mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

BASIC ASSESSMENT REPORT AND ENVIRONMENTAL MANAGEMENT PROGRAMME

SASOL SIGMA DEFUNCT COLLIERY SURFACE MITIGATION PROJECT: PROPOSED RIVER DIVERSION AND FLOOD PROTECTION BERMS

DRAFT BAR FOR PUBLIC REVIEW

SUBMITTED FOR ENVIRONMENTAL AUTHORISATIONS IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) (NEMA) AND THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT, 2008 (ACT NO. 59 OF 2008) (NEMWA) IN RESPECT OF LISTED ACTIVITIES THAT HAVE BEEN TRIGGERED BY APPLICATIONS IN TERMS OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT NO. 28 OF 2002) (MPRDA) (AS AMENDED).

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File Reference Number SAMRAD:	FS 6/2/2 (693) EM

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Basic Assessment Report**
Project Name:	**Sasol Sigma Defunct Colliery Surface Mitigation Project: Proposed River Diversion and Flood Protection Berms**
Project Code:	**SAS5250**

Name	Responsibility	Signature	Date
Claire Wannenburgh	Report Compiler		September 2018
Barbara Wessels	Report reviewer		September 2018
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IMPORTANT NOTICE

In terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 as amended), the Minister must grant a prospecting or mining right if among others the mining "will not result in unacceptable pollution, ecological degradation or damage to the environment".

Unless an Environmental Authorisation can be granted following the evaluation of an Environmental Impact Assessment and an Environmental Management Programme report in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA), it cannot be concluded that the said activities will not result in unacceptable pollution, ecological degradation or damage to the environment.

In terms of section 16(3)(b) of the EIA Regulations, 2014, any report submitted as part of an application must be prepared in a format that may be determined by the Competent Authority and in terms of section 17 (1) (c) the competent Authority must check whether the application has taken into account any minimum requirements applicable or instructions or guidance provided by the competent authority to the submission of applications.

It is therefore an instruction that the prescribed reports required in respect of applications for an environmental authorisation for listed activities triggered by an application for a right or a permit are submitted in the exact format of, and provide all the information required in terms of, this template. Furthermore, please be advised that failure to submit the information required in the format provided in this template will be regarded as a failure to meet the requirements of the Regulation and will lead to the Environmental Authorisation being refused.

It is furthermore an instruction that the Environmental Assessment Practitioner must process and interpret his/her research and analysis and use the findings thereof to compile the information required herein. (Unprocessed supporting information may be attached as appendices). The EAP must ensure that the information required is placed correctly in the relevant sections of the Report, in the order, and under the provided headings as set out below, and ensure that the report is not cluttered with un-interpreted information and that it unambiguously represents the interpretation of the applicant.

OBJECTIVE OF THE BASIC ASSESSMENT PROCESS

The objective of the basic assessment process is to, through a consultative process—

- determine the policy and legislative context within which the proposed activity is located and how the activity complies with and responds to the policy and legislative context;
- identify the alternatives considered, including the activity, location, and technology alternatives;
- describe the need and desirability of the proposed alternatives,
- through the undertaking of an impact and risk assessment process inclusive of cumulative impacts which focused on determining the geographical, physical, biological, social, economic, heritage, and cultural sensitivity of the sites and locations within sites and the risk of impact of the proposed activity and technology alternatives on these aspects to determine:
- the nature, significance, consequence, extent, duration, and probability of the impacts occurring to; and
- the degree to which these impacts—
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be managed, avoided or mitigated;
- through a ranking of the site sensitivities and possible impacts the activity and technology alternatives will impose on the sites and location identified through the life of the activity to—
  - identify and motivate a preferred site, activity and technology alternative;
  - identify suitable measures to manage, avoid or mitigate identified impacts; and
  - identify residual risks that need to be managed and monitored.

EXECUTIVE SUMMARY

Introduction

Sasol Mining's Sigma Defunct Colliery (Sigma Defunct Colliery) occupies a mining area of approximately 11 643ha. Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR). Sigma Defunct Colliery commenced operations in 1952 and was both an underground and open cast mine. It ceased mining in 2006 with rehabilitation being undertaken from 2005 to date.

Sigma Defunct Colliery applied for mine closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan and Environmental Management Programme (EMP) to address all the significant risks and rehabilitation measures which were required to obtain the needed closure certificate. Jones and Wagener (J&W) were appointed to assist Sasol Mining in the compilation of a Risk Assessment Report for mine closure process to identify all the significant latent risks which Sigma Defunct Colliery have and rate them in accordance with the Sasol Risk Assessment Methodology. This report further proposed mitigation measures to be implemented to reduce the significant rated risks to an acceptable residue risk level. The report was compiled in 2015 and has now been updated in 2018.

As part of the Risk Assessment Report, mitigation measures have been proposed and grouped together as underground mitigation measures (ash backfilling) and surface mitigation measures (river diversions and berm constructions). Sasol Mining have allocated funds in accordance with the mines financial provision to provide for the implementation of the project.

The Underground Mitigation Measures which includes ash backfilling of certain areas with ash slurry is being dealt with as a separate project and under a separate environmental authorisation process.

The Surface Mitigation Measures proposed in the Risk Assessment Report requires environmental authorisation. Two rivers flow through the Sigma mining area namely the Rietspruit and the Leeuspruit. Beneath these water courses or floodplains a hazard of pillar failure exists which can result in subsidence. Subsidence is expected to have a significant impact on surface aspects should it occur and no mitigation measures are implemented. The risk of this occurring is considered to be significant. Therefore various mitigation measures have been proposed to reduce the significant risk areas to an acceptable residual risk (insignificant risk).

To implement these surface mitigation measures new triggered Listed Activities in terms of the Environmental Impact Assessment (EIA) Regulations 2014 (as amended) (Government Notice No. R. 982 of 4 December 2014 as amended by Government Notice No. R.326 of 7 April 2017) referred to now as the EIA regulations, 2014 (as amended) promulgated under

the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) must be applied for. The proposed project triggers activities listed under Listing Notice 1 of the EIA Regulations, 2014 (as amended) and therefore a Basic Assessment (BA) Process must be followed to obtain the required Environmental Authorisation.

Digby Wells Environmental (Digby Wells) has been appointed by Sasol Mining to undertake the BA and Water Use Licence (WUL) process to obtain the required authorisation to commence with the project. The project is considered to be a rehabilitation (remediation) project to prevent further damage to the environment. This project is considered to be critical as, if no intervention is implemented pillar failure may occur which may result in subsidence leading to catastrophic impacts on the Leeuspruit and Rietspruit that feed into the Vaal River. Sasol proposes to have a proactive approach as appose to a reactive approach where potentially no remediation measures can be implemented if subsidence were to occur within the river system without the implementation of this proposed project.

Project Applicant

The particulars of the applicant are detailed in the table below.

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Environmental Consultants

Contact details for the independent EAP are provided in the table below.

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Project Description

The aim of the proposed project is to implement surface mitigation measures which include designs for diversion canals and flood protection berms to channel the Leeuspruit and Rietspruit away from areas identified to have a significant potential hazard for pillar failure which will result in subsidence. It must be noted that the surface mitigation measure proposed will not prevent subsidence from occurring however it will minimise the impact to important resources located on surface which potentially would be **critically impacted should the project not be implemented**. If the pillars were to fail beneath the water courses, without the implementation of this project, subsidence will occur which will create cracks at surface which could result in the ingress of surface water into the groundwater aquifer and potentially the underground mine workings.

According to the J&W Design Report, 2018 a total of 37 areas (associated with underground mined panels where a high potential of pillar failure has been identified) were identified of which 36 are located within the Leeuspruit and only one within the Rietspruit. J&W's Design Report, 2018 sub-divided the Leeuspruit into five sections numbered in the direction of stream flow (from south to north).

The surface mitigation measures that were considered include full stream diversions, partial stream diversion and ash backfilling of mined panels or various combinations thereof.

A description of the surface mitigation measures associated with the five sections along the Leeuspruit and one section along the Rietspruit is provided below.

Significant Risk Area	Mitigation Measure Implemented	Description
Leeuspruit: Section 2	▪ Flood protection berm to be constructed to avoid one area of significant risk.	▪ The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations.
Leeuspruit: Section 3	▪ Combination of diversion canals, flood protection berms and ash backfilling.	▪ The proposed design comprises of two flood protection berms to direct the flow of water away from significant areas; ▪ A formalised canal to divert the stream flow away from the natural stream flow path (Armorflex or a similar approved lining); and ▪ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process.

Significant Risk Area	Mitigation Measure Implemented	Description
Leeuspruit: Section 4	▪ Two Full stream diversion canals are proposed, namely the Southern diversion canal and Northern diversion canal; ▪ Flood protection berms will also be utilised; and ▪ Ash Backfilling will also be utilised.	▪ This section is located immediately west of the Sasolburg residential area and comprises approximately 2.3km of the Leeuspruit, from the Afrikaans High Sasolburg up to the R59 provincial road; and ▪ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process.
Leeuspruit: Section 5	▪ This section's design comprises mainly of backfilling polygons due to surface restrictions on either side of the stream.	▪ Located on the south-western side of the area is private infrastructure and northeast is an operational sand mine; and ▪ Some of these areas have already been backfilled. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process.
Rietspruit: Section 1	▪ Only one significant risk area has been identified; and ▪ A flood protection berm is proposed.	▪ Small diameter pipes will also be installed at low points along the berm to allow the slow release of water accumulated behind the berms.

Approach and Methodology for the Public Participation Process

The Public Participation Process (PPP) was developed to ensure compliance with environmental regulatory requirements and to provide Interested and Affected Parties (I&APs) with an opportunity to evaluate the project. During this process stakeholders are able to provide inputs and to receive feedback from the environmental specialists and/or proponent.

