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ENVIRONMENTAL

RSIP for the Sasol Sigma Mooikraal Operations, Free State Province, South Africa (Water Use Licence No: 08/C22K/CIGJFAE/6981)

Rehabilitation Strategy and Implementation Plan

Project Number:

SAS5111

Prepared for:

Sasol Mining (Pty) Ltd

February 2019

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Report Type:	**Rehabilitation Strategy and Implementation Plan**
Project Name:	**RSIP for the Sasol Sigma Mooikraal Operations, Free State Province, South Africa (Water Use Licence No: 08/C22K/CIGJFAE/6981)**
Project Code:	**SAS5111**

Name	Responsibility	Signature	Date
Manisha Nana	Report Writer		February 2019
Brett Coutts	Report Writer and reviewer		March 2019

EXECUTIVE SUMMARY

Digby Wells Environmental (Pty) Ltd (hereafter Digby Wells) was appointed by Sasol Mining (Pty) Ltd (hereafter Sasol Mining) to amend and consolidate the Sigma Colliery: Mooikraal (hereafter Mooikraal) and Sigma Colliery: 3 Shaft (hereafter 3 Shaft) Environmental Management Programmes. In addition to this Sasol Mining also requested that the Rehabilitation Strategy and Implementation Plan (RSIP) be compiled as one of the requirements of the approved Water Use Licence (WUL).

The overall objectives of this report are to address the following:

- Legal and governance framework;
- Outline of rehabilitation principles;
- Ongoing research on closure and rehabilitation options;
- Detailed description of assumptions made;
- Identification of knowledge gaps and how these will be addressed;
- Detailed rehabilitation actions to mitigate/ manage identified risks mainly linked to water related aspects and describes the nature of residual risks that will need to be managed and monitored post closure, such as the potential for water treatment;
- Rehabilitation measures to address water related aspects;
- Vegetation establishment techniques, including management of alien invasive plant species;
- High level alien invasive plant management measures;
- Assessment of post closure options that are practical and within the socio-economic and environmental opportunities of the area;
- Recommendations regarding the final end land use; and
- Outline of monitoring, auditing and reporting requirements.

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation.

The following points outline the overarching objectives, in line with the Mooikraal EIA and EMP (2014), which have been carried forward into the consolidated EMP, to assist Sasol in carrying out successful rehabilitation at Mooikraal:

- To comply with all applicable legislation at the time of final rehabilitation and closure;
- To monitor the success of rehabilitation actions to ensure post-mining land use is sustainable;

- To ensure that the post mining land use is physically stable in that it does not pose a hazard to public health and safety;
- To ensure that the post mining land use is environmentally stable, in that adverse environmental risks have been identified and mitigated;
- To constructively consult with all relevant I&APs and ensure the post-mining land uses is agreed upon and any grievances are addressed.

The rehabilitation of Mooikraal will require significant levels of control and monitoring during implementation if the desired objectives are to be achieved. For the Mooikraal operation it has been determined that the land must be rehabilitated to at least a grazing land capability.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

1 Introduction

Digby Wells Environmental (Pty) Ltd (hereafter Digby Wells) was appointed by Sasol Mining (Pty) Ltd (hereafter Sasol Mining) to amend and consolidate the Sigma Colliery: Mooikraal (hereafter Mooikraal) and Sigma Colliery: 3 Shaft Complex (hereafter 3 Shaft) Environmental Management Programmes. In addition to this Sasol Mining also requested that the Rehabilitation Strategy and Implementation Plan (RSIP) be compiled as one of the requirements of the approved Water Use Licence (WUL).

Sigma Colliery consists of two components, namely the operational complexes comprising Mooikraal and 3 Shaft, and the non-operational Sigma Defunct Colliery. This document considers the Project as relevant to the Mooikraal and 3 Shaft and associated infrastructure.

Mooikraal is an underground coal mine located in the Sasolburg area. It currently operates under a consolidated Mining Right (Reference No. FS 30/5/1/2/2/2/1/221) and approved amended Environmental Management Programme (EMPr) (Reference No. 30/5/1/2/3/2/1 (221) EM) granted April 2016. The authorisation permits the undertaking of various activities associated with the underground coal mining operation.

Mooikraal also holds a separate approved Environmental Authorisation (EA) (Reference No. EMB/28/14/43, dated 09 March 2015) for a 10 Mega litre (ML)/day and 7 ML/day water transfer pipeline. The 7 ML/day pipeline transfers water from the Kleinvlei ventilation shaft to the Pollution Control Dams (PCD)s (North and South PCD) at Mooikraal (Figure 7-1), and the 10 ML/day pipeline transfers water from the PCDs at Mooikraal to Sasolburg Operation (SO), both pipelines are constructed along mine servitudes.

Mooikraal is now proposing to reconfigure and relocate the conveyor belt series and the crusher facility located at 3 Shaft. In addition, Mooikraal wishes to amend and consolidate the approved Mooikraal Colliery EMPr. An environmental regulatory process is thus required to obtain the necessary environmental authorisations.

It is recognised that post mining landscape rehabilitation is essential to reinstate a functional end land use which positively contributes towards the future biophysical and societal demands of the people and the animals living in proximity to a disturbed environment. *Effective rehabilitation* is defined as “rehabilitation that will be sustainable, in the long term, under normal land management practices” according to the Minerals Council South Africa (2007). Mining activity in South Africa has a legacy of poor rehabilitation post extraction however this has changed substantially in recent years due to legislation, enforcement and environmental responsibility by Mining houses.

Mine rehabilitation must be considered as an on-going process aimed at restoring the physical, chemical and biological quality or potential of air, land and water regimes disturbed by mining to a state acceptable to the regulators and to post mining land users (Whitehorse Mining Initiative, 1994).

The rehabilitation plan contained herein is compiled for Mooikraal and 3 Shaft and will address their need for a sustainable rehabilitation for the areas that will be impacted by

mining related activities. The plan is also necessary to comply with the requirements of condition 10.1 of Appendix VI as outlined in their new Integrated Water Use Licence (IWUL) No. 08/C22K/CIGJFAE/6981, dated 16th January 2018 and will also be utilised for the environmental regulatory process that is currently underway.

This report builds on the existing work for the area and addresses the overall rehabilitation objectives that have been set for the mine. It should be seen as a living document and will be updated annually during the life of mine.

1.1 Project Description

Dirty water (water contaminated with coal) runoff from the primary plant (crusher, coal bunker area and conveyor belt) at 3 Shaft is currently flowing into the Leeuspruit, which is indicated in the Sigma Defunct Colliery water monitoring report dated January 2018 (Ref No. 2018/03/PJHL). This is due to the original siting of the primary plant area (in the 1950s) within the wetland area (Figure 7-3) and the lack of appropriate stormwater management measures implemented. In 2016 a wetland was delineated at 3 Shaft. Poor and/or no separation of clean and dirty water management at 3 Shaft, as well as the absence of dirty water management activities at the stockpile area resulted in dirty water runoff contaminated with coal entering the water resource.

To rectify these issues, Sasol Mining is proposing to demolish the existing infrastructure of the primary plant area and establish a new crushing facility on the existing stockpile area. This area is well outside of the wetland area but within the 500 regulated buffer area. Comprehensive clean and dirty water management activities will be established at and around the stockpile area, as well as dust management activities. The impacted delineated wetland will be remediated.

The relocation of the crusher facility will necessitate the realignment of the MK9 Belt over the shortest distance to convey Run of Mine (ROM) coal directly to the stockpile where the new crusher facility will be located. The proposed conveyor structure, namely the new MK9 Belt, will measure approximately 650 m from the existing MK8 transfer point (MK tail end) to the proposed new primary plant (crusher). The proposed conveyor route will traverse one water resource.

Sasol Mining also intends to drill boreholes with associated assess roads for exploration within the Mooikraal Mining Right Area (MRA). Some of these boreholes (approximately 100) are proposed to be drilled within wetlands, in the vicinity of wetlands (500 m buffer) and/or within 100 m of the Kromelmboogspruit, therefore requiring authorisation in terms of NEMA and the NWA. It should be noted that a WUL (08/C22K/CIGJFAE/ 6981, dated 16 January 2018) has already been authorised for the drilling of these boreholes within 100 m of the wetlands and river courses in terms of the National Water Act (NWA). An application to include the boreholes to be drilled within the 500 m buffer of the wetland is currently being applied for. Sasol Mining is investigating options to further maximise the extraction of coal at Mooikraal towards the southern reserves which necessitates diamond core drilling.

In addition to the exploration boreholes, monitoring and rescue boreholes with associated access roads will also be drilled. The monitoring boreholes will enable the mine to extend its groundwater monitoring programme within the Mooikraal Mining Right area, as well as to incorporate 3 Shaft into the monitoring network.

The rescue boreholes are intended to be drilled as emergency access points to the underground workings in the event of a disaster, as required by the Mine Health and Safety Act, 1996 (Act No. 29 of 1996).

The above-mentioned proposed activities will introduce new activities to Mooikraal for which an Environmental Authorisation through a Basic Assessment Process is being sought out.

Mooikraal operates under a consolidated mining right (Ref No. FS 30/5/1/2/2/2/1/221) and EMPr (dated 2016), which covers all the current activities associated with the operation. However, although the EMPr contains some management and mitigation measures of 3 Shaft, this area has not been adequately addressed/included in the Mooikraal EMPr.

In addition, some properties associated with the overland conveyor belt trajectory are not included in the Mooikraal EMPr, which this application intends to address.

Mooikraal has a separate environmental authorisation for the 10 ML/day and 7 ML/day transfer water pipelines which is proposed to be incorporated within the Mooikraal EMPr.

Through this application, Sasol Mining intends to incorporate the 3 Shaft, overland conveyor belt properties and water transfer pipelines into the approved Mooikraal EMPr so as to have one consolidated EMPr applicable to the entire operation. This is proposed to be done through a Regulation 31 Amendment Process in terms of NEMA.

A combined Basic Assessment and Regulation 31 Amendment Process in terms of NEMA and associated EIA Regulations 2014 (as amended) will be undertaken to fulfil the project scope.

In summary the key infrastructure/activities, relevant to the to the project, for this application include:

- Demolition of the existing conveyor belt, crushing facility and coal bunker, which is currently situated within a wetland at the 3 Shaft (primary plant);
- Relocation/reconstruction the primary plant (crusher facility) on the stockpile area (to remain within the 3 Shaft footprint);
- Proposed upgrade of the stormwater management system at 3 Shaft;
- Drilling of exploration, monitoring and rescue boreholes within the approved Mooikraal Mining Right area and 3 Shaft within 500m from a wetland; and
- Incorporate all activities at Mooikraal (including existing and proposed underground mining) into a consolidated EMPr.

2 Details of the Specialist

The following specialists compiled this groundwater report:

Responsibility	Report Writer
Full Name of Specialist	Brett Coutts
Highest Qualification	BSc Ecology
Years of experience in specialist field	11

3 Terms of Reference

The overall objectives of this report are to address the following:

- Legal and governance framework;
- Outline of rehabilitation principles;
- Ongoing research on closure and rehabilitation options;
- Detailed description of assumptions made;
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- Detailed rehabilitation actions to mitigate/ manage identified risks mainly linked to water related aspects and describes the nature of residual risks that will need to be managed and monitored post closure, such as the potential for water treatment;
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- High level alien invasive plant management measures;
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- Recommendations regarding the final end land use; and
- Outline of monitoring, auditing and reporting requirements.

4 Legal and Governance Framework

Section 41 (1) of the MPRDA has been repealed and in terms of Section 24P of the National Environmental Management Act (NEMA), as amended, which provides that the holder of a mining right must make financial provision for rehabilitation of negative environmental impacts. The financial provision must guarantee the availability of sufficient funds to undertake the following:

- Rehabilitation of the adverse environmental impacts of the listed or specified activities;

- Rehabilitation of the impacts of the prospecting, exploration, mining or production activities, including the pumping and treatment of polluted or extraneous water;
- Decommissioning and closure of the operations;
- Remediation of latent or residual environmental impacts which become known in the future;
- Removal of building structures and other objects; or/and
- Remediation of any other negative environmental impacts.

In addition to Section 24(P), the Regulations pertaining to the financial provision for prospecting, exploration, mining or production operations were promulgated on 20 November 2015 (GN R1147). For the purposes of this report, the financial provision estimate and respective reports are in line with the requirements of the Financial Provision Regulations, 2015.

Regulation 11 of the Financial Provision Regulations, 2015 requires a holder of a Mining Right to determine the quantum of the financial provision through detailed itemisation of all activities and costs, calculated based on the actual costs of implementation of the measures required for:

- Annual rehabilitation as reflected in the ARP as per the minimum content prescribed by Appendix 3 of the Regulations;
- Final rehabilitation, decommissioning and closure as reflected in the RCP as per the minimum content prescribed by Appendix 4 of the Regulations; and
- The remediation of latent or residual environmental impacts including but not limited to the pumping and treatment of polluted or extraneous water, as reflected in an ERR, as per the requirements of Appendix 5 of the Regulations.

Applicable legislation is outlined in Table 4-1.

It must be noted that the annual rehabilitation plan will need to be compiled and the Environmental Risk Report (ERR) will also need to be assessed and compiled based on the potential closure risks that could occur post closure.

Table 4-1: Applicable Legislation

Applicable legislation and guidelines	Details
Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)	Section 24 of the Constitution states that everyone has the right to an environment that is not harmful to their health or well-being and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures, that – a) Prevent pollution and ecological degradation; b) Promote conservation; and c) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development
The Conservation of Agricultural Resources, 1983 (Act No. 43 of 1983) (CARA)	The Conservation of Agricultural Resources Act 43 of 1983 states that the degradation of the agricultural potential of soil is illegal; and The Conservation of Agricultural Resources Act 43 of 1983 requires that protection of land against soil erosion and the prevention of water logging and salinization of soils means of suitable soil conservation works to be constructed and maintained.
Mineral and Petroleum Resource Development Act. 2002 (Act No. 28 of 2002) (MPRDA)	The MPRDA sets out the requirements relating to the development of the nation's mineral and petroleum resources. It also aims to ensure the promotion of economic and social development through exploration and mining related activities; Section 41 (1) of Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) has been repealed and in terms of Section 24P in the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) as amended which provides that the holder of a mining right must make financial provision for rehabilitation of negative environmental impacts. The financial provision must guarantee the availability of sufficient funds to undertake the- a) Rehabilitation of the adverse environmental impacts of the listed or specified activities; b) Rehabilitation of the impacts of the prospecting, exploration, mining or production activities, including the pumping and treatment of polluted or extraneous water; c) Decommissioning and closure of the operations; d) Remediation of latent or residual environmental impacts which become known in the future; e) Removal of building structures and other objects; and/or f) Remediation of any other negative environmental impacts. In addition to Section 24(P), the Regulations pertaining to the financial provision for prospecting, exploration, mining or production operations were promulgated on the 20 November 2015 (Government Notice No. 1147 published in GG 39425). Regulation 6 of the Financial Provision Regulations requires a holder of a Mining Right to determine the quantum of the financial provision through detailed itemisation of all activities and costs, calculated based on the actual costs of implementation of the measures required for: a) Annual rehabilitation, as reflected in Annual Rehabilitation Plans (ARPs); b) Final rehabilitation, decommissioning and closure of the mining operations as per the RCPs which includes the findings of the Environmental Risk Assessment Report (ERR); and Remediation of latent or residual environmental impacts as identified in the ERR.
National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)	The NEMA, as amended was set in place in accordance with section 24 of the Constitution of the Republic of South Africa. Certain environmental principles under NEMA have to be adhered to, to inform decision making for issues affecting the environment. Section 24 (1)(a) and (b) of NEMA state that: *The potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment, must be considered, investigated and assessed prior to their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity.*

Applicable legislation and guidelines	Details
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA)	NEMBA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act also regulates the protection of species and ecosystems that require national protection and also takes into account the management of alien and invasive species. This Act works in accordance to the framework set under NEMA. The following regulations which have been promulgated in terms of the NEM:BA are also of relevance: ▪ Alien and Invasive Species Lists, 2014 published (GN R.599 in GG 37886 of 1 August 2014) ; ▪ National Environmental Management: Biodiversity Act, 2004: Threatened and Protected Species Regulations; and ▪ National list of Ecosystems Threatened and in need of Protection under Section 52(1) (a) of the Biodiversity Act (GG 34809, GN R.1002, 9 December 2011).
National Water Act, 1998 (Act No. 36 of 1998) (NWA)	The NWA provides for the sustainable and equitable use and protection of water resources. It is founded on the principle that the National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest, and that a person can only be entitled to use water if the use is permissible under the NWA.
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA)	According to the NEM: AQA the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM: AQA. A fundamental aspect of the new approach to the air quality regulation, as reflected in the NEM: AQA is the establishment of National Ambient Air Quality Standards (NAAQS) (GN R 1210 of 2009). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured.

For rehabilitation purposes, this regulation stipulates what information will be required for the final rehabilitation plan. The final rehabilitation, decommissioning and closure plan will form a component of the environmental management programme and will be subjected to the same requirements of the environmental management programme with regards to opportunities. The objectives of the rehabilitation plan are as follows:

- Provide the applicant's vision, objectives and criteria for rehabilitation, decommissioning and closure of the project;
- Outline the design principles for closure;
- Explain the risk assessment approach and outcomes and link closure activities to risk mitigation;
- Detail the closure actions that clearly indicate the measures that will be taken to mitigate and/or manage Identified risks and describes the nature of residual risks that will need to be monitored and managed post closure;
- Commit to a schedule, budget, roles and responsibilities for rehabilitation, decommissioning and closure of each relevant activity or item of infrastructure;
- Identify knowledge gaps and how these will be addressed and filled;
- Detail the full closure costs for the life of project at increasing levels of accuracy as the project develops and approaches closure;
- Outline monitoring, auditing and reporting requirements; and
- Be measureable and auditable.

The final rehabilitation, decommissioning and closure plan must contain information that is necessary for the definition of the closure vision, objectives and design and relinquishment criteria. In addition what infrastructure and activities will ultimately be decommissioned, closed, removed and remediated and the risk drivers determining actions and how the closure actions will be implemented to achieve closure relinquishment criteria and the monitoring auditing and reporting requirements. The final rehabilitation, decommissioning and closure plan must be prepared in a manner that is measurable and auditable.

