Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Appendix F1:

Aquatic, Wetlands and Surface Water Assessments

Aquatic and Surface Water Assessment for the Proposed Dunbar Coal Mine, near Bethal, Mpumalanga Province

for

Vandabyte (Pty) Ltd

August 2019

by

Dr. James Dabrowski

Confluent Environmental

james@confluent.co.za

Declaration of Specialist Independence

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant;
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.

Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

22 August 2019

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Vandabyte (Pty) Ltd (hereafter the applicant) has appointed Enviro-Insight CC as the Environmental Assessment Practitioner (EAP) to undertake environmental authorisations (EAs) associated with the proposed Dunbar Coal Mine. The applicant obtained a Prospecting Right (reference number MP 30/5/1/1/2/10737 PR) on 22 May 2014 from the Mpumalanga Department of Mineral Resources (DMR) to prospect for coal in an area of 1797 ha on a Portion of Portion 1, Portion 2 and the remaining extent of the Farm Dunbar 189 IS, Portion 1 of the Farm Middelkraal 50 IS and Portion 6 of the Farm Halfgewonnen 190 IS located in Mpumalanga Province. The mining right application lodged on 9 May 2019 to the DMR (reference number MP30/5/1/2/2/10237MR) includes the abovementioned properties and extent.

The Integrated Environmental Authorisation (IEA) application includes the above-mentioned properties where the proposed mining blocks identified and associated infrastructure will be located on Portion 2 of the Farm Dunbar 189 IS.

In support of the application to obtain the mining right, the applicant is required to conduct a Scoping and Environmental Impact Assessment (S&EIA) process that needs to be submitted to the DMR for adjudication, which includes activities triggered under the Environmental Impact Assessment Regulations of 2014 (as amended) promulgated under the National Environmental Management Act, 1998 (Act 107 of 1998) and activities triggered under the National Environmental Management: Waste Act, 2008 (NEM:WA) (Act 59 of 2008).

This report specifically addresses the surface water and aquatic ecosystem assessment of the EIA.

1.2 OBJECTIVES

The objectives of this assessment include the following:

- Characterisation of the baseline state of surface water and aquatic and wetland ecosystems associated with the proposed development;
- Identify sensitive features, i.e. habitats, species of conservation concern, unique features that may be negatively impacted upon by the proposed development;
- Assess the significance of potential impacts on surface water and aquatic and wetland ecosystems associated with the development;
- Identify potential mitigation measures that can be implemented in order to reduce the significance of impacts;
- Reassess the significance after implementation of mitigation measures; and

- Comment on the ecological sustainability and viability of the proposed development from the perspective of surface water resources and aquatic and wetland ecosystems.

2 KEY LEGISLATIVE REQUIREMENTS

2.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA, 1998)

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In terms of the NEMA EIA Regulations (2014, as amended), the applicant is required to appoint an environmental assessment practitioner (EAP) to undertake the EIA, as well as conduct the public participation process.

The objective of the Regulations is to establish the procedures that must be followed in the consideration, investigation, assessment and reporting of the activities that have been identified. The purpose of these procedures is to provide the competent authority with adequate information to make decisions which ensure that activities which may impact negatively on the environment to an unacceptable degree are not authorized, and that activities which are authorized are undertaken in such a manner that the environmental impacts are managed to acceptable levels.

In accordance with the provisions of Sections 24 (5) and Section 44 of the NEMA the Minister has published Regulations (GN R. 982) pertaining to the required process for conducting EIA's in order to apply for, and be considered for, the issuing of an Environmental Authorisation (EA). These Regulations provide a detailed description of the EIA process to be followed when applying for EA for any listed activity. The Regulations differentiate between a simpler Basic Assessment Process (required for activities listed in GN R. 983 and 985) and a more complete EIA process (activities listed in GN R. 984). In the case of this project there are activities triggered under GN R. 984 and as such a full EIA process is necessary. On 7 April 2017, the NEMA EIA Regulations 2014 were amended, and accordingly the activities triggered under GN R. 324, 325 and 327 are applicable to the EA application.

A Scoping and EIA process is reserved for activities which have the potential to result in significant impacts which are complex to assess. Scoping and EIA accordingly provides a mechanism for the comprehensive assessment of activities that are likely to have more significant environmental impacts.

2.2 NATIONAL WATER ACT (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) aims to protect water resources, through:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be
- A watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS. For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998):

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

Wetlands are generally characterised by one or more of the following attributes (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

2.3 GENERAL NOTICE (GN) 704 AS PUBLISHED IN THE GOVERNMENT GAZETTE 20119 OF 1999 AS IT RELATES TO THE NWA, 1998 (ACT 36 OF 1998)

GN704 regulations are designed to protect water resources from mining and associated activities and stipulate, *inter alia*, the following:

- The perimeter of opencast mining pits should be located outside of the 1:50 year flood line or further than a horizontal distance of 100 m from any watercourse, whichever is the greatest.
- No residue deposit, dam, reservoir together with any associated structure or any other facility should be located within 100 m or the 1:100 year flood line of any watercourse.

- Dirty water potentially contaminated by mining activities should be separated from clean water and prevented from entering water resources through the design and implementation of a storm water management system that ultimately diverts dirty water into a pollution control dam.

3 PROJECT AREA & AFFECTED CATCHMENT

The mining right falls within quaternary catchments B11A and B11B, which forms the uppermost catchment of the Olifants River (Figure 1). Other main rivers in the catchment include the Leeufonteinspruit (which bisects the western block of the mining right application), Joubertsvleispruit and the Viskuile River.

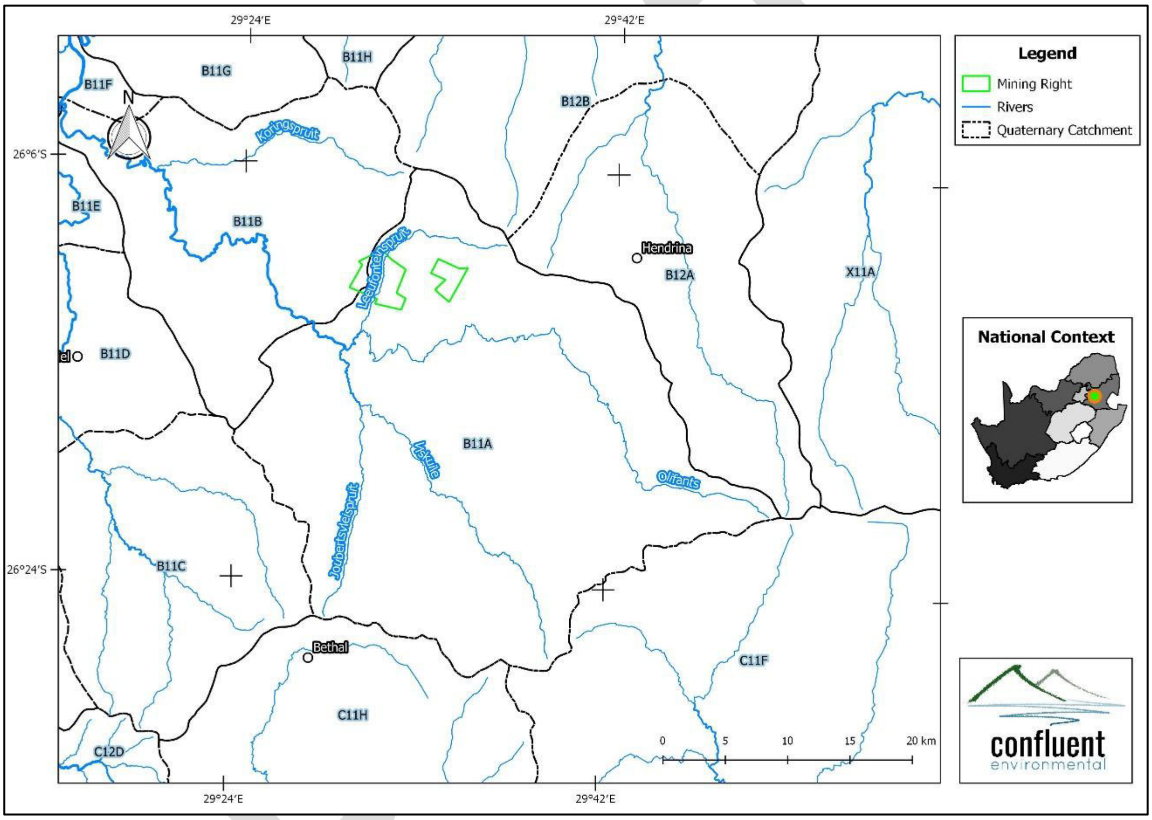

Figure 1: Map illustrating the location of the mining right application.

The mining right falls within the Steve Tshwete Local Municipality located in the Nkangala District Municipality and in the Govan Mbeki Local Municipality located in the Gert Sibande District Municipality, Mpumalanga Province. The mining right application will include Portions 1, 2 and the remaining extent of the Farm Dunbar 189 IS, Portion 1 of the Farm Middelkraal 50 IS and Portion 6 of the Farm Halfgewonnen 190 IS (Figure 2). The study area is located approximately 4.1 km south of Meerlus, 8.93 km southeast of Komati and 13.76 km west of Hendrina. The R35 is located west, R542 is located north and the R38 is located south-east of the study area.

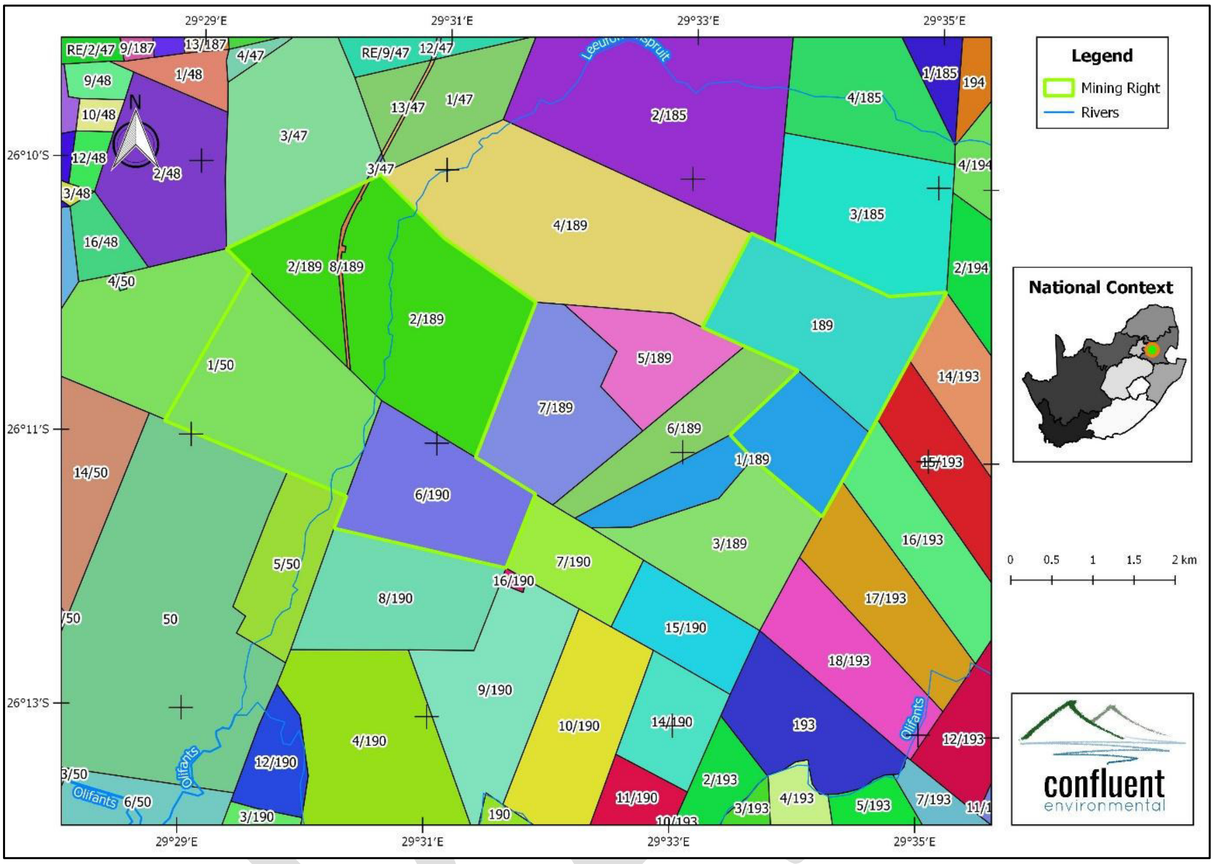

Figure 2: Properties included in the proposed Dunbar coal mine.

4 DEVELOPMENT PLANS

The generally low strip ratios and wide surface area of the project area makes it ideal for the opencast truck and shovel mining method. Also, the mining method applicability is driven by technical applicability, economic viability, safety, equipment and infrastructure.

The mining method comprised of the following main mining activities for both waste and coal:

- Topsoil and soft overburden removal
- Drilling of hard overburden material
- Charging and Blasting
- Loading and Hauling
- Tipping or Dumping.

The operational phase, known as steady-state, will commence after the completion of the boxcut. A conventional strip mining [roll-over] method will be employed. Material from the boxcut phase will be stored per overburden classification, with the bulk of the material placed in a position alongside the final strip, to facilitate filling of the final void. Steady-state mining includes the following processes and equipment.

4.1 CONSTRUCTION PHASE

The construction phase will commence immediately upon granting of a mining right and will include the following items and expected timeframes:

- Preparation of Access Roads (3 Weeks)
- Construction of contractor's yard (1 Week)
- Workshop Construction (3 Weeks)
- Fencing and trenching of Mining Area (4 Weeks)
- Construction of Security (Boom Gates, Security house) (4 Weeks)
- Installation of Weighbridge (3 Weeks)
- Construction of Ablutions (5 Weeks)
- Construction of Diesel bunds and Installation of Tanks (2 Weeks)
- Construction of Mine haul roads (4 Weeks)
- Development of trenches and pollution control facilities (8 Weeks)
- Setting up crushing, screening and washing plant (8 weeks)
- Boxcut development (9 Weeks)

4.2 OPERATIONAL PHASE

The volumes in the LOM production schedule are expected to include (Figure 3):

- Topsoil -Thickness of the topsoil is assumed to be 1.0m. Loading and hauling to topsoil stockpile by truck and shovel.
- Soft overburden - Loading and hauling to waste stockpile or in-pit backfill by truck and shovel.
- Hard overburden - This material lies just below the weathered material and above the coal seam and will require drilling and blasting. Loading and hauling to waste stockpile or in-pit backfill by truck and shovel.
- The coal seams are expected to be drilled and blasted. Loading and hauling to run-of-mine (ROM) Tip by truck and shovel.

The size and scale of the open-pit mine entails that small and conventional truck and shovel mining equipment is used to mine both waste material and coal.

The following equipment was selected for this study:

- 120t Backhoe hydraulic excavators on coal and overburden material
- Articulated dump trucks ("ADT").