A summary of the PPP activities undertaken during the basic assessment process are provided in Table 10-1 of this report. Consultation with I&APs during the basic assessment process was undertaken as follows:

- **Background Information Document:** a BID which included a project description, information about the relevant legislation, the competent authorities and details of the appointed EAP was prepared and distributed on 15 October 2018. The BID was also accompanied by a Registration and Comment Form for stakeholders to use for formal registration as I&APs or to submit comments. Information regarding the

availability of the Draft BAR was also provided, and I&APs were asked to comment. The BID has been included in Appendix C.

- **Newspaper advertisement:** a newspaper advertisement was placed in the Sasolburg Ster and Vaalweekblad, on 16 October 2018, which are local newspapers that distributes to Sasolburg and surrounding areas. The advert was published in English and included a brief project description, information about the relevant legislation, the competent authorities, details of the appointed EAP, registration process for I&APs, and information regarding the availability of the Draft BAR for public comment. Evidence of the placement of the newspaper will be included in the Final BAR.
- **Site notices:** Site notices were put up at various places on 15 October 2018. The site notices contained a brief project description, information about the relevant legislation, the competent authority and details of the EAP, registration process for I&APs and information regarding the availability of the Draft BAR for public comment. Evidence of the placement of these site notices will be included in the Final BAR.

The Draft BAR was made available for a public comment period of 30 days from *Tuesday, 16 October 2018 to Wednesday, 14 November 2018* at the Zamdela and Sasolburg Public Library and on the Digby Wells website: www.digbywells.com (under Public Documents). Due to various stakeholders and different landowners within the project area, focus group and one-on-one discussions will be undertaken during this commenting period in order to obtain comments and to identify any issues raised by individuals.

Once the commenting period is reached the Draft BAR will be updated and submitted to the DMR for consideration. Simultaneously, the Final BAR will be made available to I&APs on the Digby Wells website and I&APs will be informed of such by means of a letter (email and post). This enables I&APs to verify that their comments have been captured and responded to.

Baseline

A summary of the baseline environment in the proposed project area is provided in the sections below. The flowing specialist studies have been undertaken for the proposed project:

- Wetlands and Aquatics Specialist Study (Appendix D);
- Fauna and Flora Specialist Study (Appendix E);
- Surface Water Specialist Study (Appendix F);
- Soil, Land Use and Land Capability Specialist Study (Appendix G); and
- Heritage Specialist Study (Appendix H).

Aspect	Description
Wetlands	There are 413.9 hectares (ha) of wetlands within the project area. These wetlands have been categorised Present Ecological State (PES) values ranging from D to E and Ecological Importance and Sensitivity (EIS) values ranging from C to D. Approximately 51.5 ha will be affected through the implementation of the surface mitigation measures at Sigma Defunct Colliery. Of this, 9.8 ha is affected directly and 41.7 ha will be affected indirectly, where direct loss constitutes the loss due to the infrastructure footprint and indirectly constitutes the drying out of the floodplain portions due to separation from the main channel because of the proposed construction of the flood protection berms and canals. These surface mitigation measures will result in a decline in the PES and EIS of the wetland hydro-geomorphic (HGM) units. In addition to various mitigation measures, it is suggested that a Wetland Offset Strategy be implemented to account for the loss of wetlands due to the implementation of the project. It is suggested that monitoring take place monthly during the construction phase, quarterly for the first two years after construction and annually for three years thereafter.
Aquatics	The upper reaches of both the Leeuspruit and the Rietspruit are comprised largely of wetland habitats. In many instances, a defined instream channel was absent. Therefore, of the eleven potential biomonitoring points assessed for the determination of the PES of the aquatic resources present within the study area. Based on the in situ water quality variables recorded at the time of the survey, the elevated electrical conductivity values were expected to deter the colonisation and/or inhabitation of these watercourses by sensitive aquatic biota to some extent. However, it should be noted that extensive portions of this system were dominated by wetland habitat, the nature of which was expected to be a major driver of the elevated salt loads observed. As such, aquatic communities inhabiting these systems were expected to be relatively tolerant of the inherent water quality conditions observed. In relation to perceived reference conditions, it was determined that the ecological condition of the macroinvertebrate assemblages collected within the study area each exhibited seriously to critically modified conditions (i.e. Ecological Category E to F). Further interrogation of the applied Macro-Invertebrate Response Assessment Index (MIRAI) indices suggested that the primary driver at each of the assessed sites was related to the limited available habitat present, which was to be expected for sites SRD1, SRD4 and SRD9, however, the results suggest some impact related to water quality at sites SRD10 and SRD11. Only one fish species, *Gambussia affinis* (Mosquitofish), was captured during the field assessment. It is important to note however, that three out of the six sites sampled for fish, SRD8, SRD10 and SRD11, comprised of large areas too deep to safely assess making use of the electro-shocker. Therefore, based on habitat availability, infield observations, historical data, as well as tolerance of the fish species and professional opinion and experience, three additional species of fish were included in the application of the Fish Response Assessment Index (FRAI),

Aspect	Description
	Clarias gariepinus, *Tilapia sparrmanii*. An ecological category of E was thus assigned to this section of the Leeuspruit based on the results of the July 2018 survey.
Fauna and flora	Upon the completion of the infield assessment, it was established that the study site can be divided into four main broad vegetation types or rather habitat units: Secondary Grassland, Woodland/Savanna, Alien vegetation, and Riparian/Wetland. Two transformed land units including Infrastructure & Mining and Agricultural fields were also recorded. The study area was found to be in different states of sensitivity, with the riparian/wetland, areas, and secondary grassland areas designated as Medium Sensitivity while Alien vegetation and transformed areas being assigned low sensitivity. The Woodland/Savannah vegetation on site is in a disturbed ecological condition and was allocated a Medium Sensitivity, due to it falling inside the Soweto Highveld Grassland unit which is designated as Endangered according to Mucina & Rutherford (2012). The Secondary Grassland vegetation occurring on flat lower lying areas was overgrazed or cultivated and was in relatively poor condition. However, within the Sasol Mining the game farm area was assigned a Medium Sensitivity, as a result of ecosystem function that this area is providing. During the infield assessment, only one plant species of Species of Conservation Concern (SCC) was recorded, this being *Hypoxis hemerocallidea*. PRECIS suggests that six other SSC may potentially occur within the study area. However, during the assessment undertaken by Digby Wells in 2013, none of these species weer recoreded. A *Kniphofia* spp colony was recorded in a wetland area during the infield assessment although it was not possible to identify it down to species level due to the timing of the assessment and the fact that *Kniphofia* species hybridize very easily. There is a possibility that it could be the protected species *Kniphofia typhoides Codd*, thus it is recommended that this is further assessed prior to clearing. Removal of this colony would require an on-site offset, which would require the creation of another suitable habitat for the *Kniphofia* plants and other hygrophytic herbs that occur, to which they would then need to be relocated. Faunal species of conservation concern that were recorded during the infield assessment include Black Wildebeest (*Connochaetes gnou*), Burchell's Zebra (*Equus quagga burchellii*), Secretary Bird (*Sagittarius serpentarius*), Melodious Lark (*Mirafra cheniana*) and African Open bill (*Anastomus lamelligerus*). A total of 21 Alien Invasive Plants (AIP's) were recorded on site during the 2018 infield assessment. Of these eleven were listed AIP species according to National Environmental Management: Biodiversity 2004 (Act No. 10 of 2004) (NEMBA), while the remaining nine were either weeds or exotic plants. Six mammal species were recorded during the infield assessment and all of these were within the Sasol Mining private game farm.

Aspect	Description
Surface Water	The proposed project area is located within the Water Management Area (WMA) of the Upper Vaal River system. The proposed area is located within the secondary drainage C2 in quaternary catchment C22K. Mean annual runoff (MAR) after evaporation and recharge is 3%. The mean annual precipitation (MAP) is 644 mm with a mean annual evaporation (MAE) of 1 625 mm. The natural water balance is thus a negative one with evaporation being much higher than rainfall. The area is characterised by warm summers and cold winters, rainfall occurs mainly during the summer months (December to February). Monitoring points SIG/1 (downstream) and SIG/2 (upstream) represents the water quality of the Leeuspruit. In addition, SIG/5 and SIG/6 monitors a tributary of the Leeuspruit that flows from the east and joins the Leeuspruit between the SIG/1 and SIG/2 monitoring points. This last-mentioned tributary as well as the Leeuspruit is directed past an ash dam and old coal stockpiles before joining each other at the confluence point directly downstream of the ash dam which can potentially influence the water quality of the Leeuspruit and change the chemistry slightly between SIG/2 and SIG/1. The water type of both SIG/1 and SIG/2 can be described as sodium-bicarbonate water with SIG/1 (downstream) more enriched with sulphate (SO_4) than that of the upstream point SIG/2. The upstream point of the tributary (SIG/5) also has lower SO_4 concentration then the downstream point (SIG/6). Changes in pH and occasional peaks in SO_4 for the downstream points above the guideline values confirms the conclusion that the ash dam does have some influence on the water quality during high rainfall and runoff periods. In general, from the trend graphs it can be concluded that in the last 12 month there is a general trend of deteriorating water qualities in a downstream direction of both the Leeuspruit and its tributary that can be due to the contribution of the ash dam and coal stockpiles located at 3 Shaft Complex operated by Mooikraal Colliery. From the other parameters analysed and compared against the water quality guidelines in January 2018 all are within a tolerable range excluding sodium (Na), manganese (Mn), nitrate (NO_3), phosphate (PO_4) and total suspended solids (TSS) that are at unacceptable levels for the Leeuspruit and its tributary. Faecal coliform is also above guideline values in both drainages.
Soil, Land Use and Land Capability	The land type data indicated that the main land types were Ba23 and Dc7, all dominated by poorly drained soils. The soils are dominated by Avalon (yellow-brown) forms and (black and greyish) Rensburg forms. The dominant land capabilities based on the soils, texture and fertility status found on the project area was grazing (yellow brown soils) and wetland (black and greyish soils). Yellow brown soils are known to have a high susceptibility to water or wind erosion, very slow permeability of the subsoil, low water-holding capacity and moderate salinity or sodicity. Wetland capability represents the Rensburg soils. Although these soils are deeper, they have high expansible clay content and are physically difficult to manage. The soil pH ranged from 4.5 to 6.5 and these soils are acidic to slightly acidic.