5 Methodology and Approach

A number of tasks were involved in the compilation of this Rehabilitation Strategy and Implementation Plan for the Mooikraal and 3 Shaft; namely:

- Review of all existing information;
- Setting objectives and planning around central themes:
  - Post-mining landforms and soil;
  - Hydrology;
  - Geohydrology; and

- Biodiversity aspects

- GIS mapping; and
- Report compilation.

6 Assumptions and Limitations

The following assumptions and limitations have been made:

- The information provided in this report is based on information gathered from site visits undertaken to date, EIA, EMP and specialist studies conducted for Mooikraal and 3 Shaft;
- This report covers aspects associated with rehabilitation and does not include a financial provision assessment, which has been undertaken by Jones and Wagner;
- The information contained within this rehabilitation plan is based on the current Life-of-Mine (LoM). If there is a significant change or addition of other mining areas or infrastructure the rehabilitation plan will need to be updated to cater for this change;
- This report must be considered as a living document and will be updated as required by legislation with the most recently available monitoring and rehabilitation progresses;
- The hydrogeological impacts associated with the post-closure environment are based on specialist studies previously conducted. In the event that there is a change in the mining method it is recommended that the hydrogeological impacts associated with the post closure environment are remodelled as the recommendations provided for water management are based on the current LoM.

7 Site Description

7.1 Infrastructure

The infrastructure currently present at Mooikraal and 3 Shaft is listed in Table 7-1 and Table 7-2, respectively. The site layout is shown in Figure 7-2 and Table 7-2.

Table 7-1: Infrastructure at Mooikraal

Mooikraal Infrastructure		
Incline shaft and Coal silo	Waste storage area	7ML/day pipeline from Kleinvlei Shaft to PCDs
Ventilation Shaft (Kleinvlei Shaft) – Downcast and up cast	Workshops (cable, boiler and diesel)	Electricity pylons located with the existing servitudes
PCDs (North and South Dams)	Lamp room	Various pipelines (potable and sewerage)
Access roads (including access routes to the rescue boreholes)	Bulk fuel and oil storage area and bunds	Office blocks (including kitchen, security and proto room)

Mooikraal Infrastructure		
Pump station	Dust suppression storage area and bund	Various walkways
Sumps located at the wash bay, fuel storage, shaft complex and various areas around the mine and conveyor belt for stormwater management	Stone dust silo	Tuck-shop (where light meals are prepared)
Explosives magazine	Capital yard	Change houses
Transformers and bunds	Warehouse	Smokers facilities
Clean water channels	Material storage yards	Laundry washing facility
Soil stockpiles	Conveyor belting, associated drive houses, transformers and substations	Security fencing
Waste Rock Dump (WRD)	Coal scanners located on belts	Rescue boreholes
Borrow pits	5 ML/day pipeline from Mooikraal to SSO	Parking area
Sewage Treatment Plant (STP)	10 ML/day pipeline from Mooikraal to SSO	

Table 7-2: Infrastructure at 3 Shaft

3 Shaft Infrastructure	
Primary plant area – including crusher facility	Parking area
Stockpile area including stacker reclaimer for ROM and imported coal	Hazardous chemical storage area
Unpaved haul roads	Offices (including security and mine closure offices)
Access roads	Material handling stores
Security fencing	Workshops (diesel and boiler)
Transformers and substations	Various pipelines (potable and sewerage)
Conveyor belt and transfer points	Paint spraying booth
Coal scanners located on the belts	Waste storage area
Bulk fuel storage area	A cement dam for dust suppression (this dam is fed by the 5 ML/day pipeline from Mooikraal)
Wash bay	Contractors storage yard
ABET training centre	Dirty water storage dams
Warehouse	-

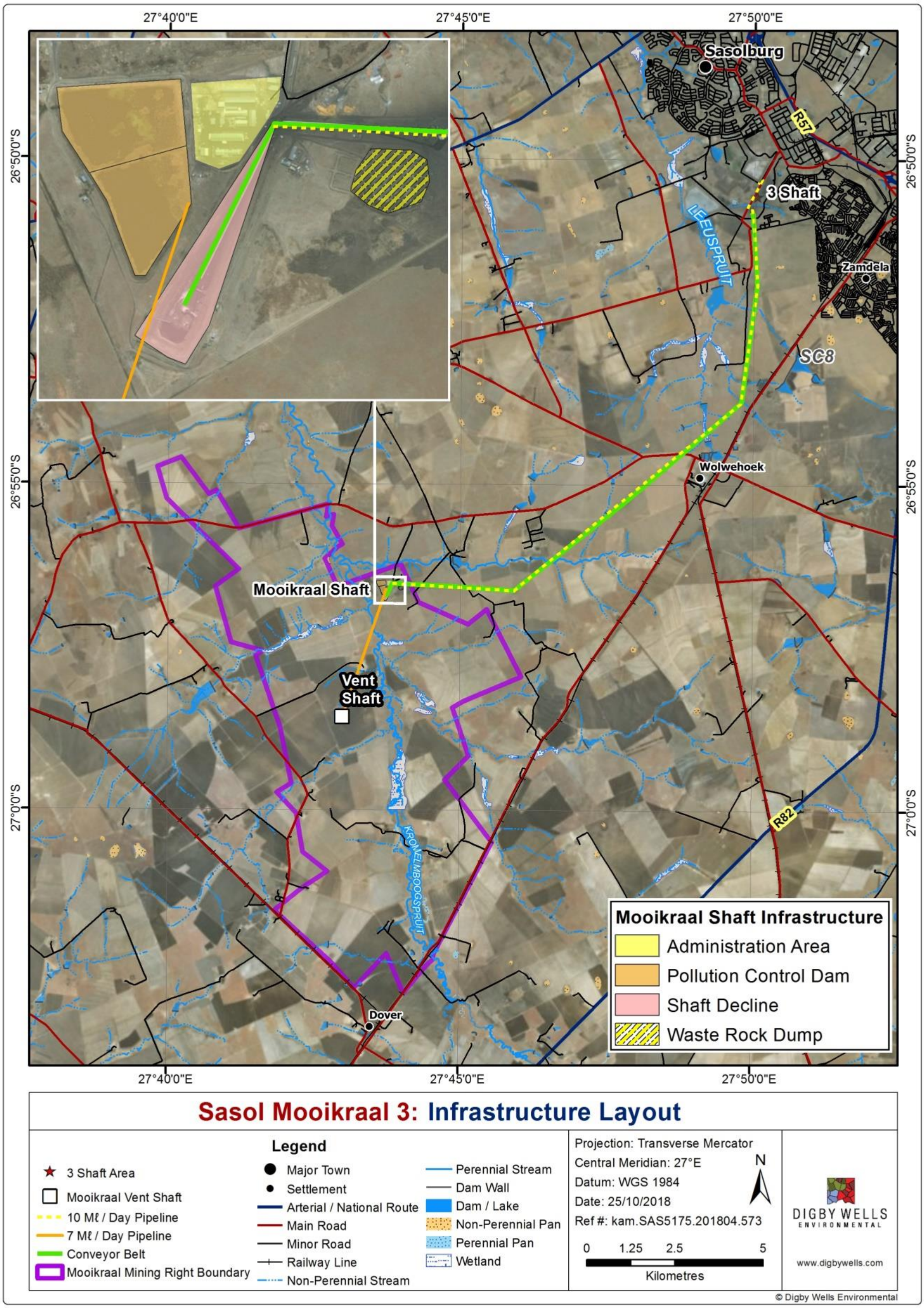


Figure 7-1: Site Layout at Mooikraal

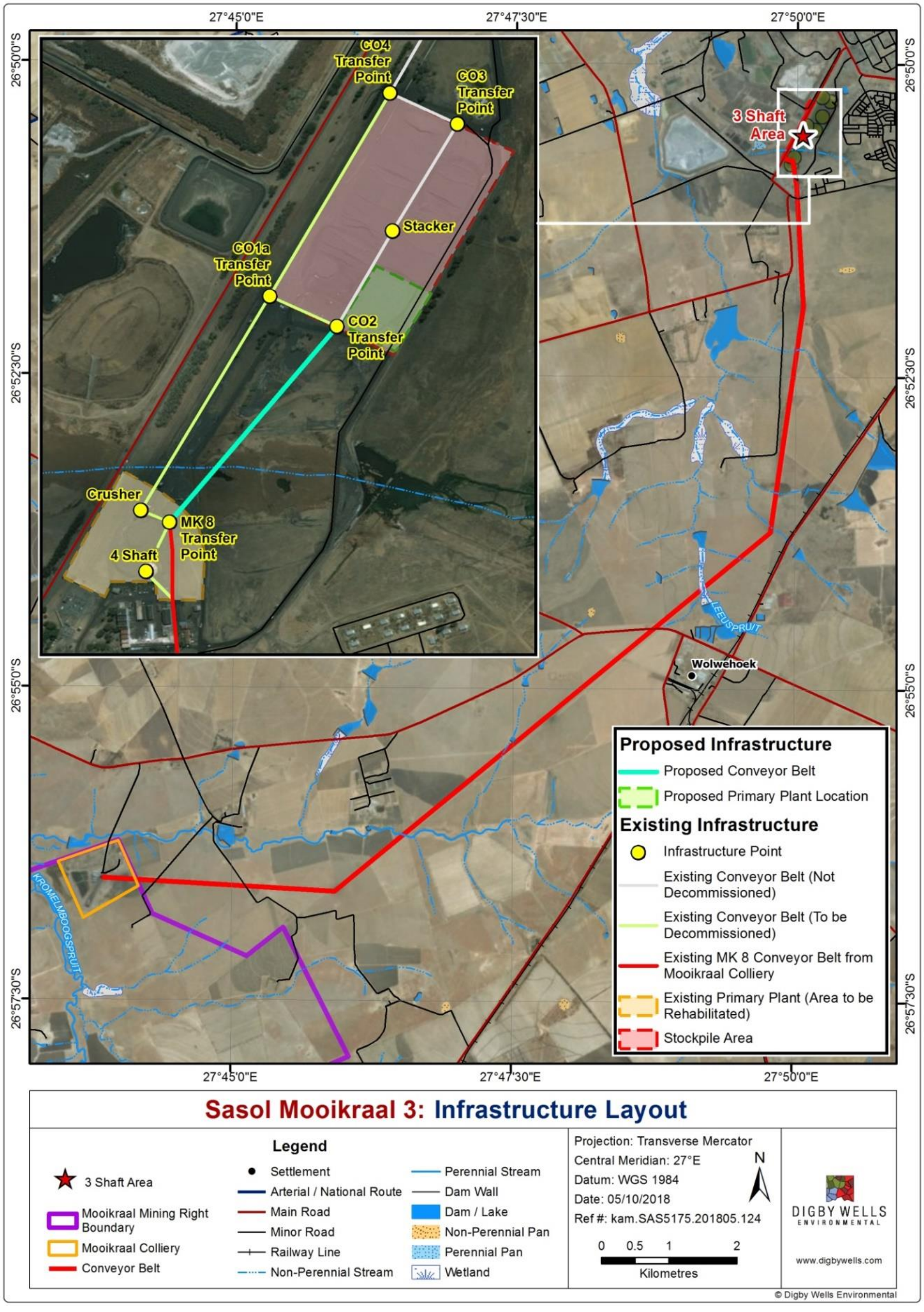


Figure 7-2: Site Layout at 3 Shaft

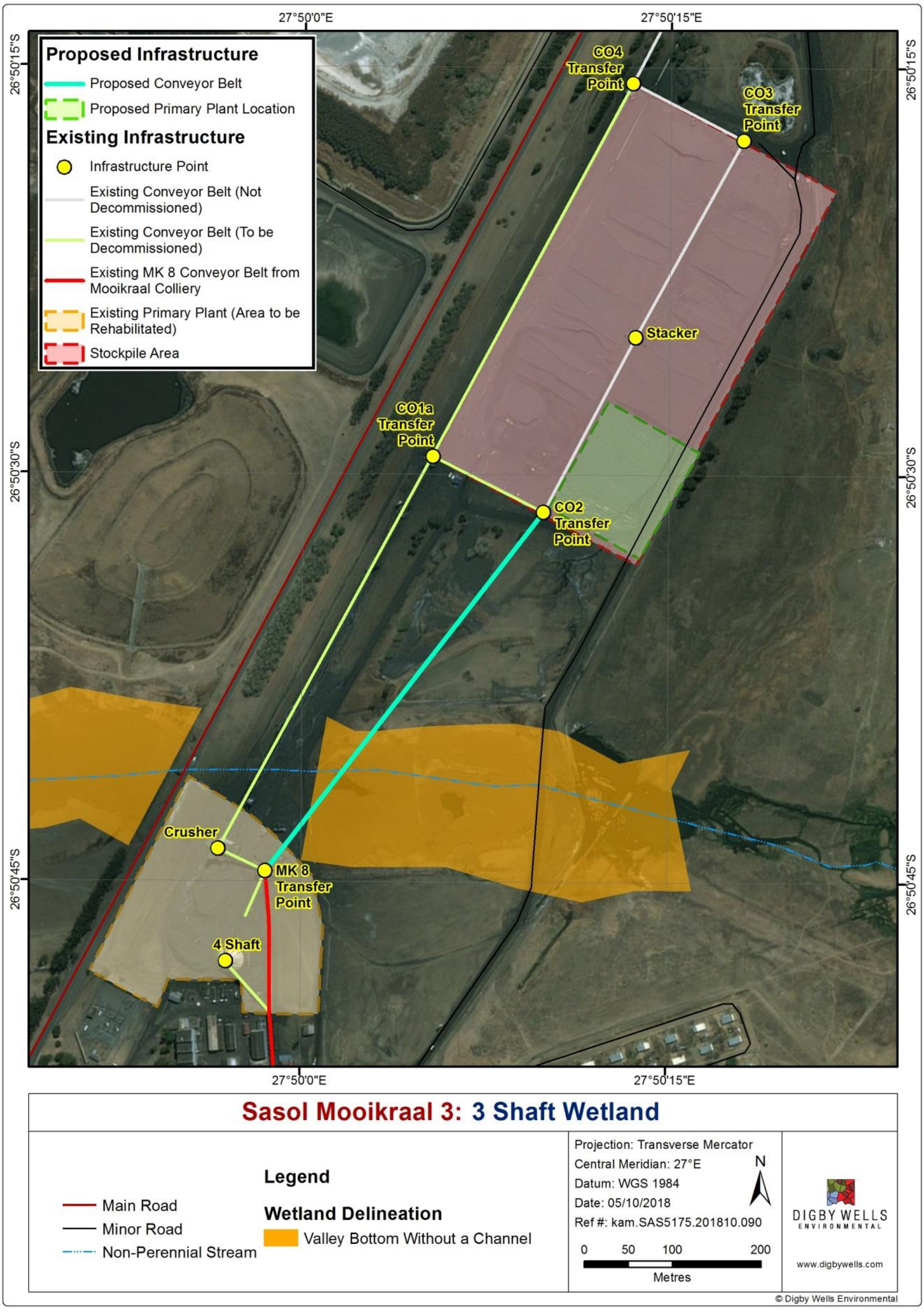


Figure 7-3: Wetland at 3 Shaft

7.2 Water Management

A description of water management at both Mooikraal and 3 Shaft is provided below. A schematic is provided which gives an indication of the water reticulation at both Mooikraal and 3 Shaft provided in Figure 7-4.

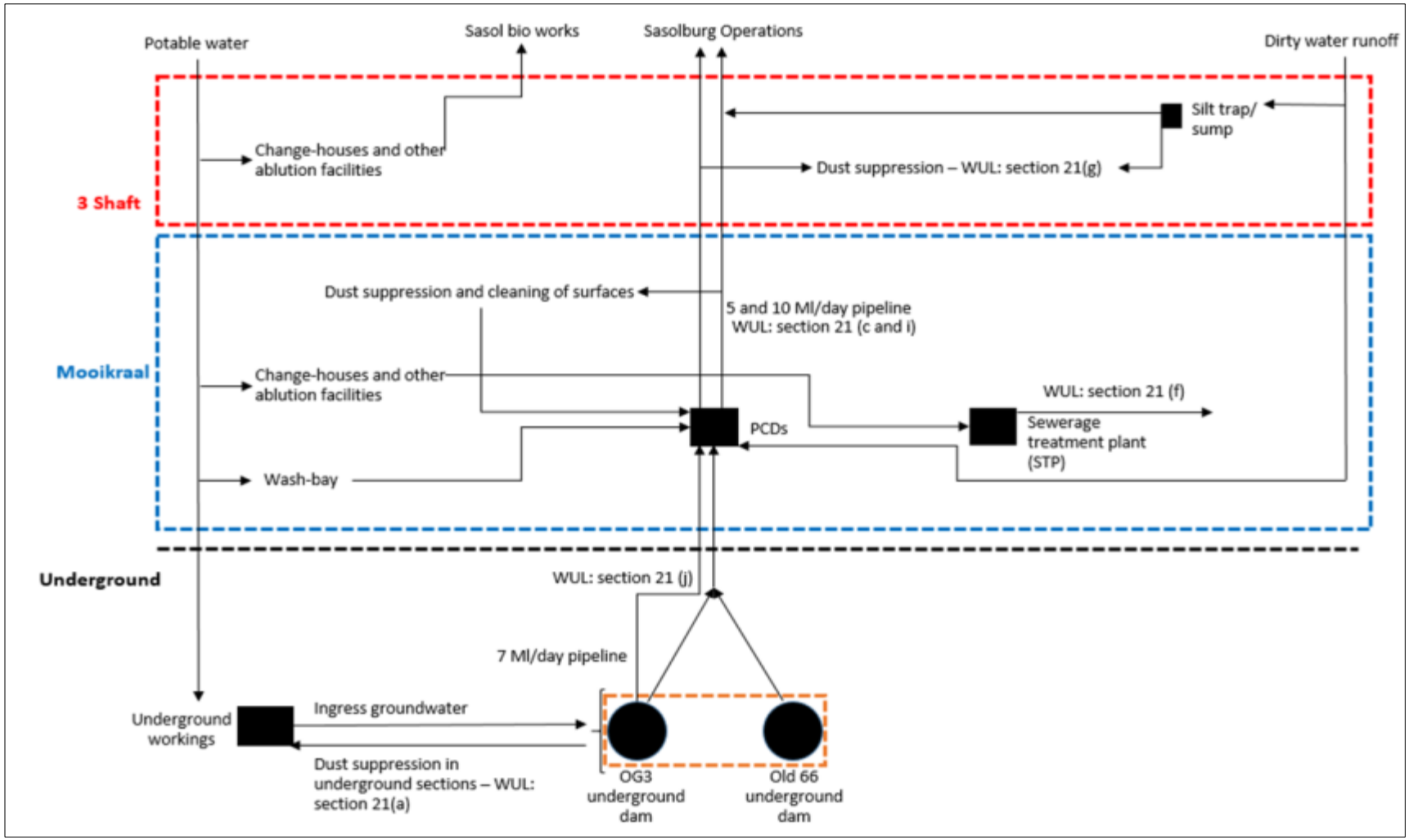


Figure 7-4: Water Management Schematic Representation at Mooikraal and 3 Shaft

7.3 Potable Water

Mooikraal and 3 Shaft both receive potable water from Rand Water via a potable water line.