Hauler selection is based on the optimal fit and number of passes with excavators and loaders with standardization if appropriate.

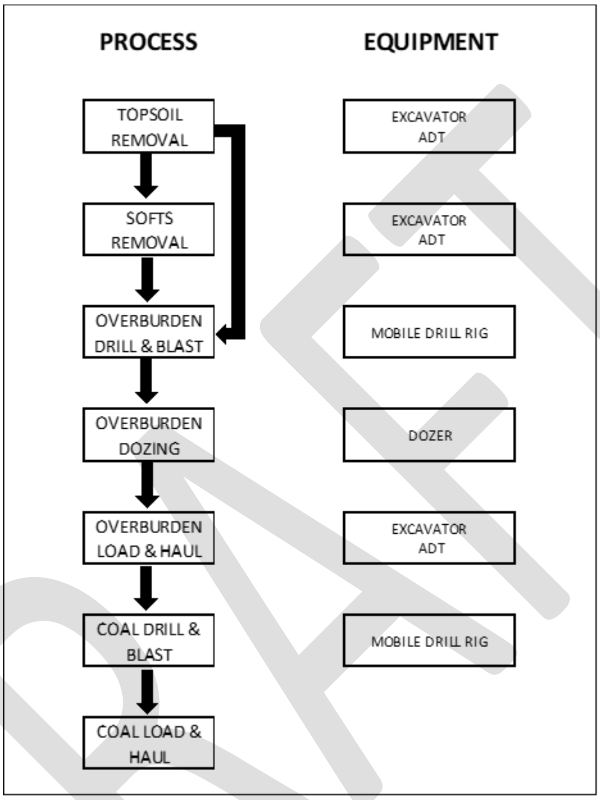

Figure 3: Coal Mining Sequence

To conduct the above-mentioned process the planned mining equipment to be utilized is as follows:

- Contractor 1: (mining – equipment per team)
- 2 x CAT Bulldozer
- 3 x Bell Hydraulic Excavators
- 12 x Bell B40 Articulated 6X6 Dump trucks
- 1 x CAT 140 Motor Grader
- 1 x 10 000 litre Water Bowser
- 1 x 4 000 litre Diesel Bowser
- 2 x Mobile Percussion Drill Rig
- 4 x Service Truck
- Support equipment (transport / material handling – Diesel)

- Contractor 4 (beneficiation / crushing)

The above equipment will be supplied by the mining contractor and the costing thereof will be included in the contractor's unit rates.

High level description of the processing plant

The actual operational time frame is calculated from the date of granting of a mining right. The operational period has been subdivided into a construction and implementation phase and a production phase.

The development plans described below are as per the latest version (Revision 5 dated 2 June 2018) of the Mining Works Programme compiled and provided by the applicant.

4.3 REHABILITATION PHASE

Rehabilitation of the opencast mining area will be done concurrently with the opencast mining according to a stated mining sequence. Materials will be placed back into the void in the former strata graphical sequence i.e. topsoil on the surface, subsoil directly below the topsoil and all hard material (sandstone and shale) in the bottom of the void. The existing surface drainage pattern will remain unchanged and the total disturbed area will be free draining. On completion of surface reinstatement, the area will be re-vegetated with suitable pasture grass species.

4.4 ACTIVITY INFRASTRUCTURE DESCRIPTION

- Access & Haul roads (with necessary security) including the upgrading of the access point to mining area;
- Contractor's Yard with septic/chemical ablution facilities;
- Offices;
- Weighbridge, workshop and stores (with septic/chemical ablution facilities);
- Rail Siding (possible future expansion);
- Diesel facilities and a hardstand;
- Power and Water;
- Boxcut;
- Stockpiles (topsoil, overburden, subsoil/softs, ROM);
- Crushing & screening facility; and
- Surface water management measures (stormwater diversion berms and trenches; pollution control dams etc).

The preliminary mining layout including infrastructure and the opencast pits is indicated in Figure 4 below. This is a preliminary layout and will likely change as specialist investigations are completed.

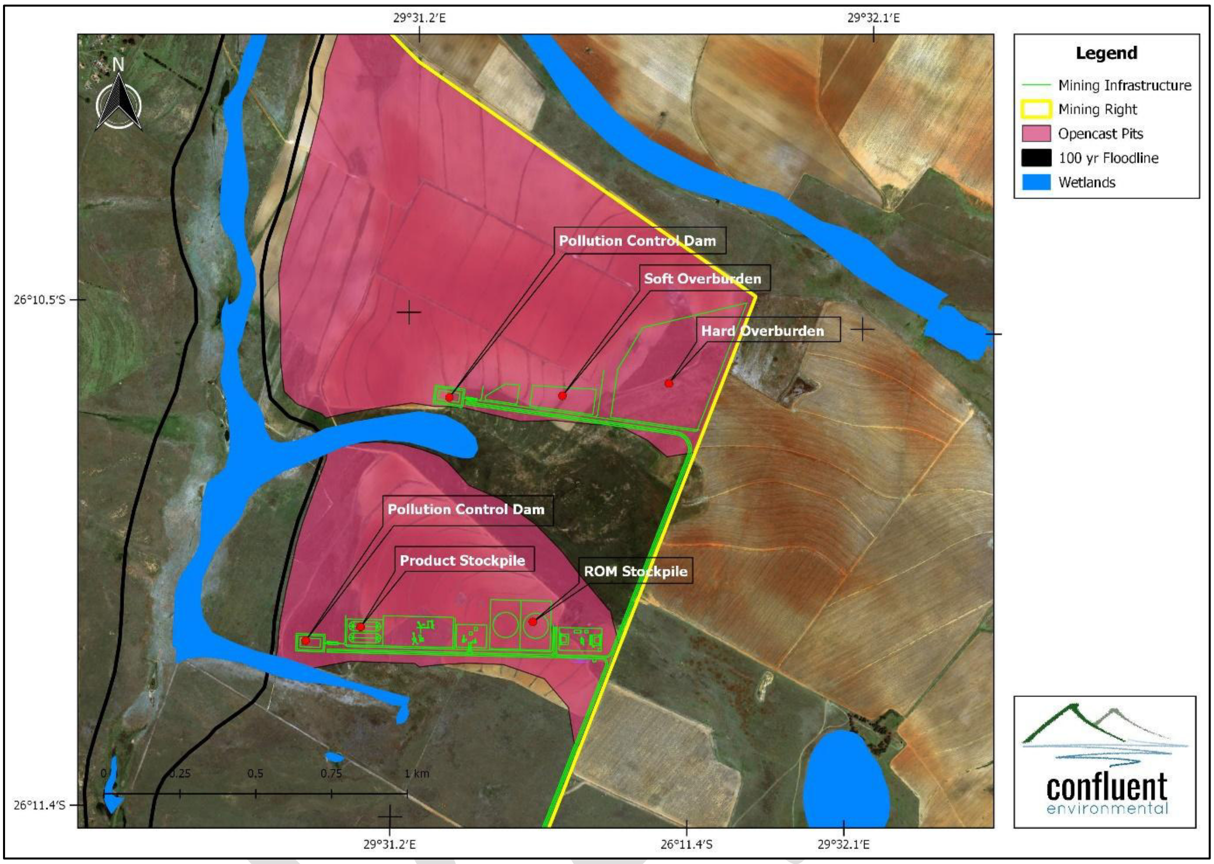

Figure 4: Mining infrastructure associated with the proposed Dunbar Coal Mine.

4.5 STORMWATER MANAGEMENT PLAN

A complete storm water management plan will be included in the final design of the Dunbar Coal Mine layout. The plan must meet the requirements of GN704 and ensure that dirty water potentially contaminated by mining activities must be separated from clean water (e.g. through construction of berms) and prevented from entering water resources through the design and implementation of a storm water management system (e.g. canals) that ultimately diverts dirty water into a pollution control dam.

4.6 FLOODLINES

Floodlines were determined by Nurizon Consulting (Pty) Ltd. The proposed opencast pits are both located outside of the 100 and 50 year floodlines (Figure 5).

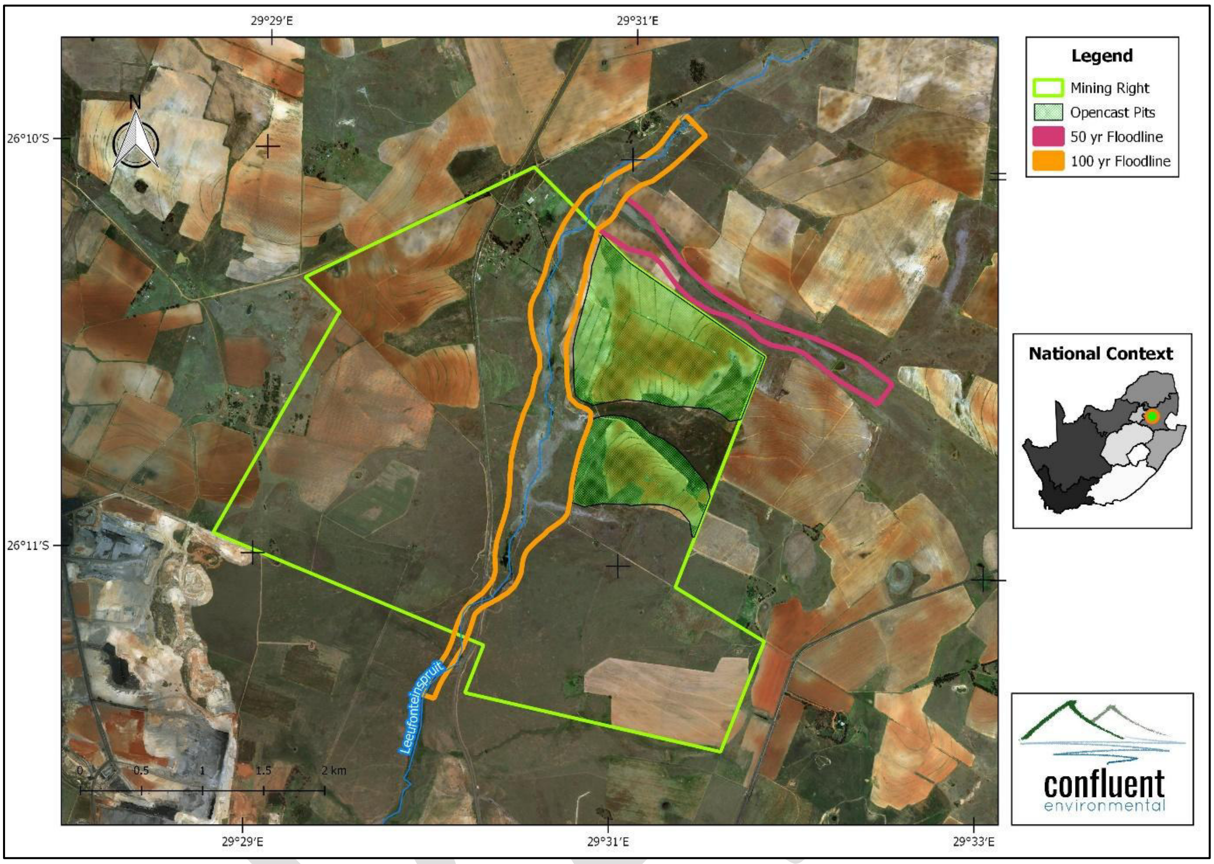

Figure 5: 100 and 50 year floodlines for the proposed Dunbar Coal Mine.

5 METHODS

The approach to this assessment comprised of a combined desktop and field-based assessment of potentially affected watercourses. The site visit was conducted on the 10th of July 2019, with the objective of identifying and classifying aquatic resources, characterizing surface water quality and determining the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of potentially affected water resources. Based on this field assessment the impacts associated with the proposed development on surface water and aquatic ecosystem health (rivers and wetlands) were assessed.

5.1 DESKTOP REVIEW

A variety of sources were consulted in order to gain a broad overview of the quantity and quality of surface water resources as well as the associated PES. The approach to the desktop review included, *inter alia*, the following:

- Review of all layout or planning information relevant to the development (including the construction and operational phases);
- Consultation with the relevant authorities, as required, to determine the full scope of freshwater specialist work required by relevant permit/authorisation/licensing processes;
- Desktop identification of any watercourses that may be affected by the proposed development;
- Assessment of all watercourses from the perspective of provincial and regional systematic biodiversity plans;
- Examination of existing maps of the area including historical images;
- Review of existing databases for land use, climatic, water resource and aquatic ecosystem health data; and
- Compilation of sensitivity maps to inform concept footprints and layouts depicting affected and potentially affected watercourses.

5.2 SURFACE WATER ASSESSMENT

5.2.1 Water Quality

Two water quality sampling sites were identified (Table 1 and Figure 6). These were located approximately upstream and dowsntream of the proposed mining activities. Samples were collected in 1 litre plastic sampling bottles and were placed on ice until delivery to the analytical laboratory. Water quality parameters were analysed and quantified by Aquatico Scientific using accredited methods. In addition, *in-situ* water quality measurements (temperature, pH, electrical conductivity and dissolved oxygen) were taken using a handheld multiparameter water quality meter (Hanna HI98914).

Table 1: Location and description of water quality sampling sites

	Latitude	Longitude	Description
DB_1	-26.316761°	28.582839°	Upstream of proposed mining activities.
DB_2	-26.314045°	28.548779°	Downstream of proposed mining activities.

