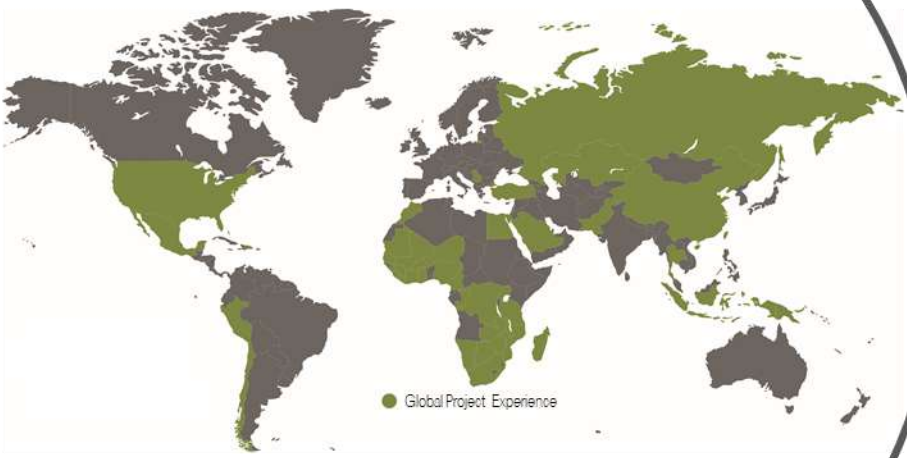

DIGBY WELLS
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Proposed Arnot South Coal Mining Project, Situated near Hendrina, Mpumalanga Province

Surface Water Impact Assessment

Prepared for:
Universal Coal Development III (Pty) Ltd

Project Number:
UCD6802: UCD6802

August 2021

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This document has been prepared by Digby Wells Environmental.

Report Type:	Surface Water Impact Assessment
Project Name:	Proposed Arnot South Coal Mining Project, Situated near Hendrina, Mpumalanga Province
Project Code:	UCD6802

Name	Responsibility	Signature	Date
Daniel Fundisi	Report writer		August 2021
Mashudu Rafundisani	Report Reviewer		August 2021

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EXECUTIVE SUMMARY

Digby Wells Environmental (hereinafter Digby Wells) was appointed to conduct an Environmental Authorisation (EA) required for the proposed Arnot South Project. The Prospecting Right, MP 30/5/1/1/2360 PR was issued to Exxaro Resources, and the Applicant for this process will be Exxaro Coal Mpumalanga (Pty) Ltd to mine coal. The EA application process is for underground mining of various farm portions within the existing Arnot Mining Right Area (MRA). This report should be read in conjunction with other specialist reports required for the EA and it constitutes the Surface Water Impact Assessment which supports the EIA process and compilation of the Environmental Management Plan report, Integrated Water Use Licence Application, for the Project

There is rainfall variability observed within the quaternaries, with the Mean Annual Precipitation (MAP) for B12A, B12B and X11A being 695 mm, 672 mm, and 688 mm, respectively (WRC, 2015). On average, the project site receives a MAP of 685 mm. The wettest month of January has a 90th percentile of 192 mm and 10th percentile 65 mm. The project area experiences wet summers and dry winters with moderate to high rainfall recorded from November to February.

Most of the baseline parameters are within the Resource Water Quality Objectives (RWQO) of the region in which the proposed Arnot South project site is located. Exceedances were, however, variably noted for Chloride (Cl), Ortho Phosphate (P), Aluminium (Al) and Copper (Cu) both upstream and downstream of the project site. Higher P, Cu, Cl and Al concentrations are likely due to industrial effluents or agricultural chemical released from upstream areas of the Arnot South project site. Sampling point ANTSW1 indicated further RWQO exceedances for Arsenic (As), Cadmium (Cd), Hexavalent Chromium as Cr (VI), Lead (Pb), Manganese (Mn) and Mercury (Hg) while at the other sampling points these parameters were below detection levels. The higher levels of heavy metals at the ANTSW1 point possibly result from already existing mining activities within the region. Mining activities upstream of the proposed Arnot South Project include Mbuyelo and Motshaotshele Collieries. Downstream of the site there is the Arnot Power Station which utilises coal to generate electricity, and several decommissioned coal mines that may still contribute to water contamination due to decant processes.

Separation of clean and dirty water should be implemented as per the storm water management plan. This should be done through a network of clean water diversion berms and dirty water channels which convey contaminated water to containment facilities such as the Pollution Control Dam (PCD). The berms will exclude or divert clean water from the clean water catchment around dirty facilities allowing the clean water to flow further downslope to natural watercourses.

The proposed Pollution Control Dam (PCD) is too close to the 1:100-year floodline such that it is recommended that it be slightly moved approximately 30 m away from the nearby watercourse so that it is clearly off the flood waterway. Streams located to the north of the

proposed Arnot South infrastructure footprint area are approximately 3 km away and so will likely not be impacted on by proposed mining activities.

Water supply for the Arnot Project is indicated to come from boreholes, groundwater ingress from underground workings (Now-closed Arnot Colliery), rainfall and runoff that is collected in storage facilities and used in the operations. Based on the Mine Works Programme Submission Report the washing plant water consumption, required as make-up water, is estimated to be between 1 000 m3 to 1 200 m3 per day (Exxaro, 2020). A dewatering volume of 200 m3/day is pumped to Underground Dams where it is used for underground dust control. Excess water from the Underground Dams will be pumped to the PCD for use as make-up water for mining operations. A volume of 132.1 m3/day will be obtained from the PCD and used for dust suppression within haul roads and relevant open surfaces. A small reverse osmosis Water Treatment Plant (WTP) will be used to treat borehole water for potable uses at the offices, workshop and change houses. The Arnot Project shall make maximum use of recycled water through the use of the filter press and thickener that clarify process water for re-use.

Recommendations:

The following is recommended to mitigate identified impacts:

- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised so as to minimise creation of new ones;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments, dust generation and hazardous substances from construction vehicles used during site clearing;
- Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the mine's maintenance program they must be inspected daily before use to ensure there are no leakages underneath;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas at the existing mining operations. Any used oil should be disposed of by accredited contractors;
- Implementation of the proposed stormwater management plan is recommended to reduce siltation and sedimentation in watercourses;
- All operational vehicles should be maintained and washed at designated wash bays;
- All mine waste should be handled and disposed of by an accredited vendor;
- The proposed water quality monitoring program should be consistently implemented to ensure adherence to stipulated water quality standards. This will enable early

detection and management of any water quality problems arising as a result of mining operations and associated activities;

- The water requirements and demands should be clearly stated and regularly reviewed through water balance updates to ensure water uses and losses are accounted for;
- Soil disturbances during decommissioning should be restricted to the relevant footprint area;
- All decommissioning debris must be cleared as soon as practically possible, and it is recommended that demolition of infrastructure be conducted during the dry season to minimise chances of soil erosion to watercourses;
- Movement of heavy vehicles and machinery must be restricted to existing roads to avoid further disturbance of landscapes thus minimising soil erosion;
- In the event of decanting, passive treatment should be applied to neutralise and treat the AMD before being discharged back into freshwater resources. If passive treatment fails, active treatment by a conventional Water Treatment Plant should be considered; and
- Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that supports desired post-mining land use.

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1. Introduction

Digby Wells Environmental (hereinafter Digby Wells) was appointed to conduct an Environmental Authorisation (EA) required for the proposed Arnot South Project. The Prospecting Right, MP 30/5/1/1/2360 PR was issued to Exxaro Resources, and the Applicant for this process will be Exxaro Coal Mpumalanga (Pty) Ltd to mine coal on various farms, with the Mining Right Area (MRA) covering approximately 16,000 ha in extent.

1.1. Terms of Reference

The EA application process is for underground mining of various farm portions within the existing Arnot Mining Right Area (MRA). This report should be read in conjunction with other specialist reports required for the EA and it constitutes the Surface Water Impact Assessment which supports the EIA process and compilation of the EMPr, IWULA and IWWMP for the Project, in accordance with the following relevant legislation:

- EIA Regulations, 2014 (General Notice (GN) R982 of 04 December 2014, as amended) (the “EIA Regulations, 2014) promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- A Waste Management Licence (WML) in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM: WA); and
- An Integrated Water Use Licence (IWUL) in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

Specific to Surface Water Impact Assessment the following legislation were considered:

- National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- NWA amendment as per Regulation 704 (GN R 704, (1999)) on use of water for mining and related activities aimed at the protection of water resources; and
- National Environmental Management Act (Act 107 of 1998), (NEMA) as amended

2. Project Background

The Arnot South Project is situated approximately 10 km east of the town of Hendrina, 25 km west of Carolina, and 50 km southeast of Middelburg in the Mpumalanga Province of South Africa. The proposed Project is close to two of Eskom’s operating power stations; Hendrina (25 km) and Arnot (5 km).

The mineral reserve consists of one economically mineable underground block (No. 2 coal seam), producing approximately 2.4 million tonnes per annum (Mtpa) of Run of Mine (RoM) coal for approximately 17 years. Further drilling will be required to confirm a resource to the south of the Mining Right area. The potential future resource of the remaining RoM coal is approximately 32,912,300 tonnes, allowing an additional mining period of approximately 13 years. This application considers the use of underground board-and-pillar mining with continuous miners due to the depth and thickness of the reserve.

Due to the depth and thickness of the No. 2 coal seam, the Arnot South resource area shall be mined by underground mining methods. Underground bord and pillar mining utilising continuous miners and shuttle cars is considered as the optimal mining method for the mining of the initial reserve. The proposed development triggers Listed Activities in terms of the EIA Regulations, 2014 (GN R 982 of 4 December 2014 as amended by GN R326 of 7 April 2017) (EIA Regulations, 2014), as amended promulgated under the NEMA, 1998 (Act No. 107 of 1998). Digby Wells is the appointed Environmental Assessment Practitioner (EAP) to undertake the environmental applications in support of the proposed Project.

2.1. Study Areas

For the purpose of this report, the following applies:

- MRA defines the farms included in the Arnot South Project Area boundary (red outlined area on the maps);
- Project Area defines farm portions directly associated with Arnot MRA (red outlined area on the maps); and
- Infrastructure footprint area refers to the area where the proposed surface infrastructure will be constructed (small zoomed in section in all the maps).

2.2. Project Locality

The Project Area falls under the jurisdiction of the Chief Albert Luthuli and Steve Tshwete Local Municipalities, located in the Gert Sibande and Nkangala District Municipalities respectively, Mpumalanga Province. The project regional and local setting details are indicated in Table 2-1 and shown in Figure 2-1 and Figure 2-2).

There are five farm homesteads situated within the planned underground mining area. The target area for mining and mining-related infrastructure lies mainly on the farms Weltevreden 174 IS, Mooiplaats 165 IS, Vlakfontein 166 IS, and Schoonoord 164 IS.

Table 2-1: Summary of the Project Location Details

Province	Mpumalanga	
District Municipality	Gert Sibande District Municipality Nkangala District Municipality	
Local Municipality	Chief Albert Luthuli Local Municipality Steve Tshwete Local Municipality	
Nearest Town	Hendrina (10 km), Carolina (25 km), Middleburg (50 km)	
Property Name and Number for the Arnot MRA	Groblersrecht 175 IS Mooiplaats 165 IS Tweefontein 203 IS	Schoonoord 164 IS Vlakfontein 166 IS Vryplaats 163 LQ

	Vaalwater 173 IS Weltevreden 174 IS Nooitgedacht 493 JS Leeuwpan 494 JS	Helpmakaar 168 IS Op Goeden Hoop 205 IS Klipfontein 495 JS
Application Area (Ha):	~16,000 ha	
Distance and direction from nearest town:	50 km southeast of Middelburg	
GPS Co-ordinates (Relative centre point of study area)	29.8634	
	-26.0171	