Aspect	Description
	Lime is required to counteract acidity, should agricultural activities take place. Calcium, potassium and magnesium levels in the soil were generally high and adequate for crop production or rehabilitation (grassing) and these nutrients are not limiting any production on the site or not considered as toxic. The sodium levels ranged from 50 to 1500 mg/kg and soils with sodium levels below 200mg/kg are considered not to be sodic (Sample 168, 203, 229 subsoils and 236 topsoil). These sodium levels are acceptable and are not of concern on the site. Samples 165, 182, 224, 229 topsoil's, 236 subsoil and 246 had higher sodium levels when compared with soil fertility guidelines and therefore classified as strongly sodic due to higher levels of sodium. Where high sodium values and sometimes also magnesium values are encountered, soil dispersion occurs, leading to a dense structure and drainage problems. The soils can be described as clay, sandy clay loam, loam, clay loam and loamy sand. Clayey soils have a slow infiltration rate but a good water retention capacity and these soils are more fertile than sandy soils due to high plant nutrient retention.
Heritage	The baseline description demonstrates that the greater study area comprises a cultural landscape predominantly associated with the historical built environment and burial grounds and graves. With the exception of the burial grounds and graves, which carry a high cultural significance, much of the archaeology in the greater study area is of low significance as determined in previously-completed heritage studies. No geological outcrops or palaeontological resources were identified during the pre-disturbance survey, and only one historical structure and four burial grounds were recorded. Additional potential historical structures were identified through aerial imagery. The identified resources occur in excess of 250 m distance from the proposed Project activities and development footprint.

Need and Desirability

The aim of the surface mitigation measure project is not to create jobs or create economic benefit to Sasol Mining or the surrounding community but rather preserve the surface water resources for future generations. It should be understood that the project does not aim to prevent pillar failure from occurring but rather reduce the impact on surface by relocating the Leeuspruit and Rietspruit away from these areas. The Leeuspruit and Rietspruit flow into the Vaal River which is considered to be the third largest River in South Africa.

The Vaal River supplies water to a large part of Gauteng and is utilised by the communities, mining and power generation companies, Sasolburg Operations and for farming practices. The Vaal River is made up of 50km of navigable water. The river basin thus offers a range of leisurely water activities that attract local and international tourists throughout the year. Should the project not be implemented the Mean Annual Runoff (MAR) of water that flows into the Vaal River will cease thereby negatively impact on the Vaal River. The Vaal River is currently being impacted on by various other activities therefore any additional negative

impact to the river system has a cumulative negative effect of the Vaal River which can indirectly impact on the country with regards to water supply and tourism.

Impact Assessment

The proposed project will only have an impact during construction phase and the operational phase as the surface mitigation measures proposed to be implemented is permanent and will not be removed once completed. A summary of the impacts both negative and positive is discussed below.

Construction Phase

The impacts associated with the construction phase are considered to range from major to minor depending on the activity taking place. Most of the construction activities are considered to have a negative impact on the environment except for social where jobs will be created.

The most significant impacts are associated with the construction of the canals at both Sections 3 and 4 of the Leeuspruit.

From a wetland perspective these impact ratings are considered to be major (negative) to both the wetland and instream ecology for the duration of the construction phase. Approximately 51.5ha will be affected through the implementation of the surface mitigation measures at Sigma Defunct Colliery. Of this, 9.8ha is directly affected and 41.7ha will be indirectly affected, where direct loss constitutes the loss due to the infrastructure footprint and indirectly constitutes the drying out of the floodplain portions due to separation from the main channel because of the proposed construction of the flood protection berms and canals. These surface mitigation measures will result in a decline in the PES and EIS of the wetland hydro-geomorphic (HGM) units.

The impacts associated with fauna and flora is also considered to be major to moderate which is directly correlated to the impacts on wetlands. The implementation of the surface mitigation measures will likely result in a direct and indirect loss on secondary grasslands as well as riparian areas. Additionally, once construction has been commenced with the spread of alien invasive species will also occur if mitigation measures are not correctly implemented.

With regards to surface water impacts the most significant impacts are also associated with the implementation of the surface mitigation measures at Section 3 and 4 more specifically the construction of the canal. This activity is likely to result in a floodline change (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain, but the canalisation of water will increase the velocity, and this will increase erosion. It is observed however that although pre-mitigation impacts are considered to be high, with the implementation of the mitigation measures all the impacts are reduced to either a minor or negligible impact.

From a soil, land use and land capability perspective it was determined that construction activities on the site will lead to land clearing and disturbance of the soil. The clearing of vegetation, the exposing of soil during construction of the flood protection berms, canals and diversion, may lead to wind and water erosion. Vehicles will be utilised during construction of the flood protection berms and canals which may impact on the soil surface, thereby causing compaction of the soils. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil. The preparation of lay-down areas for stockpiling of soil removed will result in the impacting of soils around the area.

In general, the impacts that were found to be significant even after the implementation of mitigation measures were associated with wetland, fauna and flora and soil, land use and land capability. These impacts were associated with the construction of the canals at Sections 3 and 4 of the Leeuspruit which would result in the direct loss of these various aspects. Specific attention is given to wetlands which will be the most significantly impacted should the project be commenced with.

It should however be noted that the impact to these environmental aspects in terms of migration routes and flow connectivity is likely to be short-lived should the appropriate mitigation measures be implemented. In terms of wetland loss, the impact to portions of the wetlands affected will be irreplaceable, however, ultimately, the canals will serve to maintain the connectivity of the system in the long term.

The project must be implemented to reduce the impact to surface associated with pillar failure. The impact on these various environmental aspects if no surface mitigation measures are implemented is considered to be catastrophic to the functionality of the environmental system which far outweighs the impact that would be experienced from the implementation of this project.

Operational Phase

The only activities to be undertaken during the operational phase are monitoring and maintenance. From a surface water perspective once the construction phase is completed a loss of catchment yield during operation is not seen as probable due to the same volumes of water being transferred downstream with only changes to the route. The only change will be the velocity of the flow that will lead to potential increased erosion which will be mitigated through the implementation of the measures put in place during the construction phase.

Additional potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems. Disturbances to indigenous vegetation is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive plants, further altering the natural vegetation profiles of the freshwater resources encountered in the vicinity of the project site. Hardened surfaces have the potential to result in sheet runoff and there is likely to be a loss in wetland service provision in terms of flood attenuation, sediment trapping and assimilation of toxicants and other pollutants. Storage of water, which is an important service, provided by wetlands in this area, will be compromised. Further alterations to the natural flow regimes

will take place and is likely to result in the creation of preferential flow paths over time, which may give rise to erosion and sedimentation, thus affecting the instream ecology of this portion of the Leeuspruit and the downstream resources.

If extensive maintenance activities on berms or canals are required (extensive damage from floods) the impacts identified for the construction phase will again be applicable. If the maintenance does occur the mitigation measured proposed during the construction phase should again be implemented.

Conclusions and Recommendations

The surface mitigation measure project aims to address issues associated with the current and future environmentally degraded state of the project site. It seeks to prevent further degradation of the environment and ensure a sustainable state is maintained once the project has been completed.

Sigma Defunct Colliery stopped operations in 2006. Significant efforts, since then, have been made to rehabilitate the defunct mine to a state that is able to support further development and growth specifically agriculture. As was indicated in the closure plan and EMPr, effort needed to be made to implement mitigation measures to reduce the significant risks which had been identified at the defunct colliery. It was determined that the significant risk hazard by Sasol at the Sigma Defunct Colliery was the potential for pillar failure which will result in subsidence. Subsidence occurs when the land beneath the surface gives way resulting in the ground collapsing into the underground workings. This poses a significant impact to both people and the environment (specifically surface water and the environmental aspects it supports i.e. wetlands and fauna and flora).

The surface mitigation measures are one of the proposed mitigation measures aimed to reduce the impact to surface should subsidence occur. It should however be noted that the surface mitigation measures are not the only mitigation measure proposed by Sasol Mining to address the issues surrounding pillar failure. A combination of mitigation measures implemented by Sasol mining is proposed to reduce the impact of subsidence which includes ash backfilling and demolition of infrastructure located on areas where pillar failure could occur.

Although impacts have been identified from the implementation of the proposed project and found to be significant, should the mitigation measures proposed be implemented correctly these impacts in most cases will be reduced to an acceptable impact, excluding some of the impacts to wetlands, fauna and flora and soil, land use and land capability.

However, if no intervention is implemented, pillar failure may occur which will result in subsidence which would lead to a catastrophic impact on the Leeuspruit and Rietspruit that feed into Vaal River. In general, the surface water will be lost to the groundwater and underground mine workings. This will have a direct negative impact on the quantity of water entering the Vaal River, wetlands and aquatic ecosystems which rely on these rivers for ecological functioning. The negative impact to the environment has been discussed further in Section 9 should a no-go approach be implemented. The wetlands, surface water resources,

aquatic environments and fauna and flora provide specific important environmental functioning. The implementation of the project will help preserve this functionality which could be completely destroyed should the project not receive its required environmental authorisation.

