	0	0	0	0	0	99	0	15	0	114	10	0	8	0	18	132
09:15 - 09:30	0	0	0	0	0	70	0	8	0	78	7	0	4	0	11	89
09:30 - 09:45	0	0	0	0	0	77	0	19	0	96	0	0	2	0	2	98
09:45 - 10:00	0	0	0	0	0	62	0	9	0	71	2	0	3	0	5	76
10:00 - 10:15	0	0	0	0	0	91	0	26	0	117	0	0	9	0	9	126
10:15 - 10:30	0	0	0	0	0	55	2	7	0	64	4	0	7	0	11	75
10:30 - 10:45	0	0	0	0	0	46	0	13	1	60	3	0	7	0	10	70
10:45 - 11:00	0	0	0	0	0	67	1	18	1	87	4	0	4	0	8	95
11:00 - 11:15	0	0	0	0	0	96	0	12	0	108	2	0	3	0	5	113
11:15 - 11:30	0	0	0	0	0	33	0	6	0	39	5	0	2	0	7	46
11:30 - 11:45	0	0	0	0	0	58	0	20	0	78	1	0	5	0	6	84
11:45 - 12:00	0	0	0	0	0	74	0	13	0	87	2	0	3	0	5	92
12:00 - 12:15	0	0	0	0	0	77	0	11	0	88	0	0	4	0	4	92
12:15 - 12:30	0	0	0	0	0	85	1	21	1	108	7	0	10	0	17	125
12:30 - 12:45	0	0	0	0	0	78	1	16	2	97	1	0	4	0	5	102
12:45 - 13:00	0	0	0	0	0	70	0	7	0	77	2	0	5	0	7	84
13:00 - 13:15	0	0	0	0	0	80	0	20	3	103	0	0	4	0	4	107
13:15 - 13:30	0	0	0	0	0	24	0	5	0	29	1	0	2	0	3	32
13:30 - 13:45	0	0	0	0	0	53	0	12	0	65	0	0	5	0	5	70
13:45 - 14:00	0	0	0	0	0	56	0	12	0	68	1	0	6	0	7	75
14:00 - 14:15	0	0	0	0	0	94	1	14	0	109	2	0	15	0	17	126
14:15 - 14:30	0	0	0	0	0	41	2	11	3	57	1	0	4	1	6	63
14:30 - 14:45	0	0	0	0	0	93	0	28	0	121	6	2	7	0	15	136
14:45 - 15:00	0	0	0	0	0	99	1	14	0	114	7	0	3	0	10	124
15:00 - 15:15	0	0	0	0	0	133	2	16	2	153	3	0	6	0	9	162
15:15 - 15:30	0	0	0	0	0	105	0	10	0	115	5	0	4	0	9	124
15:30 - 15:45	0	0	0	0	0	114	0	16	1	131	7	0	2	0	9	140
15:45 - 16:00	0	0	0	0	0	130	1	17	1	149	7	0	3	0	10	159
16:00 - 16:15	0	0	0	0	0	132	1	11	0	144	6	0	0	0	6	150
16:15 - 16:30	0	0	0	0	0	94	6	28	5	133	1	0	10	2	13	146
16:30 - 16:45	0	0	0	0	0	105	2	6	0	113	2	0	2	0	4	117
16:45 - 17:00	0	0	0	0	0	115	1	15	2	133	2	0	4	1	7	140
17:00 - 17:15	0	0	0	0	0	110	0	10	1	121	1	0	4	0	5	126
17:15 - 17:30	0	0	0	0	0	62	0	22	1	85	4	0	9	1	14	99
17:30 - 17:45	0	0	0	0	0	88	0	3	0	91	4	0	0	0	4	95
17:45 - 18:00	0	0	0	0	0	38	0	4	0	42	6	0	5	0	11	53
TOTAL	**0**	**0**	**0**	**0**	**0**	**3448**	**48**	**612**	**36**	**4144**	**165**	**3**	**243**	**6**	**417**	**4561**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R35 (NORTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT:	AURECON
SITE:	INTERSECTION OF N4 AND R35 (NORTH OF INTERCHANGE)
DATE:	12 HOUR COUNT ON TUESDAY 14 MAY 2019
UNITS:	CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	N4 OFF RAMP															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	8	0	0	0	8	0	0	0	0	0	10	0	5	0	15	23
06:15 - 06:30	17	0	0	0	17	0	0	0	0	0	16	0	3	1	20	37
06:30 - 06:45	56	1	3	1	61	0	0	0	0	0	7	0	0	0	7	68
06:45 - 07:00	98	0	10	0	108	0	0	0	0	0	7	0	6	0	13	121
07:00 - 07:15	99	0	1	0	100	0	0	0	0	0	5	0	1	0	6	106
07:15 - 07:30	58	0	17	0	75	0	0	0	0	0	4	0	3	1	8	83
07:30 - 07:45	92	0	11	0	103	0	0	0	0	0	15	0	10	0	25	128
07:45 - 08:00	80	0	11	1	92	0	0	0	0	0	8	0	4	0	12	104
08:00 - 08:15	72	0	13	0	85	0	0	0	0	0	12	0	3	0	15	100
08:15 - 08:30	72	0	11	0	83	0	0	0	0	0	7	0	10	0	17	100
08:30 - 08:45	31	0	2	0	33	0	0	0	0	0	6	0	8	0	14	47
08:45 - 09:00	58	1	9	0	68	0	0	0	0	0	5	0	11	0	16	84
09:00 - 09:15	77	0	14	0	91	0	0	0	0	0	6	0	13	0	19	110
09:15 - 09:30	52	0	2	0	54	0	0	0	0	0	8	0	9	0	17	71
09:30 - 09:45	37	0	4	0	41	0	0	0	0	0	2	0	4	0	6	47
09:45 - 10:00	84	0	16	0	100	0	0	0	0	0	9	0	4	0	13	113
10:00 - 10:15	93	0	14	0	107	0	0	0	0	0	1	0	7	0	8	115
10:15 - 10:30	60	0	9	0	69	0	0	0	0	0	6	0	9	0	15	84
10:30 - 10:45	76	0	9	0	85	0	0	0	0	0	1	0	3	0	4	89
10:45 - 11:00	54	0	1	0	55	0	0	0	0	0	5	0	8	0	13	68
11:00 - 11:15	59	0	25	0	84	0	0	0	0	0	2	0	10	0	12	96
11:15 - 11:30	50	0	6	0	56	0	0	0	0	0	6	0	9	0	15	71
11:30 - 11:45	66	0	28	0	94	0	0	0	0	0	4	0	5	0	9	103
11:45 - 12:00	39	0	8	0	47	0	0	0	0	0	3	0	5	0	8	55
12:00 - 12:15	57	0	15	0	72	0	0	0	0	0	4	0	3	0	7	79
12:15 - 12:30	57	0	16	0	73	0	0	0	0	0	2	0	8	0	10	83
12:30 - 12:45	62	0	15	0	77	0	0	0	0	0	5	1	5	0	11	88
12:45 - 13:00	43	2	4	0	49	0	0	0	0	0	2	0	4	0	6	55
13:00 - 13:15	75	1	21	0	97	0	0	0	0	0	4	0	4	0	8	105
13:15 - 13:30	19	0	4	0	23	0	0	0	0	0	3	0	2	0	5	28
13:30 - 13:45	52	0	6	0	58	0	0	0	0	0	6	0	3	0	9	67
13:45 - 14:00	48	0	14	0	62	0	0	0	0	0	3	0	5	0	8	70
14:00 - 14:15	70	1	9	0	80	0	0	0	0	0	4	0	4	0	8	88
14:15 - 14:30	53	1	22	0	76	0	0	0	0	0	3	0	1	0	4	80
14:30 - 14:45	87	0	16	0	103	0	0	0	0	0	2	0	4	0	6	109
14:45 - 15:00	37	0	8	1	46	0	0	0	0	0	0	0	3	0	3	49
15:00 - 15:15	52	1	11	0	64	0	0	0	0	0	3	0	5	0	8	72
15:15 - 15:30	114	0	7	0	121	0	0	0	0	0	1	0	5	0	6	127
15:30 - 15:45	62	1	5	0	68	0	0	0	0	0	1	0	3	0	4	72
15:45 - 16:00	114	0	9	0	123	0	0	0	0	0	4	1	9	0	14	137
16:00 - 16:15	49	0	7	0	56	0	0	0	0	0	1	0	8	1	10	66
16:15 - 16:30	100	2	14	0	116	0	0	0	0	0	3	0	1	0	4	120
16:30 - 16:45	25	0	3	0	28	0	0	0	0	0	3	0	3	0	6	34
16:45 - 17:00	50	0	4	0	54	0	0	0	0	0	6	0	5	0	11	65
17:00 - 17:15	123	2	6	1	132	0	0	0	0	0	4	0	3	0	7	139
17:15 - 17:30	118	0	5	2	125	0	0	0	0	0	1	0	5	1	7	132
17:30 - 17:45	55	0	2	0	57	0	0	0	0	0	1	0	1	0	2	59
17:45 - 18:00	12	0	5	0	17	0	0	0	0	0	1	0	1	0	2	19
TOTAL	**3022**	**13**	**452**	**6**	**3493**	**0**	**0**	**0**	**0**	**0**	**222**	**2**	**245**	**4**	**473**	**3966**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)															
DATE:	12 HOUR COUNT ON TUESDAY 14 MARCH 2019															
UNITS:	CLASSIFIED															
APPROACH FROM	NORTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	60	0	11	0	71	33	0	14	0	47	118
06:15 - 06:30	0	0	0	0	0	62	0	12	0	74	19	0	7	0	26	100
06:30 - 06:45	0	0	0	0	0	34	0	20	0	54	14	0	0	0	14	68
06:45 - 07:00	0	0	0	0	0	79	3	16	0	98	30	3	6	0	39	137
07:00 - 07:15	0	0	0	0	0	80	0	10	0	90	57	0	16	0	73	163
07:15 - 07:30	0	0	0	0	0	65	1	5	0	71	49	0	18	0	67	138
07:30 - 07:45	0	0	0	0	0	79	0	21	0	100	51	1	9	0	61	161
07:45 - 08:00	0	0	0	0	0	72	0	13	0	85	46	0	7	0	53	138
08:00 - 08:15	0	0	0	0	0	79	0	9	0	88	42	0	13	0	55	143
08:15 - 08:30	0	0	0	0	0	61	0	17	0	78	58	0	13	0	71	149
08:30 - 08:45	0	0	0	0	0	28	2	12	0	42	34	0	7	0	41	83
08:45 - 09:00	0	0	0	0	0	42	0	23	0	65	46	0	8	0	54	119
09:00 - 09:15	0	0	0	0	0	53	0	27	0	80	39	0	10	0	49	129
09:15 - 09:30	0	0	0	0	0	66	0	30	0	96	36	0	7	0	43	139
09:30 - 09:45	0	0	0	0	0	57	0	16	0	73	49	0	12	0	61	134
09:45 - 10:00	0	0	0	0	0	56	1	18	0	75	50	0	7	0	57	132
10:00 - 10:15	0	0	0	0	0	38	0	13	0	51	44	0	16	0	60	111
10:15 - 10:30	0	0	0	0	0	48	0	19	0	67	51	0	10	0	61	128
10:30 - 10:45	0	0	0	0	0	27	0	15	0	42	59	2	14	0	75	117
10:45 - 11:00	0	0	0	0	0	59	0	18	0	77	29	0	7	0	36	113
11:00 - 11:15	0	0	0	0	0	47	0	17	0	64	45	0	5	0	50	114
11:15 - 11:30	0	0	0	0	0	32	0	16	0	48	22	0	4	0	26	74
11:30 - 11:45	0	0	0	0	0	60	0	19	0	79	14	0	6	0	20	99
11:45 - 12:00	0	0	0	0	0	37	0	15	0	52	27	0	9	0	36	88
12:00 - 12:15	0	0	0	0	0	62	0	6	1	69	16	0	8	0	24	93
12:15 - 12:30	0	0	0	0	0	58	0	14	0	72	26	0	16	0	42	114
12:30 - 12:45	0	0	0	0	0	89	2	11	0	102	24	1	5	1	31	133
12:45 - 13:00	0	0	0	0	0	37	1	12	0	50	20	0	15	1	36	86
13:00 - 13:15	0	0	0	0	0	31	2	8	0	41	31	1	15	1	48	89
13:15 - 13:30	0	0	0	0	0	50	1	5	0	56	17	0	4	0	21	77
13:30 - 13:45	0	0	0	0	0	90	0	23	0	113	26	0	8	0	34	147
13:45 - 14:00	0	0	0	0	0	61	2	15	0	78	24	0	7	0	31	109
14:00 - 14:15	0	0	0	0	0	63	2	14	0	79	26	0	11	0	37	116
14:15 - 14:30	0	0	0	0	0	69	0	8	0	77	12	0	7	0	19	96
14:30 - 14:45	0	0	0	0	0	50	1	20	0	71	29	0	4	0	33	104
14:45 - 15:00	0	0	0	0	0	47	1	12	2	62	18	1	13	0	32	94
15:00 - 15:15	0	0	0	0	0	40	4	18	1	63	40	2	19	0	61	124
15:15 - 15:30	0	0	0	0	0	51	2	17	0	70	32	0	2	0	34	104
15:30 - 15:45	0	0	0	0	0	49	0	10	0	59	20	0	13	0	33	92
15:45 - 16:00	0	0	0	0	0	38	0	10	1	49	12	0	3	0	15	64
16:00 - 16:15	0	0	0	0	0	40	0	30	1	71	71	0	19	1	91	162
16:15 - 16:30	0	0	0	0	0	29	0	10	3	42	57	0	11	0	68	110
16:30 - 16:45	0	0	0	0	0	43	1	13	1	58	47	1	8	1	57	115
16:45 - 17:00	0	0	0	0	0	35	3	10	0	48	38	0	14	1	53	101
17:00 - 17:15	0	0	0	0	0	26	3	11	0	40	24	0	6	0	30	70
17:15 - 17:30	0	0	0	0	0	32	1	8	0	41	36	0	9	0	45	86
17:30 - 17:45	0	0	0	0	0	14	0	5	0	19	4	1	3	0	8	27
17:45 - 18:00	0	0	0	0	0	9	0	7	0	16	5	1	4	0	10	26
TOTAL	**0**	**0**	**0**	**0**	**0**	**2434**	**33**	**689**	**10**	**3166**	**1599**	**14**	**449**	**6**	**2068**	**5234**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MARCH 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	13	4	11	0	28	8	0	27	0	35	0	0	0	0	0	63
06:15 - 06:30	15	3	8	0	26	15	0	12	0	27	0	0	0	0	0	53
06:30 - 06:45	21	3	8	0	32	19	4	8	1	32	0	0	0	0	0	64
06:45 - 07:00	7	1	7	0	15	20	4	8	1	33	0	0	0	0	0	48
07:00 - 07:15	1	0	5	0	6	36	2	20	0	58	0	0	0	0	0	64
07:15 - 07:30	2	0	7	0	9	32	1	9	1	43	0	0	0	0	0	52
07:30 - 07:45	1	0	10	0	11	19	0	5	0	24	0	0	0	0	0	35
07:45 - 08:00	3	0	6	0	9	30	1	5	0	36	0	0	0	0	0	45
08:00 - 08:15	5	0	2	0	7	29	0	5	0	34	0	0	0	0	0	41
08:15 - 08:30	4	0	5	0	9	38	1	28	0	67	0	0	0	0	0	76
08:30 - 08:45	1	0	4	0	5	21	0	6	0	27	0	0	0	0	0	32
08:45 - 09:00	4	0	6	0	10	29	0	7	0	36	0	0	0	0	0	46
09:00 - 09:15	3	0	8	0	11	43	0	13	0	56	0	0	0	0	0	67
09:15 - 09:30	4	0	6	0	10	25	0	9	0	34	0	0	0	0	0	44
09:30 - 09:45	4	0	5	0	9	44	0	15	0	59	0	0	0	0	0	68
09:45 - 10:00	5	0	7	0	12	43	0	16	0	59	0	0	0	0	0	71
10:00 - 10:15	0	0	7	0	7	33	0	20	0	53	0	0	0	0	0	60
10:15 - 10:30	6	0	5	0	11	21	1	8	0	30	0	0	0	0	0	41
10:30 - 10:45	8	0	2	0	10	23	0	12	0	35	0	0	0	0	0	45
10:45 - 11:00	3	0	3	0	6	44	0	29	0	73	0	0	0	0	0	79
11:00 - 11:15	11	0	8	0	19	47	0	11	0	58	0	0	0	0	0	77
11:15 - 11:30	6	0	4	0	10	16	0	7	0	23	0	0	0	0	0	33
11:30 - 11:45	4	0	9	0	13	22	0	14	0	36	0	0	0	0	0	49
11:45 - 12:00	3	0	6	0	9	26	0	10	0	36	0	0	0	0	0	45
12:00 - 12:15	4	0	2	0	6	38	0	11	0	49	0	0	0	0	0	55
12:15 - 12:30	9	0	5	1	15	35	0	19	0	54	0	0	0	0	0	69
12:30 - 12:45	9	0	6	0	15	26	0	11	0	37	0	0	0	0	0	52
12:45 - 13:00	6	0	2	0	8	14	0	10	0	24	0	0	0	0	0	32
13:00 - 13:15	19	0	7	0	26	40	0	14	0	54	0	0	0	0	0	80
13:15 - 13:30	5	0	4	1	10	18	0	7	0	25	0	0	0	0	0	35
13:30 - 13:45	9	1	8	0	18	25	1	8	0	34	0	0	0	0	0	52
13:45 - 14:00	4	0	7	0	11	41	0	26	0	67	0	0	0	0	0	78
14:00 - 14:15	10	0	2	0	12	39	1	14	0	54	0	0	0	0	0	66
14:15 - 14:30	9	0	1	0	10	41	2	12	0	55	0	0	0	0	0	65
14:30 - 14:45	10	1	3	1	15	51	1	12	1	65	0	0	0	0	0	80
14:45 - 15:00	8	1	3	0	12	48	1	17	0	66	0	0	0	0	0	78
15:00 - 15:15	13	0	8	0	21	73	1	10	0	84	0	0	0	0	0	105
15:15 - 15:30	6	0	4	0	10	61	1	12	0	74	0	0	0	0	0	84
15:30 - 15:45	15	0	6	0	21	79	1	15	1	96	0	0	0	0	0	117
15:45 - 16:00	15	0	4	0	19	71	0	16	0	87	0	0	0	0	0	106
16:00 - 16:15	8	0	5	0	13	55	1	14	0	70	0	0	0	0	0	83
16:15 - 16:30	19	0	10	0	29	57	0	21	0	78	0	0	0	0	0	107
16:30 - 16:45	9	0	2	0	11	70	4	11	3	88	0	0	0	0	0	99
16:45 - 17:00	11	0	5	0	16	43	2	18	1	64	0	0	0	0	0	80
17:00 - 17:15	12	0	4	0	16	69	0	9	0	78	0	0	0	0	0	94
17:15 - 17:30	7	0	6	0	13	37	0	13	2	52	0	0	0	0	0	65
17:30 - 17:45	6	0	3	0	9	33	0	19	0	52	0	0	0	0	0	61
17:45 - 18:00	45	0	3	0	48	28	0	9	0	37	0	0	0	0	0	85
TOTAL	**402**	**14**	**259**	**3**	**678**	**1775**	**30**	**632**	**11**	**2448**	**0**	**0**	**0**	**0**	**0**	**3126**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MARCH 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	N4 OFF RAMP															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	26	0	14	0	40	0	0	0	0	0	3	0	5	0	8	48
06:15 - 06:30	36	0	13	0	49	0	0	0	0	0	3	0	1	0	4	53
06:30 - 06:45	27	0	11	0	38	0	0	0	0	0	4	0	2	0	6	44
06:45 - 07:00	14	0	5	0	19	0	0	0	0	0	4	2	4	1	11	30
07:00 - 07:15	8	0	3	0	11	0	0	0	0	0	42	0	3	1	46	57
07:15 - 07:30	3	1	1	1	6	0	0	0	0	0	30	1	1	0	32	38
07:30 - 07:45	3	0	1	0	4	0	0	0	0	0	43	0	2	0	45	49
07:45 - 08:00	8	0	5	0	13	0	0	0	0	0	31	0	2	0	33	46
08:00 - 08:15	5	0	5	0	10	0	0	0	0	0	31	1	0	0	32	42
08:15 - 08:30	4	0	6	0	10	0	0	0	0	0	46	2	2	0	50	60
08:30 - 08:45	2	0	1	0	3	0	0	0	0	0	24	0	5	0	29	32
08:45 - 09:00	3	0	3	0	6	0	0	0	0	0	24	0	0	0	24	30
09:00 - 09:15	5	0	6	0	11	0	0	0	0	0	54	0	2	0	56	67
09:15 - 09:30	2	0	3	0	5	0	0	0	0	0	44	0	5	0	49	54
09:30 - 09:45	2	0	3	0	5	0	0	0	0	0	37	0	2	0	39	44
09:45 - 10:00	2	0	4	0	6	0	0	0	0	0	28	0	2	0	30	36
10:00 - 10:15	3	0	6	0	9	0	0	0	0	0	39	0	5	0	44	53
10:15 - 10:30	2	0	0	0	2	0	0	0	0	0	28	1	4	0	33	35
10:30 - 10:45	1	0	3	0	4	0	0	0	0	0	26	1	3	0	30	34
10:45 - 11:00	1	0	4	0	5	0	0	0	0	0	26	0	3	0	29	34
11:00 - 11:15	2	0	8	0	10	0	0	0	0	0	75	0	5	0	80	90
11:15 - 11:30	1	0	5	0	6	0	0	0	0	0	21	0	0	0	21	27
11:30 - 11:45	1	0	2	0	3	0	0	0	0	0	21	0	7	0	28	31
11:45 - 12:00	2	1	6	0	9	0	0	0	0	0	43	0	3	0	46	55
12:00 - 12:15	1	0	5	0	6	0	0	0	0	0	53	0	1	0	54	60
12:15 - 12:30	0	0	11	0	11	0	0	0	0	0	41	1	6	1	49	60
12:30 - 12:45	5	0	3	0	8	0	0	0	0	0	35	0	8	1	44	52
12:45 - 13:00	4	0	5	0	9	0	0	0	0	0	24	0	0	0	24	33
13:00 - 13:15	2	1	1	1	5	0	0	0	0	0	37	0	2	2	41	46
13:15 - 13:30	1	1	0	0	2	0	0	0	0	0	2	0	1	0	3	5
13:30 - 13:45	4	0	4	0	8	0	0	0	0	0	23	0	0	0	23	31
13:45 - 14:00	1	0	1	0	2	0	0	0	0	0	24	0	2	0	26	28
14:00 - 14:15	1	0	5	0	6	0	0	0	0	0	32	0	7	0	39	45
14:15 - 14:30	3	0	6	0	9	0	0	0	0	0	38	0	8	0	46	55
14:30 - 14:45	2	1	6	0	9	0	0	0	0	0	41	0	5	0	46	55
14:45 - 15:00	3	0	8	0	11	0	0	0	0	0	63	0	6	0	69	80
15:00 - 15:15	3	1	9	1	14	0	0	0	0	0	57	0	8	0	65	79
15:15 - 15:30	1	0	2	0	3	0	0	0	0	0	30	2	7	0	39	42
15:30 - 15:45	4	0	7	0	11	0	0	0	0	0	57	0	1	0	58	69
15:45 - 16:00	3	0	2	0	5	0	0	0	0	0	19	0	4	0	23	28
16:00 - 16:15	3	0	7	0	10	0	0	0	0	0	72	0	3	0	75	85
16:15 - 16:30	4	0	11	0	15	0	0	0	0	0	34	2	8	0	44	59
16:30 - 16:45	7	0	7	0	14	0	0	0	0	0	33	0	6	0	39	53
16:45 - 17:00	6	0	13	0	19	0	0	0	0	0	71	0	2	2	75	94
17:00 - 17:15	3	0	2	0	5	0	0	0	0	0	42	1	2	0	45	50
17:15 - 17:30	1	2	9	0	12	0	0	0	0	0	29	1	1	0	31	43
17:30 - 17:45	0	0	5	0	5	0	0	0	0	0	59	0	2	0	61	66
17:45 - 18:00	0	0	2	0	2	0	0	0	0	0	17	0	0	0	17	19
TOTAL	**225**	**8**	**249**	**3**	**485**	**0**	**0**	**0**	**0**	**0**	**1660**	**15**	**158**	**8**	**1841**	**2326**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N4 AND R575 (SOUTH OF INTERCHANGE)

DATE: 12 HOUR COUNT ON TUESDAY 14 MARCH 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND R542

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	17	2	12	1	32	8	0	0	0	8	40
06:15 - 06:30	0	0	0	0	0	20	0	10	1	31	2	0	0	0	2	33
06:30 - 06:45	0	0	0	0	0	11	0	11	0	22	6	0	0	0	6	28
06:45 - 07:00	0	0	0	0	0	22	3	13	0	38	7	1	5	0	13	51
07:00 - 07:15	0	0	0	0	0	20	0	5	1	26	3	0	0	0	3	29
07:15 - 07:30	0	0	0	0	0	23	0	8	0	31	2	0	12	0	14	45
07:30 - 07:45	0	0	0	0	0	12	0	7	0	19	2	0	3	0	5	24
07:45 - 08:00	0	0	0	0	0	27	0	8	0	35	3	0	2	0	5	40
08:00 - 08:15	0	0	0	0	0	15	0	11	1	27	4	0	6	0	10	37
08:15 - 08:30	0	0	0	0	0	22	0	17	0	39	1	0	6	0	7	46
08:30 - 08:45	0	0	0	0	0	19	1	13	0	33	5	0	1	0	6	39
08:45 - 09:00	0	0	0	0	0	17	0	16	0	33	2	0	2	0	4	37
09:00 - 09:15	0	0	0	0	0	24	0	5	0	29	5	0	4	0	9	38
09:15 - 09:30	0	0	0	0	0	10	0	14	0	24	3	0	6	0	9	33
09:30 - 09:45	0	0	0	0	0	24	1	15	0	40	5	0	2	0	7	47
09:45 - 10:00	0	0	0	0	0	10	0	3	0	13	2	0	3	0	5	18
10:00 - 10:15	0	0	0	0	0	18	0	15	0	33	4	0	4	0	8	41
10:15 - 10:30	0	0	0	0	0	13	0	2	0	15	2	0	0	0	2	17
10:30 - 10:45	0	0	0	0	0	21	0	4	0	25	9	0	1	0	10	35
10:45 - 11:00	0	0	0	0	0	16	0	5	0	21	1	0	2	0	3	24
11:00 - 11:15	0	0	0	0	0	20	0	8	0	28	1	0	0	0	1	29
11:15 - 11:30	0	0	0	0	0	24	0	3	0	27	4	0	2	0	6	33
11:30 - 11:45	0	0	0	0	0	11	0	5	0	16	2	0	3	0	5	21
11:45 - 12:00	0	0	0	0	0	34	0	10	2	46	0	0	6	0	6	52
12:00 - 12:15	0	0	0	0	0	29	0	9	0	38	1	0	6	0	7	45
12:15 - 12:30	0	0	0	0	0	14	0	3	0	17	2	0	1	0	3	20
12:30 - 12:45	0	0	0	0	0	40	2	17	0	59	3	0	0	0	3	62
12:45 - 13:00	0	0	0	0	0	18	0	11	0	29	5	0	0	0	5	34
13:00 - 13:15	0	0	0	0	0	6	1	2	0	9	4	0	1	0	5	14
13:15 - 13:30	0	0	0	0	0	26	0	8	0	34	2	0	0	0	2	36
13:30 - 13:45	0	0	0	0	0	15	1	9	0	25	0	0	1	0	1	26
13:45 - 14:00	0	0	0	0	0	23	0	5	0	28	1	0	1	0	2	30
14:00 - 14:15	0	0	0	0	0	20	0	6	1	27	0	0	0	0	0	27
14:15 - 14:30	0	0	0	0	0	17	0	6	0	23	1	0	2	0	3	26
14:30 - 14:45	0	0	0	0	0	24	0	6	1	31	2	0	3	0	5	36
14:45 - 15:00	0	0	0	0	0	20	0	4	0	24	1	0	3	0	4	28
15:00 - 15:15	0	0	0	0	0	25	1	6	0	32	2	0	3	0	5	37
15:15 - 15:30	0	0	0	0	0	14	0	7	1	22	3	0	6	0	9	31
15:30 - 15:45	0	0	0	0	0	14	0	7	0	21	1	0	1	0	2	23
15:45 - 16:00	0	0	0	0	0	9	0	5	1	15	0	0	2	0	2	17
16:00 - 16:15	0	0	0	0	0	17	1	7	0	25	1	0	2	0	3	28
16:15 - 16:30	0	0	0	0	0	32	0	10	1	43	3	0	1	0	4	47
16:30 - 16:45	0	0	0	0	0	42	0	8	2	52	2	1	3	0	6	58
16:45 - 17:00	0	0	0	0	0	8	0	4	0	12	1	0	1	0	2	14
17:00 - 17:15	0	0	0	0	0	26	0	13	0	39	3	0	2	0	5	44
17:15 - 17:30	0	0	0	0	0	25	0	11	0	36	2	0	1	0	3	39
17:30 - 17:45	0	0	0	0	0	22	0	8	0	30	1	0	1	0	2	32
17:45 - 18:00	0	0	0	0	0	19	0	11	0	30	2	0	1	0	3	33
TOTAL	**0**	**0**	**0**	**0**	**0**	**955**	**13**	**403**	**13**	**1384**	**126**	**2**	**112**	**0**	**240**	**1624**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND R542

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	21	0	3	0	24	11	0	9	0	20	0	0	0	0	0	44
06:15 - 06:30	9	6	10	2	27	16	4	5	1	26	0	0	0	0	0	53
06:30 - 06:45	9	0	18	0	27	32	4	8	4	48	0	0	0	0	0	75
06:45 - 07:00	3	1	4	0	8	11	0	6	1	18	0	0	0	0	0	26
07:00 - 07:15	6	0	10	1	17	12	0	10	0	22	0	0	0	0	0	39
07:15 - 07:30	9	0	8	0	17	24	0	4	0	28	0	0	0	0	0	45
07:30 - 07:45	3	0	13	1	17	21	0	8	0	29	0	0	0	0	0	46
07:45 - 08:00	7	0	17	0	24	18	0	7	0	25	0	0	0	0	0	49
08:00 - 08:15	12	0	0	0	12	17	0	6	0	23	0	0	0	0	0	35
08:15 - 08:30	6	0	38	0	44	14	0	9	0	23	0	0	0	0	0	67
08:30 - 08:45	4	0	10	0	14	20	0	13	0	33	0	0	0	0	0	47
08:45 - 09:00	9	0	17	0	26	16	0	13	0	29	0	0	0	0	0	55
09:00 - 09:15	5	0	14	0	19	15	0	13	0	28	0	0	0	0	0	47
09:15 - 09:30	4	0	16	0	20	12	0	6	0	18	0	0	0	0	0	38
09:30 - 09:45	14	1	12	0	27	29	0	12	2	43	0	0	0	0	0	70
09:45 - 10:00	7	0	8	0	15	10	0	1	1	12	0	0	0	0	0	27
10:00 - 10:15	8	0	13	0	21	15	0	12	0	27	0	0	0	0	0	48
10:15 - 10:30	8	0	11	0	19	12	0	9	0	21	0	0	0	0	0	40
10:30 - 10:45	6	0	14	0	20	15	0	14	0	29	0	0	0	0	0	49
10:45 - 11:00	4	0	6	0	10	10	0	7	0	17	0	0	0	0	0	27
11:00 - 11:15	8	0	13	0	21	16	0	15	0	31	0	0	0	0	0	52
11:15 - 11:30	11	0	15	0	26	17	0	19	0	36	0	0	0	0	0	62
11:30 - 11:45	7	0	19	0	26	10	0	5	0	15	0	0	0	0	0	41
11:45 - 12:00	7	0	9	0	16	17	0	14	0	31	0	0	0	0	0	47
12:00 - 12:15	6	0	13	0	19	23	0	14	0	37	0	0	0	0	0	56
12:15 - 12:30	3	0	10	0	13	21	0	7	0	28	0	0	0	0	0	41
12:30 - 12:45	10	0	25	0	35	24	1	10	1	36	0	0	0	0	0	71
12:45 - 13:00	5	0	18	0	23	17	0	17	0	34	0	0	0	0	0	57
13:00 - 13:15	8	0	4	0	12	11	0	9	0	20	0	0	0	0	0	32
13:15 - 13:30	12	1	21	0	34	25	1	13	0	39	0	0	0	0	0	73
13:30 - 13:45	7	0	4	0	11	8	0	4	0	12	0	0	0	0	0	23
13:45 - 14:00	6	0	12	0	18	19	0	19	0	38	0	0	0	0	0	56
14:00 - 14:15	9	0	19	0	28	7	0	8	0	15	0	0	0	0	0	43
14:15 - 14:30	8	0	12	0	20	31	0	6	0	37	0	0	0	0	0	57
14:30 - 14:45	10	0	21	0	31	5	1	5	0	11	0	0	0	0	0	42
14:45 - 15:00	10	0	13	0	23	37	0	13	0	50	0	0	0	0	0	73
15:00 - 15:15	10	0	13	0	23	29	0	10	2	41	0	0	0	0	0	64
15:15 - 15:30	9	2	15	0	26	43	1	7	1	52	0	0	0	0	0	78
15:30 - 15:45	25	0	17	0	42	24	0	14	0	38	0	0	0	0	0	80
15:45 - 16:00	5	0	10	0	15	34	2	8	0	44	0	0	0	0	0	59
16:00 - 16:15	19	0	10	0	29	38	0	8	0	46	0	0	0	0	0	75
16:15 - 16:30	20	1	12	0	33	37	0	13	0	50	0	0	0	0	0	83
16:30 - 16:45	23	0	20	1	44	17	0	19	0	36	0	0	0	0	0	80
16:45 - 17:00	6	0	9	0	15	30	0	7	0	37	0	0	0	0	0	52
17:00 - 17:15	25	1	16	0	42	22	0	10	0	32	0	0	0	0	0	74
17:15 - 17:30	15	0	23	0	38	0	0	7	0	7	0	0	0	0	0	45
17:30 - 17:45	11	0	9	0	20	26	0	13	0	39	0	0	0	0	0	59
17:45 - 18:00	8	0	8	0	16	8	0	8	0	16	0	0	0	0	0	32
TOTAL	**457**	**13**	**632**	**5**	**1107**	**926**	**14**	**474**	**13**	**1427**	**0**	**0**	**0**	**0**	**0**	**2534**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND R542

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
EST. 24 HR	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND R542

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	R 542															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	1	0	0	1	2	0	0	0	0	0	13	0	8	0	21	23
06:15 - 06:30	1	2	0	0	3	0	0	0	0	0	12	0	18	0	30	33
06:30 - 06:45	3	0	0	0	3	0	0	0	0	0	14	1	14	0	29	32
06:45 - 07:00	2	1	3	0	6	0	0	0	0	0	8	1	8	0	17	23
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	7	0	8	0	15	15
07:15 - 07:30	0	0	1	0	1	0	0	0	0	0	12	0	22	0	34	35
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	13	0	12	0	25	25
07:45 - 08:00	1	0	0	0	1	0	0	0	0	0	7	0	16	0	23	24
08:00 - 08:15	3	0	5	0	8	0	0	0	0	0	5	0	7	0	12	20
08:15 - 08:30	1	0	0	0	1	0	0	0	0	0	2	0	24	0	26	27
08:30 - 08:45	1	0	3	0	4	0	0	0	0	0	11	0	25	0	36	40
08:45 - 09:00	0	0	3	0	3	0	0	0	0	0	5	0	25	0	30	33
09:00 - 09:15	1	0	6	0	7	0	0	0	0	0	9	0	11	0	20	27
09:15 - 09:30	1	0	0	0	1	0	0	0	0	0	12	0	22	0	34	35
09:30 - 09:45	2	0	4	0	6	0	0	0	0	0	11	0	17	0	28	34
09:45 - 10:00	3	0	0	0	3	0	0	0	0	0	1	0	11	0	12	15
10:00 - 10:15	2	0	1	0	3	0	0	0	0	0	8	0	11	0	19	22
10:15 - 10:30	1	0	1	0	2	0	0	0	0	0	7	0	16	0	23	25
10:30 - 10:45	1	0	1	0	2	0	0	0	0	0	14	0	18	0	32	34
10:45 - 11:00	2	0	2	0	4	0	0	0	0	0	5	0	4	0	9	13
11:00 - 11:15	3	0	1	0	4	0	0	0	0	0	6	2	15	0	23	27
11:15 - 11:30	2	0	0	0	2	0	0	0	0	0	11	0	7	0	18	20
11:30 - 11:45	0	0	1	0	1	0	0	0	0	0	8	0	11	0	19	20
11:45 - 12:00	2	0	1	0	3	0	0	0	0	0	15	0	15	0	30	33
12:00 - 12:15	2	0	3	0	5	0	0	0	0	0	6	0	24	0	30	35
12:15 - 12:30	1	0	2	0	3	0	0	0	0	0	11	1	12	0	24	27
12:30 - 12:45	5	0	0	0	5	0	0	0	0	0	3	1	17	0	21	26
12:45 - 13:00	5	0	1	0	6	0	0	0	0	0	0	0	17	0	17	23
13:00 - 13:15	1	0	0	0	1	0	0	0	0	0	16	1	6	0	23	24
13:15 - 13:30	3	0	1	0	4	0	0	0	0	0	6	0	20	0	26	30
13:30 - 13:45	3	0	0	0	3	0	0	0	0	0	5	0	7	0	12	15
13:45 - 14:00	1	0	1	0	2	0	0	0	0	0	17	1	9	0	27	29
14:00 - 14:15	4	0	2	0	6	0	0	0	0	0	11	0	16	0	27	33
14:15 - 14:30	0	1	1	0	2	0	0	0	0	0	9	0	10	0	19	21
14:30 - 14:45	7	0	5	0	12	0	0	0	0	0	4	0	17	1	22	34
14:45 - 15:00	3	0	3	0	6	0	0	0	0	0	3	0	7	1	11	17
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	6	0	10	1	17	17
15:15 - 15:30	0	1	2	0	3	0	0	0	0	0	9	0	3	0	12	15
15:30 - 15:45	4	0	0	0	4	0	0	0	0	0	1	0	7	0	8	12
15:45 - 16:00	3	0	1	0	4	0	0	0	0	0	7	0	14	0	21	25
16:00 - 16:15	8	0	3	0	11	0	0	0	0	0	10	0	15	0	25	36
16:15 - 16:30	6	0	1	0	7	0	0	0	0	0	11	2	16	0	29	36
16:30 - 16:45	9	0	4	0	13	0	0	0	0	0	6	0	15	0	21	34
16:45 - 17:00	2	0	1	0	3	0	0	0	0	0	4	0	6	0	10	13
17:00 - 17:15	2	0	5	0	7	0	0	0	0	0	5	0	11	0	16	23
17:15 - 17:30	1	0	3	0	4	0	0	0	0	0	7	0	9	0	16	20
17:30 - 17:45	2	0	3	0	5	0	0	0	0	0	5	0	8	0	13	18
17:45 - 18:00	0	0	3	0	3	0	0	0	0	0	6	0	9	0	15	18
TOTAL	**105**	**5**	**78**	**1**	**189**	**0**	**0**	**0**	**0**	**0**	**384**	**10**	**630**	**3**	**1027**	**1216**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R542 AND GOEDEHOOP MINE ACCESS

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	GOEDEHOOP MINE ACCESS															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	5	0	0	0	5	0	0	0	0	0	7	0	0	0	7	12
06:45 - 07:00	2	0	0	0	2	0	0	0	0	0	3	0	0	0	3	5
07:00 - 07:15	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	2
07:15 - 07:30	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
07:30 - 07:45	1	0	0	0	1	0	0	0	0	0	4	0	0	0	4	5
07:45 - 08:00	3	0	0	0	3	0	0	0	0	0	4	0	1	0	5	8
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
08:15 - 08:30	3	0	0	0	3	0	0	0	0	0	4	0	0	0	4	7
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5	5
08:45 - 09:00	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	2
09:00 - 09:15	2	0	1	0	3	0	0	0	0	0	2	0	0	0	2	5
09:15 - 09:30	2	0	2	0	4	0	0	0	0	0	4	0	0	0	4	8
09:30 - 09:45	0	0	1	0	1	0	0	0	0	0	2	0	0	0	2	3
09:45 - 10:00	2	0	0	0	2	0	0	0	0	0	3	0	1	0	4	6
10:00 - 10:15	1	0	0	0	1	0	0	0	0	0	6	0	0	0	6	7
10:15 - 10:30	3	0	1	0	4	0	0	0	0	0	3	0	0	0	3	7
10:30 - 10:45	4	0	1	0	5	0	0	0	0	0	1	0	0	0	1	6
10:45 - 11:00	1	0	0	0	1	0	0	0	0	0	2	0	0	0	2	3
11:00 - 11:15	2	0	0	0	2	0	0	0	0	0	1	0	0	0	1	3
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	3
11:30 - 11:45	4	0	0	0	4	0	0	0	0	0	0	0	2	0	2	6
11:45 - 12:00	3	0	0	0	3	0	0	0	0	0	2	0	1	0	3	6
12:00 - 12:15	4	0	1	0	5	0	0	0	0	0	0	0	0	0	0	5
12:15 - 12:30	1	0	0	0	1	0	0	0	0	0	5	0	3	0	8	9
12:30 - 12:45	4	0	0	0	4	0	0	0	0	0	3	0	1	0	4	8
12:45 - 13:00	1	0	0	0	1	0	0	0	0	0	3	0	2	0	5	6
13:00 - 13:15	2	0	0	0	2	0	0	0	0	0	5	0	1	0	6	8
13:15 - 13:30	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
13:30 - 13:45	1	0	0	0	1	0	0	0	0	0	2	2	1	0	5	6
13:45 - 14:00	3	0	1	0	4	0	0	0	0	0	3	0	0	0	3	7
14:00 - 14:15	2	0	0	0	2	0	0	0	0	0	4	0	1	0	5	7
14:15 - 14:30	3	0	0	0	3	0	0	0	0	0	5	0	0	0	5	8
14:30 - 14:45	3	0	1	0	4	0	0	0	0	0	3	1	0	0	4	8
14:45 - 15:00	3	0	1	0	4	0	0	0	0	0	1	1	2	0	4	8
15:00 - 15:15	9	1	0	0	10	0	0	0	0	0	33	1	0	0	34	44
15:15 - 15:30	3	0	0	0	3	0	0	0	0	0	13	0	0	0	13	16
15:30 - 15:45	2	0	0	0	2	0	0	0	0	0	4	1	1	0	6	8
15:45 - 16:00	1	0	2	0	3	0	0	0	0	0	8	0	1	0	9	12
16:00 - 16:15	3	0	0	0	3	0	0	0	0	0	10	0	0	0	10	13
16:15 - 16:30	2	0	0	0	2	0	0	0	0	0	1	1	0	0	2	4
16:30 - 16:45	5	0	0	0	5	0	0	0	0	0	4	0	0	0	4	9
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2
17:00 - 17:15	1	0	0	0	1	0	0	0	0	0	2	0	0	0	2	3
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**98**	**1**	**12**	**0**	**111**	**0**	**0**	**0**	**0**	**0**	**170**	**7**	**18**	**0**	**195**	**306**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R542 AND GOEDEHOOP MINE ACCESS

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R542 AND GOEDEHOOP MINE ACCESS

DATE: 12 HOUR COUNT ON THURSDAY 16 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	R 542															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	13	0	1	2	16	2	1	0	0	3	19
06:15 - 06:30	0	0	0	0	0	10	1	4	0	15	1	0	0	0	1	16
06:30 - 06:45	0	0	0	0	0	17	0	8	2	27	0	0	0	0	0	27
06:45 - 07:00	0	0	0	0	0	14	4	8	1	27	4	0	0	0	4	31
07:00 - 07:15	0	0	0	0	0	15	0	14	1	30	3	1	0	0	4	34
07:15 - 07:30	0	0	0	0	0	3	2	9	0	14	3	1	1	0	5	19
07:30 - 07:45	0	0	0	0	0	9	0	9	0	18	0	0	0	0	0	18
07:45 - 08:00	0	0	0	0	0	7	0	16	0	23	2	0	0	0	2	25
08:00 - 08:15	0	0	0	0	0	9	0	17	0	26	0	0	0	0	0	26
08:15 - 08:30	0	0	0	0	0	13	0	19	0	32	1	0	1	0	2	34
08:30 - 08:45	0	0	0	0	0	17	0	20	0	37	4	0	0	0	4	41
08:45 - 09:00	0	0	0	0	0	9	0	15	2	26	2	0	0	0	2	28
09:00 - 09:15	0	0	0	0	0	8	0	15	0	23	3	0	0	0	3	26
09:15 - 09:30	0	0	0	0	0	19	0	18	0	37	3	0	0	0	3	40
09:30 - 09:45	0	0	0	0	0	9	0	9	0	18	3	0	0	0	3	21
09:45 - 10:00	0	0	0	0	0	9	1	10	0	20	4	0	0	0	4	24
10:00 - 10:15	0	0	0	0	0	21	0	13	1	35	0	0	0	0	0	35
10:15 - 10:30	0	0	0	0	0	11	0	13	1	25	4	0	0	0	4	29
10:30 - 10:45	0	0	0	0	0	14	1	13	1	29	6	0	2	0	8	37
10:45 - 11:00	0	0	0	0	0	5	0	7	0	12	1	0	0	0	1	13
11:00 - 11:15	0	0	0	0	0	8	1	11	0	20	3	0	1	0	4	24
11:15 - 11:30	0	0	0	0	0	13	0	14	0	27	1	0	0	0	1	28
11:30 - 11:45	0	0	0	0	0	17	0	20	0	37	1	0	1	0	2	39
11:45 - 12:00	0	0	0	0	0	8	0	20	0	28	3	0	0	0	3	31
12:00 - 12:15	0	0	0	0	0	10	0	7	0	17	4	0	0	0	4	21
12:15 - 12:30	0	0	0	0	0	8	0	14	0	22	5	0	1	0	6	28
12:30 - 12:45	0	0	0	0	0	18	0	15	1	34	3	0	0	0	3	37
12:45 - 13:00	0	0	0	0	0	2	0	1	0	3	0	0	0	0	0	3
13:00 - 13:15	0	0	0	0	0	16	0	12	0	28	5	0	1	0	6	34
13:15 - 13:30	0	0	0	0	0	18	0	13	0	31	3	0	0	0	3	34
13:30 - 13:45	0	0	0	0	0	11	0	7	0	18	3	0	0	0	3	21
13:45 - 14:00	0	0	0	0	0	12	1	11	0	24	4	0	0	0	4	28
14:00 - 14:15	0	0	0	0	0	12	1	14	0	27	1	0	0	0	1	28
14:15 - 14:30	0	0	0	0	0	7	0	8	0	15	0	0	0	0	0	15
14:30 - 14:45	0	0	0	0	0	12	1	19	0	32	0	0	0	0	0	32
14:45 - 15:00	0	0	0	0	0	18	0	16	0	34	2	0	0	0	2	36
15:00 - 15:15	0	0	0	0	0	14	0	10	0	24	0	0	0	0	0	24
15:15 - 15:30	0	0	0	0	0	11	4	14	1	30	0	0	0	0	0	30
15:30 - 15:45	0	0	0	0	0	15	2	13	2	32	0	0	0	0	0	32
15:45 - 16:00	0	0	0	0	0	17	0	16	0	33	1	0	0	0	1	34
16:00 - 16:15	0	0	0	0	0	17	0	11	0	28	1	0	0	0	1	29
16:15 - 16:30	0	0	0	0	0	19	1	12	0	32	0	0	0	0	0	32
16:30 - 16:45	0	0	0	0	0	34	0	16	1	51	2	0	0	0	2	53
16:45 - 17:00	0	0	0	0	0	31	2	10	0	43	0	0	0	0	0	43
17:00 - 17:15	0	0	0	0	0	8	0	15	0	23	0	0	0	0	0	23
17:15 - 17:30	0	0	0	0	0	17	0	10	0	27	0	0	1	0	1	28
17:30 - 17:45	0	0	0	0	0	8	0	5	0	13	0	0	0	0	0	13
17:45 - 18:00	0	0	0	0	0	6	0	9	0	15	0	0	0	0	0	15
TOTAL	**0**	**0**	**0**	**0**	**0**	**619**	**22**	**581**	**16**	**1238**	**88**	**3**	**9**	**0**	**100**	**1338**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF R542 AND GOEDEHOOP MINE ACCESS															
DATE:	12 HOUR COUNT ON THURSDAY 16 MAY 2019															
UNITS:	CLASSIFIED															