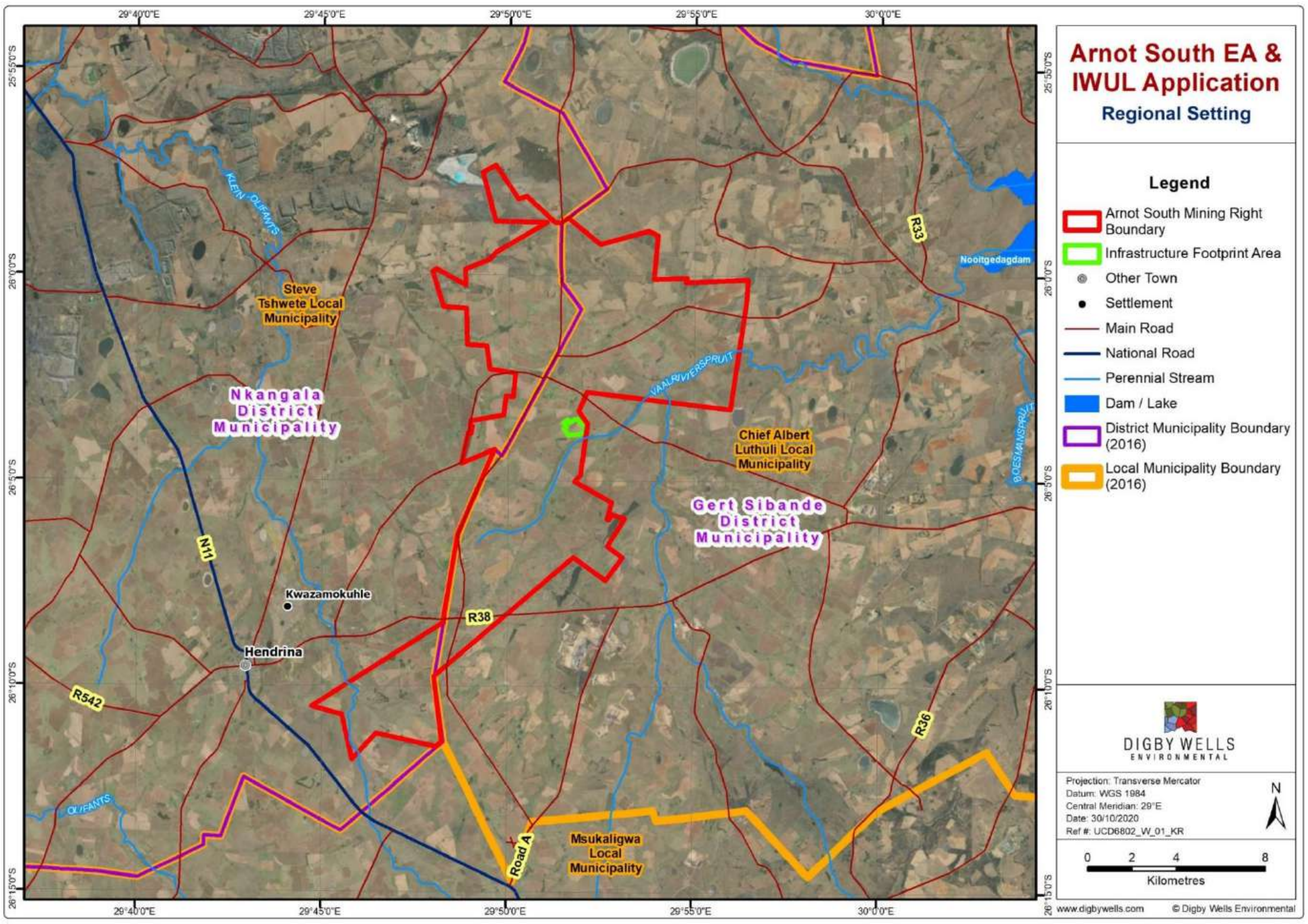


Figure 2-1: Regional Setting of the Arnot South Project

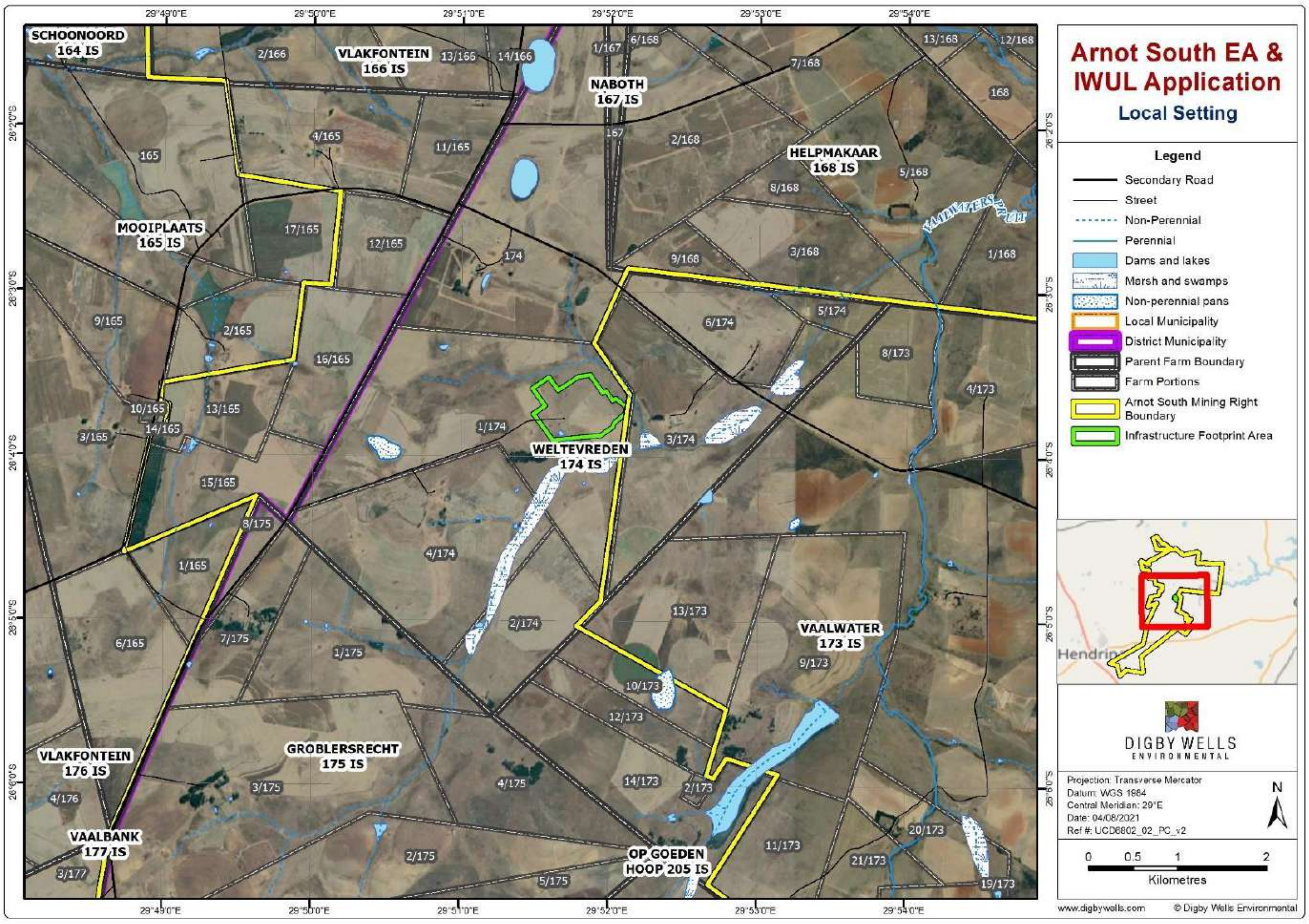


Figure 2-2: Locality of the Arnot South Project

2.3. Proposed Infrastructure and Activities

As indicated in Table 2-2 and illustrated in Figure 2-3 and Figure 2-4 below, proposed activities for the Arnot South Project will trigger listed activities under Listing Notice 1 (GN R983 of 04 December 2014, as amended) and Listing Notice 2 (GN R984 of 04 December 2014, as amended) of the EIA Regulations, 2014; and therefore, an EIA process must be undertaken and approval received prior to the activities commencing. Table 2-2 details the Project activities for the duration of the Construction, Operational and Rehabilitation Phases.

Table 2-2: Project Phases and Associated Activities

Phase	Activity
Construction	Site/vegetation clearance (52.281385 ha)
	Diesel storage and explosives magazine
	Establishment of infrastructure (Infrastructure footprint - 13.2849 ha; linear infrastructure - 51 501 m) Ventilation fans, change houses, offices, ablutions, workshops, cable workshop, weighbridge, weighbridge control room and access control office
	Construction of access and haulage road (19 113 meters), Power line construction 22kV line, 2.3 km long
	Construction of Pollution control dam (PCD) (1.6078 ha), Raw water pipeline, Process water, Sewage treatment plant (STP)
	Stockpiling of soils, rock dump and discard dump establishment.
Operational	Operating STP (18.3168 m (combination of two delineations)), PCD, raw water pipeline, process water, washing plant
	Mining of coal by underground mining (underground) (5 050.83 ha) Removal of rock (blasting). Rock/discard dumps, soils, ROM, discard dump (discard dump 2946 ha and Overburden stockpile 13716 ha)
	Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste
	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.
	Continue with exploration activities
Decommissioning	Demolition and removal of infrastructure.
	Post-closure monitoring and rehabilitation.
	Closure of the underground mine.

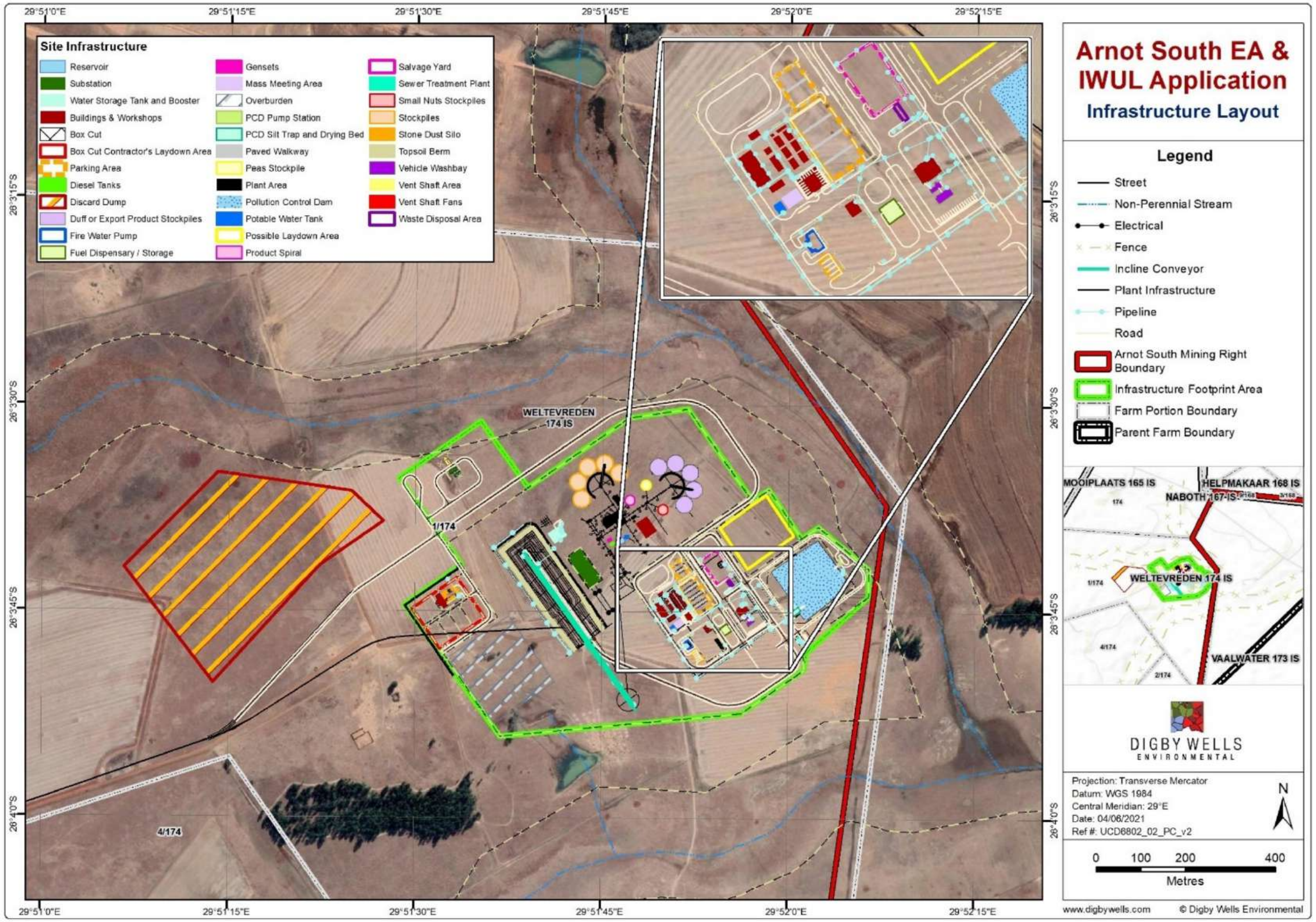


Figure 2-3: Arnot South Project proposed infrastructure layout

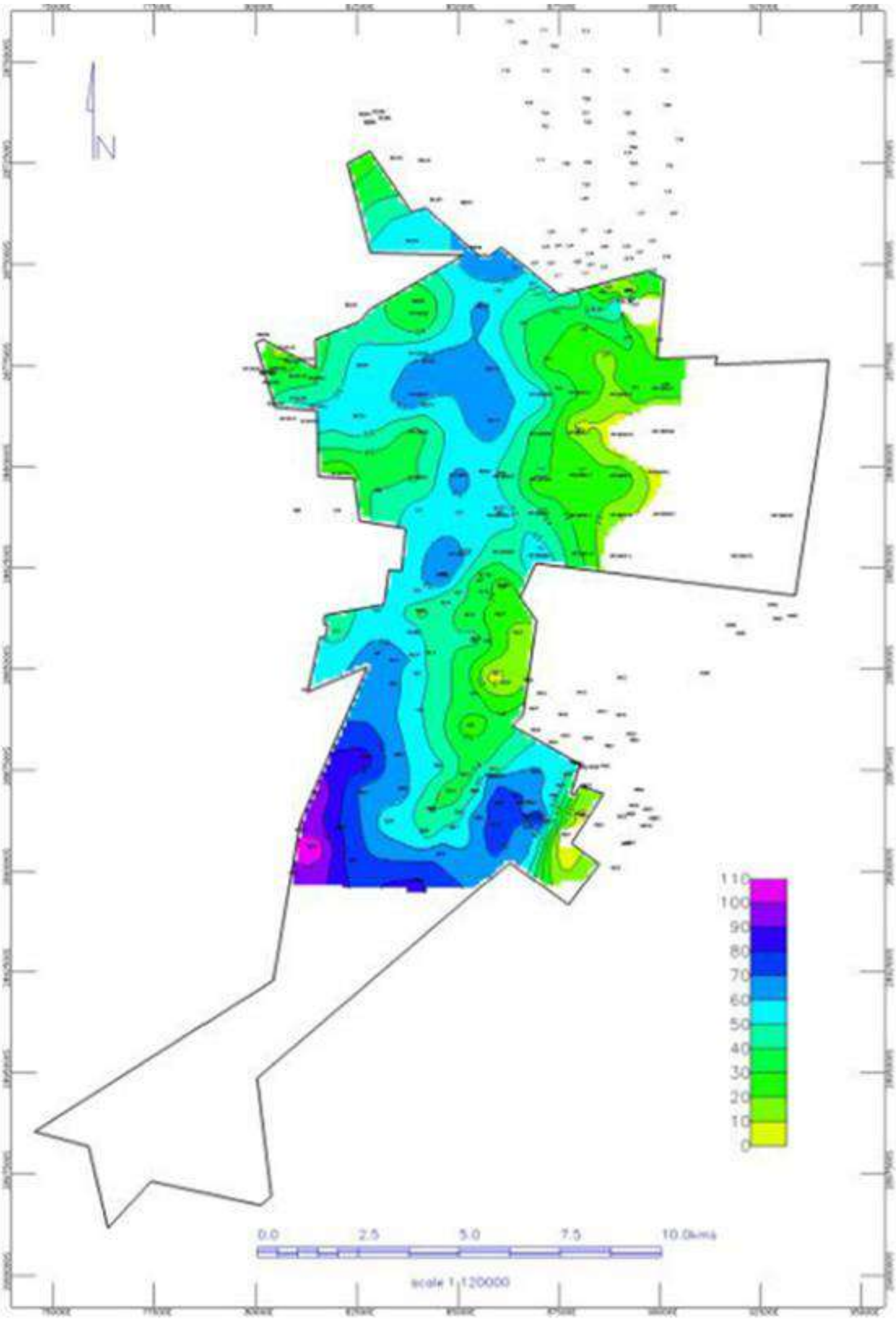


Figure 2-4: No. 2 Coal Seam Elevation (Source: Arnot South Mining Works Programme, 2020)

3. Scope of Work and Methodology

This section describes the scope of work that was followed to complete the surface water study.

3.1. Desktop assessment

A review of relevant literature and existing reports for the study area was conducted and it included:

- Assessment of aerial imagery and survey data to verify the hydrological characteristics of the area; and
- Descriptions of the hydrological setting of the site in terms of the surface water features (rivers, pans and dams) and other hydrological characteristics such as topography, drainage patterns, surrounding surface water uses, catchment characteristics and climatic conditions (rainfall, runoff and evaporation).

3.2. Site Assessment and Sampling

A site visit was undertaken on the 9th of April 2021 to physically assess and verify the hydrological characteristics of the proposed project area and the surrounds. Eight surface water samples were collected from the Vaalwaterspruit, Klein-Olifantsrivier and their tributaries upstream and downstream of the project site in order to determine upstream and downstream water quality for the site.

3.3. Water Quality

The eight collected samples were sent for chemical analysis at Waterlab, a South African National Accreditation System (SANAS) accredited laboratory. Water quality baseline conditions were evaluated and described based on the laboratory results of collected surface water samples. The results were benchmarked against relevant Klein-Olifants and Klein-Komati Resource Quality Objectives (RQOs) (DWS, 2016) and the Department of Water and Sanitation (DWS) water quality guidelines depending on the surrounding water users.