Additionally, it is not known when exactly the identified pillars will fail as it could occur at any time. Should it occur, no mitigation measures can be implemented to rectify the damage caused from subsidence to the environment. This provides motivation for an urgent proactive approach as opposed to a reactive approach.

The proposed project is for the benefit of the people living in the area. Sasol will gain no economic benefit from this project as it is a remediation project. Therefore, based on the information presented in this report, Digby Wells recommends that an authorisation for this proposed project is granted.

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LIST OF ABBREVIATIONS

Acronym	Description
ASPT	Average Score Per Taxon
BA	Basic Assessment
BAR	Basic Assessment Report
BID	Background Information Document
CBAs	Critical Biodiversity Areas
cm	Centimetre
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESAs	Ecological Support Areas
FAD	Fine Ash Dam
FDDM	Fezile Dabi District Municipality
FRAI	Fish Response Assessment Index
HFS	Heritage Free State
IHAS	Invertebrate Habitat Assessment System
I&APs	Interested and Affected Parties
IWUL	Integrated Water Use licence
J&W	Jones and Wagener
km^2	Kilometre
LOM	Life of Mine
MAE	mean annual evaporation
MAR	Mean annual runoff
MAP	mean annual precipitation
MINACT	Minerals Act No.(Act 50 of 1991)
MIRAI	Macroinvertebrate Response Assessment Index
MLM	Metsimaholo Local Municipality
m	Metres

Acronym	Description
mm	Millimetre
MPRDA	Mineral and Petroleum Resources Development (Act 28 of 2002)
NEMA	National Environmental Management Act (Act 107 of 1998)
NEMAQA	National Environmental Management: Air Quality Act (Act 39 of 2004)
NEMBA	National Environmental Management: Biodiversity Act (Act 10 of 2004)
NEMWA	National Environmental Management: Waste Act (59 of 2008)
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Areas Expansion Strategies
NHRA	National Heritage Resources Act (Act 25 of 1999)
NID	Notice of Intent to Develop
NWA	National Water Act (Act 36 of 1998)
PES	Present Ecological State
EIS	Ecological Importance and Sensitivity
PPP	Public Participation Process
PRECIS	Pretoria Computerised Information System
SAHRA	South African Heritage Resource Agency
SANBI	South African National Biodiversity Institute
SANS	South African National Standards
SASS5	South African Scoring System, Version 5
SSC	Species of Conservation Concern
SSO	Sasol Sasolburg Operations
WUL	Water Use Licence
WULA	Water Use Licence Application
WMA	Water Management Area
WML	Waste Management Licence

Part A: Scope of Assessment and Basic Assessment Report

1 Introduction

Sasol Mining's Sigma Defunct Colliery (Sigma Defunct Colliery) occupies a mining area of approximately 11 643ha. Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR). Plan 1 in Appendix B provides the areas where mining was undertaken within the Sigma Defunct Colliery mining lease area.

Sigma Defunct Colliery commenced operations in 1952 with underground mining, holding mineral rights to several coal deposits in the Sasolburg district. Underground mining methods was the primary method of extracting these reserves and included mechanised board-and-pillar, rib pillar extraction and bottom coaling methods. Access to the underground operations was via several shafts, and the coal was conveyed to a 'dry' coal handling plant at 3 Shaft Complex where the coal was screened and fed to silos.

In 1992 the Wonderwater opencast mine was developed to extract coal from the north-eastern side of the reserves which occupied a mining area of approximately 385ha. The Wonderwater opencast mine was mined utilising truck and shovel methods. Mining ceased in 2005 after which the opencast mine was backfilled and rehabilitated. The final voids were left as part of the water management of the underground workings.

The Mohlolo Operations (underground mining method), situated adjacent to the Wonderwater opencast mine commenced with its activities in 1999 and occupied a mining area or approximately 264ha. The underground operations were accessed from the Wonderwater opencast mines highwalls in the north and the south which divided the operations into Moholo North and Mohlolo South. The underground mining was scaled down and ceased by 2006, the underground mine workings were left to be flooded.

Sigma Defunct Colliery applied for mine closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan and Environmental Management Programme (EMP) to address all the significant risks and rehabilitation measures which were required to obtain the needed closure certificate. Jones and Wagener (J&W) were appointed to assist Sasol Mining in the compilation of a Risk Assessment Report for mine closure process to identify all the significant latent risks which Sigma Defunct Colliery have and rate them in accordance with the Sasol Risk Assessment Methodology. This report further proposed mitigation measures to be implemented to reduce the significant rated risks to an acceptable residue risk level. The report was compiled in 2015 and has now been updated in 2018.

As part of the Risk Assessment Report, mitigation measures have been proposed and grouped together as underground mitigation measures (ash backfilling) and surface mitigation measures (river diversions and berm constructions). Sasol Mining have allocated funds in accordance with the mines financial provision to provide for the implementation of the project.

The Underground Mitigation Measures which includes ash backfilling of certain areas with ash slurry is being dealt with as a separate project and under a separate environmental authorisation process.

The Surface Mitigation Measures proposed in the Risk Assessment Report requires environmental authorisation. Two rivers flow through the Sigma mining area namely the Rietspruit and the Leeuspruit. Beneath these water courses or floodplains a hazard of pillar failure exists which can result in subsidence. Subsidence is expected to have a significant impact on surface aspects should it occur and no mitigation measures are implemented. The risk of this occurring is considered to be significant. Therefore various mitigation measures have been proposed to reduce the significant risk areas to an acceptable residual risk (insignificant risk).

To implement these surface mitigation measures new triggered Listed Activities in terms of the Environmental Impact Assessment (EIA) Regulations 2014 (as amended) (Government Notice No. R. 982 of 4 December 2014 as amended by Government Notice No. R.326 of 7 April 2017) referred to now as the EIA Regulations, 2014 (as amended) promulgated under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) must be applied for. The proposed project triggers activities listed under Listing Notice 1 of the EIA Regulations, 2014 (as amended) and therefore a Basic Assessment (BA) Process must be followed to obtain the required Environmental Authorisation.

Digby Wells Environmental (Digby Wells) has been appointed by Sasol Mining to undertake the BA and Water Use Licence (WUL) processes to obtain the required authorisations to commence with the project. The project is considered to be a rehabilitation (remediation) project to prevent further damage to the environment. This project is further considered to be critical as; if no intervention is implemented pillar failure may occur which may result in subsidence leading to catastrophic impacts on the Leeuspruit and Rietspruit that feed into the Vaal River. Sasol proposes to have a proactive approach as appose to a reactive approach where potentially no remediation measures can be implemented if subsidence were to occur within the river system without the implementation of this proposed project.

2 Project applicant

2.1 Details of EAP

Sasol Mining Sigma Defunct Colliery particulars are detailed in Table 2-1.

Table 2-1: Particulars of the Applicant

Applicant Name:	Sasol Mining (Pty) Ltd
Contact Person:	Trevor Davids
Telephone No:	+27 17 614 2313
Email Address:	trevor.davids@sasol.com

Physical Address:	Sigma Defunct Colliery, 137 Saltberry Plain Sasolburg, 9570

2.2 Expertise of the EAP

Digby Wells has been appointed by Sasol Mining as the independent Environmental Assessment Practitioner (EAP) to conduct the BA process according to the NEMA and the EIA Regulations, 2014 (as amended) as well as the required Public Participation Process (PPP). The particulars of the EAP undertaking the BA process is supplied in Table 2-2.

Table 2-2: Contact Details of the EAP

EAP Company Name:	Digby Wells Environmental
EAP:	Danie Otto
Telephone No:	+27 11 789 9495
Fax No:	+27 11 069 6801
Email Address:	danie.otto@digbywells.com
Physical Address:	Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191, South Africa.
Postal Address:	Private Bag X10046, Randburg, 2125

2.2.1 The qualifications of the EAP

Danie Otto manages the Southern African Operations and Technical Services at Digby Wells. He holds an M.Sc in Environmental Management. He is a biogeomorphologist who specialises in ecology of wetlands and rehabilitation. He has been a registered Professional Natural Scientist (Ref No. 115092) since 2002.

Danie has 21 years of experience in the mining industry in environmental and specialist assessments, management plans, audits, rehabilitation, and research. He has experience in eight countries and his experience is in the environmental sector of coal, gold, platinum (PGMs), diamonds, asbestos, rock, clay and sand quarries, copper, phosphate, andalusite, base metals, heavy minerals (titanium), uranium, pyrophyllite, chrome, nickel etc.

He has wetland and geomorphology working experience across Africa including specialist environmental input into various water resource related studies. These vary from studies of the wetlands of the Kruger National Park to swamp forests in central Africa to alpine systems in Lesotho. Danie's CV is included in Appendix A.

2.2.2 Summary of the EAP's past experience

The CV of Danie Otto, including the relevant project experience, is included in Appendix A.

3 Location of the overall Activity

Table 3-1 provides the location for which the proposed project will be undertaken.