APPROACH FROM	WEST															TOTAL
NAME	R 542															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	3	0	0	0	3	18	0	14	1	33	0	0	0	0	0	36
06:15 - 06:30	4	0	0	0	4	11	1	6	0	18	0	0	0	0	0	22
06:30 - 06:45	1	0	0	0	1	16	2	9	0	27	0	0	0	0	0	28
06:45 - 07:00	8	1	0	0	9	15	1	9	0	25	0	0	0	0	0	34
07:00 - 07:15	9	0	0	0	9	16	1	8	0	25	0	0	0	0	0	34
07:15 - 07:30	10	0	0	0	10	9	0	11	0	20	0	0	0	0	0	30
07:30 - 07:45	1	0	0	0	1	16	0	11	0	27	0	0	0	0	0	28
07:45 - 08:00	2	0	0	0	2	14	0	12	0	26	0	0	0	0	0	28
08:00 - 08:15	3	0	0	0	3	7	0	15	0	22	0	0	0	0	0	25
08:15 - 08:30	6	0	0	0	6	7	0	15	0	22	0	0	0	0	0	28
08:30 - 08:45	2	0	0	1	3	18	1	20	0	39	0	0	0	0	0	42
08:45 - 09:00	5	0	0	0	5	3	0	16	0	19	0	0	0	0	0	24
09:00 - 09:15	11	0	0	0	11	17	0	20	0	37	0	0	0	0	0	48
09:15 - 09:30	3	0	0	1	4	13	0	21	0	34	0	0	0	0	0	38
09:30 - 09:45	3	0	0	0	3	9	0	11	0	20	0	0	0	0	0	23
09:45 - 10:00	2	0	3	0	5	12	0	15	0	27	0	0	0	0	0	32
10:00 - 10:15	3	0	0	0	3	19	0	17	0	36	0	0	0	0	0	39
10:15 - 10:30	7	0	0	0	7	12	0	18	0	30	0	0	0	0	0	37
10:30 - 10:45	1	0	0	0	1	10	1	8	0	19	0	0	0	0	0	20
10:45 - 11:00	1	0	3	0	4	9	1	18	0	28	0	0	0	0	0	32
11:00 - 11:15	0	0	1	0	1	16	1	7	0	24	0	0	0	0	0	25
11:15 - 11:30	0	0	0	0	0	13	0	7	0	20	0	0	0	0	0	20
11:30 - 11:45	6	0	1	0	7	8	0	18	0	26	0	0	0	0	0	33
11:45 - 12:00	4	0	0	0	4	7	1	15	0	23	0	0	0	0	0	27
12:00 - 12:15	4	0	0	0	4	7	1	14	0	22	0	0	0	0	0	26
12:15 - 12:30	3	0	0	0	3	14	1	20	0	35	0	0	0	0	0	38
12:30 - 12:45	13	1	1	0	15	12	1	11	0	24	0	0	0	0	0	39
12:45 - 13:00	6	0	1	0	7	7	1	11	0	19	0	0	0	0	0	26
13:00 - 13:15	5	0	1	0	6	16	2	16	0	34	0	0	0	0	0	40
13:15 - 13:30	2	1	1	1	5	11	0	12	1	24	0	0	0	0	0	29
13:30 - 13:45	3	1	0	0	4	8	1	9	0	18	0	0	0	0	0	22
13:45 - 14:00	2	0	1	1	4	12	2	14	0	28	0	0	0	0	0	32
14:00 - 14:15	1	0	0	0	1	22	0	9	0	31	0	0	0	0	0	32
14:15 - 14:30	4	1	1	0	6	8	0	10	0	18	0	0	0	0	0	24
14:30 - 14:45	1	0	0	0	1	10	2	11	3	26	0	0	0	0	0	27
14:45 - 15:00	0	0	0	0	0	12	2	12	1	27	0	0	0	0	0	27
15:00 - 15:15	2	0	0	0	2	17	1	6	1	25	0	0	0	0	0	27
15:15 - 15:30	0	0	0	0	0	17	0	5	3	25	0	0	0	0	0	25
15:30 - 15:45	0	0	0	0	0	15	2	11	0	28	0	0	0	0	0	28
15:45 - 16:00	0	0	0	0	0	22	0	14	3	39	0	0	0	0	0	39
16:00 - 16:15	0	0	0	0	0	12	1	15	3	31	0	0	0	0	0	31
16:15 - 16:30	0	0	0	0	0	13	3	15	2	33	0	0	0	0	0	33
16:30 - 16:45	0	0	0	0	0	26	3	14	0	43	0	0	0	0	0	43
16:45 - 17:00	0	0	0	0	0	12	0	11	0	23	0	0	0	0	0	23
17:00 - 17:15	0	0	0	0	0	6	1	6	0	13	0	0	0	0	0	13
17:15 - 17:30	0	0	0	0	0	1	1	3	1	6	0	0	0	0	0	6
17:30 - 17:45	4	0	1	0	5	2	0	3	0	5	0	0	0	0	0	10
17:45 - 18:00	0	0	0	0	0	1	0	3	0	4	0	0	0	0	0	4
TOTAL	**145**	**5**	**15**	**4**	**169**	**578**	**35**	**576**	**19**	**1208**	**0**	**0**	**0**	**0**	**0**	**1377**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND UNNAMED ROAD

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	9	1	6	1	17	0	0	0	0	0	17
06:15 - 06:30	0	0	0	0	0	14	1	5	0	20	0	0	0	0	0	20
06:30 - 06:45	0	0	0	0	0	19	1	4	0	24	0	0	0	0	0	24
06:45 - 07:00	0	0	0	0	0	16	0	3	0	19	0	0	0	0	0	19
07:00 - 07:15	0	0	0	0	0	12	0	6	0	18	0	0	0	0	0	18
07:15 - 07:30	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2
07:30 - 07:45	0	0	0	0	0	10	0	1	0	11	0	0	0	0	0	11
07:45 - 08:00	0	0	0	0	0	11	1	0	0	12	0	0	0	0	0	12
08:00 - 08:15	0	0	0	0	0	14	0	9	0	23	0	0	0	0	0	23
08:15 - 08:30	0	0	0	0	0	23	0	12	0	35	0	0	0	0	0	35
08:30 - 08:45	0	0	0	0	0	20	0	14	0	34	0	0	0	0	0	34
08:45 - 09:00	0	0	0	0	0	22	0	12	0	34	0	0	0	0	0	34
09:00 - 09:15	0	0	0	0	0	11	0	10	0	21	1	0	0	0	1	22
09:15 - 09:30	0	0	0	0	0	12	0	14	0	26	0	0	0	0	0	26
09:30 - 09:45	0	0	0	0	0	26	0	16	0	42	0	0	0	0	0	42
09:45 - 10:00	0	0	0	0	0	10	0	9	0	19	0	0	0	0	0	19
10:00 - 10:15	0	0	0	0	0	25	0	22	0	47	0	0	0	0	0	47
10:15 - 10:30	0	0	0	0	0	10	0	6	0	16	0	0	0	0	0	16
10:30 - 10:45	0	0	0	0	0	13	0	20	0	33	0	0	0	0	0	33
10:45 - 11:00	0	0	0	0	0	5	0	3	0	8	0	0	0	0	0	8
11:00 - 11:15	0	0	0	0	0	11	1	8	0	20	0	0	0	0	0	20
11:15 - 11:30	0	0	0	0	0	11	0	7	0	18	0	0	0	0	0	18
11:30 - 11:45	0	0	0	0	0	10	0	4	0	14	0	0	0	0	0	14
11:45 - 12:00	0	0	0	0	0	8	0	6	0	14	1	0	0	0	1	15
12:00 - 12:15	0	0	0	0	0	4	0	8	0	12	0	0	0	0	0	12
12:15 - 12:30	0	0	0	0	0	9	0	10	0	19	0	0	0	0	0	19
12:30 - 12:45	0	0	0	0	0	10	0	7	0	17	0	0	0	0	0	17
12:45 - 13:00	0	0	0	0	0	15	0	7	0	22	0	0	0	0	0	22
13:00 - 13:15	0	0	0	0	0	10	0	4	0	14	0	0	0	0	0	14
13:15 - 13:30	0	0	0	0	0	8	0	5	0	13	0	0	0	0	0	13
13:30 - 13:45	0	0	0	0	0	10	1	4	0	15	0	0	0	0	0	15
13:45 - 14:00	0	0	0	0	0	13	0	8	0	21	0	0	0	0	0	21
14:00 - 14:15	0	0	0	0	0	5	1	10	0	16	0	0	0	0	0	16
14:15 - 14:30	0	0	0	0	0	9	0	8	0	17	0	0	0	0	0	17
14:30 - 14:45	0	0	0	0	0	12	0	12	0	24	0	0	0	0	0	24
14:45 - 15:00	0	0	0	0	0	11	0	13	1	25	0	0	0	0	0	25
15:00 - 15:15	0	0	0	0	0	17	0	10	0	27	0	0	0	0	0	27
15:15 - 15:30	0	0	0	0	0	16	0	7	0	23	0	0	0	0	0	23
15:30 - 15:45	0	0	0	0	0	16	0	9	0	25	0	0	0	0	0	25
15:45 - 16:00	0	0	0	0	0	17	0	11	0	28	0	0	0	0	0	28
16:00 - 16:15	0	0	0	0	0	17	0	7	0	24	0	0	0	0	0	24
16:15 - 16:30	0	0	0	0	0	15	1	19	0	35	0	0	0	0	0	35
16:30 - 16:45	0	0	0	0	0	5	1	6	1	13	0	0	0	0	0	13
16:45 - 17:00	0	0	0	0	0	10	0	9	0	19	0	0	0	0	0	19
17:00 - 17:15	0	0	0	0	0	4	0	9	0	13	0	0	0	0	0	13
17:15 - 17:30	0	0	0	0	0	4	1	8	0	13	0	0	0	0	0	13
17:30 - 17:45	0	0	0	0	0	5	0	7	0	12	0	0	0	0	0	12
17:45 - 18:00	0	0	0	0	0	4	0	7	0	11	0	0	0	0	0	11
TOTAL	**0**	**0**	**0**	**0**	**0**	**570**	**10**	**402**	**3**	**985**	**2**	**0**	**0**	**0**	**2**	**987**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND UNNAMED ROAD

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	5	2	10	0	17	0	0	0	0	0	17
06:15 - 06:30	0	0	0	0	0	12	0	7	0	19	0	0	0	0	0	19
06:30 - 06:45	0	0	0	0	0	14	0	8	1	23	0	0	0	0	0	23
06:45 - 07:00	0	0	0	0	0	10	0	6	0	16	0	0	0	0	0	16
07:00 - 07:15	0	0	0	0	0	15	0	4	0	19	0	0	0	0	0	19
07:15 - 07:30	0	0	0	0	0	12	1	9	0	22	0	0	0	0	0	22
07:30 - 07:45	0	0	0	0	0	4	0	1	0	5	0	0	0	0	0	5
07:45 - 08:00	0	0	0	0	0	15	0	16	0	31	0	0	0	0	0	31
08:00 - 08:15	0	0	0	0	0	18	1	25	0	44	0	0	0	0	0	44
08:15 - 08:30	0	0	0	0	0	14	0	11	0	25	0	0	0	0	0	25
08:30 - 08:45	0	0	0	0	0	10	0	8	0	18	0	0	0	0	0	18
08:45 - 09:00	0	0	0	0	0	12	0	8	0	20	0	0	0	0	0	20
09:00 - 09:15	0	0	0	0	0	14	0	5	0	19	0	0	0	0	0	19
09:15 - 09:30	0	0	0	0	0	6	0	3	1	10	0	0	0	0	0	10
09:30 - 09:45	0	0	0	0	0	15	0	5	0	20	0	0	0	0	0	20
09:45 - 10:00	0	0	0	0	0	9	0	6	0	15	0	0	0	0	0	15
10:00 - 10:15	1	0	0	0	1	14	1	9	0	24	0	0	0	0	0	25
10:15 - 10:30	0	0	0	0	0	7	0	9	0	16	0	0	0	0	0	16
10:30 - 10:45	0	0	0	0	0	8	0	7	0	15	0	0	0	0	0	15
10:45 - 11:00	0	0	0	0	0	8	0	10	0	18	0	0	0	0	0	18
11:00 - 11:15	0	0	0	0	0	12	0	8	0	20	0	0	0	0	0	20
11:15 - 11:30	0	0	0	0	0	11	0	8	0	19	0	0	0	0	0	19
11:30 - 11:45	0	0	0	0	0	4	0	6	0	10	0	0	0	0	0	10
11:45 - 12:00	0	0	0	0	0	8	0	11	0	19	0	0	0	0	0	19
12:00 - 12:15	0	0	0	0	0	15	0	6	0	21	0	0	0	0	0	21
12:15 - 12:30	0	0	0	0	0	11	0	17	0	28	0	0	0	0	0	28
12:30 - 12:45	0	0	0	0	0	13	0	9	0	22	0	0	0	0	0	22
12:45 - 13:00	0	0	0	0	0	11	0	10	0	21	0	0	0	0	0	21
13:00 - 13:15	0	0	0	0	0	15	0	10	0	25	0	0	0	0	0	25
13:15 - 13:30	0	0	0	0	0	18	1	6	0	25	0	0	0	0	0	25
13:30 - 13:45	0	0	0	0	0	10	0	7	0	17	0	0	0	0	0	17
13:45 - 14:00	0	0	0	0	0	20	0	10	0	30	0	0	0	0	0	30
14:00 - 14:15	2	0	0	0	2	17	0	10	0	27	0	0	0	0	0	29
14:15 - 14:30	0	0	0	0	0	11	0	19	0	30	0	0	0	0	0	30
14:30 - 14:45	0	0	0	0	0	18	0	20	0	38	0	0	0	0	0	38
14:45 - 15:00	0	0	0	0	0	24	0	12	0	36	0	0	0	0	0	36
15:00 - 15:15	0	0	0	0	0	14	0	9	0	23	0	0	0	0	0	23
15:15 - 15:30	0	0	0	0	0	22	1	18	0	41	0	0	0	0	0	41
15:30 - 15:45	0	0	0	0	0	16	0	5	0	21	0	0	0	0	0	21
15:45 - 16:00	0	0	0	0	0	12	0	8	1	21	0	0	0	0	0	21
16:00 - 16:15	0	0	0	0	0	20	0	17	0	37	0	0	0	0	0	37
16:15 - 16:30	0	0	0	0	0	14	0	9	0	23	0	0	0	0	0	23
16:30 - 16:45	0	0	0	0	0	25	0	16	0	41	0	0	0	0	0	41
16:45 - 17:00	0	0	0	0	0	13	0	12	0	25	0	0	0	0	0	25
17:00 - 17:15	0	0	0	0	0	31	1	31	0	63	0	0	0	0	0	63
17:15 - 17:30	0	0	0	0	0	28	1	11	0	40	0	0	0	0	0	40
17:30 - 17:45	0	0	0	0	0	26	0	6	0	32	0	0	0	0	0	32
17:45 - 18:00	0	0	0	0	0	18	0	18	0	36	0	0	0	0	0	36
TOTAL	**3**	**0**	**0**	**0**	**3**	**679**	**9**	**496**	**3**	**1187**	**0**	**0**	**0**	**0**	**0**	**1190**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND UNNAMED ROAD

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND UNNAMED ROAD

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	UNNAMED ROAD															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND ROAD TO FORZANDO NORTH MINE

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	1	0	0	0	1	11	0	15	0	26	0	0	0	0	0	27
06:15 - 06:30	0	0	0	0	0	12	2	6	0	20	0	0	0	0	0	20
06:30 - 06:45	1	0	0	0	1	22	1	9	0	32	0	0	0	0	0	33
06:45 - 07:00	2	0	0	0	2	26	1	6	1	34	0	0	0	0	0	36
07:00 - 07:15	0	0	0	0	0	25	1	4	0	30	0	0	0	0	0	30
07:15 - 07:30	1	0	0	0	1	18	1	7	2	28	0	0	0	0	0	29
07:30 - 07:45	1	0	0	0	1	18	0	3	0	21	0	0	0	0	0	22
07:45 - 08:00	0	0	1	0	1	11	0	3	0	14	0	0	0	0	0	15
08:00 - 08:15	2	0	0	0	2	24	1	3	0	28	0	0	0	0	0	30
08:15 - 08:30	3	0	1	0	4	15	0	9	0	24	0	0	0	0	0	28
08:30 - 08:45	1	0	0	0	1	20	0	13	0	33	0	0	0	0	0	34
08:45 - 09:00	1	0	0	0	1	27	0	14	0	41	0	0	0	0	0	42
09:00 - 09:15	0	0	1	0	1	28	0	21	0	49	0	0	0	0	0	50
09:15 - 09:30	0	0	0	0	0	20	1	13	0	34	0	0	0	0	0	34
09:30 - 09:45	2	0	0	0	2	25	0	7	0	32	0	0	0	0	0	34
09:45 - 10:00	0	0	3	0	3	23	0	21	0	44	0	0	0	0	0	47
10:00 - 10:15	1	0	0	0	1	15	0	13	0	28	0	0	0	0	0	29
10:15 - 10:30	1	0	0	0	1	26	0	18	0	44	0	0	0	0	0	45
10:30 - 10:45	1	0	0	0	1	11	0	9	0	20	0	0	0	0	0	21
10:45 - 11:00	2	0	0	0	2	15	0	24	0	39	0	0	0	0	0	41
11:00 - 11:15	0	0	0	0	0	11	0	4	0	15	0	0	0	0	0	15
11:15 - 11:30	4	0	1	0	5	16	1	11	0	28	0	0	0	0	0	33
11:30 - 11:45	0	0	0	0	0	17	0	16	0	33	0	0	0	0	0	33
11:45 - 12:00	0	0	0	0	0	17	0	3	0	20	0	0	0	0	0	20
12:00 - 12:15	1	0	1	0	2	12	0	16	0	28	0	0	0	0	0	30
12:15 - 12:30	1	0	0	0	1	12	0	12	0	24	0	0	0	0	0	25
12:30 - 12:45	1	0	1	0	2	19	0	11	0	30	0	0	0	0	0	32
12:45 - 13:00	0	0	0	0	0	19	0	7	0	26	0	0	0	0	0	26
13:00 - 13:15	1	0	0	0	1	21	1	14	0	36	0	0	0	0	0	37
13:15 - 13:30	0	0	0	0	0	14	0	3	0	17	0	0	0	0	0	17
13:30 - 13:45	2	0	1	0	3	16	0	4	0	20	0	0	0	0	0	23
13:45 - 14:00	1	0	1	0	2	12	1	14	0	27	0	0	0	0	0	29
14:00 - 14:15	1	0	2	0	3	24	2	13	1	40	0	0	0	0	0	43
14:15 - 14:30	0	0	1	0	1	15	0	12	1	28	0	0	0	0	0	29
14:30 - 14:45	1	0	1	0	2	16	0	12	0	28	0	0	0	0	0	30
14:45 - 15:00	0	0	1	0	1	23	0	13	2	38	0	0	0	0	0	39
15:00 - 15:15	2	0	2	0	4	23	0	22	1	46	0	0	0	0	0	50
15:15 - 15:30	2	0	3	0	5	21	2	14	1	38	0	0	0	0	0	43
15:30 - 15:45	2	0	3	0	5	16	0	10	0	26	0	0	0	0	0	31
15:45 - 16:00	0	0	1	0	1	27	3	14	0	44	0	0	0	0	0	45
16:00 - 16:15	1	0	0	0	1	26	0	13	0	39	0	0	0	0	0	40
16:15 - 16:30	3	0	2	0	5	25	0	11	0	36	0	0	0	0	0	41
16:30 - 16:45	3	0	4	0	7	25	1	16	1	43	0	0	0	0	0	50
16:45 - 17:00	3	0	0	0	3	18	1	10	1	30	0	0	0	0	0	33
17:00 - 17:15	2	0	0	0	2	23	0	18	0	41	0	0	0	0	0	43
17:15 - 17:30	4	0	0	0	4	19	2	16	0	37	0	0	0	0	0	41
17:30 - 17:45	2	0	0	0	2	21	0	12	0	33	0	0	0	0	0	35
17:45 - 18:00	1	0	0	0	1	18	0	13	0	31	0	0	0	0	0	32
TOTAL	**58**	**0**	**31**	**0**	**89**	**918**	**22**	**552**	**11**	**1503**	**0**	**0**	**0**	**0**	**0**	**1592**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF R35 AND ROAD TO FORZANDO NORTH MINE															
DATE:	12 HOUR COUNT ON TUESDAY 21 MAY 2019															
UNITS:	CLASSIFIED															

APPROACH FROM	SOUTH															TOTAL
NAME	R 35															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	20	0	13	1	34	2	0	8	1	11	45
06:15 - 06:30	0	0	0	0	0	21	0	6	0	27	2	0	3	0	5	32
06:30 - 06:45	0	0	0	0	0	15	0	6	0	21	8	0	4	0	12	33
06:45 - 07:00	0	0	0	0	0	20	0	4	0	24	7	0	4	0	11	35
07:00 - 07:15	0	0	0	0	0	22	2	10	0	34	7	0	3	0	10	44
07:15 - 07:30	0	0	0	0	0	14	0	3	0	17	7	0	6	0	13	30
07:30 - 07:45	0	0	0	0	0	13	0	18	0	31	4	0	2	0	6	37
07:45 - 08:00	0	0	0	0	0	22	0	24	0	46	9	0	0	0	9	55
08:00 - 08:15	0	0	0	0	0	11	0	20	0	31	3	0	3	0	6	37
08:15 - 08:30	0	0	0	0	0	16	0	10	0	26	5	0	2	0	7	33
08:30 - 08:45	0	0	0	0	0	13	0	14	0	27	5	0	3	0	8	35
08:45 - 09:00	0	0	0	0	0	21	0	11	0	32	2	0	3	0	5	37
09:00 - 09:15	0	0	0	0	0	16	0	9	0	25	3	0	1	0	4	29
09:15 - 09:30	0	0	0	0	0	13	0	4	0	17	3	0	0	0	3	20
09:30 - 09:45	0	0	0	0	0	16	0	9	0	25	3	0	0	0	3	28
09:45 - 10:00	0	0	0	0	0	12	0	8	0	20	1	0	1	0	2	22
10:00 - 10:15	0	0	0	0	0	18	0	14	0	32	2	0	1	0	3	35
10:15 - 10:30	0	0	0	0	0	9	0	7	0	16	3	0	1	0	4	20
10:30 - 10:45	0	0	0	0	0	13	1	18	0	32	4	0	2	0	6	38
10:45 - 11:00	0	0	0	0	0	25	0	14	0	39	4	0	4	0	8	47
11:00 - 11:15	0	0	0	0	0	7	0	7	0	14	4	0	1	0	5	19
11:15 - 11:30	0	0	0	0	0	10	0	12	1	23	2	0	1	0	3	26
11:30 - 11:45	0	0	0	0	0	7	0	14	1	22	3	0	2	0	5	27
11:45 - 12:00	0	0	0	0	0	6	1	11	1	19	4	0	1	0	5	24
12:00 - 12:15	0	0	0	0	0	28	0	28	0	56	5	0	5	0	10	66
12:15 - 12:30	0	0	0	0	0	12	0	14	0	26	4	0	2	0	6	32
12:30 - 12:45	0	0	0	0	0	20	0	12	0	32	4	0	2	0	6	38
12:45 - 13:00	0	0	0	0	0	17	0	10	1	28	5	0	2	0	7	35
13:00 - 13:15	0	0	0	0	0	30	1	9	0	40	3	0	2	0	5	45
13:15 - 13:30	0	0	0	0	0	15	1	11	1	28	1	3	4	1	9	37
13:30 - 13:45	0	0	0	0	0	19	0	10	1	30	3	1	2	2	8	38
13:45 - 14:00	0	0	0	0	0	23	0	11	0	34	8	0	4	0	12	46
14:00 - 14:15	0	0	0	0	0	21	1	22	0	44	3	0	1	0	4	48
14:15 - 14:30	0	0	0	0	0	25	1	20	0	46	3	0	0	0	3	49
14:30 - 14:45	0	0	0	0	0	27	0	14	0	41	5	0	2	0	7	48
14:45 - 15:00	0	0	0	0	0	27	1	12	0	40	1	0	3	0	4	44
15:00 - 15:15	0	0	0	0	0	34	1	20	0	55	3	0	1	4	8	63
15:15 - 15:30	0	0	0	0	0	31	0	5	0	36	3	1	2	1	7	43
15:30 - 15:45	0	0	0	0	0	17	0	12	1	30	3	1	1	3	8	38
15:45 - 16:00	0	0	0	0	0	18	0	20	0	38	2	0	0	1	3	41
16:00 - 16:15	0	0	0	0	0	28	0	5	0	33	1	0	1	0	2	35
16:15 - 16:30	0	0	0	0	0	29	0	19	1	49	2	0	1	0	3	52
16:30 - 16:45	0	0	0	0	0	23	0	20	0	43	2	0	0	0	2	45
16:45 - 17:00	0	0	0	0	0	24	1	23	0	48	0	0	1	0	1	49
17:00 - 17:15	0	0	0	0	0	30	0	18	0	48	3	0	1	1	5	53
17:15 - 17:30	0	0	0	0	0	14	0	17	0	31	5	0	2	0	7	38
17:30 - 17:45	0	0	0	0	0	17	0	13	0	30	3	0	2	0	5	35
17:45 - 18:00	0	0	0	0	0	7	0	12	0	19	4	0	0	0	4	23
TOTAL	**0**	**0**	**0**	**0**	**0**	**896**	**11**	**623**	**9**	**1539**	**173**	**6**	**97**	**14**	**290**	**1829**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF R35 AND ROAD TO FORZANDO NORTH MINE															
DATE:	12 HOUR COUNT ON TUESDAY 21 MAY 2019															
UNITS:	CLASSIFIED															
APPROACH FROM	EAST															TOTAL
NAME	FORZANDO NORTH MINE															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	7	4	0	0	11	0	0	0	0	0	0	0	0	0	0	11
06:15 - 06:30	1	3	0	0	4	0	0	0	0	0	0	0	0	0	0	4
06:30 - 06:45	1	3	0	1	5	0	0	0	0	0	0	0	0	0	0	5
06:45 - 07:00	4	0	1	0	5	0	0	0	0	0	2	0	0	0	2	7
07:00 - 07:15	4	0	0	2	6	0	0	0	0	0	2	0	0	0	2	8
07:15 - 07:30	2	0	4	0	6	0	0	0	0	0	0	0	0	0	0	6
07:30 - 07:45	1	0	2	0	3	0	0	0	0	0	1	0	0	0	1	4
07:45 - 08:00	1	0	2	0	3	0	0	0	0	0	0	0	0	0	0	3
08:00 - 08:15	2	0	4	1	7	0	0	0	0	0	0	0	0	0	0	7
08:15 - 08:30	2	0	4	0	6	0	0	0	0	0	3	0	0	0	3	9
08:30 - 08:45	0	0	4	0	4	0	0	0	0	0	0	0	1	0	1	5
08:45 - 09:00	1	0	0	0	1	0	0	0	0	0	1	0	1	0	2	3
09:00 - 09:15	5	0	1	0	6	0	0	0	0	0	0	0	1	0	1	7
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	2	0	3	0	5	5
09:30 - 09:45	2	0	3	0	5	0	0	0	0	0	0	0	1	0	1	6
09:45 - 10:00	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	2
10:00 - 10:15	5	0	1	0	6	0	0	0	0	0	1	1	0	0	2	8
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	2
10:30 - 10:45	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
10:45 - 11:00	2	0	1	0	3	0	0	0	0	0	0	0	1	0	1	4
11:00 - 11:15	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
11:15 - 11:30	2	0	1	0	3	0	0	0	0	0	1	0	0	0	1	4
11:30 - 11:45	4	0	1	0	5	0	0	0	0	0	1	0	0	0	1	6
11:45 - 12:00	9	0	0	0	9	0	0	0	0	0	1	0	1	0	2	11
12:00 - 12:15	5	0	0	0	5	0	0	0	0	0	0	0	1	0	1	6
12:15 - 12:30	7	0	2	0	9	0	0	0	0	0	0	0	0	0	0	9
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	2	0	0	0	2	0	0	0	0	0	1	0	2	0	3	5
13:00 - 13:15	3	0	0	0	3	0	0	0	0	0	3	0	1	0	4	7
13:15 - 13:30	2	0	1	0	3	0	0	0	0	0	2	0	0	0	2	5
13:30 - 13:45	3	0	1	0	4	0	0	0	0	0	1	0	1	0	2	6
13:45 - 14:00	2	0	1	0	3	0	0	0	0	0	1	0	1	0	2	5
14:00 - 14:15	0	0	3	0	3	0	0	0	0	0	1	0	2	0	3	6
14:15 - 14:30	8	0	5	0	13	0	0	0	0	0	0	0	0	0	0	13
14:30 - 14:45	7	0	0	0	7	0	0	0	0	0	1	0	1	0	2	9
14:45 - 15:00	2	1	3	3	9	0	0	0	0	0	1	0	1	0	2	11
15:00 - 15:15	2	0	2	1	5	0	0	0	0	0	3	2	1	0	6	11
15:15 - 15:30	16	1	8	0	25	0	0	0	0	0	2	0	0	0	2	27
15:30 - 15:45	8	0	2	0	10	0	0	0	0	0	1	1	4	0	6	16
15:45 - 16:00	11	0	6	0	17	0	0	0	0	0	0	1	0	0	1	18
16:00 - 16:15	10	0	4	2	16	0	0	0	0	0	2	0	1	0	3	19
16:15 - 16:30	20	0	3	6	29	0	0	0	0	0	0	0	1	0	1	30
16:30 - 16:45	13	1	4	0	18	0	0	0	0	0	2	2	1	0	5	23
16:45 - 17:00	10	1	3	0	14	0	0	0	0	0	0	0	2	0	2	16
17:00 - 17:15	5	2	3	0	10	0	0	0	0	0	0	0	0	0	0	10
17:15 - 17:30	8	1	4	0	13	0	0	0	0	0	0	0	0	0	0	13
17:30 - 17:45	6	1	2	0	9	0	0	0	0	0	1	0	0	0	1	10
17:45 - 18:00	3	0	2	0	5	0	0	0	0	0	0	0	0	0	0	5
TOTAL	**212**	**18**	**89**	**16**	**335**	**0**	**0**	**0**	**0**	**0**	**39**	**7**	**30**	**0**	**76**	**411**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF R35 AND ROAD TO FORZANDO NORTH MINE

DATE: 12 HOUR COUNT ON TUESDAY 21 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 (MOSES KOTANE STREET) AND SCHLOSBERG AVENUE

DATE: 12 HOUR COUNT ON WEDNSDAY 15 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	N17 / MOSES KOTANE STREET															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	6	0	0	0	6	9	0	3	0	12	0	0	0	0	0	18
06:15 - 06:30	7	0	2	2	11	20	0	11	0	31	0	0	0	0	0	42
06:30 - 06:45	18	0	2	0	20	31	0	8	0	39	0	0	0	0	0	59
06:45 - 07:00	29	0	4	0	33	21	2	8	1	32	0	0	0	0	0	65
07:00 - 07:15	28	0	3	0	31	19	0	5	0	24	0	0	0	0	0	55
07:15 - 07:30	9	0	7	0	16	27	0	12	0	39	0	0	0	0	0	55
07:30 - 07:45	12	0	4	0	16	21	0	10	0	31	0	0	0	0	0	47
07:45 - 08:00	28	0	6	0	34	31	1	8	0	40	0	0	0	0	0	74
08:00 - 08:15	9	0	4	0	13	15	0	4	0	19	0	0	0	0	0	32
08:15 - 08:30	14	0	3	0	17	31	0	11	0	42	0	0	0	0	0	59
08:30 - 08:45	15	0	2	0	17	18	0	7	0	25	0	0	0	0	0	42
08:45 - 09:00	15	0	8	0	23	23	0	13	0	36	0	0	0	0	0	59
09:00 - 09:15	15	0	10	0	25	25	0	8	0	33	0	0	0	0	0	58
09:15 - 09:30	28	1	7	0	36	24	0	4	0	28	0	0	0	0	0	64
09:30 - 09:45	11	0	3	0	14	19	0	14	0	33	0	0	0	0	0	47
09:45 - 10:00	21	0	5	0	26	29	0	8	0	37	0	0	0	0	0	63
10:00 - 10:15	20	0	5	0	25	38	1	15	0	54	0	0	0	0	0	79
10:15 - 10:30	23	0	8	0	31	34	3	10	0	47	0	0	0	0	0	78
10:30 - 10:45	12	0	6	0	18	22	0	16	0	38	0	0	0	0	0	56
10:45 - 11:00	13	0	2	0	15	31	0	11	1	43	0	0	0	0	0	58
11:00 - 11:15	19	0	5	0	24	36	1	12	0	49	0	0	0	0	0	73
11:15 - 11:30	9	0	10	0	19	19	0	8	0	27	0	0	0	0	0	46
11:30 - 11:45	26	0	7	0	33	30	0	14	1	45	0	0	0	0	0	78
11:45 - 12:00	13	0	7	0	20	35	1	8	0	44	0	0	0	0	0	64
12:00 - 12:15	30	0	10	0	40	37	5	17	0	59	0	0	0	0	0	99
12:15 - 12:30	19	0	10	0	29	41	0	15	0	56	0	0	0	0	0	85
12:30 - 12:45	23	0	5	0	28	31	1	8	0	40	0	0	0	0	0	68
12:45 - 13:00	24	0	14	0	38	33	4	11	0	48	0	0	0	0	0	86
13:00 - 13:15	20	0	9	0	29	23	2	10	0	35	0	0	0	0	0	64
13:15 - 13:30	17	0	9	0	26	19	3	4	0	26	0	0	0	0	0	52
13:30 - 13:45	21	0	15	0	36	26	1	8	2	37	0	0	0	0	0	73
13:45 - 14:00	19	1	6	0	26	22	1	4	0	27	0	0	0	0	0	53
14:00 - 14:15	14	0	6	0	20	12	2	6	0	20	0	0	0	0	0	40
14:15 - 14:30	14	0	3	0	17	27	0	3	0	30	0	0	0	0	0	47
14:30 - 14:45	22	0	8	0	30	28	1	13	0	42	0	0	0	0	0	72
14:45 - 15:00	19	0	4	0	23	25	2	13	0	40	0	0	0	0	0	63
15:00 - 15:15	19	0	4	0	23	34	1	9	0	44	0	0	0	0	0	67
15:15 - 15:30	10	0	6	0	16	13	0	6	0	19	0	0	0	0	0	35
15:30 - 15:45	23	1	15	0	39	54	2	15	1	72	0	0	0	0	0	111
15:45 - 16:00	23	0	8	0	31	33	2	11	0	46	0	0	0	0	0	77
16:00 - 16:15	15	0	3	1	19	45	2	10	0	57	0	0	0	0	0	76
16:15 - 16:30	26	0	11	0	37	43	1	11	1	56	0	0	0	0	0	93
16:30 - 16:45	59	0	9	0	68	51	1	7	0	59	0	0	0	0	0	127
16:45 - 17:00	43	1	6	0	50	34	0	5	0	39	0	0	0	0	0	89
17:00 - 17:15	44	0	9	0	53	52	3	15	0	70	0	0	0	0	0	123
17:15 - 17:30	66	0	7	0	73	45	0	18	0	63	0	0	0	0	0	136
17:30 - 17:45	58	0	9	0	67	42	0	16	0	58	0	0	0	0	0	125
17:45 - 18:00	55	0	6	0	61	36	0	13	0	49	0	0	0	0	0	110
TOTAL	**1083**	**4**	**312**	**3**	**1402**	**1414**	**43**	**476**	**7**	**1940**	**0**	**0**	**0**	**0**	**0**	**3342**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 (MOSES KOTANE STREET) AND SCHLOSBERG AVENUE

DATE: 12 HOUR COUNT ON WEDNSDAY 15 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME	N17 / MOSES KOTANE STREET															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	80	4	4	0	88	15	0	6	0	21	109
06:15 - 06:30	0	0	0	0	0	73	2	9	0	84	7	3	5	0	15	99
06:30 - 06:45	0	0	0	0	0	36	0	8	0	44	19	5	12	3	39	83
06:45 - 07:00	0	0	0	0	0	32	1	5	0	38	27	1	11	0	39	77
07:00 - 07:15	0	0	0	0	0	26	0	6	0	32	23	0	8	0	31	63
07:15 - 07:30	0	0	0	0	0	30	0	10	0	40	25	1	6	0	32	72
07:30 - 07:45	0	0	0	0	0	30	0	15	0	45	33	2	27	2	64	109
07:45 - 08:00	0	0	0	0	0	38	1	7	1	47	44	2	24	2	72	119
08:00 - 08:15	0	0	0	0	0	22	0	7	0	29	12	0	7	0	19	48
08:15 - 08:30	0	0	0	0	0	33	0	13	0	46	19	0	22	1	42	88
08:30 - 08:45	0	0	0	0	0	22	0	7	0	29	11	0	10	0	21	50
08:45 - 09:00	0	0	0	0	0	31	0	14	0	45	18	0	16	0	34	79
09:00 - 09:15	0	0	0	0	0	19	1	6	0	26	11	0	16	2	29	55
09:15 - 09:30	0	0	0	0	0	33	0	6	0	39	27	1	5	0	33	72
09:30 - 09:45	0	0	0	0	0	19	0	15	0	34	17	0	7	0	24	58
09:45 - 10:00	0	0	0	0	0	8	0	10	1	19	19	0	10	0	29	48
10:00 - 10:15	0	0	0	0	0	39	0	9	0	48	14	1	20	1	36	84
10:15 - 10:30	0	0	0	0	0	27	0	21	0	48	16	0	16	0	32	80
10:30 - 10:45	0	0	0	0	0	18	0	8	0	26	16	0	17	1	34	60
10:45 - 11:00	0	0	0	0	0	21	0	15	0	36	11	0	16	1	28	64
11:00 - 11:15	0	0	0	0	0	27	0	15	0	42	18	1	11	1	31	73
11:15 - 11:30	0	0	0	0	0	12	0	7	0	19	18	0	19	0	37	56
11:30 - 11:45	0	0	0	0	0	29	0	10	0	39	29	0	19	1	49	88
11:45 - 12:00	0	0	0	0	0	22	0	7	0	29	24	0	4	0	28	57
12:00 - 12:15	0	0	0	0	0	20	0	7	0	27	18	0	8	0	26	53
12:15 - 12:30	0	0	0	0	0	23	0	5	0	28	26	1	8	1	36	64
12:30 - 12:45	0	0	0	0	0	28	0	6	1	35	18	0	13	0	31	66
12:45 - 13:00	0	0	0	0	0	33	4	12	1	50	28	2	6	0	36	86
13:00 - 13:15	0	0	0	0	0	25	1	4	0	30	22	0	9	0	31	61
13:15 - 13:30	0	0	0	0	0	21	0	8	0	29	14	3	8	1	26	55
13:30 - 13:45	0	0	0	0	0	40	3	25	2	70	18	0	4	0	22	92
13:45 - 14:00	0	0	0	0	0	17	2	11	0	30	9	0	8	1	18	48
14:00 - 14:15	0	0	0	0	0	46	3	25	0	74	22	0	11	0	33	107
14:15 - 14:30	0	0	0	0	0	27	2	21	0	50	21	0	8	0	29	79
14:30 - 14:45	0	0	0	0	0	34	2	13	0	49	29	1	11	0	41	90
14:45 - 15:00	0	0	0	0	0	24	1	13	0	38	15	0	9	0	24	62
15:00 - 15:15	0	0	0	0	0	28	0	15	1	44	28	0	7	5	40	84
15:15 - 15:30	0	0	0	0	0	29	1	4	0	34	19	0	2	1	22	56
15:30 - 15:45	0	0	0	0	0	28	1	13	0	42	26	0	11	0	37	79
15:45 - 16:00	0	0	0	0	0	27	2	12	0	41	29	1	20	2	52	93
16:00 - 16:15	0	0	0	0	0	32	0	23	0	55	34	1	19	1	55	110
16:15 - 16:30	0	0	0	0	0	24	1	9	0	34	16	1	18	0	35	69
16:30 - 16:45	0	0	0	0	0	31	0	15	0	46	22	1	21	0	44	90
16:45 - 17:00	0	0	0	0	0	44	0	11	0	55	36	1	15	1	53	108
17:00 - 17:15	0	0	0	0	0	49	0	10	0	59	45	2	14	0	61	120
17:15 - 17:30	0	0	0	0	0	31	4	4	0	39	28	2	11	0	41	80
17:30 - 17:45	0	0	0	0	0	6	2	6	0	14	23	1	14	0	38	52
17:45 - 18:00	0	0	0	0	0	15	1	5	0	21	19	1	4	0	24	45
TOTAL	**0**	**0**	**0**	**0**	**0**	**1409**	**39**	**511**	**7**	**1966**	**1038**	**35**	**573**	**28**	**1674**	**3640**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 (MOSES KOTANE STREET) AND SCHLOSBERG AVENUE

DATE: 12 HOUR COUNT ON WEDNSDAY 15 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	R38 / SCHLOSBERG AVENUE															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	8	1	5	0	14	0	0	0	0	0	15	1	2	0	18	32
06:15 - 06:30	21	1	7	0	29	0	0	0	0	0	19	0	7	1	27	56
06:30 - 06:45	15	6	10	3	34	0	0	0	0	0	31	0	20	0	51	85
06:45 - 07:00	19	2	6	2	29	0	0	0	0	0	41	0	2	1	44	73
07:00 - 07:15	11	1	7	0	19	0	0	0	0	0	31	0	2	0	33	52
07:15 - 07:30	11	0	8	1	20	0	0	0	0	0	32	0	7	0	39	59
07:30 - 07:45	17	2	7	0	26	0	0	0	0	0	23	0	9	0	32	58
07:45 - 08:00	22	2	6	0	30	0	0	0	0	0	24	0	6	0	30	60
08:00 - 08:15	17	0	3	1	21	0	0	0	0	0	9	0	6	0	15	36
08:15 - 08:30	15	0	4	0	19	0	0	0	0	0	10	0	9	0	19	38
08:30 - 08:45	21	0	8	0	29	0	0	0	0	0	15	0	2	0	17	46
08:45 - 09:00	21	0	9	0	30	0	0	0	0	0	10	0	7	0	17	47
09:00 - 09:15	17	0	7	0	24	0	0	0	0	0	10	0	2	0	12	36
09:15 - 09:30	24	0	13	1	38	0	0	0	0	0	14	0	7	0	21	59
09:30 - 09:45	12	1	6	0	19	0	0	0	0	0	8	0	2	0	10	29
09:45 - 10:00	12	0	7	0	19	0	0	0	0	0	17	0	6	0	23	42
10:00 - 10:15	20	0	12	1	33	0	0	0	0	0	9	0	2	0	11	44
10:15 - 10:30	20	0	8	0	28	0	0	0	0	0	2	0	4	0	6	34
10:30 - 10:45	11	0	6	0	17	0	0	0	0	0	25	0	3	0	28	45
10:45 - 11:00	7	0	10	1	18	0	0	0	0	0	16	0	3	0	19	37
11:00 - 11:15	22	1	12	1	36	0	0	0	0	0	21	0	3	0	24	60
11:15 - 11:30	8	0	7	0	15	0	0	0	0	0	14	0	3	0	17	32
11:30 - 11:45	20	0	16	0	36	0	0	0	0	0	15	0	8	0	23	59
11:45 - 12:00	18	0	16	1	35	0	0	0	0	0	10	0	3	0	13	48
12:00 - 12:15	20	0	14	0	34	0	0	0	0	0	13	0	4	1	18	52
12:15 - 12:30	17	0	8	1	26	0	0	0	0	0	5	0	1	0	6	32
12:30 - 12:45	11	1	16	0	28	0	0	0	0	0	13	0	6	0	19	47
12:45 - 13:00	12	0	18	1	31	0	0	0	0	0	17	0	3	0	20	51
13:00 - 13:15	16	1	12	0	29	0	0	0	0	0	6	0	5	0	11	40
13:15 - 13:30	14	0	10	0	24	0	0	0	0	0	8	0	6	0	14	38
13:30 - 13:45	14	2	9	0	25	0	0	0	0	0	12	0	7	0	19	44
13:45 - 14:00	9	0	6	0	15	0	0	0	0	0	7	1	5	1	14	29
14:00 - 14:15	10	2	12	0	24	0	0	0	0	0	9	0	3	0	12	36
14:15 - 14:30	26	1	8	0	35	0	0	0	0	0	14	0	5	0	19	54
14:30 - 14:45	18	0	8	2	28	0	0	0	0	0	14	0	2	0	16	44
14:45 - 15:00	15	1	13	0	29	0	0	0	0	0	12	0	2	0	14	43
15:00 - 15:15	13	2	19	0	34	0	0	0	0	0	13	0	6	0	19	53
15:15 - 15:30	12	1	14	0	27	0	0	0	0	0	7	0	5	0	12	39
15:30 - 15:45	17	0	16	0	33	0	0	0	0	0	17	1	16	0	34	67
15:45 - 16:00	11	0	12	0	23	0	0	0	0	0	20	0	4	1	25	48
16:00 - 16:15	30	1	16	3	50	0	0	0	0	0	9	0	8	0	17	67
16:15 - 16:30	24	3	5	4	36	0	0	0	0	0	26	0	9	0	35	71
16:30 - 16:45	36	0	17	0	53	0	0	0	0	0	19	1	3	0	23	76
16:45 - 17:00	15	0	23	0	38	0	0	0	0	0	15	0	2	0	17	55
17:00 - 17:15	36	4	20	0	60	0	0	0	0	0	22	0	3	0	25	85
17:15 - 17:30	19	1	11	1	32	0	0	0	0	0	16	0	11	0	27	59
17:30 - 17:45	7	2	5	0	14	0	0	0	0	0	12	0	9	0	21	35
17:45 - 18:00	15	0	11	0	26	0	0	0	0	0	2	0	6	0	8	34
TOTAL	**806**	**39**	**503**	**24**	**1372**	**0**	**0**	**0**	**0**	**0**	**729**	**4**	**256**	**5**	**994**	**2366**