3.4. Floodlines Modelling

3.4.1. Catchment Delineation and Peak Flows

Catchment delineation was undertaken in Global Mapper using a Digital Elevation Model (DEM) generated from 5 m contours (National Geospational Institute, 2013) augmented by Advanced Land Observing Satellite (ALOS) World 3D – 30m (AW3D30) global digital surface model (DSM) data (JAXA, 2015) for the study area. The ALOS dataset is stored in a raster GeoTIFF format referenced to the Hartebeesthoek 94 Datum (WGS84 ellipsoid).

Widely used and recommended methods including the Rational Method Alternative 3 (RM3), Standard Design Flood (SDF) and the Midgley & Pitman (MIPI) were used to calculate the

1:50-year and 1:100-year peak flows for delineated catchments at the project site (SANRAL, 2013). Design rainfall depths were determined using the Design Rainfall Programme for South Africa and the modified Hershfield equation as input to the RM3 and SDF methods, respectively.

3.4.2. Hydraulic Modelling

Hydraulic modelling was conducted in HEC-RAS 6 beta which allows pre-processing within the in-built RAS Mapper module. A Digital Terrain Model (DTM) was generated from the 5m Digital Elevation Model (DEM) to make the topographic data compatible with RAS Mapper. The pre-processing involved generation of the channel geometry, including the river network, banks, flow paths and cross sections.

The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity, and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A height is calculated at each cross-section, which represents the level to which water will rise at that section, given the calculated initial peak flows for the 1:50-year and 1:100-year events on all river sections.

Analyses are performed by modelling flows at the sub-catchment outlet of stream or channel sections first, moving upstream. Manning’s Roughness Coefficient (n) for the channels were set at 0.8, and those for riverbanks were determined to be 1.3 representing natural channels with weeds, reeds and brush on the banks (Chow, 1959).

Please note that the study only determined indicative floodlines, hence can only be used for environmental purposes and not for detailed engineering designs.

3.5. Storm Water Management Plan

The conceptual SWMP was undertaken with adherence to the guidelines of the Government Notice 704 (GN704) of the National Water Act, 36 of 1998 (NWA). Clean and dirty water catchments were delineated based on the functions of proposed infrastructure on site. Stormwater drains and berms were determined and sized in the Personal Computer Storm Water Management Model (PCSWMM). PCSWMM is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity (James, 2010). The PCSWMM programme derived site elevation details from a DEM generated from 5 m contours for the site.

The storage capacity of an outfall/storage structure was determined as a function of the simulated stormflow, incident rainfall and outfall depth for an optimised model to ensure zero flooding or surcharge. The drains were sized not to spill, on average, when a 1:50-year flood event occurs. The model uses the catchment area, average slope, catchment permeability and the design rainfall depth to simulate storm flows which are channelled to containment structures or discharged through low-point outlets. The influence of paved areas such as rooftops, roads and concrete slabs was incorporated in PCSWMM by specifying the proportionate percentages of impervious areas within the demarcated sub-catchments.

3.6. Water Balance

A site-wide water balance was calculated which incorporated all inflows and outflows linking relevant mine facilities. The water balance process included reviewing the proposed water management plan to gain an understanding of the entire mine water system and explaining the drivers of water within the system and management thereof.

The Water Balance was conducted in accordance with the DWS Best Practice Guidelines (BPG) G2: Water and Salt Balances (DWA, 2006). The water balance compilation utilised results of the hydrological assessment to provide hydrological inputs as rainfall, runoff, and evaporation into modelling calculations. Water infrastructure for the mine were obtained from the mine layout plan. Linkages between water balance components were represented by a flow diagram which showed inflows, outflows, and storages. Volumes and capacities of water infrastructure provided were used in the water balance and where gaps were observed, assumptions and approximations were determined.

3.7. Surface Water Impact Assessment

Potential and existing surface water impacts (quality and quantity) that may result from the proposed project activities, based on the established baseline conditions, were assessed and rated using the following impact rating methodology.

The significance rating formula is as follows:

Significance = Consequence x Probability

Where

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

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

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

The weighting assigned to the various parameters for positive and negative impacts is provided for in the formula and is presented in Table 3-1. The probability consequence matrix for impacts is displayed in Table 3-2, with the impact significance rating described in Table 3-3.

Table 3-1: Surface water Impact Assessment Parameter ratings

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

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

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

Table 3-2: Probability Consequence Matrix for Impacts

Significance (negative consequence)

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

Significance (positive consequence)

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

Consequence

Table 3-3: Significance Threshold Limits

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

4. Baseline Environment

4.1. Drainage

Previously, South Africa had 19 Water Management Areas (WMAs) however, as part of the revised National Water Resource Strategy in 2012, the WMAs were reduced to nine (DWS, 2016). Each WMA is further subdivided into primary catchment, the primary catchments are subdivided into secondary, and within each secondary catchment, there are quaternary catchments represented by letters ranging from A to X (except for O) and the latter is the lowest subdivision. For example, if the name of a quaternary catchment is written as A95C, the letter A would represent the primary catchment, A9 will be the secondary catchment and A95 is for the tertiary catchment.

The Arnot South project area is found within three quaternary catchments, namely, B12A and B12B falling under the Olifants Water Management Area 2 (WMA2) and X11A which falls within the Inkomati-Usuthu WMA3 (see Figure 4-1). The B12A and B12B quaternary catchments are found within the Olifants River Catchment. The X11A quaternary catchment is found in the Inkomati River Basin which is shared between South Africa, Eswatini and Mozambique. Within the project site, lies one of the major tributaries of the Olifants River called the Klein Olifants River. The site is also drained by several streams from the Inkomati River Basin. The Vaalrivierspruit which passes through the project site drains into the Nooitgedacht Dam which adjoins the Komati River. There are several small dams located on farms in and around the MRA, and the Nooitgedacht Dam is located within a radius of approximately 12 km from the northern end of the project.

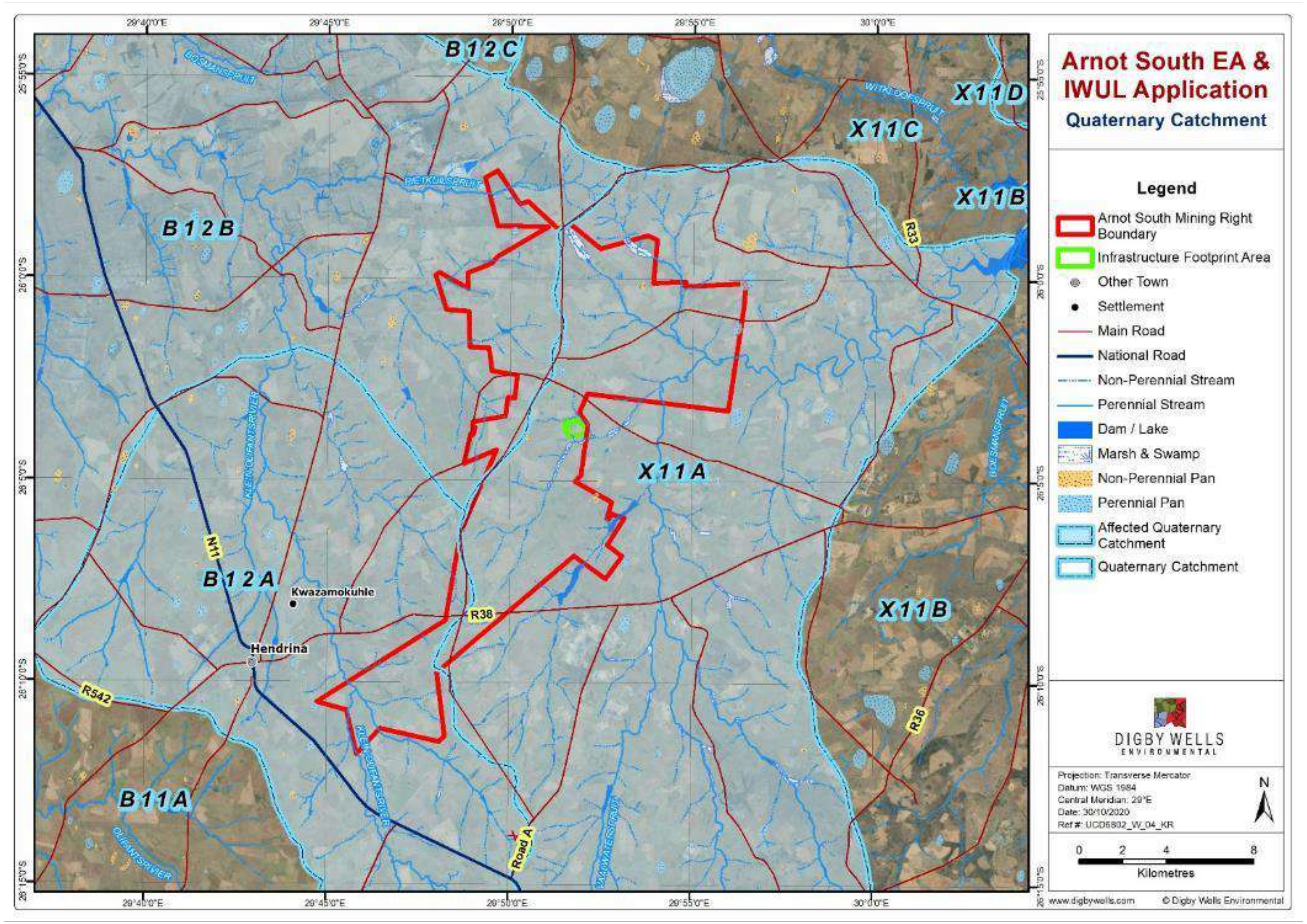
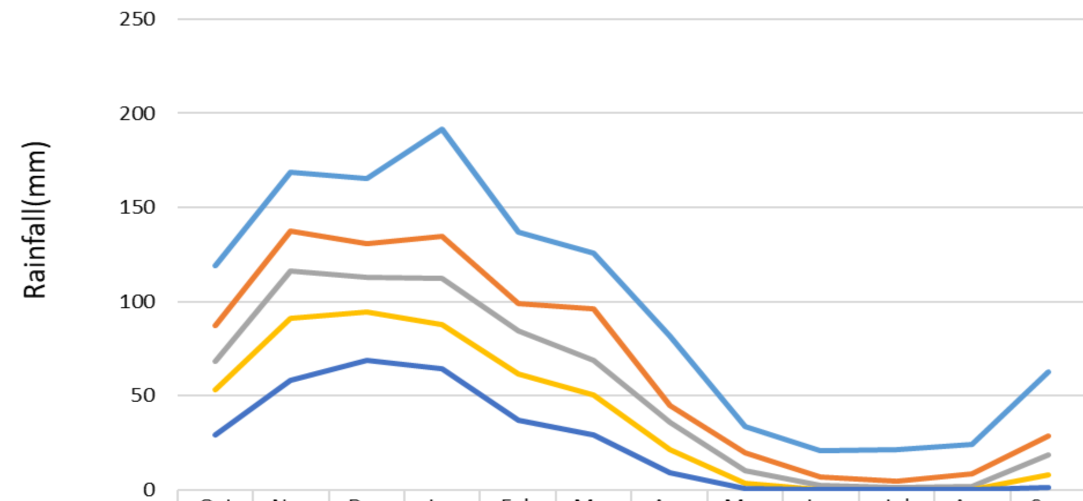


Figure 4-1: Quaternary Catchments Showing Drainage Within and Around the Project Site

4.2. Hydrometeorology

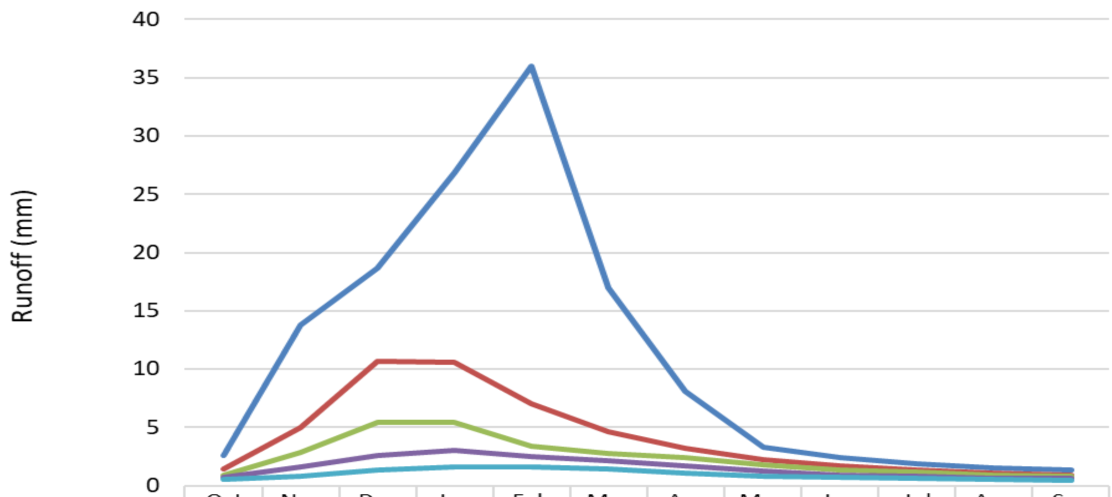
There is rainfall variability observed within the quaternaries, with the Mean Annual Precipitation (MAP) for B12A, B12B and X11A being 695 mm, 672 mm, and 688 mm, respectively (WRC, 2015). Since the project site is along the boundary line of the three quaternaries, averaging the rainfall would provide realistic localised precipitation for the project site. On average, the project site receives a MAP of 685 mm. Figure 4-2 presents the likely monthly distribution of rainfall, with the wettest month being January having a 90th percentile of 192 mm and 10th percentile 65 mm. Figure 4-2 further indicates that the project area has wet summers and dry winters as moderate to high volumes of rainfall are recorded from November to February.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Percentile	119	169	165	192	137	126	82	34	21	21	24	62
70 Percentile	87	138	131	135	99	96	45	20	7	5	8	28
50 Percentile	68	116	113	112	85	69	36	10	2	1	2	19
30 Percentile	53	91	95	88	62	50	21	4	0	0	0	8
10 Percentile	29	58	69	65	37	29	9	0	0	0	0	1