Mooikraal receives potable water from a water line that runs from 3 Shaft, within the conveyor belt servitude. The potable water line enters Mooikraal and is split to provide potable water to various sources, namely offices (kitchen and ablution facilities), laundry washing facility, the wash bay and change houses (showers and ablution facilities). Potable water utilised at the wash bay is for the cleaning of underground machinery and vehicles. Potable water is delivered to the underground workings in water canisters, no pipelines distribute potable water to the underground workings.

Potable water at 3 Shaft is utilised at the change houses (showers and ablution facilities) and offices (kitchen and ablution facilities).

7.4 Sewage Water (Effluent)

7.4.1 Mooikraal

All sewage generated at the change houses, surface ablution facilities and kitchen is pumped to the sewerage treatment plant (STP) at Mooikraal, via a sewerage network.

The sewage enters the STP through a grid screen at the entrance of the raw sump, the STP operator cleans the grid screen on a daily basis, the screenings that is generated is removed and disposed of to the drying beds. The raw sump is equipped with a pump and high level and low level float switches, when the effluent level in the raw sump reaches the high level float switch, the pump activates to empty the contents of the raw sump to the aerator tank (Photograph 7-1), and the pump is de-activated when the low level float switch is reached.

The aerator tank circulates and aerates the incoming sewage from the raw sump. The aerator tank contains bio sludge which breaks down the sewerage. As part of the process, the operator determines the volume and age of the bio-sludge on a daily basis.

Similarly to the raw sump operating mechanism, the aerator tank has a high and low level float switches. When the level reaches the high float switch, the aerator tank stops circulating and aerating, and allows for a settling period of approximately 1 hour, this is to prevent decant of sludge with the treated water.

After the settling period has been completed, the aerator pump begins to discharge the treated water to the chlorine tank (Photograph 7-2), discharge continues until the low float switch level is reached. The chlorine dosing pump is simultaneously activated upon receipt of the treated water. 2 ppm of chlorine is dosed into the first chamber of the chlorine tank to treat the water.

The chlorine tank consists of 4 settling chambers, the overflow weir is situated in the last chamber of the chlorine tank, the treated water leaves the chlorine tank through the overflow weir and is discharged to the receiving environment, and is authorised by section 21 (f) of the Mooikraal Integrated Water Use Licence (IWUL) (license number: 08/C22K/CIGJFAE/6981; file number: 27/2/2/C1022/12/1, dated 16 January 2018).

Photograph 7-1: Aeration Tank

Photograph 7-2: Chlorine Tank

7.4.2 3 Shaft

All effluent from the change houses, surface ablution facilities and kitchen is transferred to the municipal sewer system where it is treated.

7.5 Underground Water Management

Underground water management refers to the management of the ingress of groundwater into the underground workings. This section is only applicable to Mooikraal as no underground mining is taking place at 3 Shaft.

7.5.1 Mooikraal

Underground water that ingresses into the underground workings is managed via an underground water reticulation system which involves a complex system of pipelines and storage dams. The underground water storage dams are sealed off by means of seal walls. The water level and water pressure behind the seal walls are monitored on a daily basis. The underground seals are designed to contain water to a level of 5 meters.

To give effect to the design specifications of the underground seals, volumes of underground water are pumped from the underground water storage compartments to the surface PCDs, namely North and South dams, as is authorised by section 21 (j) of the Mooikraal IWUL (license number: 08/C22K/CIGJFAE/6981; file number: 27/2/2/C1022/12/1, dated 16 January 2018).

The North and South PCDs are clay lined to prevent the potential for dirty water seepage. The South Dam is utilised as a settlement dam. The water, once settled, is then allowed to flow naturally to North Dam.

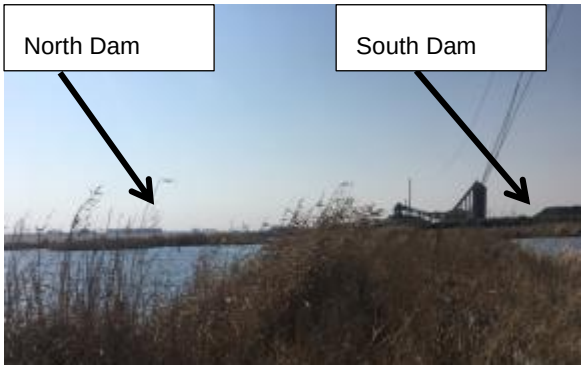
The capacity of the North and South PCDs is 50, 985 m^3 and 46,920 m^3 respectively (Photograph 7-3). A 5Ml/day pipeline was installed during the construction of Mooikraal to transport water from the PCDs to Sasol Sasolburg Operations (SSO). The 5Ml/day pipeline is installed along the conveyor belt servitude. The purpose of this pipeline was to ensure zero overflow from the PCDs, based on the assumption that approximately 5Ml/day of underground water would be removed from the underground workings and 5Ml/day of water would be transported from the PCDs to SSO.

In 2013, ingress of underground water into the underground workings far exceeded the assumption of 5Ml/day, and there existed an imbalance between the volume of water removed from underground and the volume of water transported by the hydraulically constrained 5Ml/day pipeline, resulting in unauthorised overflows of water from the PCDs.

As part of the management plan to address the PCD overflows, an environmental authorisation and water use licence process was undertaken to construct two additional pipelines (7Ml/day and 10Ml/day). The 7Ml/day pipeline will transport underground water from the Kleinvlei ventilation shaft to the South PCD. The 10Ml/day pipeline will transport water from the North PCD to SSO. The environmental authorisation was issued on the 09 March 2015 and the Water Use Licence (WUL) was issued on 16 January 2018.

Construction of the pipeline began in 2015/2016 except in the areas where the pipeline will cross watercourses.

The 7Ml/day pipeline is approximately 3 km in length and the 10Ml/day pipeline is approximately 18.5 km in length. Both pipelines run within existing Sasol Mining servitudes. The 7Ml/day pipeline is within an existing servitude utilised for power lines and the 10Ml/day pipeline has been constructed within the existing fenced off overland coal conveyor servitude. The 7Ml/day pipeline has been buried below the surface, with the exception of the watercourse crossing where it is constructed on surface for 100m either side of the Kromelmboogspruit. The 10Ml/day pipeline has been constructed above ground and placed on plinths. The 10Ml/day pipeline crosses several wetlands.



Photograph 7-3: PCDs at Mooikraal

Photograph 7-4: Existing Pump Station

Photograph 7-5: Constructed Pipelines

7.6 Dust Suppression

Dust suppression is undertaken at both Mooikraal underground and 3 Shaft at the stockpile areas to manage the level of dust generated from the operations.

7.6.1 Mooikraal

Underground water is used for dust suppression in the underground workings which is authorised by section 21 (a) of the Mooikraal IWUL (license number:

08/C22K/CIGJFAE/6981; file number: 27/2/2/C1022/12/1, dated 16 January 2018). The water is abstracted from the underground water compartments and distributed underground. Water that is pumped from underground to the PCDs is also utilised for dust suppression along the conveyor belt trajectory to ensure excessive coal dust is not generated while being transported from Mooikraal to 3 Shaft. Additionally the water is also utilised to clean areas around the conveyer belt. Sumps are located along the conveyer belt to contain any excess water generated. The water is also utilised to clean surfaces at the Mooikraal operation.

7.6.2 3 Shaft

Underground water is re-used at 3 Shaft for dust suppression. The current 5Ml/day pipeline from the Mooikraal PCDs, when entering 3 Shaft is split to provide 3 Shaft with water for dust suppression, and the remainder water is transported to SSO for use in their process. The 15 Ml/day pipeline will similarly provide water at 3 Shaft for dust suppression, and the remainder will be transported to SSO. It is envisaged that the 15 Ml/day will be the operational pipeline.

Water utilised at 3 Shaft is authorised to be used for dust suppression, at a rate of 20 Ml/day, as per section 21 (g) of the Mooikraal IWUL (license number: 08/C22K/CIGJFAE/6981; file number: 27/2/2/C1022/12/1, dated 16 January 2018).

Dust suppression will be concentrated on the stockpile area, using fogger cannons on the perimeter fence. The water that will be utilised in the fogger cannons will be sourced from a tank/ reservoir with a capacity of 1.6 Ml, which will be filled by the 15 Ml/day pipeline.

7.7 Clean and Dirty Water Management

In accordance with GN704 of the National Water Act, 1998 (Act No. 36 of 1998), dirty water generated at Mooikraal and 3 Shaft will be contained within designated dirty water areas and will not be permitted to discharge to the environment. Clean water will be directed away from the dirty water areas and discharged back to the environment.

7.7.1 Mooikraal

Clean and dirty water areas are separated at Mooikraal, the dirty water footprint is kept as small as possible, and the clean water footprint is maximised. Water entering dirty water areas (rainfall, cleaning or dust suppression) will be considered dirty water, and must be separated from clean water areas through a dirty water management system.

The dirty water management system involves a system of channels and sumps/ silt traps which ultimately divert dirty water to the Mooikraal PCDs. A series of sumps are located at Mooikraal to manage dirty water generated around the shaft complex.

Dirty water management along the incline/decline and conveyor belts, MK 1 and MK2, is managed through a series of sumps, which ultimately pump to the Mooikraal PCDs.

Two sumps are located near the wash bay and at the fuel and oil storage area. The sumps separate hydrocarbons from the runoff water prior to entering the PCDs. Dirty water runoff from the diesel workshop is also contained in a sump prior to it entering the PCDs.

Various sumps and channels are used to divert dirty water runoff from the office area and parking lot areas. Photograph 7-6 to Photograph 7-9 provides an indication of the sumps located at Mooikraal.

Photograph 7-6: Sump Located at Wash Bay

Photograph 7-7: Oil Skimmers at Wash Bay

Photograph 7-8: Sump Located at Workshop

Photograph 7-9: Sump Located at Incline

7.7.2 3 Shaft

The 3 Shaft area has been used for coal operations since 1952. The 3 shaft area is currently used for handling the Run-of-Mine (ROM) coal mined at Mooikraal prior to the coal being transported to SSO. Coal handling at 3 Shaft involves a series of incoming conveyor belts from Mooikraal, crushing and sizing the incoming ROM coal at the primary plant area. A coal bunker is also located within this area. From the primary plant area, the coal is transported, via conveyor belts, to the coal stockpile area, where the coal is further handled and blended.

In 2016 Mooikraal delineated wetlands at the 3 shaft area, from this delineation, it was noted that the current primary plant infrastructure is placed within a delineated wetland.

In order for 3 Shaft to implement a comprehensive stormwater management system, Mooikraal intends to relocate the primary plant area to the current stockpile area, where a comprehensive dirty water management system as well as dust management system can be

implemented, in accordance with GN 704 principles. The bunker (4 shaft bunker) will be demolished.

Furthermore, as part of the relocation of the crusher house (primary plant) to the stockpile area, the adjoining conveyor belt will need to be realigned. The conveyor belt will be constructed over the delineated wetland, so as to span the shortest distance from MK 9 transfer point to the newly constructed crusher (refer to Figure 7-3 above).

8 Baseline Environment

8.1 Climate

The study area occurs within a summer rainfall region with warm summers and moderate dry winters. Climate data used herein originates from the Vereeniging International Weather Station (Station Number 043 87843) from the South African Weather Bureau. Rainfall records reported are for the periods 1951 – 1984 and 1991-2012 to give long term climatic averages and variability (Digby Wells Environmental, 2014).

Relative to the country's average mean annual precipitation (MAP) of 490 mm (Worldwide Fund for Nature - South Africa, 2016), this area experiences moderately high mean rainfall of approximately 635 mm per annum (i.e. long term average between 1951 – 2012). Furthermore, the study area is located within the Highveld ecoregion (Level II ecoregion 11.03), which has been noted to attain an average temperature range of 12-20°C, a maximum temperature range between 20-32°C during January and a minimum temperature range between -2-4°C during July (Kleynhans *et al*., 2007).

8.2 Catchment

South Africa is divided into nine Water Management Areas (WMA) as part of the Revised National Water Resource Strategy (DWS, 2012). Each of the WMAs is made up of quaternary catchments which relate to the drainage regions of South Africa, ranging from A to X (excluding O). These drainage regions are subdivided into four known divisions based on size. For example, the letter A represents the primary drainage catchment; A2 for example will represent the secondary catchment; A21 represents the tertiary catchment and A21D would represent the quaternary catchment which is the lowest subdivision in the Water Resources of South Africa, 2012 manual. Each of the quaternary catchments has associated hydrological parameters.

The project is located in the Vaal Water Management Area 5 (WMA 5), with Mooikraal and 3 Shaft sites falling within quaternary catchments C23B and C22K, respectively. These quaternary catchments lie in the Vaal River catchment with the Mooikraal and 3 Shaft sites located within the Kromelmboogspruit and Leeuspruit sub-catchments respectively. The Kromelmboogspruit and Leeuspruit are perennial tributaries of the Vaal River.

8.3 Regional Vegetation

The Mooikraal site falls within the Grassland Biome (Mucina and Rutherford, 2012), one of the nine South African plant biomes and the second most bio-diverse biome in South Africa. The Grassland Biome is situated primarily on the central plateau of South Africa, and the inland areas of Kwa-Zulu-Natal and the Eastern Cape provinces. This biome is rich in flora and fauna diversity but is under threat due to rapid urbanisation and expansion of mining and industrial activities.

The study area also occurs in the Central Free State Grassland regional vegetation type, which is characterised by short grassland covering undulating plains (Mucina and Rutherford, 2012). It is considered a 'Vulnerable' vegetation type with a conservation target of 24%. In natural condition *Themeda triandra* is dominant, whereas *Eragrostis curvula* and *E. chloromelas* become dominant in degraded habitats. Table 8-1 lists a number of other species characteristic of the vegetation type.

Table 8-1: Plant species characteristic of the Central Free State Grassland

Plant form	Species
Graminoids	*Aristida adscensionis (d), A. congesta (d), Cynodon dactylon (d), Eragrostis chloromelas (d), E. curvula (d), E. plana (d), Panicum coloratum (d), Setaria sphacelata (d), Themeda triandra (d), Tragus koelerioides (d), Agrostis lachnantha, Andropogon appendiculatus, Aristida bipartita, A. canescens, Cymbopogon pospischilii, Cynodon transvaalensis, Digitaria argyrograpta, Elionurus muticus, Eragrostis lehmanniana, E. micrantha, E. obtusa, E. racemosa, E. trichophora, Heteropogon contortus, Microchloa caffra, Setaria incrassata, Sporobolus discosporus.*
Herbs	*Berkheya onopordifolia var. onopordifolia, Chamaesyce inaequilatera, Conyza pinnata, Crabbea acaulis, Geigeria aspera var. aspera, Hermannia depressa, Hibiscus pusillus, Pseudognaphalium luteo-album, Salvia stenophylla, Selago densiflora, Sonchus dregeanus.*
Geophytic Herbs	*Oxalis depressa, Raphionacme dyeri.*
Succulent herbs	*Tripteris aghillana var. integrifolia.*
Low shrubs	*Felicia muricata (d), Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, Melolobium candicans, Pentzia globosa.*

8.4 Topography

The topography of Mooikraal and 3 Shaft varies between 1 480m to 1 500m. The highest surface elevations are found in the southern and eastern parts of the area and the surface elevations in these areas can go up to 1500mamsl. It is characterised by flat boundless plains. The slope is that of a gently sloping surface towards the Vaal River.

8.5 Geology

Mooikraal and 3 Shaft is situated within the Sasolburg-Vereeniging coal field and this Coal field is located on the Northern edge of the Karoo basin and according to the 1: 250 000 geological map, is predominantly characterized by mudstone and sandstones of the overlying Beaufort Group (Adelaide Subgroup). The study area is located within the Sigma sub-basin, which is underlain by lava and dolomite as well as metasedimentary rocks of the Ventersdorp and Transvaal super groups respectively.

8.6 Soils

8.6.1 Land Type

The dominant land types at Mooikraal are Ca1 and Dc7 as explained in Table 8-2 below.

Table 8-2: Dominant land types at Sasol Mooikraal Colliery

Land Type	Description
Ca1	Indicative of land that qualifies as a plinthic catena but which has, upland positions, margalitic or duplex soils.
Dc7	Accommodates land where duplex soils are dominant. The land type is made up of soils that have one or more of the following diagnostic horizons: vertic, melanic & red structured.

8.6.2 Soil Forms

The dominant soil forms at Mooikraal and 3 Shaft are Arcadia and Avalon as explained in Table 8-3 below.

Table 8-3: Dominant soil forms at Sasol Mooikraal Colliery

Soil Forms	Description
Arcadia	Consists of a deep vertic A over unspecified material (if the material at depth is gleyed clay, then the soil form is Rensburg). They have shrink-swell properties (Fey *et al*., 2010). With the start of the rainy season, Arcadia soils are dry and cracked and water infiltration is high bypassing the soil body and potentially recharging the groundwater or downslope soils. When it rains, the soil swells and the cracks close and infiltration rate slows (Fey *et al*., 2010). These soils hold large amounts of water which often are not available to crops. Arcadia soils can accommodate a selected composition of vegetation such as grazing vegetation for cattle or strong rooted crops such as cotton or sunflower.
Avalon	Consists of Orthic A, on a yellow-brown apedal B, over a soft plinthic B horizon. Avalon soils are freely draining and chemically active. Manganese and iron oxides accumulate under conditions of a fluctuating water table forming localised mottles or soft iron concretions of the soft plinthic B horizon.