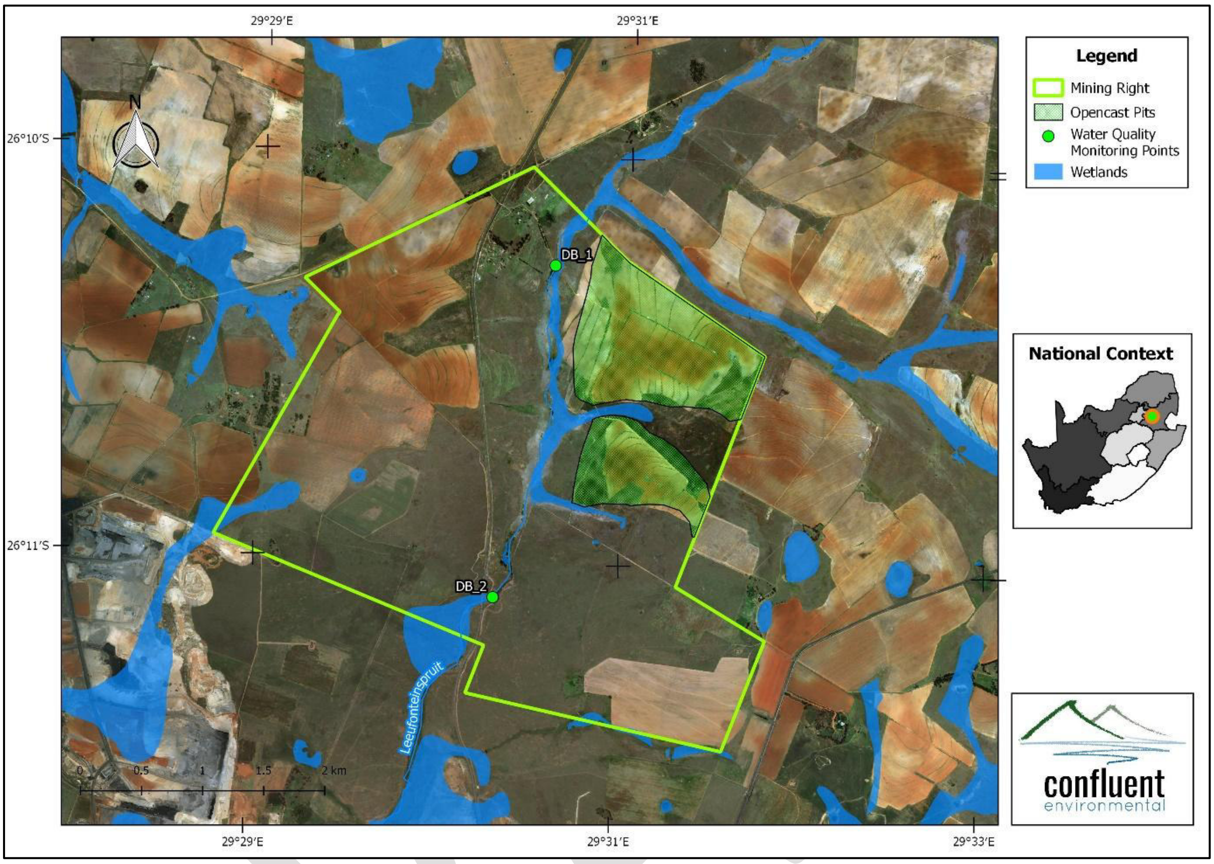

Figure 6: Map illustrating the location of water quality sampling points in relation to proposed mining activities.

5.3 WETLAND ASSESSMENT

5.3.1 Desktop Analysis

The wetland assessment involved a preliminary desktop analysis to identify the possible location of wetlands and important land use activities that may be potentially impacting the wetlands. The desktop analysis was undertaken using 2014 aerial photography for the area (Chief Directorate: National Geo-spatial Information) and was supplemented by the most recent and historical Google Earth imagery. In addition, historical orthophotos were also interrogated to assess changes to identified wetlands over time.

5.3.2 Site Visit

A site visit was conducted to verify the locations of identified wetlands and describe existing onsite impacts, which were mapped using a hand-held GPS device. All wetlands occurring within the project area were categorised into discrete hydrogeomorphic units (HGMs) based on their geomorphic characteristics, source of water and pattern of water flow through the wetland unit. HGMs were classified according to Ollis et al. (2013). The outer edge of wetlands occurring within and adjacent to the footprint of the proposed mine were delineated according to the following four indicators (DWAF, 2005):

- The presence of wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation such as grey horizons, mottling streaks, hard pans, organic matter depositions, iron and manganese concretion resulting from prolonged saturation (soil indicator);
- The presence of water loving plants (hydrophytes) (vegetation indicator);
- A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil; and
- Topographical location of the wetland in relation to the surrounding landscape (terrain indicator).

The desktop analysis, in combination with vegetation and terrain indicators were primarily used to delineate wetlands in the project area and were verified through inspection of soil cores obtained through use of a hand-held soil auger.

5.3.3 Present Ecological State

Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2008) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall condition of the wetland on a scale from 1-10. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 2 below.

Table 2: Wetland Present Ecological State categories and impact descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	1 – 1.9
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2 – 3.9
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	4 – 5.9
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	6 – 7.9
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	8 - 10

5.3.4 Ecological Importance and Sensitivity

The ecological importance of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales (Duthie, 1999). Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Duthie, 1999). The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

The revised method for the determination of the EIS of a wetland considers the three following ecological aspects (Rountree et al., 2013):

Ecological importance and sensitivity

- Biodiversity support including rare species and feeding/breeding/migration;
- Protection status, size and rarity in the landscape context;
- Sensitivity of the wetland to floods, droughts and water quality fluctuations.

Hydro-functional importance

- Flood attenuation;
- Streamflow regulation;
- Water quality enhance through sediment trapping and nutrient assimilation;
- Carbon storage

Direct human benefits

- Water for human use and harvestable resources;
- Cultivated foods;
- Cultural heritage;
- Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system (Table 3).

Table 3: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended

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

5.4 BUFFER ZONE DETERMINATION

Buffer zones have been defined as a strip of land with a use, function or zoning specifically designed to act as barriers between human activities and sensitive water resources with the aim of protecting these water resources them from adverse negative impacts. Appropriate buffers were estimated based on buffer zone guidelines developed by Macfarlane and Bredin (2017). These guidelines estimate required buffer zone widths based on a combination of input parameters which include, inter alia, the nature of the activity and associated impacts, basic climatic and soil conditions, the PES and EIS of potentially affected wetlands and the implementation of appropriate mitigation measures. For the purposes of sensitivity mapping, the implementation of appropriate mitigation measures has been considered in the determination of buffer zone widths.

6 ASSUMPTIONS & LIMITATIONS

- The field assessment was undertaken during the dry season, which is not the best time to observe vegetative indicators of wetland habitat. Wetland soil indicators were therefore the primary means of delineation.
- The field assessment was restricted to those watercourses that are likely to be impacted by mining activities, which include the opencast pits and associated infrastructure;
- The accuracy of wetland delineations was based primarily on the recording of onsite wetland terrain, vegetation and soil indicators using a GPS. GPS accuracy will therefore influence the accuracy of the mapped sampling points and the water resource boundaries and an error of 1-5m

can be expected. All wetland indicators were recorded using a Garmin MontanaTM Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing;

- All vegetation information recorded was based on the onsite observations of the author and no formal vegetation sampling was undertaken. Furthermore, the vegetation information provided only gives an indication of the dominant and/or indicator aquatic species and only provides a general indication of the composition of the vegetation communities;
- Although every effort was made to correctly identify the plant species encountered onsite, the author is not a botanist and experience in plant identification is limited to facultative wetland and obligate wetland plants. Therefore, it is possible that some plants may have been overlooked and other may have been incorrectly identified, particularly dryland plant species;
- While fish species are likely to occur within the main reach of the Leeufonteinspruit, these would have been restricted to the isolated in-stream dams occurring along the length of the river which were not sampled as part of this assessment. No fish species of conservation concern are expected to occur within the Leeufonteinspruit and those that are expected to occur, are relatively tolerant to modifications in flow and water quality. No wetland fauna sampling or faunal searches were conducted and the assessment of wetlands was purely habitat focussed;
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked. Similarly, sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified; and
- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. An effort has been made to substantiate all claims where applicable and necessary.

7 DESKTOP REVIEW

7.1 WATER RESOURCE CLASSIFICATION

It is recognised that some water resources, by virtue of their ecological importance, may require a high level of protection, whereas other water resources may serve the country's developmental and economic growth needs. The Water Resource Classification System is a step-wise process whereby water resources are categorized according to specific classes that represent a management vision of a particular catchment by taking into account the current state of the water resource and defining the ecological, social and economic aspects that are dependent on the resource.

The management class for the broader Upper Olifants River catchment has been classified as Class III which is regarded as a water resource that is heavily utilised, and the overall ecological condition of the resource is significantly altered from its pre-development condition. Based on this classification the Resource Quality Objectives (RQOs) for the Upper Olifants River catchment have been gazetted and set according to Table 4 (Government Notice No. 619 of 20 July 2015). RQOs establish clear goals relating to the quality of the relevant water resources and are a numerical or descriptive statement of the conditions which should be met in the receiving water resource, in terms of resource quality, in order to ensure that the water resource is protected. Generally speaking, the RQOs associated with all resource quality descriptors are relatively high, which is indicative of the Management Class set for the catchment. In terms of habitat and biota the ecological category must be maintained at a D (Largely Modified).

Table 4: Resource Quality Objectives for the Upper Olifants Catchment

Resource Quality Descriptor	RQO	Indicator	Numerical Limit		
Water Quantity	Low flows should be improved in order to maintain the river habitat for the ecosystem and ecotourism.	EWR maintenance low and drought flows: Olifants EWR1 in B11J VMAR = $184.5x10^6m^3$ PES-D category		Maintenance Low Flows (m3/s) (Percentile)	Drought Flows (m3/s) (Percentile)
			Oct	0.150 (99)	0.161 (99)
			Nov	0.272 (90)	0.185 (99)
			Dec	0.360 (80)	0.146 (99)
			Jan	0.447 (99)	0.675 (80)
			Feb	0.549 (99)	0.692 (90)
			Mar	0.442 (80)	0.261 (90)
			Apr	0.361 (80)	0.204 (90)
			May	0.249 (80)	0.164 (90)
			Jun	0.171 (80)	0.127 (99)
			Jul	0.130 (99)	0.131 (99)
			Aug	0.103 (80)	0.153 (70)
			Oct	0.150 (99)	0.161 (99)
Water Quality: *Nutrients*	Nutrient concentrations must be maintained in the river at mesotrophic or better levels	Nitrate (NO_3) & Nitrite (NO_2)	≤ 4.00 mg/L N		
		Phosphate	≤ 0.125 mg/L P		
		Total Ammonia	≤ 0.100 mg/L N		
Water Quality: *Salts*	Salt concentrations need to be maintained at levels where they do not render the ecosystem unsustainable.	Sulphate	≤ 500 mg/L		
		Electrical conductivity	≤ 111 mS/m		
Water Quality: *Toxicants*	Maintain the levels of toxic contaminants at concentrations acceptable for the ecosystem and users	F	≤ 3.0 mg/L		
		Al	≤ 0.150 mg/L		
		As	≤ 0.130 mg/L		
		Cd	≤ 5 µg/L		
		Cr(VI)	≤ 200 µg/L		

Resource Quality Descriptor	RQO	Indicator	Numerical Limit
	(B).	Cu	≤ 8.0 µg/L
		Hg	≤ 1.7 µg/L
		Mn	≤ 1.3 mg/L
		Pb	≤ 13.0 µg/L
		Se	≤ 0.03 mg/L
		Zn	≤ 36 µg/L
		Chlorine	≤ 5.0 µg/L
		Endosulfan	≤ 0.2 µg/L
		Atrazine	≤ 100.0 µg/L
Habitat & Biota	• Instream habitat must be in a largely modified or better condition to support the ecosystem and for ecotourism users. • Instream biota must be in a largely modified or better conditions and at sustainable levels. • Low and high flows must be suitable to maintain the river habitat for ecosystem condition and ecotourism.		• Instream Habitat Integrity category ≥ D (≥ 42) • Fish ecological category: ≥ D (≥ 42) • Macro -invertebrate ecological category: ≥ D (≥ 42) • Instream Ecostatus category ≥ D (≥ 42) • Hydrological category ≥ D (≥ 42) • Water Quality category: ≥ D (≥ 42)

7.2 RAINFALL, RUNOFF AND EVAPORATION

7.2.1 Rainfall and Evaporation

The proposed Dunbar Coal Mine is situated on the Mpumalanga Highveld which experiences warm summers and cold winters. The Highveld is in the summer rainfall region of southern Africa, with the majority of rain falling from October to March. The climate is temperate with hot summers and dry cold winters. Summer precipitation occurs in the form of mist, drizzle, hail and thunderstorms. Based on available weather data the mean annual precipitation for the catchment is 617 mm, with mean annual evaporation far exceeding rainfall (Table 5).

Table 5: Mean monthly precipitation and evaporation for the B11A quaternary catchment (Schulze et al., 2008)

Month	Mean Rainfall (mm)	A-Pan Evaporation (mm)
January	107	203
February	83	169
March	67	170
April	35	136
May	16	121
June	4	100
July	5	112
August	7	153
September	27	185
October	64	206
November	105	202
December	100	215
Mean Annual Statistics	**617**	**1976**

7.2.2 Mean Annual Runoff

Mean annual runoff (MAR) for the B11A quaternary catchment is 38.9 mm (Bailey and Pitman, 2016) which is approximately 6.3 % of the MAP. Given a catchment area of 945 km^2, this corresponds to a MAR of 36.76 million cubic meters (Mm^3) (Table 6).

According to GN704 requirements pertaining to mine water use, all runoff emanating from dirty water areas such as mine infrastructures, operational areas and ROM stockpiles need to be contained within these areas, so as not to mix with the downstream clean water. The total area of the mine layout, including the opencast pits, is 1.7 km^2. Considering that a roll-over strip mining method will be employed, the excavated area of the pit at any given point in time will be considerably less that 1.7 km^2 and will therefore have a minimal impact on loss of surface runoff. According to the Stormwater Management Plan, the total infrastructure area is approximately 0.33 km^2 which is 0.03 % of the total area of the B11A quaternary catchment. Containment of water within a dirty water system will therefore result in an approximate reduction of 0.02 Mm^3 to MAR (assuming that MAR is evenly distributed across the entire catchment area).

The catchment area for each wetland was delineated using a DEM that covers the entire B11A catchment area (Figure 7). The permanent infrastructure area for which dirty water will be diverted into the stormwater management network is less than 0.5 km^2 for each wetland and represents negligible losses to the channelled valley-bottom wetland (0.5 %) and up to 5 and 10 % for the seep and unchannelled valley-bottom wetland, respectively (Table 6).