Figure 4-2: Monthly Percentile Distribution of Rainfall

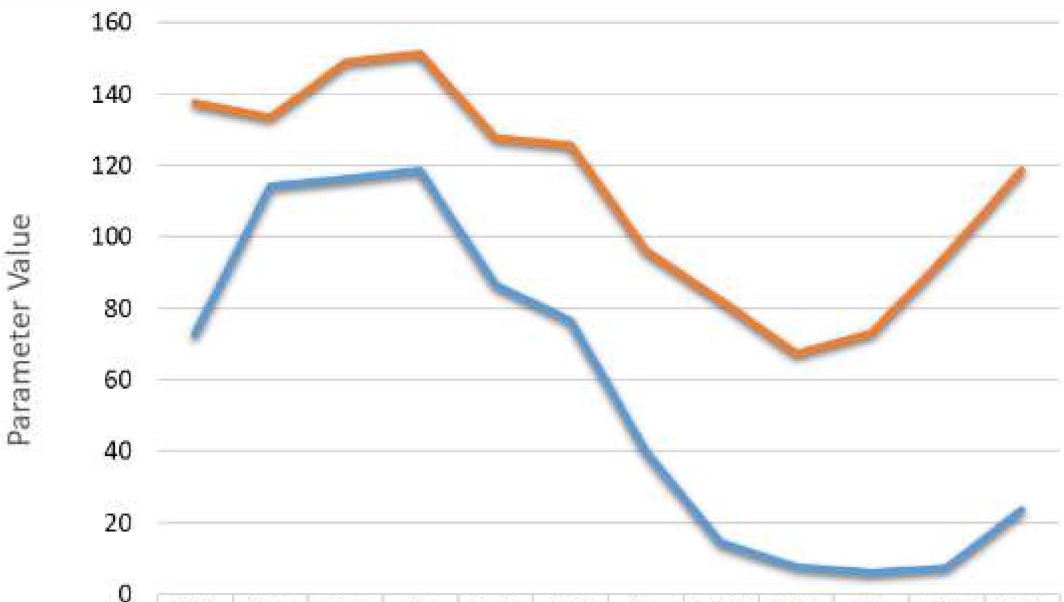
Like MAP, the Mean Annual Precipitation (MAR) also differed with each quaternary catchment, however, the average MAR was calculated as 55.02 mm which is 8% of MAP. The highest amount of runoff was recorded in February with a 90th percentile of 36 mm and a 10th percentile of 1.6 mm (See Figure 4-3). The indicated rainy months had moderate to high runoff depths.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90 Perecentile	2,6	13,8	18,7	26,9	36,0	17,0	8,1	3,3	2,4	1,9	1,5	1,3
70 Percentile	1,4	5,0	10,6	10,6	7,0	4,6	3,2	2,3	1,7	1,3	1,1	0,9
50 Percentile	0,9	2,9	5,5	5,4	3,4	2,7	2,4	1,8	1,4	1,2	0,9	0,8
30 Percentile	0,7	1,6	2,6	3,1	2,5	2,1	1,7	1,3	0,9	0,8	0,7	0,6
10 Percentile	0,6	0,8	1,4	1,6	1,6	1,4	1,1	0,8	0,7	0,6	0,5	0,4

Figure 4-3: Monthly Percentile Distribution of Runoff

On average, the area has a Mean Annual Evaporation (MAE) of 1358 mm which is much greater than the average MAP (WRC, 2015). Figure 4-4 indicates the distribution of runoff, the highest evaporation loss is observed in January (151 mm) which is also the wettest month.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	138	133	149	151	128	126	96	82	67	73	95	119
Rainfall(mm)	73	114	116	119	87	77	40	15	8	6	7	24

Figure 4-4: Monthly Distribution of Potential Evaporation and Rainfall

4.3. Surface Water Quality

4.4. Sampling Points

Seven (7) surface water points were sampled during the site visit conducted on the 9th of April 2021. The sampling points are presented in Figure 4-5. The samples were analysed at Waterlab, a SANAS accredited laboratory. Water quality results were benchmarked against Department of Water and Sanitation (DWS) Resource Water Quality Objectives (RWQO) for the region.

4.5. Water Quality Results

Most of the analysed parameters are within the RWQO of the region in which the proposed Arnot South project site is located (Table 4-1). Exceedances were, however, variably noted for Chloride (Cl), Ortho Phosphate (P), Aluminium (Al) and Copper (Cu) both upstream and downstream of the project site. Higher P, Cu, Cl and Al concentrations are likely due to industrial effluents or agricultural chemical released from upstream areas of the Arnot South project site. Sampling point ANTSW1 indicated further RWQO exceedances for Arsenic (As), Cadmium (Cd), Hexavalent Chromium as Cr (VI), Lead (Pb), Manganese (Mn) and Mercury (Hg) while at the other sampling points these parameters were below detection levels. The higher levels of heavy metals at the ANTSW1 point possibly result from already existing mining activities within the region. Mining activities upstream of the proposed Arnot South Project include Mbuyelo and Motshaotshele Collieries. Downstream of the site there is the Arnot Power Station which utilises coal to generate electricity, and several decommissioned coal mines that may still contribute to water contamination due to decant processes.

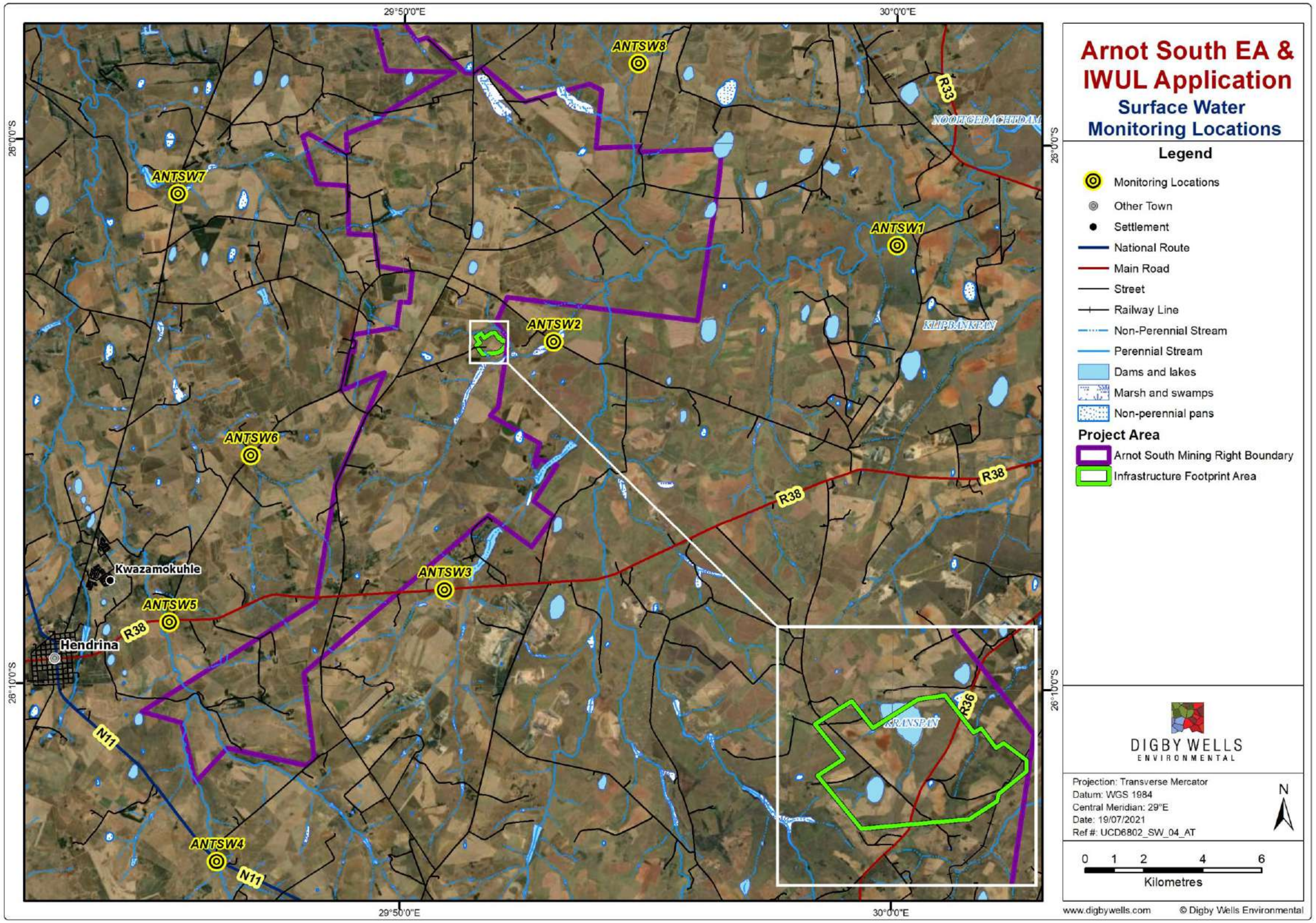


Figure 4-5: Surface Water Quality Sampling Points for Arnot South Mining Right Area

Table 4-1: Surface Water Quality in Rivers Within and Adjacent to the Arnot South Mining Right Area

Parameters		Sampling Site							Resource Quality Objectives
	Units	ANTSW1	ANTSW2	ANTSW3	ANTSW4	ANTSW5	ANTSW6	ANTSW7	
pH - Value @ 25 ºC	pH meter units	7.70	7.30	7.50	8.40	7.60	6.90	7.00	5.9 - 8.8
Electrical Conductivity @ 25°C	mS/m	25.70	27.80	35.80	45.20	38.50	19.00	21.80	≤ 111
Total Dissolved Solids @ 180°C	mg/L	186.00	232.00	240.00	290.00	262.00	148.00	168.00	N/S
Suspended Solids at 105°C	mg/L	18.00	13.30	36.00	12.70	66.00	16.00	8.70	N/S
Chloride as Cl	mg/L	16.00	27.00	26.00	28.00	29.00	24.00	27.00	≤ 0.05
Sulphate as SO_4	mg/L	55.00	44.00	66.00	28.00	43.00	38.00	18.00	500
Fluoride as F	mg/L	0.20	0.20	0.40	0.40	0.40	0.40	0.30	≤ 3.00
Nitrate as N	mg/L	0.20	0.10	0.10	0.10	0.10	0.20	<0.1	≤ 4.00
Ortho Phosphate as P	mg/L	0.20	0.10	0.20	0.10	0.20	0.10	<0.1	≤ 0.025
Free and Saline Ammonia as N	mg/L	0.20	0.20	0.20	0.30	0.40	0.30	0.20	N/S
Sodium as Na	mg/L	12.00	14.00	21.00	30.00	27.00	13.00	13.00	N/S
Potassium as K	mg/L	4.10	6.50	6.00	5.30	5.50	8.60	6.70	N/S
Calcium as Ca	mg/L	18.00	20.00	23.00	31.00	25.00	8.00	12.00	N/S
Magnesium as Mg	mg/L	19.00	11.00	13.00	19.00	14.00	5.00	8.00	N/S
Aluminium as Al	mg/L	20.00	0.17	0.13	0.12	0.19	0.27	<0.100	≤ 0.150
Arsenic as As	mg/L	21.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	≤ 0.095
Cadmium as Cd	mg/L	22.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	≤ 0.003
Hexavalent Chromium as Cr (VI)	mg/L	23.00	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	≤ 0.121
Cobalt as Co	mg/L	24.00	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	N/S
Copper as Cu	mg/L	25.00	0.14	0.14	0.14	0.14	0.14	0.14	≤ 0.08
Iron as Fe	mg/L	26.00	0.34	0.66	0.17	0.57	1.05	0.76	N/S
Lead as Pb	mg/L	27.00	<0.001	<0.001	<0.001	0.00	0.00	<0.001	≤ 0.0095
Manganese as Mn	mg/L	28.00	<0.025	0.22	0.06	0.11	<0.025	<0.025	≤ 1.300
Mercury as Hg	mg/L	29.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	≤ 0.0097
Molybdenum as Mo	mg/L	30.00	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	N/S
Nickel as Ni	mg/L	31.00	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	N/S
Selenium as Se	mg/L	32.00	<0.001	<0.001	0.00	0.00	<0.001	0.00	≤ 0.022
Zinc as Zn	mg/L	33.00	<0.025	<0.025	0.03	<0.025	<0.025	<0.025	≤ 14.4

4.6. Floodlines Determination

4.6.1. Delineated Catchments

Eight subcatchments were delineated that cover the Arnot South project site and the catchments are shown in Figure 4-6.

4.6.2. Design Rainfall Depths and Peak Flows

Design Rainfall Depths for the 1:2-year to 1:100-year return periods were calculated using the Design Rainfall Software for South Africa (Smithers and Schulze, 2000). The rainfall depths are presented in Table 4-2. Rainfall depths with durations equal to the time of concentration (Tc) of the delineated catchments were used to calculate peak flows using the RM3 method. The recalibrated modified Hershfield equation was used to determine precipitation depths used in the SDF method (Alexander, 2002). Results of the RM3 method were used in hydraulic modelling since these were representative of the area due to site-specific runoff coefficients which were generated using an in-built RM3 module. The MIPI results helped in the selection of suitable peak flows because these were of the same order of magnitude to the RM3 method. The SDF results were deemed an over-estimate of peak flows for the site due to high regionalised runoff coefficients. The calculated peak flows are presented in Table 4-3.

Table 4-2: 24-Hour Design Rainfall Depths for Arnot South Project Site

Return Period						
Duration	**2year**	**5year**	**10year**	**20year**	**50year**	**100year**
5 m	8.5	11.9	14.4	17.1	21.1	24.5
10 m	12.3	17.1	20.8	24.8	30.5	35.4
15 m	15.3	21.3	25.8	30.7	37.9	43.9
30 m	19.6	27.2	33	39.3	48.4	56.1
45 m	22.6	31.4	38.1	45.3	55.8	64.8
1 h	25	34.7	42.2	50.2	61.8	71.7
1.5 h	28.8	40.1	48.7	57.9	71.4	82.8
2 h	31.9	44.4	53.9	64.1	79	91.6
4 h	38	52.8	64.1	76.2	94	109
6 h	42	58.4	71	84.4	104	120.6
8 h	45.2	62.8	76.3	90.7	111.8	129.6
10 h	47.8	66.4	80.6	95.9	118.2	137.1
12 h	50	69.5	84.4	100.4	123.7	143.5

Return Period						
Duration	**2year**	**5year**	**10year**	**20year**	**50year**	**100year**
16 h	53.7	74.7	90.7	107.8	132.9	154.2
20 h	56.8	79	95.9	114	140.6	163
24 h	59.5	82.7	100.4	119.4	147.1	170.6

Table 4-3: Peak flows for delineated catchments at the Arnot South project site

Catchment	**Method**					
	RM3		**SDF**		**MIPI**	
	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr
	(m^3/s)					
C1	531.60	743.14	538.52	686.51	529.51	668.85
C2	164.03	229.16	191.47	244.09	163.93	207.07
C3	141.13	197.18	167.44	213.45	139.42	176.11
C4	249.54	348.73	414.60	528.54	240.51	303.80
C5	134.94	188.52	152.60	194.54	126.62	159.94
C6	137.52	192.14	157.58	200.88	138.16	174.52
C7	225.83	315.51	338.71	431.79	211.01	266.53
C8	194.06	271.13	232.99	297.01	188.84	238.54