8.6.3 Present Land Use and Land Capability

The present land use was identified from satellite images and from the site visit and is depicted in Figure 8-1 below. As seen in the figure, the Mooikraal Mining Right Area is dominated by cultivated areas and open grassland. Limited areas of mining and urban areas are present namely at Mooikraal and Kleinvlei Ventilation Shaft Areas. Small patches of plantation / woodlots and thicket / dense bush areas are also present within the Mooikraal Mining Right Area. The conveyor belt servitude to 3 Shat traverses mostly grassland areas with some limited portions traversing cultivated areas. 3 Shaft is characterised by mining land use with urban area and grassland / woodlands (open bush) in adjacent areas.

Land capability was determined by assessing a combination of soil, terrain and climate features. The land classes were identified based of soil forms, texture and fertility. The classes were IV and V (Table 8-4). The limitations and agricultural potential associated with the two classes are listed in Table 8-4.

Table 8-4: Land capability classification at Sasol Mooikraal Colliery

Land type	Land capability class and limitations	Agricultural Potential
Ca1	IV (Light cultivation) ▪ Has severe limitations that restrict the choice of plants, require very careful management or both; ▪ May be used for cultivated areas, but more careful management is required; ▪ Conservation practices are more difficult to apply and maintain; and ▪ Restrictions to land use are greater than those in Class III	*Low to moderate
Dc7	V (Wet zones) ▪ Although these soils are deeper, they have high clay content and shrink/swell properties, making them very difficult to manage from an agricultural perspective; ▪ Land in Class V has little or no erosion hazard but has other limitations such as impractical to ameliorate which limits its use largely to grazing or wildlife; and ▪ Limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops.	*Low

* Agricultural Potential rated low in a wetland context but can be high with suitable management.

8.6.4 Proposed Future Land Use

Post closure land use (PCLU) is determined in consultation with stakeholders so that the PCLU meets the requirements of the stakeholders, within the context of the closure plan. This activity is undertaken for the whole mine lease area affected by mining activities and integrates stakeholder requirements with risk mitigation.

As specific consultation regarding PCLU has not been undertaken at this stage of the closure process, for purposes of current planning and liability costing, the assumption is made that post rehabilitation and closure, the land capability developed on the footprints where covers are placed and vegetation established will be a land capability defined as grazing by the Chamber of Mines of South Africa. This implies a growth medium cover of a minimum of 300 mm on average across the footprints rehabilitated. There are also portions of land that have been undisturbed by mining activities that currently have an arable potential. As mining activities have not been undertaken on these areas, no specific closure actions are envisaged and these arable areas can be utilised for arable activities post closure.

According to the Mooikraal EMP the objective of the PCLU is to rehabilitate the land use to sustain grazing of domestic animals. The following management action will be required to restore the land back to grazing potential:

- Rectify any soil erosion that occurs immediately;
- Prevent intrusion of alien and exotic plants; and
- Implement an alien control programme.

Assuming that grazing animals will be re-introduced to the rehabilitated area it is important that:

- Careful consideration be given to the carrying capacity of the area,
- Stocking rates be controlled and limited to the carrying capacity, and
- The re-introduction of grazing animals be appropriately timed i.e. only occur when the rehabilitated area is able to withstand the pressure of grazing animals.

The rehabilitated areas must be well managed when post-mining utilisation commences to prevent deterioration of the grazing and degradation of the environment.

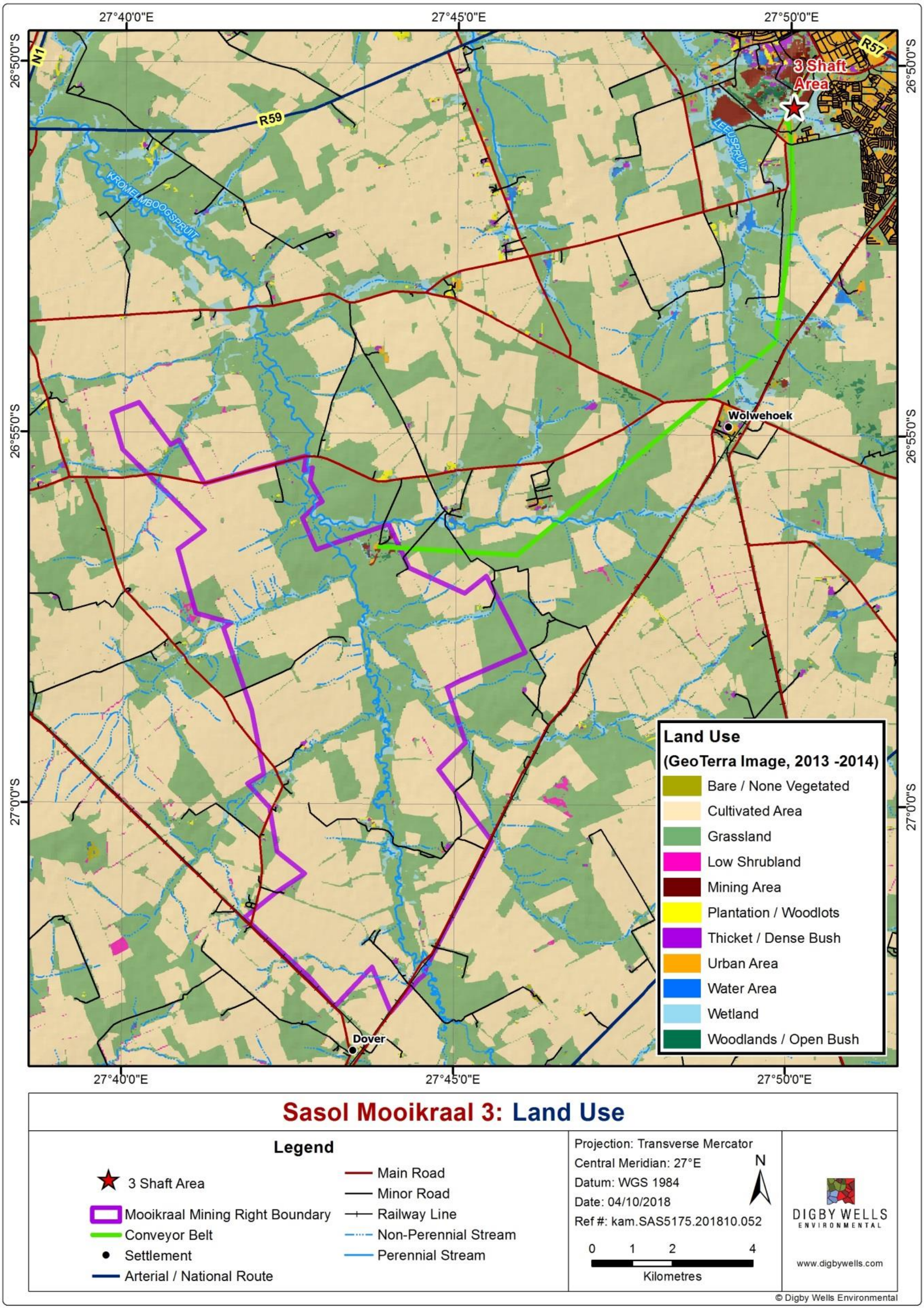


Figure 8-1: Present Land Use

8.7 Wetlands

A total of three HGM units were identified within the project area, namely: the Kromelmboogspruit floodplain, occupying 344.97 ha; the channelled valley bottom wetlands, occupying 188.05 ha and the unchannelled valley bottom wetlands, occupying 341.98 ha (Figure 8-2). The Kromelmboogspruit floodplain traverses the Mooikraal Mining Right Area from north to south with adjoining unchannelled valley bottom wetlands in to the north and south of the Mooikraal Mining Right Area which are associated with tributaries of the Kromelmboogspruit. The Kromelmboogspruit floodplain is characterized by typical floodplain wetland features, such as a deep channel, oxbow lakes and levees. The conveyor belt servitude intersects channelled valley bottom and unchannelled wetlands associated with both the Kromelmboogspruit and Leeuspruit. An unchannelled valley bottom wetland is located within the 3 Shaft area. The HGM units are illustrated in Figure 8-3.

Figure 8-2: Examples of the HGM Units within the Study Area

(A: Floodplain; B: unchannelled valley bottom; C and D: channelled valley bottom)

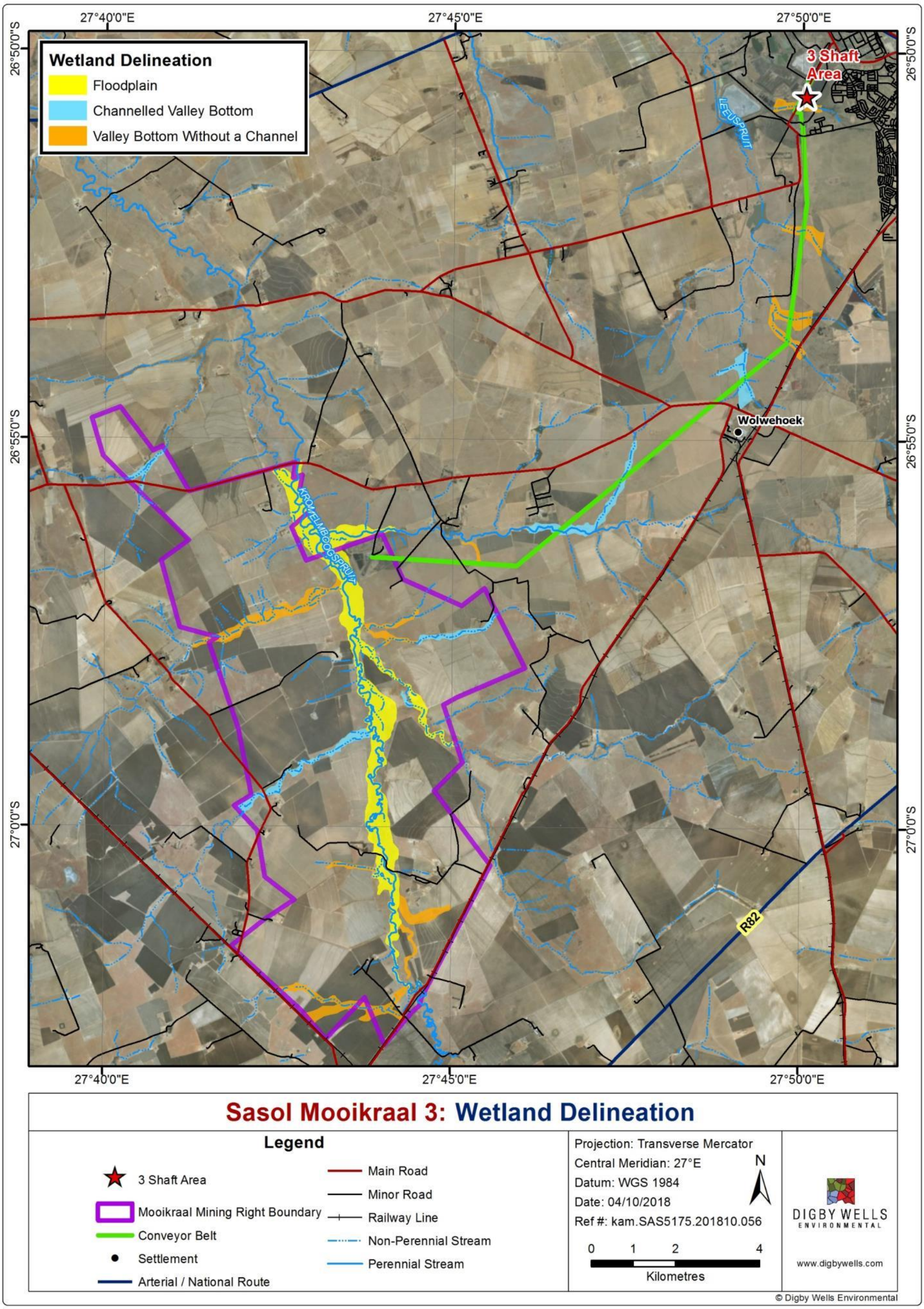


Figure 8-3: HGM Units

All wetlands on site were allocated a PES of moderately modified in the original assessment, with the exception of unchanneled valley bottoms which were allocated a C/D. In 2018 PES has deteriorated slightly within the unchanneled valley bottoms due to the cumulative impacts of roads, agriculture, upstream dams, too few culverts and associated erosion (Table 8-5).

The channelled valley bottoms were allocated a C, mainly due to the impact of dams and road crossings (to the channelled valley bottoms along the pipeline and conveyor route) as well as agriculture and grazing (to the remainder of the channelled valley bottoms) (Table 8-5).

The Kromelmboogspruit was also allocated a C, with the main contributors being agriculture and road crossings, which causes compaction of sediments and reduced flow through the wetland. When the sediment load downstream is not replenished, erosional processes are promoted and the floodplain becomes incised (Table 8-5).

Table 8-5: Overall PES Score

HGM Unit	2014		2018
Kromelmboogspruit Floodplain	C		C
Valley bottom without a channel	C	D	D
Channelled valley bottom	C		C

8.8 Surface Water

The Mooikraal and 3 Shaft region is characterised by moderate to high rainfall with the Mean Annual Precipitation (MAP) ranging from 619 mm to 644 mm. Annual average runoff depth is moderate ranging between 35.5mm and 57.28mm. On an average basis high evaporative losses of 1650 mm, are experienced annually.

Normal rainfall (90% of events) for the wettest month of January will likely not exceed 56 mm. Extreme rainfall (10% of events) for January will likely not exceed 171 mm. Normal runoff depth during the wettest month (January) will likely not exceed 1.1 mm. Runoff resulting from extreme events in January will likely not exceed 33.4 mm.

A water quality assessment was conducted for the Kromelmboogspruit, Dirty Water Dams or PCDS and the Sewage Treatment Plant (STP) at Mooikraal, the Leeuspruit tributary and dirty water containment facilities at 3 Shaft based on continuous water quality monitoring data. Water quality analysis is conducted on a weekly basis upstream and downstream of the operations, furthermore, Mooikraal has appointed IGS to undertake continuous bi-annual water monitoring assessments of the Mooikraal and 3 Shaft area. The monitoring data was benchmarked against the Water Use License (WUL) limits (Number: 08/C22K/CIGJFAE/6981).

8.8.1 Kromelmboogspruit

Surface water quality upstream (KROM/S) and downstream (KROM/N) of Mooikraal on the Kromelmboogspruit is within the WUL standard limits.

8.8.2 Mooikraal Dirty Water Dams (Sump, South & North PCDs)

The water quality in dirty water dams (South & North PCDs) at Mooikraal reflects a strong sodium bicarbonate character typical of the underlying geology (rich in sodium). The water from the Mooikraal Adit Sump has a more calcium-magnesium bicarbonate character. A sharp increase in total alkalinity occurred in 2010 which later levelled off at values just below 400mg/l.

8.8.3 Sewage Treatment Plant (STP)

The quality of treated effluent from the STP is monitored at Mooikraal as required by the WUL (License No. 08/C22K/CIGJFAE/6981). EC, pH, TSS, PO_4 are within acceptable WUL limits for the monitoring period from February to June 2018. Samples analysed from the 29th of March to 31st of May 2018 show elevated NO_3 above the 15 mg/L WUL standard limit. Ammonia levels are generally within acceptable WUL (6 mg/L) except for a sample collected on 17th of April 2018 which exceeded the limit. E Coli level exceeded the WUL standard of 0 CFU/100ml, while Faecal Coliform was within the acceptable WUL limit (1000 CFU/100ml). From February to June 2018, Cl levels exceeded the stringent WUL standard limit of 0.25 mg/L.

8.8.4 3 Shaft

Trend analysis for electrical conductivity (EC), pH, SO_4 and chloride (Cl) sourced from the bi-annual IGS report (IGS, 2018) leads to the following conclusions on the Leeuspruit water quality:

- SO4 levels both upstream and downstream of 3 Shaft are within the WUL acceptable limit of 200 mg/L. Point SIG/5 upstream of 3 Shaft has lower SO4 concentration than the downstream point (SIG/6) indicating some contamination from activities at the existing 3 Shaft Plant and Crusher.
- Cl and EC are generally within the WUL acceptable limits for all monitoring points at least from 2007 to 2018.
- All other parameters analysed and compared against WUL limits in January 2018 are within acceptable WUL ranges excluding sodium (Na), manganese (Mn), nitrate (NO3), phosphate (PO4), total suspended solids (TSS), Faecal Coliform and E. Coli.
- Farming activities including use of pesticides and fertilisers in agricultural fields around the Leeuspruit drainage are possible sources of NO3, PO4, and TSS in addition to sediments washed-off by runoff at 3 Shaft;

- Faecal coliform, E Coli exceed WUL limits within the Leeuspruit tributary which can be explained by contamination from regular municipal sewage overflows upstream of 3 Shaft.
- Although the Leeuspruit is perennial, flow volumes and rates are generally low with high flows generally associated with high rainfall events. High runoff can cause the increase in TSS observed in the January results that represent a wet season survey; and
- Mn and Na are naturally occurring elements that are enriched in the soils and geology of the area which is the source of these contaminants (IGS, 2018);

8.9 Ground Water

The groundwater levels at Mooikraal are affected by mining activities. This could be attributed to the presence of vertical groundwater pathways within the project area. This trend is not observed for all boreholes meaning that the presence of the dolerite sills does restrict impact. Some water levels are also observed to have been affected by pumping for water supply activities within the study area.

Water table at the 3 Shaft range from 4.73 to 31.63 mbgl, with an east to west groundwater flow direction.

The local groundwater quality at Mooikraal is predominantly influenced by the local geology and at 3 Shaft only the intermediate aquifer shows remnants of this characteristic with high alkalinity showing signs of impact from the ash backfilling from the underlying Sigma mine void. The shallow aquifer at 3 Shaft is a fresh aquifer with recently recharged groundwater. Of all the aquifers assessed, none are impacted by mining related activities (including the mine aquifer however with the exception of the intermediate aquifer at 3 Shaft). This is concluded based on the relatively minimal sulphate concentrations and EC values found in the groundwater.