Table 3-1: Location of the Overall Activity

<table>
<tr><td>Farm Name:</td><td>The river diversion will intersect the following farm portions.
<table>
<tr><th>Farm Name</th><th>Farm Portion</th></tr>
<tr><td>Alfresco 202</td><td>1/202</td></tr>
<tr><td>Zwanenberg 366</td><td>1/366</td></tr>
<tr><td>Donkerhoek 323</td><td>1/323</td></tr>
<tr><td>Donkerhoek 323</td><td>RE/323</td></tr>
<tr><td>The Star 387</td><td>1/387</td></tr>
<tr><td>Roseberry Plain 250</td><td>5/250</td></tr>
<tr><td>Wilgefontein 433</td><td>433</td></tr>
<tr><td>Wilgefontein 431</td><td>18/431</td></tr>
<tr><td>Herewarde 409</td><td>6/409</td></tr>
<tr><td>Herewarde 409</td><td>RE/409</td></tr>
<tr><td>Rand Water Board 8 312</td><td>312</td></tr>
<tr><td>Rand Water Board 7 300</td><td>300</td></tr>
<tr><td>Erf-A- 32</td><td>32</td></tr>
<tr><td>Boschbank 12</td><td>RE/12</td></tr>
<tr><td>Alfresco 202</td><td>RE/202</td></tr>
<tr><td>Zwanenberg 450</td><td>1/450</td></tr>
<tr><td>Erven Bcd 33</td><td>33</td></tr>
<tr><td>Roseberry Plain 250</td><td>7/250</td></tr>
<tr><td>Wonderwater 180</td><td>9/180</td></tr>
</table></td></tr>
<tr><td>Application Area (Ha):</td><td>Sigma Defunct Colliery occupies a mining area of approximately 11 643ha. Of this area 48.19ha will be directly impacted by the proposed project.</td></tr>
<tr><td>Magisterial District:</td><td>Sigma Defunct Colliery is located in the magisterial district of Sasolburg and falls under the administrative jurisdiction of the Northern Free State District Council and the Metsimaholo Local Municipality (MLM).</td></tr>
<tr><td>Distance and direction from nearest town:</td><td>Sigma Defunct Colliery is located west of the town of Sasolburg and south of the Vaal River in the Free-State Province. The mine covers approximately 11 643 ha, with Sasolburg forming the eastern boundary and the Vaal River the northern boundary.</td></tr>
<tr><td>21 digit Surveyor General Code for each farm portion:</td><td>
<table>
<tr><th>Farm Name</th><th>Farm Portion</th><th>21 SG Code</th></tr>
<tr><td>Alfresco 202</td><td>1/202</td><td>F02500000000020200001</td></tr>
<tr><td>Zwanenberg 366</td><td>1/366</td><td>F02500000000036600001</td></tr>
<tr><td>Donkerhoek 323</td><td>1/323</td><td>F02500000000032300001</td></tr>
<tr><td>Donkerhoek 323</td><td>RE/323</td><td>F02500000000032300000</td></tr>
<tr><td>The Star 387</td><td>1/387</td><td>F02500000000000100000</td></tr>
<tr><td>Roseberry Plain 250</td><td>5/250</td><td>F02500000000025000005</td></tr>
<tr><td>Wilgefontein 433</td><td>433</td><td>F02500000000043300000</td></tr>
<tr><td>Wilgefontein 431</td><td>18/431</td><td>F02500000000043100018</td></tr>
</table></td></tr>
</table>

	Herewarde 409	6/409	F02500000000040900006
	Herewarde 409	RE/409	F02500000000040900000
	Rand Water Board 8 312	312	F02500000000031200000
	Rand Water Board 7 300	300	F02500000000030000000
	Erf-A- 32	32	F02500000000003200000
	Boschbank 12	RE/12	F02500000000001200000
	Alfresco 202	RE/202	F02500000000020200000
	Zwanenberg 450	1/450	F02500000000045000001
	Erven Bcd 33	33	F02500000000003300000
	Roseberry Plain 250	7/250	F02500000000025000007
	Wonderwater 180	9/180	F02500000000018000009

4 Locality map

The Sigma Defunct Colliery falls under the jurisdiction of the MLM and is situated in the Fezile Dabi District Municipality (FDDM) in the Free State Province. The closest towns are Sasolburg, Deneysville, Oranjeville and Viljoensdrift. See Plan 2 of Appendix B for a regional setting.

4.1 Property Particulars

The project site has been defined as Ward 14, Sasolburg residential area, as well as Zamdela. See Plan 3, Appendix B for an illustration of the local setting of the proposed surface mitigation project area.

The land owner information is listed in Table 4-1 and the land tenure is depicted in Plan 4, Appendix B.

Table 4-1: Landowner Information

Name	Property
AM Rossouw Eiendomme (Pty) Ltd	Boschbank 12 (RE)
DWS Representatives	Rand Water Board 7 300 Rand Water Board 8 312
F.C. Verway	Wilgefontein 431 (Portion18)
Interferon Trust	Alfresco 202 (Portion 1 and RE)
Lewies Trust	Donkerhoek 323 (RE)
Metsimaholo Local Municipality	Roseberry Plain 250 (Portion 5)
R. Knoetze	Zwanenberg 450 (Portions 1 and 2)
Riverbank Trust	Wonderfontein 350 (Portion 1)

Name	Property
Sasol Chemical Industries (Pty) Ltd	Donkerhoek 323 (Portion 1) Herewarde 409 (Portion 6) Roseberry Plain 250 (Portion 7)
Sasol Townships (Pty) Ltd	Herewarde 409 (RE) The Star 387 (Portion 1)
T.C. Johannes	Erven BCD 33
Sasol Mining (Pty) Ltd	Wonderwater 180 (Portion 9)

5 Description of the scope of the proposed overall activity

The description of the project as well as the listed activities triggered in accordance with the EIA Regulations, 2014 (as amended) is discussed below.

5.1 Listed and specified activities

An Environmental Authorisation and WUL application process commenced in 2013 to obtain the required authorisations for the underground mitigation measures (ash backfilling). The following licences have been received for the ash backfilling project:

- Waste Management Licence (WML) in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA) for the Ash Backfilling Project received in 2017; and
- WUL in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) received in 2017.

The following authorisations have lapsed for the Sigma Defunct Colliery:

- Mining Licenses No 1/2001 and 3/2001, granted by the DMR;
- EMPr for the Sigma Defunct Colliery granted in accordance with the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) approved in 2001;
- WUL for ash backfilling (Ref No. 20021165) which expired in 2010; and
- Environmental Authorisation in terms of the NEMA for listed activities associated with the Ash Backfilling Project received in 2014.

The Environmental Authorisation is still required for the ash backfilling project which is currently being completed. The final Ash Backfilling Basic Assessment Report (BAR) was submitted to the DMR on 30 August 2018 for consideration.

The following listed activities in accordance with the EIA regulations, 2014 (as amended) are triggered by the proposed project as shown in Table 5-1.

Table 5-1: Listed and specified activities for the project

NAME OF ACTIVITY	AERIAL EXTENT OF THE ACTIVITY (Ha or m^2)	LISTED ACTIVITY Mark with an X where applicable or affected.	APPLICABLE LISTING NOTICE
Construction of canals to divert the water will exceed 1000 metres in length and will have a width of 12.5 - 30metres.	48.19ha	X	GNR 327 - Listing Notice 1 Activity 9
The canals to be constructed will divert water that will exceed 100m^2 which are proposed to be located within a water course.	48.19ha	X	GNR 327 - Listing Notice 1 Activity 12
Excavation and movement of soil of more than 10m^3 within a watercourse.	48.19ha	X	GNR 327 - Listing Notice 1 Activity 19
The clearing of natural vegetation of more than 1ha but less than 20ha. The vegetation clearance will include areas for the laydown area. Vegetation clearance required for the river diversion is considered to be linier activities and therefore excluded from this listed activity	3.97ha	X	GNR 327 - Listing Notice 1 Activity 27
A small portion of Soweto Highveld Grassland, is located within the project area however no vegetation is this area will be removed.	0ha	N/A	N/A
Construction of access roads to the river during construction phase and maintenance to be undertaken during operational phase. It is noted that existing roads where possible will be utilised to access the areas where surface mitigation measures will be undertaken. New roads will be constructed where existing roads do not exist.	New Roads- 1.623m Existing Roads - 23510.78 m	X	GNR 327 - Listing Notice 1 Activity 24
Construction of access roads to the river during construction phase and maintenance to be undertaken during operational phase.	No new road intercept sensitive CBA's	X	N/A

5.2 Description of the activities to be undertaken

This section of the report has been informed by the "*Sigma Defunct Mine Closure Leeuspruit and Rietspruit Ingress Mitigations Feasibility Design Report compiled by Jones and Wagener on behalf of Sasol Mining, 2018 (Ref No. JW030/18/F903 - Rev 0)"* now referred to as J&W Design Report, 2018.

The aim of the proposed project is to implement surface mitigation measures which include designs for diversion canals and flood protection berms to channel the Leeuspruit and Rietspruit away from areas identified to have a significant potential for pillar failure which could potentially result in subsidence. It must be noted that the surface mitigation measures proposed will not prevent subsidence from occurring however it will minimise the impact to important resources located on surface which potentially would be critically impacted should the project not be implemented. If the pillars were to fail beneath the water courses, without the implementation of this project, subsidence will occur which could result in the ingress of surface water into the groundwater aquifer and potentially the underground mine workings. The location of where pillar failure is predicted to occur is shown in Plan 6 in Appendix B.

According to the J&W Design Report, 2018 a total of 37 potentially significant risks (associated with underground mined panels where a high potential of pillar failure has been identified) were identified of which 36 are located within the Leeuspruit and only one within the Rietspruit. J&W's Design Report, 2018 sub-divided the Leeuspruit into four sections numbered in the direction of stream flow (from south to north).