TRAFFIC SURVEY																
CLIENT:	AURECON															
SITE:	INTERSECTION OF N17 (MOSES KOTANE STREET) AND SCHLOSBERG AVENUE															
DATE:	12 HOUR COUNT ON WEDNSDAY 15 MAY 2019															
UNITS:	CLASSIFIED															
APPROACH FROM	WEST															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT:	AURECON
SITE:	INTERSECTION OF N17 AND ROAD TO ISIBONELO MINE
DATE:	12 HOUR COUNT ON WEDNESDAY 15 MAY 2019
UNITS:	CLASSIFIED

APPROACH FROM	NORTH															TOTAL
NAME	ROAD ISIBONELO COLLIERS MINE															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	2	1	0	0	3	0	0	0	0	0	12	1	0	0	13	16
06:15 - 06:30	1	0	0	1	2	0	0	0	0	0	4	2	0	0	6	8
06:30 - 06:45	9	1	0	0	10	0	0	0	0	0	0	1	0	0	1	11
06:45 - 07:00	3	1	0	0	4	0	0	0	0	0	0	1	0	0	1	5
07:00 - 07:15	4	1	0	1	6	0	0	0	0	0	0	1	0	0	1	7
07:15 - 07:30	5	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5
07:30 - 07:45	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
07:45 - 08:00	6	0	0	0	6	0	0	0	0	0	6	0	0	0	6	12
08:00 - 08:15	10	0	0	0	10	0	0	0	0	0	0	0	0	0	0	10
08:15 - 08:30	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
08:30 - 08:45	5	1	0	0	6	0	0	0	0	0	1	0	0	0	1	7
08:45 - 09:00	5	1	0	1	7	0	0	0	0	0	1	0	0	0	1	8
09:00 - 09:15	22	0	0	1	23	0	0	0	0	0	0	0	0	0	0	23
09:15 - 09:30	7	1	0	0	8	0	0	0	0	0	0	0	0	0	0	8
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
09:45 - 10:00	2	0	0	0	2	0	0	0	0	0	1	0	0	0	1	3
10:00 - 10:15	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
10:15 - 10:30	10	1	1	0	12	0	0	0	0	0	0	0	0	0	0	12
10:30 - 10:45	5	0	1	0	6	0	0	0	0	0	0	0	0	0	0	6
10:45 - 11:00	1	0	0	0	1	0	0	0	0	0	14	0	0	0	14	15
11:00 - 11:15	8	1	0	0	9	0	0	0	0	0	5	0	0	0	5	14
11:15 - 11:30	6	0	2	0	8	0	0	0	0	0	5	0	0	0	5	13
11:30 - 11:45	4	0	1	0	5	0	0	0	0	0	2	0	0	0	2	7
11:45 - 12:00	4	0	0	0	4	0	0	0	0	0	4	0	0	0	4	8
12:00 - 12:15	2	0	0	0	2	0	0	0	0	0	1	1	0	0	2	4
12:15 - 12:30	4	0	0	0	4	0	0	0	0	0	5	0	0	0	5	9
12:30 - 12:45	4	0	0	0	4	0	0	0	0	0	4	0	0	0	4	8
12:45 - 13:00	4	0	0	0	4	0	0	0	0	0	3	0	0	0	3	7
13:00 - 13:15	13	0	0	0	13	0	0	0	0	0	2	0	0	0	2	15
13:15 - 13:30	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
13:30 - 13:45	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4
13:45 - 14:00	6	0	1	0	7	0	0	0	0	0	0	0	0	0	0	7
14:00 - 14:15	16	0	1	0	17	0	0	0	0	0	0	1	0	0	1	18
14:15 - 14:30	28	0	1	0	29	0	0	0	0	0	0	0	0	0	0	29
14:30 - 14:45	6	0	2	0	8	0	0	0	0	0	1	0	0	0	1	9
14:45 - 15:00	3	0	3	0	6	0	0	0	0	0	0	0	0	0	0	6
15:00 - 15:15	6	0	0	0	6	0	0	0	0	0	1	0	0	0	1	7
15:15 - 15:30	13	1	0	1	15	0	0	0	0	0	3	0	0	0	3	18
15:30 - 15:45	12	1	0	0	13	0	0	0	0	0	7	0	0	0	7	20
15:45 - 16:00	19	0	0	0	19	0	0	0	0	0	6	0	1	0	7	26
16:00 - 16:15	17	0	0	0	17	0	0	0	0	0	10	0	0	0	10	27
16:15 - 16:30	22	0	1	0	23	0	0	0	0	0	16	0	0	0	16	39
16:30 - 16:45	14	0	0	0	14	0	0	0	0	0	11	1	0	0	12	26
16:45 - 17:00	15	0	0	0	15	0	0	0	0	0	17	0	0	0	17	32
17:00 - 17:15	36	0	0	0	36	0	0	0	0	0	30	0	0	0	30	66
17:15 - 17:30	40	1	0	1	42	0	0	0	0	0	46	1	0	0	47	89
17:30 - 17:45	6	0	0	0	6	0	0	0	0	0	13	0	0	0	13	19
17:45 - 18:00	2	0	0	0	2	0	0	0	0	0	7	0	0	0	7	9
TOTAL	**418**	**12**	**14**	**6**	**450**	**0**	**0**	**0**	**0**	**0**	**239**	**10**	**1**	**0**	**250**	**700**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 AND ROAD TO ISIBONELO MINE

DATE: 12 HOUR COUNT ON WEDNESDAY 15 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	SOUTH															TOTAL
NAME																
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:15 - 06:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:30 - 06:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:45 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00 - 07:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 - 07:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 - 07:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 - 08:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 - 08:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 - 08:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:00 - 09:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:15 - 09:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:30 - 09:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 - 10:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 - 10:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 - 10:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:45 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:00 - 11:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:15 - 11:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:30 - 11:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11:45 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:00 - 12:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:15 - 12:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:30 - 12:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12:45 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:00 - 13:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:15 - 13:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:30 - 13:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13:45 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:00 - 14:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:15 - 14:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:30 - 14:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14:45 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:00 - 15:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:15 - 15:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:30 - 15:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15:45 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:00 - 16:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:15 - 16:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:30 - 16:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16:45 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00 - 17:15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:15 - 17:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:30 - 17:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:45 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
EST. 24 HR	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 AND ROAD TO ISIBONELO MINE

DATE: 12 HOUR COUNT ON WEDNESDAY 15 MAY 2019

UNITS: CLASSIFIED

APPROACH FROM	EAST															TOTAL
NAME	N17															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	0	0	0	0	0	24	2	3	1	30	43	3	1	0	47	77
06:15 - 06:30	0	0	0	0	0	34	3	0	1	38	41	0	0	0	41	79
06:30 - 06:45	0	0	0	0	0	50	1	0	0	51	91	2	0	0	93	144
06:45 - 07:00	0	0	0	0	0	48	0	2	0	50	62	1	0	0	63	113
07:00 - 07:15	0	0	0	0	0	37	2	4	0	43	22	1	0	0	23	66
07:15 - 07:30	0	0	0	0	0	41	1	5	4	51	18	0	0	0	18	69
07:30 - 07:45	0	0	0	0	0	45	1	3	1	50	13	0	1	0	14	64
07:45 - 08:00	0	0	0	0	0	30	0	1	0	31	13	0	1	0	14	45
08:00 - 08:15	0	0	0	0	0	42	0	8	0	50	6	1	0	1	8	58
08:15 - 08:30	0	0	0	0	0	57	0	7	0	64	14	0	1	0	15	79
08:30 - 08:45	0	0	0	0	0	28	0	5	0	33	3	0	2	0	5	38
08:45 - 09:00	0	0	0	0	0	35	0	4	0	39	6	0	2	2	10	49
09:00 - 09:15	0	0	0	0	0	51	1	10	1	63	10	0	1	1	12	75
09:15 - 09:30	0	0	0	0	0	18	0	6	0	24	2	0	0	0	2	26
09:30 - 09:45	0	0	0	0	0	59	0	9	2	70	13	0	0	0	13	83
09:45 - 10:00	0	0	0	0	0	17	0	7	0	24	5	0	1	0	6	30
10:00 - 10:15	0	0	0	0	0	43	0	8	0	51	10	0	1	0	11	62
10:15 - 10:30	0	0	0	0	0	39	0	9	0	48	14	0	1	0	15	63
10:30 - 10:45	0	0	0	0	0	37	0	9	0	46	8	0	0	0	8	54
10:45 - 11:00	0	0	0	0	0	36	0	13	0	49	10	1	0	0	11	60
11:00 - 11:15	0	0	0	0	0	43	0	16	0	59	8	0	3	0	11	70
11:15 - 11:30	0	0	0	0	0	42	0	9	0	51	6	0	1	0	7	58
11:30 - 11:45	0	0	0	0	0	38	0	7	0	45	8	0	0	0	8	53
11:45 - 12:00	0	0	0	0	0	24	0	5	0	29	10	0	-2	0	8	37
12:00 - 12:15	0	0	0	0	0	41	1	12	0	54	6	1	4	0	11	65
12:15 - 12:30	0	0	0	0	0	34	0	6	0	40	5	0	0	0	5	45
12:30 - 12:45	0	0	0	0	0	51	0	7	0	58	7	0	2	0	9	67
12:45 - 13:00	0	0	0	0	0	42	1	9	0	52	10	0	1	0	11	63
13:00 - 13:15	0	0	0	0	0	59	2	7	0	68	16	1	1	0	18	86
13:15 - 13:30	0	0	0	0	0	47	2	7	0	56	10	1	1	0	12	68
13:30 - 13:45	0	0	0	0	0	16	0	2	1	19	2	0	0	0	2	21
13:45 - 14:00	0	0	0	0	0	41	1	13	0	55	8	0	2	0	10	65
14:00 - 14:15	0	0	0	0	0	57	2	13	0	72	7	1	0	0	8	80
14:15 - 14:30	0	0	0	0	0	55	2	8	0	65	11	0	1	0	12	77
14:30 - 14:45	0	0	0	0	0	66	1	13	1	81	9	2	0	1	12	93
14:45 - 15:00	0	0	0	0	0	57	0	16	4	77	12	1	0	1	14	91
15:00 - 15:15	0	0	0	0	0	49	2	5	0	56	10	1	0	1	12	68
15:15 - 15:30	0	0	0	0	0	50	1	13	0	64	26	0	0	0	26	90
15:30 - 15:45	0	0	0	0	0	63	1	5	0	69	24	1	0	0	25	94
15:45 - 16:00	0	0	0	0	0	51	1	6	0	58	9	0	0	0	9	67
16:00 - 16:15	0	0	0	0	0	61	0	11	0	72	6	0	0	0	6	78
16:15 - 16:30	0	0	0	0	0	55	1	7	1	64	8	2	1	1	12	76
16:30 - 16:45	0	0	0	0	0	59	3	4	0	66	4	1	0	0	5	71
16:45 - 17:00	0	0	0	0	0	68	1	8	0	77	9	0	0	0	9	86
17:00 - 17:15	0	0	0	0	0	82	0	9	0	91	12	0	0	0	12	103
17:15 - 17:30	0	0	0	0	0	65	2	9	1	77	20	2	0	0	22	99
17:30 - 17:45	0	0	0	0	0	47	0	8	4	59	5	0	0	0	5	64
17:45 - 18:00	0	0	0	0	0	12	0	2	0	14	3	0	0	0	3	17
TOTAL	**0**	**0**	**0**	**0**	**0**	**2146**	**35**	**350**	**22**	**2553**	**675**	**23**	**27**	**8**	**733**	**3286**

TRAFFIC SURVEY

CLIENT: AURECON

SITE: INTERSECTION OF N17 AND ROAD TO ISIBONELO MINE

DATE: 12 HOUR COUNT ON WEDNESDAY 15 MAY 2019
UNITS: CLASSIFIED

APPROACH FROM	WEST															TOTAL
NAME	N17															
MOVEMENT	LEFT TURN					STRAIGHT					RIGHT TURN					ALL
TIME	C	T	H	B	TOTAL	C	T	H	B	TOTAL	C	T	H	B	TOTAL	MOVEMENTS
06:00 - 06:15	10	1	2	0	13	9	1	7	0	17	0	0	0	0	0	30
06:15 - 06:30	6	0	1	0	7	6	5	5	0	16	0	0	0	0	0	23
06:30 - 06:45	78	0	2	0	80	85	5	8	0	98	0	0	0	0	0	178
06:45 - 07:00	24	0	1	0	25	76	1	9	0	86	0	0	0	0	0	111
07:00 - 07:15	5	0	0	3	8	52	1	8	0	61	0	0	0	0	0	69
07:15 - 07:30	8	1	0	0	9	53	0	6	0	59	0	0	0	0	0	68
07:30 - 07:45	5	0	4	1	10	49	3	5	0	57	0	0	0	0	0	67
07:45 - 08:00	4	0	1	0	5	44	0	10	0	54	0	0	0	0	0	59
08:00 - 08:15	7	1	1	0	9	54	1	6	0	61	0	0	0	0	0	70
08:15 - 08:30	5	0	5	0	10	50	0	11	0	61	0	0	0	0	0	71
08:30 - 08:45	5	0	1	0	6	57	0	8	0	65	0	0	0	0	0	71
08:45 - 09:00	3	3	0	0	6	52	0	13	0	65	0	0	0	0	0	71
09:00 - 09:15	4	1	0	0	5	61	0	13	0	74	0	0	0	0	0	79
09:15 - 09:30	2	0	0	1	3	42	0	9	0	51	0	0	0	0	0	54
09:30 - 09:45	4	0	1	1	6	54	0	16	0	70	0	0	0	0	0	76
09:45 - 10:00	4	2	1	0	7	63	0	10	0	73	0	0	0	0	0	80
10:00 - 10:15	5	1	0	0	6	50	0	10	0	60	0	0	0	0	0	66
10:15 - 10:30	6	2	0	0	8	49	0	19	0	68	0	0	0	0	0	76
10:30 - 10:45	7	3	0	0	10	29	0	6	0	35	0	0	0	0	0	45
10:45 - 11:00	5	3	2	0	10	35	0	9	0	44	0	0	0	0	0	54
11:00 - 11:15	8	0	3	0	11	44	0	11	0	55	0	0	0	0	0	66
11:15 - 11:30	12	1	0	0	13	32	0	11	0	43	0	0	0	0	0	56
11:30 - 11:45	6	0	3	0	9	43	0	16	0	59	0	0	0	0	0	68
11:45 - 12:00	5	4	3	0	12	44	0	12	0	56	0	0	0	0	0	68
12:00 - 12:15	5	1	6	0	12	40	0	10	0	50	0	0	0	0	0	62
12:15 - 12:30	1	2	1	0	4	34	0	12	0	46	0	0	0	0	0	50
12:30 - 12:45	3	1	1	0	5	36	0	12	0	48	0	0	0	0	0	53
12:45 - 13:00	4	2	3	0	9	37	0	9	0	46	0	0	0	0	0	55
13:00 - 13:15	3	4	3	0	10	26	0	15	0	41	0	0	0	0	0	51
13:15 - 13:30	3	2	0	0	5	35	0	14	0	49	0	0	0	0	0	54
13:30 - 13:45	2	1	0	1	4	47	0	9	0	56	0	0	0	0	0	60
13:45 - 14:00	4	3	0	0	7	30	0	9	0	39	0	0	0	0	0	46
14:00 - 14:15	2	1	1	1	5	48	0	5	0	53	0	0	0	0	0	58
14:15 - 14:30	1	1	0	1	3	53	0	15	0	68	0	0	0	0	0	71
14:30 - 14:45	2	1	2	1	6	41	0	13	0	54	0	0	0	0	0	60
14:45 - 15:00	5	1	0	0	6	45	0	7	0	52	0	0	0	0	0	58
15:00 - 15:15	8	0	0	1	9	41	0	4	0	45	0	0	0	0	0	54
15:15 - 15:30	20	5	0	0	25	44	0	7	0	51	0	0	0	0	0	76
15:30 - 15:45	19	3	0	2	24	66	0	16	0	82	0	0	0	0	0	106
15:45 - 16:00	5	3	0	2	10	47	0	11	0	58	0	0	0	0	0	68
16:00 - 16:15	4	1	0	0	5	47	0	8	0	55	0	0	0	0	0	60
16:15 - 16:30	1	2	0	2	5	63	0	6	0	69	0	0	0	0	0	74
16:30 - 16:45	3	3	0	1	7	53	0	13	0	66	0	0	0	0	0	73
16:45 - 17:00	1	3	0	0	4	48	0	7	0	55	0	0	0	0	0	59
17:00 - 17:15	1	3	4	3	11	47	0	10	0	57	0	0	0	0	0	68
17:15 - 17:30	9	3	0	2	14	44	0	11	0	55	0	0	0	0	0	69
17:30 - 17:45	6	2	3	2	13	52	0	7	0	59	0	0	0	0	0	72
17:45 - 18:00	2	2	1	2	7	32	0	5	0	37	0	0	0	0	0	44
TOTAL	**342**	**73**	**56**	**27**	**498**	**2189**	**17**	**473**	**0**	**2679**	**0**	**0**	**0**	**0**	**0**	**3177**

Appendix B
SIDRA Analysis

Existing Analyses without Development Traffic

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.020	9.4	LOS A	0.1	0.4	0.74	0.91	41.2
2	T1	1	0.0	0.020	36.7	LOS E	0.1	0.4	0.74	0.91	41.4
3	R2	1	0.0	0.020	37.0	LOS E	0.1	0.4	0.74	0.91	41.3
Approach		3	0.0	0.020	27.7	LOS D	0.1	0.4	0.74	0.91	41.3
East: R555											
4	L2	1	0.0	0.147	5.6	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	572	0.0	0.147	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	44	0.0	0.078	9.3	LOS A	0.3	1.8	0.50	0.74	50.9
Approach		617	0.0	0.147	0.7	NA	0.3	1.8	0.04	0.05	59.2
North: Road to Elandspruit Colliery											
7	L2	29	0.0	0.156	8.4	LOS A	0.5	3.3	0.39	0.85	44.6
8	T1	1	0.0	0.156	46.5	LOS E	0.5	3.3	0.39	0.85	44.8
9	R2	9	0.0	0.156	55.4	LOS F	0.5	3.3	0.39	0.85	44.8
Approach		39	0.0	0.156	20.2	LOS C	0.5	3.3	0.39	0.85	44.6
West: R555											
10	L2	13	0.0	0.054	5.5	LOS A	0.0	0.0	0.00	0.07	57.7
11	T1	493	0.0	0.103	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
12	R2	1	0.0	0.001	8.1	LOS A	0.0	0.0	0.51	0.58	51.5
Approach		507	0.0	0.103	0.2	NA	0.0	0.0	0.00	0.02	59.8
All Vehicles		1166	0.0	0.156	1.2	NA	0.5	3.3	0.03	0.07	58.7

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.024	9.5	LOS A	0.1	0.4	0.78	0.91	39.4
2	T1	1	0.0	0.024	42.7	LOS E	0.1	0.4	0.78	0.91	39.6
3	R2	1	0.0	0.024	43.4	LOS E	0.1	0.4	0.78	0.91	39.4
Approach		3	0.0	0.024	31.9	LOS D	0.1	0.4	0.78	0.91	39.5
East: R555											
4	L2	1	0.0	0.156	5.6	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	609	0.0	0.156	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	34	0.0	0.077	11.3	LOS B	0.2	1.7	0.59	0.82	49.5
Approach		644	0.0	0.156	0.6	NA	0.2	1.7	0.03	0.04	59.3
North: Road to Elandspruit Colliery											
7	L2	25	0.0	0.263	10.6	LOS B	0.8	5.5	0.62	0.85	38.3
8	T1	1	0.0	0.263	72.3	LOS F	0.8	5.5	0.62	0.85	38.5
9	R2	10	0.0	0.263	89.4	LOS F	0.8	5.5	0.62	0.85	38.5
Approach		36	0.0	0.263	34.2	LOS D	0.8	5.5	0.62	0.85	38.4
West: R555											
10	L2	6	0.0	0.073	5.5	LOS A	0.0	0.0	0.00	0.03	58.1
11	T1	683	0.0	0.140	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
12	R2	1	0.0	0.001	8.3	LOS A	0.0	0.0	0.52	0.58	51.3
Approach		690	0.0	0.140	0.1	NA	0.0	0.0	0.00	0.01	59.9
All Vehicles		1373	0.0	0.263	1.3	NA	0.8	5.5	0.03	0.05	58.7

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - AM]

New Site
Stop (All-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	37	0.0	0.769	71.8	LOS F	6.3	44.4	1.00	1.88	27.6
2	T1	1	0.0	0.769	71.9	LOS F	6.3	44.4	1.00	1.88	27.6
3	R2	129	0.0	0.769	71.6	LOS F	6.3	44.4	1.00	1.88	27.6
Approach		167	0.0	0.769	71.6	LOS F	6.3	44.4	1.00	1.88	27.6
East: R555											
4	L2	486	0.0	1.213	439.9	LOS F	82.1	575.0	1.00	9.94	7.3
5	T1	748	0.0	1.761	1399.2	LOS F	277.7	1943.6	1.00	22.16	2.5
6	R2	1	0.0	1.761	1399.3	LOS F	277.7	1943.6	1.00	22.16	2.5
Approach		1235	0.0	1.761	1021.7	LOS F	277.7	1943.6	1.00	17.35	3.4
North: R575											
7	L2	1	0.0	0.077	106.6	LOS F	0.3	2.0	1.00	1.24	21.9
8	T1	1	0.0	0.077	106.7	LOS F	0.3	2.0	1.00	1.24	21.9
9	R2	1	0.0	0.077	106.4	LOS F	0.3	2.0	1.00	1.24	21.8
Approach		3	0.0	0.077	106.6	LOS F	0.3	2.0	1.00	1.24	21.9
West: R555											
10	L2	1	0.0	0.722	30.3	LOS D	5.4	37.7	1.00	1.78	40.5
11	T1	536	0.0	0.722	30.9	LOS D	5.4	37.7	1.00	1.78	39.9
12	R2	75	0.0	0.722	32.0	LOS D	5.4	37.6	1.00	1.78	39.1
Approach		612	0.0	0.722	31.0	LOS D	5.4	37.7	1.00	1.78	39.8
All Vehicles		2017	0.0	1.761	641.1	LOS F	277.7	1943.6	1.00	11.32	5.2

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - PM]

New Site
Stop (All-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	158	0.0	1.458	869.1	LOS F	152.0	1063.7	1.00	14.90	3.9
2	T1	1	0.0	1.458	869.2	LOS F	152.0	1063.7	1.00	14.90	3.9
3	R2	390	0.0	1.458	868.8	LOS F	152.0	1063.7	1.00	14.90	3.9
Approach		549	0.0	1.458	868.9	LOS F	152.0	1063.7	1.00	14.90	3.9
East: R555											
4	L2	241	0.0	0.776	48.2	LOS E	6.7	46.6	1.00	1.93	33.6
5	T1	441	0.0	1.282	562.3	LOS F	90.6	634.3	1.00	10.35	5.8
6	R2	1	0.0	1.282	562.4	LOS F	90.6	634.3	1.00	10.35	5.8
Approach		683	0.0	1.282	380.9	LOS F	90.6	634.3	1.00	7.38	8.3
North: R575											
7	L2	1	0.0	0.017	27.2	LOS D	0.1	0.4	1.00	1.23	41.6
8	T1	1	0.0	0.017	27.3	LOS D	0.1	0.4	1.00	1.23	41.7
9	R2	1	0.0	0.017	27.0	LOS D	0.1	0.4	1.00	1.23	41.5
Approach		3	0.0	0.017	27.2	LOS D	0.1	0.4	1.00	1.23	41.6
West: R555											
10	L2	1	0.0	1.003	141.1	LOS F	26.2	183.2	1.00	4.29	18.1
11	T1	696	0.0	1.003	143.4	LOS F	26.2	183.2	1.00	4.22	17.9
12	R2	72	0.0	1.003	146.8	LOS F	25.0	175.0	1.00	4.13	17.5
Approach		769	0.0	1.003	143.7	LOS F	26.2	183.2	1.00	4.22	17.8
All Vehicles		2004	0.0	1.458	423.0	LOS F	152.0	1063.7	1.00	8.22	7.5

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - AM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	37	0.0	0.591	32.3	LOS C	4.9	34.0	0.97	0.82	38.5
2	T1	1	0.0	0.591	26.7	LOS C	4.9	34.0	0.97	0.82	39.2
3	R2	129	0.0	0.591	32.2	LOS C	4.9	34.0	0.97	0.82	38.4
Approach		167	0.0	0.591	32.2	LOS C	4.9	34.0	0.97	0.82	38.4
East: R555											
4	L2	486	0.0	0.393	10.4	LOS B	6.4	45.0	0.48	0.72	50.1
5	T1	748	0.0	0.578	5.8	LOS A	11.9	83.4	0.58	0.53	54.7
6	R2	1	0.0	0.578	11.3	LOS B	11.9	83.4	0.58	0.53	53.1
Approach		1235	0.0	0.578	7.6	LOS A	11.9	83.4	0.55	0.61	52.8
North: R575											
7	L2	1	0.0	0.011	28.5	LOS C	0.1	0.5	0.85	0.60	41.0
8	T1	1	0.0	0.011	22.9	LOS C	0.1	0.5	0.85	0.60	41.8
9	R2	1	0.0	0.011	28.4	LOS C	0.1	0.5	0.85	0.60	40.8
Approach		3	0.0	0.011	26.6	LOS C	0.1	0.5	0.85	0.60	41.2
West: R555											
10	L2	1	0.0	0.366	10.3	LOS B	6.1	42.9	0.47	0.42	54.2
11	T1	536	0.0	0.366	5.4	LOS A	6.1	42.9	0.49	0.44	54.8
12	R2	75	0.0	0.366	15.9	LOS B	2.6	18.1	0.65	0.66	47.6
Approach		612	0.0	0.366	6.7	LOS A	6.1	42.9	0.51	0.47	53.8
All Vehicles		2017	0.0	0.591	9.4	LOS A	11.9	83.4	0.57	0.58	51.5

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - PM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	158	0.0	0.721	20.3	LOS C	13.7	95.7	0.85	0.86	44.1
2	T1	1	0.0	0.721	14.8	LOS B	13.7	95.7	0.85	0.86	45.0
3	R2	390	0.0	0.721	20.3	LOS C	13.7	95.7	0.85	0.86	43.9
Approach		549	0.0	0.721	20.3	LOS C	13.7	95.7	0.85	0.86	44.0
East: R555											
4	L2	241	0.0	0.371	21.6	LOS C	5.4	37.7	0.79	0.78	43.4
5	T1	441	0.0	0.652	18.1	LOS B	11.2	78.2	0.90	0.78	46.2
6	R2	1	0.0	0.652	23.6	LOS C	11.2	78.2	0.90	0.78	45.0
Approach		683	0.0	0.652	19.3	LOS B	11.2	78.2	0.86	0.78	45.2
North: R575											
7	L2	1	0.0	0.004	14.6	LOS B	0.0	0.3	0.55	0.53	48.5
8	T1	1	0.0	0.004	9.1	LOS A	0.0	0.3	0.55	0.53	49.6
9	R2	1	0.0	0.004	14.6	LOS B	0.0	0.3	0.55	0.53	48.3
Approach		3	0.0	0.004	12.8	LOS B	0.0	0.3	0.55	0.53	48.8
West: R555											
10	L2	1	0.0	0.714	25.2	LOS C	13.1	91.7	0.93	0.84	44.4
11	T1	696	0.0	0.714	21.2	LOS C	13.1	91.7	0.94	0.85	44.2
12	R2	72	0.0	0.714	30.3	LOS C	8.3	58.2	0.97	0.89	40.7
Approach		769	0.0	0.714	22.1	LOS C	13.1	91.7	0.94	0.86	43.9
All Vehicles		2004	0.0	0.721	20.6	LOS C	13.7	95.7	0.89	0.83	44.3

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	387	0.0	0.236	0.2	LOS A	0.5	3.2	0.12	0.08	58.9
3	R2	50	0.0	0.236	6.9	LOS A	0.5	3.2	0.12	0.08	56.5
Approach		437	0.0	0.236	1.0	NA	0.5	3.2	0.12	0.08	58.6
North: R575											
7	L2	77	0.0	0.150	5.6	LOS A	0.0	0.0	0.00	0.16	57.0
8	T1	211	0.0	0.150	0.0	LOS A	0.0	0.0	0.00	0.16	58.5
Approach		288	0.0	0.150	1.5	NA	0.0	0.0	0.00	0.16	58.1
West: N4 Off Ramp											
10	L2	188	0.0	0.918	21.7	LOS C	13.6	95.4	0.87	1.74	43.6
12	R2	439	0.0	0.918	23.3	LOS C	13.6	95.4	0.87	1.74	43.1
Approach		627	0.0	0.918	22.8	LOS C	13.6	95.4	0.87	1.74	43.2
All Vehicles		1352	0.0	0.918	11.2	NA	13.6	95.4	0.44	0.87	50.2

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	227	0.0	0.180	1.0	LOS A	0.7	4.8	0.30	0.16	57.5
3	R2	66	0.0	0.180	8.1	LOS A	0.7	4.8	0.30	0.16	55.3
Approach		293	0.0	0.180	2.6	NA	0.7	4.8	0.30	0.16	57.0
North: R575											
7	L2	126	0.0	0.266	5.6	LOS A	0.0	0.0	0.00	0.15	57.1
8	T1	386	0.0	0.266	0.0	LOS A	0.0	0.0	0.00	0.15	58.6
Approach		512	0.0	0.266	1.4	NA	0.0	0.0	0.00	0.15	58.2
West: N4 Off Ramp											
10	L2	224	0.0	0.708	14.1	LOS B	6.8	47.3	0.62	1.16	45.9
12	R2	219	0.0	0.708	22.2	LOS C	6.8	47.3	0.62	1.16	45.4
Approach		443	0.0	0.708	18.1	LOS C	6.8	47.3	0.62	1.16	45.7
All Vehicles		1248	0.0	0.708	7.6	NA	6.8	47.3	0.29	0.51	52.8

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	265	0.0	0.143	5.6	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	351	0.0	0.180	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		616	0.0	0.180	2.4	NA	0.0	0.0	0.00	0.25	57.0
East: N4 Off Ramp											
4	L2	181	0.0	0.259	12.0	LOS B	1.1	7.5	0.60	1.01	49.7
6	R2	1	0.0	0.259	46.7	LOS E	1.1	7.5	0.60	1.01	49.1
Approach		182	0.0	0.259	12.2	LOS B	1.1	7.5	0.60	1.01	49.7
North: R575											
8	T1	587	0.0	0.557	3.8	LOS A	5.3	37.2	0.52	0.23	54.6
9	R2	188	0.0	0.557	12.6	LOS B	5.3	37.2	0.52	0.23	52.6
Approach		775	0.0	0.557	6.0	NA	5.3	37.2	0.52	0.23	54.1
All Vehicles		1573	0.0	0.557	5.3	NA	5.3	37.2	0.33	0.33	54.7

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	224	0.0	0.121	5.6	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	266	0.0	0.136	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		490	0.0	0.136	2.5	NA	0.0	0.0	0.00	0.26	56.9
East: N4 Off Ramp											
4	L2	89	0.0	0.186	9.8	LOS A	0.7	4.8	0.55	0.92	49.3
6	R2	21	0.0	0.186	24.4	LOS C	0.7	4.8	0.55	0.92	48.7
Approach		110	0.0	0.186	12.6	LOS B	0.7	4.8	0.55	0.92	49.2
North: R575											
8	T1	361	0.0	0.446	3.1	LOS A	3.7	26.2	0.53	0.34	54.8
9	R2	224	0.0	0.446	9.9	LOS A	3.7	26.2	0.53	0.34	52.8
Approach		585	0.0	0.446	5.7	NA	3.7	26.2	0.53	0.34	54.0
All Vehicles		1185	0.0	0.446	5.0	NA	3.7	26.2	0.31	0.36	54.7

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - AM]

New Site
Stop (All-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	266	0.0	0.460	14.3	LOS B	2.1	14.6	0.88	1.43	48.6
3	R2	40	0.0	0.078	9.4	LOS A	0.2	1.7	0.81	1.25	51.1
Approach		306	0.0	0.460	13.6	LOS B	2.1	14.6	0.87	1.41	48.9
North: R35											
7	L2	271	0.0	0.937	55.1	LOS F	19.5	136.5	1.00	3.59	31.7
8	T1	532	0.0	0.937	54.8	LOS F	19.5	136.5	1.00	3.59	31.6
Approach		803	0.0	0.937	54.9	LOS F	19.5	136.5	1.00	3.59	31.6
West: N4 Off Ramp											
10	L2	344	0.0	0.725	30.5	LOS D	5.5	38.2	0.99	1.80	40.2
12	R2	34	0.0	0.725	30.0	LOS D	5.5	38.2	0.99	1.80	39.9
Approach		378	0.0	0.725	30.5	LOS D	5.5	38.2	0.99	1.80	40.1
All Vehicles		1487	0.0	0.937	40.2	LOS E	19.5	136.5	0.97	2.68	36.2

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - PM]

New Site
Stop (All-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	500	0.0	0.818	33.3	LOS D	8.3	58.4	1.00	2.16	38.9
3	R2	29	0.0	0.052	8.9	LOS A	0.2	1.1	0.77	1.24	51.4
Approach		529	0.0	0.818	32.0	LOS D	8.3	58.4	0.99	2.11	39.4
North: R35											
7	L2	227	0.0	0.689	19.8	LOS C	4.7	32.6	0.87	1.73	45.5
8	T1	346	0.0	0.689	19.5	LOS C	4.7	32.6	0.87	1.73	45.3
Approach		573	0.0	0.689	19.6	LOS C	4.7	32.6	0.87	1.73	45.4
West: N4 Off Ramp											
10	L2	330	0.0	0.720	31.2	LOS D	5.3	37.4	0.99	1.78	39.8
12	R2	28	0.0	0.720	30.8	LOS D	5.3	37.4	0.99	1.78	39.6
Approach		358	0.0	0.720	31.2	LOS D	5.3	37.4	0.99	1.78	39.8
All Vehicles		1460	0.0	0.818	26.9	LOS D	8.3	58.4	0.94	1.88	41.7

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - AM - Upgraded]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	266	0.0	0.136	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	40	0.0	0.058	9.9	LOS A	0.2	1.5	0.63	0.82	49.7
Approach		306	0.0	0.136	1.3	NA	0.2	1.5	0.08	0.11	58.4
North: R35											
7	L2	271	0.0	0.419	5.6	LOS A	0.0	0.0	0.00	0.20	56.6
8	T1	532	0.0	0.419	0.1	LOS A	0.0	0.0	0.00	0.20	58.1
Approach		803	0.0	0.419	1.9	NA	0.0	0.0	0.00	0.20	57.6
West: N4 Off Ramp											
10	L2	344	0.0	0.452	10.6	LOS B	3.0	21.1	0.52	0.96	49.6
12	R2	34	0.0	0.452	28.4	LOS D	3.0	21.1	0.52	0.96	49.2
Approach		378	0.0	0.452	12.2	LOS B	3.0	21.1	0.52	0.96	49.5
All Vehicles		1487	0.0	0.452	4.4	NA	3.0	21.1	0.15	0.37	55.4

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - PM - Upgraded]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	500	0.0	0.256	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
3	R2	29	0.0	0.029	8.0	LOS A	0.1	0.8	0.53	0.70	51.1
Approach		529	0.0	0.256	0.5	NA	0.1	0.8	0.03	0.04	59.4
North: R35											
7	L2	227	0.0	0.300	5.6	LOS A	0.0	0.0	0.00	0.23	56.3
8	T1	346	0.0	0.300	0.0	LOS A	0.0	0.0	0.00	0.23	57.8
Approach		573	0.0	0.300	2.2	NA	0.0	0.0	0.00	0.23	57.2
West: N4 Off Ramp											
10	L2	330	0.0	0.523	13.5	LOS B	3.5	24.3	0.67	1.14	48.1
12	R2	28	0.0	0.523	30.3	LOS D	3.5	24.3	0.67	1.14	47.7
Approach		358	0.0	0.523	14.8	LOS B	3.5	24.3	0.67	1.14	48.1
All Vehicles		1460	0.0	0.523	4.7	NA	3.5	24.3	0.18	0.39	55.4

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - AM]

New Site
Stop (All-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	64	0.0	0.413	17.0	LOS C	1.8	12.4	0.87	1.39	47.2
2	T1	166	0.0	0.413	16.7	LOS C	1.8	12.4	0.87	1.39	47.0
Approach		230	0.0	0.413	16.8	LOS C	1.8	12.4	0.87	1.39	47.1
East: N4 Off Ramp											
4	L2	74	0.0	0.367	18.3	LOS C	1.5	10.6	0.90	1.36	46.3
6	R2	95	0.0	0.367	17.9	LOS C	1.5	10.6	0.90	1.36	46.0
Approach		169	0.0	0.367	18.1	LOS C	1.5	10.6	0.90	1.36	46.1
North: R35											
8	T1	313	0.0	0.650	23.2	LOS C	4.1	28.7	0.98	1.64	43.5
9	R2	193	0.0	0.435	15.5	LOS C	2.0	13.7	0.93	1.40	47.1
Approach		506	0.0	0.650	20.3	LOS C	4.1	28.7	0.96	1.55	44.8
All Vehicles		905	0.0	0.650	19.0	LOS C	4.1	28.7	0.93	1.47	45.6

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - PM]

New Site
Stop (All-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	72	0.0	0.930	88.4	LOS F	15.6	109.5	1.00	3.04	24.6
2	T1	308	0.0	0.930	88.0	LOS F	15.6	109.5	1.00	3.04	24.5
Approach		380	0.0	0.930	88.1	LOS F	15.6	109.5	1.00	3.04	24.5
East: N4 Off Ramp											
4	L2	53	0.0	0.474	18.6	LOS C	2.2	15.4	0.90	1.43	46.1
6	R2	203	0.0	0.474	18.2	LOS C	2.2	15.4	0.90	1.43	45.8
Approach		256	0.0	0.474	18.3	LOS C	2.2	15.4	0.90	1.43	45.9
North: R35											
8	T1	188	0.0	0.605	28.4	LOS D	3.5	24.7	1.00	1.56	41.0
9	R2	208	0.0	0.594	25.6	LOS D	3.4	23.8	1.00	1.55	41.7
Approach		396	0.0	0.605	27.0	LOS D	3.5	24.7	1.00	1.55	41.4
All Vehicles		1032	0.0	0.930	47.3	LOS E	15.6	109.5	0.97	2.07	33.7

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - AM - Upgraded]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	64	0.0	0.120	5.6	LOS A	0.0	0.0	0.00	0.17	56.9
2	T1	166	0.0	0.120	0.0	LOS A	0.0	0.0	0.00	0.17	58.5
Approach		230	0.0	0.120	1.6	NA	0.0	0.0	0.00	0.17	58.1
East: N4 Off Ramp											
4	L2	74	0.0	0.341	10.6	LOS B	1.6	11.4	0.61	1.00	47.7
6	R2	95	0.0	0.341	18.7	LOS C	1.6	11.4	0.61	1.00	47.4
Approach		169	0.0	0.341	15.1	LOS C	1.6	11.4	0.61	1.00	47.5
North: R35											
8	T1	313	0.0	0.161	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	193	0.0	0.132	6.5	LOS A	0.6	4.4	0.35	0.62	51.9
Approach		506	0.0	0.161	2.5	NA	0.6	4.4	0.13	0.24	56.6
All Vehicles		905	0.0	0.341	4.6	NA	1.6	11.4	0.19	0.36	55.0

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - PM - Upgraded]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	72	0.0	0.197	5.6	LOS A	0.0	0.0	0.00	0.11	57.4
2	T1	308	0.0	0.197	0.0	LOS A	0.0	0.0	0.00	0.11	58.9
Approach		380	0.0	0.197	1.1	NA	0.0	0.0	0.00	0.11	58.6
East: N4 Off Ramp											
4	L2	53	0.0	0.652	15.3	LOS C	4.7	33.2	0.71	1.18	42.8
6	R2	203	0.0	0.652	26.4	LOS D	4.7	33.2	0.71	1.18	42.5
Approach		256	0.0	0.652	24.1	LOS C	4.7	33.2	0.71	1.18	42.6
North: R35											
8	T1	188	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	208	0.0	0.167	7.2	LOS A	0.8	5.4	0.47	0.69	51.6
Approach		396	0.0	0.167	3.8	NA	0.8	5.4	0.24	0.36	55.3
All Vehicles		1032	0.0	0.652	7.8	NA	4.7	33.2	0.27	0.47	52.5

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	69	0.0	0.037	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	116	0.0	0.059	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		185	0.0	0.059	2.1	NA	0.0	0.0	0.00	0.21	57.4
North: R35											
8	T1	117	0.0	0.045	0.1	LOS A	0.2	1.4	0.07	0.08	59.0
9	R2	36	0.0	0.045	6.2	LOS A	0.2	1.4	0.26	0.32	54.5
Approach		153	0.0	0.045	1.6	NA	0.2	1.4	0.11	0.14	57.9
West: R542											
10	L2	10	0.0	0.009	8.5	LOS A	0.0	0.2	0.22	0.87	51.7
12	R2	95	0.0	0.143	10.5	LOS B	0.6	4.0	0.46	0.91	50.4
Approach		105	0.0	0.143	10.4	LOS B	0.6	4.0	0.44	0.91	50.5
All Vehicles		443	0.0	0.143	3.9	NA	0.6	4.0	0.14	0.35	55.8

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	134	0.0	0.072	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	155	0.0	0.079	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		289	0.0	0.079	2.6	NA	0.0	0.0	0.00	0.27	56.9
North: R35											
8	T1	146	0.0	0.045	0.2	LOS A	0.1	1.0	0.08	0.05	59.2
9	R2	17	0.0	0.045	6.7	LOS A	0.1	1.0	0.19	0.14	56.2
Approach		163	0.0	0.045	0.9	NA	0.1	1.0	0.09	0.06	58.9
West: R542											
10	L2	30	0.0	0.029	8.7	LOS A	0.1	0.7	0.26	0.87	51.6
12	R2	76	0.0	0.129	11.5	LOS B	0.5	3.5	0.51	0.94	49.8
Approach		106	0.0	0.129	10.7	LOS B	0.5	3.5	0.44	0.92	50.3
All Vehicles		558	0.0	0.129	3.6	NA	0.5	3.5	0.11	0.33	56.0

MOVEMENT SUMMARY

Site: [Count 8: R542 / Goedehoop Mine Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.003	8.3	LOS A	0.0	0.1	0.28	0.84	51.5
2	T1	1	0.0	0.003	9.1	LOS A	0.0	0.1	0.28	0.84	51.4
3	R2	1	0.0	0.003	9.1	LOS A	0.0	0.1	0.28	0.84	51.0
Approach		3	0.0	0.003	8.8	LOS A	0.0	0.1	0.28	0.84	51.3
East: R542											
4	L2	1	0.0	0.061	5.9	LOS A	0.1	0.7	0.06	0.07	57.5
5	T1	98	0.0	0.061	0.1	LOS A	0.1	0.7	0.06	0.07	59.1
6	R2	13	0.0	0.061	5.9	LOS A	0.1	0.7	0.06	0.07	57.2
Approach		112	0.0	0.061	0.8	NA	0.1	0.7	0.06	0.07	58.9
North: Goedehoop Mine Access											
7	L2	10	0.0	0.024	8.1	LOS A	0.1	0.6	0.13	0.93	51.3
8	T1	1	0.0	0.024	9.3	LOS A	0.1	0.6	0.13	0.93	51.2
9	R2	11	0.0	0.024	9.6	LOS A	0.1	0.6	0.13	0.93	51.1
Approach		22	0.0	0.024	8.9	LOS A	0.1	0.6	0.13	0.93	51.2
West: R542											
10	L2	29	0.0	0.034	5.6	LOS A	0.1	0.9	0.05	0.26	56.5
11	T1	97	0.0	0.034	0.0	LOS A	0.1	0.9	0.02	0.09	59.0
12	R2	1	0.0	0.034	5.7	LOS A	0.0	0.0	0.01	0.01	57.6
Approach		127	0.0	0.034	1.3	NA	0.1	0.9	0.03	0.13	58.4
All Vehicles		264	0.0	0.061	1.8	NA	0.1	0.9	0.05	0.18	57.8

MOVEMENT SUMMARY

Site: [Count 8: R542 / Goedehoop Mine Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.004	8.5	LOS A	0.0	0.1	0.34	0.82	51.3
2	T1	1	0.0	0.004	9.5	LOS A	0.0	0.1	0.34	0.82	51.2
3	R2	1	0.0	0.004	9.6	LOS A	0.0	0.1	0.34	0.82	50.9
Approach		3	0.0	0.004	9.2	LOS A	0.0	0.1	0.34	0.82	51.1
East: R542											
4	L2	1	0.0	0.079	5.9	LOS A	0.0	0.1	0.01	0.01	58.2
5	T1	149	0.0	0.079	0.0	LOS A	0.0	0.1	0.01	0.01	59.9
6	R2	2	0.0	0.079	5.9	LOS A	0.0	0.1	0.01	0.01	57.9
Approach		152	0.0	0.079	0.1	NA	0.0	0.1	0.01	0.01	59.8
North: Goedehoop Mine Access											
7	L2	8	0.0	0.022	8.2	LOS A	0.1	0.6	0.20	0.90	51.2
8	T1	1	0.0	0.022	9.6	LOS A	0.1	0.6	0.20	0.90	51.0
9	R2	10	0.0	0.022	10.0	LOS B	0.1	0.6	0.20	0.90	50.9
Approach		19	0.0	0.022	9.2	LOS A	0.1	0.6	0.20	0.90	51.0
West: R542											
10	L2	1	0.0	0.029	5.6	LOS A	0.0	0.0	0.00	0.01	59.1
11	T1	112	0.0	0.029	0.0	LOS A	0.0	0.0	0.01	0.01	59.9
12	R2	1	0.0	0.029	5.9	LOS A	0.0	0.0	0.01	0.01	57.6
Approach		114	0.0	0.029	0.1	NA	0.0	0.0	0.01	0.01	59.9
All Vehicles		288	0.0	0.079	0.8	NA	0.1	0.6	0.02	0.08	59.1

MOVEMENT SUMMARY

Site: [Count 9: R35 / Unnamed Road - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	80	0.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		81	0.0	0.041	0.1	NA	0.0	0.0	0.00	0.01	59.9
North: R35											
8	T1	63	0.0	0.032	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	1	0.0	0.001	5.8	LOS A	0.0	0.0	0.17	0.53	52.9
Approach		64	0.0	0.032	0.1	NA	0.0	0.0	0.00	0.01	59.9
West: Unnamed Road											
10	L2	1	0.0	0.002	8.3	LOS A	0.0	0.1	0.21	0.86	51.7
12	R2	1	0.0	0.002	8.7	LOS A	0.0	0.1	0.21	0.86	51.5
Approach		2	0.0	0.002	8.5	LOS A	0.0	0.1	0.21	0.86	51.6
All Vehicles		147	0.0	0.041	0.2	NA	0.0	0.1	0.00	0.02	59.8