Table 6: Summary of the surface water attributes of the B11A quaternary catchment

Catchment Area	Total Area (km^2)	MAR (Mm^3)	Mining Infrastructure Area (km^2)	Decrease in MAR (%)	Loss in MAR (Mm^3)
B11A	945	36.76	0.33	0.035	0.013
Channelled Valley-Bottom Wetland	70	2.72	0.33	0.5	0.013
Unchannelled Valley-Bottom Wetland	2.7	0.11	0.26	10	0.011
Seep Wetland	1.3	0.05	0.065	5	0.002

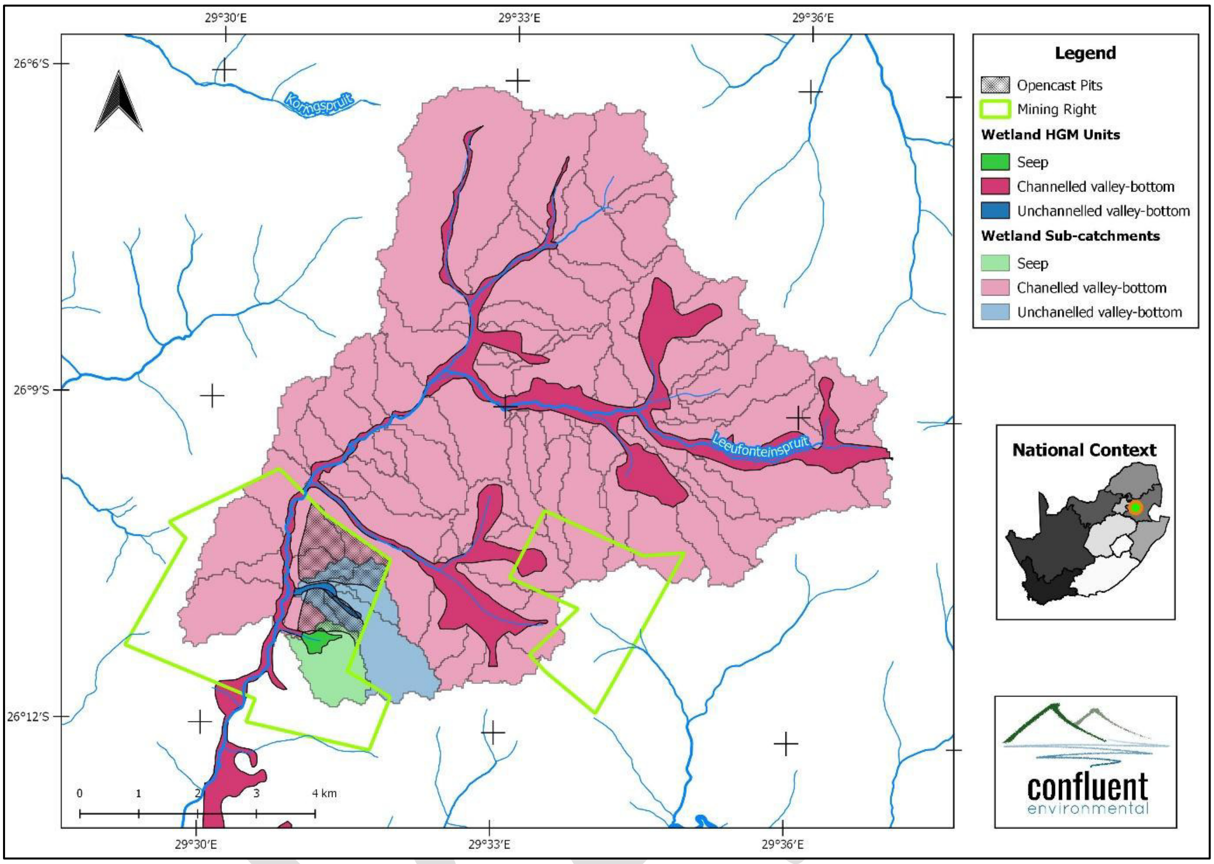

Figure 7: Delineated sub-catchments of the Leeufonteinspruit

7.2.3 Topography description

The topography of the general area consists of low to moderate relief. The opencast pits are situated on terrain that slopes gently (gradient of approximately 2 %) towards to channelled valley-bottom wetland with other wetlands occurring in the valleys adjacent to the pits (Figure 8).

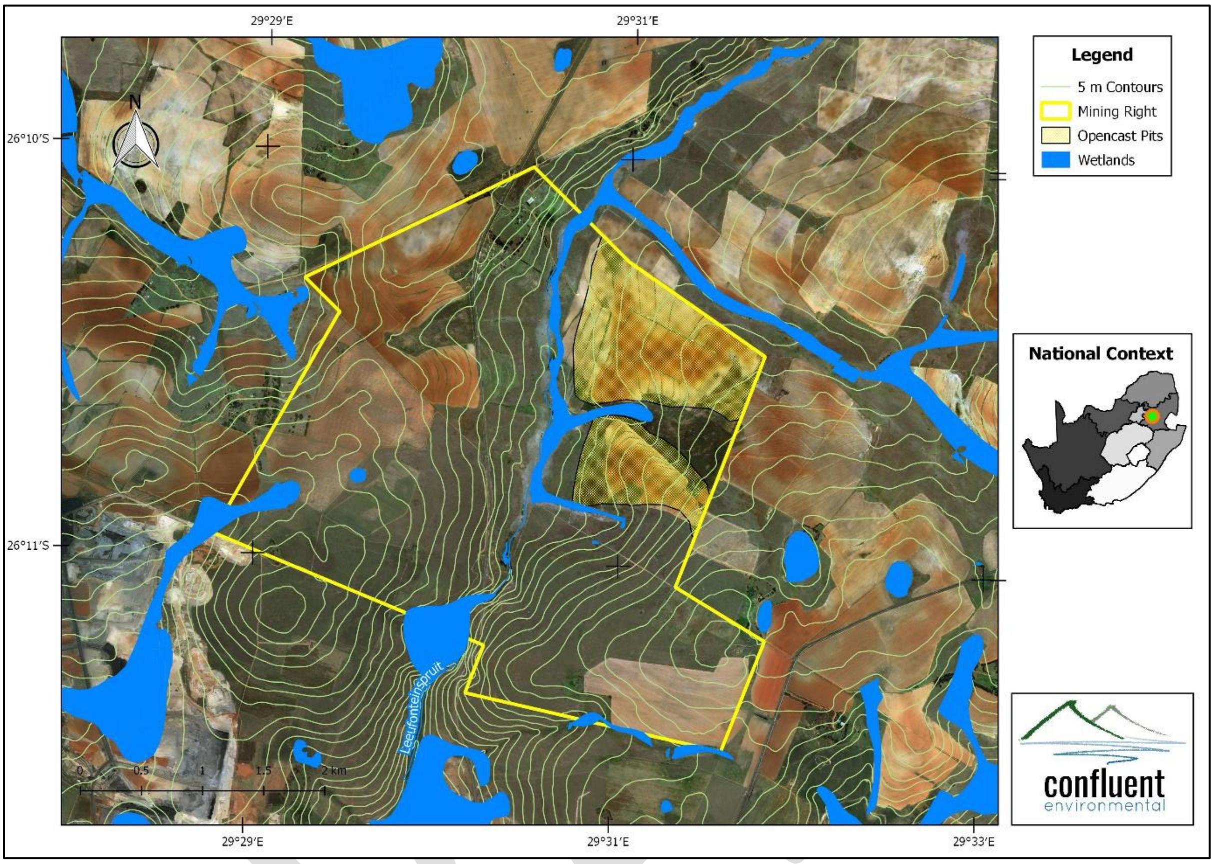

Figure 8: Map illustrating the topography associated with the proposed Dunbar Coal Mine.

7.3 AQUATIC ECOSYSTEMS

7.3.1 NFEPA

The National Freshwater Ecosystem Priority Areas (NFEPA) database (Nel et al., 2011) forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel et al., 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's (NEM:BA) (Act 10 of 2004) biodiversity goals, informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel et al., 2011).

The proposed Dunbar Coal Mine falls within sub-quaternary catchment (SQC) 1331, which has not been categorized as a National Freshwater Ecosystem Priority Area (NFEPA) (Figure 9). Additionally, none of the wetlands that are indicated to occur within the SQC have been identified as wetland FEPAs.

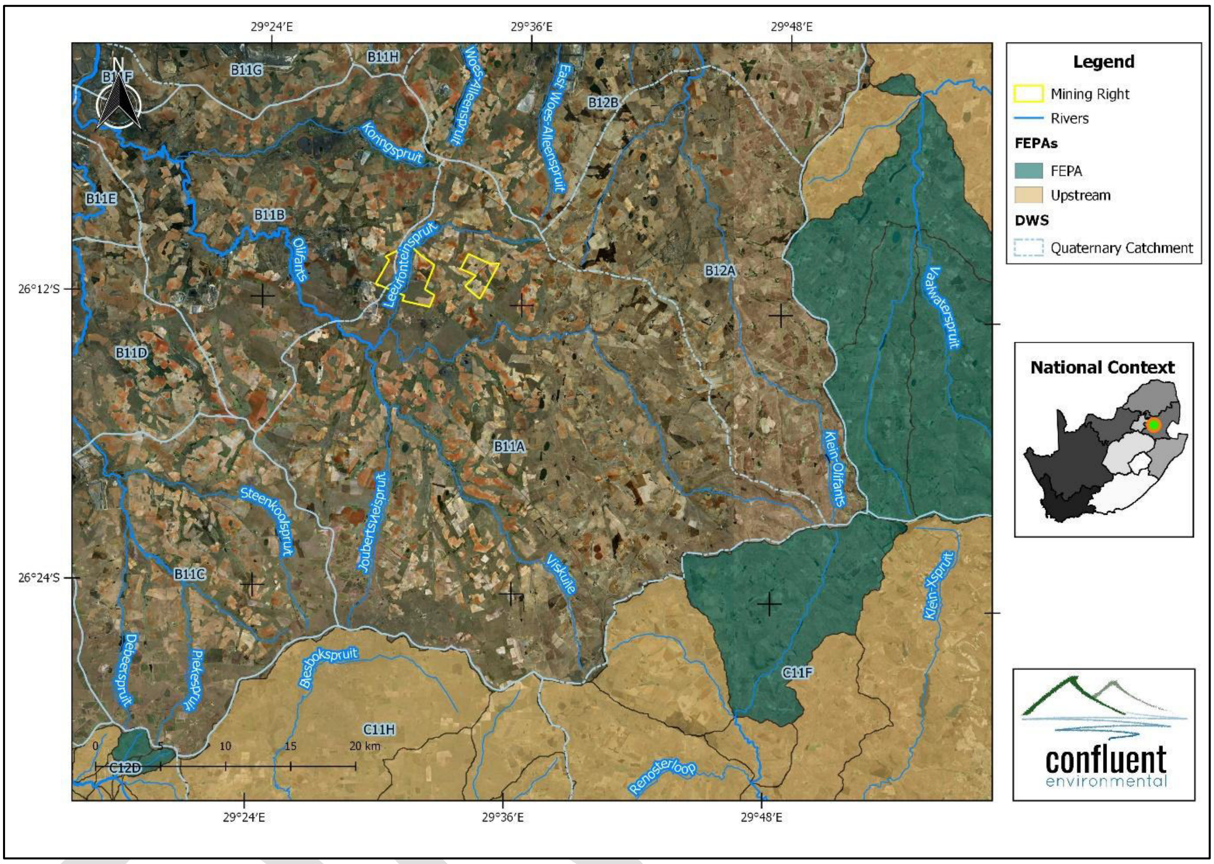

Figure 9: NFEPA categories for sub-quaternary reaches of the upper Olifants River.

7.3.2 Mpumalanga Biodiversity Sector Plan

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool with land-use guidelines that forms part of a broader set of national biodiversity planning tools and initiatives that are provided for in national legislation and policy. It comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines that make the most recent and best quality biodiversity information available for use in land-use and development planning, environmental assessment and regulation, and natural resource management.

Classification of the Biodiversity Classification categories in the study area is as follows:

- CBA: Irreplaceable – sites where no other options exist for meeting targets for biodiversity features
- CBA: Important – best-design sites which represent an efficient configuration of sites to meet targets in an ecologically sustainable way that is least conflicting with other land uses and activities

- ESA: Natural, near-natural, degraded or heavily modified areas required to be maintained in an ecologically functional state to support Critical Biodiversity Areas and/or Protected Areas.

All wetlands that occur adjacent to the proposed mining area have been classified as Ecological Support Areas (ESAs) (Figure 10). Ecological support areas are not essential for meeting freshwater biodiversity targets but play an important role in supporting the ecological functioning of freshwater CBAs. Freshwater ESAs need to be maintained in at least a functional state, supporting the purpose of the ESA. Impacts in the upstream catchment should be mitigated or minimised through application of the land-use guidelines that accompany the CBA map.

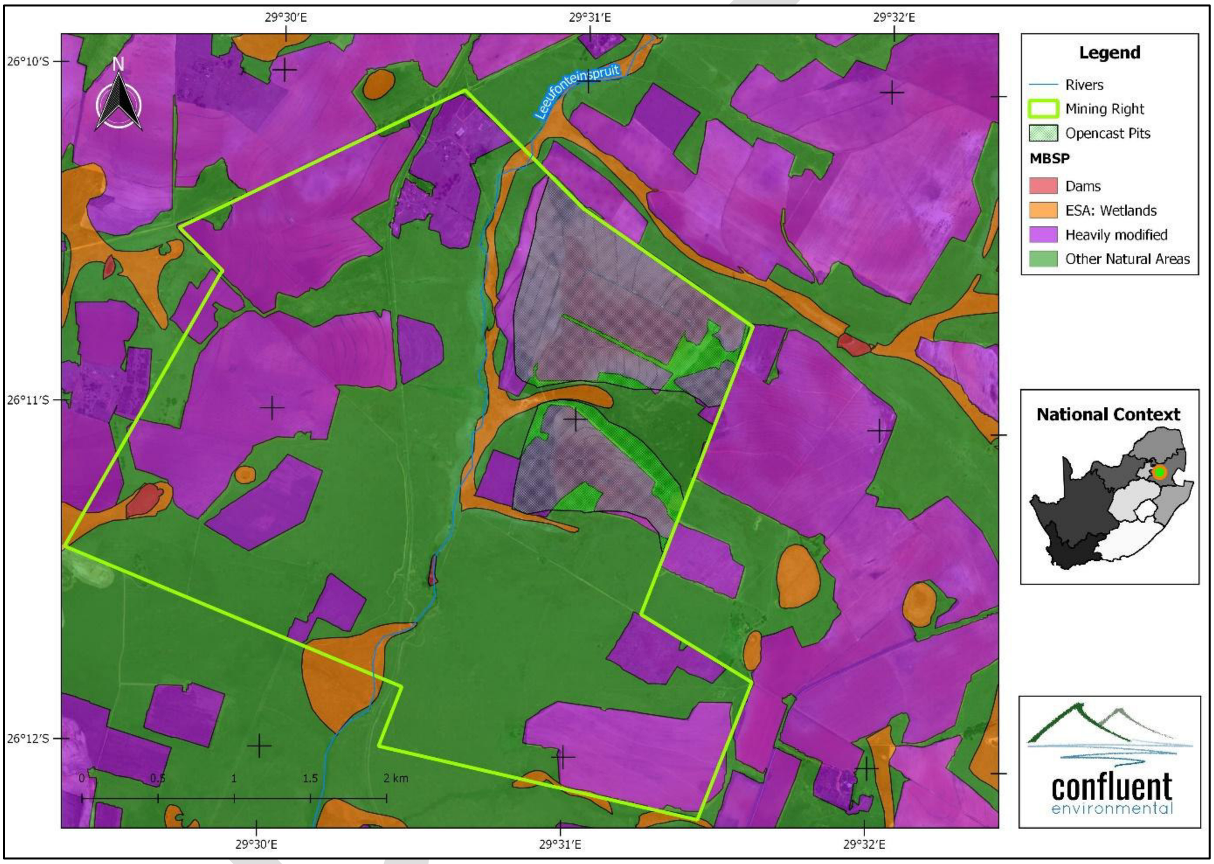

Figure 10: Mpumalanga Biodiversity Sector Plan in relation to the location of water resources potentially affected by the proposed mine development.