The surface mitigation measures that were considered include full stream diversions, partial stream diversion and ash backfilling of mined panels or various combinations thereof. A description of the various diversion types is provided below:

- Full stream diversion:
  - Typically consists of a diversion canal which follows along a completely new alignment from the original stream alignment. The stream flow is diverted along the new route and discharges back into the existing stream downstream of the affected area. A diversion canal mitigates the risk by moving the stream away from the significant risk area.
- Partial stream diversion:
  - A partial stream diversion entails confining the stream flow by means of either channelling the stream or flood protection berms or both in order for it not to cross areas where a high chance of pillar failure which will result in subsidence could occur. The purpose of flood protection berms is to prevent the existing stream flow from entering significant risk areas. Where possible, flood protection berms are used in isolation, however if the position of a berm obstructs the natural stream flow (i.e. crossing existing watercourse centreline), flood protection berms are used in combination with channelling the stream. This prevents unnecessary

secondary issues, for example backwater or ponding upstream of the berm, and allows unimpeded flow of the stream past the problem areas.

- Backfilling:
  - Ash backfilling is predominantly used where a full stream diversion or partial stream diversion alone does not mitigate the risk or where a diversion canal cannot avoid crossing over a significant risk area. In the case where a full diversion or partial diversion is not possible, only backfilling is proposed.
  - It must be noted that although mentioned, ash backfilling is being dealt with as a separate project and is not considered to be incorporated as part of this environmental authorisation process.

The surface mitigation measures have been divided into five sections along the Leeuspruit with only one section in the Rietspruit. A description of each section is provided below. Figure 5-1 shows the location of where the surface mitigation measures will be implemented. Plan 5 in Appendix B provides a map of the surface mitigation measures and associated surface infrastructure including new roads, batching plant and laydown area.

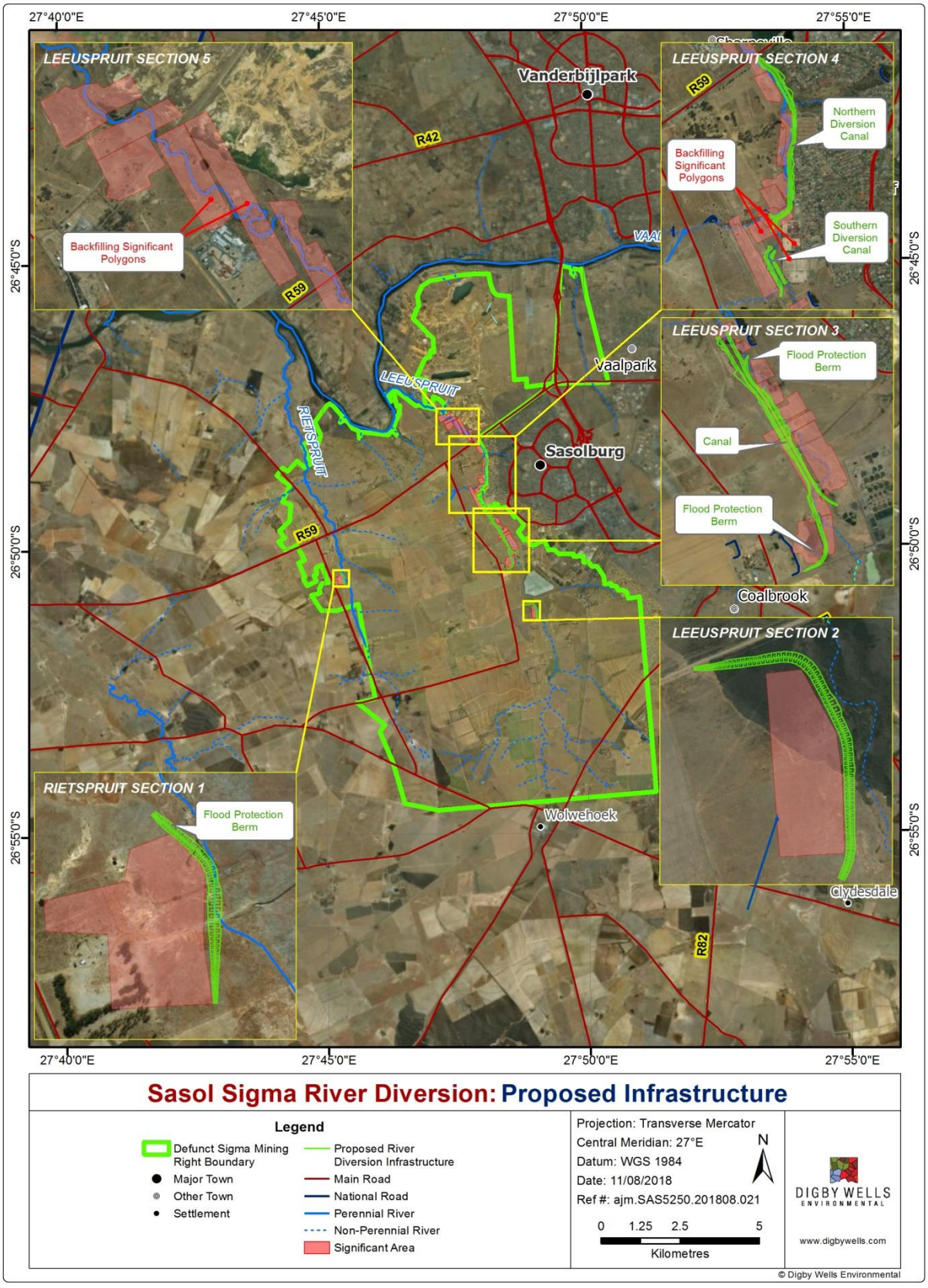

Figure 5-1: Proposed Surface Mitigation Measure Infrastructure

5.2.1 Leeuspruit Section 2

Leeuspruit Section 2 is located just above the existing Fine Ash Dump (FAD) which was constructed and operated by Sasol Synfuels (Pty) Ltd. The FAD was constructed within the floodlines of the Leeuspruit. A river diversion was therefore implemented 500 metres (m) downstream of where the proposed surface mitigation measure will be constructed (Figure 5-2).

Only one area for pillar failure has been identified within the Leeuspruit Section 2. It is proposed that a flood protection berm will be constructed to prevent the stream flow from crossing this area. The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations, compacted in layers and shaped to the design grade and level.

Top soil will be placed on the berm and it will be hydro-seeded which refers to a planting process where seed slurry mixed with mulch is pumped onto the berm. Vegetation of the berm will assist in erosion protection. Additionally, the berm will be sloped to have a 1:5 ratio. The flood protection berms will extend up to the 1:100-year floodline on the upstream side to channel the water away from the area where pillar failure has been identified. The berms will be able to withstand a flood peak flow rate of 129m^3/s, plus 500mm of freeboard. The berm will be 785m in length with a width of 1m and a height of 2.5m. The total amount of soil to construct the berm will be approximately 20 450m^3 which will be sourced for Leeuspruit Section 4.

Some ponding may occur at low spots behind the flood protection berm. Slow release outlet pipes will be installed within the berm to allow water to dissipate back into the Leeuspruit should the water flow over the berm and into the area where pillar failure may occur. The pipes will have a diameter of 600mm to 900mm and will be made of concrete.

The idea behind these pipes is to limit the volume of water encroaching onto the risk area during a flood event, thereby limiting the impact of subsidence on surface water ingress, whilst allowing the water ponding behind the berm to be released after the flood peak has passed. Refer to Figure 5-3.

With the implementation of the flood protection berm, this will result in a slight change to the floodlines of the river. It can be concluded that the increase in the floodline elevation is negligible with no risk of flooding of any residential areas or major infrastructure for floods up to a 1:100-year flood event. The existing culvert at the gravel road is only designed for a small flood event (less than 1:5-year). The proposed mitigations will have no notable impact on the flow reporting to the culvert.

Plan 7 in Appendix B illustrates the implementation of the surface mitigation measure.

Figure 5-2: Leeuspruit Section 2 Habitat

(A and B: Area adjacent to the FAD; C: Secondary channel; D: Main channel; E: culvert; F: *Azolla filiculoides*, an invasive species, can be seen as a red mat covering the water's surface)

Figure 5-3: Leeuspruit Section 2 Surface Mitigation Measure

5.2.2 Leeuspruit Section 3

Leeuspruit Section 3 is located 500m downstream of the FAD just past the existing gravel road which is located parallel to the FAD (Figure 5-5). Two pipes cross this section of the Leeuspruit by means of a steel pipe gantry suspended above the flood level. The proposed new diversion canal will divert flow towards the west of the existing stream, resulting in a second pipe gantry that will need to be constructed.

Within this section, 11 areas beneath the Leeuspruit have been identified to have a significant potential for pillar failure which can result in subsidence and a direct impact to the water course. It is therefore proposed that a combination of surface mitigation measures (diversion canals and flood protection berms) as well as underground mitigation measures (ash backfilling which is being authorised as a separate project) be implemented.

The reason for the combination of mitigation measures is because a full stream diversion is not possible as all the adjacent areas to the Leeuspruit have also been found to have the same potential for pillar failure.

The proposed surface mitigation measure in this section will comprise of two flood protection berms to direct the flow of water away from significant risk areas. The berms will extend up to the 1:100-year floodline level on the upstream and downstream ends.

The berms will be compacted with side slopes of 1V:5H. The berms will be top soiled and covered with grass by means of hydro seeding to minimise erosion. Areas behind the flood protection berms will be made free draining to prevent ponding. Slow release outlet pipes will also be installed within the berms to allow the release of water back into the Leeuspruit. The berm will be approximately 680m long with a width of 1m and a height of 4m. A total of 29 750m^3 of soil will be required to construct the berms which will be sourced from Leeuspruit Section 4 and this section. The flood protection berms are designed for a flow rate of 237m^3/s.