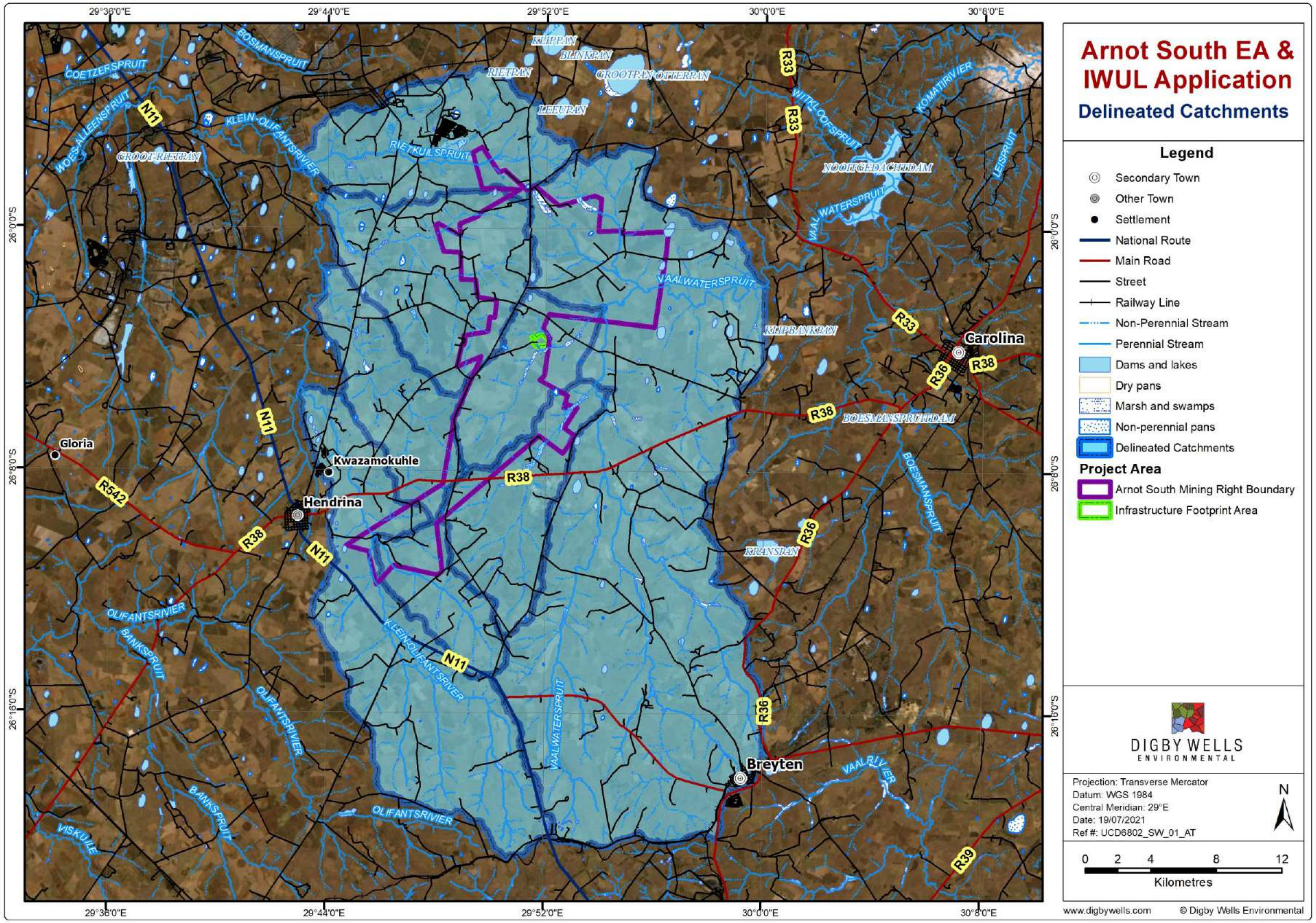


Figure 4-6: Delineated catchments for the Arnot South Mining Right Area

4.6.3. Floodlines

The floodlines show that the proposed infrastructure is outside both the 1:50-year and 1:100-year floodlines. The proposed Pollution Control Dam (PCD) is, however, too close to the 1:100-year floodline such that it is recommended that it be slightly moved approximately 30 m away from the nearby watercourse so that it is clearly off the flood waterway. Streams located to the north of the proposed Arnot South infrastructure footprint area are approximately 3 km away and so will likely not be impacted on by proposed mining activities. The floodlines are presented in Figure 4-7.

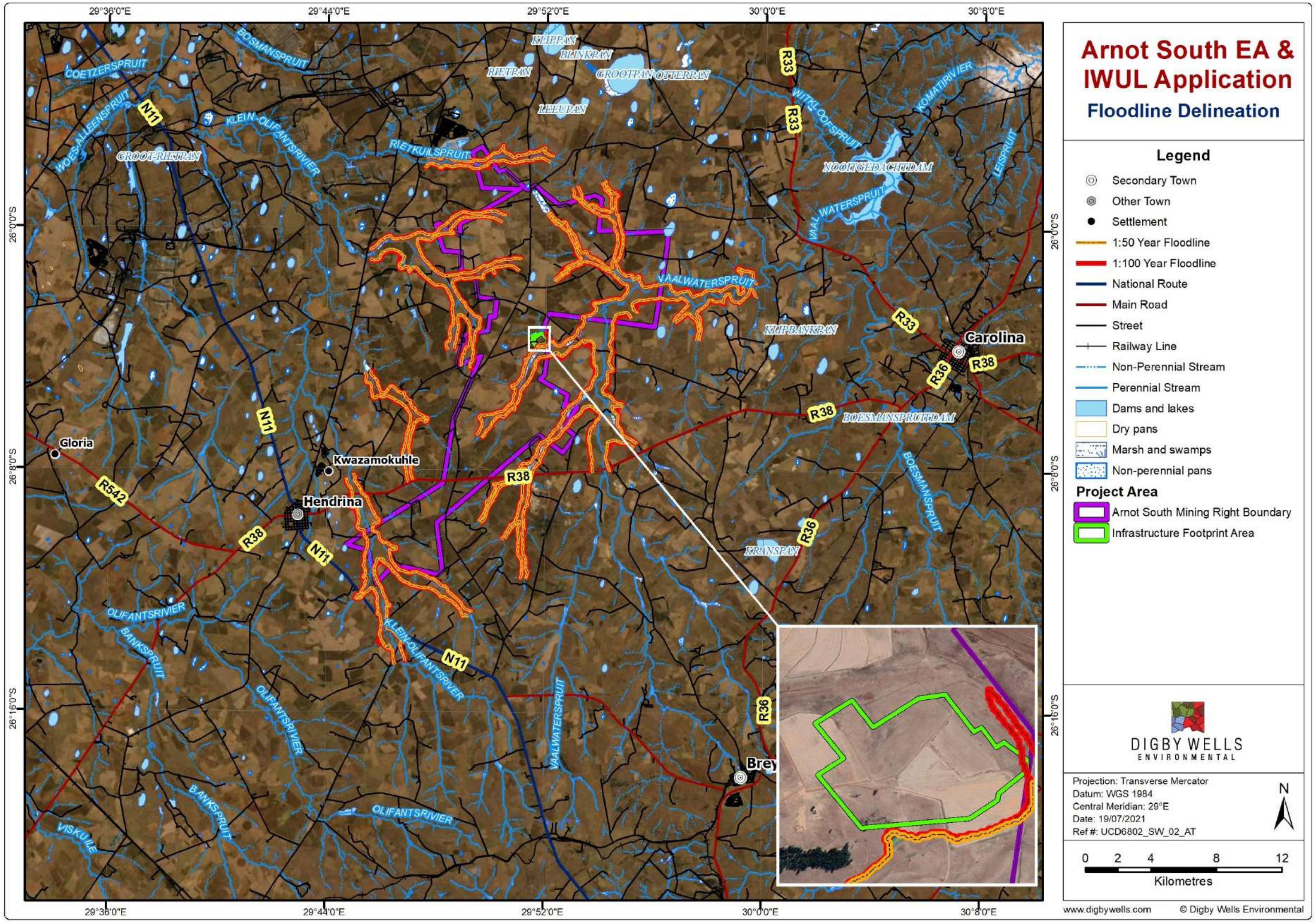


Figure 4-7: 1:50-year and 1:100-year Floodlines for Rivers Draining the Arnot South Mining Right Area

4.7. Storm Water Management Plan

Manning's roughness coefficient (n) used in the model for the impervious and pervious areas were 0.013 (float finish, concrete) and 0.035 (grassland vegetation), respectively (McCuen, 1996). The soils on the project site are generally classified as sand clay loam. The PCSWMM model used in this study requires these criteria to incorporate infiltration into the analysis and the Green-Ampt infiltration method was adopted. The silty clay loam soil texture classification resulted in a suction head of 218.5 mm, a hydraulic conductivity of 3 mm/hr and an initial deficit of 0.250. The 1:50-year design rainfall used to drive the model was calculated using the Design Rainfall Software for South Africa (Smithers , 2000).

4.7.1. Clean and Dirty Stormwater Catchments

The dirty areas identified on the project site are:

- Discard Dump;
- Workshop and Wash bay;
- Mine Plant area;
- Stockpile area;
- Overburden Dump; and
- Box cut area.

Simulated peak flows and runoff volumes for delineated storm water subcatchments are summarised in Table 4-4 for the 1:50-year recurrence interval, 24-hour flood event.

Table 4-4: Simulated peak runoff rates and volumes at Arnot South

Stormwater Subcatchment	Description	Classification	Area (m^2)	Precipitation (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
S1_1	Discard_Dump	Dirty	9.241	147.09	9.11	3.8
S1_2	Discard_Dump	Dirty	4.445	147.09	4.38	1.83
S3	Boxcut_Laydown_area	Dirty	1.3106	147.09	1.29	0.54
S4	Overburden_Dump	Dirty	2.9304	147.09	2.89	1.2
S5	Boxcut	Dirty	2.6064	147.09	2.57	1.07
S6_1	Mine_Plant &_Stockpiles	Dirty	5.1394	147.09	5.07	2.11
S6_2	Mine_Plant &_Stockpiles	Dirty	3.522	147.09	3.47	1.45
S7_1	Laydown_area	Dirty	0.6905	147.09	0.68	0.28
S7_2	Laydown_area	Dirty	0.7011	147.09	0.69	0.29
S8	PCD	Dirty	1.557	147.09	1.54	0.32
S9_1	Workshop_Washbay	Dirty	0.0583	147.09	0.05	0.02
S9_2	Workshop_Washbay	Dirty	0.0543	147.09	0.05	0.02

Stormwater Subcatchment	Description	Classification	Area (m^2)	Precipitation (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
S10	Offices, Car Park	Clean	131.0008	147.09	129.12	53.82

4.7.2. Proposed Storm Water Management Strategy

A conceptual SWMP has been developed for the Project site. The purpose of a SWMP is to prevent the pollution of water resources in and around the mining area, or areas where mining-related activities occur. It also prevents flooding and provides a safe working environment during extreme rainfall-runoff events. The layout of the clean water diversion berms and dirty water channels or conduits required to separate clean and dirty runoff are presented in Figure 4-8.

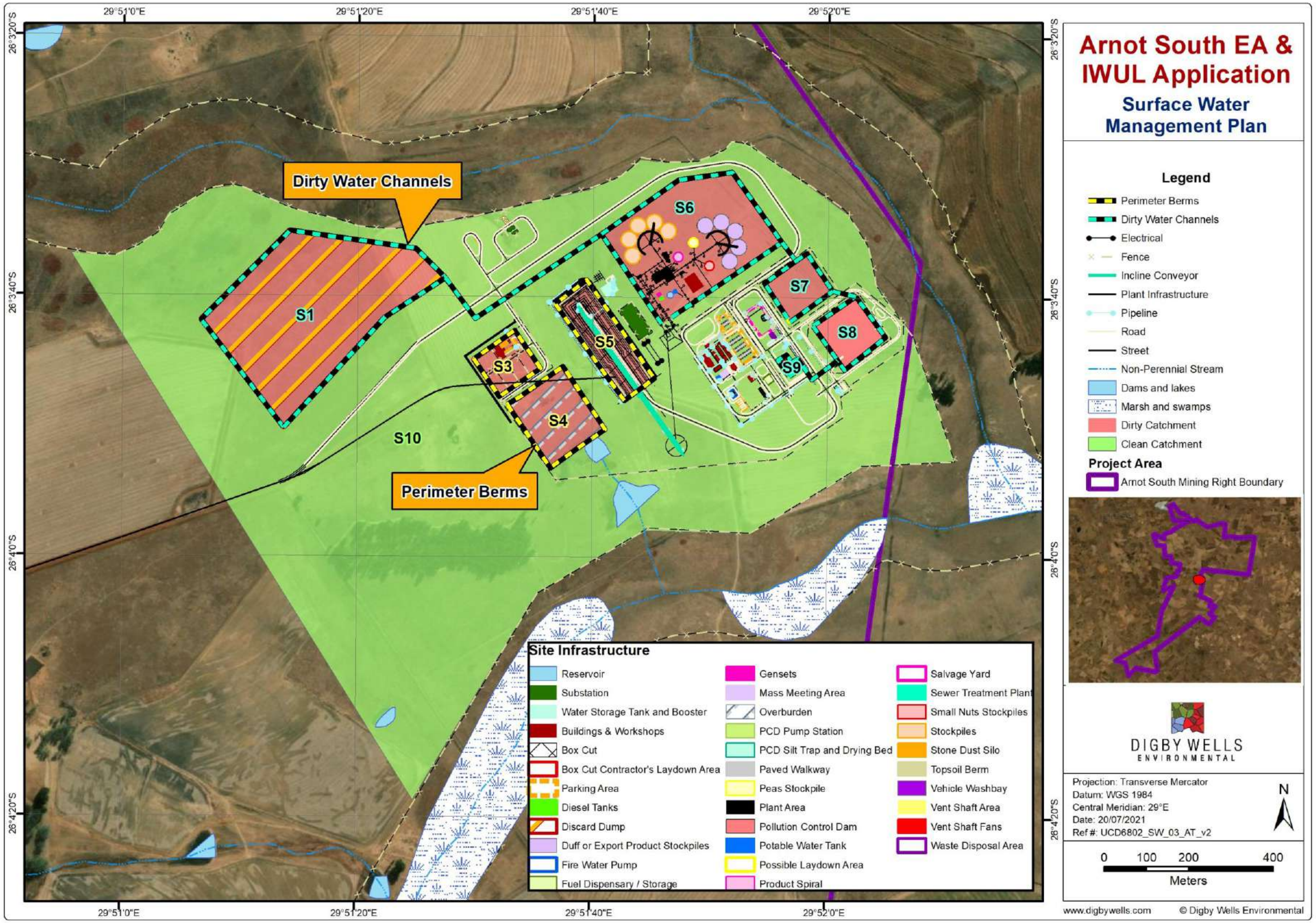


Figure 4-8: Arnot South Conceptual Stormwater Management Plan

4.7.3. Stormwater Channels

Dimensions and characteristics of proposed storm water channels are presented in Table 4-5. All storm water channels have been sized to convey the 1: 50-year return period flood peak as per Regulation 704 of the National Water Act. Manning's roughness coefficient assumed for the proposed High-Density Polyethylene (HDPE) lined channels was 0.013. Modelling results show that flow velocities in some channels conveying dirty water to the PCD are greater than 3 m/s implying that they are erosive (see Table 4-5) (Hicks and Mason, 1991). Since the channels will be lined (e.g., by HDPE) to prevent pollution of groundwater resources, no erosion will occur due to the lining.