7.3.3 Desktop Present Ecological State

According to DWS (2014), habitat, flow, riparian and physico-chemical characteristics of the Leeufonteinspruit have been **Largely Modified** and the desktop Present Ecological State (PES) is **D** (Table 7). The Ecological Importance and Sensitivity of the stream is **Moderate** (Table 7). Six fish species are expected to occur within the river and include *Barbus anoplus, Barbus neefi* (Greenwood, 1962)*, Barbus paludinosus, Clarias gariepinus,* *Pseudocrenilabrus philander* and *Tilapia sparrmanii.* All of these fish species are relatively tolerant to modifications in flow and water quality. Similarly, the expected invertebrate assemblage is also tolerant to flow and water quality modifications (DWS, 2014).

Table 7: Desktop Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the Leeufonteinspruit.

Present Ecological State		Ecological Importance		Ecological Sensitivity	
Seriously Modified (D)		**Moderate (C)**		**Moderate (C)**	
Modification to Instream Habitat Continuity	Large	Fish Species per Sub Quaternary Catchment	6	Sensitivity of Fish to Modification in Physico-chemistry	High
Modification to Riparian/Wetland Zone Continuity	Moderate	Invertebrate Taxa per Sub Quaternary Catchment	42	Sensitivity of Fish to No-Flow	High
Modification to Potential Instream Habitat	Large	Habitat Diversity Class	Low	Sensitivity of Invertebrates to Modification in Physico-chemistry	Very High
Modification to Riparian/Wetland Zone	Small	Instream Migration Link Class	Moderate	Sensitivity of Invertebrates to Velocity	Very High
Potential Flow Modifications	Large	Riparian-Wetland Zone Migration Link	High	Riparian/Wetland/Instream vertebrates (excl Fish) Intolerance to Water Level/Flow Changes	High
Potential Physico-Chemical Modifications	Moderate	Instream Habitat Integrity Class	Moderate	Stream Size Sensitivity to Modified Flow/Water Level Changes	Very High
		Riparian-Wetland Zone Habitat Integrity Class	Very High	Riparian/wetland Vegetation Intolerance to Water Level Changes	High

7.4 SURFACE WATER QUALITY

Interrogation of DWS databases did not yield any data for the Leeufonteinspruit. The assessment of water quality is therefore based on water quality data collected on site (Figure 6). Concentrations of water quality parameters were compared to the RQOs set for the Upper Olifants River catchment (see Table 4). RQOs for all parameters that were analysed are not available. Similarly, there are some parameters for which RQOs have been set that were not included in the analysis performed for this study. In general, none of the analysed parameters exceeded RQOs and there is no indication that water quality is currently impacted by mining activities, which typically results in high TDS concentrations with sulphate comprising the largest proportion of major ions. Concentrations of water quality parameters are slightly lower downstream (at DB_2). Surface water at DB_1 was restricted to isolated pools with no flow through of water which most likely led to the slightly higher concentration of water quality parameters due to evaporation from the pool.

Table 8: Water quality measured at sites upstream and downstream of the proposed Dunbar Coal Mine.

Parameter.	Units	RQOs	DB_1	DB_2
In-situ Water Quality				
Temperature	°C		16.32	19.5
Dissolved Oxygen	mg/ℓ		18.1	15.6
E.C. (mS/m)	mS/m	< 111 mS/m	37.7	25.5
TDS (E.C. * 6.5)	mg/ℓ		188	128
pH			8.13	7.77
MAJOR CATIONS				
Calcium	mg Ca/ℓ		13.3	9.61
Magnesium	mg Mg/ℓ		8.48	6.02
Sodium	mg Na/ℓ		19.3	21
Potassium	mg K/ℓ		11.5	4.25
MAJOR ANIONS				
Chloride	mg Cl/ℓ		21.8	18
Sulphate	mg SO_4/ℓ	< 500 mg/L	33.5	14.9
Alkalinity	mg $CaCO_3$/ℓ		58.2	64.8
NUTRIENTS				
Nitrate + Nitrite (N)	mg N/ℓ	≤4.00 mg/L N	0.225	0.288
Nitrite nitrogen	mg N/ℓ		0.103	0.087
ortho Phosphate	mg PO_4-P/ℓ	<0.125 mg/L P	0.011	<0.005
Total Phosphate	mg P/ℓ		0.016	<0.01
TRACE METALS				
Aluminium	mg Al/ℓ	<0.105 mg/L	0.005	0.002
Iron	mg Fe/ℓ		<0.004	<0.004
Manganese	mg Mn/ℓ	<1.3 mg/L	0.004	0.001

Figure 11: Water quality monitoring points in the Leeufornteinspruit, DB_1 (left) and DB_2 (right).

8 WETLAND ASSESSMENT

The assessment of wetlands relied primarily on hydrological, geomorphological and vegetation characteristics of wetlands occurring in the area. While fish species are likely to occur within the main reach of the Leeufonteinspruit, these would have been restricted to the isolated dams occurring along the length of the river which were not sampled as part of this assessment.

8.1 WETLAND DELINEATION

The potential presence of wetlands was identified through use of desktop resources (e.g. NFEPA Wetlands layer – Nel et al., 2011) and confirmed during the field visit. Several wetlands occur adjacent to the proposed mining area. These wetlands were classified according to Ollis et al. (2013) and essentially comprise a channelled valley-bottom wetland located along the Leeufonteinspruit to the west of the proposed opencast pits, an unchanelled valley-bottom wetland running between the two pits and a hillslope seep wetland located to the south of the southern pit (Table 9). Sub-surface flows are likely to be important sources of water for both the unchannelled valley-bottom and the seep wetland.

Table 9: Classification of wetlands occurring within 500 m of the proposed coal mine

HGM	Level 1	Level 2	Level 3	Level 4	
Site	**System**	**DWS Ecoregion**	**Landscape Unit**	**4A (HGM)**	**4B (Outflow Drainage)**
1	Inland	Mesic Highveld Grassland	Valley floor	Channelled Valley-bottom Wetland	n/a
2	Inland	Mesic Highveld Grassland	Valley floor	Unchannelled Valley-bottom Wetland	n/a
3	Inland	Mesic Highveld Grassland	Slope	Seep	Chanelled Outflow

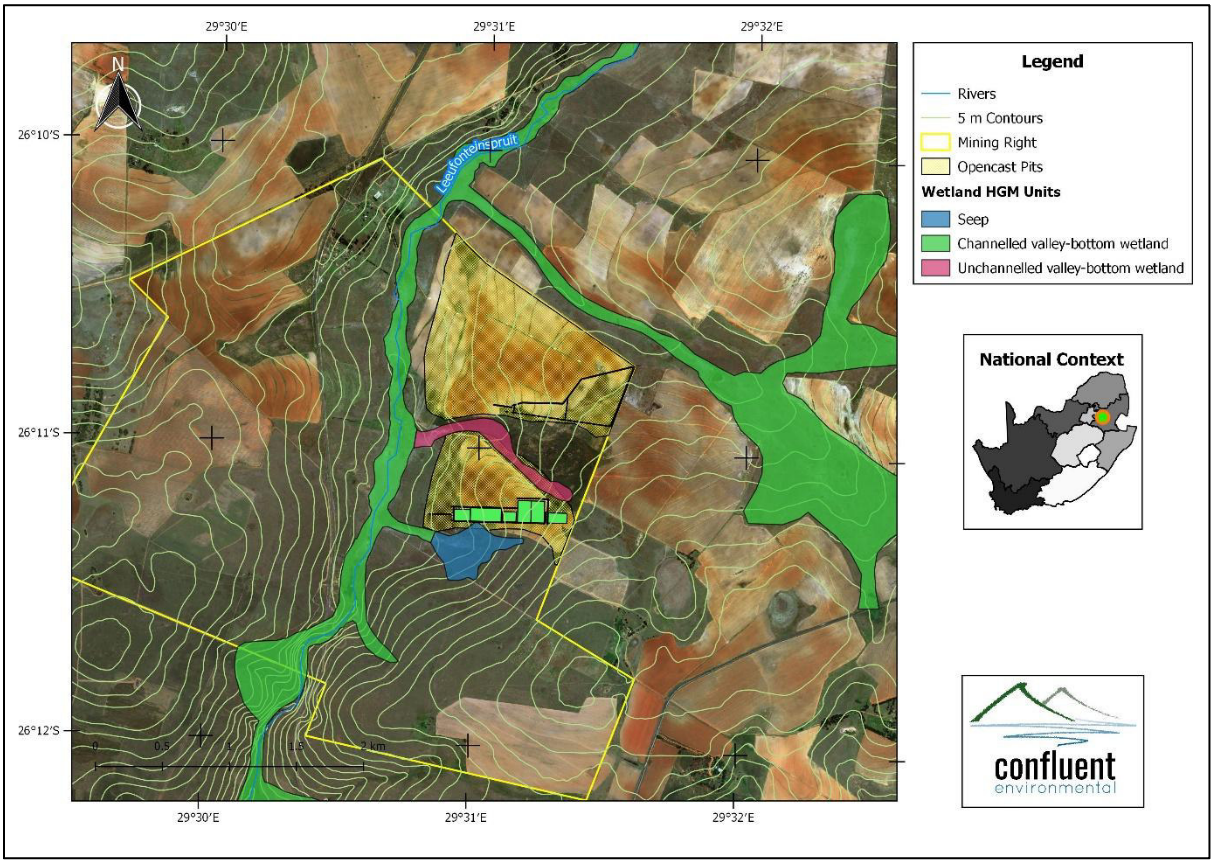

Figure 12: Classification of different wetland HGMs potentially affected by the development of the proposed Dunbar Coal Mine.

The delineation of the wetland HGMs was confirmed based on a combination of terrain, vegetation and soil indicators (Figure 12). This was augmented with current and historical Google Earth imagery and orthophotos.

8.2 PRESENT ECOLOGICAL STATE

Impacts to the hydrology, geomorphology and vegetation of each wetland HGM were used to determine the PES. The PES of each wetland type is summarised in Table 10 and a description of impacts to each wetland type is discussed in the section below.

Table 10: PES scores for different wetland types potentially affected by the development of the proposed Dunbar Coal Mine.

Wetland	Hydrology	Geomorphology	Vegetation	Overall PES
HGM1	E (35 %)	B (86 %)	D (46 %)	D (54 %) – Largely Modified
HGM2	C/D (60 %)	A/B (90 %)	C (73 %)	C (68 %) – Moderately Modified
HGM3	B/C (80 %)	A/B (90 %)	C (73 %)	B/C (81 %) - Moderately Modified

8.2.1 Channelled Valley-Bottom Wetland (HGM1)

The channelled valley-bottom wetland runs along the non-perennial Leeufonteinspruit to the west of the proposed opencast pits (Figure 12). The hydrology of the wetland has been significantly impacted by the presence of several farm dams that are located along the length of the Leeufonteinspruit (Figure 13). These dams capture surface flows and reduce water inputs into downstream areas, reducing the surface area that would normally be saturated. These dams also have the effect of creating localized areas of inundation upstream of the dam wall and causing reduced saturation and more channelized flow paths downstream of the dam. These concentrated flow paths lead to localized areas of erosion and gulley formation. The dams also trap sediments which starves downstream reaches of sediment loads which further contributes to the erosion of the wetland. The surface roughness of the wetland has been largely modified due to grazing by livestock and transformation of natural areas into croplands which has the effect of reducing the ability of the wetland to retain water.

Figure 13: Photographs illustrating wetland vegetation along the channel (left) and one of several dams built within the course of the wetland (right).

8.2.2 Unchannelled Valley-Bottom Wetland

The unchannelled valley-bottom wetland lies in between to the two proposed pits (Figure 12). The main existing impacts are a series of three small dams located towards the lower end of the wetland (Figure 14). These dams create localized areas of inundation upstream of the dams and reduce surface water flows further downstream. Reduction in surface roughness is not as pronounced as in the channelled valley-bottom wetland and water retention is unlikely to be significantly affected. Agricultural croplands have however led to the encroachment of alien invasive weed species around the margins of the wetland (e.g. *Verbena* spp., *Cirsium vulgare, Tagetes minuta*).

Figure 14: Photographs illustrating a landscape view of the unchannelled valley-bottom wetland (left) and one of three dams built along the course of the wetland (right).

8.2.3 Hillslope Seep Wetland

The hillslope seep is bordered by agricultural croplands along its northern perimeter (Figure 12). This disturbance has led to the encroachment of alien invasive weed species along this northern boundary. A small dam has been excavated into the slope to intercept and capture sub-surface and surface flows (Figure 15). The extent of this infilling is limited to a relatively narrow section of the larger wetland area. Two farm roads traverse the wetland to the east (upslope) and west (downslope). The upper road is unlikely to significantly affect the hydrology of the wetland as flows are likely to be sub-surface at this altitude and should therefore not be impeded by the road. Surface flows during high rainfall periods are also unlikely to be impeded by the road. The lower road has resulted in an area of inundation upstream of the road and more channelized flow down slope of the road where the extent of saturation is limited to the lower points in the valley.


Figure 15: Photographs illustrating a landscape view of the seep wetland (left) and the small dam built into the wetland (right).

8.3 ECOLOGICAL IMPORTANCE & SENSITIVITY

The ecological importance of each wetland is moderate from the perspective of biodiversity support and landscape scale (Table 11). The sensitivity of the channelled valley-bottom wetland is high given is sensitivity to changes in floods and low flow conditions. The reduced roughness of the channelled valley-bottom wetland and hydrological modifications have however compromised the ability of the wetland to retain water, trap sediments and assimilate pollutants (Table 12). This capability is however less compromised in the unchannelled valley-bottom and seep wetlands, which due to their high vegetative cover and relatively large size have a relatively high hydro-functional importance. The direct human benefit for all wetland HGMs is low (Table 13).