The proposed canal diversion aims to divert the water along a new channel away from the areas where pillar failure may occur. The canal is proposed to have a width of 20m designed to convey a 1:50-year flood event which will then be expanded to 40m and then 60m as the topography flattens out. The slopes of the canal will be constructed with a slope of 1:3 to prevent erosion from occurring.

To the eastern side of the proposed canal the slope will be slightly higher to accommodate a 1:100 year flood to prevent water overflowing into the significant risk area located east of the canal. The total length of the proposed canal will be 1 460m. The canal bottom width and side slopes are summarised in Table 5-2. The diversion canal is sized to accommodate a 1:50-year design flood peak flow rate of 188m^3/s. A total of 25 600m^3 of soil will be required to construct the diversion canal while 93 700m^3 of soil will be removed.

Table 5-2: Leeuspruit Section 3 canal dimensions

Chainage start (m)	Chainage end (m)	Length (m)	Bottom width (m)	Side slope (left)	Side slope (right)
0	1 160	1 160	20	1:3	1:3
1 160	1 360	200	40	1:7	1:7
1 360	1 460	100	60	1:7	1:7

It is proposed that the canal will have an Armorflex liner, Terraforce or something similar to prevent erosion. Armorflex, Terraforce or a similar liner is an erosion control system which provides an alternative for a wide variety of erosion control and drainage projects. It is a flexible, interlocking matrix of machine-compressed, cellular concrete blocks of uniform size, shape, and weight. The liner encourages vegetation establishment and drainage which will prevent the loss of soil. Figure 5-4 provides an example of what the liner would look like.

Plan 8 in Appendix B illustrates the implementation of the surface mitigation measure.

Figure 5-4: Example of an Armorflex Liner

(https://www.conteches.com/Erosion-Control/Hard-Armor/ArmorFlex)

Figure 5-5: Leeuspruit Section 3 Habitat

(A: Road crossing; B: *Kniphofia* species in abundance near the school field; C: *Azolla filiculoides* (an invasive species) covering open water; D: Stormwater entering the wetland; E: A pipeline crossing the wetland; F: Powerline servitude within the wetland)

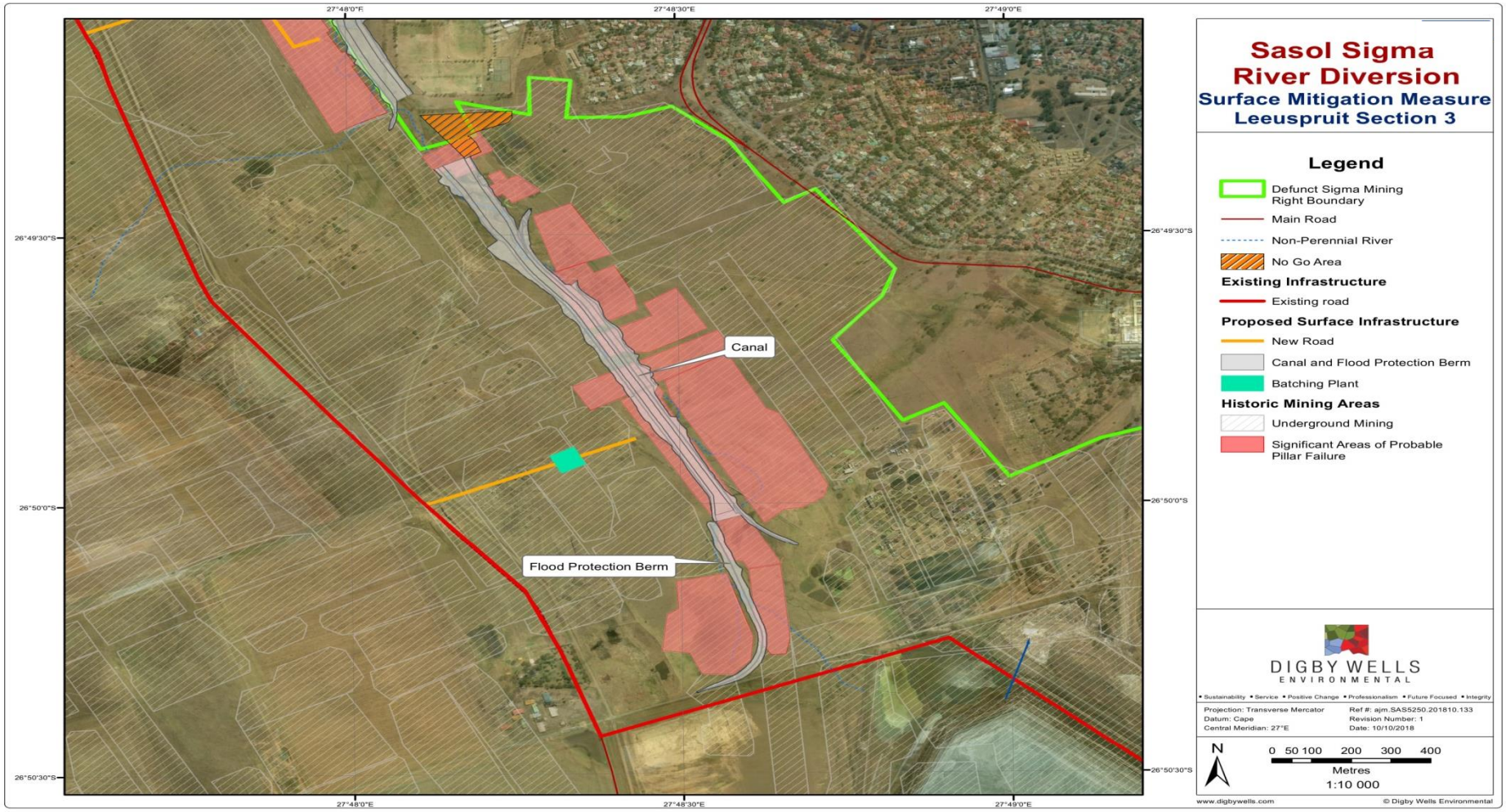

Figure 5-6: Leeuspruit Section 3 Surface Mitigation Measure

5.2.3 Leeuspruit Section 4

Leeuspruit Section 4 is located immediately west of Sasolburg residential area. The surface mitigation measure will impact the Leeuspruit for 2.3km from the Afrikaanse Hoërskool Sasolburg up to the R59 provincial road. To the west of the Leeuspruit is designated to be agricultural land owned by Sasol and is being utilised as a game farm (Figure 5-7).

Within this section nine significant risk areas have been identified. Based on the location of these risk areas the Leeuspruit cannot remain in its existing position without potentially significant residual risk for surface water ingress. It is therefore proposed that two full stream diversions namely the southern and northern diversion will be constructed. Ash backfilling (dealt with as a separate project) is also proposed to be implemented in some areas (Figure 5-8).

Plan 9 in Appendix B illustrates the implementation of the surface mitigation measure.

Figure 5-7: Leeuspruit Section Habitat

(A and D: disturbed area; B: houses in proximity to river; C: Road crossing)

5.2.3.1 Southern Diversion Canal

The southern diversion is located west of the Afrikaanse Hoërskool Sasolburg. The canal is proposed to be approximately 30m wide with a slope of 1:5 along the full length of the canal. A flood protection berm will also be constructed within this section. Armorflex lining (or similar) will be utilised as the stream velocity is expected to exceed 2.0m/s. The average and maximum excavation depth for this canal is 1.72m and 3.5m respectively. The Southern diversion canal is designed to contain a 1:100-year design flood with a peak flow rate of 325m^3/s. The diversion canal is proposed to have a total length of 380m and a width of 30m. The slope is proposed to have a 1:5 ratio. A total of 13 200m^3 of soil will be required to construct the southern diversion canal while 11 500m^3 of soil will be removed.

5.2.3.2 Northern Diversion Canal

The northern stream diversion will be located east of the current Leeuspruit alignment, directly west of the residential area. This diversion is located in close proximity to the residential area as this is the only space suitably available for the canal to be constructed. It must be noted that the historic underground mining restricts the location of where the Leeuspruit canal can be constructed as the adjacent areas to the Leeuspruit also have a significant potential for pillar failure.

Due to the limited space available, the canal cannot be widened which will result in an increased velocity of water flowing downstream and an increased risk of erosion. Therefore, to reduce this risk an Armorflex liner or something similar will be implemented. The width of the canal will be approximately 12.5m with a slope of 1:2. Where the topography flattens out and more space is available the canal will widen to 20m with a slope of 1:2 but may increase in areas to 1:4. The canal will discharge the water into the existing stream approximately 1.8km north of the Leeuspruit Primary School just south of the R59 provincial road.

The canal will be excavated to a depth of 2.5m with a maximum depth of 4.6m. Due to the space limitations the canal has been designed to contain a 1:10 year flood event which according to the engineers is sufficient (J&W Design Report, 2018). To prevent flooding of the residential area, the canal has been designed to overtop on the western side only during a 1:100-year flood event which will prevent flooding on the residential side located to the east. The length of the proposed canal is approximately 1 790m. The canal bottom width and side slopes are summarised in Table 5-3. A total of 30 700m^3 of soil will be required to construct the southern diversion canal while 103 700m^3 of soil will be removed.

Table 5-3: Leeuspruit Section 4 canal dimensions

Chainage start (m)	Chainage end (m)	Length (m)	Bottom width (m)	Side slope (left)	Side slope (right)
0	1240	1240	12.5	1:2	1:2
1240	1270	30	Transition	1:2	1:3
1270	1790	520	20	1:2	1:4

The bridge culvert below the R59 was modelled to assess its current hydraulic capacity and need for a possible upgrade. The current capacity of the R59 culvert is not sufficient to convey a 1:10 year design flood without causing flooding of the road. No upgrade of the culvert, other than cleaning up debris and silt depositions, is proposed as part of this project.