Table 4-5: Proposed storm water channel dimensions and characteristics

Stormwater Channel	Cross-Section	Geom1 (m)	Geom2 (m)	Geom3	Geom4	Slope (m/m)	Max (Flow) m3/s	Max (Velocity) (m/s)
C1	TRAPEZOIDAL	1	1	2	2	0.00913	3.582	4.26
C5	TRAPEZOIDAL	1	1	2	2	0.00339	2.06	2.5
C6	TRAPEZOIDAL	1	1	2	2	0.02879	0.016	1.03
C7	TRAPEZOIDAL	1	1	2	2	0.02406	1.424	4.56
C8	TRAPEZOIDAL	1	1	2	2	0.01411	8.584	6.12
C9	TRAPEZOIDAL	1	1	2	2	0.01549	0.315	1.04
C10	TRAPEZOIDAL	1	1	2	2	0.00589	8.835	4.46
C11	TRAPEZOIDAL	1	1	2	2	0.03041	0.285	2.97
C12	TRAPEZOIDAL	1	1	2	2	0.0222	0.311	1.26
C13	TRAPEZOIDAL	1	1	2	2	0.00733	0.318	1.94
C14	TRAPEZOIDAL	1	1	2	2	0.01294	9.094	6.02
C15	TRAPEZOIDAL	1	1	2	2	0.05629	0.015	1.23
C16	TRAPEZOIDAL	1	1	2	2	0.01331	0.031	1.04
C17	TRAPEZOIDAL	1	1	2	2	0.01771	1.775	4.37
C18	TRAPEZOIDAL	1	1	2	2	0.0255	5.297	6.73
C19	TRAPEZOIDAL	1	1	2	2	0.01212	7.264	5.58

4.7.4. Pollution Control Dam

Storm flow from dirty areas is conveyed through dirty water channels to the PCD as indicated in Figure 4-8. The maximum monthly capacity of 5 376 m^3 will be required for the PCD. This will cater for the maximum direct rainfall, the 50-year 24-hour storm event, pit dewatering from underground workings and the required free board capacity. Provision for a freeboard of at least 0.8 m should be implemented for the PCD, or the proposed berm should be elevated to at least 0.8 m above the surface of the PCD to ensure adequate containment of the 1:50-year flood event.

Any excess water from the PCD can be pumped for authorised uses on the mine site, such as dust suppression.

4.8. Water Balance

A site-wide static water balance was compiled for the proposed Arnot South Project. Rainfall and evaporation data used to calculate water volumes directly falling on all open water facilities and that evaporating out of the facilities were obtained from the WR2012 database and are presented in Table 4-6 and Table 4-7, respectively.

Table 4-6: Monthly rainfall for the Arnot South region

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall(mm)	73	114	116	119	87	77	40	15	8	6	7	24

Table 4-7: Monthly potential evaporation for the Arnot South region

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation(mm)	138	133	149	151	128	126	96	82	67	73	95	119

4.8.1. Assumptions and Constants

Constant values and assumptions considered during the water balance development are presented in Table 4-8.

Table 4-8: Assumptions and constants used in the water balance calculations

Description of Assumptions and Constants	Value	Unit	Source
Discard Dump	1 500	m^2	Arnot South Mine Works Program Report (Exxaro, 2020)
Pollution Control Dam	1 200	m^2	Arnot South Mine Works Program Report (Exxaro, 2020)

Plant Footprint	68 600	m^2	Arnot South Mine Works Program Report (Exxaro, 2020)
Potable water supply	42.6	m^3/day	Arnot South Mine Works Program Report (Exxaro, 2020)
Mine Plant make-up water for coal washing	1200	m^3/day	Arnot South Mine Works Program Report (Exxaro, 2020)
Seepage from underground workings assumed to be 1% of inflows	0.5	%	Assumed % of total inflow
Dust suppression assumed to be 95% of U/G pumped water	95	%	Assumed % of treated water
Number of employees	154	number	Arnot South Mine Works Program Report (Exxaro, 2020)
Underground dust control volume	30	%	Assumed % of inflows
Recycled water from filter press and thickener for re-use	95	%	recycled water assumed to be 90% of plant water consumption
Process Plant losses assumed to be 5% of inflows	5	%	Assumed % of inflows
Treated sewage effluent to PCD	80	%	Assumed to be 80% of inflows to STP
Seepage from Discard Dump to PCD	80	%	Assumed to be 80% of inflows rainfall input
Borehole yield at 2.5 L/s	216	m^3/day	Groundwater model
Critical moisture content in lignite & anthracite is 25% and 20%, respectively	20	%	Assumed to be 20% of process water
Groundwater inflow rate	200	m^3/day	Groundwater model
Losses from thickener	20	%	Assumed % of outflow from CHPP
Runoff factor from dirty areas	0.8	-	Dimensionless, and it is based on roughness of catchments

4.8.2. Water Balance Results

The water flow diagram (WFD) and daily water balance volumes are shown in Figure 4-9. Annual, monthly and daily average water balances in the DWS format are presented in Table 4-9 to Table 4-11, respectively. Water supply for the Arnot Project is indicated to come from boreholes, groundwater ingress from underground workings (Now-closed Arnot Colliery), rainfall and runoff that is collected in storage facilities and used in the operations. Based on the Mine Works Programme Submission Report the washing plant water consumption, required as make-up water, is estimated to be between 1 000 m^3 to 1 200 m^3 per day (Exxaro, 2020). A dewatering volume of 200 m³/day is pumped to Underground Dams where it is used for underground dust control. Excess water from the Underground Dams will be pumped to the PCD for use as make-up water for mining operations. A volume of 132.1 m³/day will be obtained from the PCD and used for dust suppression within haul roads and relevant open surfaces. A small reverse osmosis Water Treatment Plant (WTP) will be used to treat borehole water for potable uses at the offices, workshop and change houses. The Arnot Project shall make maximum use of recycled water through the use of the filter press and thickener that clarify process water for re-use.

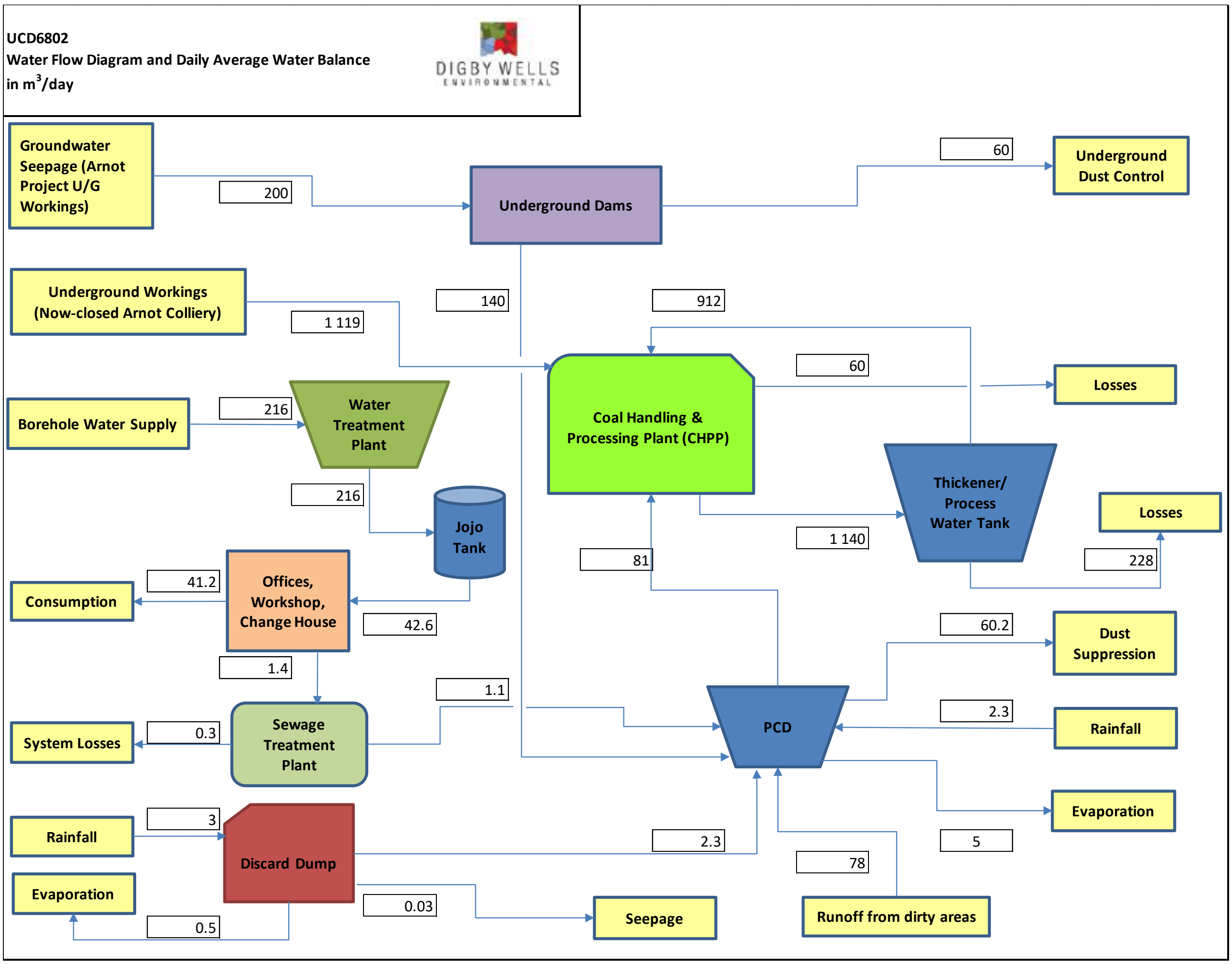


Figure 4-9: Water flow diagram for Arnot South with daily average water volumes

Table 4-9: Annual average water balance for Arnot South

Annual Average Water Balance for Arnot South					
		Water In		Water Out	Balance
Facility Name	Water Circuit/stream	Quantity (m^3/annum)	Water Circuit/stream	Quantity (m^3)/annum	
Underground Dams					
	From: Groundwater Seepage (Arnot Project U/G Workings)	73 200.00	To: Underground Dust Control	21 960.00	
			To: PCD	51 240.00	
			To: Seepage	0.00	
	Total	73 200.00		73 200.00	-
Water Treatment Plant (WTP)	From: Borehole Water Supply	79 056.00	To: Storage in Jojo Tank	79 056.00	
	Total	79 056.00		79 056.00	-
Coal Handling & Processing Plant (CHPP)	From: Underground Workings (Now-closed Arnot Colliery)	409 713.39	To: Process Water Tank	417 240.00	
	From: Process Water Tank	333 792.00	To: Process losses	21 960.00	
	From: PCD	29 486.61	To: Recycled through filter press and thickener	333 792.00	
	Total	772 992.00		772 992.00	-
Thickener/ Process Water Tank	From: Processing Plant	417 240.00	To: Processing Plant	333 792.00	
			To: Losses	83 448.00	
	Total	417 240.00		417 240.00	-
Pollution Control Dam (PCD)	From: Rainfall	828.46	To: Evaporation	28 964.89	
	From: Runoff from dirty areas	28 416.24	To: Dust Suppression	22 033.20	
	From: Underground Dams	51 240.00	To: Coal Handling & Processing Plant (CHPP)	29 486.61	
	Total	80 484.70		80 484.70	-
Offices, Workshop & Change House			To: Consumption	15 083.80	
	From: Jojo Tank	15 591.60	To: Sewage Treatment Plant	507.80	
	Total	15 591.60		15 591.60	-
Sewage Treatment Plant (STP)			To: PCD	406.24	
	From: Offices, Workshop & Change House	507.80	To: System Losses	101.56	
		507.80		507.80	
Discard Dump	From: Rainfall	1 035.58	To: Evaporation	196.76	
			To: PCD	828.46	
			To: Seepage	10.36	
		1 035.58		1 035.58	-
Total Water Balance		1 440 107.68		1 440 107.68	

Table 4-10: Monthly average water balance for Arnot South

Monthly Average Water Balance for Arnot South					
		Water In		Water Out	Balance
Facility Name	Water Circuit/stream	Quantity (m^3/mon)	Water Circuit/stream	Quantity (m^3)/mon	
Underground Dams					
	From: Groundwater Seepage (Arnot Project U/G Workings)	6 100.00	To: Underground Dust Control	1 830.00	
			To: PCD	4 270.00	
			To: Seepage	0.00	
	Total	6 100.00		6 100.00	-
Water Treatment Plant (WTP)					
	From: Borehole Water Supply	6 588.00	To: Storage in Jojo Tank	6 588.00	
	Total	6 588.00		6 588.00	-
Coal Handling & Processing Plant (CHPP)					
	From: Underground Workings (Now-closed Arnot Colliery)	34 142.78	To: Process Water Tank	34 770.00	
	From: Process Water Tank	27 816.00	To: Process losses	1 830.00	
	From: PCD	2 457.22	To: Recycled through filter press and thickener	27 816.00	
	Total	64 416.00		64 416.00	-
Thickener/ Process Water Tank					
	From: Processing Plant	34 770.00	To: Processing Plant	27 816.00	
			To: Losses	6 954.00	
	Total	34 770.00		34 770.00	-
Pollution Control Dam (PCD)					
	From: Rainfall	69.04	To: Evaporation	2 413.74	
	From: Runoff from dirty areas	2 368.02	To: Dust Suppression	1 836.10	
	From: Underground Dams	4 270.00	To: Coal Handling & Processing Plant (CHPP)	2 457.22	
	Total	6 707.06		6 707.06	-
Offices, Workshop & Change House					
			To: Consumption	1 256.98	
	From: Jojo Tank	1 299.30	To: Sewage Treatment Plant	42.32	
	Total	1 299.30		1 299.30	-
Sewage Treatment Plant (STP)					
			To: PCD	33.85	
	From: Offices, Workshop & Change House	42.32	To: System Losses	8.46	
		42.32		42.32	
Discard Dump					
	From: Rainfall	86.30	To: Evaporation	16.40	
			To: PCD	69.04	
			To: Seepage	0.86	
		86.30		86.30	-
Total Water Balance		120 008.97		120 008.97	

Table 4-11: Daily average water balance for Arnot South

Daily Average Water Balance for Arnot South					
		Water In		Water Out	Balance
Facility Name	Water Circuit/stream	Quantity (m^3/day)	Water Circuit/stream	Quantity (m^3)/day	
Underground Dams	From: Groundwater Seepage (Arnot Project U/G Workings)	200.00	To: Underground Dust Control	60.00	
			To: PCD	140.00	
			To: Seepage	0.00	
	Total	**200.00**		**200.00**	-
Water Treatment Plant (WTP)	From: Borehole Water Supply	216.00	To: Storage in Jojo Tank	216.00	
	Total	**216.00**		**216.00**	-
Coal Handling & Processing Plant (CHPP)	From: Underground Workings (Now-closed Arnot Colliery)	1 119.44	To: Process Water Tank	1 140.00	
	From: Process Water Tank	912.00	To: Process losses	60.00	
	From: PCD	80.56	To: Recycled through filter press and thickener	912.00	
	Total	**2 112.00**		**2 112.00**	-
Thickener/ Process Water Tank	From: Processing Plant	1 140.00	To: Processing Plant	912.00	
			To: Losses	228.00	
	Total	**1 140.00**		**1 140.00**	-
Pollution Control Dam (PCD)	From: Rainfall	2.26	To: Evaporation	79.14	
	From: Runoff from dirty areas	77.64	To: Dust Suppression	60.20	
	From: Underground Dams	140.00	To: Coal Handling & Processing Plant (CHPP)	80.56	
	Total	**219.90**		**219.90**	-
Offices, Workshop & Change House			To: Consumption	41.21	
	From: Jojo Tank	42.60	To: Sewage Treatment Plant	1.39	
	Total	**42.60**		**42.60**	-
Sewage Treatment Plant (STP)			To: PCD	1.11	
	From: Offices, Workshop & Change House	1.39	To: System Losses	0.28	
		1.39		**1.39**	
Discard Dump	From: Rainfall	2.83	To: Evaporation	0.54	
			To: PCD	2.26	
			To: Seepage	0.03	
		2.83		**2.83**	-
Total Water Balance		**3 934.72**		**3 934.72**	

4.9. Surface Water Impact Assessment

The potential impacts of the proposed activities for the construction, operation and decommissioning phases of the project were assessed and are presented in this section.