Model simulations indicate minimal impacts from the removal of groundwater. This is due to the presence of the dolerite sills which act as aquicludes; restricting impact to the local aquifers in terms of groundwater quantity deterioration. However, there are monocline structures within the western parts of Mooikraal which are preferential flow pathways. These structures were conceptualised to not penetrate the dolerite sills because their formation is understood to have taken place prior the sill intrusions. Thus, the dolerite sills predominantly restrict the extent of the drawdown to the immediate area.

Relocation of the facilities onto the stockpile may generate contaminating leachate at the new location; as rainwater infiltrates through the coal, metals could be dissolved, and leachate may form. The leachate may then seep to the groundwater and migrate by advection within the groundwater environment.

Looking at the current groundwater quality at 3 Shaft area, no mining related impact thus far have been observed although the existing primary plant area has been operational since 1950. However, the location of the monitoring boreholes needs to be reassessed as they are

not located in areas within close proximity to the existing primary plant area and therefore it is with low confidence that 3 Shaft is deemed as an area that is without contamination. Two boreholes are recommended downstream of the existing primary plant (one borehole at the shallow aquifer and another at the intermediate aquifer).

The stockpile area, however, is much less of a risk to the groundwater environment compared to the previous location. This is because the relocation area (stockpile area) is lined with concrete therefore reducing the potential or rate at which leachate may seep into the underlying unsaturated and saturated zone (aquifer). The stormwater management system will also be upgraded reducing the potential impact even further. Due to these factors, the plant area is not observed to be a high risk to the groundwater environment.

9 Closure and Rehabilitation Objectives and Approach

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation.

The following points outline the overarching objectives, in line with the Mooikraal EIA and EMP (2014), which have been carried forward into the consolidated EMP, to assist Sasol in carrying out successful rehabilitation at Mooikraal:

- Comply with all applicable legislation (local and national) regulatory requirements at the time of final decommissioning and rehabilitation;
- Achieve post mining land use which is compatible with the surrounding land uses;
- Ensure that the post mining land use is physically stable in that it does not pose a hazard to public health and safety
- Ensure that the post mining land use is environmentally stable, in that adverse environmental risks have been identified and mitigated
- Implement rehabilitation actions to achieve post mining land use, to ensure that the land is environmentally and physically stable;
- Monitor the rehabilitation actions; and
- Consult with all relevant interested and affected parties (stakeholders).

9.1 Rehabilitation Strategy

The section below details the overall management strategies for rehabilitation.

9.1.1 Soil Management

Soil management measures typically include the following:

- The rehabilitated area should be profiled to replicate the natural landform;

- When there is insufficient soil material for use, select suitable sub surface materials (i.e. those that are neither saline nor sodic) to use as a substitute for soil when covering rehabilitated areas; and
- Ensuring organic content is sufficient to sustain microbial activity, encourage infiltration, limit runoff and improve soil stability. Despite not being practical, mulch with grass clippings (cut when seed content is at its highest) as an attempt to provide a seed bank.

9.1.2 Shaping and Levelling

Disturbed areas should be shaped and levelled back to original pre-construction ground level and should be free draining, shaping and levelling should be informed by a qualified professional.

9.1.3 Soil Compaction Alleviation

In order to alleviate or reduce soil compaction the following should take place:

- Rip all disturbed footprints and heavily compacted areas (hard pans, access roads);
- Soil should be ripped when moist to allow for maximum alleviation of compaction; and
- Soils should be moved and/or replaced when they are dry to minimise compaction.

9.1.4 Soil Amelioration

Soil amelioration should be done as follows:

- Following de-compaction, an acceptable seed-bed should be produced through surface tillage;
- Soil should be sampled and analysed once placed on rehabilitated areas; and
- Fertiliser should be applied to raise the soil nutrient content to the desired levels and maintenance should continue.

9.1.5 Erosion Control

The following should be done as part of erosion control on rehabilitated land:

- Unnecessary disturbance and vegetation removal should be avoided and prevented;
- Pre-development drainage patterns should be reinstated as far as possible; and
- Rehabilitated areas should be monitored for erosion.

9.1.6 Subsidence

An initially well-graded surface may subside differentially due to the presence of relatively under-compacted zones in the spoil. The effect of differential subsidence is to downgrade the standard of rehabilitation in two ways:

- Localised hollows ("melon holes") may become wet spots which cause management problems irrespective of whether the land is destined for grazing or arable use. In extreme cases, sink-holes may develop in the rehabilitated topography; and
- Subsidence on sloping topography will cause failure of anti-erosion structures such as banks and furrows that have been aligned according to immediate post-levelling contours. This will lead to aggravated rill and gully erosion at points of failure.

In practice, differential subsidence is unavoidable. Remedial measures consist of levelling hollows using additional soil material, and over-designing surface water interception structures.

9.1.7 Vegetation Establishment

The establishment of natural vegetation is a necessary component of the decommissioning and rehabilitation phase. The overall objectives for the establishment of natural vegetation of reshaped areas are to:

- Prevent erosion;
- Avoid soil loss;
- Restore the land to the agreed land capability;
- Reduce sedimentation into aquatic ecosystems such as rivers and streams;
- Re-establish eco-system processes (succession) to ensure that a sustainable land use can be established without requiring excessive fertiliser additions; and
- Restore the biodiversity of the area as far as possible.

In order to ensure vegetation establishment, the following should be done:

- Rehabilitated areas should be properly prepared;
- Woody patch cavities should be in-filled with suitable growth medium;
- Growth properties should be improved by the addition of organic matter and fertilizer, where required;
- The area should be seeded with an appropriate seed mix consisting of locally found and sourced species.

9.1.8 Surface Water Mitigation

The following mitigation measures are recommended:

- Use of accredited contractors for removal or demolition of infrastructure must be adhered to, in order to reduce the risk of waste generation and accidental spillages;
- Landscape re-profiling must be undertaken on rehabilitated land to allow good drainage. This will ensure improvement of catchment yield close to pre-mining conditions in the surrounding Kromelmboogspruit and Leeuspruit watercourses; and
- The possibility of contaminated decant can be reduced by sealing-off mine shafts and boreholes with cement and plugging them with concrete.

9.1.9 Groundwater Mitigations

The following mitigation measures are recommended:

- All existing boreholes as informed by the registers, with the exception of private water supply boreholes and monitoring boreholes should have been sealed and decommissioned according to Sasol Mining procedure during the operational phase, in order to minimise the chance of decant occurring;
- All shaft adits, ventilation shafts and downcasts must be sealed and decommissioned as guided by a professional;
- Should there be an negative impact to surface water bodies due to decant and baseflow contribution, investigations must occur, and rehabilitation must commence as informed by a professional;
- Should there be an negative impact to delineated wetlands, investigations must ensue, and rehabilitation must commence as informed by a professional;
- The waste rock material which must be backfilled into the shaft should be completely flooded to eliminate exposure to oxygen, this must hinder contamination generating reactions;
- Potential decant should be informed by the numerical model as new data becomes available, should decant be predicted to occur, decant locations should be monitored for decant quality and rate;
- The groundwater monitoring network may be re-assessed and amended to determine the boreholes, to be monitored, necessary to monitor the relevant aquifers sources of contamination and receptors; and
- Groundwater monitoring should be conducted to assess the time series water level and water quality trends.

9.1.10 Wetland Area Guidelines

There are many wetland areas on the Mooikraal site and various measures should be adhered to when working in these areas (Freshwater Impact Assessment, Digby Wells, 2018)

- Ensure that sound environmental management is in place during the proposed decommissioning phase;
- Limit the footprint area of the decommissioning and rehabilitation activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas);
- All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan;
- All soils compacted as a result of decommissioning activities should be ripped/scarified (<300mm) and profiled;
- Permit only essential personnel within the zones of regulation for all freshwater features identified;
- Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream;
- No material may be dumped or stockpiled within any wetland areas (or the buffers) in the vicinity of the proposed decommissioning footprint;
- Freshwater resources and their associated zones of regulation are to be clearly demarcated and avoided wherever possible;
- An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases;
- As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils, vegetation clearance should be kept to a minimum;
- Monitor all freshwater systems for erosion and incision;
- All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses;
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint;
- Compacted soils should be ripped, re-profiled and re-seeded;
- All vehicles must be regularly inspected for leaks;
- Re-fueling must take place at a diesel facility on a sealed and bunded surface area away from wetlands to prevent ingress of hydrocarbons into topsoil;

- All existing litter, debris should be removed from the freshwater systems and littering should be prohibited on an ongoing basis;
- All spills from machinery should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility; and
- Monitoring should be carried out as specified in the monitoring programme.
- The road servitude and conveyor have affected the integrity of the wetlands resulting in a loss of habitat and downstream surface water recharge. Rehabilitation during the decommissioning and closure phase should focus on the rehabilitation of these areas. Management in this regard would include removal of the structures, re-profiling of the bed and marginal zones to restore the geomorphological and hydrological integrity and ripping and re-seeding with indigenous wetland grass species.
- All incidents of erosion should be remedied and AIPs removed, as in the operational phase; and
- Any coal contamination should be removed and discarded at the correct facility as in the operational phase.

To ensure successful rehabilitation at Mooikraal, it is important to note vegetation types so that these can be replaced to some extent once mining has been completed.

Table 9-1 indicates the Rehabilitation Actions that are required to meet the rehabilitation objectives of Mooikraal.

Table 9-1: Summary of Rehabilitation and Closure Actions for the Project Area

Target Area	Main Actions
Infrastructure and Plant Area	■ Infrastructure such as the offices, administration buildings and workshops should be removed, unless legally transferred or sold to another party; ■ If complete infrastructure removal is chosen, all infrastructure should be demolished to 1m below surface and the demolition rubble removed and taken to the nearest waste facility or utilised as backfill for the shaft area, if not contaminated; ■ If contamination in the soil is discovered around stockpiled areas, this soil should be removed by 300 mm and disposed of in the appropriate waste disposal facility; ■ The footprint should be ripped 300 mm to alleviate compaction; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Infrastructure	■ All salvageable equipment and plant is to be removed as the mine is decommissioned; ■ All tanks, pipes and sumps containing hydrocarbons or any other fluids to be flushed or emptied prior to removal or abandonment once underground mine is sealed off. These tanks should be disposed of at an appropriate waste facility; ■ All power and water services to be disconnected and certified as safe. Where practicable cabling containing copper is to be brought to surface; ■ Surface openings (air vents, shafts, portals, etc.) will be sealed with a steel or concrete cover that attaches to the existing concrete collar; ■ Box cuts, inclines and portals will be backfilled with the overburden material stripped ahead of mining; and ■ The seals between the underground workings and the backfill or surface, will be engineered to withstand potential pressure exerted on the seal from water as the workings fill during groundwater rebound.
Waste Rock Dump and Product Stockpiles	■ All stockpiled product must be removed; ■ If contamination in the soil is discovered around stockpiled areas, this soil must be removed and disposed of in an appropriately lined waste disposal facility; ■ Use waste rock material in rehabilitation efforts (envirobund, in-filling, back-filling etc.); ■ Rehabilitated areas must be contoured to be free draining and roughly emulate the surrounding surface topography; ■ Rip the waste dump footprint areas to alleviate compaction; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.

Target Area	Main Actions
Roads and Parking areas and other paved surfaces (incl. concrete slabs and bricks)	■ Mine roads that are not needed for closure and post-closure uses at the site (e.g. security and monitoring) will be closed; ■ Removal of all signage, fencing, shade structures, traffic barriers, etc.; ■ All 'hard top' surfaces to be ripped and bitumen/concrete removed along with any culverts and concrete structures; ■ All concrete lined drainage channels and sumps will be broken up and removed; ■ All potentially contaminated soils are to be identified 'and demarcated for later remediation; ■ All haul roads that have been treated with saline dust suppression water need to be treated as “sealed” roads with the upper surface ripped and removed to designated contaminant disposal areas; ■ Establish vegetation establishment to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; ■ All concrete slabs and brick material will be broken up and used as infill material at Mooikraal; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Conveyor and Pipeline Route	■ All power and water services to be disconnected and certified as safe prior to commencement of any demolition works; ■ Electrical, water and other services that are more than 1 m below ground surface will remain; ■ Conveyor belting to be removed, cut up and disposed of offsite or reused at other operations; ■ Salvageable equipment will be removed and transported offsite prior to the commencement of demolition; ■ Concrete slabs and footings will be broken and buried in situ. This concrete will be broken up and used as infill material at Mooikraal; ■ All concrete below 1 m depth will remain underground with the invert of all structures broken/sealed to prevent possible ingress and ponding of water; ■ All excavations resulting from demolition of the conveyor plinths will be left in a safe manner; ■ Rehabilitated areas must be contoured to be free draining and roughly emulate the surrounding surface topography. The natural topography of the wetland crossing the servitude should be re-instated to ensure that the flow connectivity is restored, this will be informed by a professional; ■ Rip the servitude road and conveyor footprint to reduce compaction; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Mooikraal Silo	■ If complete infrastructure removal is chosen, all infrastructure should be demolished to 1 m below surface and the demolition rubble removed and used as infill at Mooikraal. ■ If contamination is discovered, this soil should be removed and disposed of in the appropriate waste disposal facility. ■ Rehabilitated areas must be shaped to be free draining and roughly emulate the surrounding surface topography. ■ Rip disturbed area, place 300 mm topsoil to reduce compaction. ■ Establish vegetation cover. ■ Remove alien invasive vegetation.
PCDs and Water Pipelines	■ De-silt pollution control dams; ■ Conduct a contamination assessment on the PCD’s to determine the appropriate rehabilitation measures to be adopted, if sediment is contaminated it may be required that the sediment is removed and disposed of at a registered facility and/or investigate options for in situ rehabilitation;

Target Area	Main Actions
	■ Doze the dam walls; ■ Concrete of the dam overflow to be broken up and used as infill material at Mooikraal; wire mesh at the overflow to be removed and disposed of; ■ Remove supporting plinths for pipeline as well as foundations; piping and other associated infrastructure to be removed; ■ Pump station to be decommissioned, infrastructure removed, concrete slab to be demolished and used as infill material at Mooikraal; ■ Remaining structures should be demolished to 1 m below surface and the demolition rubble removed and any re-usable items should be removed from the site; ■ Soil should be tested for contamination; ■ If contamination is discovered, this contaminated soil should be removed and disposed of in the appropriate waste disposal facility; ■ The footprints of dams must be ripped to 200 mm; ■ Appropriate topsoil should be replaced to a minimum thickness of 300 mm on the rehabilitated areas; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Water Treatment and Sewage Treatment Plants	■ If complete infrastructure removal is chosen, all infrastructure should be demolished to 1m below surface and the demolition rubble removed and placed into Quarry. ■ If contamination is discovered, this soil should be removed and disposed of in the appropriate waste disposal facility. ■ Rehabilitated areas must be shaped to be free draining and roughly emulate the surrounding surface topography. ■ Rip disturbed area, place150 mm topsoil to reduce compaction. ■ Establish vegetation cover. ■ Remove alien invasive vegetation.
Fencing	■ Service roads providing access to the fences will be rehabilitated; ■ Fencing and walls will be demolished as sections are rehabilitated/closed to ensure access control and monitoring of rehabilitation measures; ■ Monitor and maintain vegetation establishment; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Coal Stockpile Area and Crusher Plant at 3 Shaft	■ All coal product will be removed from the stockpile area; ■ All infrastructure will be removed (mining and dust suppression infrastructure) ■ The delineated wetland area will be barricaded off, with appropriate signage, to prevent any disturbance or unauthorised activity within the regulated area, ■ The conveyor belt spanning the wetland will be removed, as well as associated infrastructure, foundations, and terraces – these actions will be informed by a professional, ■ The stockpile area access roads traversing the wetland will be rehabilitated as informed by a professional; ■ All applicable authorisations will be applied for prior to commencement of any activities within the regulated area of the wetland ■ Cement stockpile pad will be demolished, a contamination assessment of the rubble will determine the disposal of the rubble; ■ Soil containing coal duff will be removed to a depth of 300 mm unless it is noted that the level of coal duff is deeper, a contamination assessment of the soil-coal duff will be undertaken to determine the appropriate means of disposal. ■ Dirty water management structures will be demolished, a contamination assessment of the soil-coal duff will be undertaken to determine the appropriate means of disposal. ■ The area will be contoured to reduce the likelihood of ponding occurring on surface and to blend in with the surrounding topography;

Target Area	Main Actions
	■ The area should be ripped to 500mm to reduce compaction; ■ Appropriate topsoil should be replaced to a minimum thickness of 300mm on the rehabilitated areas; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Any remaining dumps should be rehabbed in situ if an excess of material is discovered. ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Substation	■ Remove generator and sub-station and associated infrastructure from site (it is assumed that all contamination is removed during operation); ■ Demolish concrete bund area and conduct a contamination assessment of the rubble to determine the appropriate means of disposal of material; ■ A contamination assessment of the substation footprint must be carried out and corrective actions, as determined by a professional, must be undertaken to address any contamination present. Once the site has been cleared of all infrastructure and rubble and no contamination is present, the area should be contoured to create a gently sloping, free-draining topography; ■ Topsoil should be replaced over the area and ripped to 200 mm to reduce compaction, thereafter establish successful vegetation cover; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Diesel Storage Tanks	■ Remove diesel tanks (by owner) and associated infrastructure from site (it is assumed that all potential contamination is removed during operations). ■ Thereafter, demolish concrete bund wall and dispose of contaminated material at a hazardous waste facility. ■ Once the site has been cleared of all infrastructure and rubble and no contamination is present, the exposed area should be reshaped to create a gently sloping, free-draining topography. ■ Monitor and maintain vegetation establishment. ■ Remove alien invasive vegetation.
Disturbed areas	■ Contamination assessments must be undertaken in areas where hazardous material was handled to determine if there is any contamination of soils. If contamination in the soil is discovered, this soil must be removed and disposed of in the appropriate waste disposal facility; ■ Rehabilitated areas must be contoured to be free draining and roughly emulate the surrounding surface topography; ■ Rip footprint areas to alleviate compaction; ■ Establish vegetation to ensure a sustainable cover and to prevent erosion; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; ■ Remove alien invasive vegetation; and ■ Monitor required aspects according to guidelines stipulated in specialist reports appended to the EIA.
Shaft 3 wetland	■ All rehabilitation actions within the wetland regulated area will be informed by a professional, ■ All applicable authorisations will be applied for prior to commencement of any activities within the regulated area of the wetland; ■ During decommissioning of the 3 shaft area, the wetland area will be demarcated and appropriate signage will be erected, to prevent any unauthorised activities and disturbance within the area ■ A dedicated waste disposal is to be established for the inert demolition waste from the conveyor. Steel and any other material of salvage value to be sold and removed from site;

Target Area	Main Actions
	■ Removal of the disused road crossing the wetland (see B in Figure 11-1); ■ All coal and fine carbonaceous material up to 300mm from the natural ground should be removed from the wetland and stockpiled. Stockpiled waste should be collected with a back-actor, parked on a safe place on the edge of the infilled areas. The remaining 300mm of waste material should be loaded manually (using spades) into the skip of the back-actor to limit any impacts on the existing soils; ■ Subsoil is to be levelled according to surrounding wetland landscape to promote functional hydrology. This includes infilling of the channel that was dug. Wetland soils that can be preserved from the excavated areas associated with the site should be levelled over the area and manually compacted. Patches of Phragmites that don't need to be levelled should be left in place to assist with colonisation and provide a refuge for biota; ■ Revegetation should ideally take place in the wet season, as far as possible, to promote successful germination. Table 11-1 lists plant species that would be suitable for revegetation. Many of these species (if not all of them) can be found on site and seed can be harvested manually; ■ Wetland area to be monitored monthly, for six months for six months after the rehabilitation actions are completed to ensure that erosion and alien plant invasion are kept under control and remedied;
Kleinvlei Ventilation Shaft and adit	■ Remove all vent shaft related infrastructure; ■ Cap shaft with engineering requirement seal (6.1 m diameter); ■ Appropriate topsoil should be replaced to a minimum of 300 mm thick in all rehabilitated areas. This must be included in the monitoring programme; ■ Topsoil should be fertilised and ripped to 200 mm to reduce compaction. The fertiliser requirements can only be determined once a fertility assessment is carried out at the proposed project area; ■ Remove alien invasive plants; ■ Prevent access of people/machinery/vehicles/grazing animals on newly rehabilitated land to allow regeneration of vegetation and reduce erosion; and ■ Ensure that robust care and maintenance plans are in place.