Table 11. Ecological Importance and Sensitivity importance criteria for wetlands

Ecological Importance and Sensitivity	Channelled Valley-Bottom	Unchannelled Valley-Bottom	Seep
Biodiversity Support			
Presence of Red Data species	**1**- Low likelihood given its hydroperiod	**2**- Moderate possibility	**2** – Possibility of red data species given relative rarity and size of wetland type
Populations of unique species	**1** – No uncommonly large populations of wetland species expected	**1** – No uncommonly large populations of wetland species expected	**2** – Possibility of unique wetland plant species given relative rarity and size of wetland type
Migration/feeding/breeding sites	**2** - Likely to be seasonally important for both aquatic and terrestrial species (wet season).	**1** - Relatively unimportant for both aquatic and terrestrial species (no open water habitats).	**1** - Relatively unimportant for both aquatic and terrestrial species (no open water habitats).
Average	**1.3 (Moderate)**	**1.3 (Moderate)**	**1.7 (Moderate)**
Landscape Scale			
Protection status of wetland	**1** - Not formally protected	**1** - Not formally protected	**1** - Not formally protected
Protection status of vegetation type	**1**-Mesic Highveld Grassland (Least threatened)	**1**-Mesic Highveld Grassland (Least threatened)	**1**-Mesic Highveld Grassland (Least threatened)

Regional context of the ecological integrity	**1** - Ecological integrity is average to low from a regional perspective (PES – D)	**2 –** Ecological integrity is relatively good from a regional perspective (PES – C)	**2 –** Ecological integrity is relatively good from a regional perspective (PES – C)
Size and rarity of the wetland types present	**1** - Medium sized wetland, relatively common throughout the landscape.	**2**- Medium sized wetland, relatively rare throughout the landscape.	**3 –** Large seep wetland. Relatively rare in the landscape
Diversity of habitat types	**3** – Relatively high diversity of habitat types expected during the wet season	**1 –** Relatively uniform habitat type across the wetland	**1 –** Relatively uniform habitat type across the wetland
Average	**1.4 (Moderate)**	**1.4 (Moderate)**	**1.6 (Moderate)**
Sensitivity of Wetland			
Sensitivity to changes in floods	**3** – Channelled valley-bottom wetland and sensitive to changes in floods	**2** – Relatively sensitive to changes in floods	**1** – Low sensitivity to changes in floods
Sensitivity to changes in low flows	**1** – Non-perennial with low sensitivity to low flow	**2** – Moderately sensitive to changes in low flow	**1** – Predominantly fed by sub-surface flows with low sensitivity to changes in low flows (no open water habitats)
Sensitivity to changes in water quality	**2** – Relatively large and non-perennial and moderately tolerant of water quality changes	**1** – Low sensitivity to changes in water quality (no open water habitats)	**1** – Low sensitivity to changes in water quality (no open water habitats)
Average	**2.0 (High)**	**1.7 (Moderate)**	**1.0 (Low)**
Overall Ecological Importance and Sensitivity			
	2.0 (High)	**1.7 (Moderate)**	**1.7 (Moderate)**

Table 12: Hydro-functional importance criteria results for the wetland

Hydro-functional Importance			**Channelled Valley-Bottom**	**Unchannelled Valley-Bottom**	**Seep**
Regulating & supporting benefits	Flood attenuation		**2** - Moderate potential to attenuate floods	**3** - Good potential to attenuate floods	**2** - Moderate potential to attenuate floods
	Streamflow regulation		**2** - Non-perennial system	**1** - Non-perennial system	**1** - Moderate potential to attenuate floods
	Water quality enhancement	Sediment trapping	**2** – Reduced surface roughness provides moderate retention of sediments.	**3** – Good surface roughness provides good retention of sediments.	**3** – Good surface roughness provides good retention of sediments.
		Phosphate assimilation	**2** - Reduced surface roughness provides moderate assimilation of phosphates	**3** – Good surface roughness provides enhanced assimilation of phosphates.	**3** – Good surface roughness provides enhanced assimilation of phosphates.
		Nitrate assimilation	**2** - Reduced surface roughness provides moderate retention of nitrates	**3** – Good surface roughness provides enhanced assimilation of nitrates.	**3** – Good surface roughness provides enhanced assimilation of nitrates.
		Toxicant assimilation	**2** - Reduced surface roughness provides moderate retention of toxicants	**3** – Good surface roughness provides enhanced assimilation of toxicants.	**3** – Good surface roughness provides enhanced assimilation of toxicants.
		Erosion control	**1** - Extended retention time reduces erosive power of flow	**3** – Good surface roughness provides enhanced assimilation of toxicants.	**3** – Good surface roughness provides enhanced assimilation of toxicants.
	Carbon storage		**1** - Minor trapping of soil organic matter	**2** - Moderate trapping of soil organic matter	**2** - Moderate trapping of soil organic matter

HYDRO-FUNCTIONAL IMPORTANCE	**1.6 (Moderate)**	**2.6 (High)**	**2.6 (High)**

Table 13: Direct human benefit importance criteria results for the wetland

Direct Human Benefits		**Channelled Valley-Bottom**	**Unchannelled Valley-Bottom**	**Seep**
Subsistence benefits	Water for human use	**2** – Source of water for agriculture and livestock	**0** - None	**0** - None
	Harvestable resources / cultivated foods	**1** - Few resources of value	**1** - Few resources of value	**1** - Few resources of value
Cultural benefits	Cultural heritage	**1** - Very limited, if any	**1** - Very limited, if any	**1** - Very limited, if any
	Tourism and recreation	**1** - Limited recreational value	**1** - Limited recreational value	**1** - Limited recreational value
	Education and research	**1 –** Limited research value	**1 –** Limited research value	**1 –** Limited research value
DIRECT HUMAN BENEFITS		**1.2 (Moderate)**	**0.8 (Low)**	**0.8 (Low)**

9 IMPACT ASSESSMENT

Development activities typically impact on the following important drivers of aquatic ecosystems:

- *Impairment of surface water quality:* This refers to the contamination of water resources from mining related impacts such that the quality of water is impaired to the detriment of the aquatic ecosystem and other water users.
- *Destruction and modification of aquatic habitat:* This refers to the physical disturbance of in-stream and riparian aquatic habitat and associated ecosystem goods and services;
- *Flow modification and erosion/sedimentation:* This refers to the alteration of hydrological and geomorphological processes and drivers, and associated impacts to aquatic habitat and ecosystem goods and services;

Modifications to these drivers ultimately influence the PES of aquatic ecosystems. Accordingly, development impacts were described and assessed based on their potential to modify each of the above-mentioned drivers of aquatic ecosystem health, using the PES and EIS of the wetland as a baseline against which to assess impacts. The impact assessment methodology is described in the appendix to this report. Construction and operational phase activities that could potentially contribute to each of the above-mentioned impacts were identified and assessed using the impact assessment methodology.

9.1 IMPAIRMENT OF WATER QUALITY

9.1.1 Construction Phase

Activities that could potentially contribute to a deterioration in water quality during the construction phase are assessed in Table 14 and include the following:

- Spills and leakages of hydrocarbons (i.e. fuel, oil, grease etc.) from construction vehicles and machinery and storage facilities;
- Spills, leakages or inadequate treatment and disposal of sewage effluent; and
- Spills, leakages or inadequate disposal construction materials (i.e. bitumen and cement).

Mitigation Measures

- Develop and implement environmental management and auditing systems to ensure that pollution prevention and impact minimization plans developed in the design and feasibility stages are fully implemented;
- All potentially hazardous substances should be stored in secure facilities in an appropriately bunded area that falls within an appropriate storm water management network to ensure that contaminants are not released to water resources through storm water runoff. The bund height of the bund wall should be able to contain 110 % of any stored volume;
- Storage containers for hazardous substances should be regularly inspected to prevent leaks and unnecessary seepage or contamination of storm water;
- Vehicle maintenance and refueling should only take place within the delineated 'dirty' area of the mine (i.e. designated workshop and wash-bay);
- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of stormwater;
- Cement/concrete mixing is to be located in an area of low environmental sensitivity away from water courses;
- An emergency spill response procedure must be formulated and staff is to be trained in spill response. All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site;
- Portable toilets should be provided at a rate of 1 toilet per 10 users and use of the surrounding environment should be discouraged. Toilets must be located outside of the 1:100 year flood line or further than 100 m or from any delineated watercourse. Waste from chemical toilets must be disposed of regularly (at least once a week) and in a responsible manner by a registered waste contractor;

- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment and should be disposed of at an appropriate waste facility by a registered waste contractor.

9.1.2 Operational Phase

Activities that could potentially contribute to a deterioration in water quality during the operational phase are assessed in Table 15 and include the following:

- Large opencast mines have high potential for water to accumulate within the pit (from groundwater recharge and surface precipitation) which creates the opportunity for water to come into contact with high sulphide content ore bodies which further leads to contamination with high concentrations of salts and possibly metals. This is exacerbated in pits that have a significant rehabilitation backlog. Dewatering of the pit increases the potential of this water to contaminate surface water resources;
- Frequent utilization of haul roads by heavy vehicles creates a high potential for the generation of significant storm water impacts and erosion from these roads. Water quality problems could also arise where such roads contain sulphide waste material;
- Pollution from hydrocarbons remains a potential impact due to storage of fuels on site and the maintenance of a large heavy vehicle fleet at refueling depots, workshops and wash-bays and operation of the vehicles throughout the mine;
- Waste and product stockpiles generally contain high sulphide-bearing materials which oxidise upon exposure to the atmosphere and therefore also liberate high concentrations of salts and metals following mixture with water (i.e. from rainfall). These inherent geochemical characteristics in combination with the hardening and compaction of surfaces (e.g. haul roads and mining operations areas) results in the potential to generate large quantities of contaminated storm water;
- Dust from mine residue deposits could contain significant levels of sulphide minerals that pose a risk of becoming a secondary source of pollution in the area that they are deposited; and
- Product loading facilities, such as coal stockpiles, sidings, etc. are a potential source of pollution, especially in cases where the material is stored directly on the ground.

Mitigation Measures

- All operational planning and activities should be undertaken with eventual mine closure in mind, such that mining operations can end in a manner that minimizes the final risks and liabilities in the post-closure phase. To this end a mining plan that explicitly considers mine closure and rehabilitation must be prepared and approved before mining begins. The plan should be updated regularly (every 3 to 5 years) as mining progresses;
- During the mine planning phase, a detailed geochemical characterisation of the coal and soft and hard overburden should be undertaken and handling and placement strategies for the material should then

be based on the geochemical characterization of the material, with the aim of placing the material such that the long-term pollution potential is minimized;

- Develop a comprehensive Storm Water Management Plan that complies to guidelines stipulated in GN704. The plan should *inter alia* separate dirty areas (any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource) from clean areas, minimize the footprint of the dirty area and divert contaminated storm water to correctly sized and located pollution control dams water by means of an appropriately designed storm water network. Clean runoff volume should be maximized and diverted away from dirty areas and straight to natural water bodies;
- Storm water channels should be maintained and cleaned regularly to ensure that their capacity to convey contaminated runoff from stockpiles and other mine infrastructure areas are not compromised;
- Detailed water and salt balances that take account of climatic and operational variability should be developed and used as a planning tool to ensure that all pollution control dams are adequately sized and are integrated into a robust water reuse and reclamation strategy to ensure that captured contaminated water is effectively reused within the mining operations and that system spillages to the environment are avoided;
- Operate and concurrently rehabilitate opencast pits to minimize the exposed, excavated area of the pit at any moment in time;
- Rehabilitated sections of the pit should be free-draining away from the pit such that water drainage to the pit is reduced;
- Water collection and pumping systems that are capable of rapidly pumping accumulated water (i.e. from groundwater recharge and rainfall) out of the pit should be installed to minimize the contact time between water and geochemically reactive materials;
- Ensure that the mine plan includes contingency planning, equipment and training to enable operators to deal with common and foreseeable process upsets, leaks and releases as well as extreme climatic events;
- Develop detailed water quality monitoring systems that are capable of early detection of potential water quality problems at all facilities where potential for contamination of water resources exists. This monitoring system should also be extended to watercourses that could potentially receive contaminated water. The monitoring programme should lead to rapid and effective management actions aimed at addressing the source of pollution source and minimizing it to the full extent possible;
- Proper storage and handling and monitoring of fuel and chemicals used on site to minimize the risk of spillages to the environment;
- Reduction of dust by early revegetation and by good maintenance of roads and work areas. Specific dust suppression measures, such as minimizing drop distances and covering equipment and storage

piles, may be required for ore and product handling and loading facilities. Release of dust from crushing and other ore processing and beneficiation operations should be controlled; and
- The structural integrity of diversion berms that separate the clean and dirty water areas must be regularly monitored and maintained for the duration of the operational phase.

9.1.2.1 Rehabilitation and Closure Phase

Mining operations tend to exhibit serious long-term residual water impacts and can act as sources of pollution for long after mining has been completed. The primary reason for this is mining activities expose geochemically active minerals to water and oxygen, which lead to chemical and microbiological oxidation processes that liberate a wide range of contaminants (which can include acid mine drainage and associated contaminants, including sulphate and dissolved metals). Activities that could potentially contribute to a deterioration in water quality during the closure phase are assessed in Table 16 and include the following:

- Backfilled and rehabilitated opencast pits that fill up with water and discharge contaminated water at one or more decant/seepage points into the surface or ground water resource;
- Waste residue deposits that produce contaminated runoff, seepage and/or dust that enters the water resource;
- Footprints from reclaimed waste deposits that continue to provide a secondary source of contaminants after the primary source (the waste deposit itself) has been removed; and
- Spillages or seepage from pollution control dams that remain after closure as part of the environmental management system.

Mitigation Measures

- Design and construct a waste deposit in a manner that ensures that geochemically active material is isolated as far as possible from water and oxygen;
- Design and implement a waste deposit cover on the basis of an assessment of its long-term performance in preventing or minimizing pollution of the water resource. Once the cover performance characteristics have been specified, ensure that the cover is designed to be sustainable in terms of erosion by employing suitably qualified persons to assess cover erodability. Concurrent rehabilitation allows for the actual performance of the cover to be monitored and validated;
- Minimize water ingress into mine voids or backfilled pits by designing water management measures to maximize clean water diversion directly to the water resource;
- Remove potential sources of pollution such as hydrocarbon-contaminated soils and dispose of at an authorised disposal facility; and

- Implement as many of the closure measures as possible during the operational phase of the mine and institute appropriate monitoring programmes in order to demonstrate the actual performance of the various management actions during the life of mine, rather than after decommissioning.