MOVEMENT SUMMARY

Site: [Count 9: R35 / Unnamed Road - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	152	0.0	0.078	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		153	0.0	0.078	0.0	NA	0.0	0.0	0.00	0.00	59.9
North: R35											
8	T1	80	0.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	1	0.0	0.001	6.0	LOS A	0.0	0.0	0.25	0.52	52.7
Approach		81	0.0	0.041	0.1	NA	0.0	0.0	0.00	0.01	59.9
West: Unnamed Road											
10	L2	1	0.0	0.002	8.7	LOS A	0.0	0.1	0.30	0.83	51.4
12	R2	1	0.0	0.002	9.5	LOS A	0.0	0.1	0.30	0.83	51.2
Approach		2	0.0	0.002	9.1	LOS A	0.0	0.1	0.30	0.83	51.3
All Vehicles		236	0.0	0.078	0.1	NA	0.0	0.1	0.00	0.01	59.8

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	96	0.0	0.049	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	46	0.0	0.036	6.0	LOS A	0.1	1.0	0.23	0.55	52.7
Approach		142	0.0	0.049	1.9	NA	0.1	1.0	0.07	0.18	57.4
East: Road to Forzando North Mine											
4	L2	22	0.0	0.024	5.8	LOS A	0.1	0.6	0.15	0.53	53.8
6	R2	4	0.0	0.024	8.0	LOS A	0.1	0.6	0.15	0.53	53.2
Approach		26	0.0	0.024	6.2	LOS A	0.1	0.6	0.15	0.53	53.7
North: R35											
7	L2	4	0.0	0.003	5.7	LOS A	0.0	0.1	0.12	0.51	53.9
8	T1	124	0.0	0.032	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		128	0.0	0.032	0.2	LOS A	0.0	0.1	0.00	0.02	59.8
All Vehicles		296	0.0	0.049	1.5	NA	0.1	1.0	0.05	0.14	58.1

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	188	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	11	0.0	0.009	6.0	LOS A	0.0	0.2	0.25	0.54	52.7
Approach		199	0.0	0.096	0.3	NA	0.0	0.2	0.01	0.03	59.5
East: Road to Forzando North Mine											
4	L2	71	0.0	0.072	5.9	LOS A	0.3	1.9	0.17	0.53	53.7
6	R2	8	0.0	0.072	9.5	LOS A	0.3	1.9	0.17	0.53	53.1
Approach		79	0.0	0.072	6.2	LOS A	0.3	1.9	0.17	0.53	53.6
North: R35											
7	L2	17	0.0	0.010	5.6	LOS A	0.0	0.3	0.05	0.53	54.1
8	T1	150	0.0	0.038	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		167	0.0	0.038	0.6	LOS A	0.0	0.3	0.01	0.05	59.3
All Vehicles		445	0.0	0.096	1.5	NA	0.3	1.9	0.04	0.13	58.3

MOVEMENT SUMMARY

Site: [Count 11: N17 / Moses Kotane / R38 - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: N17											
5	T1	154	0.0	0.079	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	141	0.0	0.088	6.0	LOS A	0.4	2.9	0.25	0.55	52.8
Approach		295	0.0	0.088	2.9	NA	0.4	2.9	0.12	0.26	56.3
North: R38											
7	L2	102	0.0	0.055	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
9	R2	167	0.0	0.324	14.2	LOS B	1.6	10.9	0.61	1.04	48.4
Approach		269	0.0	0.324	11.0	LOS B	1.6	10.9	0.38	0.85	50.7
West: N17											
10	L2	100	0.0	0.054	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
11	T1	134	0.0	0.069	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		234	0.0	0.069	2.4	NA	0.0	0.0	0.00	0.23	57.7
All Vehicles		798	0.0	0.324	5.5	NA	1.6	10.9	0.17	0.45	54.7

MOVEMENT SUMMARY

Site: [Count 11: N17 / Moses Kotane / R38 - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: N17											
5	T1	194	0.0	0.099	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	193	0.0	0.131	6.3	LOS A	0.6	4.3	0.34	0.58	52.5
Approach		387	0.0	0.131	3.2	NA	0.6	4.3	0.17	0.29	56.0
North: R38											
7	L2	187	0.0	0.101	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
9	R2	100	0.0	0.282	18.3	LOS C	1.2	8.2	0.72	1.03	46.0
Approach		287	0.0	0.282	10.0	LOS B	1.2	8.2	0.25	0.71	51.5
West: N17											
10	L2	208	0.0	0.112	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
11	T1	224	0.0	0.115	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		432	0.0	0.115	2.7	NA	0.0	0.0	0.00	0.25	57.4
All Vehicles		1106	0.0	0.282	4.8	NA	1.2	8.2	0.12	0.38	55.3

MOVEMENT SUMMARY

Site: [Count 12: N17 / Road to Isibonelo Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.012	8.4	LOS A	0.0	0.3	0.46	0.88	45.4
2	T1	1	0.0	0.012	24.8	LOS C	0.0	0.3	0.46	0.88	45.5
3	R2	1	0.0	0.012	23.8	LOS C	0.0	0.3	0.46	0.88	45.4
Approach		3	0.0	0.012	19.0	LOS C	0.0	0.3	0.46	0.88	45.4
East: N17											
4	L2	1	0.0	0.050	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
5	T1	195	0.0	0.050	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	197	0.0	0.210	7.7	LOS A	0.9	6.2	0.49	0.72	51.7
Approach		393	0.0	0.210	3.9	NA	0.9	6.2	0.25	0.36	55.5
North: Road to Isibonelo Mine											
7	L2	25	0.0	0.045	8.4	LOS A	0.1	1.0	0.23	0.89	50.1
8	T1	1	0.0	0.045	23.6	LOS C	0.1	1.0	0.23	0.89	50.3
9	R2	3	0.0	0.045	26.3	LOS D	0.1	1.0	0.23	0.89	50.2
Approach		29	0.0	0.045	10.8	LOS B	0.1	1.0	0.23	0.89	50.1
West: N17											
10	L2	122	0.0	0.111	5.6	LOS A	0.0	0.0	0.00	0.34	55.5
11	T1	304	0.0	0.111	0.0	LOS A	0.0	0.0	0.00	0.10	59.1
12	R2	1	0.0	0.001	6.2	LOS A	0.0	0.0	0.29	0.52	52.6
Approach		427	0.0	0.111	1.6	NA	0.0	0.0	0.00	0.17	58.0
All Vehicles		852	0.0	0.210	3.0	NA	0.9	6.2	0.12	0.28	56.5

MOVEMENT SUMMARY

Site: [Count 12: N17 / Road to Isibonelo Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.009	8.7	LOS A	0.0	0.2	0.48	0.86	47.1
2	T1	1	0.0	0.009	18.0	LOS C	0.0	0.2	0.48	0.86	47.3
3	R2	1	0.0	0.009	21.3	LOS C	0.0	0.2	0.48	0.86	47.2
Approach		3	0.0	0.009	16.0	LOS C	0.0	0.2	0.48	0.86	47.2
East: N17											
4	L2	1	0.0	0.077	5.5	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	298	0.0	0.077	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	38	0.0	0.034	6.6	LOS A	0.1	0.9	0.35	0.59	52.4
Approach		337	0.0	0.077	0.8	NA	0.1	0.9	0.04	0.07	59.0
North: Road to Isibonelo Mine											
7	L2	88	0.0	0.387	10.2	LOS B	1.9	13.4	0.41	0.95	46.6
8	T1	1	0.0	0.387	22.3	LOS C	1.9	13.4	0.41	0.95	46.8
9	R2	75	0.0	0.387	24.1	LOS C	1.9	13.4	0.41	0.95	46.7
Approach		164	0.0	0.387	16.6	LOS C	1.9	13.4	0.41	0.95	46.7
West: N17											
10	L2	27	0.0	0.071	5.5	LOS A	0.0	0.0	0.00	0.12	57.3
11	T1	247	0.0	0.071	0.0	LOS A	0.0	0.0	0.00	0.05	59.5
12	R2	1	0.0	0.001	6.6	LOS A	0.0	0.0	0.36	0.53	52.3
Approach		275	0.0	0.071	0.6	NA	0.0	0.0	0.00	0.06	59.3
All Vehicles		779	0.0	0.387	4.1	NA	1.9	13.4	0.11	0.25	55.9

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	69	0.0	0.037	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	116	0.0	0.059	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		185	0.0	0.059	2.1	NA	0.0	0.0	0.00	0.21	57.4
North: R35											
8	T1	134	0.0	0.049	0.2	LOS A	0.2	1.5	0.07	0.08	59.0
9	R2	36	0.0	0.049	6.2	LOS A	0.2	1.5	0.25	0.29	54.8
Approach		170	0.0	0.049	1.4	NA	0.2	1.5	0.11	0.12	58.0
West: R542											
10	L2	10	0.0	0.009	8.5	LOS A	0.0	0.2	0.22	0.87	51.7
12	R2	95	0.0	0.146	10.7	LOS B	0.6	4.1	0.47	0.92	50.2
Approach		105	0.0	0.146	10.5	LOS B	0.6	4.1	0.45	0.91	50.4
All Vehicles		460	0.0	0.146	3.8	NA	0.6	4.1	0.14	0.34	55.9

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	134	0.0	0.072	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	172	0.0	0.088	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		306	0.0	0.088	2.4	NA	0.0	0.0	0.00	0.25	57.0
North: R35											
8	T1	146	0.0	0.046	0.2	LOS A	0.1	1.0	0.08	0.05	59.2
9	R2	17	0.0	0.046	6.8	LOS A	0.1	1.0	0.20	0.14	56.2
Approach		163	0.0	0.046	0.9	NA	0.1	1.0	0.09	0.06	58.8
West: R542											
10	L2	30	0.0	0.030	8.8	LOS A	0.1	0.7	0.28	0.87	51.6
12	R2	76	0.0	0.132	11.7	LOS B	0.5	3.6	0.52	0.94	49.6
Approach		106	0.0	0.132	10.9	LOS B	0.5	3.6	0.45	0.92	50.2
All Vehicles		575	0.0	0.132	3.6	NA	0.5	3.6	0.11	0.32	56.1

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	80	0.0	0.052	0.1	LOS A	0.1	0.8	0.07	0.11	58.7
3	R2	18	0.0	0.052	5.7	LOS A	0.1	0.8	0.07	0.11	56.9
Approach		99	0.0	0.052	1.1	NA	0.1	0.8	0.07	0.11	58.3
East: Elders Colliery Access											
4	L2	1	0.0	0.004	8.3	LOS A	0.0	0.1	0.23	0.86	51.4
5	T1	1	0.0	0.004	9.4	LOS A	0.0	0.1	0.23	0.86	51.4
6	R2	1	0.0	0.004	9.3	LOS A	0.0	0.1	0.23	0.86	51.2
Approach		3	0.0	0.004	9.0	LOS A	0.0	0.1	0.23	0.86	51.3
North: R35											
7	L2	17	0.0	0.041	5.5	LOS A	0.0	0.0	0.00	0.13	57.3
8	T1	63	0.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.13	58.9
9	R2	1	0.0	0.001	5.8	LOS A	0.0	0.0	0.17	0.53	52.9
Approach		81	0.0	0.041	1.2	NA	0.0	0.0	0.00	0.13	58.4
West: Elders Colliery Access											
10	L2	1	0.0	0.004	8.3	LOS A	0.0	0.1	0.25	0.85	51.4
11	T1	1	0.0	0.004	9.5	LOS A	0.0	0.1	0.25	0.85	51.4
12	R2	1	0.0	0.004	9.2	LOS A	0.0	0.1	0.25	0.85	51.2
Approach		3	0.0	0.004	9.0	LOS A	0.0	0.1	0.25	0.85	51.3
All Vehicles		186	0.0	0.052	1.4	NA	0.1	0.8	0.05	0.14	58.1

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	152	0.0	0.079	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	1	0.0	0.079	5.7	LOS A	0.0	0.0	0.00	0.00	58.0
Approach		154	0.0	0.079	0.1	NA	0.0	0.0	0.00	0.01	59.9
East: Elders Colliery Access											
4	L2	18	0.0	0.045	8.4	LOS A	0.2	1.2	0.24	0.89	51.2
5	T1	1	0.0	0.045	10.1	LOS B	0.2	1.2	0.24	0.89	51.2
6	R2	17	0.0	0.045	10.2	LOS B	0.2	1.2	0.24	0.89	51.0
Approach		36	0.0	0.045	9.3	LOS A	0.2	1.2	0.24	0.89	51.1
North: R35											
7	L2	1	0.0	0.042	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	80	0.0	0.042	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
9	R2	1	0.0	0.001	6.0	LOS A	0.0	0.0	0.25	0.52	52.7
Approach		82	0.0	0.042	0.1	NA	0.0	0.0	0.00	0.01	59.8
West: Elders Colliery Access											
10	L2	1	0.0	0.004	8.7	LOS A	0.0	0.1	0.35	0.82	51.1
11	T1	1	0.0	0.004	10.0	LOS A	0.0	0.1	0.35	0.82	51.1
12	R2	1	0.0	0.004	10.1	LOS B	0.0	0.1	0.35	0.82	50.9
Approach		3	0.0	0.004	9.6	LOS A	0.0	0.1	0.35	0.82	51.0
All Vehicles		275	0.0	0.079	1.4	NA	0.2	1.2	0.04	0.13	58.4

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	114	0.0	0.058	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	46	0.0	0.036	6.0	LOS A	0.1	1.0	0.23	0.55	52.7
Approach		160	0.0	0.058	1.7	NA	0.1	1.0	0.06	0.16	57.7
East: Road to Forzando North Mine											
4	L2	22	0.0	0.024	5.8	LOS A	0.1	0.6	0.15	0.53	53.8
6	R2	4	0.0	0.024	8.3	LOS A	0.1	0.6	0.15	0.53	53.2
Approach		26	0.0	0.024	6.2	LOS A	0.1	0.6	0.15	0.53	53.7
North: R35											
7	L2	4	0.0	0.003	5.7	LOS A	0.0	0.1	0.12	0.51	53.9
8	T1	124	0.0	0.032	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		128	0.0	0.032	0.2	LOS A	0.0	0.1	0.00	0.02	59.8
All Vehicles		314	0.0	0.058	1.5	NA	0.1	1.0	0.05	0.13	58.2

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	188	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	11	0.0	0.009	6.1	LOS A	0.0	0.2	0.26	0.55	52.6
Approach		199	0.0	0.096	0.3	NA	0.0	0.2	0.01	0.03	59.5
East: Road to Forzando North Mine											
4	L2	71	0.0	0.073	5.9	LOS A	0.3	1.9	0.18	0.54	53.6
6	R2	8	0.0	0.073	9.7	LOS A	0.3	1.9	0.18	0.54	53.0
Approach		79	0.0	0.073	6.3	LOS A	0.3	1.9	0.18	0.54	53.6
North: R35											
7	L2	17	0.0	0.010	5.6	LOS A	0.0	0.3	0.05	0.53	54.1
8	T1	168	0.0	0.043	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		185	0.0	0.043	0.5	LOS A	0.0	0.3	0.00	0.05	59.4
All Vehicles		463	0.0	0.096	1.4	NA	0.3	1.9	0.04	0.12	58.4

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	112	0.0	0.060	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	141	0.0	0.072	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		253	0.0	0.072	2.5	NA	0.0	0.0	0.00	0.25	57.0
North: R35											
8	T1	143	0.0	0.056	0.2	LOS A	0.3	1.8	0.07	0.08	59.0
9	R2	44	0.0	0.056	6.5	LOS A	0.3	1.8	0.32	0.34	54.2
Approach		187	0.0	0.056	1.7	NA	0.3	1.8	0.13	0.14	57.8
West: R542											
10	L2	12	0.0	0.012	8.6	LOS A	0.0	0.3	0.24	0.87	51.7
12	R2	144	0.0	0.243	11.8	LOS B	1.0	7.1	0.54	0.96	49.6
Approach		156	0.0	0.243	11.6	LOS B	1.0	7.1	0.52	0.95	49.8
All Vehicles		596	0.0	0.243	4.6	NA	1.0	7.1	0.18	0.40	55.1

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	191	0.0	0.103	5.6	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	189	0.0	0.097	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		380	0.0	0.103	2.8	NA	0.0	0.0	0.00	0.29	56.6
North: R35											
8	T1	178	0.0	0.056	0.3	LOS A	0.2	1.4	0.09	0.06	59.1
9	R2	21	0.0	0.056	7.2	LOS A	0.2	1.4	0.24	0.15	56.0
Approach		199	0.0	0.056	1.0	NA	0.2	1.4	0.11	0.07	58.8
West: R542											
10	L2	37	0.0	0.038	8.9	LOS A	0.1	0.9	0.29	0.87	51.5
12	R2	121	0.0	0.239	13.3	LOS B	1.0	6.8	0.59	1.00	48.7
Approach		158	0.0	0.239	12.2	LOS B	1.0	6.8	0.52	0.97	49.3
All Vehicles		737	0.0	0.239	4.3	NA	1.0	6.8	0.14	0.38	55.4

MOVEMENT SUMMARY

Site: [Count 8: R542 / Goedehoop Mine Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.004	8.4	LOS A	0.0	0.1	0.33	0.83	51.2
2	T1	1	0.0	0.004	9.6	LOS A	0.0	0.1	0.33	0.83	51.1
3	R2	1	0.0	0.004	10.2	LOS B	0.0	0.1	0.33	0.83	50.7
Approach		3	0.0	0.004	9.4	LOS A	0.0	0.1	0.33	0.83	51.0
East: R542											
4	L2	1	0.0	0.096	6.0	LOS A	0.3	2.2	0.13	0.16	56.5
5	T1	119	0.0	0.096	0.2	LOS A	0.3	2.2	0.13	0.16	58.0
6	R2	44	0.0	0.096	6.0	LOS A	0.3	2.2	0.13	0.16	56.2
Approach		164	0.0	0.096	1.8	NA	0.3	2.2	0.13	0.16	57.5
North: Goedehoop Mine Access											
7	L2	40	0.0	0.050	8.1	LOS A	0.2	1.4	0.11	0.93	51.4
8	T1	1	0.0	0.050	10.0	LOS B	0.2	1.4	0.11	0.93	51.3
9	R2	13	0.0	0.050	10.5	LOS B	0.2	1.4	0.11	0.93	51.2
Approach		54	0.0	0.050	8.8	LOS A	0.2	1.4	0.11	0.93	51.3
West: R542											
10	L2	35	0.0	0.042	5.7	LOS A	0.2	1.1	0.10	0.26	56.3
11	T1	118	0.0	0.042	0.0	LOS A	0.2	1.1	0.04	0.09	59.0
12	R2	1	0.0	0.042	5.8	LOS A	0.0	0.0	0.01	0.01	57.6
Approach		154	0.0	0.042	1.4	NA	0.2	1.1	0.05	0.13	58.3
All Vehicles		375	0.0	0.096	2.7	NA	0.3	2.2	0.10	0.26	56.8

MOVEMENT SUMMARY

Site: [Count 8: R542 / Goedehoop Mine Access - PM]

New Site
Stop (Two-Way)

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.004	8.7	LOS A	0.0	0.1	0.40	0.82	50.9
2	T1	1	0.0	0.004	10.3	LOS B	0.0	0.1	0.40	0.82	50.8
3	R2	1	0.0	0.004	10.9	LOS B	0.0	0.1	0.40	0.82	50.4
Approach		3	0.0	0.004	10.0	LOS A	0.0	0.1	0.40	0.82	50.7
East: R542											
4	L2	1	0.0	0.118	6.1	LOS A	0.2	1.7	0.09	0.09	57.3
5	T1	182	0.0	0.118	0.1	LOS A	0.2	1.7	0.09	0.09	58.9
6	R2	30	0.0	0.118	6.1	LOS A	0.2	1.7	0.09	0.09	57.0
Approach		213	0.0	0.118	1.0	NA	0.2	1.7	0.09	0.09	58.6
North: Goedehoop Mine Access											
7	L2	38	0.0	0.050	8.3	LOS A	0.2	1.4	0.17	0.91	51.3
8	T1	1	0.0	0.050	10.5	LOS B	0.2	1.4	0.17	0.91	51.2
9	R2	12	0.0	0.050	11.1	LOS B	0.2	1.4	0.17	0.91	51.1
Approach		51	0.0	0.050	9.0	LOS A	0.2	1.4	0.17	0.91	51.3
West: R542											
10	L2	1	0.0	0.036	5.7	LOS A	0.0	0.0	0.00	0.01	59.1
11	T1	137	0.0	0.036	0.0	LOS A	0.0	0.0	0.01	0.01	59.9
12	R2	1	0.0	0.036	6.0	LOS A	0.0	0.0	0.01	0.01	57.6
Approach		139	0.0	0.036	0.1	NA	0.0	0.0	0.01	0.01	59.9
All Vehicles		406	0.0	0.118	1.8	NA	0.2	1.7	0.07	0.17	57.9

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	98	0.0	0.051	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
3	R2	1	0.0	0.051	5.8	LOS A	0.0	0.0	0.00	0.01	58.0
Approach		100	0.0	0.051	0.1	NA	0.0	0.0	0.00	0.01	59.8
East: Elders Colliery Access											
4	L2	1	0.0	0.023	8.3	LOS A	0.1	0.6	0.35	0.86	51.0
5	T1	1	0.0	0.023	9.7	LOS A	0.1	0.6	0.35	0.86	51.0
6	R2	14	0.0	0.023	9.8	LOS A	0.1	0.6	0.35	0.86	50.8
Approach		16	0.0	0.023	9.7	LOS A	0.1	0.6	0.35	0.86	50.8
North: R35											
7	L2	14	0.0	0.047	5.5	LOS A	0.0	0.0	0.00	0.09	57.6
8	T1	77	0.0	0.047	0.0	LOS A	0.0	0.0	0.00	0.09	59.2
9	R2	15	0.0	0.011	5.8	LOS A	0.0	0.3	0.20	0.54	52.8
Approach		106	0.0	0.047	1.6	NA	0.0	0.3	0.03	0.16	58.0
West: Elders Colliery Access											
10	L2	15	0.0	0.017	8.4	LOS A	0.1	0.4	0.21	0.88	51.7
11	T1	1	0.0	0.017	9.7	LOS A	0.1	0.4	0.21	0.88	51.7
12	R2	1	0.0	0.017	9.6	LOS A	0.1	0.4	0.21	0.88	51.4
Approach		17	0.0	0.017	8.6	LOS A	0.1	0.4	0.21	0.88	51.6
All Vehicles		239	0.0	0.051	2.0	NA	0.1	0.6	0.05	0.19	57.7

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	185	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	1	0.0	0.096	5.9	LOS A	0.0	0.0	0.00	0.00	58.0
Approach		187	0.0	0.096	0.1	NA	0.0	0.0	0.00	0.01	59.9
East: Elders Colliery Access											
4	L2	1	0.0	0.028	8.4	LOS A	0.1	0.7	0.43	0.87	50.2
5	T1	1	0.0	0.028	10.8	LOS B	0.1	0.7	0.43	0.87	50.3
6	R2	14	0.0	0.028	11.2	LOS B	0.1	0.7	0.43	0.87	50.0
Approach		16	0.0	0.028	11.0	LOS B	0.1	0.7	0.43	0.87	50.1
North: R35											
7	L2	14	0.0	0.058	5.5	LOS A	0.0	0.0	0.00	0.07	57.7
8	T1	98	0.0	0.058	0.0	LOS A	0.0	0.0	0.00	0.07	59.3
9	R2	15	0.0	0.012	6.2	LOS A	0.0	0.3	0.28	0.55	52.6
Approach		127	0.0	0.058	1.3	NA	0.0	0.3	0.03	0.13	58.2
West: Elders Colliery Access											
10	L2	15	0.0	0.018	8.9	LOS A	0.1	0.5	0.30	0.86	51.4
11	T1	1	0.0	0.018	10.9	LOS B	0.1	0.5	0.30	0.86	51.4
12	R2	1	0.0	0.018	10.9	LOS B	0.1	0.5	0.30	0.86	51.2
Approach		17	0.0	0.018	9.1	LOS A	0.1	0.5	0.30	0.86	51.4
All Vehicles		347	0.0	0.096	1.5	NA	0.1	0.7	0.05	0.13	58.3

MOVEMENT SUMMARY

Site: 101 [R35 Elders Truck Access AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	124	0.0	0.064	0.0	LOS A	0.0	0.1	0.01	0.01	59.9
3	R2	1	0.0	0.064	6.0	LOS A	0.0	0.1	0.01	0.01	57.7
Approach		125	0.0	0.064	0.1	NA	0.0	0.1	0.01	0.01	59.9
East: Elders Truck Access											
4	L2	1	0.0	0.034	8.5	LOS A	0.1	0.8	0.33	0.88	51.6
6	R2	29	0.0	0.034	8.7	LOS A	0.1	0.8	0.33	0.88	51.1
Approach		31	0.0	0.034	8.7	LOS A	0.1	0.8	0.33	0.88	51.2
North: R35											
7	L2	29	0.0	0.089	5.5	LOS A	0.0	0.0	0.00	0.10	57.5
8	T1	143	0.0	0.089	0.0	LOS A	0.0	0.0	0.00	0.10	59.1
Approach		173	0.0	0.089	1.0	NA	0.0	0.0	0.00	0.10	58.8
All Vehicles		328	0.0	0.089	1.3	NA	0.1	0.8	0.03	0.14	58.4

MOVEMENT SUMMARY

Site: 101 [R35 Elders Truck Access PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	257	0.0	0.132	0.0	LOS A	0.0	0.1	0.00	0.00	60.0
3	R2	1	0.0	0.132	6.0	LOS A	0.0	0.1	0.00	0.00	57.7
Approach		258	0.0	0.132	0.0	NA	0.0	0.1	0.00	0.00	60.0
East: Elders Truck Access											
4	L2	1	0.0	0.039	8.5	LOS A	0.1	0.9	0.39	0.90	51.2
6	R2	29	0.0	0.039	9.4	LOS A	0.1	0.9	0.39	0.90	50.7
Approach		31	0.0	0.039	9.4	LOS A	0.1	0.9	0.39	0.90	50.8
North: R35											
7	L2	29	0.0	0.080	5.5	LOS A	0.0	0.0	0.00	0.11	57.4
8	T1	124	0.0	0.080	0.0	LOS A	0.0	0.0	0.00	0.11	59.0
Approach		154	0.0	0.080	1.1	NA	0.0	0.0	0.00	0.11	58.6
All Vehicles		442	0.0	0.132	1.0	NA	0.1	0.9	0.03	0.10	58.8

Horizon Year plus Elders Colliery Operational Trip Generation to Isibonelo Mine

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	15	0.0	0.008	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	98	0.0	0.059	0.0	LOS A	0.1	0.6	0.05	0.07	59.1
3	R2	14	0.0	0.059	5.7	LOS A	0.1	0.6	0.05	0.07	57.3
Approach		127	0.0	0.059	1.3	NA	0.1	0.6	0.04	0.13	58.2
East: Elders Colliery Access											
4	L2	14	0.0	0.015	8.3	LOS A	0.1	0.4	0.18	0.89	51.7
5	T1	1	0.0	0.015	9.7	LOS A	0.1	0.4	0.18	0.89	51.7
6	R2	1	0.0	0.015	9.5	LOS A	0.1	0.4	0.18	0.89	51.4
Approach		16	0.0	0.015	8.5	LOS A	0.1	0.4	0.18	0.89	51.7
North: R35											
7	L2	1	0.0	0.040	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	77	0.0	0.040	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
9	R2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.21	0.52	52.8
Approach		79	0.0	0.040	0.1	NA	0.0	0.0	0.00	0.01	59.8
West: Elders Colliery Access											
10	L2	1	0.0	0.025	8.4	LOS A	0.1	0.7	0.36	0.86	51.0
11	T1	1	0.0	0.025	9.7	LOS A	0.1	0.7	0.36	0.86	51.1
12	R2	15	0.0	0.025	9.8	LOS A	0.1	0.7	0.36	0.86	50.8
Approach		17	0.0	0.025	9.7	LOS A	0.1	0.7	0.36	0.86	50.8
All Vehicles		239	0.0	0.059	2.0	NA	0.1	0.7	0.06	0.20	57.6

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	15	0.0	0.008	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	185	0.0	0.104	0.0	LOS A	0.1	0.7	0.03	0.04	59.5
3	R2	14	0.0	0.104	5.8	LOS A	0.1	0.7	0.03	0.04	57.6
Approach		214	0.0	0.104	0.8	NA	0.1	0.7	0.03	0.08	58.9
East: Elders Colliery Access											
4	L2	14	0.0	0.016	8.4	LOS A	0.1	0.4	0.21	0.88	51.5
5	T1	1	0.0	0.016	10.9	LOS B	0.1	0.4	0.21	0.88	51.6
6	R2	1	0.0	0.016	10.9	LOS B	0.1	0.4	0.21	0.88	51.3
Approach		16	0.0	0.016	8.7	LOS A	0.1	0.4	0.21	0.88	51.5
North: R35											
7	L2	1	0.0	0.051	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	98	0.0	0.051	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
9	R2	1	0.0	0.001	6.2	LOS A	0.0	0.0	0.29	0.52	52.5
Approach		100	0.0	0.051	0.1	NA	0.0	0.0	0.00	0.01	59.8
West: Elders Colliery Access											
10	L2	1	0.0	0.030	8.9	LOS A	0.1	0.8	0.45	0.87	50.2
11	T1	1	0.0	0.030	10.8	LOS B	0.1	0.8	0.45	0.87	50.3
12	R2	15	0.0	0.030	11.2	LOS B	0.1	0.8	0.45	0.87	50.0
Approach		17	0.0	0.030	11.0	LOS B	0.1	0.8	0.45	0.87	50.1
All Vehicles		347	0.0	0.104	1.5	NA	0.1	0.8	0.05	0.14	58.3

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck access AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	103	0.0	0.072	0.1	LOS A	0.2	1.3	0.11	0.13	58.4
3	R2	29	0.0	0.072	5.8	LOS A	0.2	1.3	0.11	0.13	56.3
Approach		133	0.0	0.072	1.4	NA	0.2	1.3	0.11	0.13	57.9
East: Elders Truck Access											
4	L2	29	0.0	0.024	8.4	LOS A	0.1	0.6	0.21	0.88	51.8
6	R2	1	0.0	0.024	8.5	LOS A	0.1	0.6	0.21	0.88	51.3
Approach		31	0.0	0.024	8.4	LOS A	0.1	0.6	0.21	0.88	51.7
North: R35											
7	L2	1	0.0	0.057	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	111	0.0	0.057	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
Approach		112	0.0	0.057	0.1	NA	0.0	0.0	0.00	0.01	59.9
All Vehicles		275	0.0	0.072	1.6	NA	0.2	1.3	0.07	0.16	57.9

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck access PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	195	0.0	0.119	0.1	LOS A	0.2	1.4	0.08	0.08	59.0
3	R2	29	0.0	0.119	5.9	LOS A	0.2	1.4	0.08	0.08	56.8
Approach		224	0.0	0.119	0.8	NA	0.2	1.4	0.08	0.08	58.7
East: Elders Truck Access											
4	L2	29	0.0	0.025	8.5	LOS A	0.1	0.7	0.23	0.87	51.7
6	R2	1	0.0	0.025	9.2	LOS A	0.1	0.7	0.23	0.87	51.2
Approach		31	0.0	0.025	8.5	LOS A	0.1	0.7	0.23	0.87	51.7
North: R35											
7	L2	1	0.0	0.069	5.5	LOS A	0.0	0.0	0.00	0.00	58.3
8	T1	133	0.0	0.069	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
Approach		134	0.0	0.069	0.0	NA	0.0	0.0	0.00	0.00	59.9
All Vehicles		388	0.0	0.119	1.2	NA	0.2	1.4	0.06	0.12	58.5

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	145	0.0	0.074	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	56	0.0	0.046	6.2	LOS A	0.2	1.3	0.28	0.57	52.6
Approach		201	0.0	0.074	1.7	NA	0.2	1.3	0.08	0.16	57.7
East: Road to Forzando North Mine											
4	L2	27	0.0	0.032	5.9	LOS A	0.1	0.8	0.19	0.53	53.6
6	R2	5	0.0	0.032	9.5	LOS A	0.1	0.8	0.19	0.53	53.0
Approach		32	0.0	0.032	6.5	LOS A	0.1	0.8	0.19	0.53	53.5
North: R35											
7	L2	5	0.0	0.003	5.7	LOS A	0.0	0.1	0.13	0.51	53.8
8	T1	179	0.0	0.046	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		184	0.0	0.046	0.2	LOS A	0.0	0.1	0.00	0.01	59.8
All Vehicles		417	0.0	0.074	1.4	NA	0.2	1.3	0.05	0.12	58.3

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	257	0.0	0.132	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	13	0.0	0.011	6.3	LOS A	0.0	0.3	0.30	0.56	52.5
Approach		270	0.0	0.132	0.3	NA	0.0	0.3	0.01	0.03	59.6
East: Road to Forzando North Mine											
4	L2	87	0.0	0.096	6.0	LOS A	0.4	2.5	0.22	0.55	53.5
6	R2	10	0.0	0.096	11.8	LOS B	0.4	2.5	0.22	0.55	52.9
Approach		97	0.0	0.096	6.6	LOS A	0.4	2.5	0.22	0.55	53.4
North: R35											
7	L2	21	0.0	0.013	5.6	LOS A	0.1	0.4	0.05	0.53	54.1
8	T1	211	0.0	0.054	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		232	0.0	0.054	0.5	LOS A	0.1	0.4	0.00	0.05	59.4
All Vehicles		599	0.0	0.132	1.4	NA	0.4	2.5	0.04	0.12	58.4

MOVEMENT SUMMARY

Site: [Count 11: N17 / Moses Kotane / R38 - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: N17											
5	T1	188	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	172	0.0	0.110	6.1	LOS A	0.5	3.7	0.28	0.56	52.7
Approach		360	0.0	0.110	2.9	NA	0.5	3.7	0.14	0.27	56.3
North: R38											
7	L2	124	0.0	0.067	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
9	R2	232	0.0	0.541	19.7	LOS C	3.4	23.5	0.74	1.15	45.3
Approach		356	0.0	0.541	14.8	LOS B	3.4	23.5	0.48	0.93	48.2
West: N17											
10	L2	150	0.0	0.081	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
11	T1	163	0.0	0.084	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		313	0.0	0.084	2.7	NA	0.0	0.0	0.00	0.25	57.4
All Vehicles		1029	0.0	0.541	7.0	NA	3.4	23.5	0.22	0.49	53.5

MOVEMENT SUMMARY

Site: [Count 11: N17 / Moses Kotane / R38 - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: N17											
5	T1	236	0.0	0.121	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	235	0.0	0.168	6.6	LOS A	0.8	5.6	0.39	0.61	52.4
Approach		471	0.0	0.168	3.3	NA	0.8	5.6	0.20	0.30	55.9
North: R38											
7	L2	228	0.0	0.123	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
9	R2	150	0.0	0.567	29.1	LOS D	2.9	20.3	0.87	1.15	40.7
Approach		378	0.0	0.567	14.9	LOS B	2.9	20.3	0.34	0.77	48.3
West: N17											
10	L2	282	0.0	0.152	5.6	LOS A	0.0	0.0	0.00	0.53	54.9
11	T1	273	0.0	0.140	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		555	0.0	0.152	2.9	NA	0.0	0.0	0.00	0.27	57.3
All Vehicles		1404	0.0	0.567	6.2	NA	2.9	20.3	0.16	0.42	54.1

MOVEMENT SUMMARY

Site: [Count 12: N17 / Road to Isibonelo Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.018	8.5	LOS A	0.1	0.4	0.61	0.89	41.6
2	T1	1	0.0	0.018	35.4	LOS E	0.1	0.4	0.61	0.89	41.7
3	R2	1	0.0	0.018	35.8	LOS E	0.1	0.4	0.61	0.89	41.6
Approach		3	0.0	0.018	26.6	LOS D	0.1	0.4	0.61	0.89	41.6
East: N17											
4	L2	1	0.0	0.061	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
5	T1	238	0.0	0.061	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	268	0.0	0.318	8.9	LOS A	1.6	11.0	0.57	0.82	50.9
Approach		507	0.0	0.318	4.7	NA	1.6	11.0	0.30	0.44	54.8
North: Road to Isibonelo Mine											
7	L2	58	0.0	0.096	8.5	LOS A	0.3	2.3	0.27	0.88	50.1
8	T1	1	0.0	0.096	34.4	LOS D	0.3	2.3	0.27	0.88	50.2
9	R2	4	0.0	0.096	39.9	LOS E	0.3	2.3	0.27	0.88	50.1
Approach		63	0.0	0.096	10.9	LOS B	0.3	2.3	0.27	0.88	50.1
West: N17											
10	L2	149	0.0	0.135	5.6	LOS A	0.0	0.0	0.00	0.34	55.5
11	T1	371	0.0	0.135	0.0	LOS A	0.0	0.0	0.00	0.10	59.1
12	R2	1	0.0	0.001	6.3	LOS A	0.0	0.0	0.32	0.52	52.5
Approach		521	0.0	0.135	1.6	NA	0.0	0.0	0.00	0.17	58.0
All Vehicles		1094	0.0	0.318	3.7	NA	1.6	11.0	0.16	0.34	55.9

MOVEMENT SUMMARY

Site: [Count 12: N17 / Road to Isibonelo Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.013	8.8	LOS A	0.0	0.3	0.60	0.88	44.5
2	T1	1	0.0	0.013	22.9	LOS C	0.0	0.3	0.60	0.88	44.6
3	R2	1	0.0	0.013	30.7	LOS D	0.0	0.3	0.60	0.88	44.5
Approach		3	0.0	0.013	20.8	LOS C	0.0	0.3	0.60	0.88	44.6
East: N17											
4	L2	1	0.0	0.093	5.5	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	363	0.0	0.093	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	74	0.0	0.071	6.9	LOS A	0.3	2.0	0.40	0.63	52.2
Approach		438	0.0	0.093	1.2	NA	0.3	2.0	0.07	0.11	58.5
North: Road to Isibonelo Mine											
7	L2	135	0.0	0.642	17.4	LOS C	5.0	34.9	0.52	1.10	41.3
8	T1	1	0.0	0.642	37.3	LOS E	5.0	34.9	0.52	1.10	41.4
9	R2	91	0.0	0.642	41.0	LOS E	5.0	34.9	0.52	1.10	41.4
Approach		227	0.0	0.642	26.9	LOS D	5.0	34.9	0.52	1.10	41.3
West: N17											
10	L2	33	0.0	0.086	5.5	LOS A	0.0	0.0	0.00	0.12	57.3
11	T1	301	0.0	0.086	0.0	LOS A	0.0	0.0	0.00	0.05	59.5
12	R2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.40	0.54	52.2
Approach		335	0.0	0.086	0.6	NA	0.0	0.0	0.00	0.06	59.3
All Vehicles		1003	0.0	0.642	6.9	NA	5.0	34.9	0.15	0.32	53.6

Horizon Year plus Elders Colliery Operational Trip Generation to Elandspruit Colliery

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.054	9.8	LOS A	0.1	1.0	0.90	0.92	28.8
2	T1	1	0.0	0.054	78.3	LOS F	0.1	1.0	0.90	0.92	28.9
3	R2	1	0.0	0.054	111.0	LOS F	0.1	1.0	0.90	0.92	28.8
Approach		3	0.0	0.054	66.3	LOS F	0.1	1.0	0.90	0.92	28.8
East: R555											
4	L2	1	0.0	0.179	5.6	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	697	0.0	0.179	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	82	0.0	0.168	10.8	LOS B	0.6	4.0	0.57	0.82	49.9
Approach		780	0.0	0.179	1.2	NA	0.6	4.0	0.06	0.09	58.7
North: Road to Elandspruit Colliery											
7	L2	63	0.0	0.379	14.1	LOS B	1.5	10.3	0.52	0.86	39.9
8	T1	1	0.0	0.379	92.6	LOS F	1.5	10.3	0.52	0.86	40.1
9	R2	11	0.0	0.379	115.6	LOS F	1.5	10.3	0.52	0.86	40.1
Approach		75	0.0	0.379	30.1	LOS D	1.5	10.3	0.52	0.86	40.0
West: R555											
10	L2	16	0.0	0.066	5.5	LOS A	0.0	0.0	0.00	0.07	57.7
11	T1	601	0.0	0.126	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
12	R2	1	0.0	0.001	8.9	LOS A	0.0	0.0	0.55	0.60	50.8
Approach		618	0.0	0.126	0.2	NA	0.0	0.0	0.00	0.02	59.8
All Vehicles		1476	0.0	0.379	2.3	NA	1.5	10.3	0.06	0.10	57.6

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.105	10.0	LOS A	0.3	1.8	0.95	0.94	20.3
2	T1	1	0.0	0.105	137.7	LOS F	0.3	1.8	0.95	0.94	20.4
3	R2	1	0.0	0.105	210.6	LOS F	0.3	1.8	0.95	0.94	20.3
Approach		3	0.0	0.105	119.4	LOS F	0.3	1.8	0.95	0.94	20.4
East: R555											
4	L2	1	0.0	0.191	5.6	LOS A	0.0	0.0	0.00	0.00	58.3
5	T1	742	0.0	0.191	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R2	69	0.0	0.195	14.2	LOS B	0.7	4.6	0.70	0.88	47.6
Approach		812	0.0	0.195	1.2	NA	0.7	4.6	0.06	0.08	58.7
North: Road to Elandspruit Colliery											
7	L2	58	0.0	0.753	119.2	LOS F	5.4	38.0	0.79	1.31	17.0
8	T1	1	0.0	0.753	265.2	LOS F	5.4	38.0	0.79	1.31	17.0
9	R2	12	0.0	0.753	316.8	LOS F	5.4	38.0	0.79	1.31	17.0
Approach		71	0.0	0.753	154.6	LOS F	5.4	38.0	0.79	1.31	17.0
West: R555											
10	L2	7	0.0	0.089	5.5	LOS A	0.0	0.0	0.00	0.02	58.1
11	T1	833	0.0	0.171	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
12	R2	1	0.0	0.002	9.3	LOS A	0.0	0.0	0.57	0.62	50.6
Approach		841	0.0	0.171	0.1	NA	0.0	0.0	0.00	0.01	59.9
All Vehicles		1727	0.0	0.753	7.2	NA	5.4	38.0	0.06	0.09	53.6

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - AM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.011	28.5	LOS C	0.1	0.5	0.85	0.60	41.0
2	T1	1	0.0	0.011	23.0	LOS C	0.1	0.5	0.85	0.60	41.8
3	R2	1	0.0	0.011	28.5	LOS C	0.1	0.5	0.85	0.60	41.0
Approach		3	0.0	0.011	26.7	LOS C	0.1	0.5	0.85	0.60	41.3
East: R555											
4	L2	1	0.0	0.268	9.9	LOS A	4.1	28.9	0.43	0.38	54.5
5	T1	697	0.0	0.268	4.4	LOS A	4.1	28.9	0.43	0.37	56.0
6	R2	82	0.0	0.148	10.5	LOS B	1.0	7.0	0.43	0.68	50.1
Approach		780	0.0	0.268	5.0	LOS A	4.1	28.9	0.43	0.41	55.3
North: Road to Elandspruit Colliery											
7	L2	63	0.0	0.254	30.2	LOS C	2.0	14.1	0.91	0.75	39.4
8	T1	1	0.0	0.254	24.6	LOS C	2.0	14.1	0.91	0.75	40.2
9	R2	11	0.0	0.254	30.2	LOS C	2.0	14.1	0.91	0.75	39.6
Approach		75	0.0	0.254	30.1	LOS C	2.0	14.1	0.91	0.75	39.5
West: R555											
10	L2	16	0.0	0.099	9.3	LOS A	1.3	9.2	0.38	0.35	54.4
11	T1	601	0.0	0.188	4.0	LOS A	2.7	19.0	0.40	0.34	56.1
12	R2	1	0.0	0.002	10.7	LOS B	0.0	0.1	0.41	0.60	49.7
Approach		618	0.0	0.188	4.2	LOS A	2.7	19.0	0.40	0.34	56.1
All Vehicles		1476	0.0	0.268	6.0	LOS A	4.1	28.9	0.44	0.40	54.5

MOVEMENT SUMMARY

Site: [Count 1: R555 / Road to Elandspruit Colliery - PM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Unnamed Road											
1	L2	1	0.0	0.011	28.5	LOS C	0.1	0.5	0.85	0.60	41.0
2	T1	1	0.0	0.011	23.0	LOS C	0.1	0.5	0.85	0.60	41.8
3	R2	1	0.0	0.011	28.5	LOS C	0.1	0.5	0.85	0.60	41.0
Approach		3	0.0	0.011	26.7	LOS C	0.1	0.5	0.85	0.60	41.3
East: R555											
4	L2	1	0.0	0.286	10.0	LOS A	4.5	31.2	0.44	0.38	54.5
5	T1	742	0.0	0.286	4.4	LOS A	4.5	31.2	0.44	0.38	55.9
6	R2	69	0.0	0.155	11.5	LOS B	0.9	6.5	0.46	0.68	49.4
Approach		812	0.0	0.286	5.0	LOS A	4.5	31.2	0.44	0.41	55.3
North: Road to Elandspruit Colliery											
7	L2	58	0.0	0.242	30.1	LOS C	1.9	13.3	0.91	0.75	39.5
8	T1	1	0.0	0.242	24.6	LOS C	1.9	13.3	0.91	0.75	40.2
9	R2	12	0.0	0.242	30.1	LOS C	1.9	13.3	0.91	0.75	39.7
Approach		71	0.0	0.242	30.0	LOS C	1.9	13.3	0.91	0.75	39.5
West: R555											
10	L2	7	0.0	0.134	9.5	LOS A	1.9	13.0	0.39	0.34	54.7
11	T1	833	0.0	0.256	4.2	LOS A	3.9	27.3	0.42	0.36	56.0
12	R2	1	0.0	0.002	10.7	LOS B	0.0	0.1	0.41	0.60	49.7
Approach		841	0.0	0.256	4.3	LOS A	3.9	27.3	0.42	0.36	56.0
All Vehicles		1727	0.0	0.286	5.7	LOS A	4.5	31.2	0.45	0.40	54.7

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - AM]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	73	0.0	0.697	32.3	LOS C	6.9	48.4	0.98	0.87	38.5
2	T1	1	0.0	0.697	26.8	LOS C	6.9	48.4	0.98	0.87	39.2
3	R2	157	0.0	0.697	32.3	LOS C	6.9	48.4	0.98	0.87	38.4
Approach		231	0.0	0.697	32.3	LOS C	6.9	48.4	0.98	0.87	38.4
East: R555											
4	L2	592	0.0	0.503	11.9	LOS B	9.4	65.6	0.58	0.76	49.0
5	T1	912	0.0	0.741	8.5	LOS A	18.8	131.5	0.75	0.69	52.6
6	R2	1	0.0	0.741	14.0	LOS B	18.8	131.5	0.75	0.69	51.1
Approach		1505	0.0	0.741	9.8	LOS A	18.8	131.5	0.68	0.72	51.1
North: R575											
7	L2	1	0.0	0.009	26.5	LOS C	0.1	0.5	0.82	0.59	41.9
8	T1	1	0.0	0.009	21.0	LOS C	0.1	0.5	0.82	0.59	42.7
9	R2	1	0.0	0.009	26.5	LOS C	0.1	0.5	0.82	0.59	41.7
Approach		3	0.0	0.009	24.7	LOS C	0.1	0.5	0.82	0.59	42.1
West: R555											
10	L2	1	0.0	0.530	12.1	LOS B	10.6	74.1	0.59	0.53	52.8
11	T1	653	0.0	0.530	6.5	LOS A	10.6	74.1	0.59	0.53	54.1
12	R2	119	0.0	0.690	30.5	LOS C	3.7	26.0	0.92	0.91	38.9
Approach		773	0.0	0.690	10.2	LOS B	10.6	74.1	0.64	0.59	51.1
All Vehicles		2512	0.0	0.741	12.0	LOS B	18.8	131.5	0.70	0.69	49.6