9.2 Alien Invasive Species Management

Alien invasive species tend to out-compete the indigenous vegetation; this is due to the fact that they are vigorous growers that are adaptable and able to invade a wide range of ecological niches (Bromilow, 1995). They are tough, can withstand unfavourable conditions and are easily spread which is detrimental to rehabilitation of vegetation. Alien Invasive Plants (AIPs) directly compete with rehabilitating vegetation and could result in increasing costs of revegetation in the long term. In addition, various invasive species are required by law to be removed. Methods should be used that are appropriate for the species concerned, as well as to the ecosystem in which they occur. When performing the controlling methodology for weeds and invaders, damage to the environment must be limited to a minimum. One of the most cost-effective and sustainable options is to utilise biocontrol. Biocontrol makes use of a natural enemy of the AIP in its native country to help reduce the population in the country it invades (see the Agricultural Research Council website for more information on Biocontrol) – most likely not to be adopted to the study area. If mechanical and chemical means need to be used, AIPs must be continually removed after rehabilitation has occurred for at least three growing seasons to ensure the seed bank is depleted. Continual monitoring will be needed for seeds that are likely to be blown in from adjacent areas.

The following should be considered during the rehabilitation process:

- AIP control should be focused on areas that the mine has had direct disturbance on, such as areas that have been cleared or rehabilitated;
- There must be no planting of alien plants;
- The transportation of soils or other substrates infested with alien species should be strictly controlled;
- It is considered essential that appropriate veld management (particularly appropriate grazing levels and burning frequencies) should be applied to areas of secondary indigenous vegetation (e.g. secondary grassland of historically cultivated areas), and especially the grassland and wetland vegetation of untransformed habitats.

9.2.1 Legal Requirements

9.2.1.1 Category 1a Listed Invasive Species

Category 1a Listed Invasive Species are those species listed as such by notice in terms of Section 70(1) (a) of the Act as species which must be combatted or eradicated.

- A person in control of a Category 1a Listed Invasive Species must-
  - Comply with the provisions of section 73(2) of the Act;
  - Immediately take steps to combat or eradicate listed invasive species in compliance with sections 75(1), (2) and (3) of the Act; and

- Allow an authorised official from the Department to enter onto land to monitor, assist with, or implement the combatting or eradication of the listed invasive species.

- If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must combat or eradicate the listed invasive species in accordance with such programme.

9.2.1.2 Category 1b Listed Invasive Species

Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled;

- A person in control of a Category 1 b Listed Invasive Species must control the listed invasive species in compliance with sections 75(1), (2) and (3) of the Act;
- If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme; and
- A person contemplated in sub-regulation (2) must allow an authorised official from the Department to enter onto the land to monitor, assist with, or implement the control of the listed invasive species, or compliance with the Invasive Species Management Programme contemplated in section 75(4) of the Act.

9.2.1.3 Category 2 Listed Invasive Species

Category 2 Listed Invasive Species are those species listed by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be;

- Unless otherwise indicated in the Notice, no person may carry out a restricted activity in respect of a Category 2 Listed Invasive Species without a permit;
- A landowner on whose land a Category 2 Listed Invasive Species occurs or person in possession of a permit, must ensure that the specimens of the species do not spread outside of the land or the area specified in the Notice or permit;
- If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme;
- Unless otherwise specified in the Notice, any species listed as a Category 2 Listed Invasive Species that occurs outside the specified area contemplated in sub-regulation (1), must, for purposes of these regulations, be considered to be a Category 1 b Listed Invasive Species and must be managed according to Regulation 3; and

- Notwithstanding the specific exemptions relating to existing plantations in respect of Listed Invasive Plant Species published in Government Gazette No. 37886, Notice 599 of 1 August 2014 (as amended), any person or organ of state must ensure that the specimens of such Listed Invasive Plant Species do not spread outside of the land over which they have control.

9.2.1.4 Category 3 Listed Invasive Species

Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of Act, as specified in the Notice;

- Any plant species identified as a Category 3 Listed Invasive Species that occurs in riparian areas, must, for the purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to regulation 3; and
- If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.

9.2.2 General Approach in compilation and implementation of a Management Plan for the eradication and control of declared Category 1a, 1b, 2 and 3 AIPs

The following general approach for the compilation of a management plan and proposed control methods has been provided for Category 1a, 1b, 2 & 3 Listed AIP's.

The management measures and approach needs to be an integrated control strategy focusing on the combination of various control methods, such as mechanical, chemical and/ or, if required, biological methods over the various phases of control. Mechanical removal of species within wetlands and stream areas are not recommended due to soil disturbance of wetlands that are associated with mechanical removal.

A three phase approach is proposed according to Campbell (2000) for each of the Priority Groupings identified, namely:

- **Phase 1: Initial control:** The drastic reduction of the existing population;
- **Phase 2: Follow-up control:** Control of seedlings, root suckers and coppice re-growth; and
- **Phase 3: Maintenance control:** monitoring and preventing the re-infestation, spread and densification of Category 1, 2 & 3 species, but also any other AIPs.

The ultimate objective of the Category 1a, 1b, 2 & 3 Listed AIPs Management Plan will be to reach the maintenance control phase. To reach this phase, the following Strategic Goals should be set and achieved:

- Prevention
  - Prevent the establishment and spreading of any Category 1a, 1b, 2 & 3 Listed AIPs within Mooikraal and 3 Shaft areas. Prevention could include measures such as washing the working parts and wheels of earth-moving equipment prior to it being brought onto rehabilitation sites, visual walk-through surveys every three months and other measures. Prevention of establishment of new populations is achievable through continuous monitoring and early detection. Any new disturbed and/or recent rehabilitated area where soil was disturbed normally tends to be invaded by pioneer species and AIPs. Implementation of immediately control measures of AIPs within these recent disturbed and/or newly rehabilitated areas can result in large cost savings should any declared Category 1a, 1b, 2, and 3 species be treated immediately and before such species start to produce seeds. Early detection of such category 1a, 1b, 2 and 3 AIPs within these areas are therefore critical.

- Early detection
  - Early detection will be dependent on continuous monitoring of Category 1a, 1b, 2 & 3 Listed AIPs through the Mooikraal and 3 Shaft areas. It is recommend that any new disturbed areas and/or rehabilitated areas where soil disturbances have occurred and any recently disturbed areas (such as the recent rehabilitated areas) be assessed to detect any AIPs established. Biannually monitoring in the form of movement (by foot) through the surface area is required in order to identify any new species that may start to established or that spread either through water, animals or wind-blown of seeds. Any Category 1a, 1b, 2 & 3 Listed AIPs detected during this phase should be treated immediately to prevent seed production. Young juvenile plants can easily be removed by hand;

- Rapid response
  - Species detected should rapidly be addressed by either hand pulling, herbicide application and/ or both in order to prevent more drastic steps such as mechanical removal; and

- Eradication, containment and control
  - Where prevention, early detection and rapid response, was not addressed, eradication measure should be followed to treat large infestation in order to maintain the footprint areas of infestations and to control and prevent species from spreading.

If the above objectives are met, during the maintenance control phase, Category 1a, 1b, 2 & 3 Listed AIPs should no longer be considered a problem, annual maintenance costs should be low and plant numbers/densities should be sustained.

In order to reach this phase a number of control methods are required, including mechanical, chemical, or biological. These control methods are discussed in detail under the various control phases below.

9.2.2.1 Phase 1: Initial Control (A drastic reduction of the existing population)

Within Phase 1, a selection of appropriate methods of control must be based on the following criteria:

- Species to *be controlled;*
- *Size of target plants;*
- *Density of stand;*
- *Accessibility of terrain;*
- *Environmental safety;*
- *Disposal of vegetation; and*
- *Cost of application*.

9.2.2.1.1 Species to be controlled

It is important to understand this grouping is based on the results of the infield assessment and takes the AIPs recorded, its densities, age class, NBAL's, and management units into consideration. Utilising the information gathered during the infield assessment, the following was determined:

- *Compilation of AIPs distribution maps: mapping of the Alien Invader Plants infestation involves the division of the area into Management Units (MU);*
- *Subdividing the area into Natural Biological Alien Land (NBALs) or polygons;*
- *The development of an annual Management Unit Clearing Plan (MUCP) which projects expected clearing operations;*
- *The compilation of an Annual Plan of Operations (APO) (Budget) which projects costs based on the Management Unit Clearing Plan (MUCP); and*
- *Implementation based on* the MUCP and APO.

Please refer to APO species to be control per NBAL

9.2.2.1.2 Size of the Target plants and methods of control

The following methods of control are appropriate for age or size target plants (as approved by WfW programme):

9.2.2.1.3 Seedlings & Saplings:

- *Hand pulling or hoeing*. Hand pulling or hoeing can be carried out in sparse stands under conditions where seedlings are easily removed from the soil. Seedlings should be severed below the soil surface or removed from the soil. Soil disturbance should be minimized to reduce re-germination. Species at the Sasol's Sigma: Mooikraal Coal Mine that can be hand pulled include seedlings of the following species:
  - *Acacia dealbata;*
  - *Acacia mearnsii;*
  - *Acacia melanoxylon;*
  - *Eucalyptus camaldulensis;*
  - *Eucalyptus cinerea;*
  - *Eucalyptus grandis;*
  - *Jacaranda mimosifolia;*
  - *Ligustrum lucidum;*
  - *Melia azedarach*;
  - Schinus terebinthifolius.

It is recommended that seedlings of the above species recorded in recent rehabilitated areas, along trenches and stockpile areas and newly disturbed areas within NBAL's 1-24 are monitored on an annual basis during the rainy season and that all seedlings and/or juvenile individuals pulled out by hand. This is required and must be conducted to prevent these species from reaching the reproductive stage and prior to the production of fruit and seeds to prevent them from spreading.

- *Foliar applications of herbicides*. This can be carried out in dense or open stands but not near any watercourse (for example: recent re-vegetated areas with medium infestations, this should be seen as a last resort). For dense stands suitable fan nozzles for overall application should be fitted. Sprayers should be fitted with pressure or flow regulators. In stands where individual plants are treated solid cone nozzles should be fitted. Spraying should be restricted to plants waist height or lower, but ensure there is sufficient foliage to carry the applied herbicide to the root system. Foliar spray application/treatment can be applied to control the following species: *Circium vulgare*, *Acacia mearnsii, Acacia melanoxylon* (certain herbicides for seedlings and coppice to 1m height and different herbicides for seedlings and coppice between 1m and 2m height).

- *Basal stem treatments.* Application of suitable herbicide in preferably an EcoDye can be carried out to the bottom 250 mm of the stem. Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle.
    - *Cut stump treatments*. Stems should be cut as low as possible as stipulated on the Herbicides label. Applications of diesel (not recommend) but preferably an EcoDye should be applied to the whole stump and exposed roots and mixed in water and applied to the cut area as recommended on the label. Cut stump treatment can be applied to the following species: all *Euc. spp.* (Only mature plants), *Cereus jamacaru* (all size / ages), *Populus X Canescens* (all size / ages), *Melia azedarach* (Only mature plants), *Ligustrum lucidum* (All sizes/ages), *Tamarix ramosissima* (Only mature plants), and *Schinus terebinthifolius* (all size / ages).

9.2.2.1.4 Mature trees:

These should be regarded as trees above 2m or robust bushes 12-18 months or older. This is applicable to the genera such as the *Eucalyptus* spp. and *Pinus* spp.

- *Ring barking. Bark must be removed from the bottom of the stem to a height of 0.75-1m. All bark must be removed to below ground level for good results. Where clean de-barking is not possible due to crevices in the stem or where exposed roots present, a combination of bark removal and basal stem treatments should be carried out. Bush knives (machetes) or hatchets should be used for de-barking. Can be applied on site to the following specie, Pinus spp. and Populus spp*
- *Frilling or partial frilling. Cuts should be through the bark into the sapwood by means of a bush knife or light axe and a suitable herbicide applied into the cuts. Can be applied on site to the following specie: Melia azedarach (mature / adult plants), Schinus terebinthifolius, E. camaldulensis,Schinus terebinthifolius, Pinus spp., Ligustrum spp.*
- *Basal stem treatments. Suitable herbicides should be applied in diesel to the base of the stem and to any exposed roots. Stems with a diameter up to 50mm should be treated to a height of 250mm and stems above 50mm diameter to a height of 500mm. This method is only suitable for stems up to 100mm in diameter. Application is by means of a low pressure coarse droplet spray from a narrow angle, solid cone nozzle.*
- *Cut stump treatments. Stumps should be cut as low as practical as stipulated on the label. Herbicide is applied in diesel (not recommended) or water as recommended for the herbicide. Applications in diesel should be to the whole stump and exposed roots and in water to the cut area as recommended on the label. Can be applied on site to the following species: Salix baylonica/fragile (Once properly identified, they should be felled and removed. Replacement with indigenous species is recommended. I.e. Salix mucronata (Larger trees should be felled/cut stump & the entire* root system

removed. As this is costly & undesirable in a riparian environment, ring-barking is recommended)

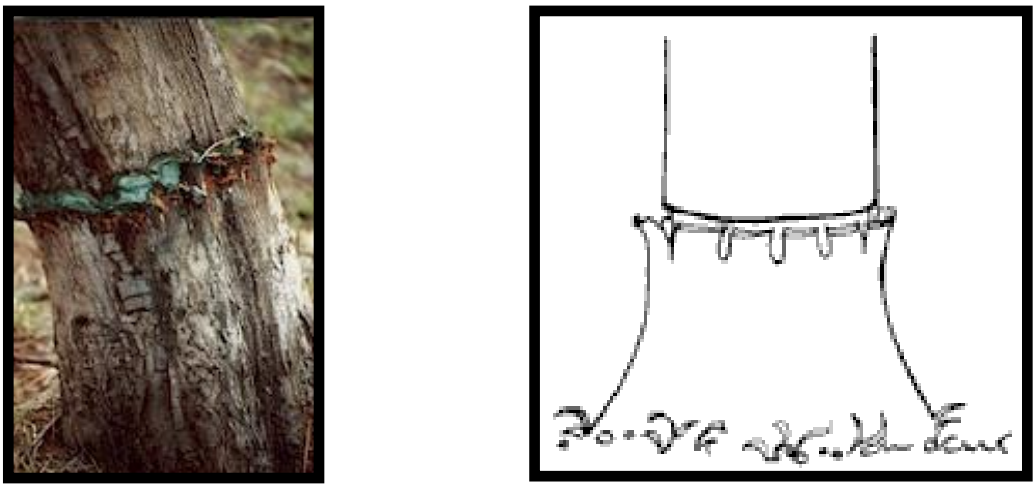


Figure 9-1: The Frilling Methods (Working for Water website)

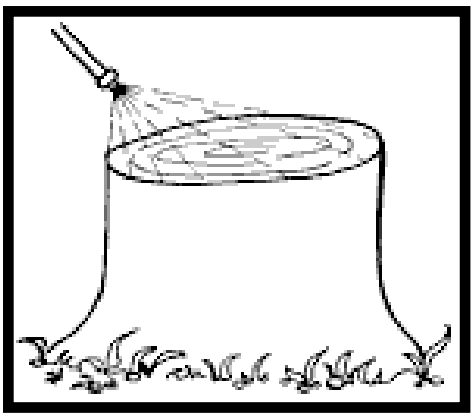


Figure 9-2: Cut Stem Treatment (Working for Water Website)

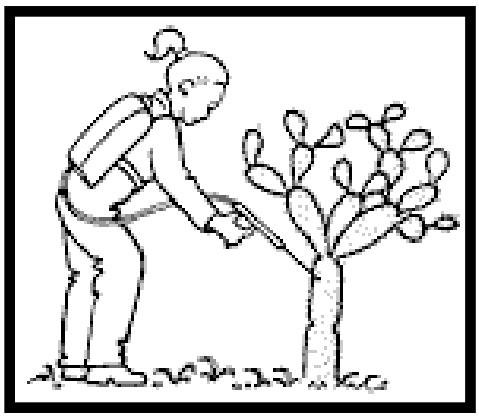


Figure 9-3: Stem Injection (Working for Water Website)

Stem injection. Preferably, due to the limited numbers of individuals, small plants can easily be mechanically removed and disposed of at a refuse transfer station. Stem injection if required: 4-10 jabs (depending on size of plant) of 5 ml undiluted glyphosate. Leave to rot on site. Normally applied to Opuntia spp.