Table 14: Assessment of Construction Phase impacts on water quality

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Refuelling and maintenance of construction vehicles	Local spillages of hydrocarbons and chemicals	Contamination of surface water by hydrocarbons	Moderate	Short term	Limited	Probably	Minor (-)	Low	Short term	Limited	Unlikely	Negligible (-)
Construction of infrastructure	Generation of solid waste.	Contamination of water resources by solid waste	Moderate	Long term	Limited	Probably	Minor (-)	Low	Long term	Limited	Unlikely	Negligible (-)
Sewage handling facilities	Spillage or inadequate management of sewage	Microbiological and nutrient contamination of surface water	Moderate	Short term	Limited	Probably	Minor (-)	Low	Short term	Limited	Unlikely	Negligible (-)

Table 15: Assessment of Operational Phase impacts on water quality

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Refuelling and maintenance of mining machinery and vehicles	Local spillages of hydrocarbons and chemicals	Contamination of surface water	Moderate	Ongoing	Local	Probably	Minor (-)	Very low	Medium term	Limited	Unlikely	Negligible (-)
Storage of hydrocarbons and chemicals	Local spillages of hydrocarbons and chemicals	Seepage of contaminants into groundwater	Moderate	Ongoing	Local	Probably	Minor (-)	Very low	Medium term	Limited	Unlikely	Negligible (-)
Wash-bays and Workshops	Dirty water runoff	Contamination of surface water	Moderate	Ongoing	Local	Probably	Minor (-)	Very low	Medium term	Limited	Unlikely	Negligible (-)
Run of Mine and Waste Rock Stockpiles	Weathering and oxidation of exposed waste rock	Runoff of contaminants in surface runoff	High	Ongoing	Local	Almost certain	Moderate (-)	Low	Ongoing	Local	Unlikely	Minor (-)

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Undeveloped catchment area	Dirty runoff mixing with clean runoff	Contaminants in surface runoff	High	Ongoing	Local	Almost certain	Moderate (-)	Low	Ongoing	Local	Unlikely	Minor (-)
Sewage handling facilities	Overflow of septic tanks	Microbiological and nutrient contamination of surface water	Moderate	Ongoing	Local	Probably	Minor (-)	Low	Ongoing	Limited	Unlikely	Negligible (-)
Mine residue dust	Off site deposition of high sulphide content material	Contamination of surface water	Moderate	Ongoing	Local	Probably	Minor (-)	Low	Ongoing	Local	Probably	Minor (-)

Table 16: Assessment of Rehabilitation and Closure impacts on water quality

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Waste Stockpiles	Oxidation of geochemically active minerals	Seepage and runoff of contaminants into surface and groundwater	High	Ongoing	Local	Likely	Minor (-)	Moderate	Long term	Limited	Probably	Minor (-)
Rehabilitated opencast pits	Oxidation of geochemically active minerals	Decant of contaminated mine water	Very high	Ongoing	Local	Almost certain	Moderate (-)	High	Ongoing	Limited	Likely	Minor (-)
Contaminated soils	Long-term source of pollutants	Seepage and runoff of contaminants into surface and groundwater	Moderate	Ongoing	Local	Probably	Minor (-)	Low	Short term	Limited	Unlikely	Negligible (-)

9.2 ALTERATION OF THE FLOW REGIME

This impact relates to the alteration of the quantity, timing and distribution of water inputs to and flows within a watercourse (e.g. wetland or river/stream). Certain biota require specific flow requirements in order to survive and reductions in flow typically lead to the loss of flow sensitive species and the establishment of more tolerant species. In addition, reductions in streamflow directly influence the availability and quality of different habitat types for aquatic biota. Reductions in flow also have implication for downstream water users.

GN704 regulations require that dirty water within the mine footprint (e.g. mine infrastructure) be contained and diverted to a pollution control dam which will result in a decline in MAR to receiving surface waters. The area of excavated opencast pit will also trap rainwater and reduce runoff, however these volumes are expected to be minimal as a strip mining method will be instated in combination with concurrent rehabilitation. This will minimse the extent of the excavated portion of the pit (i.e. only a small portion of the total pit area will trap rainwater at any given point in time). Based on the size of the mine infrastructure footprint, small reductions in surface water runoff will occur. Reductions in flow are most important for unchannelled valley-bottom wetland that lies in between the northern and southern pit.

Compaction and hardening of catchment surfaces caused by the movement of heavy machinery and establishment of haul roads may result in reduced infiltration of surface water and associated reduced baseflow during the winter months and increased runoff during the summer months.

9.2.1 Construction Phase

Impacts associated with the construction phase will be associated with the development of the initial boxcut in each opencast pit which will reduce runoff in proportion to the excavated area (Table 17). The area covered by the boxcut covers a relatively small area within the context of the broader catchment and will result in a small reduction in runoff volumes. It is not possible to mitigate against the loss of runoff associated with the development of the boxcut.

9.2.2 Operational Phase

Operational phase impacts will be associated with the operation of stormwater infrastructure that will separate dirty mine water from clean water and will therefore result in a decrease in runoff proportional to the dirty mine area (Table 18). Excavation of the pit will also lead to decreased runoff in proportion to area exposed opencast mining operations. The operational phase, known as steady-state, will commence after the completion of the boxcut. A conventional strip mining (roll-over) method will be employed. Material from the boxcut phase will be stored per overburden classification, with the bulk of the material placed in a position alongside the final strip, to facilitate filling of the final void. Rehabilitation of the opencast mining area will be done concurrently with the opencast mining according to a stated mining sequence. Materials will be placed back into the void in the former strata graphical sequence i.e. topsoil on the surface, subsoil directly below the topsoil and all hard material (sandstone and shale) in the bottom of the void. This method will limit the open exposed area of the pit at any moment in time, (provided there is no backlog in rehabilitation) thereby minimizing the loss of surface runoff.

Mitigation Measures

- The Storm Water Management Plan should maximize clean runoff volumes which should be diverted straight to natural surface waters;
- The open cast operations must be rehabilitated to return as much storm water to the environment as possible; and
- Backfilling and rehabilitation of old boxcuts as mining progresses

9.2.3 Rehabilitation and Closure Phase

Impacts related to the rehabilitation phase are related to long term alterations in surface flow following rehabilitation of the opencast mining area (Table 19). The existing surface drainage pattern will remain unchanged and the total disturbed area will be free draining. On completion of surface reinstatement, the area will be re-vegetated with suitable pasture grass species.

Mitigation Measures

- Topography should be restored to a pre-mining state to ensure existing surface drainage pattern will remain unchanged and the total disturbed area will be free draining.

Table 17: Assessment of Construction Phase impacts on flow regime

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Development of Boxcut	Initial excavation of opencast pit	Reduced surface runoff	Very low	Ongoing	Limited	Certain	Minor (-)	Very low	Ongoing	Limited	Certain	Minor (-)

Table 18: Assessment of Operational Phase impacts on flow regime

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Opencast mining	Excavation of opencast pit	Reduction in surface runoff	Moderate	Ongoing	Limited	Certain	Moderate (-)	Low	Ongoing	Limited	Certain	Minor (-)
Stormwater management	Containment of surface runoff originating from mine area	Reduction in surface runoff	Very low	Ongoing	Limited	Certain	Minor (-)	Negligible	Ongoing	Limited	Certain	Minor (-)

Table 19: Assessment of Rehabilitation and Closure Phase impacts on flow regime

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Rehabilitation	Alteration in surface flow	Reduction in surface runoff	Low	Permanent	Limited	Likely	Minor (-)	Very low	Permanent	Limited	Unlikely	Negligible (-)

9.3 SEDIMENTATION AND EROSION

9.3.1 Construction Phase

The mining footprint is currently almost completely covered by agricultural fields (maize, soybeans and other field crops) which are currently subject to relatively high erosion processes. The

removal of any existing non-agricultural vegetation for site clearance and construction of infrastructure will expose soils to erosion elements. The movement of heavy machinery and vehicles during the construction phase may cause compaction of soils resulting in reduced infiltration of surface water and reduced baseflow. These impacts are assessed in Table 20.

Mitigation Measures

- Development of the storm water management structures to ensure that sediment generated during the construction phase is conveyed to the silt trap;
- Ensure that storm water management structures are within good working condition through regular inspection, especially after large storm events. The silt trap and storm water management structures should be inspected after large storm events to ensure that there are no blockages or breaches. Should blockages or breaches occur, then immediate action should be undertaken to remove debris or to repair breached areas;
- Agricultural fields unaffected by the footprint of the opencast pit and mine infrastructure should continue to be planted (e.g. through leasing to farmers) or alternatively should be treated for annual weeds (using an appropriate herbicide) and sewed with an indigenous grass mix to minimise soil losses post construction phase;
- Clearing of vegetation should be limited to areas where it is absolutely needed;
- Vegetation clearing activities should preferably be undertaken during the dry season;
- Construction activities should be planned so as to minimise the duration of exposure of bare soils on site, especially on steep slopes;
- Run-off generated from cleared and disturbed areas such as access roads and slopes that drain into watercourses must be controlled using erosion control and sediment trapping measures. These control measures must be established at regular intervals perpendicular to the slope to break surface flow energy and reduce erosion as well as trap sediment;
- Berms, sandbags and/or silt fences employed must be maintained and monitored for the duration of the construction phase and repaired immediately when damaged. The berms, sandbags and silt fences must only be removed once vegetation cover has successfully recolonized the disturbed areas post-rehabilitation;

- Ensure that any trenches or excavations are closed and compacted immediately after construction is completed; and
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until grass has re-colonised the rehabilitated area.

9.3.2 Operational Phase

Increased runoff velocity as a result of the establishment of impermeable surfaces (mine infrastructure) and compaction (e.g. haul roads) may further result in erosion and sedimentation of nearby water resources (Table 21). A further impact as a result of this interaction is the alteration in current surface water drainage patterns. This is also applicable to areas where impermeable surfaces such as offices and workshops will be developed. The development of the new boxcut will further alter the onsite drainage patterns.

Mitigation Measures

- Roads should be maintained regularly to ensure that surface water drains freely off the road preventing erosion; and
- Soils compacted by heavy machinery in areas that are not utilised post construction can be ripped to allow infiltration

9.3.3 Rehabilitation and Closure Phase

Impacts related to the rehabilitation phase are related to long term alterations in surface flow following rehabilitation of the opencast mining area (Table 22). It is envisaged that the final reinstated surface level will be approximately 0.29 m above the original surface level. During the closure and rehabilitation phase care must therefore be taken that the reshaping of the topography does not result in erosion and sedimentation of adjacent river and wetland habitat. Additionally, the movement of heavy machinery and vehicles during the decommissioning phase may cause compaction of soils resulting in reduced infiltration of surface water. Increased runoff velocity as a result of compaction may also result in erosion and sedimentation of nearby watercourses.

Mitigation Measures

- On completion of surface reinstatement, the area should be re-vegetated with suitable pasture grass species;
- Ensure that vegetation establishment on the rehabilitated area occurs as soon as possible to prevent runoff high in sediment content;

- Leaving the storm water management structures in place during the decommissioning and post closure phase until the rehabilitation process is completed. This will ensure that sediment generated during this phase is captured;
- Storm water management structures should be inspected after large storm events to ensure that there are no blockages or breaches. Should blockages or breaches occur, then immediate action should be undertaken to remove debris or to repair breached areas; and
- Soils compacted by heavy machinery can be ripped to allow infiltration.

Table 20: Assessment of Construction Phase impacts on erosion and sedimentation

Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Site Clearing	Increased erosion	Sedimentation of aquatic habitats	Moderate	Medium term	Local	Certain	Moderate (-)	Low	Medium term	Local	Probably	Minor (-)
Vacant agricultural fields	Increased erosion	Sedimentation of aquatic habitats	High	Medium term	Local	Certain	Moderate (-)	Moderate	Medium term	Local	Probably	Minor (-)

Table 21: Assessment of Operational Phase impacts on erosion and sedimentation

Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Haul Roads	Increased erosion	Sedimentation of aquatic habitats	High	Ongoing	Local	Almost certain	Moderate (-)	Moderate	Ongoing	Local	Probably	Minor (-)
Mine Stockpiles	Increased erosion	Sedimentation of aquatic habitats	High	Ongoing	Local	Almost certain	Moderate (-)	Low	Ongoing	Local	Unlikely	Minor (-)

Table 22: Assessment of Rehabilitation and Closure Phase impacts on erosion and sedimentation

Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Removal of infrastructure	Compaction of soil surface	Increased erosion	Moderate	Short term	Limited	Probably	Minor (-)	Low	Short term	Limited	Unlikely	Negligible (-)
Rehabilitation of opencast pit	Alteration in surface flow	Increased erosion	Moderate	Long term	Limited	Probably	Minor (-)	Low	Long term	Limited	Unlikely	Negligible (-)
	Bare soil surface	Increased erosion	High	Short term	Limited	Probably	Minor (-)	Low	Short term	Limited	Unlikely	Negligible (-)

9.4 DISTURBANCE TO AQUATIC HABITATS

Impacts to aquatic habitats during the construction and operational phase are largely associated with the physical disturbance of instream aquatic habitat or associated riparian zone through activities that include the clearing of vegetation, placement and construction of infrastructure and intentional or unintentional operation of vehicles through watercourses (e.g. rivers and wetlands). Establishment of and adherence to appropriate buffer zone areas are therefore key to mitigating against these impacts. Proliferation of alien vegetation also has the potential to establish in watercourses and alter habitat through modifications to in-stream and riparian species assemblages.

Possible ecological consequences associated with this impact may include:

- Reduction in representation and conservation of freshwater ecosystem/habitat types;
- Reduction in the supply of ecosystem goods & services;
- Reduction/loss of habitat for aquatic dependent flora & fauna; and
- Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).

9.4.1 Construction Phase

Impacts to aquatic habitats during the construction phase are largely associated with activities that include the clearing of vegetation, placement and construction of infrastructure and intentional or unintentional operation of vehicles through watercourses (Table 23).

Mitigation Options

- During the construction phase of the development, all wetland areas other than the immediate areas of road crossings are to be demarcated as no-go areas for vehicles and construction personnel. In this respect recommended buffer zones should be strictly adhered to. The map presented in Figure 16 should be used to guide the footprint of the mine layout in this respect.
- Solid waste generated during the operational phase should be disposed of as per the requirements for the waste class.
- An alien invasive plant management plan needs to be compiled and implemented prior to construction to control and prevent the spread of invasive aliens.

For wetland road crossings:

- The design of the bridge crossing must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion;
- No support pillars should be constructed within the active channel of the wetland;
- The crossing must take place at right angles to the course of the channel;

- Stabilisation of river-banks in the vicinity of the bridge crossing by employing one or a combination of the following individual techniques:
    - Re-sloping of banks to a maximum of a 1:3 slope;
    - Revegetation of re-profiled slopes;
    - Temporary stabilisation of slopes using geotextiles; and
    - Installation of gabions and reno mattresses.
- It must be ensured that flow connectivity along the channel is maintained and that road crossing will not result in any barriers preventing biota (i.e. fish) moving upstream and downstream of the crossing.

9.4.2 Operational Phase

Operational phase impacts are similar to those that are likely during the construction phase (Table 24).

Mitigation Measures

- During the operational phase of the development, all wetland areas are to be demarcated as no-go areas for vehicles and construction personnel. In this respect recommended buffer zones should be strictly adhered to. The map presented in Figure 16 should be used to guide the footprint of the mine layout in this respect.
- Any areas where active erosion within wetland features are observed must be immediately rehabilitated to ensure that the hydrology of the area is reinstated to conditions which are as natural as possible;
- A routine biomonitoring programme using appropriate habitat and biotic indicators should be established to identify any changes to ecosystem health in potentially affected wetlands.

9.4.1 Rehabilitation and Closure Phase

Impacts to aquatic habitats during the closure phase are largely associated with the removal of infrastructure and the intentional or unintentional operation of vehicles through watercourses (Table 25).

Mitigation Measures

- During the operational phase of the development, all wetland areas are to be demarcated as no-go areas for vehicles and construction personnel. In this respect recommended buffer zones should be strictly adhered to. The map presented in Figure 16 should be used to guide the footprint of the mine layout in this respect.