MOVEMENT SUMMARY

Site: [Count 2: R555 / R575 - PM]

New Site
Signals - Fixed Time Coordinated Cycle Time = 75 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	221	0.0	0.912	43.4	LOS D	30.9	216.4	1.00	1.06	34.5
2	T1	1	0.0	0.912	37.8	LOS D	30.9	216.4	1.00	1.06	35.0
3	R2	475	0.0	0.912	43.3	LOS D	30.9	216.4	1.00	1.06	34.4
Approach		697	0.0	0.912	43.3	LOS D	30.9	216.4	1.00	1.06	34.4
East: R555											
4	L2	294	0.0	0.383	22.2	LOS C	7.5	52.8	0.74	0.78	43.1
5	T1	538	0.0	0.676	19.5	LOS B	16.2	113.5	0.87	0.77	45.4
6	R2	1	0.0	0.676	25.0	LOS C	16.2	113.5	0.87	0.77	44.3
Approach		833	0.0	0.676	20.4	LOS C	16.2	113.5	0.83	0.77	44.6
North: R575											
7	L2	1	0.0	0.015	37.7	LOS D	0.1	0.7	0.90	0.61	37.1
8	T1	1	0.0	0.015	32.1	LOS C	0.1	0.7	0.90	0.61	37.8
9	R2	1	0.0	0.015	37.6	LOS D	0.1	0.7	0.90	0.61	37.0
Approach		3	0.0	0.015	35.8	LOS D	0.1	0.7	0.90	0.61	37.3
West: R555											
10	L2	1	0.0	0.887	33.8	LOS C	28.0	196.1	0.94	1.00	40.1
11	T1	848	0.0	0.887	30.5	LOS C	28.0	196.1	0.95	1.01	39.7
12	R2	116	0.0	0.887	48.1	LOS D	11.1	77.4	1.00	1.07	33.6
Approach		965	0.0	0.887	32.7	LOS C	28.0	196.1	0.96	1.02	38.9
All Vehicles		2498	0.0	0.912	31.6	LOS C	30.9	216.4	0.93	0.95	39.1

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	500	0.0	0.307	0.3	LOS A	0.7	4.6	0.15	0.07	58.8
3	R2	61	0.0	0.307	7.6	LOS A	0.7	4.6	0.15	0.07	56.4
Approach		561	0.0	0.307	1.1	NA	0.7	4.6	0.15	0.07	58.5
North: R575											
7	L2	122	0.0	0.197	5.6	LOS A	0.0	0.0	0.00	0.19	56.7
8	T1	257	0.0	0.197	0.0	LOS A	0.0	0.0	0.00	0.19	58.3
Approach		379	0.0	0.197	1.8	NA	0.0	0.0	0.00	0.19	57.7
West: N4 Off Ramp											
10	L2	229	0.0	1.910	1654.9	LOS F	464.3	3250.0	1.00	17.81	2.1
12	R2	535	0.0	1.910	1665.4	LOS F	464.3	3250.0	1.00	17.81	2.1
Approach		764	0.0	1.910	1662.3	LOS F	464.3	3250.0	1.00	17.81	2.1
All Vehicles		1704	0.0	1.910	746.1	NA	464.3	3250.0	0.50	8.05	4.5

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	305	0.0	0.249	1.6	LOS A	1.1	7.8	0.35	0.16	57.0
3	R2	80	0.0	0.249	9.5	LOS A	1.1	7.8	0.35	0.16	54.8
Approach		385	0.0	0.249	3.2	NA	1.1	7.8	0.35	0.16	56.5
North: R575											
7	L2	185	0.0	0.341	5.6	LOS A	0.0	0.0	0.00	0.17	56.9
8	T1	471	0.0	0.341	0.0	LOS A	0.0	0.0	0.00	0.17	58.4
Approach		656	0.0	0.341	1.6	NA	0.0	0.0	0.00	0.17	58.0
West: N4 Off Ramp											
10	L2	273	0.0	1.096	207.8	LOS F	79.3	554.9	1.00	4.97	13.2
12	R2	267	0.0	1.096	225.0	LOS F	79.3	554.9	1.00	4.97	13.1
Approach		540	0.0	1.096	216.3	LOS F	79.3	554.9	1.00	4.97	13.1
All Vehicles		1581	0.0	1.096	75.3	NA	79.3	554.9	0.43	1.81	26.7

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - AM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 65 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	500	0.0	0.895	35.4	LOS D	22.6	158.5	1.00	1.15	37.6
3	R2	61	0.0	0.895	41.1	LOS D	22.6	158.5	1.00	1.15	36.6
Approach		561	0.0	0.895	36.0	LOS D	22.6	158.5	1.00	1.15	37.5
North: R575											
7	L2	122	0.0	0.513	22.3	LOS C	9.4	65.5	0.82	0.74	45.0
8	T1	257	0.0	0.513	16.8	LOS B	9.4	65.5	0.82	0.74	46.0
Approach		379	0.0	0.513	18.5	LOS B	9.4	65.5	0.82	0.74	45.6
West: N4 Off Ramp											
10	L2	229	0.0	0.891	35.8	LOS D	29.8	208.5	0.99	1.01	37.0
12	R2	535	0.0	0.891	36.0	LOS D	29.8	208.5	0.99	1.01	36.7
Approach		764	0.0	0.891	35.9	LOS D	29.8	208.5	0.99	1.01	36.8
All Vehicles		1704	0.0	0.895	32.1	LOS C	29.8	208.5	0.95	0.99	38.7

MOVEMENT SUMMARY

Site: [Count 3: R575 / N4 North Ramp - PM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
2	T1	305	0.0	0.768	23.9	LOS C	11.6	81.0	0.96	0.93	42.4
3	R2	80	0.0	0.768	29.6	LOS C	11.6	81.0	0.96	0.93	41.2
Approach		385	0.0	0.768	25.1	LOS C	11.6	81.0	0.96	0.93	42.2
North: R575											
7	L2	185	0.0	0.731	20.6	LOS C	16.4	114.5	0.87	0.82	46.1
8	T1	471	0.0	0.731	15.1	LOS B	16.4	114.5	0.87	0.82	47.1
Approach		656	0.0	0.731	16.7	LOS B	16.4	114.5	0.87	0.82	46.8
West: N4 Off Ramp											
10	L2	273	0.0	0.793	27.9	LOS C	16.1	112.5	0.96	0.92	40.3
12	R2	267	0.0	0.793	28.0	LOS C	16.1	112.5	0.96	0.92	39.9
Approach		540	0.0	0.793	27.9	LOS C	16.1	112.5	0.96	0.92	40.1
All Vehicles		1581	0.0	0.793	22.6	LOS C	16.4	114.5	0.92	0.88	43.2

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	323	0.0	0.174	5.6	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	428	0.0	0.219	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		751	0.0	0.219	2.4	NA	0.0	0.0	0.00	0.25	57.0
East: N4 Off Ramp											
4	L2	221	0.0	0.962	87.2	LOS F	14.8	103.6	0.92	2.35	23.2
6	R2	29	0.0	0.962	172.6	LOS F	14.8	103.6	0.92	2.35	23.0
Approach		250	0.0	0.962	97.1	LOS F	14.8	103.6	0.92	2.35	23.1
North: R575											
8	T1	716	0.0	0.739	7.7	LOS A	12.7	88.8	1.00	0.30	51.3
9	R2	229	0.0	0.739	18.1	LOS C	12.7	88.8	1.00	0.30	49.5
Approach		945	0.0	0.739	10.2	NA	12.7	88.8	1.00	0.30	50.9
All Vehicles		1946	0.0	0.962	18.4	NA	14.8	103.6	0.60	0.55	45.7

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	273	0.0	0.147	5.6	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	324	0.0	0.166	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		597	0.0	0.166	2.5	NA	0.0	0.0	0.00	0.26	56.9
East: N4 Off Ramp											
4	L2	108	0.0	0.511	15.9	LOS C	2.6	18.3	0.74	1.14	42.4
6	R2	54	0.0	0.511	43.3	LOS E	2.6	18.3	0.74	1.14	41.9
Approach		162	0.0	0.511	25.0	LOS D	2.6	18.3	0.74	1.14	42.2
North: R575											
8	T1	440	0.0	0.587	5.4	LOS A	6.6	46.0	0.66	0.40	52.9
9	R2	273	0.0	0.587	12.6	LOS B	6.6	46.0	0.66	0.40	51.0
Approach		713	0.0	0.587	8.1	NA	6.6	46.0	0.66	0.40	52.1
All Vehicles		1472	0.0	0.587	7.7	NA	6.6	46.0	0.40	0.42	52.6

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - AM - Upgraded]

New Site
Signals - Fixed Time Coordinated Cycle Time = 68 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	323	0.0	0.696	32.3	LOS C	10.3	72.4	0.96	0.86	38.5
2	T1	428	0.0	0.878	36.7	LOS D	17.0	118.8	1.00	1.09	37.4
Approach		751	0.0	0.878	34.8	LOS C	17.0	118.8	0.98	0.99	37.9
East: N4 Off Ramp											
4	L2	221	0.0	0.915	51.3	LOS D	10.7	75.1	1.00	1.12	32.1
6	R2	29	0.0	0.915	51.5	LOS D	10.7	75.1	1.00	1.12	31.8
Approach		250	0.0	0.915	51.4	LOS D	10.7	75.1	1.00	1.12	32.0
North: R575											
8	T1	716	0.0	0.923	13.0	LOS B	21.0	146.9	0.62	0.77	48.5
9	R2	229	0.0	0.923	18.6	LOS B	21.0	146.9	0.62	0.77	46.9
Approach		945	0.0	0.923	14.3	LOS B	21.0	146.9	0.62	0.77	48.1
All Vehicles		1946	0.0	0.923	27.0	LOS C	21.0	146.9	0.81	0.90	41.1

MOVEMENT SUMMARY

Site: [Count 4: R575 / N4 South Ramp - PM - Upgraded]

New Site
Signals - Fixed Time Isolated Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R575											
1	L2	273	0.0	0.198	8.4	LOS A	2.8	19.4	0.32	0.67	51.4
2	T1	324	0.0	0.224	3.0	LOS A	3.4	23.6	0.33	0.28	57.2
Approach		597	0.0	0.224	5.5	LOS A	3.4	23.6	0.33	0.46	54.4
East: N4 Off Ramp											
4	L2	108	0.0	0.763	42.6	LOS D	6.0	42.2	1.00	0.90	34.7
6	R2	54	0.0	0.763	42.7	LOS D	6.0	42.2	1.00	0.90	34.4
Approach		162	0.0	0.763	42.6	LOS D	6.0	42.2	1.00	0.90	34.6
North: R575											
8	T1	440	0.0	0.770	9.0	LOS A	16.9	118.2	0.67	0.73	50.7
9	R2	273	0.0	0.770	14.6	LOS B	16.9	118.2	0.67	0.73	48.9
Approach		713	0.0	0.770	11.1	LOS B	16.9	118.2	0.67	0.73	50.0
All Vehicles		1472	0.0	0.770	12.3	LOS B	16.9	118.2	0.57	0.64	49.2

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	324	0.0	0.166	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	49	0.0	0.099	12.4	LOS B	0.4	2.5	0.74	0.91	48.1
Approach		373	0.0	0.166	1.6	NA	0.4	2.5	0.10	0.12	58.1
North: R35											
7	L2	330	0.0	0.511	5.6	LOS A	0.0	0.0	0.00	0.20	56.5
8	T1	649	0.0	0.511	0.1	LOS A	0.0	0.0	0.00	0.20	58.1
Approach		979	0.0	0.511	2.0	NA	0.0	0.0	0.00	0.20	57.5
West: N4 Off Ramp											
10	L2	419	0.0	0.832	24.9	LOS C	13.8	96.6	0.73	1.62	40.3
12	R2	69	0.0	0.832	58.6	LOS F	13.8	96.6	0.73	1.62	40.0
Approach		488	0.0	0.832	29.7	LOS D	13.8	96.6	0.73	1.62	40.2
All Vehicles		1840	0.0	0.832	9.2	NA	13.8	96.6	0.21	0.56	51.7

MOVEMENT SUMMARY

Site: [Count 5: R35 / N4 North Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	609	0.0	0.312	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
3	R2	35	0.0	0.043	8.9	LOS A	0.2	1.2	0.58	0.76	50.4
Approach		644	0.0	0.312	0.5	NA	0.2	1.2	0.03	0.04	59.3
North: R35											
7	L2	277	0.0	0.366	5.6	LOS A	0.0	0.0	0.00	0.23	56.3
8	T1	422	0.0	0.366	0.0	LOS A	0.0	0.0	0.00	0.23	57.8
Approach		699	0.0	0.366	2.2	NA	0.0	0.0	0.00	0.23	57.2
West: N4 Off Ramp											
10	L2	402	0.0	0.858	25.8	LOS D	10.4	72.6	0.87	1.67	41.1
12	R2	62	0.0	0.858	42.7	LOS E	10.4	72.6	0.87	1.67	40.8
Approach		464	0.0	0.858	28.1	LOS D	10.4	72.6	0.87	1.67	41.1
All Vehicles		1807	0.0	0.858	8.3	NA	10.4	72.6	0.23	0.53	52.6

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	106	0.0	0.161	5.6	LOS A	0.0	0.0	0.00	0.20	56.6
2	T1	202	0.0	0.161	0.0	LOS A	0.0	0.0	0.00	0.20	58.1
Approach		308	0.0	0.161	1.9	NA	0.0	0.0	0.00	0.20	57.6
East: N4 Off Ramp											
4	L2	90	0.0	0.554	15.1	LOS C	3.2	22.6	0.75	1.16	43.6
6	R2	116	0.0	0.554	28.7	LOS D	3.2	22.6	0.75	1.16	43.3
Approach		206	0.0	0.554	22.7	LOS C	3.2	22.6	0.75	1.16	43.4
North: R35											
8	T1	410	0.0	0.210	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	235	0.0	0.174	6.8	LOS A	0.8	5.8	0.42	0.66	51.7
Approach		645	0.0	0.210	2.5	NA	0.8	5.8	0.15	0.24	56.7
All Vehicles		1159	0.0	0.554	5.9	NA	3.2	22.6	0.22	0.39	54.0

MOVEMENT SUMMARY

Site: [Count 6: R35 / N4 South Ramp - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	116	0.0	0.255	5.6	LOS A	0.0	0.0	0.00	0.14	57.1
2	T1	375	0.0	0.255	0.0	LOS A	0.0	0.0	0.00	0.14	58.7
Approach		491	0.0	0.255	1.3	NA	0.0	0.0	0.00	0.14	58.3
East: N4 Off Ramp											
4	L2	65	0.0	0.833	22.5	LOS C	7.4	51.8	0.82	1.45	39.5
6	R2	247	0.0	0.833	33.7	LOS D	7.4	51.8	0.82	1.45	39.3
Approach		312	0.0	0.833	31.4	LOS D	7.4	51.8	0.82	1.45	39.3
North: R35											
8	T1	257	0.0	0.132	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
9	R2	254	0.0	0.232	7.9	LOS A	1.1	7.5	0.55	0.76	51.2
Approach		511	0.0	0.232	3.9	NA	1.1	7.5	0.27	0.38	55.2
All Vehicles		1314	0.0	0.833	9.5	NA	7.4	51.8	0.30	0.54	51.3

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	84	0.0	0.045	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	169	0.0	0.087	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		253	0.0	0.087	1.8	NA	0.0	0.0	0.00	0.19	57.7
North: R35											
8	T1	171	0.0	0.064	0.2	LOS A	0.3	2.0	0.08	0.08	58.9
9	R2	44	0.0	0.064	6.5	LOS A	0.3	2.0	0.30	0.29	54.7
Approach		215	0.0	0.064	1.5	NA	0.3	2.0	0.13	0.12	58.0
West: R542											
10	L2	12	0.0	0.012	8.8	LOS A	0.0	0.3	0.27	0.86	51.6
12	R2	116	0.0	0.209	12.2	LOS B	0.8	5.9	0.55	0.97	49.3
Approach		128	0.0	0.209	11.9	LOS B	0.8	5.9	0.53	0.96	49.5
All Vehicles		596	0.0	0.209	3.9	NA	0.8	5.9	0.16	0.33	55.8

MOVEMENT SUMMARY

Site: [Count 7: R35 / R542 North - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	163	0.0	0.088	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	217	0.0	0.111	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		380	0.0	0.111	2.4	NA	0.0	0.0	0.00	0.25	57.1
North: R35											
8	T1	206	0.0	0.064	0.2	LOS A	0.2	1.4	0.08	0.05	59.2
9	R2	21	0.0	0.064	7.2	LOS A	0.2	1.4	0.21	0.13	56.2
Approach		227	0.0	0.064	0.9	NA	0.2	1.4	0.10	0.06	58.9
West: R542											
10	L2	37	0.0	0.039	9.1	LOS A	0.1	1.0	0.32	0.87	51.5
12	R2	93	0.0	0.196	13.7	LOS B	0.8	5.3	0.60	1.00	48.5
Approach		130	0.0	0.196	12.4	LOS B	0.8	5.3	0.52	0.96	49.3
All Vehicles		737	0.0	0.196	3.7	NA	0.8	5.3	0.12	0.32	56.0

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	98	0.0	0.051	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
3	R2	1	0.0	0.051	5.8	LOS A	0.0	0.0	0.00	0.01	58.0
Approach		100	0.0	0.051	0.1	NA	0.0	0.0	0.00	0.01	59.8
East: Elders Colliery Access											
4	L2	1	0.0	0.023	8.3	LOS A	0.1	0.6	0.35	0.86	51.0
5	T1	1	0.0	0.023	9.7	LOS A	0.1	0.6	0.35	0.86	51.0
6	R2	14	0.0	0.023	9.8	LOS A	0.1	0.6	0.35	0.86	50.8
Approach		16	0.0	0.023	9.7	LOS A	0.1	0.6	0.35	0.86	50.8
North: R35											
7	L2	14	0.0	0.047	5.5	LOS A	0.0	0.0	0.00	0.09	57.6
8	T1	77	0.0	0.047	0.0	LOS A	0.0	0.0	0.00	0.09	59.2
9	R2	15	0.0	0.011	5.8	LOS A	0.0	0.3	0.20	0.54	52.8
Approach		106	0.0	0.047	1.6	NA	0.0	0.3	0.03	0.16	58.0
West: Elders Colliery Access											
10	L2	15	0.0	0.017	8.4	LOS A	0.1	0.4	0.21	0.88	51.7
11	T1	1	0.0	0.017	9.7	LOS A	0.1	0.4	0.21	0.88	51.7
12	R2	1	0.0	0.017	9.6	LOS A	0.1	0.4	0.21	0.88	51.4
Approach		17	0.0	0.017	8.6	LOS A	0.1	0.4	0.21	0.88	51.6
All Vehicles		239	0.0	0.051	2.0	NA	0.1	0.6	0.05	0.19	57.7

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	1	0.0	0.001	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	185	0.0	0.096	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	1	0.0	0.096	5.9	LOS A	0.0	0.0	0.00	0.00	58.0
Approach		187	0.0	0.096	0.1	NA	0.0	0.0	0.00	0.01	59.9
East: Elders Colliery Access											
4	L2	1	0.0	0.028	8.4	LOS A	0.1	0.7	0.43	0.87	50.2
5	T1	1	0.0	0.028	10.8	LOS B	0.1	0.7	0.43	0.87	50.3
6	R2	14	0.0	0.028	11.2	LOS B	0.1	0.7	0.43	0.87	50.0
Approach		16	0.0	0.028	11.0	LOS B	0.1	0.7	0.43	0.87	50.1
North: R35											
7	L2	14	0.0	0.058	5.5	LOS A	0.0	0.0	0.00	0.07	57.7
8	T1	98	0.0	0.058	0.0	LOS A	0.0	0.0	0.00	0.07	59.3
9	R2	15	0.0	0.012	6.2	LOS A	0.0	0.3	0.28	0.55	52.6
Approach		127	0.0	0.058	1.3	NA	0.0	0.3	0.03	0.13	58.2
West: Elders Colliery Access											
10	L2	15	0.0	0.018	8.9	LOS A	0.1	0.5	0.30	0.86	51.4
11	T1	1	0.0	0.018	10.9	LOS B	0.1	0.5	0.30	0.86	51.4
12	R2	1	0.0	0.018	10.9	LOS B	0.1	0.5	0.30	0.86	51.2
Approach		17	0.0	0.018	9.1	LOS A	0.1	0.5	0.30	0.86	51.4
All Vehicles		347	0.0	0.096	1.5	NA	0.1	0.7	0.05	0.13	58.3

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck Access AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	124	0.0	0.064	0.0	LOS A	0.0	0.1	0.01	0.01	59.9
3	R2	1	0.0	0.064	6.2	LOS A	0.0	0.1	0.01	0.01	57.7
Approach		125	0.0	0.064	0.1	NA	0.0	0.1	0.01	0.01	59.9
East: Elders Truck Access											
4	L2	1	0.0	0.037	8.8	LOS A	0.1	0.8	0.37	0.89	51.4
6	R2	29	0.0	0.037	9.1	LOS A	0.1	0.8	0.37	0.89	50.9
Approach		31	0.0	0.037	9.1	LOS A	0.1	0.8	0.37	0.89	51.0
North: R35											
7	L2	29	0.0	0.121	5.6	LOS A	0.0	0.0	0.00	0.07	57.7
8	T1	205	0.0	0.121	0.0	LOS A	0.0	0.0	0.00	0.07	59.3
Approach		235	0.0	0.121	0.7	NA	0.0	0.0	0.00	0.07	59.1
All Vehicles		391	0.0	0.121	1.2	NA	0.1	0.8	0.03	0.12	58.6

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck Access PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	257	0.0	0.132	0.0	LOS A	0.0	0.1	0.00	0.00	60.0
3	R2	1	0.0	0.132	6.0	LOS A	0.0	0.1	0.00	0.00	57.7
Approach		258	0.0	0.132	0.0	NA	0.0	0.1	0.00	0.00	60.0
East: Elders Truck Access											
4	L2	1	0.0	0.040	8.5	LOS A	0.1	0.9	0.40	0.90	51.1
6	R2	29	0.0	0.040	9.6	LOS A	0.1	0.9	0.40	0.90	50.7
Approach		31	0.0	0.040	9.5	LOS A	0.1	0.9	0.40	0.90	50.7
North: R35											
7	L2	29	0.0	0.090	5.5	LOS A	0.0	0.0	0.00	0.10	57.5
8	T1	145	0.0	0.090	0.0	LOS A	0.0	0.0	0.00	0.10	59.1
Approach		175	0.0	0.090	0.9	NA	0.0	0.0	0.00	0.10	58.8
All Vehicles		463	0.0	0.132	1.0	NA	0.1	0.9	0.03	0.10	58.8

Horizon Year plus Elders Colliery Operational Trip Generation to Forzando North Mine

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	15	0.0	0.008	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	98	0.0	0.059	0.0	LOS A	0.1	0.6	0.05	0.07	59.1
3	R2	14	0.0	0.059	5.7	LOS A	0.1	0.6	0.05	0.07	57.3
Approach		127	0.0	0.059	1.3	NA	0.1	0.6	0.04	0.13	58.2
East: Elders Colliery Access											
4	L2	14	0.0	0.015	8.3	LOS A	0.1	0.4	0.18	0.89	51.7
5	T1	1	0.0	0.015	9.7	LOS A	0.1	0.4	0.18	0.89	51.7
6	R2	1	0.0	0.015	9.5	LOS A	0.1	0.4	0.18	0.89	51.4
Approach		16	0.0	0.015	8.5	LOS A	0.1	0.4	0.18	0.89	51.7
North: R35											
7	L2	1	0.0	0.040	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	77	0.0	0.040	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
9	R2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.21	0.52	52.8
Approach		79	0.0	0.040	0.1	NA	0.0	0.0	0.00	0.01	59.8
West: Elders Colliery Access											
10	L2	1	0.0	0.025	8.4	LOS A	0.1	0.7	0.36	0.86	51.0
11	T1	1	0.0	0.025	9.7	LOS A	0.1	0.7	0.36	0.86	51.1
12	R2	15	0.0	0.025	9.8	LOS A	0.1	0.7	0.36	0.86	50.8
Approach		17	0.0	0.025	9.7	LOS A	0.1	0.7	0.36	0.86	50.8
All Vehicles		239	0.0	0.059	2.0	NA	0.1	0.7	0.06	0.20	57.6

MOVEMENT SUMMARY

Site: [Count 9: R35 / Elders Colliery Access - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
1	L2	15	0.0	0.008	5.5	LOS A	0.0	0.0	0.00	0.58	53.6
2	T1	185	0.0	0.104	0.0	LOS A	0.1	0.7	0.03	0.04	59.5
3	R2	14	0.0	0.104	5.8	LOS A	0.1	0.7	0.03	0.04	57.6
Approach		214	0.0	0.104	0.8	NA	0.1	0.7	0.03	0.08	58.9
East: Elders Colliery Access											
4	L2	14	0.0	0.016	8.4	LOS A	0.1	0.4	0.21	0.88	51.5
5	T1	1	0.0	0.016	10.9	LOS B	0.1	0.4	0.21	0.88	51.6
6	R2	1	0.0	0.016	10.9	LOS B	0.1	0.4	0.21	0.88	51.3
Approach		16	0.0	0.016	8.7	LOS A	0.1	0.4	0.21	0.88	51.5
North: R35											
7	L2	1	0.0	0.051	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	98	0.0	0.051	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
9	R2	1	0.0	0.001	6.2	LOS A	0.0	0.0	0.29	0.52	52.5
Approach		100	0.0	0.051	0.1	NA	0.0	0.0	0.00	0.01	59.8
West: Elders Colliery Access											
10	L2	1	0.0	0.030	8.9	LOS A	0.1	0.8	0.45	0.87	50.2
11	T1	1	0.0	0.030	10.8	LOS B	0.1	0.8	0.45	0.87	50.3
12	R2	15	0.0	0.030	11.2	LOS B	0.1	0.8	0.45	0.87	50.0
Approach		17	0.0	0.030	11.0	LOS B	0.1	0.8	0.45	0.87	50.1
All Vehicles		347	0.0	0.104	1.5	NA	0.1	0.8	0.05	0.14	58.3

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck Access AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: RoadName											
2	T1	103	0.0	0.072	0.1	LOS A	0.2	1.3	0.11	0.13	58.4
3	R2	29	0.0	0.072	5.8	LOS A	0.2	1.3	0.11	0.13	56.3
Approach		133	0.0	0.072	1.4	NA	0.2	1.3	0.11	0.13	57.9
East: RoadName											
4	L2	29	0.0	0.024	8.4	LOS A	0.1	0.6	0.21	0.88	51.8
6	R2	1	0.0	0.024	8.5	LOS A	0.1	0.6	0.21	0.88	51.3
Approach		31	0.0	0.024	8.4	LOS A	0.1	0.6	0.21	0.88	51.7
North: RoadName											
7	L2	1	0.0	0.057	5.5	LOS A	0.0	0.0	0.00	0.01	58.3
8	T1	111	0.0	0.057	0.0	LOS A	0.0	0.0	0.00	0.01	59.9
Approach		112	0.0	0.057	0.1	NA	0.0	0.0	0.00	0.01	59.9
All Vehicles		275	0.0	0.072	1.6	NA	0.2	1.3	0.07	0.16	57.9

MOVEMENT SUMMARY

Site: 101 [R35 / Elders Truck Access PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: RoadName											
2	T1	195	0.0	0.119	0.1	LOS A	0.2	1.4	0.08	0.08	59.0
3	R2	29	0.0	0.119	5.9	LOS A	0.2	1.4	0.08	0.08	56.8
Approach		224	0.0	0.119	0.8	NA	0.2	1.4	0.08	0.08	58.7
East: RoadName											
4	L2	29	0.0	0.025	8.5	LOS A	0.1	0.7	0.23	0.87	51.7
6	R2	1	0.0	0.025	9.2	LOS A	0.1	0.7	0.23	0.87	51.2
Approach		31	0.0	0.025	8.5	LOS A	0.1	0.7	0.23	0.87	51.7
North: RoadName											
7	L2	1	0.0	0.069	5.5	LOS A	0.0	0.0	0.00	0.00	58.3
8	T1	133	0.0	0.069	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
Approach		134	0.0	0.069	0.0	NA	0.0	0.0	0.00	0.00	59.9
All Vehicles		388	0.0	0.119	1.2	NA	0.2	1.4	0.06	0.12	58.5

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - AM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	117	0.0	0.060	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	56	0.0	0.045	6.1	LOS A	0.2	1.2	0.25	0.56	52.6
Approach		173	0.0	0.060	2.0	NA	0.2	1.2	0.08	0.18	57.4
East: Road to Forzando North Mine											
4	L2	27	0.0	0.083	5.9	LOS A	0.3	2.1	0.25	0.58	52.7
6	R2	33	0.0	0.083	9.2	LOS A	0.3	2.1	0.25	0.58	52.1
Approach		60	0.0	0.083	7.7	LOS A	0.3	2.1	0.25	0.58	52.3
North: R35											
7	L2	33	0.0	0.021	5.8	LOS A	0.1	0.6	0.13	0.52	53.8
8	T1	151	0.0	0.039	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		184	0.0	0.039	1.0	LOS A	0.1	0.6	0.02	0.09	58.8
All Vehicles		417	0.0	0.083	2.4	NA	0.3	2.1	0.08	0.20	57.2

MOVEMENT SUMMARY

Site: [Count 10: R35 / Road to Forzando North Mine - PM]

New Site
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: R35											
2	T1	229	0.0	0.117	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
3	R2	13	0.0	0.011	6.2	LOS A	0.0	0.3	0.28	0.55	52.6
Approach		242	0.0	0.117	0.3	NA	0.0	0.3	0.01	0.03	59.5
East: Road to Forzando North Mine											
4	L2	87	0.0	0.156	6.0	LOS A	0.6	4.1	0.24	0.57	52.7
6	R2	38	0.0	0.156	11.3	LOS B	0.6	4.1	0.24	0.57	52.2
Approach		125	0.0	0.156	7.6	LOS A	0.6	4.1	0.24	0.57	52.6
North: R35											
7	L2	49	0.0	0.030	5.6	LOS A	0.1	0.9	0.06	0.53	54.1
8	T1	183	0.0	0.047	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		232	0.0	0.047	1.2	LOS A	0.1	0.9	0.01	0.11	58.6
All Vehicles		599	0.0	0.156	2.2	NA	0.6	4.1	0.06	0.17	57.6

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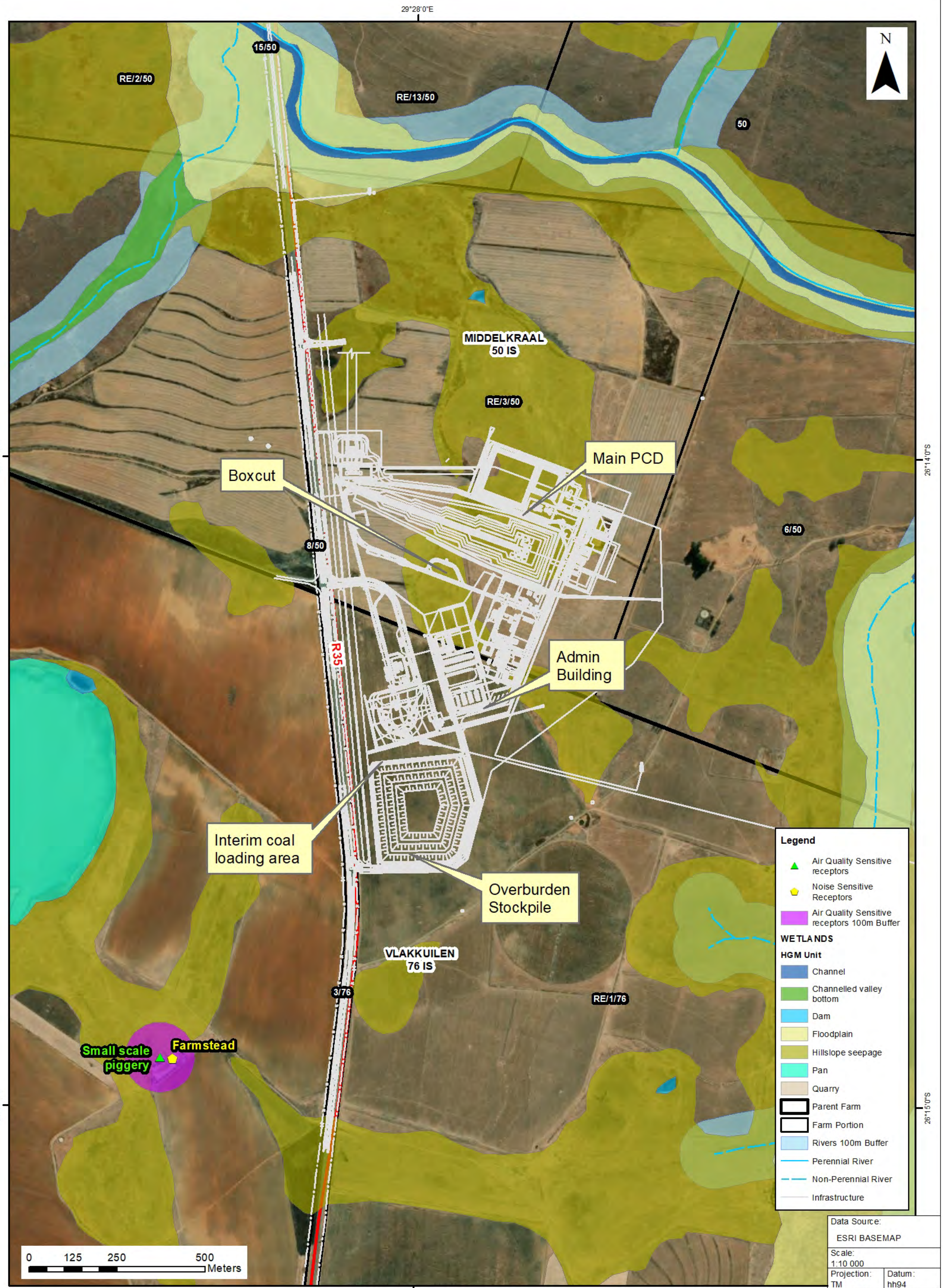
Appendix H: Final Layout Map



Data Source: ESRI BASEMAP

Scale: 1:10 000

Projection: TM | Datum: hh94

Central Meridian/Zone: LO 29

Date: 03/09/2021 | Compiled by: SCHB

Project No. 570283 | Figure APPENDIX H

srk consulting

ELDERS COLLIERY
FINAL LAYOUT MAP

Path: J:\Proj\570283_Elders_EIA_WULA\8GIS\GISPROJ\MXD\570283_A3P_Elders_Block Plan_Sensitivity Map_zoom_20210903.mxd

Revision: A Date: 08 2021

Appendix I: Biodiversity Action Plan

BIODIVERSITY ACTION PLAN FOR ELDERS COLLIERY PROVINCE

ANGLO AMERICAN INYOSI COAL (PTY) LTD

JANUARY 2014

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This document has been prepared by Digby Wells Environmental.

Report Title: **Biodiversity Action Plan for Elders Colliery**

Project Number: **SRK1860**

Name	**Responsibility**	**Signature**	**Date**
Brett Reimers	Report Compiler		
Brett Coutts	Report Reviewer		
Andrew Husted	Report Reviewer		

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1 INTRODUCTION

The variation of life forms within an ecosystem (plants and animals, ecosystems and landscapes, and the ecological and evolutionary processes that allow these) can be referred to as *Biodiversity* and is a measure of the health of ecosystems. (Ferrar and Lotter, 2007) The benefits of Biodiversity are widely accepted as vital for ensuring the going provision of ecosystem services such as production of clean water, prevention of erosion, carbon storage and clean air. Loss of Biodiversity puts aspects of our life at risk and reduces socio-economic options for future generations and therefore protection of Biodiversity is regarded as essential.

As human impacts on the environment expand in intensity and extent, there is a critical need to understand the degree of intersection between conservation priorities for biodiversity and for ecosystem services (DEA, 2012). This intersection of conservation priorities could achieve a measured and thoughtful balance between previously competing goals, while providing new sources of funding for its full-scale implementation (Chan et al. 2006).

Biodiversity within South Africa provides an important basis for economic growth and development, in obvious ways such as providing a basis for rangelands that support commercial and subsistence farming. Keeping Biodiversity intact is vital for ensuring provision of ecosystem services such as production of clean water through good catchment management, prevention of erosion, carbon storage and clean air. Loss of Biodiversity puts aspects of the South African economy and quality of life at risk, which also reduces socio-economic options for future generations (NBF, 2007). Conservation of Biodiversity is a critical issue for today's society. The issue was formally recognised at the Convention on Biological Diversity (CBD) which was opened for signature at the 1992 Earth Summit. The CBD has three primary goals including; the conservation of biodiversity, sustainable use of biodiversity in order that the benefits can be ensured for future generations; and fair and equitable sharing of benefits arising from the use of genetic resources (Coombes, 2004). Traditionally the role of Biodiversity Conservation sat with Government and non-governmental organisations. There is now increasing realisation that all sectors of society need to engage collaboratively in order to manage Biodiversity sustainably (CBD, 2012).

There are a number of important issues influencing the sustainability of land resources within South Africa and the services that they provide. Limited agricultural resources and high population numbers continue to exert pressure on the country's land resources. These factors, in combination with the potential impacts of climate change, land degradation and desertification on the limited agricultural resources of the country, emphasise the need for integrated management and conservation of agricultural land. The social impacts and economic costs of not managing ecosystems in a sustainable manner is high, as is demonstrated through land degradation, loss of ecosystem resilience, loss of freshwater resources, the intensification of the global carbon cycle and resulting climate change, the loss of fishing stock and the deterioration of air quality. It is therefore obvious that economic valuation of Biodiversity is needed and can help in better informing decision-making processes (NBF, 2007).

The significance of Biodiversity and good land use has been recognised internationally, nationally and locally. National legislation, policies and standards promoting the protection of Biodiversity and effective land use has subsequently been promulgated and developed.

The report describes an integrated management plan which is the product of a synthesis of specialist recommendations regarding Biodiversity and land management within the Elders Colliery Project Area.

2 ASSUMPTIONS AND LIMITATIONS

- Studies conducted were based on the current mine plan, should this plan change further studies may need to be conducted in order to reassess impacts and potentially different mitigation strategies;
- This Biodiversity Action Plan (BAP) is based on the work of various specialists and specialist reports that are all subject to their own set of assumptions and limitations, this document therefore is also limited by the same set of criteria as the supporting documents.

3 LEGISLATION

Various legislation and associated frameworks have been considered and complied with in the development of the BLMP. The overarching legislation is described in Table 3.1 below.

Table 3-1: Legislation which has guided the development of the Elders Colliery BAP

LEGISLATION	RELEVANCE
Convention on Biological Diversity (CBD)	*The treaty aims to effect international cooperation in the conservation of biological diversity and to promote the sustainable use of living natural resources worldwide.*
National South African Constitution (Constitution) **Section 24**	*"Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development..."*
National Environmental Management Act (NEMA) No. 107 of 1998 **NEMA Principles and EIA Regulations**	*Environmental Management must place people and their needs at the forefront of its concern. Development must be socially, environmentally and economically sustainable. Sustainable development requires the consideration of all relevant factors.* *The Environmental Impact Assessment (EIA) regulations (GN R. 385) dictate that any development that could result in significant environmental pollution or degradation is required to undertake an EIA process. The EIA regulations also provide for the formulation of Environmental Management Frameworks for designated geographic*

LEGISLATION	RELEVANCE
	areas to promote pro-active decision-making with regards to the choice of development alternatives.
National Biodiversity Act, Act 10 of 2004 (NEMBA) **Chapter 3 and 4**	*"To provide for the management and Conservation of South Africa's Biodiversity within the framework of the National Environmental Management Act, 1998;* *The protection of species and ecosystems that warrant national protection;* *The sustainable use of indigenous biological resources, the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment of functions of a South African Biodiversity Institute, and for matters herewith."*
Conservation of Agricultural Resources (CARA) Act 43 of 1983	*To provide for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.*
National Water Act (NWA)	*Ensures sustainable use of water through the protection of quality of water resources for the benefit of all water users. Aquatic and wetland ecosystems are protected by legislation in order to secure ecologically sustainable development and use of the relevant water resources.*
National Forests Act 84 of 1998 (NFA)	*Natural Forest and woodland form an important part of the Biodiversity of the country. They must be conserved and protected in accordance with the principles of sustainable management. This Act guides decisions affecting forests with regards to conservation of biological diversity, ecosystems, habitats and natural resources.*

In addition to this legislation a number of frameworks have guided the BAP. The various frameworks which have been referenced and used as a guide in the formulation of the BAP are listed in Table 3-2 below.

Table 3-2: Frameworks which have guided the development of the Elders BAP

FRAMEWORK	RELEVANCE
National Biodiversity Framework (NBF) **Section 4**	*Conservation and development focussed on the most urgent strategies and actions required for Biodiversity management. It defines roles and responsibilities for key stakeholders, including key organs of state and the private sector.*
National Spatial Biodiversity	*South Africa's National Spatial Biodiversity Assessment (NSBA) is the first ever comprehensive spatial assessment of Biodiversity throughout the country. It has four components dealing with the terrestrial,*

FRAMEWORK	RELEVANCE
Assessment (NSBA)	*freshwater, estuarine and marine environments.*

4 METHODOLOGY

The development of the Elders Colliery BAP involved a number of steps. The steps all contribute to a framework in which Biodiversity of the project area is defined and assessed in order to develop a management plan for the Elders Colliery. The diagram below illustrates the various steps taken in development of the BAP.

Specialist Studies

Step 1	Determine Biodiversity value of land within project boundary
Step 2	Determine Biodiversity value of land outside project boundary
Step 3	Determine key components that define the Biodiversity
Step 4	Determine project activity that poses a risk to the Biodiversity
Step 5	Define Biodiversity objectives for land **not impacted** by the project
Step 6	Compile Biodiversity and land management plan
Step 7	Develop management tool

Figure 4-1: Steps taken during the development of the BAP

4.1 Specialist Assessments

Baseline information related to the various specialist fields was required in order to ascertain the current ecological state and land use for the Elders Colliery area. Recent baseline and EIA reports generated for the project area were utilized for the formation of the BAP.

4.2 Step 1: Biodiversity value of land within project area

In order to adequately include all aspects of biodiversity as described by the CBD it is important to give a qualitative definition of the ‘perceived biodiversity value’ of the land within the Elders Colliery boundaries. This is done at a broad level, to simply categorise the total area of land owned based on potential biodiversity value. Biodiversity Value is understood as being a combination of the conservation status and the functional status of the area.

Functional Status refers to an indication of the services provided by an area and includes both ecological and human related services. Functional Status depends on the degree to which the area or system still provides a noticeable service.

Conservation Status depends on;

- The amount of the area or system remaining (the extent);
- The diversity in terms of 1. Proportional species composition of the area of system, 2. The presence of ecosystems/habitat and species which are endemic, threatened, vulnerable of have particularly high religious/cultural value; and
- The degree to which the area or system reflects/represents its original state.

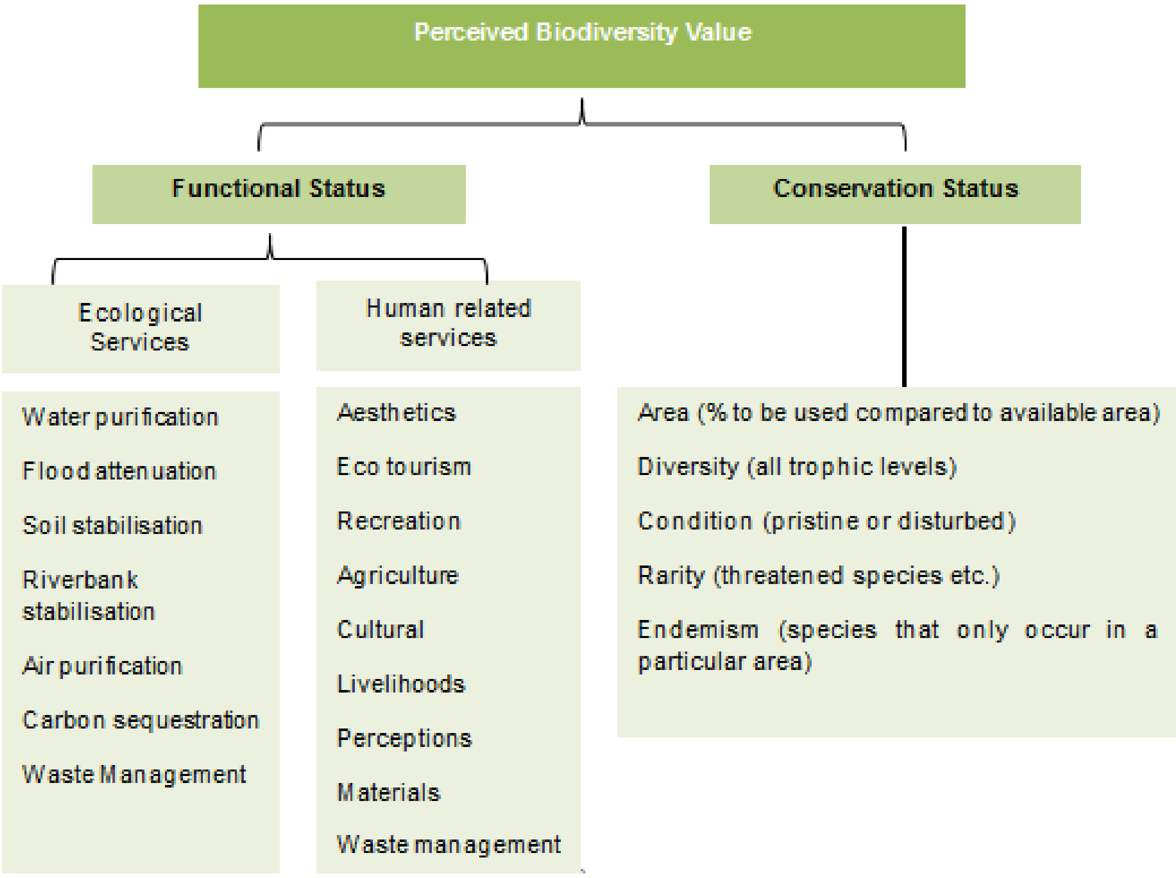

Figure 4-2: Perceived Biodiversity Value

The final decision on the biodiversity value of an area depends on the combination of the functional and conservation status (Coombes, 2004). In assessing the biodiversity value of the area various literature and data is referenced such as that of the International Union of the Conservation of Nature (IUCN), Plants of South Africa (POSA), etc. Based on this approach the total land surface within the project area is categorised into the following biodiversity classes as listed in Table 4-1 below.