4.9.1. Construction Phase

- The activities in the construction phase and their impacts on water resources are detailed in Table 4-12. The section also gives a detailed description of the impacts and recommends mitigation strategies. Thereafter,

Table 4-13 presents the significance rating before and after the proposed mitigation strategies.

Table 4-12: Interactions and impact activities

Interaction	Impacts
Removal of vegetation/topsoil for establishment of mining and linear infrastructure. Stockpiling of soils, rock dump and discard dump establishment.	Sedimentation and siltation of water resources reducing flow regime within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries
Handling of hydrocarbons and general waste. Diesel storage and explosives magazine	Surface water contamination leading to deteriorated water quality within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries
Construction of infrastructure, and ventilation fans	Interception of rainfall, runoff and subsurface flow leading to reduced downstream runoff yield

4.9.1.1. *Impact Description: Sedimentation and siltation of water resources reducing flow regime within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries*

Vegetation cover protects and stabilises soil, reducing the amount of runoff and consequently reducing soil erosion. The removal of vegetation and topsoil during construction increases the vulnerability of soil to erosion. Eroded soils are transported as sediments to the nearby watercourses (Vaalrivierspruit, Klein-Olifantsrivier and their tributaries) resulting in the siltation of water resources and reduced streamflow regimes. Runoff from stockpiles, rock dumps and discard also add on the sedimentation and siltation of rivers.

4.9.1.2. *Impact Description: Surface water contamination leading to deteriorated water quality within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries*

Spillages and leakages of hydrocarbons and other chemicals from storage areas, moving vehicles/machinery or due to mishandling of waste during construction could lead to surface water contamination. These chemicals could be washed off to the nearest surface water resources during rainfall events thereby contaminating the receiving waterbodies.

4.9.1.3. Impact Description: Interception of rainfall, runoff and subsurface flow leading to reduced downstream runoff yield

Changing land cover and excavations lead to changes of catchment characteristics, as such, this will disturb water flow paths, subsequently affecting runoff volumes and subsurface flow within the catchment. Infrastructure can affect the amount of water flowing into streams through its interception of rainfall, runoff and subsurface flow and the impact will be observed in rivers and felt even to downstream reaches of the catchment.

4.9.1.4. Mitigation/management measures

The recommended mitigation/management measures:

- Limit vegetation clearing and limit disturbing the soil to the project/building footprint;
- Control fluvial erosion and sedimentation by establishing a stormwater management plan;
- Control through use of spill kits and accredited vendors for waste disposal;
- Control by training of personnel in proper hydrocarbon and chemical handling methods; and
- Control by bunding hydrocarbon and other waste storage facilities.

Table 4-13: Impact significance rating for the construction phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of water resources reducing flow regime within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries			
Duration	5	The impact will occur for most the project's life	-96 Moderate (Negative)
Intensity	5	The impacts will have serious impacts on water resources hence affecting the ecosystem function	
Spatial scale	6	The impacts will be felt mostly downstream of the project area	
Probability	6	It is mostly likely that the impact will occur if no mitigation measures are put in place	
Post-mitigation			
Duration	3	The impact will only occur at certain times during the construction phase	-28

Intensity	2	The impact will have minor and manageable effects on water resources after mitigation measures	Negligible (negative)
Spatial scale	2	The impacts will be limited to the project site and surrounding areas	
Probability	4	The probability of the impacts occurring will be reduced after the implementation of the proposed mitigation measures	

Dimensions	Rating	Motivation	Significance
Impact: Surface water contamination leading to deteriorated water quality within the Vaalrivierspruit, Klein-Olifantsrivier and their tributaries			
Duration	6	The impacts could persist for some time after the project has ended	-96 Moderate (negative)
Intensity	5	The impacts will have serious effect on water resources that might take extreme measures to manage, especially on the ecosystem	
Spatial scale	5	The impacts will be felt further downstream of the Vaalrierspruit and Klein-Olifantsrivier	
Probability	6	There is a high probability that the impact will occur if no mitigation measures are put in place	
Post-mitigation			
Duration	3	The impact duration will be reduced to medium tern with the implementation of the proposed mitigation measures.	-14 Negligible (negative)
Intensity	2	The impact will have minor effects on the surround rivers and its tributaries	
Spatial scale	2	The impacts will only be limited to the project site and immediate surroundings	
Probability	2	There is a rare possibility that the impact will occur, unless in extreme uncontrollable circumstances	

Dimensions	Rating	Motivation	Significance

Impact: Interception of rainfall, runoff and subsurface flow leading to reduced downstream runoff yield			
Duration	5	The impact will occur throughout the project life	-96 Moderate (Negative)
Intensity	6	The impact will have significant impacts on water resources, it will also affect catchment dynamics and ecosystems	
Spatial scale	5	The impacts can be observed mostly downstream of Vaalrierspruit and Klein-Olifantsrivier	
Probability	6	There is high possibility that the impact will take place	
Post-mitigation			
Duration	5	The impacts will occur for as long as the infrastructure stands, which is throughout the project life	-40 Minor (Negative)
Intensity	3	The impact will have short-term, manageable effects on the water resources and river dynamics	
Spatial scale	2	The impact will be limited to the project site and its immediate surrounding if the mitigation measure are implemented	
Probability	4	The possibility of the impact occurring will be reduced with proper mitigation measures in place	

4.9.2. Operations Phase

Table 4-14 presents the interaction and the potential impacts of the proposed activities in the operation phase. This section also describes the impacts and further propose mitigation/management measures to minimise the effects of the proposed impacts. In addition, the impact significance rating is given in Table 4-15.

Table 4-14: Interactions and impact activities

Interaction	Impacts
Areas containing topsoil stockpiles, overburden, and discard dumps	Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries
Handling of hydrocarbons and general waste; and Spillages and leakages from maintenance of haul roads, pipelines, and machinery.	Contamination of water resources and deterioration of water quality

Use of water for mining operations and production of contaminated effluent/process water.	
Concurrent rehabilitation of mined-out areas as mining progresses	Restoration of free drainage and runoff yield at least to a certain extent

4.9.2.1. Impact Description: Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries

As mining operations take place, more stockpiling takes place. Sedimentation and siltation of nearby watercourses will occur due to erosion of disturbed soils and transportation of sediments by runoff from areas containing stockpiles of soils, overburden, and discard dumps.

4.9.2.2. Impact Description: Contamination of water resources and deterioration of water quality

Chemical leakages and spillages during operations will have negative impacts on water resources by reducing its quality. Dirty runoff from workshops, equipment, haul roads, pipelines and chemical storage infrastructure will contaminate the nearest receiving surface waterbodies, therefore reducing their water quality. Use of water for mining operations results in the production of contaminated effluent/process water which if not well managed may contaminate natural water resources.

4.9.2.3. Impact Description: Restoration of free drainage and runoff yield at least to a certain extent

Concurrent rehabilitation (backfilling, topsoiling & reprofiling) and the restoration of vegetation in mined-up parts of the mine will restore landscape shapes thereby promoting free drainage to nearby watercourses. Rehabilitation thus improves streamflow regimes hence will have positive impacts on the nearest surface water resources and downstream water users.

4.9.2.4. Mitigation/Management measures

Recommended mitigation/management measures are as follows:

- Control by implementing a comprehensive storm water management plan which addresses fluvial erosion control;
- Stockpiles should be stored away from the drainage line;
- Control through implementation of a SWMP for dirty water management;
- Control through water quality and quantity monitoring and updating the mine-wide water balance;
- Maintenance of infrastructure and mining vehicles to reduce leakages; and
- Remedy through re-profiling and rehabilitation of previously disturbed landscapes.

Table 4-15: Impact significance rating for the operation phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries			
Duration	5	The impact will occur throughout the project life	-90 Moderate (Negative)
Intensity	5	The impact will have serious long-term effect on water resources if no mitigation measures are implemented	
Spatial scale	5	The impact will affect areas beyond the project area, especially downstream	
Probability	6	There is a high probability of the impact taking place without mitigation	
Post-mitigation			
Duration	3	With the mitigation measures in place, the impact will only occur for a shorter time	-18 Negligible (Negative)
Intensity	2	The impacts will have minor impacts on water resources because most of the runoff will be discharged into SWMP	
Spatial scale	1	The impact will only be limited to the designated sites within the project area	
Probability	3	With the proper mitigation plans in place, the probability of the impact taking place will be reduced, unless in extreme uncontrollable circumstances	

Dimensions	Rating	Motivation	Significance
Impact: Contamination of water resources and deterioration of water quality			
Duration	6	The impacts will persist for some time after the project activities have ceased	-85 Moderate (negative)
Intensity	6	Without proper mitigation plans, the impact will have significant impacts on water resources and surrounding ecosystem	
Spatial scale	5	The impact will go beyond the project boundary and the surrounding area, it will be felt mostly downstream	

Probability	5	The impact is most likely to occur, especially after rainfall events	
Post-mitigation			
Duration	3	With the implementation of effective mitigation measures, the impact will only persist for a couple of years and cease with the project	-18 Negligible (Negative)
Intensity	2	The impact will have minor effects on water resources because water will be monitored before being discharged into natural courses	
Spatial scale	1	The impact will be restricted withing the project area	
Probability	3	The impact will only occur during extreme circumstances	

Dimensions	Rating	Motivation	Significance
Impact: Restoration of free drainage and runoff yield at least to a certain extent			
Duration	7	The benefits from the impact will remain long after the project has ended	108 Moderate (positive)
Intensity	6	The impact will improve water resources and the quality of the environment	
Spatial scale	5	The impact will have positive impacts on the water resources where the rehabilitation will be taking place and further downstream	
Probability	6	It is highly possible that water resources will be improved in some parts of the mine where rehabilitation will be taking place	

4.9.3. Decommissioning Phase

The potential impacts of the proposed activities in the decommissioning phase are listed in Table 4-16, this section also includes detailed description of the impacts and proposed mitigation/management strategies. Table 4-17 further rates the significance of the impacts.

Table 4-16: Interactions and impact activities

Interaction	Impacts
Demolition and removal of infrastructure	Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries
Spillages and leakages from vehicles and machinery during demolition of infrastructure	Contamination of water resources and deterioration of water quality
Decant of Acid Mine Drainage (AMD)	Impact Description: Contamination of surface water resources by acid mine drainage
Post-closure monitoring and rehabilitation Closure of the underground mine	Restoration of free drainage and runoff yield at least to a certain extent

4.9.3.1. Impact Description: Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries

The demolition and removal of infrastructure destabilises and disturbs the soil, therefore making the ground susceptible to erosion. During rainfall, runoff transports sediments from the disturbed areas to nearest surface water resources subsequently resulting in sedimentation and siltation of water resources.

4.9.3.2. Impact Description: Contamination of water resources and deterioration of water quality

The removal of chemical storages and infrastructure, pipelines and as well as the movement of demolition vehicles could lead to the spillage and leakage of chemicals during decommission phase. Runoff from this area will contaminate the quality of water resources thus reducing the potability of those resources.

4.9.3.3. Impact Description: Contamination of surface water resources by acid mine drainage

Acid Mine Drainage (AMD) causes acidification and heavy metal contamination of surface water bodies when residues containing metal sulphides (e.g. iron pyrites) are exposed to oxidizing conditions. Heavy-metal contaminated and acidified groundwater discharges into streams at points where the water table is close to the surface. The oxidation of iron sulphide causes the precipitation of sulphuric acid which lowers in-stream water pH. Acidic water environments are detrimental to most aquatic life species, and they affect irrigation and livestock watering functions for downstream water users. The potential for AMD will be confirmed for the Project site through geochemical assessment which is underway and groundwater contamination modelling (Digby Wells, 2021).

4.9.3.4. Impact Description: Restoration of free drainage and runoff yield at least to a certain extent

Restoring vegetation and topsoil will improve river dynamics and quality of water resources. It will also have positive impacts on runoff regime thus improving streamflow and the aquatic ecosystem, hence improving the sustainability of water resources.