Ecoplugs. These are placed directly in the stem of standing trees. They can be used in inaccessible rocky areas where the use of implements such as chain saws is difficult or hazardous.

9.2.2.1.5 Density of stands

The density of the stands of AIPs within the Sasol's Sigma: Mooikraal Coal Mine's mining right areas has been determined during the infield assessment and were taken into consideration during calculation of the priority groupings and APO.

9.2.2.1.6 Accessibility of terrain

The project area is relatively flat with the exception of the undermined area and some sections in the Southern and Eastern parts of the area. However all areas can be assessed by vehicles and where required by foot.

9.2.2.1.7 Environmental considerations

Sigma: Mooikraal Coal Mine ought to be in possession of a Biodiversity Action Plan (BAP) in line with the requirements of the National Environmental Management Biodiversity Act (NEMBA, 2004). The BAP must guide all things to do at some stage in the existence of mine which include the building of additional or any new infrastructure and post closure and after care and maintenance phases of the project. The BAP has to point out all requirements and objectives for closure and manage of impacts such as erosion and alien vegetation. Care ought to be taken to make certain that bare uncovered surfaces to be rehabilitated with an accepted seed mix and monitored for any signs re-emergence of alien invasives.

9.2.2.1.8 Watercourses/Wetlands

Wetlands are present on site along the Sasol's Sigma: Mooikraal pipeline route as well as on the Shaft 3 area. Care should therefore be taken to prevent contamination of surface water in streams, dams, and pans and surface water on site that may run into the natural vegetation of surrounding areas.

9.2.2.1.9 Natural Vegetation Pockets

Where natural vegetation is present, methods of control must be selected that will result in minimum damage to the desirable vegetation. The project area was comprised of pockets of three main habitats, namely *Themeda – Sporobolus* dominated Grassland, Transformed Areas associated with crop agriculture and wetland areas along the route of the pipeline (which were avoided during construction).

9.2.2.1.10 Disposal of vegetation

Where possible, utilizable wood should be removed after felling and felled trees should be removed off site. Burning of specific species (should it be recorded) should be carried out within a designated previously disturbed area. When removing material it is important to remove all debris including shoots and seeds.

9.2.2.2 Phase 2: Follow-up control – control of seedlings, root suckers and coppice/regrowth

Follow up control of alien seedlings, saplings and coppice re-growth is essential (Cambell, 2000) to achieve and sustain the progress made in the initial control work. Follow up control for re-growth should contain one or more of the following methods:

- Chemical Control, using only registered herbicides, specifically broadleaved herbicides. Furthermore application can either be aerial or ground, however aerial tends to be unselective and only justifiable in larger areas with higher density of targeted species and other woody species that are accepted to be eradicated;
- Mechanical Control; and
- Biological Control Agents (not required due to low numbers).

9.2.2.3 Phase 3: Maintenance – to sustain low AIPs numbers with low annual control costs

The aim of maintenance control is to keep the area stabilized by maintaining good indigenous cover and to prevent further soil disturbance. The following is essential within this phase:

- Bi-annual inspections and detailed assessment of alien plant re-growth, specifically three to four weeks after the rainy season begins, however, it is recommended that biannual monitoring of areas invaded needs to be conducted, and where required, that rapid treatment should be applied. This is required especially along the wetland areas, newly disturbed areas due to groundworks and rehabilitation of disturbed areas, along roads and rehabilitated areas as weeds like *Tagetes minuta,* certain wattles (Australian *Acacia spp.),* certain gumtrees *(Eucalyptus spp.), Cirsium vulgare* and *Datura stramonium* tends to invade such disturbed and recently rehabilitated areas;
- Quarterly monitoring in order to identify any seedlings, re-growth, coppices and or new area of invasion; and
- When resources are limited an integrated approach is required. Therefore each area needs to be ranked according to category and extent of disturbance.

10 Monitoring, Auditing, Reporting and Maintenance

Achieving the rehabilitation objectives for Mooikraal and 3 Shaft (as detailed in Section 9) requires maintenance and regular monitoring of all rehabilitated areas following re-vegetation. The physical aspects of rehabilitation should be carefully monitored during the operational phase as well as during the progress of establishing the desired final ecosystems. In general, the following items should be monitored continuously:

- Chemical, physical and biological status of replaced soil;
- Erosion status;

- Surface drainage systems (created wetland zones) and surface water quality;
- Groundwater levels and quality at agreed locations;
- Vegetation basal cover;
- Vegetation species diversity;
- Alien vegetation control;
- Faunal re-colonisation; and
- Proportion of mined land that has been fully rehabilitated.

It is expected that areas where infrastructure is located, will be areas that the current land use will be impacted upon. For these areas it is recommended that the mine rehabilitate the areas back to a predefined the pre-mining land use, as these footprints are expected to be small in size.

As a result of the mine being an underground operation, the surface land use should not be impacted upon; however subsidence will impact on land use should there be a collapse. It is recommended that ongoing monitoring is undertaken on the surface and modelling is undertaken to predict if subsidence would occur and the risk associated with it. In the event that subsidence does occur, rehabilitation of these areas needs to be undertaken. The level of rehabilitation would be dependent on the risk of collapse and the degree of subsidence. If subsidence is a high risk and occurs on sites resulting in a drastic change in topography, these areas may need to be designated as no-go areas and should be fenced off with appropriate signage erected.

Moreover, poor water quality emanating (decanting) post closure could be a concern and the potential formation of Acid Mine Drainage (AMD). Alternatives would therefore need to be considered during Mooikraal's operational phase with respect to water treatment (both active and passive forms of treatment).it is unlikely that this will be required, but the predictions towards the end of LoM should become more accurate, thus enabling a decision to be made with respect to water treatment.

Table 10-2 sets out the proposed monitoring plan and audit requirements for Mooikraal.

Table 10-1: Post Closure Monitoring Programme

Component / Aspect	Monitoring		Performance / success criteria	Corrective action
	Methodology	Frequency / duration		
Soil Management				
Soil fertility	▪ Undertake a visual assessment and delineate areas where poor vegetation growth has occurred; ▪ Submit soil samples to an accredit soil laboratory to conduct soil fertility analysis for areas where vegetation establishment is lacking.	Yearly until soil fertility supports the proposed final land use or for at least five years post-closure. A final land use design should be compiled to align with the Mooikraal EMP.	▪ Soil analysis results comply with remediation targets[1] at a 95 percentile level; and ▪ Self-sustaining vegetation establishment.	▪ Apply amelioration where required as informed by sampling undertaken.
Erosion	▪ Conduct a visual assessment to determine areas of potential erosion; and ▪ Undertake field investigations, fixed point photography to document the significance of the erosion occurring on site	Twice yearly for at least five years post closure.	▪ No evidence of significant erosion; and ▪ Good vegetation cover and species composition.	As required: ▪ Re-shape areas to ensure that they are free-draining; ▪ Establish vegetation on bare patches; and ▪ Repair and stabilisation of erosion gullies and sheet erosion.
Post-mining end land use	▪ Assess activities completed, as well as legal and related documentation completed and signed-off; and ▪ Ensure rehabilitation measures are aligned to the LUP, which will need to be re-developed five years prior to closure.	Once off, at mine closure.	▪ Area has been rehabilitated to an aesthetic quality not to compromise potential grazing activities; ▪ Transfer to third party operator has taken place once the area has been proven to be safe for grazing; ▪ Legal and zoning issues have been addressed; and ▪ Vegetation re-establishment, cover and composition are sustainable.	▪ Refer back to end land use plan, which must be compiled five years prior to closure, and refine measures to be implemented in achieving the desired final land use.
Topography	▪ Conduct a visual assessment to determine areas of potential erosion; and ▪ Undertake quarterly digital surveys of rehabilitated areas to confirm that final topography is aligned with landform designs.	During rehabilitation phase	▪ No evidence of significant erosion. ▪ No evidence of water pooling on rehabilitated areas. ▪ The final profile achieved should be acceptable in terms of surface water drainage requirements and the end land use objectives.	As required: ▪ Re-shape areas to ensure that they are free-draining; and ▪ Refer back to end land use plan, which must be compiled five years prior to closure, and refine measures to be implemented in achieving the desired final land use.

[1] Refer to Section 9.1.4

Component / Aspect	Monitoring		Performance / success criteria	Corrective action
	Methodology	Frequency / duration		
Vegetation establishment	▪ Determine whether re-established vegetation communities are on a trajectory of achieving a stable self-sustaining community dominated by species typical of the climax-species present in the adjacent areas: ▪ Inspect rehabilitated areas to assess vegetation establishment and provide for early detection of erosion in recently planted/seeded areas (monthly); ▪ Undertake fixed point photography at specific points at the rehabilitated sites to obtain a long term directly comparable method of determining changes in the landscape; and ▪ Conduct evaluation of rehabilitated areas by means of field inspections. During these assessments measurement of growth performance and species abundance will be carried out to determine: i. Plant basal cover and species abundance in the grassed areas. Estimates of vegetation canopy and ground cover as well as height; ii. Distribution, growth and survival of woody species; iii. Dominant plant species (woody and herbaceous); iv. Presence of exotic invasive species, and degree of encroachment; v. Browsing or grazing intensity; vi. Notes regarding erosion, such as, type, severity, degree of sediment build-up; and vii. Species composition and richness.	Yearly for at least five years post-closure.	▪ Limited to no erosion; and ▪ Self-sustaining vegetation ecosystem.	As required: ▪ Re-vegetate poorly established rehabilitated areas; ▪ Re-seed bare patches; and ▪ Apply additional fertiliser and/or organic matter, depending on the condition of the vegetation and the initial organic material application.
Invasive alien species	▪ Visually inspect areas where invasive species have been previously eradicated and areas prone to invasive species (e.g. eroded/degraded areas, along drainage lines, etc.); and ▪ Undertake surveys on relevant sites where bush encroachment has previously been identified to determine the status quo of invasive vegetation.	Yearly for at least five years post-closure.	▪ Limit and/or prevent declared Category 1, 2 and 3 invader species establishing; ▪ Minimise extended threat to ecosystems, habitats or other species; ▪ Increase the potential for natural systems to deliver goods and services; and ▪ Minimise economic or environmental harm or harm to human health.	▪ Revisit mitigation measures; and ▪ Continue control and management.

Component / Aspect	Monitoring		Performance / success criteria	Corrective action
	Methodology	**Frequency / duration**		
General site status	▪ Conduct a visual assessment with respect to compliance of the afore-mentioned closure measures and to ensure that the site is aesthetically neat and tidy, and that no health or safety risks exist on site.	Once-off following implementation of rehabilitation measures.	▪ Waste/rubble free sites.	As required: ▪ Clear remnant rubble and dispose of in open quarry as backfill material.
Surface Water Quantity	▪ Visually assess the functionality of the surface water drainage systems feeding surface water runoff from rehabilitated areas. ▪ Undertake field investigations, fixed point photography to document the significance of the erosion occurring on site.	After the first major rains of the season and after any major storm.	▪ No evidence of significant erosion; and ▪ No evidence of water pooling on rehabilitated areas.	As required: ▪ Re-shape areas to ensure that they are free-draining; and ▪ Refer back to end land use plan, which must be compiled five years prior to closure, and refine measures to be implemented in achieving the desired final land use.
Surface Water and Groundwater Quality	▪ Sample and monitor surface and groundwater quality.	Bi-annually for at least five years post-closure.	▪ Water quality results within ranges of the WUL and/or DWS standards.	As required: ▪ Increase monitoring frequency and detect point sources. ▪ Optimise monitoring plan if needed.
Groundwater Quantity	▪ Sample and monitor groundwater levels in the vicinity of the mine.	Bi-annually for at least five years post-closure.	▪ No evidence of dewatering and lowering of water tables within the vicinity of the mine.	As required: ▪ Increase monitoring frequency and detect point sources. ▪ Optimise monitoring plan if needed.

Table 10-2: Monitoring Plan and Audit Requirements

Aspect	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions	Type of Requirement (Monitoring, Auditing and/or Reporting)
Flora	Establishment of AIP species	AIP monitoring.	Qualified botanist	Quarterly monitoring for five years	Monitoring
Dust	Nuisance dust	Dust monitoring using the ASTM Method. Monitoring must meet the South African National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) Dust Control Regulations (2013).	A designated air quality officer to collect data/analyse and reporting to regulatory authorities on compliance.	Monthly at existing locations where baseline dust deposition data were collected	Monitoring
		Continuous PM_{10} monitoring. Monitoring must meet the South African National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) Dust Control Regulations (2013).	A designated air quality officer to collect data/analyse and reporting to regulatory authorities on compliance.	At a sensitive receptor location (i.e. neighbouring farmer etc.)	Monitoring

Aspect	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions	Type of Requirement (Monitoring, Auditing and/or Reporting)
Groundwater & Surface water	Water quality	▪ Macro Analysis i.e. Ca, Mg, Na, K, SO_4, NO_3, F, Cl; ▪ Initial full suite metals and then Al, Fe, Mn and other metals identified according to results of the initial analyses; and ▪ pH and Alkalinity; and TDS and EC.	Samples must be collected by an independent water consultant, using best practice guidelines and must be analysed by a SANAS accredited laboratory.	It is suggested that bi-annual samples be collected, extending to at least four years post-closure. Post-closure monitoring must continue until a sustainable situation is reached and after it has been signed off by the authorities.	Monitoring and Reporting
	Groundwater levels	Groundwater levels must be recorded using an electrical contact tape or pressure transducer, to detect any changes or trends in groundwater elevation and flow direction.	Samples must be collected by an independent groundwater consultant, using best practice guidelines and must be analysed by a SANAS accredited laboratory.	It is suggested that bi-annual samples be collected, extending to at least four years post-closure. Post-closure monitoring must continue until a sustainable situation is reached and after it has been signed off by the authorities.	Monitoring and Reporting
Soils	Erosion, loss of soil fertility, compaction	The rehabilitated area must be assessed for compaction, fertility and erosion.	The soils must be assessed by a soil specialist yearly (during the dry season so that recommendations can be implemented before the start of the wet season) so as to correct any nutrient deficiencies.	The rehabilitated area must be assessed once a year for compaction, fertility, and erosion during the dry season.	Monitoring
Audit Reports	EMPr/ RCP Conditions	Auditing against the conditions outlined within the approved EMPr and EA (environmental audit) or RCP at time of mine closure. To determine compliance to EMPr or RCP conditions.	Environmental Officer/Independent Third Party.	Annual environmental audit	Audit Report
	Financial Provision Update.	To ensure that the mine is compliant with the financial provision regulations and that there is sufficient funding provided by the mine for closure and rehabilitation cost and meets the requirements as stipulated in Regulation 11 of the Financial Provisioning Regulations (2015).	Environmental Officer/Independent Third Party	Annually and must be audited by an independent auditor.	Financial Provision Report submitted to the DMR

11 Wetland Rehabilitation Measures

Below provides a summary of specific wetland rehabilitation measures that should be adopted for Mooikraal and the 3 Shaft Area.

11.1 Operational Rehabilitation

- Removal of AIPs, specifically with a focus on water-loving species such as. Eucalyptus species, will aid in rehabilitation. These trees utilise large amounts of water and therefore impact on the hydrology of wetlands.
- Incidents of erosion should be remedied as soon as possible to reduce deterioration of the wetland habitat. Erosion downstream of culverts/crossings is one of the largest impacts and can be addressed with fairly inexpensive energy dissipating measures such as reno mattresses or small concrete structures; and
- Any coal contamination should be removed to reduce contamination of the water quality. The contaminated material should then be discarded at the correct facility.

11.2 Decommissioning Phase

In summary the following actions also need to be considered and implemented during the decommissioning stage:

- Limit the footprint area of the decommissioning activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas);
- Ensure that no additional wetland area is disturbed in the rehabilitation process;
- When reprofiling, ensure that machinery does not disturb additional wetland;
- Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream;
- Ensure that rock is removed carefully, and that no additional wetland area is disturbed in the rehabilitation process;
- No material may be dumped or stockpiled within any wetland areas (or the buffers) in the vicinity of the proposed decommissioning footprint;
- Although it is expected that the existing *Phragmites, Typha* and other wetland species will spread and colonise the newly rehabilitated area, it is important to seed the area to promote stabilisation and reduce the possibility of weed infestation, erosion and/or associated sedimentation of the wetland system both in the immediate surrounds or further downstream;
- Ripping should take place to a maximum depth of 150mm;
- Seeding should take place immediately after ripping to ensure the best chance of survival and should be done by hand to avoid compaction of the soils;

- After ripping and seeding has taken place, the area should be avoided and not driven over;
- As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils, vegetation clearance should be kept to a minimum;
- Cattle movement should be restricted from the areas that have been repaired until those areas have been reasonably rehabilitated;
- An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases;
- All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan;
- The use of machinery should be minimised in order to reduce compaction of the wetland soils;
- All vehicles must be regularly inspected for leaks;
- Re-fueling must take place at a diesel facility on a sealed and bunded surface area away from wetlands to prevent ingress of hydrocarbons into topsoil;
- All spills from machinery should be immediately cleaned up and treated accordingly;
- All existing litter and debris should be removed from the freshwater systems and littering should be prohibited on an ongoing basis;
- Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities;
- All waste generated must be removed to an appropriate waste facility;
- Any coal contamination should be removed and discarded at the correct facility;
- Rehabilitation measures should take place as soon as possible after decommissioning; and
- Monitoring should be carried out as specified in the monitoring programme.

11.3 Final Rehabilitation

- The road servitude and conveyor have affected the integrity of the wetlands resulting in a loss of habitat and downstream surface water recharge. Rehabilitation during the decommissioning and closure phase should focus on the rehabilitation of these areas. Management in this regard would include removal of the structures, re-profiling of the bed and marginal zones to restore the geomorphological and hydrological integrity and ripping and re-seeding with indigenous wetland grass species.