Table 4-1: Score table describing the Biodiversity value scores (Step 1 and 2)

Score	Biodiversity Value	Percentage Score
1	Very High Biodiversity Value	0 - 25%
2	High Biodiversity Value	25-50%
3	Moderate Biodiversity Value	50 – 75%
4	Low Biodiversity Value	75 – 100%

The entire area is divided into various land management units within the project boundary and assigned a score reflecting the particular biodiversity value of the unit, according to this system.

4.3 Step 2: Determination of the Biodiversity value of land adjacent to project area

This step is performed in order to identify the areas of land that are contiguous or close to the site that would likely be affected by development on the site through indirect effects such as access roads, inward migration resulting in informal settlements, etc (Coombes, 2004)

Based on this step, areas of contiguous land that would be likely to be affected by the project will be categorised or subdivided into Biodiversity classes similar to Step 1, as listed in Table 4-1, above. This component of the study consisted largely of desktop studies which have been jointly considered in order to describe the relevant Biodiversity Values for the selected systems. A desktop level assessment for the adjacent areas was undertaken with reference to spatial information which included the following:

4.4 Step 3: Determining the key components of Biodiversity Value

Where the biodiversity value of land has been categorised from Steps 1 and 2, it is important to understand the key components of that value if the biodiversity is to be appropriately managed. To achieve this

- Quantitative measurement of Conservation Status

  This includes the determination of:

  - Species diversity;
  - Threatened Species; and
  - Endemic Species.

- Quantitative measurement Ecological Functioning

  If the ecological services provided by an area are considered to be of value or particularly important, it is recommended that the appropriate specialist be appointed to quantify the service. From this a monitoring system should be developed.

- Quantitative measurement of human service provision

  Human service provision of an area can be defined and its use recorded. Examples of this are; number of persons using a defined area for recreation, what type and how frequent, or Actual plants used for medicinal purposes; the importance of traditional medicine in the area.

4.5 Step 4: Determination of risks to Biodiversity

Once the Biodiversity value of an area has been defined, it then becomes possible to assess the extent to which the Biodiversity may be affected by the activities associated with the Elders operations. This is achieved through overlaying the mine plane on the Biodiversity categories map (a map illustrating the various Biodiversity land management units and their various scores). This then reflects the extent to which Biodiversity is at risk due to the operations.

In managing Biodiversity the mitigation hierarchy is applied;

1. Designing to avoid harm to Biodiversity
2. Where harm to Biodiversity is unavoidable it then becomes necessary to mitigate the impact.
3. Sites of very high and high Biodiversity value need more than to simply reduce the impact. In these cases a 'No go' option is implemented.

In order to further understand the extent to which each activity affects the Biodiversity an interactive matrix is used which illustrated the interactions with particular land management units. An example of an interactive matrix, as presented in Table 4-2 below describes the project activities of Elders Colliery Operations in the vertical axis, and the Biodiversity management units along the horizontal axis. This approach rigorously identifies the extent to which the project affects Biodiversity (Coombes, 2004).

Table 4-2: Example of the project interaction matrix (Step 4)

Project Activities	Land Units			
	Unit 1	Unit 1	Unit 1	Unit 1
Activity 1	■		■	■
Activity 1		■		
Activity 1		■		■

■ **Note:** denotes interaction between the activity and unit

To determine the potential significance of each interaction between the project and a land unit, the following Biodiversity impact matrix, based on a combination of the conservation status and functional status, is applied. It is important to remember that a small impact on a component that is of high Biodiversity value may be deemed significant, and therefore should receive priority attention.

Table 4-3: Significance of interactions

Conservation Status	Functional Status			
	Very High service value	High service value	Moderate service value	Low service value
Very High	Very high impact	Very high impact	Very high impact	High Impact
High	Very high impact	High Impact	High Impact	Moderate impact
Moderate	High Impact	Moderate impact	Moderate impact	Low impact
Low	Moderate impact	Low impact	Low impact	Low impact

4.6 Step 5: Definition of land management objectives for land not impacted by the project

Once the nature and extent of all the aspects and components making up biodiversity has been determined (Steps 1 to 4), areas of land not affected by the project are identified. It is necessary to set biodiversity objectives for these units. Biodiversity objectives take into account a broad range of social, economic and environmental concerns. Furthermore past and present land uses are considered. Table 4-4 below describes typical management objectives for areas of land not affected by the mining operations.

Table 4-4: Typical objectives assigned to land Management Units

Management Unit (MU)	Biodiversity Value	Objective	
MU 1	Very High Biodiversity Value	***Maintain :***	Variation and complexity of species Ecological Processes Human Use Value
MU 2	High Biodiversity Value	***Maintain and where necessary improve:***	Variation and complexity of species Ecological Processes Human Use Value
MU 3	Moderate Biodiversity Value	***Improve and Maintain:***	Variation and complexity of species Ecological Processes Human Use Value
MU 4	Low Biodiversity Value	***Improve:***	Variation and complexity of species Improve ecological Processes Improve Human Use Value

4.7 Step 6: Biodiversity and Land Management Plan Compilation

The outputs of Steps 1 – 5 undertaken by the various specialists in the respective reports are then mapped and integrated to develop an understanding of biodiversity units within the area and surrounds and the biodiversity value.

These biodiversity management units describe the

- Extent and condition;
- Abundance of habitats associated species;
- Ecological services provided;
- Extent of Human use; and
- Contribution to National, Local biodiversity objectives.

Based in this information the BAP will define and describe;

- A Biodiversity aim and respective objectives for each unit.
- For each objective a key performance indicator should be defined together with actions, responsibilities, resources and deadlines required to achieve the objective.

4.8 Step 7: Interactive map

The information generated for the project will be incorporated into a GIS tool which will allow for information to be accessed and visually represented. The interactive Compliance Management Tool is a GIS based interactive programme which encompasses basic GIS functioning and assigns management related actions to specific entities within a project area.

The interactive map allows users to identify and query any feature illustrated on the map. Users click on an area or point of interest, which initiates a pop-up window which contains general information pertaining to that particular aspect, such as the identity, area, length, type of feature, responsibility and ecological state for example. This information also includes a hyperlink tab which links to an action items spread sheet. Each of the prescribed action items are assigned an urgency as well as a recommended implementation date. The implementation of these prescribed action items can also be monitored. This tool can then by amended according to the project schedule and requirements where needed so as to provide an up-to-date information database for decision makers. Table 4-5 below summarises the various steps taken in developing the BAP.

Table 4-5: Summary of the Steps taken in defining Biodiversity Value

STEP	ASSESS	DESCRIPTION	OUTCOMES
Biodiversity Value of land within project area	Conservation Status	The amount of area still remaining, The diversity and the degree to which the area is representative of its original state.	Biodiversity Value Scores • Very High • High • Moderate • Low
	Functional Status	The degree to which an area, or system still provides a noticeable service.	
Biodiversity Value of land outside project area	Biodiversity Value of surrounding land	Integrated findings of MBCP, threatened ecosystems and FEPAs.	See Step 1
Key components that define Biodiversity Value	Measurement of conservation status and ecological functioning, human service provision.	• Species diversity, threatened species, endemic species • Ecosystem services • Socio-economic uses	See Step 1 and Step 2
Risks to Biodiversity	Extent to which Biodiversity is affected by operations	Mine plan overlaid on Biodiversity category areas map in order to identify project activities which interact or affect Biodiversity.	The significance of each interaction is then assessed Areas thus have associated Impact scores
Biodiversity Management objectives for land not impacted by project	Past land use, potential and future land use	Socio economic and environmental uses of the land	Areas which need to be maintained and improved
Biodiversity objectives for land impacted by project	Level of impact and mitigation strategy	Values which have been defined and the resulting impact score of interaction of mining activity with Biodiversity management units	Consider "No go" option Minimise the impact footprint Implement Biodiversity offset Restore ecosystem functions
Biodiversity and Land Management Plan	All steps and design plan	Information which has been gathered through various Steps (1-6)	Map of Biodiversity management units with associated activities
Management tool	Suitability for application	Information from BAP report	ArcReader

5 POLICIES AND STANDARDS

Various policies and standards have been considered in the formulation of the Elders Colliery BAP. These include policies and standards listed in Table 5-1 below.

Table 5-1: Policies and Standards which have guided the development of the Elders Colliery BAP

POLICY/STANDARD	RELEVANCE
International Council for Mining and Metallurgy (ICMM) Sustainable Development Framework Principle 7	*Contribute to conservation of Biodiversity and integrated approaches to land use planning, Respect legally designated protected areas, Disseminate scientific data on and promote practices and experiences in Biodiversity assessment and management.*
International Finance Corporation (IFC) Performance Standard 6	*Recognizes that protecting and conserving Biodiversity – the variety of life in all its forms, is fundamental to sustainable development. The Standard reflects the objectives of the CBD. The standard addresses avoidance and mitigation of threats to Biodiversity.*
Anglo American **Policies and Standards**	*'Active stewardship of Biodiversity in all phases of our activities'. Anglo has stated commitment to the wise use of natural environment as well as the prevention or minimisation of environmental impacts arising from operations.*

6 TERMS OF REFERENCE

Digby Wells Environmental (Digby Wells) was commissioned by SRK Consulting (Pty) Ltd to produce a management action plan for Anglo American Inyosi Coal to aid in the management of biodiversity within the Elders Colliery. The Management Plan would incorporate the following.

- Prescribed management action items for identified current and potential impacts;
- Protected Plant species management plan, that will be incorporated into the BAP and interactive GIS tool; and
- Geographic Information Systems (GIS) tool integrating specialist findings, impact scenarios and action items; and an interactive management action item tool for quality control are provided.

7 AIMS AND OBJECTIVES

The overall purpose Biodiversity Action Plan is to determine the Biodiversity value of land resources, as well as to develop management strategies for these resources in order to achieve desired conservation or economic uses. It is further envisaged that the BAP for Anglo America Inyosi Coal managed land resources will assist in the realisation of the following environmental, social and cultural objectives:

- Minimising and restoring degraded land;
- Conserving and enhancing Biodiversity;
- Effective and timely mine rehabilitation;
- Preventing contamination and ensuring early rehabilitation of existing contaminated land;
- Recognising opportunities for conservation management;
- Minimising impacts on local communities including maximising opportunities for communities to continue to use acquired land in a sustainable manner; and
- Efficient and effective management of property assets.

8 STUDY AREA

8.1 Location

Elders Colliery is located in Mpumalanga Province close to the town of Bethal (as seen in Figure 8-1). The proposed workings are within 10 km of another Anglo American Inyosi Coal Site Goedehoop where the coal will be processed. The coal will be transferred via conveyor belt between Elders Colliery and Goedehoop. The proposed conveyor will stretch between two quaternary catchments. The quatenery catchments are B11A and B11B.

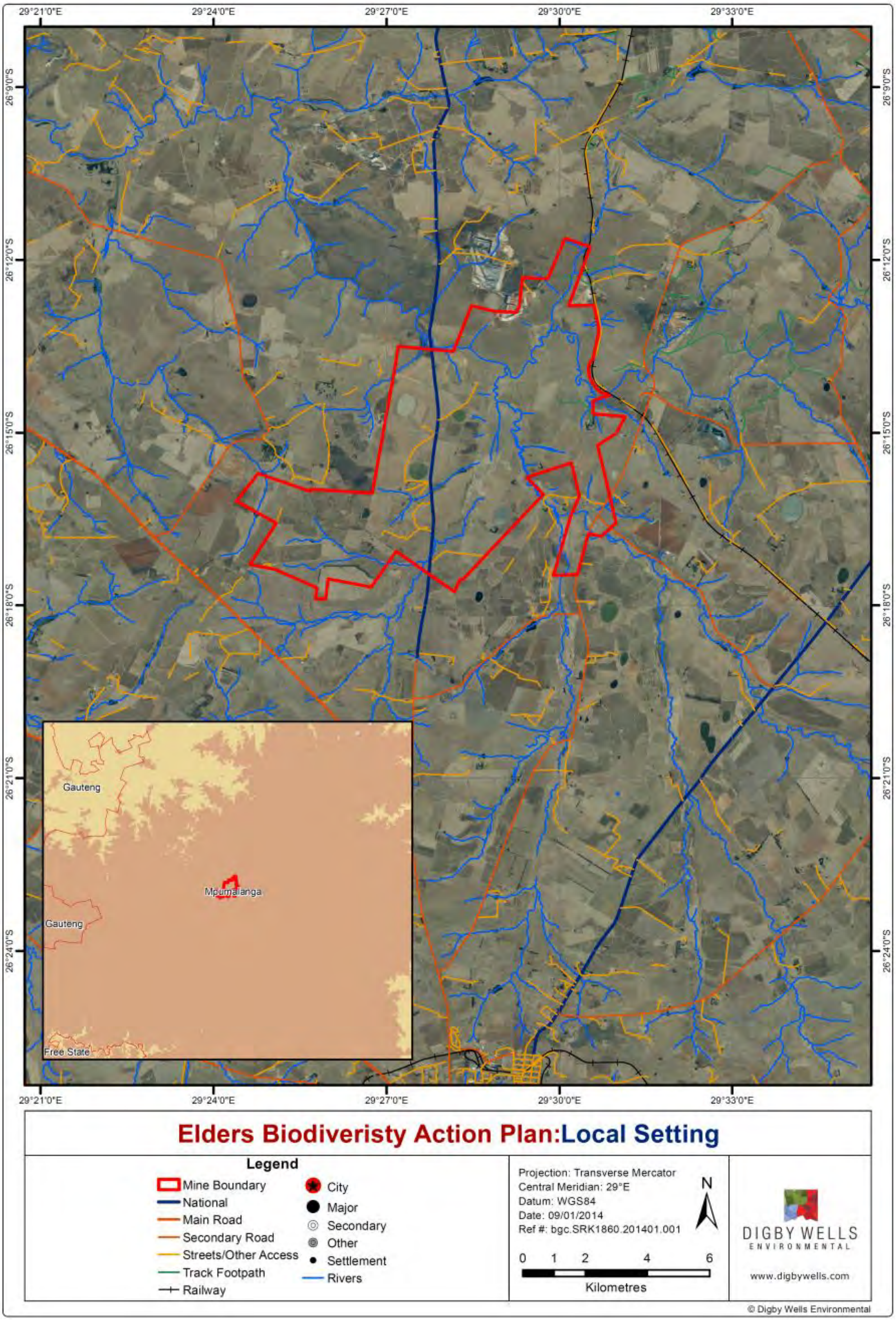

Figure 8-1: Map illustrating the Elders Colliery Project Area

8.2 Flora and Fauna

The study area is situated within the Grassland Biome of South Africa (Rutherford & Westfall, 1986, Mucina & Rutherford 2006). The Grassland Biome is found on the high central plateau of South Africa, and the inland areas of Kwazulu-Natal and the Eastern Cape. The topography is mainly flat and rolling, but includes the escarpment itself. The altitude where this biome occurs varies from near sea level to 2 850 m above sea level. The vegetation type consists of a simple, single-layered herbaceous community of mainly tussocked grasses, herbs and forbs. High rainfall on the cold, frosty, Mpumalanga highveld, together with sandy soils, controls the distribution of this vegetation type.

Grasslands are dominated by a single layer of grasses (Rutherford & Westfall, 1986). The amount of cover depends on rainfall and the degree of grazing. Trees are absent, except in a few localized habitats. Geophytes are often abundant. Frost, fire and grazing maintain the grass dominance and prevent the establishment of trees (Rutherford & Westfall, 1986).

The study area is situated within an area vegetated by the Moist Sandy Highveld Grassland vegetation type according to Low & Rebelo (1998) with the most recent vegetation classification, classifying it as Eastern Highveld Grassland (Mucina & Rutherford 2006) (Figure 8-2). The vegetation type is considered to be Endangered nationally with none conserved and 55% altered, primarily by cultivation.

The grassland biome is one of the most threatened biomes in South Africa, due to agricultural and mining activities. According to the publication “THE BIODIVERSITY OF SOUTH AFRICA” (Le Roux 2002), 60-80% of the grassland biome is irreversibly transformed, while only 2% is formally conserved.

It lists the geophyte *Hypoxis hemerocallidea* (Star Flower) as a flagship species. This species is under pressure as a medicinal plant and its status needs to be revised every five years.

The site has seen a large degree of transformation in the form of cultivation and grazing as can be seen from the Table 8-1.

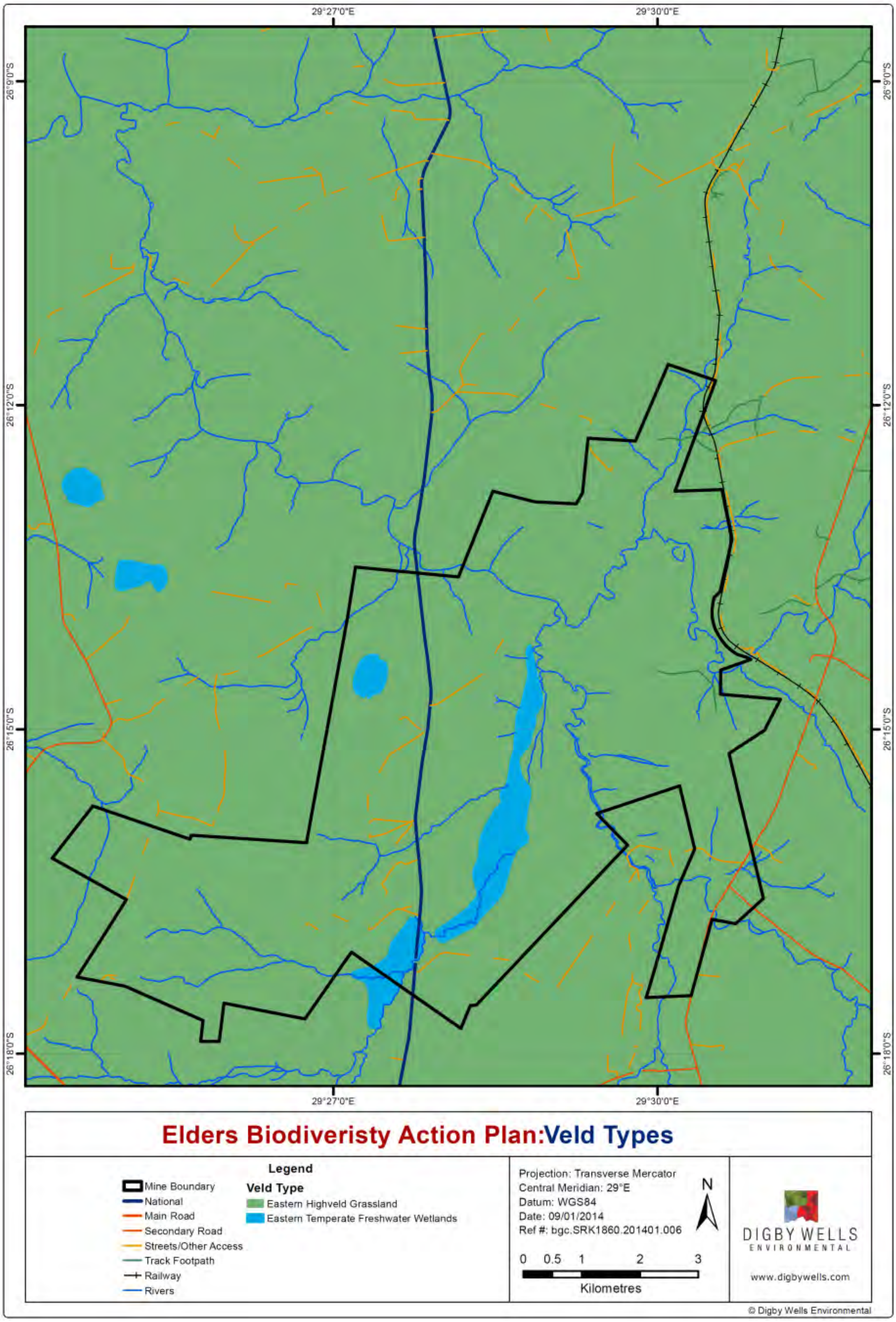

Figure 8-2: Veld types within Elders Colliery project boundary

Table 8-1: Broad land cover of the study area and surrounds

Broad Land Cover Categories	Derived Ecological Status		Total (Ha)	% Cover
	Natural (Ha)	Transformed (Ha)		
Bare Rock and Soil (erosion : dongas / gullies)	66		66	0%
Cultivation (Various)		63838	63838	46%
Forestry (Various)		70	70	0%
Mines & Quarries (surface-based mining)		2064	2064	1%
Thicket, Bushland, Bush Clumps, High Fynbos	1		1	0%
Unimproved (natural) Grassland	69836		69836	51%
Urban/ Built- up (Various)		467	467	0%
Water bodies	731		731	1%
Wetlands	1006		1006	1%
Total	71640	66439	138080	100%
Total (%)	52%	48%		

*Adapted from EkoInfo CC 2013 report.

9 GENERAL

Elders Colliery lies on gently undulating terrain with elevations ranging from 1585-1661 mams. The average annual rainfall is approximately 696mm (Max 1032 mm). The minimum and maximum temperate is 15°C and 27° C respectively. Gusty winds usually occur between August and September and frost occurring between May and August.

10 BIODIVERSITY WITHIN PROJECT AREA

10.1 Geology

Elders Colliery lies in the Central Block of the Springs-Witbank Coalfield. Lithologies are Permian and Triassic Age segments of the Dwyka and Vryheid Formations of the coal bearing Ecca Group of the Karoo. Extensive alluvial deposits are found bordering the larger rivers and streams. Small amounts of dolerite and granite also occur on the site.

10.2 Soils

Sand stone weathers to form snady soils which allow for ease of infiltration by surface water, this ease of infiltration limits runoff. Shallow perched water tables result from shallow impermeable layers below the sandy soil which allows for seasonal or permanent saturation of the soils within the top 50 cm of the profile.

A detailed soils investigation was carried out within the proposed project area which resulted in the compilation of the soils map seen in Figure 10-1.

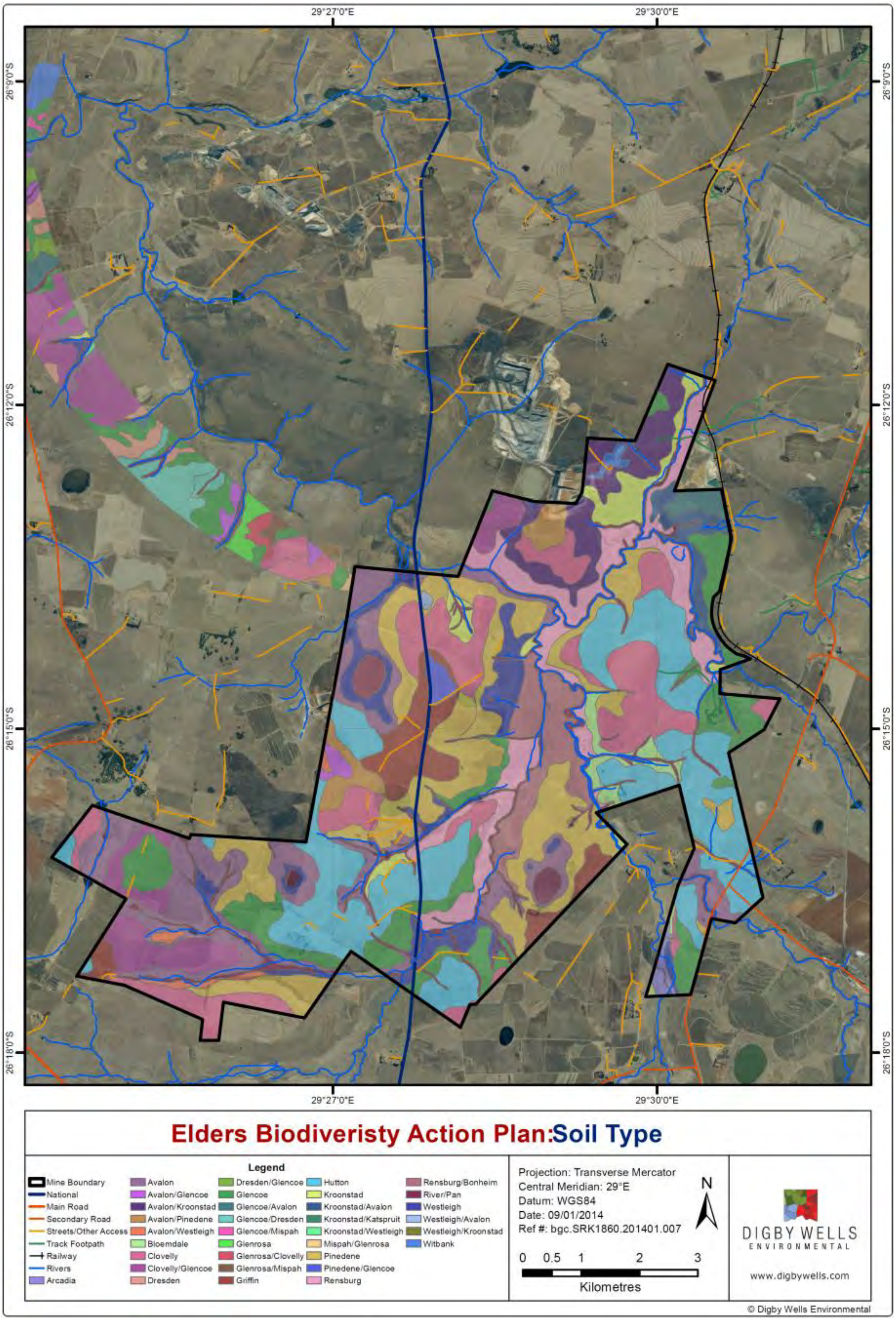

Figure 10-1: Elders Colliery Soils Type

From the soils type data a land capability map was constructed (Figure 10-2). As can be seen from the land capability map very little of the soil is suitable for crop farming and is more suitable for grazing of stock animals. Large areas of the project area are occupied by wetlands and aquatic systems which are unsuitable for grazing or stock farming. However it is a common sight to see stock animals being grazed in wetlands even though this practise greatly impacts on the fragile habitat.

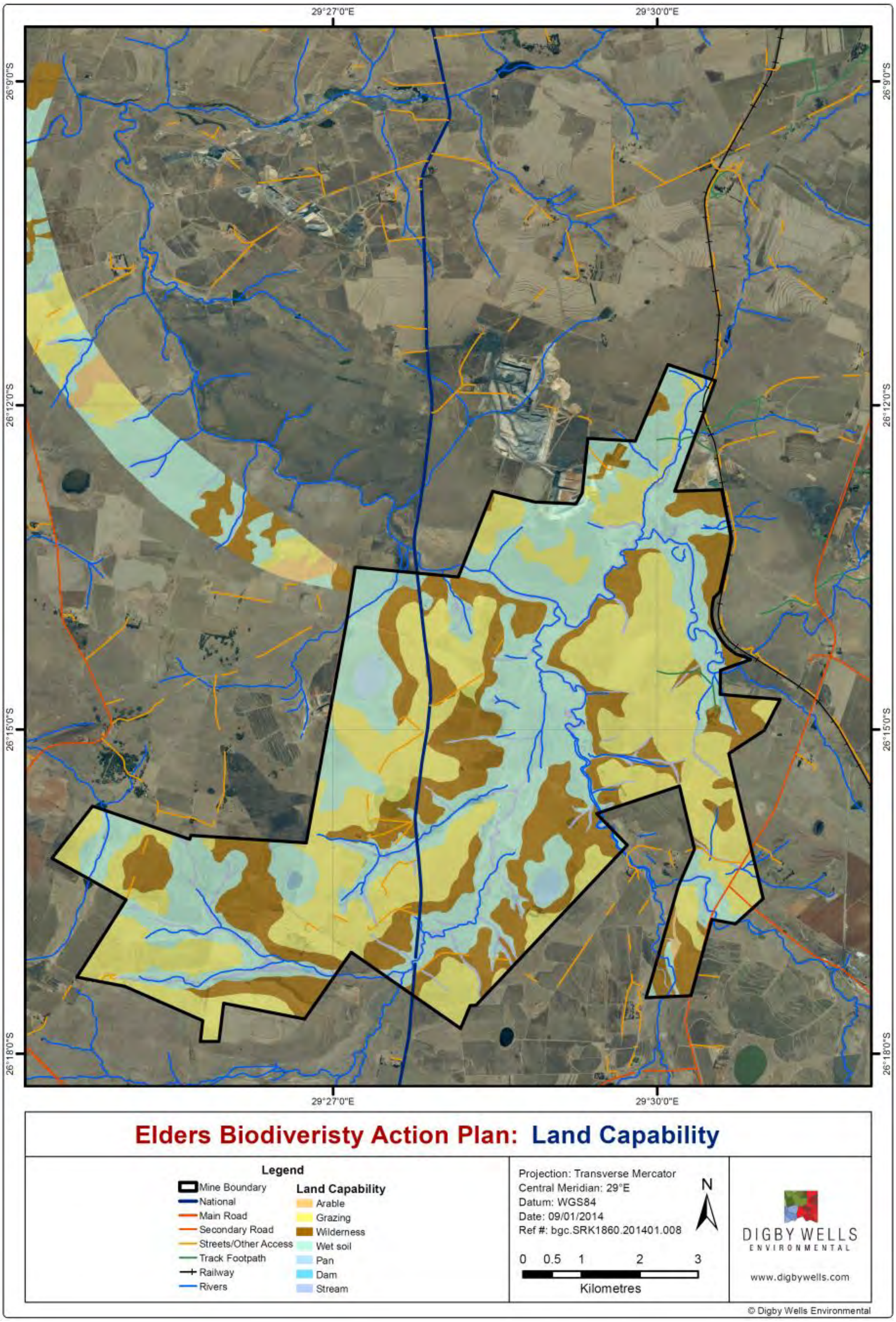

Figure 10-2: Land capability map

10.3 Flora

The Flora component of the BAP was compiled relying on the data provided by EkoInfo CC 2013 baseline report. Two site visits were taken into account, the initial visit was conducted in 2002 and the second in 2013.

10.3.1 Sites

In total 80 sites were surveyed on and around the proposed project area. 51 plots were carried out in the sampling that occurred in 2002 while 29 plots were surveyed in the 2013 sampling survey.

10.3.2 Community analysis

The flora study conducted TWINSPAN statistical analysis to identify the floral communities present on the Elders Colliery site.

Two communities were identified each consisting of two sub-communities (Figure 10-3). They were:

- *Verbena bonariensis* - *Eragrostis plana* (Coarse textured soils)
  - 1) The above consisted of *Verbena bonariensis*, *Eragrostis plana* and *Eragrostis gummiflua* (Drier high lying areas, sandy soils)
  - *2) Verbena bonariensis, Eragrostis plana and Cirsium vulgare* (Low lying areas, more loamy soils)
- *Themeda triandra – Senecio erubescens* (Fine textured soils)
  - 1) *Themeda triandra*, *Senecio erubescens* and *Hermannia transvaalensis* (High lying loamy sandy soils)
  - 2) *Themeda triandra*, *Scenecio erubescens* and *Ranunculus multifidus* (Low lying clay soils)

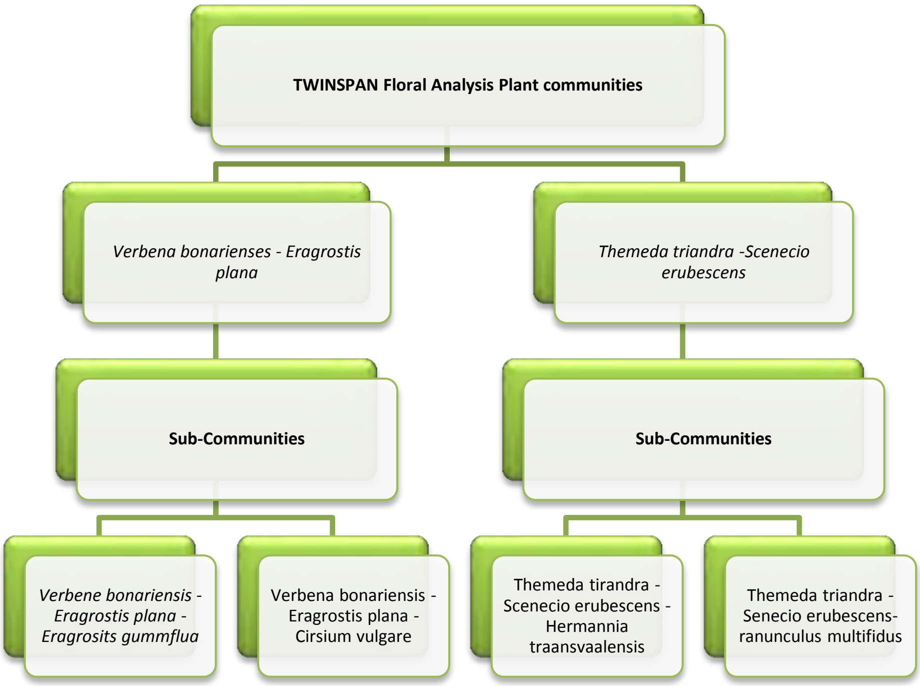

Figure 10-3: Diagram of floral communities and sub-communities

The biotic attributes such as: altitude slope, soil depth and clay percentage of the soil are explained in greater detail in Table 10-1.

Table 10-1: Biotic attributes of the two identified floral communities

Community	Number of plots	Average altitude	Average estimated % slope	Average soil depth (mm)	Average estimated % clay: A - horizon
Verbena bonariensis - Eragrostis plana	19	1595	4	953	12
Themeda triandra - Senecio erubescens	32	1583	4	902	41

10.3.3 Identification of areas of high biodiversity

The proposed Elders Colliery surface area has been extensively modified by agricultural activities both stock and crop farming, so much so that 48% on the landscape has been classified as modified (Table 8-1). Figure 10-4 illustrates the vegetation sensitivity as defined in the biodiversity baseline study. The flora sensitivity map largely conforms to the delineated wetland areas that are discussed later in the document and are seen in Figure 10-6. Wetlands have largely been left unmodified on the site due to the soil being too wet to grow crops. However they are still impacted upon by stock animals grazing in them and trampling the vegetation in order to reach a source of water.

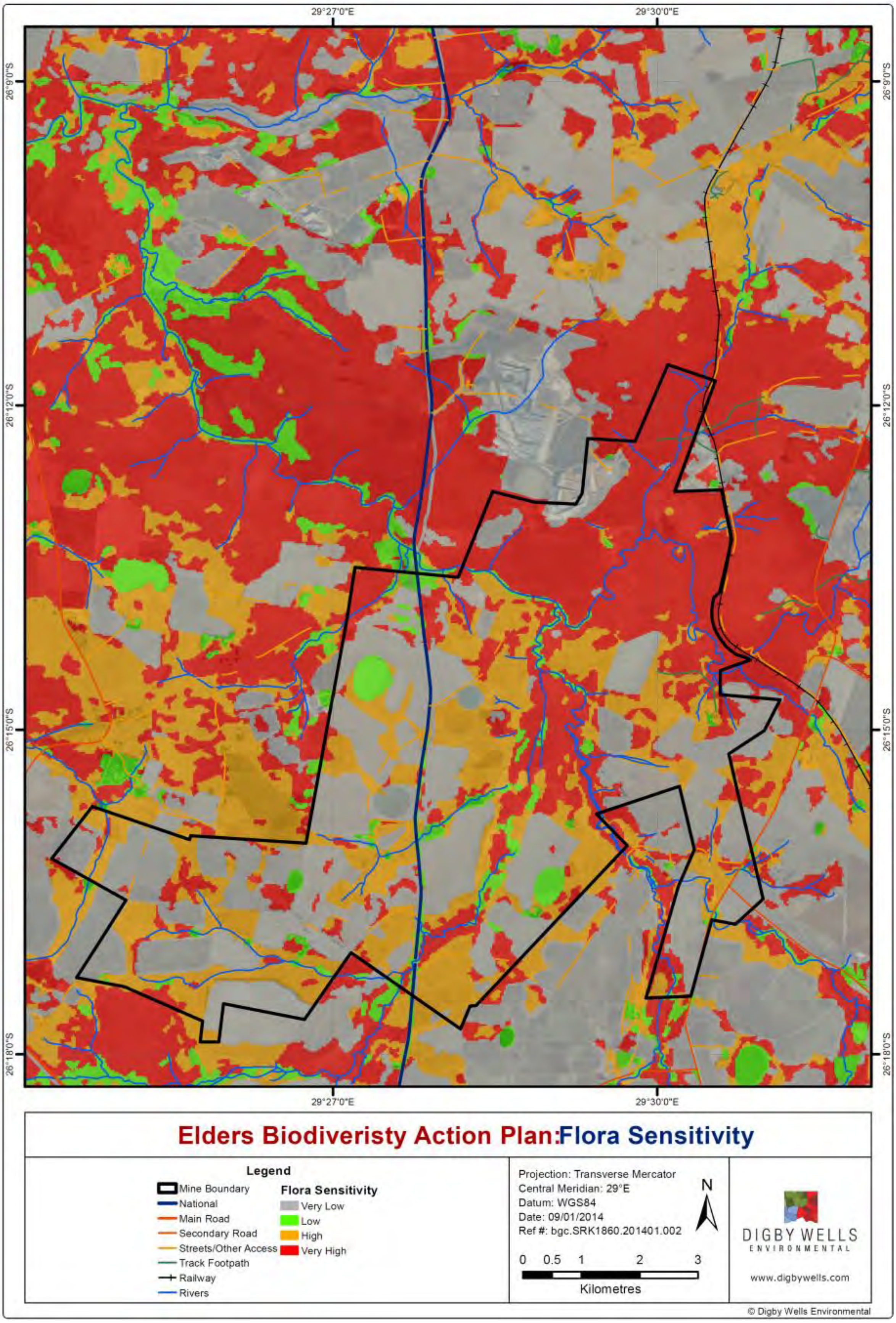

Figure 10-4: Flora Sensitivity Map

A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. Primarily, the factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation that is adapted to its unique soil conditions: Wetlands consist primarily of hydric soil, which supports aquatic plants. Wetlands are described further in Section 10-7 on page 43.

10.3.4 Threatened Fauna and Flora

Flora in South Africa are conserved on two levels. 1) Nationally in terms of red data status and 2) Provincially in terms of protected species. Red data flora include species considered to be threatened on a national level. Either via over-exploitation or habitat destruction it further includes species with very limited distribution or low densities. These species are also very difficult to identify and known to a few specialists or interested individuals. Protected species include these species, which are exploited commercially for their medicinal or collectors value.

Only one species *Gladiolus macneilii*, which is included here even though it does not occur on the National Herbarium of Pretoria (PRE) Computerised Information system (PRECIS) list for the area, is endangered, and may require special measures to protect any populations that are positively identified. The remainder of the threatened species are in the vulnerable and near threatened categories indicating that conservation efforts aimed at the level of habitat conservation are adequate in the surface rights area.

10.3.5 Ecological and conservation status of natural vegetation

The conservation status of a habitat is based on three criteria, they are:

- The Condition;
- Quantity; and
- Social importance of the habitat.

The variables and/ or number of variables used to determine these attributes will vary according to the scale, time and funds available.

For the purpose of this study the following variables were used to determine the conservation status of the plant communities, they were:

- The ecological status;
- The surface area covered by each plant community; and
- Relevant environmental legislation.

Both positive and negative ecological indicators were utilized to obtain the vegetation's ecological status for each community. They are as follows:

- Red data species recorded in area;
- Protected species recorded in area;
- Species richness of area;

- Maximum cover of herbaceous layer;
- Declared weeds and invaders recorded in area;
- Forbs to grass ratio in area;
- Maximum cover of woody layer; and
- Categories of erosion present in area

The results are summarised in Table 10-2. Of the two communities, the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils has a slightly higher conservation status at 53% compared to the 50% of the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils. This would appear to be a contradiction as the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils ecological status is higher, but the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils covers a smaller area of the study area.

Table 10-2: Derived ecological and conservation status of plant communities

Vegetation community	Average ecological status (A)	Surface area (ha)	% of study area	Weight (100-% of total) (B)	Applicable environmental legislation (5=100%)	Percentage of applicable legislation (C)	Total (D = A+B+C)	Derived conservation status (E=D/3)
Verbena bonariensis - Eragrostis plana	**4**	8455	34	**66**	4	**80**	150	**50**
Themeda triandra - Senecio erubescens	**-8**	3276	14	**86**	4	**80**	158	**53**

The *Verbena bonariensis - Eragrostis plana* Grassland community occurs on coarse textured soils covers approximately 8 455 ha of the study area and represents 34% of the study area and 67% of the natural vegetation. It is associated with sandy soils of which the average estimated clay content is 12%. This does not reflect the true distribution of the sandy soils nor the vegetation associated with the soils, as large areas of the sandy soils had been transformed for cultivation. The conservation status of this community is 50%.

The *Themeda triandra - Senecio erubescens* Grassland community occurs on fine textured soils is associated with clayey soils of which the average estimated clay content is 41%. This community covers approximately 3 276 ha of the study area and represents 14% of the study area and 26% of the natural vegetation. The conservation status of this community is 53%.

10.3.5.1 Red data flora within the project area

Four species were identified during the biodiversity assessment they are:

- *Nerine gracilis* R.A.Dyer (Family: Amaryllidaceae, Conservation status: Vulnerable);
- *Boophane disticha* (L.f.) Herb. (Family: Amaryllidaceae, Conservation status Near Threatened);
- *Eucomis autumnalis* (Mill.) Chitt. subsp. clavata (Baker) Reyneke (Family: Hyacinthaceae, Conservation status: Near Threatened); and
- *Hypoxis hemerocallidea* Fisch. & C.A.Mey. (Family: Hypoxidaceae, Conservatin status: Near Threatened).

Of the four potential red data species only one near threatened species was recorded during the survey. It was the geophyte *H. hemerocallidea*. It should be noted that *H. hemerocallidea* is a flagship species for the Grassland Biome.

10.3.5.2 Protected species

A comparison of the survey species list against the Mpumalanga Conservation Plan's list of protected plants, indicates that the following species recorded during the survey have protected status:

- *Crinum bulbispermum*
- *Cyrtanthus tuckii*
- *Gladiolus crassifolius*
- *Gladiolus longicollis*

It should further be noted that ALL of the species from the three genera *Gladiolus sp*, *Crinum* sp. and *Cyrtanthus* sp. are protected in terms of the Mpumalanga Conservation Plan's list of protected flora.

10.3.5.3 Medicinal plants

Six medicinal plants were located recorded during the surveys They were:

- *Centella asiatica;*
- *Elephantorrhiza elephantin;*
- *Hypoxis hemerocallide;*
- *Pelargonium luridum;*
- *Scabiosa columbaria; and*
- *Vernonia oligocephala.*

These plants occur throughout the natural vegetation within the surface area, densities are dependent on local soil conditions and management strategies. *Centella asiatica* and *Pelargonium luridum* are more common in and around wetlands, with the *Elephantorrhiza elephantine, Hypoxis hemerocallidea* and *Scabiosa columbaria* more common in well-drained (dryer) soils.

10.3.6 Alien Plants

Three aliens invasive plants were found during the biodiversity survey, they are listed in Table 10-3 below. Of particular concern has been the introduction of *Campuloclinium macrophalum* which was not found during the 2002 survey.

Table 10-3: Alien plants found on Elders Colliery Surface Rights

Scientific name	Common name	Status	Habitat
Campuloclinium macrocephalum	Pom pom weed	Category 1, Proposed legislation: NEMBA – Category 1b in Gauteng, North West, Limpopo and Mpumalanga; 1a in the rest of South Africa	It invades grassland regions in the following provinces: Eastern Cape, Gauteng, Kwazulu-Natal, Limpopo and Mpumalanga Provinces
Cirsium vulgare	Scottish thistle	Declared weed	Invades grasslands, roadsides, old lands, vleis, wetland margins
Solanum elaeagnifolium	Silver leaf bitter apple	Category 1, Proposed legislation: NEMBA – Category 1b	Invades most habitats found in all provinces of South Africa
Acacia mearnsii	Black Wattle	Transformer and declared weed (category 2)	Invades most habitats, particularly watercourses, roadsides, disturbed grassland.

Scientific name	Common name	Status	Habitat
Eucalyptus sp.	Gum tree	Transformer and declared invader (category 2)	Invades forest gaps, plantations, watercourses and roadsides.
Populus spp.	Poplar species	Declared invader (category 2)	Invades riverbanks and marshes

10.4 Fauna

The Elders Colliery provides varied habitats for a number of species, despite the terrestrial ecology of the area largely modified by various forms of agriculture. The species present are however lower than would be expected of a pristine area which is reflective of a history of anthropogenic activity which has negatively impacted Biodiversity within the area.

The natural areas which exist within the project area provide habitat for these species, while the transformed areas may provide a source of food. Natural areas are priorities for conservation of species and should be maintained in order that Biodiversity is enhanced. Wetlands are particularly high priority natural areas as a result of the significant role they play in provision of habitat and support of Biodiversity furthermore, they provide potential habitat for the Red Data listed amphibians. The wetland areas provide habitat for the owl species.

Agriculture has transformed much of the natural vegetation, which has resulted in alteration of the natural ecology. Habitat could be vastly improved in a number of situations through various means:

Habitat improvement could be initiated through various activities such as increased ‘natural’ areas, corridor creation, decreased disturbances to habitat, water quality improvement and rehabilitation. Furthermore mechanisms such as bat boxes and owl boxes could be implemented in order to attract species to the area.

Grasslands are the habitat of large herds of antelope, as well as many smaller animals, but are currently one of the most threatened in South Africa; forestry, mining and development industries have irreversibly transformed 60-80% of grasslands in South Africa – with only 2% formally conserved. Grasslands are characterised by high levels of species richness and endemism. Detailed below are the expected species of animals that occur in grasslands and what number of them are endemic or threatened (Table 10-4).

Table 10-4: Expected species in grassland biome

Group	Number of species	Number of endemic species	Number of threatened species
Mammals	89	18	9
Reptiles	84	17	4
Amphibians	36	18	2
Invertebrates	unknown	unknown	16

A fauna sensitivity map can be found below in Figure 10-5. As can be seen the fauna of the area rely greatly on the wetland areas within the site which increases the overall sensitivity of the systems. As opposed to looking at flora and fauna separately.