Table 23: Assessment of Construction Phase impacts on aquatic habitats

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Site Clearing	Increased anthropogenic activity within the wetland feature	Loss of habitat and biological integrity	High	Long term	Local	Likely	Minor (-)	Low	Short term	Local	Unlikely	Negligible (-)
Site Clearing	Disturbance of soils	Proliferation of alien plants in sensitive wetland and riparian habitats.	High	Long term	Local	Likely	Minor (-)	Moderate	Long term	Local	Probably	Minor (-)

Table 24: Assessment of Operational Phase impacts on aquatic habitats

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Routine operation and maintenance activities	Increased anthropogenic activity within watercourses	Deterioration of habitat and biological integrity	Moderate	Ongoing	Local	Likely	Minor (-)	Very low	Ongoing	Local	Unlikely	Negligible (-)
Opencast mining	Mining into wetland habitats	Loss of habitat and biological integrity	Moderate	Ongoing	Local	Likely	Minor (-)	Very low	Ongoing	Local	Unlikely	Negligible (-)

Table 25: Assessment of Rehabilitation and Closure Phase impacts on aquatic habitats

Impact Description			No Mitigation					With Mitigation				
Activity	Impact	Aspect	Intensity	Duration	Extent	Probability	Significance	Intensity	Duration	Extent	Probability	Significance
Removal of infrastructure	Increased anthropogenic activity within watercourses	Deterioration of habitat and biological integrity	Moderate	Short-term	Local	Likely	Minor (-)	Very low	Short-term	Local	Unlikely	Negligible (-)

9.5 CUMULATIVE IMPACTS

The upper Olifants River catchment is the most important source of coal in South Africa, and the introduction of high concentrations of total dissolved salts (particularly sulphate) and metals associated with wastewater and seepage from existing active mines and acid mine drainage (AMD) from old, abandoned mines has been identified as one of the major long-term water quality impacts in the catchment (Hobbs et al., 2008). As a result, Water Quality Planning Limits (WQPLs) are generally exceeded for most water quality parameters across the catchment (DWS, 2016). Furthermore, the complete or partial loss of wetlands throughout the catchment continues to impact on the water resources of the catchment and the valuable ecosystem services provided by wetlands. The cumulative impacts of coal mining on water quality and aquatic ecosystem health in the upper Olifants River are therefore significant and it is essential that a stormwater management plan that adheres to GN704 regulations be designed. In addition, minimum recommended buffer zones must be implemented so as to avoid loss of wetland habitat.

10 WETLAND BUFFERS

Wetlands and their associated buffers are sensitive and must be designated as No-Go areas. With respect to buffers, GN 704 stipulates the following:

- The perimeter of the opencast pits should be located outside of the 1:50 year flood line or further than a horizontal distance of 100 m from a watercourse, whichever is the greatest.
- According to GN704, no residue deposit, dam, reservoir together with any associated structure or any other facility should be located within the 1:100 year flood line or within a horizontal distance of 100 m from any watercourse, whichever is the greatest.

The opencast pits and infrastructure of the mine take place outside of the 1:50 and 1:100 year floodlines. While GN704 stipulates a minimum buffer width of 100m, experience has shown that the Department of Water and Sanitation requires that the buffer width be scientifically determined. In this respect, the buffer tool developed by Macfarlane and Bredin (2017), determined a buffer of 60 m to be sufficient for the protection of wetlands from surface water impacts originating from the mine (Figure 16). This buffer assumes the full implementation of mitigation measures as described in Section 9 and takes the PES and EIS of wetlands into account, as well as the physical characteristics of the buffer (e.g. slope and soil and vegetation characteristics). Based on the delineation of the wetlands on site and their buffers, the layout of the pits (particularly the southern pit) must be reconfigured to avoid intruding into these areas. Furthermore, it is important to stress that the buffer determined in this report does not take sub-surface and groundwater impacts into account. The geohydrological and hydropedological reports should therefore be consulted with the aim of determining a buffer that that takes all hydrological pathways into account. This could result in a buffer that is substantially wider than the 60m proposed in this report.

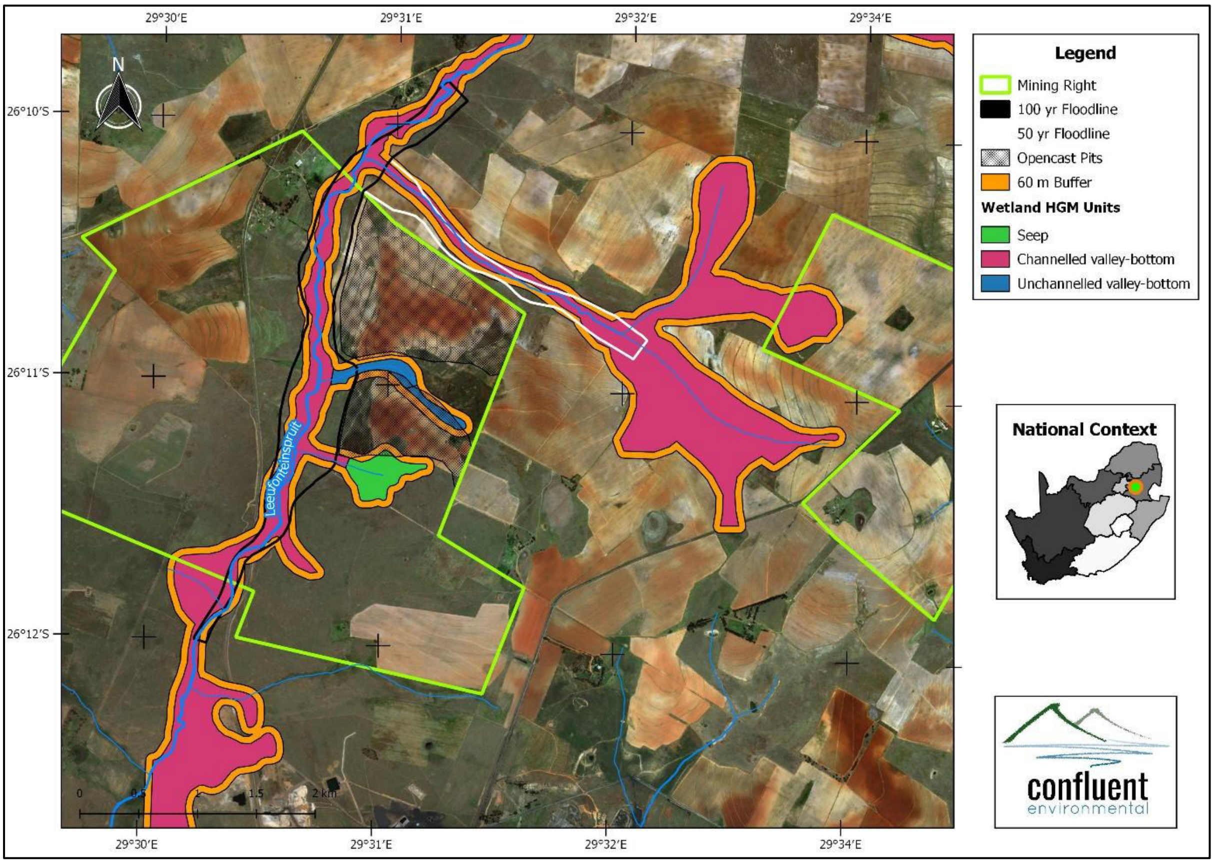

Figure 16: Sensitivity map indicating buffers and floodlines for all wetlands potentially affected by the proposed Dunbar Coal Mine.

11 MONITORING PLAN

A water quality monitoring and aquatic biomonitoring programme is essential for detecting negative impacts as they arise and ensuring that necessary mitigation measures are operating effectively. It also ensures that storm water management structures are in working order. Monitoring should be implemented prior to and throughout the life of the mine.

11.1 SURFACE WATER QUALITY

Water quality monitoring is recommended at the sampling sites indicated in (Figure 17). These sites are located in channelled valley-bottom wetlands, upstream and downstream of the proposed mining area. Water quality parameters listed in Table 4 should be included in the analyses. In addition to chemical sampling, *in-situ* water quality measurements should also be taken as certain parameters (e.g. dissolved oxygen) should be measured in the field. Water quality sampling should be undertaken on a monthly basis and results should be compared to the RQOs for upper Olifants River catchment.

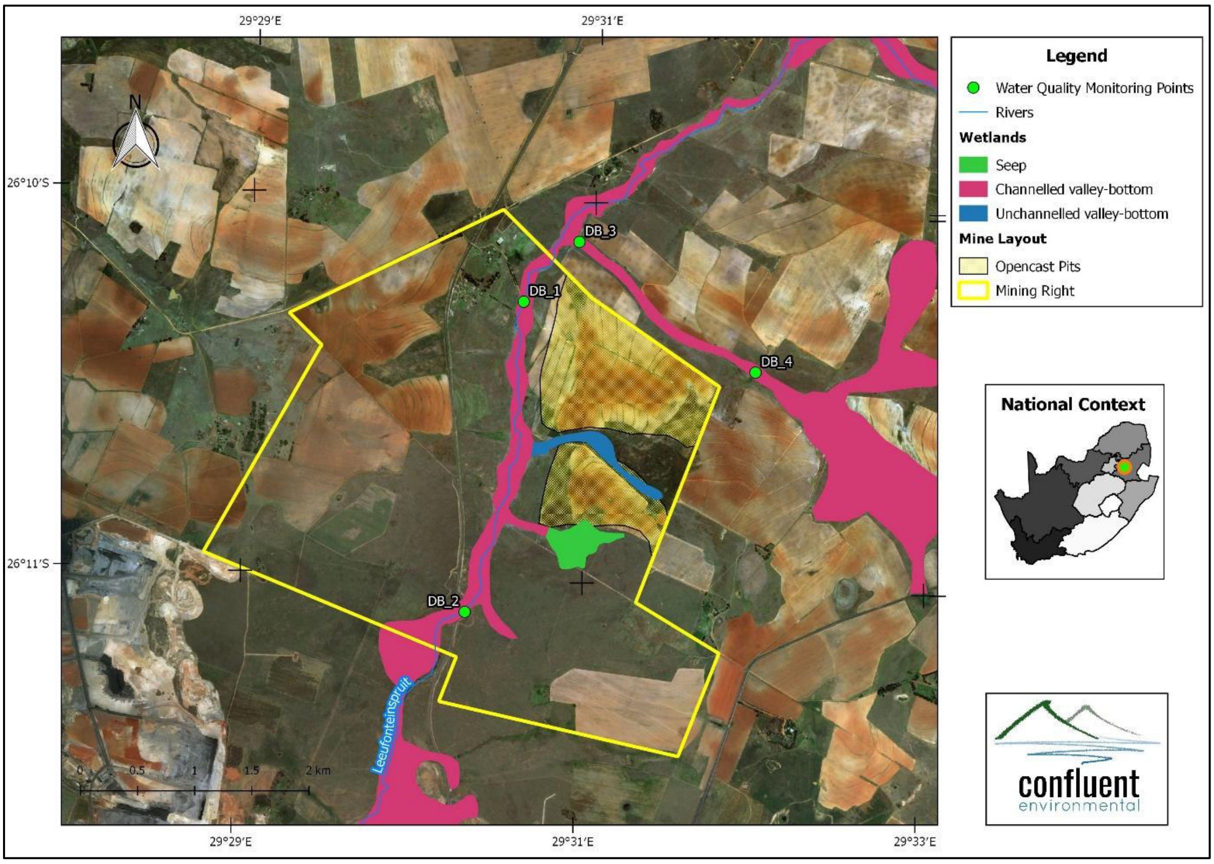

Figure 17: Recommended water quality monitoring points for the proposed Dunbar coal mine.

11.2 AQUATIC BIOMONITORING

Habitat and flow in the channelled valley-bottom wetland has been largely modified to the extent that conventional SASS5 biomonitoring techniques (Dickens and Graham, 2002) are unlikely to be sensitive enough to indicate deterioration (or improvement) in water quality at sites downstream of mining activities. Diatoms are less reliant on suitable in-stream habitat quality and are excellent indicators of water quality. Diatom indices have been designed primarily for lotic systems (i.e. running water), however, given the riverine characteristics of channelled valley-bottom wetlands, the use of diatoms as a biomonitoring tool should be adopted at all water quality monitoring points within the channelled valley-bottom wetland.

- Diatom sampling should be conducted bi-annually during the wet and dry season.
- The relative abundance and pollution sensitivity of each diatom species should be used to calculate the Specific Pollution Sensitivity Index (SPI) which can be used to derive one of five ecological health categories, ranging from High Quality to Bad Quality (Harding and Taylor, 2011).
- Wetland health assessments should be implemented once a year for all wetlands that fall within the mine property. The primary objective of these assessments should be to ensure that no modifications to the hydrological, geomorphological and vegetation characteristics of the wetlands have occurred during the construction and operational phase.

12 CONCLUSION AND RECOMMENDATION

Several wetlands within the B11A quaternary catchment are potentially affected by the proposed coal mine development. These include a channelled valley-bottom an unchannelled valley-bottom wetland and a hillside seep wetland. All of these wetlands have been moderately (PES of C) to largely (PES of D) modified and are regarded as being of moderate to high ecological importance and sensitivity. The wetlands and water quality within the channelled valley-bottom wetland are all currently unimpacted by mining activities and current agricultural activities are primarily responsible for these modifications. The implementation of a storm water management system that effectively contains dirty water from the mine is therefore regarded as critical to ensuring that water quality in the tributaries is not compromised by future mining activities of the proposed Dunbar coal mine. Numerous other potential negative impacts to surface water quantity and aquatic ecosystem integrity are associated with the mine development, the majority of which can be managed to minor or negligible levels, subject to the implementation of appropriate mitigation measures and buffer areas. A routine water quality and biomonitoring programme is regarded as crucial to actively identifying and managing any mine related impacts in the future.

In summary, impacts associated with the proposed Dunbar coal mine can be successfully mitigated so as to avoid deterioration to aquatic ecosystems and surface water resources. This report and its conclusions should not however be considered in isolation and other specialist reports should be consulted including the geohydrological and hydropedological assessments.

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14 APPENDICES

Appendix 1: Significance Rating Methodology

Individual impacts for the construction and operational phase were identified and rated according to criteria which include their intensity, duration and extent. The ratings were then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence = *type x (intensity + duration + extent)*

where type is either negative (i.e. -1) or positive (i.e. 1). The significance of the impact was then calculated by applying the probability of occurrence to the consequence as follows:

Significance = *consequence x probability*

The criteria and their associated ratings are shown in Table 26.

Table 26: Categorical descriptions for impacts and their associated ratings

Rating	Intensity	Duration	Extent	Probability
1	Negligible	Immediate	Very limited	Highly unlikely
2	Very low	Brief	Limited	Rare
3	Low	Short term	Local	Unlikely
4	Moderate	Medium term	Municipal area	Probably
5	High	Long term	Regional	Likely
6	Very high	Ongoing	National	Almost certain
7	Extremely high	Permanent	International	Certain

Categories assigned to the calculated significance ratings are presented in Table 27.

Table 27: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact

Significance Rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact was considered from the perspective of whether losses or gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence was also determined and rated as low, medium or high (Table 28).

Table 28: Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage and is not represented elsewhere.	Substantial data supports the assessment