- All incidents of erosion should be remedied and AIPs removed, as in the operational phase; and
- Any coal contamination should be removed and discarded at the correct facility as in the operational phase.

11.4 3 Shaft Wetland Rehabilitation

A report was compiled with rehabilitation measures in 2016. Please see Appendix D of the Freshwater Impact Report (Digby Wells, 2018) for the full report. For ease of reference, the rehabilitation measures are summarized below:

Figure 11-1: 3 Shaft Wetland to be Rehabilitated (2018)

(A: Channel cut into wetland; B: Road crossing wetland; C: Coal deposits in wetland D*: Phragmites australis* dominated)

- A dedicated waste disposal is to be established for the inert demolition waste from the conveyor. Steel and any other material of salvage value to be sold and removed from site;
- Removal of the disused road crossings the wetland (see B in Figure 11-1);
- All coal and fine carbonaceous material up to 300mm from the natural ground should be removed from the wetland and stockpiled. Stockpiled waste should be collected

with a back-actor, parked on a safe place on the edge of the infilled areas. The remaining 300mm of waste material should be loaded manually (using spades) into the skip of the back-actor to limit any impacts on the existing soils;

- Coal that has spread into the wetlands downstream of the 3 shaft footprint should also be removed and the area rehabilitated;
- Subsoil is to be levelled according to surrounding wetland landscape to promote functional hydrology. This includes infilling of the channel that was dug. Wetland soils that can be preserved from the excavated areas associated with the site should be levelled over the area and manually compacted. Patches of *Phragmites* that don't need to be levelled should be left in place to assist with colonisation and provide a refuge for biota;
- Revegetation should ideally take place in the wet season, as far as possible, to promote successful germination. Table 11-1 lists plant species that would be suitable for revegetation. Many of these species (if not all of them) can be found on site and seed can be harvested manually;
- The buffer zone of the wetland area should be clearly demarcated with stakes positioned in the ground (preferably painted white) and this area should be regarded as 'no-go' for future development;
- Wetland area to be monitored monthly, for six months after rehabilitation to ensure that erosion and alien plant invasion are kept under control and remedied;
- The support for the proposed new conveyor gantry should cover as small an area as possible; and
- The proposed conveyor gantry shall be covered where the conveyor crosses the watercourse (30m).

Table 11-1: Plant species for rehabilitation at 3 Shaft

Plant Species	Common Name	Wetland Zone
Cynodon dactylon	Couch Grass	Edge of wetland channel and in dry zones
Digitaria eriantha	Common Finger Grass	Edge of wetland channel and in dry zones
Imperata cylindrica	Cottonwool Grass	Channel
Ischaemum fasciculatum	Hippo Grass	Edge of wetland channel
Phragmites australis	Common Reed	Channel
Setaria sphacelata	Golden Bristle Grass	Edge of wetland channel
Themeda triandra	Red Grass	Dry zones
Typha capensis	Common Bulrush	Channel

11.5 Wetland Monitoring

Monitoring to be conducted by an independent wetland specialist The timing of such monitoring audits should be as follows:

- Monthly during the construction phase;
- Quarterly during the operational phase;
- Monthly during decommissioning and rehabilitation phase;
- Annually for two years after closure and rehabilitation.

It is highly recommended that ongoing monitoring of the wetlands in the vicinity of the Mooikraal continue so as to identify any emerging trends in terms of improvements or degradations in the ecological integrity and functioning of these systems. This data should be compared to the results obtained in both this and historical studies so as to guide the management process going forward.

The rehabilitated areas should be monitored by a qualified wetland specialist monthly during the decommissioning and rehabilitation phases then quarterly for a minimum of three years thereafter to ensure that vegetation is establishing. Should vegetation not establish, the area may need to be ripped/spiked (to a depth no deeper than 150mm) and reseeded. Monitoring will then need to continue until vegetation has established.

PES and EIS will only need to be assessed annually. The remainder of the assessments should be monitoring the rehabilitation to remedy any issues that may arise.

12 Potential Latent and Residual Environmental Risks

Latent and residual environmental risk are environmental impacts which may become known in the future, the following section outlines the potential latent and residual risks:

12.1 Subsidence

Underground mining due to bord-and-pillar methods has been reported to result in unplanned surface collapse (Ochieng et al. 2010). Generally, this collapse results in ground and surface water contamination due to acidification and/or salinization of nearby aquifers as well as ponding of run-off water.

The underground mining operations conducted at Mooikraal could result in potential pillar failure, resulting in a risk of subsidence, which could pose significant risks to people, infrastructure and the environment (specifically surface water and the environmental aspects it supports i.e wetlands and fauna and flora). The Mooikraal WUL authorises the undermining of watercourses within the Mooikraal Mining Right Area, subject to conditions. No high extraction is authorised under any water courses. The bord and pillar mining safety factors are determined by competent rock engineers.

Based on the underground mining operations conducted at Mooikraal, the following recommendations are made to address the risks that could potentially occur post-closure:

- Development of an underground stability model to determine the probability of subsidence occurring due to underground mining activities; from this model develop a risk assessment to determine the impact of subsidence on environmental media. Monitor the surface above mined out areas utilising lidar to determine if pillar failure has occurred and take corrective/ mitigation actions when and where required;
- Implement and maintain a subsidence register, input confirmed incidents of subsidence on this register;
- Maintain a register of “permission to undermine restricted areas register”, this register as well as mine surface plans will reflect restricted areas that have been undermined, where restricted areas are defined by the Mine Health and Safety Act;
- Ensure that all structures identified by a heritage assessment are included as restricted areas; and
- If sinkholes from subsidence are formed after closure, the mitigation measures as informed by the stability model and risk assessment will be implemented, as informed by a professional.

12.2 Decant Management

The post-mining model indicated groundwater levels will not fully recover within a 300 year simulation period. The slow recovery, in spite of the underground mine voids being fully flooded, is attributed to the partial depressurisation of the confined aquifer system below the No. 5 dolerite sill. A steady state model was subsequently used to model the fully recovered water levels imposing an equilibrium state and infinite time. It must be noted that the model is conservative, implying that worst case scenarios were modelled, nevertheless, should decant occur (though the probability remains low, and is subject to change as information becomes available) the northern boundary of the Mooikraal underground mine is the area where decant is predicted to occur (Figure 12-1) due to the highest hydraulic pressure coupled with the lowest topography. The model estimated a decant rate of 2.5 m^3/d, but this value should be considered only as an initial estimation due to the uncertainty associated with predicting flow rates far into the future based on the current groundwater and climatic conditions.

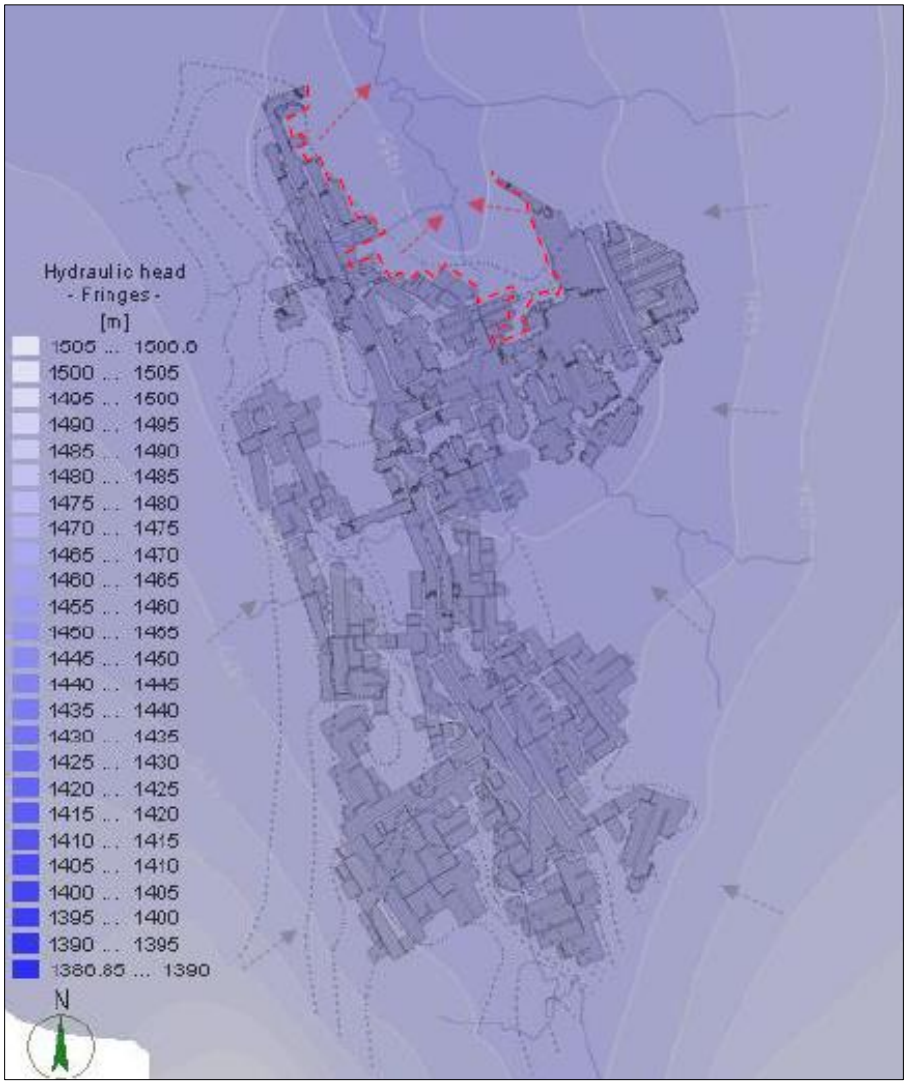


Figure 12-1: Potential Decant Area (Indicated In Red)

The following mitigation measures are proposed for the management of possible decant:

- The numerical model for decant prediction should be updated every five years based on groundwater monitoring results as to identify any potential concerns that may occur over the years, until closure;
- Should there be an negative impact to surface water bodies, due to decant and base-flow contribution, investigations will occur, and rehabilitation will commence as informed by a professional;
- All existing boreholes, with the exception of private water supply boreholes and monitoring boreholes should have been sealed and decommissioned according to Sasol Mining procedure during the operational phase, in order to minimise the chance of decant occurring; and

- All shaft adits, ventilation shafts and down-casts will be sealed and decommissioned as guided by a professional.

12.3 Contaminate Leachate Management

12.3.1 3 Shaft

The groundwater quality at 3 Shaft area shows no indication of mining related impacts thus far as a result of the existing primary plant area which has been operational since 1950. It is noted however that the location of the monitoring boreholes needs to be reassessed as they are not located in areas within close proximity to the existing plant area and therefore it is with low confidence that 3 Shaft is deemed as an area that is without contamination. Sasol does plan to drill additional boreholes downstream of the existing primary plant area as recommended by the Groundwater Assessment.

The existing stockpile area is lined with concrete therefore the relocation of the primary plant to the stockpile area further reduces contamination risks to the groundwater environment. This is because the concrete liner reduces the potential or rate at which leachate may seep into the underlying unsaturated and saturated zone (aquifer). Furthermore, stormwater management structures will be upgraded to ensure that dirty water is adequately contained in this area, reducing the potential risk even further.

12.3.2 Mooikraal

The WRD at Mooikraal is a potential source of contamination; once material is exposed to oxygen and rainfall, leachate generating reaction may occur and introduce contamination into the groundwater environment via seepage. Total concentration analysis identified Barium and Copper as potential elements of concern however these results are a worst case scenario. Leachable concentration analysis, which is the most representative of the expected leachate at the site, shows no concern within regards to the leachate expected to emanate from the WRD.

A contamination plume model was conducted for Mooikraal by IGS in 2018. The plume model modelled potential contaminant structures at Mooikraal at 100% contaminant concentration and 100% mobility in the groundwater regime. It was noted in the study that the contaminants that leach from these structures will be limited to the weathered zone, and only have lateral movement in the weathered zone, due to the 2 competent sills.

Contaminant lateral movement can be seen in the figure below. From the figure it can be seen that over a 100 year period 5 – 10 mg/l contaminant will have a maximum lateral movement of <10 meters from the WRD.

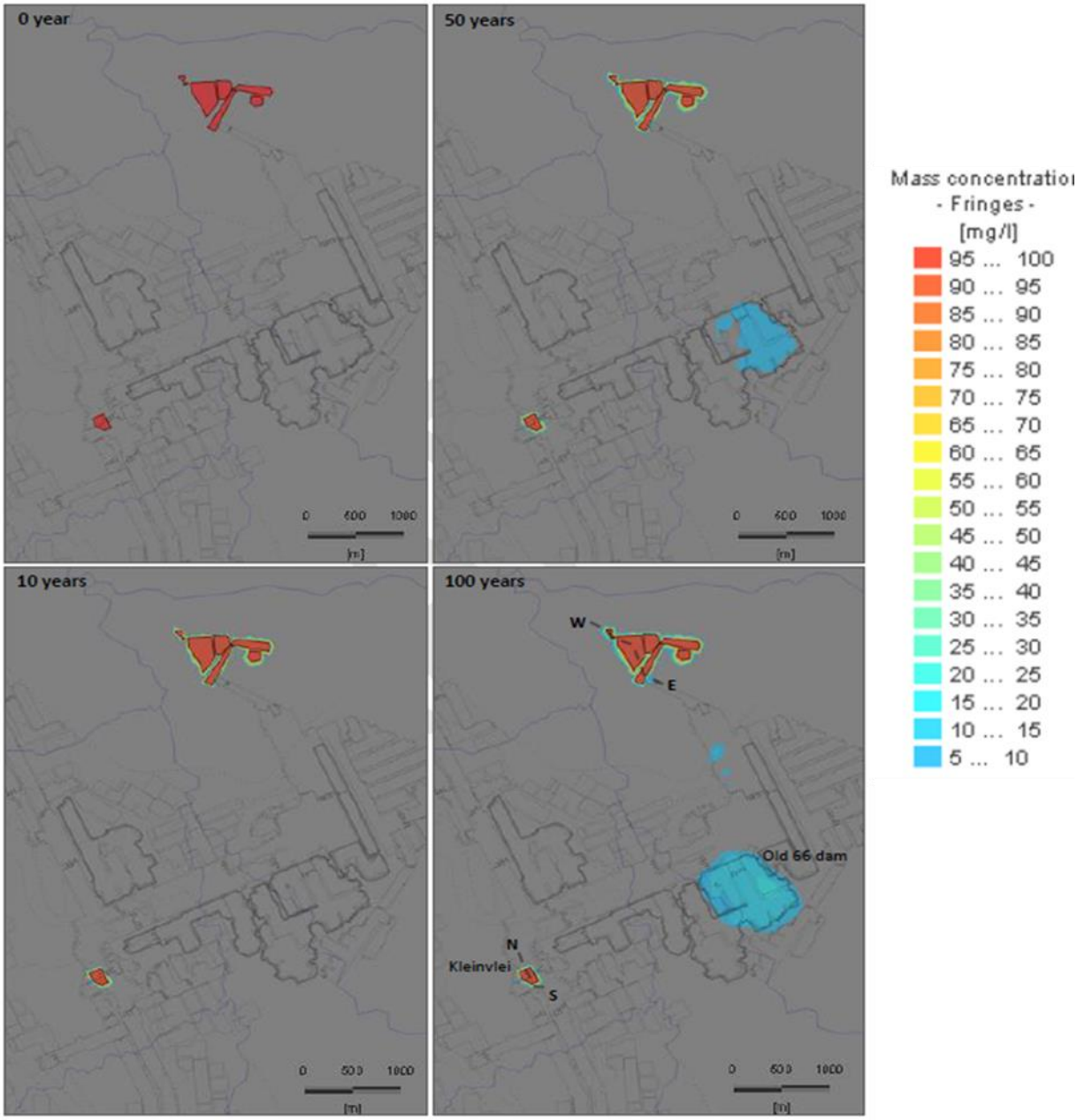


Figure 12-2: Contaminant Lateral Movement

The intention is to backfill the WRD material into the adit and therefore will not exist as a potential contamination source at the surface post-closure. The following is recommended with respect to management of the contamination plume associated with the WRD facility:

- A contamination assessment must be conducted of the WRD to inform a pollution plume model prior to backfilling of the WRD material into the adit. The results of the model must subsequently be used to inform whether the material can be used to backfill the adit or if other options of disposal must be investigated;

- Should the material be backfilled, the adit should be completely flooded to eliminate exposure to oxygen, this will hinder contamination generating reactions;
- Stormwater management structures must be adequately maintained to prevent potential contamination migration due to runoff; and
- Continue to monitor the groundwater qualities as per groundwater monitoring plan.

13 Conclusion

The rehabilitation of Mooikraal will require significant levels of control and monitoring during implementation if the desired objectives are to be achieved. The overarching objective with respect to closure is to rehabilitate land in a manner that ensures that it is physically and environmentally stable. This will allow for it to be ceded for other productive land uses. For the Mooikraal operation it has been determined that the land must be rehabilitated to at least a grazing land capability.

To achieve the desired objectives, the following key recommendations have been provided:

- Progressive rehabilitation and the rehabilitation actions provided in this report must be correctly implemented;
- Assessment of mining related impacts and rehabilitation measures that can be adopted to mitigate adverse environmental impacts;
- Proper surface water management must be maintained to avoid impacts to water resources;
- Monitoring of wetland crossings must be undertaken and the rehabilitation measures provided must be implemented as and when required;
- An underground stability model must be developed to determine the probability of subsidence occurring due to underground mining activities;
- A risk assessment model must be developed to assess the potential for pillar failure which may result in a risk of subsidence;
- If sinkholes from subsidence are formed after closure, the mitigation measures as informed by the stability model and risk assessment will be implemented, as informed by a professional;
- The numerical model for decant prediction should be updated every five years based on groundwater monitoring results as to identify any potential concerns associated with decant that may occur over the years, until closure;
- Groundwater qualities must continue to be monitored in accordance with the groundwater monitoring plan to detect any contamination; and
- A comprehensive land use plan must be developed five years prior to closure based on the outcomes of a risk assessment.

- Assessment on the post closure options for the WRD. Based on the outcome of the assessment two options are proposed:
  - Utilise the material as backfill material for the shaft; and
  - Rehabilitate material *in situ* with appropriate designed capping.

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