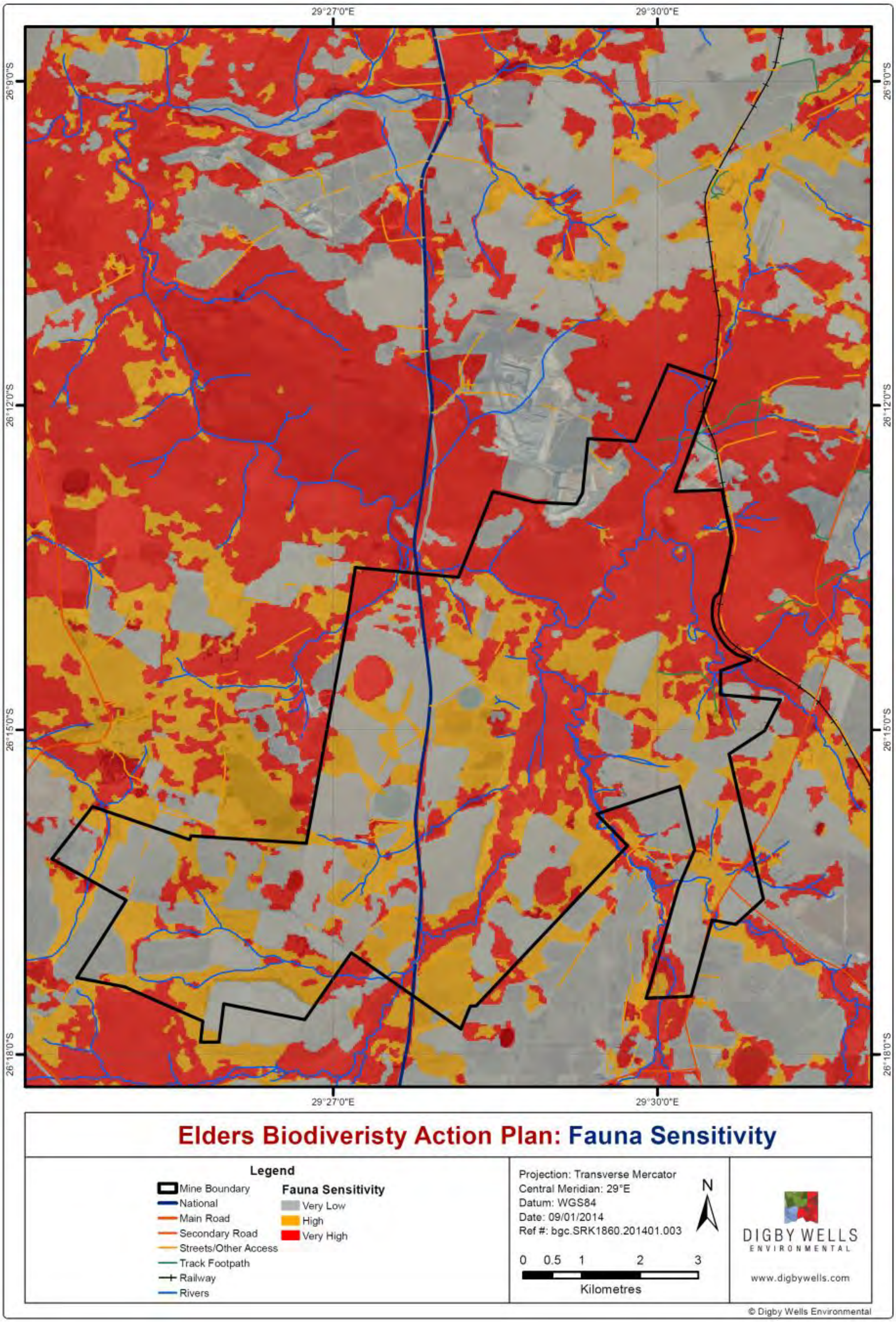

Figure 10-5: Fauna sensitivity map

Of these a number were identified as potentially inhabiting the area the proposed mine site these are detailed below in Table 10-5. Animals listed as endangered have been highlighted in red.

Table 10-5: Protected fauna species that could possibly occur in the Elders Colliery project area.

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
Dragonflies and Damselflies			
***Pseudagrion inopinatum* Balinsky, 1971**	Balinsky's Sprite	EN	low
***Pseudagrion newtoni* Pinhey, 1962**	Newton's Sprite	VU	low
Butterflies			
***Aloeides barbarae* Henning S.F. & Henning G.A., 1994c**	Barbara's Copper	EN	low
***Aloeides nubilus* Henning G.A. & Henning S.F., 1982**	Cloud Copper	EN	low
***Aloeides rossouwi* Henning G.A. & Henning S.F., 1982**	Rossouw's Copper	EN	low
***Chrysoritis aureus* (van Son, 1966)**	Heidelberg Opal	EN	moderate-low
***Dingana alaedeus* Henning G.A. & Henning S.F., 1984**	Wakkerstroom Widow	NT	low
***Dingana fraterna* Henning G.A. & Henning S.F., 1996a**	Stoffberg Widow	CR	low
***Lepidochrysops irvingi* (Swanepoel, 1948)**	Irving's Blue	EN	low
***Lepidochrysops jefferyi* (Swierstra, 1909)**	Jeffrey's Blue	EN	low
***Lepidochrysops swanepoeli* (Pennington, 1948)**	Swanepoel's Blue	EN	low
***Orachrysops violescens* Henning G.A. & Henning S.F., 1994i**	Violescent Blue	VU	low
Frogs			
***Breviceps sopranus* Minter, 2003**	Whistling Rain Frog	DD	low
***Hemisus guttatus* Rapp, 1842**	Spotted Shovel-nosed Frog	VU	low
***Strongylopus wageri* Wager, 1961**	Plain Stream Frog	NT	low
Reptiles			
***Acontias breviceps* Essex, 1925**	Short-headed Legless Skink	NT	moderate-low
***Afroedura pondolia major* Onderstall, 1984**	Swazi Flat Gecko	NT	low
***Chamaesaura aenea* Fitzinger, 1843**	Coppery Grass Lizard	NT	moderate
***Chamaesaura macrolepis* Cope, 1862**	Large-scaled Grass Lizard	NT	low
***Homoroselaps dorsalis* Smith, 1849**	Striped Harlequin Snake	NT	moderate
Kininyx natalensis	Natal Hinged Tortoise	NT	low
***Lamprophis fuscus* Boulenger, 1893**	Yellow-bellied House	NT	low

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
	Snake		
Smaug giganteus **(Smith, 1844)**	Giant Girdled Lizard	VU	low
Tetradactylus breyeri **Roux, 1907**	Breyer's Long-tailed Seps	VU	moderate
Birds			
Pelecanus rufescens **Gmelin, 1789**	Pink-backed Pelican	VU	low
Pelecanus onocrotalus **Linnaeus, 1758**	Great White Pelican	NT	low
Gorsachius leuconotus **(Wagler, 1827)**	White-backed Night-Heron	VU	low
Leptoptilos crumeniferus **(Lesson, 1831)**	Marabou Stork	NT	low
Anastomus lamelligerus **Temminck, 1823**	African Openbill	NT	low
Ephippiorhynchus senegalensis **(Shaw, 1800)**	Saddle-billed Stork	EN	low
Mycteria ibis **(Linnaeus, 1766)**	Yellow-billed Stork	NT	moderate
Ciconia episcopus **(Boddaert, 1783)**	Woolly-necked Stork	NT	low
Ciconia nigra **(Linnaeus, 1758)**	Black Stork	NT	low
Geronticus calvus **(Boddaert, 1783)**	Southern Bald Ibis	VU	moderate-high
Phoenicopterus ruber **Linnaeus, 1758**	Greater Flamingo	NT	confirmed
Phoenicopterus minor **E. Geoffroy Saint-Hilare, 1789**	Lesser Flamingo	NT	moderate-high
Nettapus auritus **(Boddaert, 1783)**	African Pygmy-Goose	NT	low
Oxyura maccoa **(Eyton, 1838)**	Maccoa Duck	NT	moderate
Sagittarius serpentarius **(J.F. Miller, 1779)**	Secretarybird	NT	high
Gyps coprotheres **(J.R. Forster, 1798)**	Cape Vulture	VU	low
Gyps africanus **Salvadori, 1865**	White-backed Vulture	VU	low
Torgos tracheliotus **(J.R. Forster, 1796)**	Lappet-faced Vulture	VU	low
Trigonoceps occipitalis **(Burchell, 1824)**	White-headed Vulture	VU	low
Necrosyrtes monachus **(Temminck, 1823)**	Hooded Vulture	VU	low
Neophron percnopterus **(Linnaeus, 1758)**	Egyptian Vulture	EX	low
Falco peregrinus **Tunstall, 1771**	Peregrine Falcon	NT	moderate-low
Falco biarmicus **Temminck, 1825**	Lanner Falcon	NT	high
Falco vespertinus **Linnaeus, 1766**	Red-footed Falcon	NT	moderate-low
Macheiramphus alcinus **Bonaparte, 1850**	Bat Hawk	NT	low
Aquila rapax **(Temminck, 1828)**	Tawny Eagle	VU	low
Aquila ayresii **(Gurney, 1862)**	Ayres's Hawk-Eagle	NT	low
Polemaetus bellicosus **(Daudin, 1800)**	Martial Eagle	VU	low
Stephanoaetus coronatus **(Linnaeus, 1766)**	African Crowned Eagle	NT	low
Terathopius ecaudatus **(Daudin, 1800)**	Bateleur	VU	low
Circus ranivorus **(Daudin, 1800)**	African Marsh Harrier	VU	moderate-high
Circus macrourus **(S.G. Gmelin, 1770)**	Pallid Harrier	NT	high
Circus maurus **(Temminck, 1828)**	Black Harrier	NT	moderate-high
Crex crex **(Linnaeus, 1758)**	Corn Crake	VU	moderate
Sarothrura ayresi **(Gurney, 1877)**	White-winged Flufftail	CR	low

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
***Sarothrura affinis* (A. Smith, 1828)**	Striped Flufftail	VU	low
***Podica senegalensis* (Vieillot, 1817)**	African Finfoot	VU	low
***Balearica regulorum* (E.T. Bennett, 1834)**	Grey Crowned Crane	VU	moderate
***Bugeranus carunculatus* (Gmelin, 1789)**	Wattled Crane	CR	low
***Anthropoides paradiseus* (A.A.H. Lichtenstein, 1793)**	Blue Crane	VU	moderate-low
***Ardeotis kori* (Burchell, 1822)**	Kori Bustard	VU	low
***Neotis denhami* (Children & Vigors, 1826)**	Denham's Bustard	VU	moderate
***Eupodotis senegalensis* (Vieillot, 1820)**	White-bellied Korhaan	VU	low
***Eupodotis caerulescens* (Vieillot, 1820)**	Blue Korhaan	NT	confirmed
***Lissotis melanogaster* (Rüppel, 1835)**	Black-bellied Bustard	NT	low
***Microparra capensis* (A. Smith, 1839)**	Lesser Jacana	NT	low
***Rostratula benghalensis* (Linnaeus, 1758)**	Greater Painted-snipe	NT	low
***Charadrius pallidus* Strickland, 1853**	Chestnut-banded Plover	NT	low
***Vanellus melanopterus* (Cretzschmar, 1829)**	Black-winged Lapwing	NT	low
***Vanellus albiceps* Gould, 1834**	White-crowned Lapwing	NT	low
***Glareola pratincola* (Linnaeus, 1766)**	Collared Pratincole	NT	low
***Glareola nordmanni* Fischer von Waldheim, 1842**	Black-winged Pratincole	NT	moderate-high
***Sterna caspia* Pallas, 1770**	Caspian Tern	NT	low
***Centropus grillii* Hartlaub, 1861**	Black Coucal	NT	low
***Tyto capensis* (A. Smith, 1834)**	African Grass-Owl	VU	confirmed
***Scotopelia peli* (Bonaparte, 1850)**	Pel's Fishing-Owl	VU	low
***Alcedo semitorquata* Swainson, 1823**	Half-collared Kingfisher	NT	high
***Turnix nanus* (Sundevall, 1850)**	Black-rumped Buttonquail	EN	low
***Bucorvus leadbeateri* (Vigors, 1825)**	Southern Ground-Hornbill	VU	low
***Mirafra cheniana* Smith, 1843**	Melodious Lark	NT	confirmed
***Spizocorys fringillaris* (Sundevall, 1850)**	Botha's Lark	EN	moderate-high
***Heteromirafra ruddi* (Grant, 1908)**	Rudd's Lark	CR	low
***Hirundo atrocaerulea* Sundevall, 1850**	Blue Swallow	CR	low
***Lioptilus nigricapillus* (Vieillot, 1818)**	Bush Blackcap	NT	low
***Zoothera gurneyi* (Hartlaub, 1864)**	Orange Ground-Thrush	NT	low
***Schoenicola brevirostris* (Sundevall, 1850)**	Broad-tailed Warbler	NT	low
***Apalis ruddi* Grant, 1908**	Rudd's Apalis	NT	low
***Platysteira peltata* Sundevall, 1850**	Black-throated Wattle-eye	NT	low
***Anthus brachyurus* Sundevall, 1850**	Short-tailed Pipit	VU	low
***Anthus chloris* Lichtenstein, 1842**	Yellow-breasted Pipit	VU	low
***Buphagus africanus* Linnaeus, 1766**	Yellow-billed Oxpecker	VU	low

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
***Buphagus erythrorhynchus* (Stanley, 1814)**	Red-billed Oxpecker	NT	low
***Spermestes fringilloides* (Lafresnaye, 1835)**	Magpie Mannikin	NT	low
***Hypargos margaritatus* (Strickland, 1844)**	Pink-throated Twinspot	NT	low
Mammals			
***Chrysospalax villosus* (A. Smith, 1833)**	Rough-haired Golden Mole	CR	low
***Amblysomus hottentotus* (A. Smith, 1829)**	Hottentot's Golden Mole	DD	low
***Amblysomus robustus* Bronner, 2000**	Robust Golden Mole	EN	low
***Amblysomus septentrionalis* Roberts, 1913**	Higveld Golden Mole	NT	moderate
***Neamblysomus juliane* (Meester, 1972)**	Juliana's Golden Mole	VU	low
***Atelerix frontalis* (A. Smith, 1831)**	South African Hedgehog	NT	high
***Elephantulus brachyrhynchus* (A. Smith, 1836)**	Short-snouted Elephant-shrew	DD	low
***Myosorex cafer* (Sundevall, 1846)**	Dark-footed Forest Shrew	DD	high
***Myosorex varius*(Smuts, 1832)**	Forest Shrew	DD	high
***Crocidura cyanea*(Duvernoy, 1838)**	Reddish-grey Musk Shrew	DD	high
***Crocidura flavescens* (I. Geoffroy Saint-Hilaire, 1827)**	Greater Musk Shrew	DD	moderate-low
***Crocidura fuscomurina* (Heuglin, 1865)**	Tiny Musk Shrew	DD	moderate
***Crocidura hirta* Peters, 1852**	Lesser Red Musk Shrew	DD	moderate
***Crocidura maquassiensis* Roberts, 1946**	Maquassie Musk Shrew	VU	low
***Crocidura mariquensis* (A. Smith, 1844)**	Swamp Musk Shrew	DD	moderate
***Crocidura silacea* Thomas, 1895**	Lesser Grey-brown Musk Shrew	DD	moderate
***Suncus infinitesimus* (Heller, 1912)**	Least Dwarf Shrew	DD	moderate
***Suncus lixus* (Thomas, 1898)**	Greater Dwarf Shrew	DD	moderate
***Suncus varilla* (Thomas, 1895)**	Lesser Dwarf Shrew	DD	moderate
***Cloeotis percivali* Thomas, 1901**	Percival's Short-eared Trident Bat	VU	low
***Rhinolophus blasii* Peters, 1866**	Blasius's Horseshoe Bat	NT	low
***Rhinolophus swinnyi* Gough, 1908**	Swinny's Horseshoe Bat	NT	low
***Miniopterus natalensis* (A. Smith, 1834)**	Natal Long-fingered Bat	NT	low
***Scotophilus nigrita* (Schreber, 1774)**	Giant Yellow House Bat	NT	low
***Manis temminckii* Smuts, 1832**	Ground Pangolin	VU	low

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
***Graphiurus platyops* Thomas, 1897**	Rock Dormouse	DD	low
***Mystromys albicaudatus* (A. Smith, 1834)**	White-tailed Rat	EN	moderate-low
***Tatera leucogaster* (Peters, 1852)**	Bushveld Gerbil	DD	high
***Lemniscomys rosalia* (Thomas, 1904)**	Single-striped Mouse	DD	high
***Dasymys incomtus* (Sundevall, 1847)**	Water Rat	NT	high
***Grammomys dolichurus* (Smuts, 1832)**	Woodland Mouse	DD	low
***Otomys sloggetti* Thomas, 1902**	Sloggett's Rat	DD	low
***Panthera leo* (Linnaeus, 1758)**	Lion	VU	low
***Panthera pardus* (Linnaeus, 1758)**	Leopard	NT	confirmed
***Leptailurus serval* (Schreber, 1776)**	Serval	NT	confirmed
***Acinonyx jubatus* (Schreber, 1775)**	Cheetah	VU	low
***Felis nigripes* Burchell, 1824**	Black-footed Cat	VU	moderate-low
***Crocuta crocuta* (Erxleben, 1777)**	Spotted Hyaena	NT	low
***Parahyaena brunnea* (Thunberg, 1820)**	Brown Hyaena	NT	confirmed
***Paracynictis selousi* (de Winton, 1896)**	Selous' Mongoose	DD	low
***Rhynchogale melleri* (Gray, 1865)**	Meller's Mongoose	DD	low
***Canis adustus* Sundevall, 1847**	Side-striped Jackal	NT	moderate
***Lycaon pictus* (Temminck, 1820)**	African Wild Dog	EN	low
***Mellivora capensis* (Schreber, 1776)**	Honey Badger	NT	confirmed
***Poecilogale albinucha* (Gray, 1864)**	African Striped Weasel	DD	low
***Hydrictis maculicollis* (Lichtenstein, 1835)**	Spotted-necked Otter	NT	high
***Loxodonta africana* (Blumenbach, 1797)**	African Savanna Elephant	VU	low
***Diceros bicornis* (Linnaeus, 1758)**	Black Rhinoceros	CR	low
***Ceratotherium simum* (Burchell, 1817)**	White Rhinoceros	NT	low
***Hippopotamus amphibius* Linnaeus, 1758**	Common Hippopotamus	VU	low
***Raphicerus sharpei* Thomas, 1897**	Sharp's Grysbok	NT	low
***Ourebia ourebi* (Zimmerman, 1783)**	Southern Oribi	EN	moderate-low
***Hippotragus equinus* (Desmarest, 1804)**	Roan Antelope	VU	low
***Hippotragus niger* (Harris, 1838)**	Southern Sable Antelope	VU	low
***Damaliscus lunatus* (Burchell, 1823)**	Western Tsessebe	EN	low

Invertebrates, herpetofauna birds and mammals were all sampled using a variety of visual observation vocalization and habitat assessments. From these assessments an observed species list was compiled as seen below in Table 10-6. A key is located at the bottom of the table.

Table 10-6: Confirmed fauna species from the site visit

Class	Order	Family	*Genus species*	English Name
Insecta	Odonata	Aeshnidae	*Anax imperator* Leach, 1815	Blue Emperor
	Isoptera	Termitidae	*Trinervitermes* species	Snouted Harvester Termite
	Mantodea	Mantidae	*Pyrgomantis rhodesica* Giglio-Tos, 1917	Grass Mantid
	Orthoptera	Tettigoniidae	*Conocephalus caudalis* (Walker, F., 1869)	Meadow Katydid
		Pyrgomorphidae	*Zonocerus elegans* (Thunberg, 1815)	Elegant Grasshopper
	Hemiptera	Lygaeidae	*Spilostethus pandurus*	Milkweed Bug
	Neuroptera	Myrmeleontidae	*Palpares caffer* (Burmeister, 1839)	Mottled Veld Antlion
	Coleoptera	Scarabaeidae	*Popillia biguttata* (Wiedemann, 1821)	Yellow Shining Leaf Chafer
			Porphyronota hebreae	Marbled Fruit Chafer
		Coccinellidae	*Cheilomenes lunata*	Lunate Ladybird
			Exochomus flavipes (Thunberg, 1781)	Black Mealy Bug Predator
		Tenebrionidae	*Lagria* species	Hairy Darkling Beetle
		Melyridae	*Astylus atromaculatus*	Spotted Maize Beetle
	Lepidoptera	Hesperiidae	*Metisella meninx* (Trimen, 1873)	Marsh Sylph
		Pieridae	*Catopsilla florella* (Fabricius, 1775)	African Migrant
			Eurema brigitta brigitta (Stoll, [1780])	Broad-bordered Grass Yellow
			Pontia helice helice (Linnaeus, 1764)	Common Meadow White
		Nymphalidae	*Acraea neobule neobule* Doubleday, [1847a]	Wandering Donkey Acraea
			Byblia ilithyia (Drury, [1773])	Spotted Joker
			Catacroptera cloanthe cloanthe (Stoll, [1781])	Pirate
			Danaus chryssipus orientis (Aurivillius, 1909)	African Monarch
			Hypolimnas missipus (Linnaeus, 1764)	Common Diadem
			Junonia hierta cebrene Trimen, 1870	Yellow Pansy
			Junonia oenone oenone (Linnaeus, 1758)	Blue Pansy

Class	Order	Family	Genus species	English Name
			Phalanta phalantha aethiopica (Rotschild & Jordan, 1903)	African Leopard
			Physcaeneura panda (Boisduval, 1847)	Dark-webbed Ringlet
			Telchinia rahira rahira (Boisduval, 1833a)	Marsh Acraea
			Vanessa cardui (Linnaeus, 1758)	Painted Lady
		Lycaenidae	*Aloeides henningi* Tite & Dickson, 1973	Henning's Copper
			Eicochrysops messapus mahallakoaena (Wallengren, 1857)	Cupreous Blue
			Lampides boeticus (Linnaeus, 1767)	Pea Blue
			Zizula hylax (Fabricius, 1775)	Gaika Blue
	Hymenoptera	Apidae	*Apis mellifera* Linnaeus, 1758	Honey Bee
Amphibia	Anura	Bufonidae	*Amietophrynus gutturalis* Power, 1927	Guttural Toad
		Hyperoliidae	*Kassina senegalensis* Duméril & Bibron, 1841	Bubbling Kassina
			Semnodactylus wealii (Boulenger, 1882)	Rattling Frog
		Pipidae	*Xenopus laevis* Daudin, 1802	Common Platanna
		Pyxicephalidae	*Cacosternum boettgeri* (Boulenger, 1882)	Boettger's Caco
			Amietia angolensis (Bocage, 1866)	Common River Frog
			Amietia fuscigula Duméril & Bibron, 1841	Cape River Frog
			Strongylopus fasciatus Smith, 1849	Striped Stream Frog
			Strongylopus grayii Smith, 1849	Clicking Stream Frog
Reptilia	Squamata	Typhlopidae	*Afrotyphlops bibronii* (Smith, 1846)	Bibron's Blind Snake
		Leptotyphlopidae	*Leptotyphlops scutifrons* Peters, 1854	Peters' Thread Snake
		Colubridae	*Psammophylax rhombeatus* (Linnaeus, 1758)	Spotted Grass Snake
			Crotaphopeltis hotamboeia Laurenti, 1768	Red-lipped Snake
		Elapidae	*Hemachatus haemachatus* Lacépède, 1789	Rinkhals
		Scincidae	*Trachylepis punctatissima* Smith, 1849	Speckled Rock Skink

Class	Order	Family	Genus species	English Name
		Varanidae	*Varanus niloticus* Linnaeus, 1758	Water Monitor
		Gekkonidae	*Pachydactylus affinis* Boulenger, 1896	Transvaal Gecko
Aves	Galliformes	Numididae	*Numida meleagris* (Linnaeus, 1758)	Helmeted Guineafowl
		Phasianidae	*Coturnix coturnix* (Linnaeus, 1758)	Common Quail
			Pternistis swainsonii (A.Smith, 1836)	Swainson's Spurfowl
	Anseriformes	Anatidae	*Alopochen aegyptiaca* (Linnaeus, 1766)	Egyptian Goose
			Anas capensis Gmelin, 1789	Cape Teal
			Anas erythrorhyncha Gmelin, 1789	Red-billed Teal
			Anas smithii (Hartert, 1891)	Cape Shoveler
			Anas undulata C.F. Dubois, 1839	Yellow-billed Duck
			Netta erythrophthalma (Wied-Neuwied, 1833)	Southern Pochard
			Plectropterus gambensis (Linnaeus, 1766)	Spur-winged Goose
	Podicipediformes	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe
	Ciconiiformes	Phoenicopteridae	*Phoenicopterus ruber* Linnaeus, 1758	Greater Flamingo
		Treshkiornithidae	*Bostrychia hagedash* (Latham, 1790)	Hadeda Ibis
			Platalea alba Scopoli, 1786	African Spoonbill
			Threskiornis aethiopicus (Latham, 1790)	African Sacred Ibis
		Ardeidae	*Ardea cinerea* Linnaeus, 1758	Grey Heron
			Ardea melanocephala Children & Vigors, 1826	Black-headed Heron
			Bubulcus ibis (Linnaeus, 1758)	Cattle Egret
		Scopidae	*Scopus umbretta* Gmelin, 1789	Hamerkop
	Suliformes	Phalacrocoracidae	*Microcarbo africanus* (Gmelin, 1789)	Reed Cormorant
			Phalacrocorax lucidus (Lichtenstein, 1823)	White-breasted Cormorant
	Accipitiriformes	Accipitridae	*Buteo vulpinus*	Steppe Buzzard
			Circus pygargus (Linnaeus, 1758)	Montagu's Harrier
			Elanus caeruleus (Desfontaines, 1789)	Black-shouldered Kite
			Haliaeetus vocifer (Daudin, 1800)	African Fish-Eagle

Class	Order	Family	Genus species	English Name
	Falconiformes	Falconidae	*Falco amurensis* Radde, 1863	Amur Falcon
	Gruiformes	Otitidae	*Afrotis afraoides* (A. Smith, 1831)	Northern Black Korhaan
			Eupodotis caerulescens (Vieillot, 1820)	Blue Korhaan
		Rallidae	*Fulica cristata* Gmelin, 1789	Red-knobbed Coot
	Charadriiformes	Burhinidae	*Burhinus capensis* (Lichtenstein, 1823)	Spotted Thick-knee
		Recurvirostridae	*Himantopus himantopus* (Linnaeus, 1758)	Black-winged Stilt
			Recurvirostra avosetta Linnaeus, 1758	Pied Avocet
		Charadridae	*Charadrius tricollaris* Vieillot, 1818	Three-banded Plover
			Vanellus armatus (Burchell, 1822)	Blacksmith Lapwing
			Vanellus coronatus (Boddaert, 1783)	Crowned Lapwing
		Scolopacidae	*Actitis hypoleucos* (Linnaeus, 1758)	Common Sandpiper
			Gallinago nigripennis Bonaparte, 1839	African Snipe
			Philomachus pugnax (Linnaeus, 1758)	Ruff
			Tringa glareola Linnaeus, 1758	Wood Sandpiper
			Tringa nebularia (Gunnerus, 1767)	Common Greenshank
	Columbiformes	Columbidae	*Columba guinea* Linnaeus, 1758	Speckled Pigeon
			Spilopelia senegalensis	Laughing Dove
			Streptopelia capicola (Sundevall, 1857)	Cape Turtle-Dove
			Streptopelia semitorquata (Ruppell, 1837)	Red-eyed Dove
	Cuculiformes	Cuculidae	*Chrysococcyx caprius* (Boddaert, 1783)	Diderick Cuckoo
	Strigiformes	Tytonidae	*Tyto capensis* (A. Smith, 1834)	African Grass-Owl
		Strigidae	*Asio capensis* (A. Smith, 1834)	Marsh Owl
			Bubo africanus (Temminck, 1821)	Spotted Eagle-Owl
	Apodiformes	Apodidae	*Apus affinis* (J.E. Gray, 1830)	Little Swift
			Apus caffer (Lichtenstein, 1823)	White-rumped Swift
	Piciformes	Picidae	*Geocolaptes olivaceus* (Gmelin, 1788)	Ground Woodpecker
	Passeriformes	Laniidae	*Lanius collaris* Linnaeus, 1766	Common Fiscal
		Corvidae	*Corvus albus* Müller, 1776	Pied Crow

Class	Order	Family	*Genus species*	English Name
		Alaudidae	*Calandrella cinerea* (J.F. Gmelin, 1789)	Red-capped Lark
			Chersomanes albofasciata (Lafresnaye, 1836)	Spike-heeled Lark
			Mirafra africana Smith, 1836	Rufous-naped Lark
			Mirafra cheniana Smith, 1843	Melodious Lark
			Spizocorys conirostris (Sundevall, 1850)	Pink-billed Lark
		Hirundinidae	*Hirundo albigularis* Strickland, 1849	White-throated Swallow
			Hirundo cucullata Boddaert, 1783	Greater Striped Swallow
			Hirundo rustica Linnaeus, 1758	Barn Swallow
			Hirundo spilodera Sundevall, 1850	South African Cliff-Swallow
			Riparia cincta (Boddaert, 1783)	Banded Martin
			Riparia paludicola (Vieillot, 1817)	Brown-throated Martin
			Riparia riparia (Linnaeus, 1758)	Sand Martin
		Cisticolidae	*Cisticola aridulus* Witherby, 1900	Desert Cisticola
			Cisticola ayresii Hartlaub, 1863	Wing-snapping Cisticola
			Cisticola cinnamomeus	Pale-crowned Cisticola
			Cisticola juncidis (Rafinesque, 1810)	Zitting Cisticola
			Cisticola lais (Hartlaub & Finsch, 1870)	Wailing Cisticola
			Cisticola textrix (Vieillot, 1817)	Cloud Cisticola
			Cisticola tinniens (Lichtenstein, 1842)	Levaillant's Cisticola
			Prinia flavicans (Vieillot, 1820)	Black-chested Prinia
			Prinia subflava (J.F. Gmelin, 1789)	Tawny-flanked Prinia
		Locustellidae	*Sphenoeacus afer* (J.F. Gmelin, 1789)	Cape Grassbird
		Acrocephalidae	*Acrocephalus baeticatus* (Vieillot, 1817)	African Reed-Warbler
			Acrocephalus gracilirostris (Hartlaub, 1864)	Lesser Swamp-Warbler
			Acrocephalus palustris (Bechstein, 1798)	Marsh Warbler
		Zosteropidae	*Zosterops capensis*	Cape White-eye
		Muscicapidae	*Cossypha caffra* (Linnaeus,	Cape Robin-Chat

Class	Order	Family	Genus species	English Name
			1771)	
			Myrmecocichla formicivora (Vieillot, 1818)	Anteating Chat
			Saxicola torquatus (Linnaeus, 1766)	African Stonechat
		Estrildidae	*Estrilda astrild* (Linnaeus, 1758)	Common Waxbill
			Ortygospiza atricollis (Vieillot, 1817)	African Quailfinch
		Ploceidae	*Euplectes afer* (J.F. Gmelin, 1789)	Yellow-crowned Bishop
			Euplectes albonotatus (Cassin, 1848)	White-winged Widowbird
			Euplectes axillaris (Smith, 1838)	Fan-tailed Widowbird
			Euplectes orix (Linnaeus, 1758)	Southern Red Bishop
			Euplectes progne (Boddaert, 1783)	Long-tailed Widowbird
			Ploceus velatus Vieillot, 1819	Southern Masked-Weaver
			Quelea quelea (Linnaeus, 1758)	Red-billed Quelea
		Passeridae	*Passer melanurus* (Müller, 1776)	Cape Sparrow
		Viduidae	*Vidua macroura* (Pallas, 1764)	Pin-tailed Whydah
		Motacillidae	*Anthus cinnamomeus* Rüppell, 1840	African Pipit
			Macronyx capensis (Linnaeus, 1766)	Cape Longclaw
			Motacilla capensis Linnaeus, 1766	Cape Wagtail
		Fringillidae	*Critagra flaviventris*	Yellow Canary
			Crithagra atrogularis	Black-throated Canary
			Crithagra mozambica	Yellow-fronted Canary
Mammalia	Lagomorpha	Leporidae	*Lepus saxatilis* F. Cuvier, 1823	Scrub Hare
	Rodentia	Bathyergidae	*Cryptomys hottentotus* (Lesson, 1826)	Common Mole-rat
		Hystricidae	*Hystrix africaeaustralis* Peters, 1852	Porcupine
		Muridae	*Tatera brantsii* (Smith, 1836)	Highveld Gerbil
	Carnivora	Felidae	*Caracal caracal* (Schreber, 1776)	Caracal
			Leptailurus serval (Schreber, 1776)	Serval
			Panthera pardus (Linnaeus, 1758)	Leopard

Class	Order	Family	Genus species	English Name
		Hyaenidae	*Parahyaena brunnea* (Thunberg, 1820)	Brown Hyaena
			Proteles cristatus (Sparrman, 1783)	Aardwolf
		Herpestidae	*Atilax paludinosus* (G. [Baron] Cuvier, 1829)	Marsh Mongoose
			Cynictis penicillata (G. [Baron] Cuvier, 1829)	Yellow Mongoose
			Galerella sanguinea (Rüppell, 1835)	Common Slender Mongoose
			Herpestes ichneumon (Linnaeus, 1758)	Egyptian Mongoose
		Canidae	*Canis mesomelas* Schreber, 1775	Black-backed Jackal
			Vulpes chama (A. Smith, 1833)	Cape Fox
		Mustelidae	*Aonyx capensis* (Schinz, 1821)	African Clawless Otter
			Mellivora capensis (Schreber, 1776)	Honey Badger
	Tubulidentata	Orycteropodidae	*Orycteropus afer* (Pallas, 1766)	Aardvark
	Artiodactyla	Suidae	*Phacochoerus africanus* (Gmelin, 1788)	Common Warthog
			Potamochoerus larvatus (F. Cuvier, 1822)	Bushpig
		Bovidae	*Raphicerus campestris* (Thunberg, 1811)	Steenbok
			Redunca arundinum (Boddaert, 1785)	Southern Reedbuck
			Sylvicapra grimmia (Linnaeus, 1758)	Bush Duiker

IUCN red listed species

Provincially protected animals

Alien invasive

10.5 Wetlands

10.5.1 Delineated wetlands

Four Hydrogeomorphic (HGM) units were found on the site, they include:

- Floodplains;
- Seeps;
- Depressions; and
- Channelled valley bottom wetlands.

All of these ecosystems have been classified as endangered (EN) or critically endangered (CR) as per Table 10-9 below.

The delineated wetlands within the Elders Colliery site are illustrated in Figure 10-7.

Table 10-7: Types of wetlands and current threat level

Wetland Ecosystem Type	Wetland HGM Type (WT)	Threat Status of WT	Protection level of WT	Wetland Vegetation Group (WVG)	Threat Status of WVG
Mesic Highveld Grassland Group 4_Floodplain wetland	Floodplain	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Seep	Seep	EN	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Depression	Depression	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Channelled valley bottom	Channelled valley bottom	CR	Hardly protected	Mesic Highveld Grassland	CR

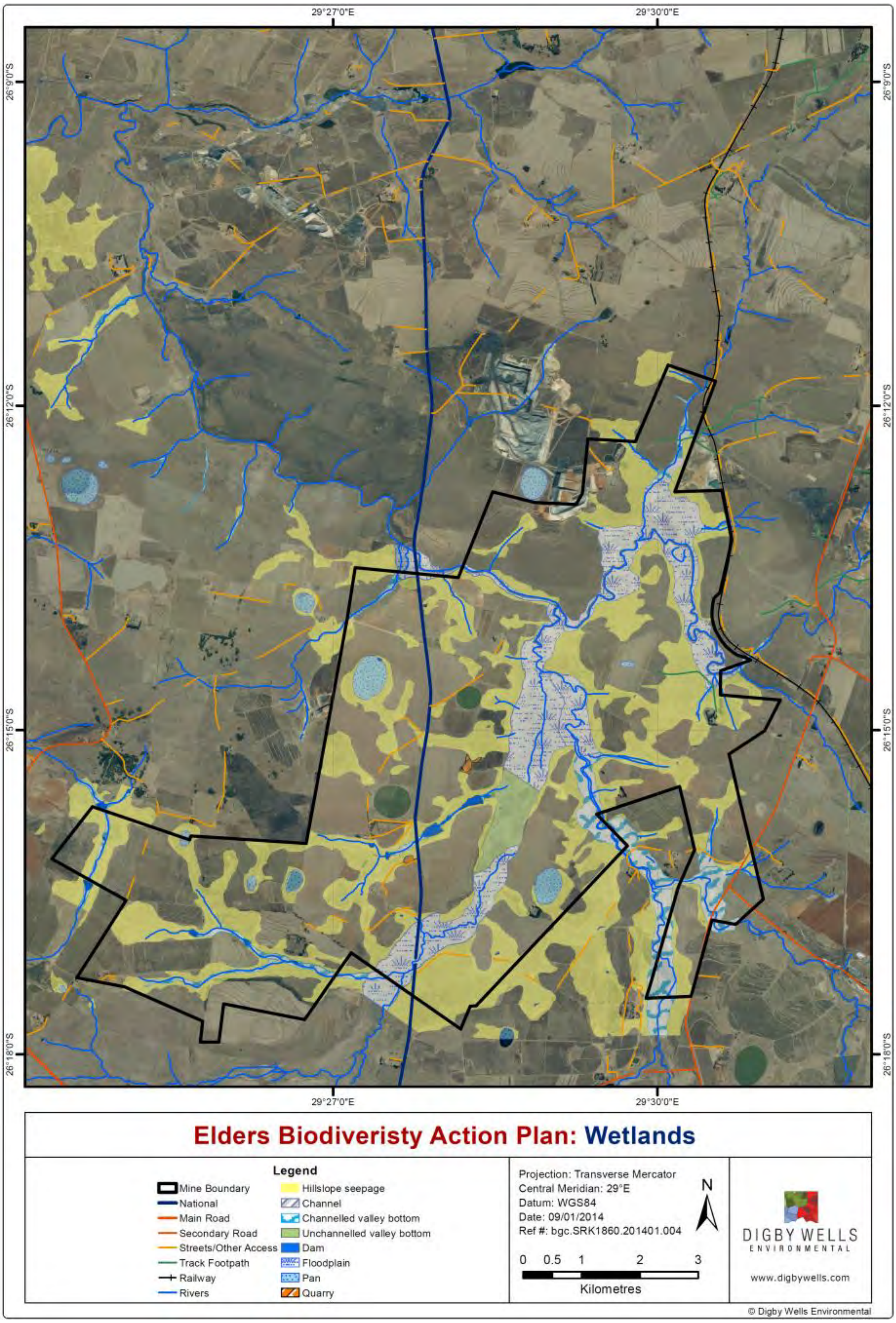

Figure 10-6: Wetlands within Elders Colliery

10.5.2 Present Ecological Status

Most of the wetlands are considered to be moderately modified (PES category C) as a result of degradation due to crop and stock farming activities adjacent to wetlands. Additional impacts are accrued due to impacts from farming within the wetland catchment.

Extensive areas of hillslope seepage wetland that have been cultivated are however mostly considered largely modified (PES category D).

The large Viskuile and Vlakkuilen floodplain wetlands are rated as largely natural to moderately modified (PES category B/C). These systems have been buffered somewhat from agricultural impacts by the surrounding hillslope seepage wetlands, though some degradation has occurred. For example from formal and informal road crossings.

The Olifants floodplain is considered moderately modified

The results of the PES assessment for all of the wetlands within the study area are illustrated in Figure 10-7 below.

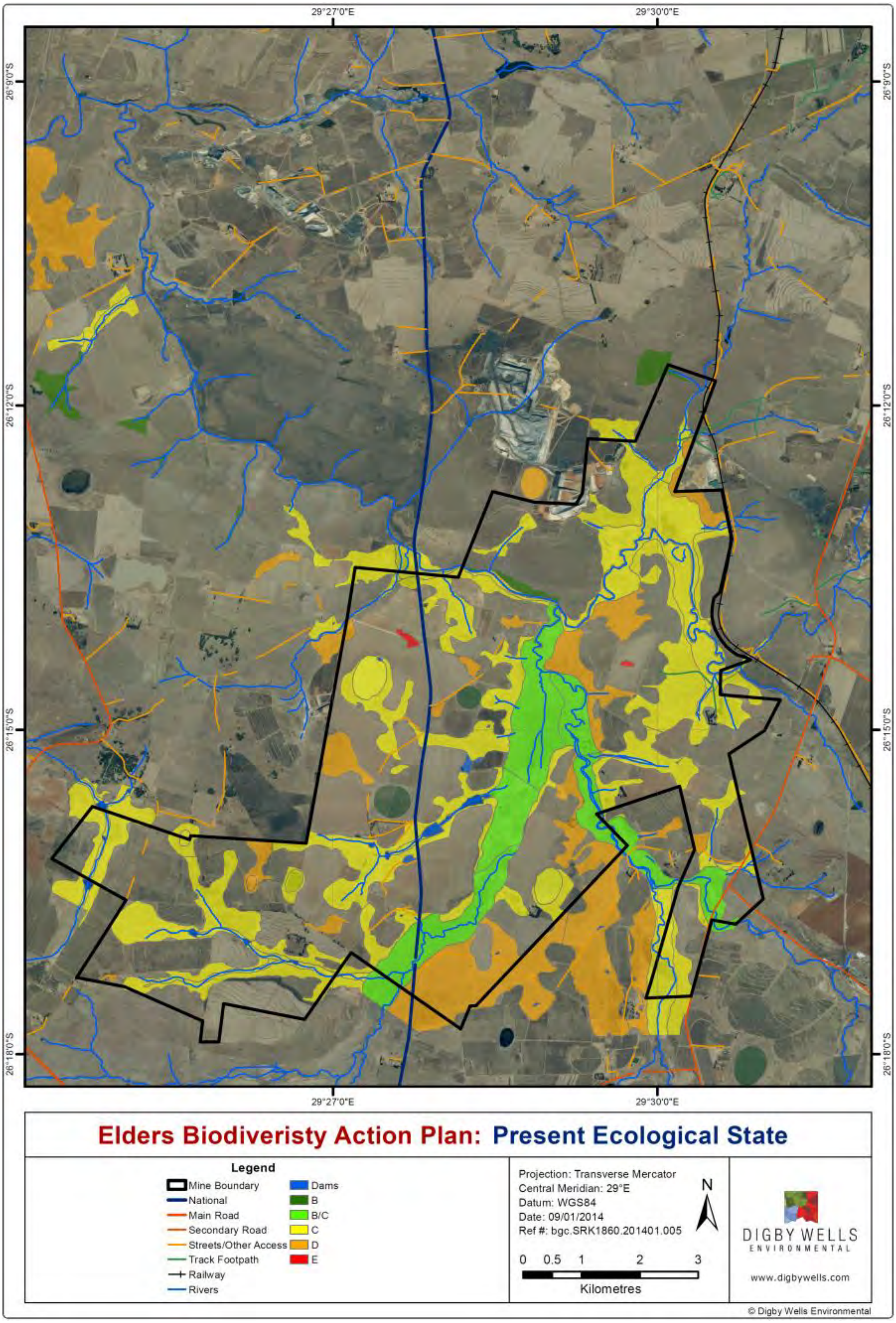

Figure 10-7: Present ecological status for wetlands within Elders Colliery

10.6 Aquatics

The proposed mine is located in the upper reaches of the Olifants River Catchment (Figure 2-1). Two quaternary catchments within this area are potentially affected:

- B11A: The proposed development is located in the lower reaches of Quaternary Catchment B11A, and incorporates the following aquatic features:
  - Olifants River frontage (10 km long);
  - Lower Viskuile Wetland (5 km long);
  - Vlakkuilen Wetland (5 km long and 2.5 km2 in extent); and
  - Two endorheic pans (28 and 17 ha in extent).
- B11B: The proposed development has the potential to impact the Olifants River in quaternary catchment B11B, located downstream of the proposed mine.

10.6.1 Sampling

The sample sites selected by Nepid consulting are shown in Figure 10-8 below.

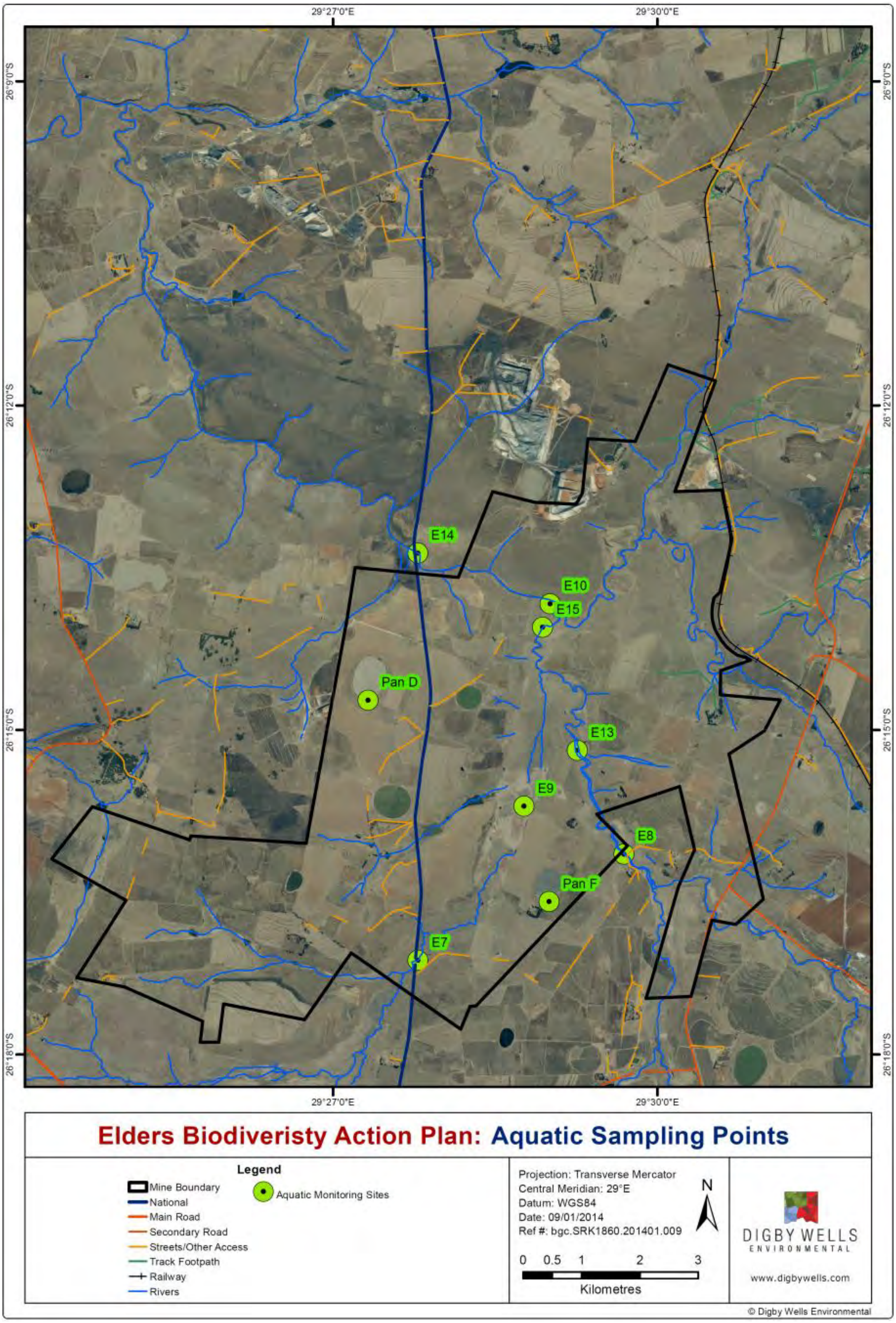

Figure 10-8: Aquatic sampling points

Four field surveys were carried out a high and low flow in both the 2002/2003 period and again in 2012/2013. Nepid consulting conducted diatom, aquatic invertebrates as well as fish surveys on the Elders Colliery site.

10.6.2 Water quality

Water quality for the 2012/2013 sampling seasons is reported below in Table 10-10. This includes: wetlands, rivers and pans.