4.9.3.5. Mitigation/Management measures

Recommended mitigation/management measures:

- Control through limiting disturbance of soils to where demolition will be taking place and the demolition site should be cleared as quickly as possible to avoid sediment erosion;
- Maintain demolition vehicles to ensure that no leakages occur, and all chemical related waste and storages should be handled by trained personnel;
- Control the quality of water through water quality monitoring;
- Options to deal with AMD include the following:
  - Actively treating AMD decant to acceptable water quality levels for re-use or prior to discharge into the natural stream; and
  - Passive treatment or neutralisation of AMD effluent with calcium carbonate or lime at identified decant points to obtain water with acceptable quality.
- Remedy through rehabilitation of areas previously occupied by ventilation fans and other infrastructure, post-closure;
- Remedy through re-profiling and rehabilitation of previously disturbed landscapes

Table 4-17: Impact significance rating for the construction phase

Dimensions	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses including Vaalrivierspruit, Klein-Olifantsrivier and their tributaries			
Duration	6	The impact will last for some time after the life of the project	-96 Moderate (Negative)
Intensity	5	The impact will have very serious, long-term effects on water resources if no mitigation measures are implemented	
Spatial scale	5	The impacts will be felt mostly downstream of the project area	
Probability	6	There is high probability that this impact will occur	
Post-mitigation			

Duration	3	The impact will only occur for a short period of time during the demolition	-21 Negligible (Negative)
Intensity	2	The impact will have minor impacts on water resources because soil disturbances will be kept to as minimum as possible	
Spatial scale	2	The impacts will be limited to the project site and immediate surroundings	
Probability	3	The possibility of the impact occurring will be reduced	

Dimensions	Rating	Motivation	Significance
Impact: Contamination of water resources from AMD and deterioration of water quality			
Duration	6	The impacts could last for some time after demolition and removal of infrastructure	-80 Moderate (negative)
Intensity	5	The impact could have serious long-term effects on water resources	
Spatial scale	5	The effects of the impacts will be felt downstream of the project area	
Probability	5	The impact is likely to occur if no mitigation measures are implemented	
Post-mitigation			
Duration	3	With effective mitigation measures, the impact will only last for several years	-14 Negligible (Negative)
Intensity	2	The impacts will have minor effects on water resources because measures will be taken ensure water quality standards	
Spatial scale	2	The impact will be restricted to the project area and immediate surroundings	
Probability	2	With mitigation measures in place, the impacts will likely occur during extreme circumstances	

Dimension	Rating	Motivation	Significance
Impact: Water Contamination from Acid Mine Drainage into surface water resources			
Duration	7	The impact will remain for some time after the life of the project.	108-Moderate (negative)

Intensity	7	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem.	
Spatial scale	4	The impact has the potential to affect the whole municipal area.	
Probability	6	It is highly probable that the impact will occur.	
Post-mitigation			
Duration	7	The impact will remain for some time after the life of the project.	44-Minor (negative)
Intensity	2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants.	
Spatial scale	2	Limited to the site and its immediate surroundings.	
Probability	4	It is probable the impact will occur.	

Dimensions	Rating	Motivation	Significance
Impact: Restoration of free drainage and runoff yield at least to a certain extent			
Duration	7	The effects of the impact on water resources will last long after the project has ended	**114 Major Positive**
Intensity	6	The impact will have significant impacts on water resources and the environment at large	
Spatial scale	6	The impacts will be felt beyond the projects area and at a big a scale	
Probability	6	It is high likely that water resources will be improved once restoration of vegetation and free drainage is done	

4.10. Cumulative Impacts

Mines have a huge impact on water resources, both on the availability and quality. In coal mines, a significant amount of water is used for mining and processing, and dust suppression, thus having huge impacts on the availability of water. Furthermore, water availability is also reduced with deteriorating water quality because of dirty runoff from mines and contamination from decant water after mine closure. Despite the efforts to recycle water in this industry, a significant amount of water is needed to ensure effective operation, therefore, water requirements and water consumption remain high.

The project area is situated on the divide of the Olifants and Inkomati WMAs, where similar mining activities are being conducted, already with reports of pollution within river systems in this part of the catchment. In fact, the Olifants catchment, in particular, is considered one of the most polluted in Southern Africa (Le Roux, Schaefer, & Genthe, 2012). Extreme caution and care should, therefore, be taken to avoid exacerbating the water challenges already being experienced prior to the proposed Arnot South Project.

Water quality should closely and rigorously be monitored within the surrounding surface water resources to ensure adherence to South African Target Water Quality Guidelines. The proposed mitigation measures will ensure overall minimum cumulative impacts on the Olifants and Crocodile Rivers.

5. Environmental Management Plan

This section summarises the proposed activities, the potential impacts of the proposed activities and the environmental aspects affected and associated mitigation measures.

Table 5-1: Environmental Mangement Plan

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
• Vegetation clearing; • Construction of infrastructure including the culvert, haul road and diversion of the provincial road; and • Loading and transportation of materials including topsoil and discard to designated dumps and stockpile areas,	• Sedimentation and siltation of water sources due to increased soil erosion	Surface Water quantity and Quality	Construction	• Strategically clear all vegetation within the development site and limit disturbing the soil; • Encourage the use of existing access roads and minimise creating new ones as to limit soil disturbances; • Avoid stockpiling close to the drainage lines and construction must be done mostly during drier periods to minimise erosion; and • Maintain vehicles and machinery regularly to avoid leakages.	Control by implementing proposed stormwater management plan to minimise impacts on the environment	During the construction phase
• Flow of dirty water from workshops, stockpiles, operational plants, haul roads and blasting sites; and • Hydrocarbon spillages and leakages from equipment, moving heavy vehicles and machinery.	• Siltation of water resources due to increased dust and soil erosion; and • Hydrocarbon contamination of water resources	Surface Water Quality and Quantity	Operational	• Installation of effective drainage systems with sediments filtration material is recommended to reduce siltation and sedimentation in watercourses; • Ensure that water quality complies with DWS guidelines before discharging it to watercourses; • Storage facilities for hydrocarbon fuels, oils and grease must be equipped to contain leakages and spills and must be on impermeable surface (concrete or paved) and should be an enclosed area built in accordance with the SANS1200; • All mining personnel must be trained and educated on proper handling and disposal of hazardous material; • All operational vehicles should be maintained and washed in a single designated area and all the runoff water should be diverted to the PCD and all mine waste should be handled by a trained contractor; • Water quality monitoring should be effectively implemented to ensure adherence to the stipulated water quality standards, and through this, any water quality problems arising because of the mine can be detected and dealt with early; • The water requirements should be clearly stated and frequently reviewed as to not compromise the Reserve; and • Recycling and reusing of mine water are highly recommended to reduce the abstraction of freshwater resources.	Control by implementation of proposed SWMP and regular monitoring of water quality and quantity to minimise the negative impacts of mining and related activities; and Regular maintenance of SWMP to ensure effective functioning of storm water structures.	During the operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
• Decommissioning and removal of mine infrastructure will result in the disturbance of soils thereby accelerating soil erosion; • Handling hydrocarbon material and potential leakage and spillage from moving vehicles and machinery; and • Backfilling, re-profiling and revegetation of disturbed landscapes.	• Sedimentation and siltation of watercourses subsequently affecting water quality and flow of streams; • Contamination of water resources due to chemical contamination such as hydrocarbons as result of mishandling; • Contamination of water resources from decant of Acid Mine Drainage (AMD) at low-lying riverine areas; and • Allowing free drainage and possible increase of streamflow regimes.	Water Quality and Water quantity	Decommissioning	• Soil disturbances during decommissioning should be restricted to the relevant footprint area; • All decommissioning debris must be cleared as soon as practically possible, and it is recommended that demolition of infrastructure be conducted during the dry season to minimise chances of soil erosion to watercourses; • Movement of heavy vehicles and machinery must be restricted to existing roads to avoid further disturbance of landscapes thus minimising soil erosion; • In the event of decanting, passive treatment should be applied to neutralise and treat the AMD before being discharged back into freshwater resources. If passive treatment fails, active treatment by a conventional Water Treatment Plant should be considered; and • Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that is close to pre-mining conditions.	Monitoring of water quality and quantity post-closure; and Rehabilitation of disturbed landscapes monitoring and maintenance of rehabilitated areas until vegetation has fully been established.	During the decommissioning phase

6. Surface Water Monitoring Programme

The monitoring program assists with the early detection of water contamination thereby allowing mitigation or management strategies to be implemented at an early stage, thus minimising the significance of potential impacts on water resources. Surface water monitoring localities for rivers and streams within or adjacent to the Arnot South Project are indicated in Figure 4-5 (see Section 4) and in Table 6-2 presents the proposed surface water resources monitoring plan to ensure sustainability of mining activities within the Arnot South Project site. The frequency of mitigation, timing of implementation and the responsible persons in ensuring the implementation of the EMP are indicated.

Table 6-1: Surface water monitoring localities for the Arnot South Project

Monitoring Point	Description	Latitude (°)	Longitude (°)
ANTSW1	Downstream of MRA boundary on Vaalrivierspruit	-26.031198	29.940574
ANTSW2	Adjacent to infrastructure footprint area on Vaalrivierspruit	-26.061016	29.884349
ANTSW3	R38 Road/Vaalrivierspruit crossing	-26.137215	29.847975
ANTSW4	Upstream of MRA on the N11 Road/Klein-Olifantsrivier crossing	-26.22074	29.771309
ANTSW5	Downstream of MRA on R38 Road/ Klein-Olifantsrivier crossing	-26.147591	29.754761
ANTSW6	On tributary of the Klein-Olifantsrivier to the west of MRA	-26.096384	29.78202
ANTSW7	On tributary of the Klein-Olifantsrivier northwest of MRA	-26.011645	29.759324
ANTSW8	On tributary of Vaalrivierspruit to the north of the MRA	-25.975701	29.912479
ANTSW9	Farm Dam on the western fringe of the proposed infrastructure area	-26.051297	29.82186

Table 6-2: Surface Water Monitoring Plan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Ensure water quality monitoring as per sampled and proposed monitoring locations (See Figure 4-5). Parameters should include but not limited to pH; Electrical Conductivity; major cations (K, Ca, Mg & Na); trace metals (Al, Fe, Zn, Cu, Mn, Co, Se, Mo, Cd, Ni, Cr (VI), Pb, Hg & As); Anions (NO_3, NO_2, NH_4, Cl, F, SO_4, PO_4); Total Dissolved Solids; Total Suspended solids. It is also recommended to monitor water quality within the mine water dams or water containment facilities at the existing NCC operations to determine the concentration levels in case of an overflow or need for discharge.	Monthly monitoring during construction, operation, decommissioning and for at least five (5) years after closure, or until rehabilitation has reached a sustainable state with no further changes.	Environmental Officer
Sedimentation	Inspect construction sites, sites where infrastructure is demolished and rehabilitated sites for traces of erosion to ensure no entrance of sediment occurs into nearby watercourses, especially after rainfall events. Temporary silt fences, soil stabilization blankets should be installed and maintained until vegetation is established.	After rainfall event, until the establishment of vegetation on all rehabilitated sites	Environmental Officer
Water quantity and water balance	Monitoring or measuring of all the water inflows into the mine, reticulation within the mine and the outflows from the mine. This can be achieved by installing automatic flow meters to ensure real time measurements of water.	In operational areas where automatic flow meters are in place, daily records need to be kept	Environmental Officer
Physical structures and Storm Water Management Plan (SWMP) performance	Personnel should have a walk around facilities to determine the facilities conditions and pick out any anomalies such as leaks or overflows and system malfunctions.	Continuous process and yearly formal report	Environmental Officer

Monitoring Element	Comment	Frequency	Responsibility
	Storm water channels, berms and storage facilities are inspected for silting and blockages of inflows, pipelines for hydraulic integrity; monitoring and maintenance of the overall SWMP performance.		

7. Stakeholder Engagement Comments Received

No comments received from stakeholders.

8. Recommendations

The following is recommended to mitigate identified impacts:

- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised so as to minimise creation of new ones;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments, dust generation and hazardous substances from construction vehicles used during site clearing;
- Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the mine’s maintenance program they must be inspected daily before use to ensure there are no leakages underneath;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas at the existing mining operations. Any used oil should be disposed of by accredited contractors;
- Implementation of the proposed stormwater management plan is recommended to reduce siltation and sedimentation in watercourses;
- All operational vehicles should be maintained and washed at designated wash bays;
- All mine waste should be handled and disposed of by an accredited vendor;
- The proposed water quality monitoring program should be consistently implemented to ensure adherence to stipulated water quality standards. This will enable early detection and management of any water quality problems arising as a result of mining operations and associated activities;

- The water requirements and demands should be clearly stated and regularly reviewed through water balance updates to ensure water uses and losses are accounted for;
- Soil disturbances during decommissioning should be restricted to the relevant footprint area;
- All decommissioning debris must be cleared as soon as practically possible, and it is recommended that demolition of infrastructure be conducted during the dry season to minimise chances of soil erosion to watercourses;
- Movement of heavy vehicles and machinery must be restricted to existing roads to avoid further disturbance of landscapes thus minimising soil erosion;
- In the event of decanting, passive treatment should be applied to neutralise and treat the AMD before being discharged back into freshwater resources. If passive treatment fails, active treatment by a conventional Water Treatment Plant should be considered; and
- Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that supports desired post-mining land use.

9. Reasoned Specialist Opinion

Provided all the recommended mitigation and management measures are implemented, there is no hydrological reason why the Arnot South Project may not proceed.

10. Conclusions

There is rainfall variability observed within the quaternaries, with the Mean Annual Precipitation (MAP) for B12A, B12B and X11A being 695 mm, 672 mm, and 688 mm, respectively (WRC, 2015). On average, the project site receives a MAP of 685 mm. The wettest month of January has a 90th percentile of 192 mm and 10th percentile 65 mm. The project area experiences wet summers and dry winters with moderate to high rainfall recorded from November to February.

Most of the analysed parameters are within the RWQO of the region in which the proposed Arnot South project site is located. Exceedances were, however, variably noted for Chloride (Cl), Ortho Phosphate (P), Aluminium (Al) and Copper (Cu) both upstream and downstream of the project site. Higher P, Cu, Cl and Al concentrations are likely due to industrial effluents or agricultural chemical released from upstream areas of the Arnot South project site. Sampling point ANTSW1 indicated further RWQO exceedances for Arsenic (As), Cadmium (Cd), Hexavalent Chromium as Cr (VI), Lead (Pb), Manganese (Mn) and Mercury (Hg) while at the other sampling points these parameters were below detection levels. The higher levels of heavy metals at the ANTSW1 point possibly result from already existing mining activities within the region. Mining activities upstream of the proposed Arnot South Project include Mbuyelo and Motshaotshele Collieries. Downstream of the site there is the Arnot Power Station which utilises coal to generate electricity, and several decommissioned coal mines that may still contribute to water contamination due to decant processes.

Separation of clean and dirty water should be implemented as per the storm water management plan. This should be done through a network of clean water diversion berms and dirty water channels which convey contaminated water to containment facilities such as the Pollution Control Dam (PCD). The berms will exclude or divert clean water from the clean water catchment around dirty facilities allowing the clean water to flow further downslope to natural watercourses.

The proposed Pollution Control Dam (PCD) is too close to the 1:100-year floodline such that it is recommended that it be slightly moved approximately 30 m away from the nearby watercourse so that it is clearly off the flood waterway. Streams located to the north of the proposed Arnot South infrastructure footprint area are approximately 3 km away and so will likely not be impacted on by proposed mining activities.

Water supply for the Arnot Project is indicated to come from boreholes, groundwater ingress from underground workings (Now-closed Arnot Colliery), rainfall and runoff that is collected in storage facilities and used in the operations. Based on the Mine Works Programme Submission Report the washing plant water consumption, required as make-up water, is estimated to be between 1 000 m3 to 1 200 m3 per day (Exxaro, 2020). A dewatering volume of 200 m3/day is pumped to Underground Dams where it is used for underground dust control. Excess water from the Underground Dams will be pumped to the PCD for use as make-up water for mining operations. A volume of 132.1 m3/day will be obtained from the PCD and used for dust suppression within haul roads and relevant open surfaces. A small reverse osmosis Water Treatment Plant (WTP) will be used to treat borehole water for potable uses at the offices, workshop and change houses. The Arnot Project shall make maximum use of recycled water through the use of the filter press and thickener that clarify process water for re-use.

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