Table 10-8: Field water quality during the 2012/2013 sampling

Site	Date	Flow	Temp (C)	pH	Secchi (cm)	Cond. (mS/m)
Wetlands						
E7	8 May 2012	Zero	20	9.0	71	101
E9	8 May 2012	Zero (Dry)	n/a	n/a	n/a	n/a
E13	8 May 2012	Zero	23	9.9	62	83
E15	8 May 2012	Zero	17	8.5	100	84
	8 Jan 2013	V Low	27	-	25	35
E17	8 Jan 2013	V Low	27	-	22	32
Olifants River						
E16	8 Jan 2013	Mod	25	-	15	34
E10	8 May 2012	Trickle	21	9.1	42	85
	8 Jan 2013	Mod	23	-	22	36
E14	8 May 2012	Trickle	19	9.0	70	74
	8 Jan 2013	Mod	24	-	22	36
Pans						
D	8 May 2012	Dry	n/a	n/a	n/a	n/a
	8 Jan 2013	n/a	-	-	-	490
F	8 May 2012	n/a	21	9.9	7	880
	8 Jan 2013	n/a	25	-	1	200

Adapted from Nepid Consulting (2013)

10.6.3 Biotic indicators

10.6.3.1 Diatoms

Table 10-11 comprises the Diatom analysis for the 2012/2013 sampling season.

Table 10-9: Diatom analysis for the 2012/2013 season

Date/Site	No Species	SPI score	Class	Category	PTV (%)
Wetlands					
May 2012					
E7	41	8.1	Poor quality	D	39.5
E13	49	9.2	Poor quality	D	44.5
E15	48	9.7	Poor quality	D	43
January 2013					
E15	49	6.9	Poor quality	D/E	71.5
E17	44	5.9	Bad quality	E	58.3
Olifants River					
May 2012					
E10	62	10	Moderate quality	C/D	47.8
E14	35	11.9	Moderate quality	C/D	30
January 2013					
E10	31	5.7	Bad quality	E	82.5
E14b	47	5.7	Bad quality	E	78
E16	30	9.9	Bad quality	D	36
Pans					
May 2012					
PANF	23	8	Bad quality	D	19.7

10.6.3.2 Invertebrate assessment

SASS 5 is the current rapid sampling protocol accepted by the department of water affairs for invertebrate sampling. Historical data from as far back as 1998 has been compared to the most recent survey data collected in 2013 (Table 10-12).

Table 10-10: Historic SASS results compared to most recent SASS 5 survey

		Olifants River									
Site	E16	E10		E14-B							
Date	9/01/2013	30/01/2003	9/01/2013	4/01/1998	09/1999	05/2000	10/2000	05/2001	30/01/2003	09/01/2013
Flow (m^3/s)	Moderate	Very Low 0.018	Moderate	Very Low 0.019	Trickle	High 2.0	Low 0.05	Very Low 0.014	Very Low 0.018	Moderate
Collector	R Palmer	R Palmer	R Palmer	C Thirion	J Rall	J Rall	J Rall	J Rall	R Palmer	R Palmer
SASS Score	64	67	109	71	95	84	77	66	83	121
No Taxa	15	15	23	14	20	15	16	13	17	23
ASPT	4.3	4.5	4.7	5.1	4.8	5.6	4.8	5.1	4.9	5.3
PES category (A-F)	C/D	C	B	B	B	B	B/C	B	B/C	A/B

A) Natural state	C)Moderately modified	E) Seriously Modified
B) Largely Natural	D) Largely Modified	F) Critically modified

10.6.3.3 Fish assessment

A summary of the fish data is outlined below in Table 10-13

Table 10-11: Fish survey data

	Wetlands							
Site	8D		E7	E8	E9	E13	E13	E15
Date	01/09/1999	01/05/2000	31/01/2003	31/01/2003	31/01/2003	31/01/2003	08/05/2012	08/05/2012
PES Category (A-F)	-	-	D	C	C	B	C	F

	Olifants River								
Site	E16	E10			E14				
Date	09/01/2013	01/01/2003	08/05/2003	08/01/2013	01/09/1999	01/05/2000	01/01/2003	08/05/2012	08/01/2013
PES Category (A-F)	E	C	D	C	B	B	E	D	D

A) Natural state	C)Moderately modified	E) Seriously Modified
B) Largely Natural	D) Largely Modified	F) Critically modified

11 PERCEIVED BIODIVERSITY, RISKS AND RECOMMENDATIONS

Table 11-1 is a summary of the perceived biodiversity values for the vegetation types of Elders Colliery these tables rate the extent, diversity and condition of the land to give a conservation value. The functional status of the land is determined by ranking the recreation, services and aesthetic capacity of the land scape.

Table 11-1: Perceived biodiversity values of the different land types identified at Elders Colliery

	Conservation value			Functional status			Value
Grasslands	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	5	5	5	5	5	5	**High**
	Two grassland communities were identified each with 2 sub-communities. Certain areas are rated as primary grassland and conservation status is endangered			Often overgrazed but capable of recovering if managed correctly			
Wetlands/Pans	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	5	5	5	5	7	5	**High**
	Certain sections of wetland in the Viskuile system are still pristine and serve as import sites for fish recruitment			Multiple important ecological functions: maintaining water purity and supply and reducing soil erosion. Habitat provision, Flood attenuation			
Aquatic systems	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	5	3	5	5	5	5	**Moderate**
	Low to moderate fish biodiversity with multiple impacts from farming such as sedimentation from trampling and high nutrient loads Alien invasive fish are present.			Fish are present for recreational fishing. River banks have alien trees. Dams and Weirs have altered the natural water course			
Alien Vegetation	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	3	3	3	3	3	3	**Low**
	Alien vegetation occurs in clumps across the study area, various species are present, eradication discussed in this report in the Management Programmes (Section 12)			Provides very limited services, possibly habitat for bird species.			
Proposed Infrastructure	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	3	3	3	3	5	5	**Low**
	These areas have very little value.			The proposed infrastructure site is located very near to a Pan			
Cultivated land	**Extent**	**Diversity**	**Condition**	**Recreation**	**Services**	**Aesthetic**	**Total**
	3	3	3	3	3	3	Low
	Monoculture fields offer very little to no conservation value			No recreational or aesthetic value, only function is food provision.			

Score	Biodiversity Value	Percentage Score
1	Very High Biodiversity Value	0 - 25%
2	High Biodiversity Value	25-50%
3	Moderate Biodiversity Value	50 – 75%
4	Low Biodiversity Value	75 – 100%

11.1 Determination of risks to Biodiversity

Based on the known species in the general study are, a few major risks were apparent, these include:

11.1.1 Loss of fauna habitat

Loss and degradation of untransformed faunal habitat as a direct result of clearing of vegetation and habitat to allow for mining and farming activities as well as related infrastructure to be built. This in turn affects the biodiversity regionally, as present ecological systems are altered and replaced by another less sensitive system.

11.1.2 Habitat fragmentation

Habitat fragmentation has occurred as a result of the degradation and seclusion of various natural corridors and habitat types. This results in the disruption of ecological connectivity and migration routes of larger, animals (such as hyena and jackal) as well as territorial infringement. This will occur in and between the two more natural areas, the degraded woodland and the open grassland.

11.1.3 The loss of fauna species

This includes the loss of natural animal individuals through increase of traffic through natural areas results in collisions with animals on roads. Direct mortality is highly likely of ground-living animals as a result of blasting operations and operation of heavy mining machinery.

11.1.4 Pollution of environment

The impacts associated with the potential leaching of chemicals into the ground water and surface water in the region of the study area result in a number of fauna impacts including loss of species, loss of habitat and overall loss of ecological integrity which is not limited to the project boundary. Contamination can also occur on areas of open surface water with coal dust. Furthermore noise and lighting disturb animal migration, occupation patterns and natural foraging activities.

11.1.5 Recommendations are according to the risks identified, they include:

11.1.6 Loss of fauna habitat

- Limit the footprint of the mining process within the natural faunal habitat areas remaining;
- No go areas include habitat that is under rehabilitation, or habitat that is still semi natural.

11.1.7 Habitat fragmentation

- All linear infrastructure associated with the mine should include “ecological crossing” – areas where possible, this is a passage where animals can safely cross such structures (roads, pipelines, conveyors etc.).
- Corridors could be buffered and fenced according to the sensitive area used as a corridor.
- Restore corridors by removing agricultural land/alien vegetation between pans and natural areas.
- Remove mining infrastructure as rehabilitation progresses, so as to not promote fragmentation.

11.1.8 The loss of fauna species

- Traffic: Toad fences and amphibian underpasses (pipes under road) inlaid at regular intervals will allow safe passage across the roads (especially important for roads in close proximity to wetlands/ponds/streams). The use of large underpasses or culverts will also allow safe passage of large/meso-predators such as hyena and jackal, throughout the landscape. Warning signage will have to be erected as well as the speed limit reduced to 80km/h in sensitive areas for standard vehicles and 60km/h for heavy vehicles. Rumble strips can also be applied for animals such as owls that are active at nights, car headlights will blind them.
- Monitoring of small mammals could be implemented to monitor the effects of mine activities on small mammal regimes, which are indicative of environmental health. This can take place biannually.

11.1.9 Pollution of environment

- A waste management plan should be in place. It should be ensured that no leaching or spillage of any chemical into any natural water system (groundwater or surface water) occurs. It must also be ensured that the transport and storage of all chemicals are done in a manner that no animals can gain access to these chemicals. In case of spillage or leaching, immediate clean-up actions and rehabilitation procedures must be followed. Constant monitoring of areas where spillages and leaching might occur could prevent long-term contamination of ground water and other sensitive areas.

- Dust suppression of gravel roads (water tankers) should take place.
- Noise pollution must be kept to the minimum possible levels. Blasting (if still employed at Elders Colliery) should be restricted to daylight hours when nocturnal animals are not foraging.

11.1.10 Impact on Red Data species and sensitive areas

- Rocky outcrops are suitable habitat for an array of species including Red Data reptiles. It is also an ecological system that can function independently from an impacted surrounding environment. Buffering of ridges from mine infrastructure is suggested around 50m.
- Rivers/wetland/pans are also classified as sensitive ecological systems that support many forms of animal life. Buffers around wetlands, pans and streams should be 100m as the occurrence of Giant Bullfrog is high.
- Aquatic dependent birds: Red Data birds that require an aquatic habitat can be conserved by avoiding these sensitive areas (No-go areas) or polluting substances escaping into it. The action plan already established by AEWA (African-Eurasian Waterbird Agreement) has the aim to improve the conservation status of the Lesser Flamingo from a "Near Threatened" species to a species of "Least Concern" globally.

In order to mitigate against the above mentioned impacts the following management objectives are proposed:

- Ensuring that all key breeding and feeding sites are designated as protected areas, Ramsar sites, BirdLife IBAs, and where appropriate, World Heritage Sites;
- Ensuring that all key breeding and feeding sites are protected and maintained in good ecological condition by identifying the management needs of Lesser Flamingo habitat at key sites and implementing necessary management actions. In some cases this will require maintaining, and restoring where necessary, favourable hydrological conditions and water quality;
- Ensuring that breeding colonies are not disturbed by planning and zoning;
- Raising awareness about the conservation needs of the species at national and local level;

Ensuring that pollution guidelines and legislation at all key sites reflect the sensitivity of the species, particularly to industrial chemicals and heavy metals; and

Ensuring that collisions with man-made structures, particularly power lines, telephone lines, fences, light masts and guide wires are minimised.

Table 10-8 shows the interaction between the biodiversity management units (pans and wetlands are here combined) and the activities that take place within the project boundary of Elders Colliery.

Table 11-2: Interaction matrix between biodiversity management units and Elders Colliery project activities

Project Activities	Biodiversity Management Units				
	Remnant Grassland	Wetlands	Alien Vegetation	Infrastructure	Cultivated land
Roads/Conveyors	■				
Rock dumps	■				
Informal roads	■		■	■	■
Mine Traffic	■		■		
Pollution	■	■	■	■	■
Noise	■	■	■	■	■
Dust	■	■	■	■	■

Note: ■ denotes interaction between the activity and unit

12 MANAGEMENT PROGRAMMES

12.1 Rehabilitation

12.1.1 Methods

Within the guidelines for the rehabilitation of mined land produced by the Chamber of Mines and Coaltech, there is provision for the use of local, native species seed for rehabilitation to address the above issues. In particular, it is thought that re-establishment of native grass and the non-grass species making up the veld in the region mined will contribute to the “no net loss of biodiversity” objectives as well as, from an economic point of view, create a more sustainable vegetation cover that will require less input in the long term for maintenance. The restored native species should also form a more resilient stand of vegetation, which should be capable of providing enhanced levels of ecosystem services relative to a stand of pasture grass.

12.1.2 Suggested species:

- *Chloris gayana*, Rhodes Grass;
- *Cenchrus ciliaris*, Buffelgrass;

- *Cynodon dactylon*, Bermuda Grass;
- *Digiteria eriantha*, Smuts finger Grass;
- *Eragrostis curvula*, Weeping love Grass;
- *Eragrostis teff*; and
- *Medicago sativa* Lucerne

The process by which topsoil is stripped, stockpiled and placed on regarded burden material often results in severe compaction. This is detrimental to the physical, chemical and biological properties of the soil. Consequently, these soils have lower soil aggregate stability, lower infiltration rates, reduced water holding capacity, and a greater capacity to resist root extension (Chapman et al, 1994), all of which inhibit the potential for plant growth and establishment on the rehabilitated soil.

12.1.3 Soil ameliorants

Substrates can be added to soil to alleviate the severity of soil compaction. These might include sewage sludge, pine bark, earthworms, and microbes. Many studies have illustrated the use of these additives as ameliorants of soil compaction. Earthworms improve soil physical structure. Their burrowing activity results in the production of increased macro pores. This improves hydraulic processes in the soil, improves aeration (Tian et al, 2000) and can decrease the bulk density of a soil (Jascho et al, 1989; Whalley et al, 1995). Additions of pine bark have been reported to decrease then bulk density of a soil. Brown *et al* (1975).

12.1.4 Time

- Harvesting time of seeds should be several times per year early, mid and late in season) a minimum of three harvests per site being early, mid and late season; and
- Spring Early Summer, Late Summer

12.1.5 Harvesting

- The environment has to be dry for optimum harvesting to prevent clogging of the harvester. Sunny days are preferable, and harvesting should start after any dew has dried up. Typically, this would be from about 10h30 onwards;
- Once the harvester is full, seed should be emptied into polyethylene woven bags, and left in the open with the bags open to allow for the seed and associated leaf and stem material to start drying. All bags harvested in a day should be removed from their bags and spread onto a sheet of plastic in a well-ventilated building for further drying;
- The seed should be turned several times per day for at least one week to ensure proper drying and prevent the growth of mould. Once the seed is properly dry, it can be replaced in the polyethylene bags for storage. The bags should still be left open to allow for movement of air; and

- Note that it is virtually impossible to separate out the residual leaf, stem and flower material that is harvested as a “by-product” of the seed.

12.1.5.1 Seed Storage

- Typically, veld grass seed has a dormancy period during which germination will be impaired. In general storage of seed for one year will serve to break the dormancy and increase the germination rate; and
- Seed should be stored in dry, cool conditions. Ideally, an air conditioned facility should be used to reduce the humidity and temperature. However, storage at room temperature has also been successful.

12.1.6 Planting

Planting dates should be brought forward to coincide with the first rains to allow a full growing season for the native species seed to germinate and grow. Typically, this would be around mid-October.

12.1.7 Soil

The soil fertility should be close to the fertility levels of natural, undisturbed veld in the vicinity. In particular, nitrogen levels should not be elevated too high, as this will have a negative effect on the diversity of species.

12.1.8 Defoliation

Grazing is preferable, and veld that is grazed tends to be more diverse than veld mowed regularly, provided the grazing is not too extreme in intensity, or too uniform. Grazing has the added advantage of enhancing nutrient cycling, and creating some mild soil disturbance that facilitates germination of seed of the species present.

Fire is a natural part of grassland ecosystems, and should be considered as part of the management of restoration areas in the long term. However, fire should be avoided on newly established areas, at least until there is a good vegetation cover.

12.2 FLORA: Alien vegetation programme

Three alien invasive species were identified during the biodiversity study they were: *Campuloclinium macrocephalum, Cirsium vulgare, Solanum elaeagnifolium*. They are all category one species in terms of Conservation of Agricultural Resource Act (No 43 of 1983).

specific concern is the presence of *Campuloclinium macrocephalum*, commonly known as the Pom-Pom plant. This plant has spread extensively in the grassland the past years and is difficult to control, where the other two species recorded are often found in close proximity to feeding areas or in cultivated fields, *Campuloclinium macrocephalum* spreads into natural grassland irrespective of its condition. To support this statement and concern it should be noted that *Campuloclinium macrocephalum* was not recorded in earlier studies conducted in 2002, while both *Cirsium vulgare* and*, Solanum elaeagnifolium* were recorded.

12.2.1 Alien invasive control

Included below are management strategies for commonly occurring invasive flora species in the South African Grassland Biome.

The design of an alien invasive control program is critical for the success of this objective, the steps are as follows:

- Assess the spread/extent of the infestation. Rate accordingly, Light Intermediate or Dense.
- Assess maturity of alien plants
- Plot findings on a topographical map 1:20 000
- Prioritise control areas and stages for effective control.

After these steps are followed the affected areas should be divided into control blocks, using different age classes or species as divider. Each control block will have a rating of the infestation within it, age, species, etc.

The aim is to eradicate all species within a block.

- Stage 1: Clear sparsely infested areas first (apply follow up within 3-6 months)
- Stage 2: Clear small isolated infestations (apply follow up within 3-6 months)
- Stage 3: Stop edges of dense infestations from spreading (apply follow up within 3-6 months)
- Stage 4: Reduce area of dense infestation working from the edges inwards (apply follow up within 3-6 months)
- Prioritising of control blocks is based on the urgency of the control needed within a particular block.
- Control methods

The choice of control method depends on a range of factors, including type and ecology of the plant, density of infestation, nature of the terrain, the climate, season and availability of resources.

12.2.2 Alien plants eradication procedure

Guidelines for commonly occurring alien plants have been included below in Table 12-1 to 11-6. Not all of these species have been found within Elders Colliery, however the potential exists for them to be introduced accidentally from nearby surrounds.

Table 12-1: ***Acacia mearnsii*** **(Black wattle (Swartwattel))**

List of Alien Invasive plants that occur / could at Elders Colliery				**Treatment detail**			**Application detail**				**Planning detail**		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Acacia mearnsii	Black wattle (Swartwattel)	Unarmed, evergreen tree 5-10(-15) m high; branchlets shallowly ridged; all parts finely hairy; growth tips golden-hairy. Leaves: dark olive-green, finely hairy, bipinnate; leaflets short (1.5-4.0 mm) and crowded; raised glands occur at and between the junctions of pinnae pairs. Flowers: pale yellow or cream, globular flowerheads in large, fragrant sprays, August-September. Fruits: dark brown pods, finely hairy, usually markedly constricted.	Category 2	Seedlings	Hand pull	None							
				Seedlings and up to 1 m tall	Foliar spray	**clopyralid / triclopyr (-amine salt) 90 / 270 g/L SL** *Confront 360 SL (L7314)*	30ml / 10 Litres water and 0.5% Wetter & Dye	**0.03**	**10**	0.3	Closed / Dense	**0.90**	300
						fluroxypyr 200 g/L EC *Starane 200 EC (L4918), Tomahawk 200 EC (L6652), Voloxypyr 200 EC (7776)*	12.5ml / 10 Litres water and 0.5% Wetter & Dye	**0.0125**	**10**	0.125	Closed / Dense	**0.38**	300
						glyphosate (ammonium) 680 g/kg WG *Roundup Max 680 WG (L6790)*	80gr / 10 Litres water and 0.1% Dye	**0.08**	**10**	0.8	Closed / Dense	**2.40**	300
						glyphosate (isopropylamine) 240 g/L SL *Tumbleweed 240 SL (L4781)*	112.5ml / 10 Litres water and 0.1% Dye	**0.1125**	**10**	1.125	Closed / Dense	**3.38**	300
						glyphosate (isopropylamine) 360 g/L SL *Glyph 360 SL (L4767), Mamba 360 SL (L4817), Roundup 360 SL (L407), Springbok 360 SL (L6719)*	150ml / 10 Litres water and 0.1% Dye	**0.15**	**10**	1.5	Closed / Dense	**4.50**	300
						glyphosate (isopropylamine) 450 g/L SL *RoundUp Turbo 450 SL (L7166)*	120ml / 10 Litres water and 0.1% Dye	**0.12**	**10**	1.2	Closed / Dense	**3.60**	300
						glyphosate (isopropylamine) 480 g/L SL *Mamba Max 480 SL (L7714)*	110ml / 10 Litres water and 0.1% Dye	**0.11**	**10**	1.1	Closed / Dense	**3.30**	300

						glyphosate (sodium) 500 g/kg WG *Kilo 500 WSG (L7431)*	100gr / 10 Litres water and 0.1% Dye	**0.1**	**10**	1	Closed / Dense	**3.00**	300
						triclopyr (butoxy ethyl ester) 240 g/L EC *Ranger 240 EC adjuvant incl. (L6179)*	50ml / 10 Litres water and 0.1% Dye	**0.05**	**10**	0.5	Closed / Dense	**1.50**	300
						triclopyr (butoxy ethyl ester) 480 g/L EC *Garlon 4 EC (L3249) & 480 EC (L4916), Triclon EC (L6661), Viroaxe EC (L6663)*	25ml / 10 Litres water and 0.5% Wetter & Dye	**0.025**	**10**	0.25	Closed / Dense	**0.75**	300
				Up to 2m tall & Coppice	Spot spray	**clopyralid / triclopyr (-amine salt) 90 / 270 g/L SL** *Confront 360 SL (L7314)*	50ml / 10 Litres water and 0.5% Wetter & Dye	**0.05**	**10**	0.5	Closed / Dense	**1.50**	300
						fluroxypyr / picloram 80 / 80 g/L ME *Plenum 160 ME (L7702)*	75ml / 10 Litres water and 0.5% Wetter & Dye	**0.075**	**10**	0.75	Closed / Dense	**2.25**	300
						glyphosate (isopropylamine) 240 g/L SL *Tumbleweed 240 SL (L4781)*	150ml / 10 Litres water and 0.1% Dye	**0.15**	**10**	1.5	Closed / Dense	**4.50**	300
						glyphosate (potassium) 500 g/L SL *Touchdown Forte Hitech 500 SL adjuvant incl.(L7305)*	100ml / 10 Litres water and 0.1% Dye	**0.1**	**10**	1	Closed / Dense	**3.00**	300
						triclopyr (butoxy ethyl ester) 240 g/L EC *Ranger 240 EC adjuvant incl. (L6179)*	150ml / 10 Litres water and 0.1% Dye	**0.15**	**10**	1.5	Closed / Dense	**4.50**	300
						triclopyr (butoxy ethyl ester) 480 g/L EC *Garlon 4 EC (L3249) & 480 EC (L4916), Triclon EC (L6661), Viroaxe EC (L6663)*	75ml / 10 Litres water and 0.1% Wetter & Dye	**0.075**	**10**	0.75	Closed / Dense	**2.25**	300

				Mature	Bark strip	None	Strip into the ground						
					Cut stump	**fluroxypyr / picloram 80 / 80 g/L ME** *Plenum 160 ME (L7702)*	200ml / 10 Litres water and 0.5% Wetter & Dye	**0.2**	**10**	2	Closed / Dense	**4.00**	200
						imazapyr 100 g/L SL *Chopper 100 SL (L3444), Hatchet 100 SL (L7409)*	1000ml / 10 Litres Water and 0.1% Dye	**1**	**10**	10	Closed / Dense	**20.00**	200
						picloram (potassium salt) 240 g/L SL *Access 240 SL (L4920), Browser 240 SL (L7357)*	150ml / 10 Litres Water and 0.5% Wetter & Dye	**0.15**	**10**	1.5	Closed / Dense	**3.00**	200
						triclopyr (-amine salt) 360 g/L SL *Lumberjack 360 SL (L7295), Timbrel 360 SL (L4917)*	300ml / 10 Litres Water and 0.5% Wetter & Dye	**0.3**	**10**	3	Closed / Dense	**6.00**	200
					Frill	**picloram (potassium salt) 240 g/L SL** *Access 240 SL (L4920), Browser 240 SL (L7357)*	600ml / 10 Litres Water and 2% Wetter & Dye	**0.6**	**10**	6	Closed / Dense	**12.00**	200

Table 12-2:*Solanum sisymbriifolium* (Wild tomato, Dense-thorned bitter apple (Wildetamatie, Doringtamatie))

List of Alien Invasive Plants that occur / could occur at Elders Colliery				**Treatment detail**			**Application detail**				**Planning detail**		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Solanum sisymbriifolium	Wild tomato, Dense-thorned bitter apple (Wildetamatie,	Much-branched, very spiny, low shrub 0.5-1.5 m high, with extensive root system; all parts covered with sticky, glandular hairs and bright orange-red to	Category 1	Seedling <1m	Hand pull ***NB: keep roots off the ground***	None							

	Doringtamatie)	brown-yellow spines up to 20 mm long. Leaves: dull green, spiny, glandular-hairy, deeply pinnately lobed and toothed, up to 200 mm long; spines mainly on midrib and veins. Flowers: white, cream or bluish, all year. Fruits: shiny berries, green turning bright red, about 15 mm across.		Seedling 0.5 to 1m and Coppice	Foliar spray	**clopyralid / triclopyr (-amine salt) 90 / 270 g/L SL** *Confront 360 SL (L7314)*	600ml / 10 Litres water and 0.5% Wetter & Dye	**0.6**	**10**	6	Closed / Dense	**18.00**	300
						fluroxypyr 200 g/L EC *Starane 200 EC (L4918), Tomahawk 200 EC (L6652), Voloxypyr 200 EC (7776)*	12.5 ml / 10 Litres water and 0.5%Wetter & Dye	**0.0125**	**10**	0.125	Closed / Dense	**0.38**	300
						fluroxypyr / picloram 80 / 80 g/L ME *Plenum 160 ME (L7702)*	25ml / 10 Litres water and 0.5% Wetter & Dye	**0.025**	**10**	0.25	Closed / Dense	**0.75**	300
						glyphosate (ammonium) 680 g/kg WG *Roundup Max 680 WG (L6790)*	80gr / 10 Litres water and 0.1% Dye	**0.08**	**10**	0.8	Closed / Dense	**2.40**	300
						glyphosate (isopropylamine) 240 g/L SL *Tumbleweed 240 SL (L4781)*	75ml / 10 Litres water and 0.1% Dye	**0.075**	**10**	0.75	Closed / Dense	**2.25**	300
						glyphosate (isopropylamine) 360 g/L SL *Glyph 360 SL (L4767), Mamba 360 SL (L4817), Roundup 360 SL (L407), Springbok 360 SL (L6719)*	150ml / 10 Litres water and 0.1% Dye	**0.15**	**10**	1.5	Closed / Dense	**4.50**	300
						glyphosate (isopropylamine) 450 g/L SL *RoundUp Turbo 450 SL (L7166)*	40ml / 10 Litres water and 0.1% Dye	**0.04**	**10**	0.4	Closed / Dense	**1.20**	300
						glyphosate (isopropylamine) 480 g/L SL *Mamba Max 480 SL (L7714)*	40ml / 10 Litres water and 0.1% Dye	**0.04**	**10**	0.4	Closed / Dense	**1.20**	300
						glyphosate (potassium) 500 g/L SL *Touchdown Forte Hitech 500 SL adjuvant*	100ml / 10 Litres water and 0.1% Dye	**0.1**	**10**	1	Closed / Dense	**3.00**	300

						incl.(L7305)							
						glyphosate (sodium) 500 g/kg WG *Kilo 500 WSG (L7431)*	50gr / 10 Litres water and 0.5% Wetter & Dye	**0.05**	**10**	0.5	Closed / Dense	**1.50**	300
						imazapyr 100 g/L SL *Chopper 100 SL (L3444), Hatchet 100 SL (L7409)*	63ml / 10 Litres Water and 0.1% Dye	**0.063**	**10**	0.63	Closed / Dense	**1.89**	300
						triclopyr (butoxy ethyl ester) 240 g/L EC *Ranger 240 EC adjuvant incl. (L6179)*	100ml / 10 Litres water and 0.1% Dye	**0.1**	**10**	1	Closed / Dense	**3.00**	300
						triclopyr (butoxy ethyl ester) 480 g/L EC *Garlon 4 EC (L3249) & 480 EC (L4916), Triclon EC (L6661), Viroaxe EC (L6663)*	50ml / 10 Litres water and 0.5% Wetter & Dye	**0.05**	**10**	0.5	Closed / Dense	**1.50**	300
				Mature	Cut stump ***NB: for trial, not registered***	**glyphosate (ammonium) 680 g/kg WG** *Roundup Max 680 WG (L6790)*	265gr / 10 Litres water and 0.1% Dye	**0.265**	**10**	2.65	Closed / Dense	**5.30**	200
					Cut stump/frill	**glyphosate (isopropylamine) 480 g/L SL** *Mamba Max 480 SL (L7714)*	110ml / 10 Litres water and 0.1% Dye	**0.11**	**10**	1.1	Closed / Dense	**2.20**	200
						imazapyr 100 g/L SL *Chopper 100 SL (L3444), Hatchet 100 SL (L7409)*	200ml / 10 Litres Water and 0.1% Dye	**0.2**	**10**	2	Closed / Dense	**4.00**	200
						picloram (potassium salt) 240 g/L SL *Access 240 SL (L4920), Browser 240 SL (L7357)*	100ml / 10 Litres Water and 0.5% Wetter & Dye	**0.1**	**10**	1	Closed / Dense	**2.00**	200
						triclopyr (-amine salt) 360 g/L SL *Lumberjack 360 SL (L7295), Timbrel 360 SL (L4917)*	300ml / 10 Litres Water and 0.5% Wetter & Dye	**0.3**	**10**	3	Closed / Dense	**6.00**	200

Table 12-3: ***Eucalyptus spp***.

List of Alien Invasive Plants that occur / could occur at Elders Colliery				Treatment detail			Application detail				Planning detail		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Eucalyptus sideroxylon	Black / Red ironbark, Blue gums (Swartysterbasbloekom)	Evergreen tree 15-26 m high with a moderately spreading crown; bark persistent to the small branches, hard, ridged and deeply furrowed; the blackest bark of all eucalypts. Leaves: dark greyish-green; adult leaves lance-shaped, pendulous; juvenile leaves linear to broadly ovate or oblong. Flowers: cream, pink or rose-red with exserted stamens; buds pendulous, with conical or beaked lids, to 12 mm long. Pendulous capsules, deeply enclosed valves; often covered with sub-persistent staminal ring.	Category 2	Seedlings	Hand pull	None							
				Mature plants	Cut stump	**clopyralid / triclopyr (-amine salt) 90 / 270 g/L SL** *Confront 360 SL (L7314)*	1,250ml / 10 Litres Water and 0.1% Dye	**1.25**	**10**	12.5	Closed / Dense	**25.00**	200
						fluroxypyr / picloram 80 / 80 g/L ME *Plenum 160 ME (L7702)*	450ml / 10 Litres water and 0.5% Wetter & Dye	**0.45**	**10**	4.5	Closed / Dense	**9.00**	200

Table 12-4: ***Populus X canescens*** **(Grey poplar, Matchwood poplar (Vaalpopulier)), including *P. deltoids, P. nigra***

List of Alien Invasive Plants that occur / could occur at Elders Colliery				Treatment detail			Application detail				Planning detail		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Populus X canescens	Grey poplar, Matchwood poplar (Vaalpopulier)	Deciduous or semi-evergreen tree 10-20(-35) m high, suckering freely; bark white or grey with horizontal dark lines becoming rough and darker with age; buds and twigs thinly downy. Leaves: dark green and shiny above, grey- or white-woolly to green and smooth beneath; leaves of sucker shoots and ends of long shoots: large, to 120 mm long, ± triangular, ± evenly toothed, not or shallowly lobed, woolly beneath; leaves of short shoots: smaller, 30-60 mm long, becoming almost glabrous beneath.	Category 2	All	Cut stump / Frill	**imazapyr 100 g/L SL** *Chopper 100 SL (L3444), Hatchet 100 SL (L7409)*	500ml / 10 Litres Water	**0.5**	**10**	5	Closed / Dense	**10.00**	200
						picloram (potassium salt) 240 g/L SL *Access 240 SL (L4920), Browser 240 SL (L7357)*	200ml / 10 Litres Water and 0.5% Wetter & Dye	**0.2**	**10**	2	Closed / Dense	**4.00**	200
						triclopyr (-amine salt) 360 g/L SL *Lumberjack 360 SL (L7295), Timbrel 360*	600ml / 10 Litres Water and 0.1% Wetter &	**0.6**	**10**	6	Closed / Dense	**12.00**	200

						SL (L4917)	Dye						

Table 12-5: *Cirsium vulgare* (Spear / Scotch Thistle)

List of Alien Invasive Plants that occur / could occur at Elders Colliery				**Treatment detail**			**Application detail**				**Planning detail**		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Cirsium vulgare	Spear / Scotch Thistle	Spiny, herbaceous biennial, forming a large, flat rosette of leaves and deep tap-root the first year and much-branched stems up to 1.5 m high in the second year; stems have spiny wings. Leaves: dark green with stiff hairs above, white woolly beneath, deeply lobed, the lobes ending in strong spines. Flowers: pink to mauve, in heads up to 50 mm long x 50 mm wide, surrounded by spiny bracts.	Category 1	All	Foliar	**clopyralid / triclopyr (-amine salt) 90 / 270 g/L SL** *Confront 360 SL (L7314)*	75ml / 10 Litres water and 0.5% Wetter & Dye	**0.075**	**10**	0.75	Closed / Dense	**2.25**	300
						fluroxypyr / picloram 80 / 80 g/L ME *Plenum 160 ME (L7702)*	75ml / 10 Litres water and 0.5% Wetter & Dye	**0.075**	**10**	0.75	Closed / Dense	**2.25**	300
						picloram (potassium salt) 240 g/L SL *Access 240 SL (L4920)*	50ml / 10 Litres Water and 0.5% Wetter & Dye	**0.05**	**10**	0.5	Closed / Dense	**1.50**	300

Table 12-6: *Argemone mexicana* (Yellow-flowered Mexican poppy (Geelblom-bloudissel))

List of Alien Invasive Plants that occur / could occur at Elders Colliery				**Treatment detail**			**Application detail**				**Planning detail**		
Scientific Name	**Common Name**	**Description and Identification**	**Invasive status / Category**	**Size class**	**Treatment**	**Herbicide**	**Dosage**	**a.i. Litres**	**Mix Litres**	**% Mix a.i.**	**Density**	**Estimated Product Litres / Ha (or kg)**	**if Mix volume Litres / Ha**
Argemone mexicana	Yellow-flowered Mexican poppy (Geelblom-bloudissel)	Annual, very spiny herb up to 0.9 m high; stems exude a yellow sap when cut. Leaves: bluish-green, with prominent white veins, spiny; up to 150 mm x 60 mm. Flowers: bright yellow. Fruits: spiny capsules, ovoid , green turning brown, up to 50 mm long, splitting into five lobes and releasing numerous small black seeds.	Category 1	All	Physical removal of entire plant.	None							

13 SUGGESTED MANAGEMENT UNITS:

The following series of tables below (Table 13-1 through Table 11-21) outline the current state of the management units on Elders Colliery. The Suggested management units are:

- Grasslands Unit (Table 13-1);
- Wetlands/Pans Unit (Table 13-2);
- Aquatic Systems Unit (Table 13-3);
- Alien Vegetation Unit (Table 13-4); and
- Infrastructure Unit (Table 13-5).
- Cultivated Land Unit (Table 13-6)

From there a target state is proposed that could be reached if the management objectives are followed for the specific management units. Seven management units are outlined below they are grasslands, wetlands, pans, alien vegetation, rehabilitated areas, infrastructure/disturbed land and the conservation areas respectively.

Table 13-1: Grassland Unit

ITEM	CURRENT	TARGET	DESCRIPTION
Biodiversity Value	High	High	The removal of alien vegetation and the connection of isolated units will increase the value of the overall unit, due to the increase in size as well as increased diversity of species.
Threats/impacts	High	Low	The encroachment of agriculture and mining infrastructure needs to be prevented and the associated impacts to the unit better managed.

ACTION		TIMEFRAME	URGENCY	RESPONSIBILITY
1	Install nesting boxes and poles to aid in the owl re-introduction.	Construction phase	Medium	Environmental Officer
2	Put a waste management plan in place to ensure the correct disposal of waste and an action plan for spillages and runoff from mining infrastructure.	Construction phase	High	Environmental Officer
3	Demarcated area as “No go” zone, this grassland type very important in the project area.	Continually	High	Environmental Officer
4	Prevent unnecessary vegetation removal and encroachment of fields.	Continually	Medium	Environmental Officer
5	Implement an alien eradication programme that will remove alien invasive plants in order to improve ecological integrity.	Continually	High	Environmental Officer
6	Design and implement fire management plan.	Before dry season	Medium	Environmental Officer
7	Update flora species list to confirm Red Data, endemic and medicinal in area.	Summer	High	Consultant

Table 13-2: Wetlands/Pans Unit

ITEM	CURRENT	TARGET	DESCRIPTION
Biodiversity Value	High	High	Wetland areas have been reduced in size due to agriculture encroachment and the water quality of the systems impacted due to mining discharge. These need to be addressed in order to increase the value.
Threats/impacts	High	Low	The main threats alien vegetation colonisation of wetland habitat as well as the discharge of contaminated water into the system impacting on water quality.

	ACTION	TIMEFRAME	URGENCY	RESPONSIBILITY
1	Prevent grazing in wetlands. Use cattle grids and fence off grazing areas	Immediately	Medium	Environmental Officer
2	Use wetland areas as corridors to other natural areas.	Immediately	Medium	Environmental Officer
3	Put a waste management plan in place to ensure the correct disposal of waste and an action plan for spillages and runoff from mining infrastructure	Immediately	High	Environmental Officer
4	Adopt a 50m buffer zone for all wetland areas	Immediately	Medium	Environmental Officer
5	Demarcated area as “No go” zone, these systems are protected by the NWA	Continually	High	Environmental Officer
6	Implement an alien eradication programme that will systematically remove alien invasive plant species	Continually	High	Environmental Officer
7	Design and implement fire management plan	Before dry season	Medium	Environmental Officer
8	Update flora species list to confirm Red Data, endemic and medicinal species	September	High	Consultant
9	Conduct an amphibian survey to determine the current population	November	Medium	Consultant
10	Install nesting boxes and poles to aid in the owl re-introduction	Immediately	Medium	Environmental Officer

Table 13-3: Aquatic Systems Unit

ITEM	CURRENT	TARGET	DESCRIPTION
Biodiversity Value	Moderate	High	Wetland areas have been reduced in size due to agriculture encroachment and the water quality of the systems impacted due to mining discharge. These need to be addressed in order to increase the value.
Threats/impacts	High	Low	The main threats are the discharge/runoff of contaminated water into the system impacting on water quality.

ACTION		TIMEFRAME	URGENCY	RESPONSIBILITY
1	Adopt a 50m buffer zone. Fence off the pan area and treat it as a NO GO.	Immediately	Medium	Environmental Officer
2	Erect owl perches and bat boxes.	Immediately	Medium	Environmental Officer
3	Prevent contaminated runoff from surrounding agricultural operations entering the Pan	Immediately	High	Environmental Officer
4	Erect signage indicating NO Go zone	Continually	High	Environmental Officer
5	Erect bird hide and boardwalk	Continually	High	Environmental Officer
6	Erect Go Slow signage indicating Frog and faunal crossing	June	Medium	Environmental Officer
7	Conduct an amphibian survey to determine the current population	September	High	Consultant
8	Monitor area to ensure that alien vegetation does not colonise	Continually	High	Environmental Officer
9	Addition of Fish ladders	Immediately	Medium	Consultant
10	Removal of dams and Weirs	Immediately	Medium	Consultant

Table 13-4: Alien vegetation Unit

ITEM	CURRENT	TARGET	DESCRIPTION
Biodiversity Value	Low	Low	Alien vegetation are of a low biodiversity value.
Threats/impacts	Low	Moderate	Alien vegetation threatens water supply and available habitat for indigenous species.

ACTION		TIMEFRAME	URGENCY	RESPONSIBILITY
1	Implement the alien eradication program as outlined in this report.	Immediately	High	Environmental Officer
2	Monitor areas that have been cleared of alien vegetation to ensure follow up treatments are conducted timeously.	Immediately	High	Environmental Officer

Table 13-5: Infrastructure Unit

ITEM		CURRENT	TARGET	DESCRIPTION		
Biodiversity Value		Low	Moderate	These areas have inherently low biodiversity value		
Threats/impacts		Very High	Moderate	Mining infrastructure is a very large threat to this Management Unit. Careful rehabilitation will need to be carried out to restore the area to its previous level of Biodiversity. Considerable management will be required to prevent impacts from occurring in the sensitive pan environment.		
ACTION				TIMEFRAME	URGENCY	RESPONSIBILITY
1	Put a waste management plan in place to ensure the correct disposal of waste and an action plan for spillages and runoff from mining infrastructure			Immediately	High	Environmental Officer
2	Prevent unnecessary vegetation removal and encroachment of fields			Continually	Medium	Environmental Officer
3	Implement an alien eradication programme that will remove alien invasive plants in order to improve ecological integrity; especially *Verbena bonariensis*			Continually	High	Environmental Officer
4	Design and implement fire management plan			Before dry season	Medium	Environmental Officer

Table 13-6: Cultivated land Unit

ITEM	CURRENT	TARGET	DESCRIPTION
Biodiversity Value	Low	Low to Moderate	These areas have inherently low biodiversity value. However better farming practises could increase the biodiversity and reduce the impacts on the soils.
Threats/impacts	Moderate	Moderate	There are few perceived threats to the cultivated fields from the mine workings apart from the potential loss of farm land due to infrastructure

ACTION		TIMEFRAME	URGENCY	RESPONSIBILITY
1	Determine the desired outcome of the conservation area operation.	November	High	Environmental Officer
2	Decide on an appropriate location.	December	Medium	Environmental Officer
3	Determine the carrying capacity of the current farm size.	January	High	Environmental Officer
4	Decide on the stocking rate that will be applied to the project area.	February	High	Environmental Officer
5	Determine the current sex ratios of the three animal species that will be managed in the project area.	November	High	Environmental Officer
6	Develop veld management actions, such as rotational grazing, and resting of certain areas, veld burning.	December	High	Environmental Officer
7	Following on desired management outcome, decide of culling program	January	High	Environmental Officer
8	Develop fire control program to protect valuable browse and graze during the winter season.	February	High	Environmental Officer
9	Determine correct placement and type of waterholes.	November	High	Environmental Officer
10	Through relevant flora report results, implement alien invasive management strategy.	December	Medium	Environmental Officer

14 RECOMMENDATIONS

14.1 Flora and Fauna Recommendations

If managed correctly the post mining environment can be as diverse as the current environment with potential to increase the overall diversity of the site

- Edge effects should be reduced and smoothed;
- Increase habitat diversity, active management of wetlands and removal of alien vegetation will allow the natural vegetation to recover;
- Attempting to mimic the current vegetation conditions when rehabilitation is carried out by focusing on plant families that are important to pollinators such as Asteraceae and Fabacea;
- Installing signs and setting up “No-Go” areas to reduce disturbance;
- Remove old roads and rehabilitate the area to remove the potential for habitat fragmentation; and
- Reduce and actively manage farming practises to prevent stock animals grazing in the wetlands and reduce trampling effects and siltation of the wetlands and aquatic systems.

14.2 Wetlands Recommendations

- The wetlands should have restricted access and the development of these systems should be prohibited. An effective buffer zone should be implemented along all wetland systems, with firm stipulations that all land uses and mining activities should be set back from the water resources by at least 50m;
- Signage should be put up along roads adjacent to wetlands in order to inform staff and visitors to the Elders Colliery site of the importance of wetland systems to people and biodiversity, as well as to prohibit entrance to wetlands on site;
- Levelling of the surface of all berms in the floodplain and valley bottom systems should take place, in order to reinstate the natural historical flow (pre-mining) of wetlands;
- Areas where *Phragmites australis* has formed dense impenetrable stands should be cleared and a mixed seed-spray of indigenous sedges and hydrophilic grasses should be applied in order to improve wetland plant diversity. In order to reduce the re-establishment of stands of *Phragmites australis,* excessive into floodplain systems should be prevented. *Phragmites australis* is adapted to withstand loose sandy soils and re-vegetating the banks of floodplains and valley bottom systems, sedimentation into the wetlands will be somewhat hampered;
- All alien-invasive tree species should be removed as recommended in the Flora and Fauna Assessment for this study (Digby Wells, 2013).

14.3 Aquatics Recommendations

- It is recommended that an aquatic monitoring program be set up to monitor the state of the aquatic environments and allow for early management action should an impact be detected.
- The aquatic monitoring plan should consist of:
  - Bethic Diatom sampling (Specific Pollution Index);
  - Aquatic macroinvetebrate assessment (SASS5);
  - Alien vegetation monitoring
  - Terrestrialisation
  - Water quality should be taken at least quarterly; and water samples should be sent for analysis specifically looking at key indicators such as sulphates pH and Nitrates.
- It is not recommended that the following are monitored:
  - Fish
  - Habitat integrity
  - Riparian Vegetation
  - Pans

Annual biomonitoring sites have been suggested in the aquatics report for the early wet season, sites E16 and E14b

- With the aid of a suitably qualified consultant the following recommendations should be carried out:
  - The removal of alien fish and vegetation species present in the aquatic systems should be encouraged. Fish could be removed by hosting bass and carp fishing competitions.
  - The addition of fish ladders would aid indigenous fish species in migrating to spawning grounds or reducing competition between juveniles and adults
  - Removal of dams and weirs would allow the river to resume a more natural course. A more natural flow regime would encourage more sensitive species to return and greatly benefit the systems overall health

15 CONCLUSION AND WAY FORWARD

15.1 Fauna and Flora

The current proposed management actions will have to monitored and re-assessed continually as the project develops to ensure that the desired outcomes are correctly managed towards. It is suggested that biodiversity studies remain ongoing to ensure that there is not a large departure from the baseline conditions and that where improvements can be made ie in farming practices that these management items are adhered to. Management actions are prescribed in order for the management of the area to gain baseline data against which future data can be measured, and management actions be planned accordingly.

Adaptive management is a critical part of such an operation, however this management philosophy can only be applied with success if dependable monitoring data is gathered annually. Adaptive management will then be guided by desired outcomes and monitoring data.

Areas that are disturbed during construction and operations phase of the mine will need to be rehabilitated concurrently in order reduce disturbance and costs for closure. The establishment of native grass species during this process would be beneficial as these species are better suited to the prevailing conditions.

Eradicating alien invasive plant species is also a high priority objective that must be accomplished, with this in mind, all natural areas must be cleared of alien vegetation to enhance the positive habitat regulating services that will return. Establishment of new stands of alien invasive plant species must be actively identified and eradicated with the procedures outlined in this report.

15.2 Wetlands

Wetlands are mainly associated with floodplain systems and pans. The integrity of wetlands on site has been compromised, primarily due to agricultural activities. It is imperative that efforts are made to restore biodiversity lost due to agriculture as well as minimise the potential impact that the proposed pit and underground workings may have on the area. If the recommendations listed in the former section are adhered to, it is very possible that a net gain in biodiversity value could be expected.

15.3 Aquatics

All aquatic systems in the study site are sensitive however it is believed that the lower Vlakkuilen wetland is the most sensitive. It is structurally intact and forms an important area for the recruitment of fish.Currently the system is most heavily impacted upon by agriculture and upstream activities which introduce high nutrient loads into the system. Both Diatoms and Aquatic Macroinvertebrates are useful indicators of system health.

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