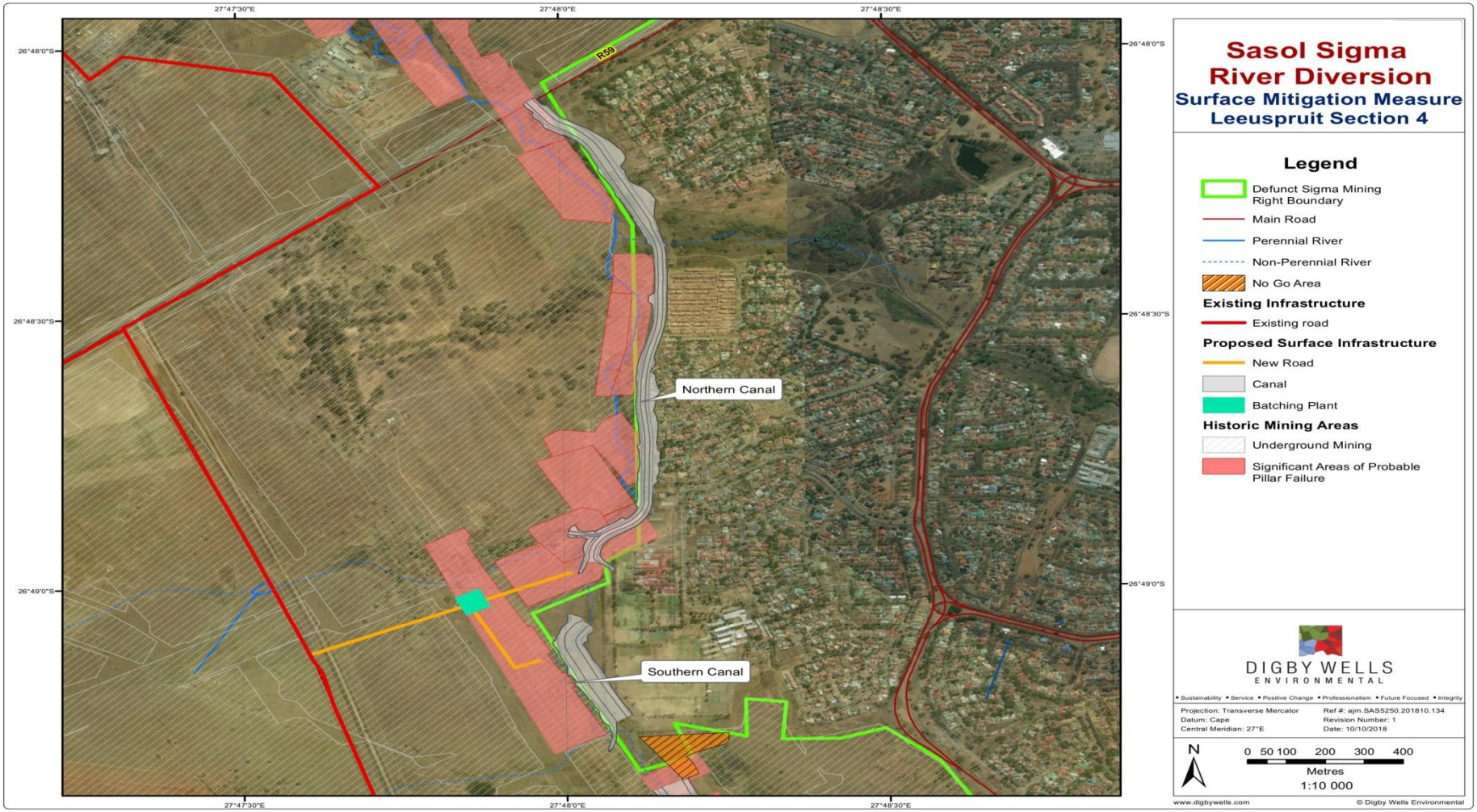

Figure 5-8: Leeuspruit Section 4 Surface Mitigation Measures

5.2.4 Leeuspruit Section 5

This section has been heavily impacted on most notably by a sand mining operation currently operating within Sigma Defunct mining lease area but is not operated by Sasol Mining as well as channelization due to the R59 culvert upstream and a large pipeline crossing (Figure 5-9). This section will not be directly impacted on by surface mitigation measures. Ash backfilling is proposed to be undertaken which is being assessed as part of a separate project. The section is shown in Plan 10 in Appendix B and Figure 5-10 illustrates the area where the ash backfilling will be undertaken which is not considered to be part of the project as well as surface infrastructure proposed to be constructed.

Figure 5-9: Leeuspruit Section 5 Habitat

(A: habitat; B: large pipeline crossings)

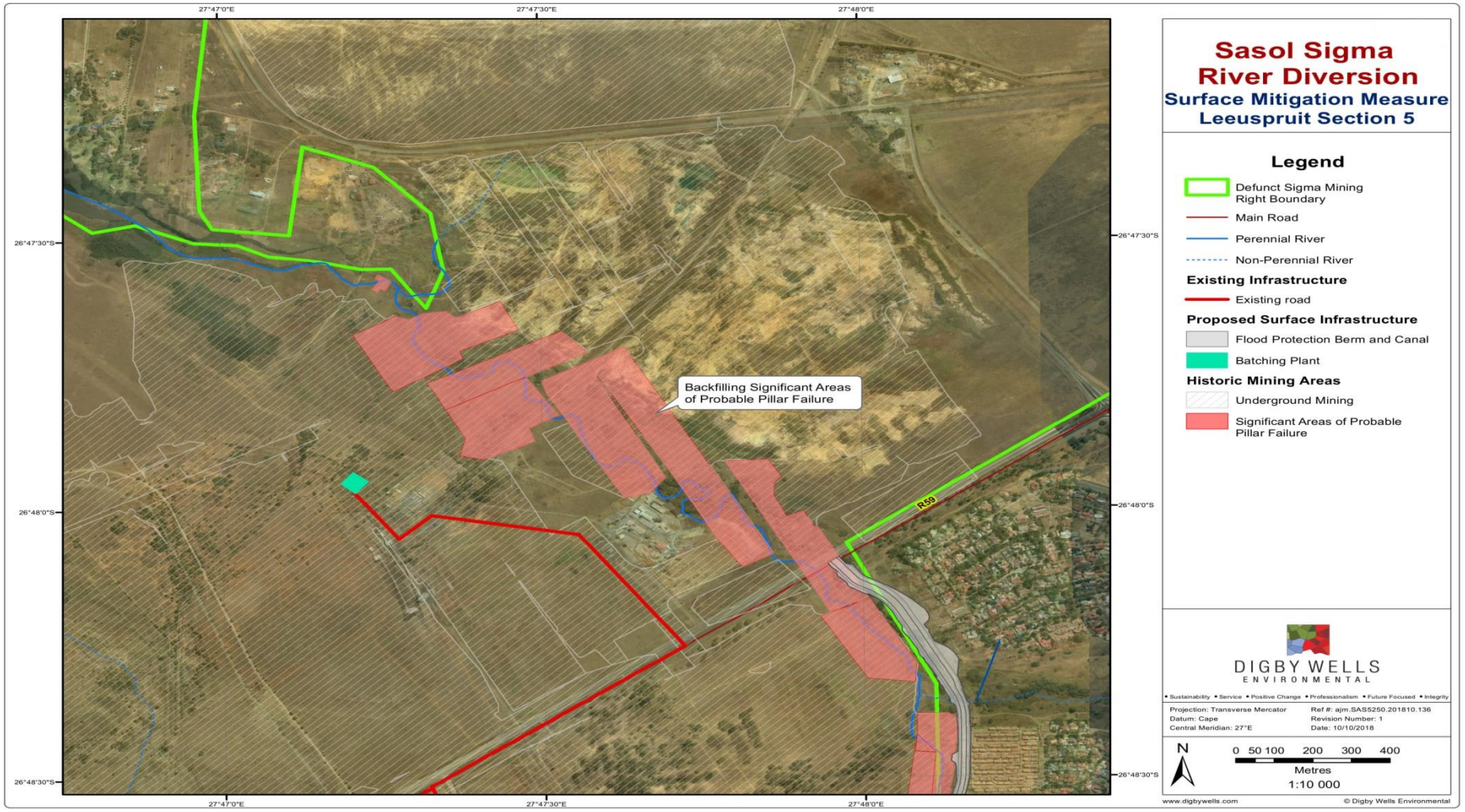

Figure 5-10: Leeuspruit Section 5 with surface infrastructure

5.2.5 Rietspruit Section 1

Quarrying, not undertaken by Sasol Mining, has taken place within this area. Additionally, two roads with associated culverts have altered the Rietspruit (Figure 5-11).

Only one significant risk area has been identified within the Rietspruit which can be mitigated through the construction of a flood protection berm. The proposed flood protection berm is located on the western bank of the stream to prevent the flood plain from extending over the area where potential pillar failure may occur. The flood protection berm is sized for a 1:100-year flood, plus allowance for freeboard with a slope of 1:5. The berm will be constructed in the same way at discussed in Leeuspruit Section 2. The berm will have a length of 420m, a width of 1m and a height of 2.8m. A total volume of 9 645m^3 of soil will be required to construct the berm (Figure 5-12).

Plan 11 in Appendix B illustrates the implementation of the surface mitigation measure.

Figure 5-11: Rietspruit Section 1 Habitat

(A: a dry channel; B: Excavations within the wetland; C: Invasive alien species are present; D; a culvert with erosion)

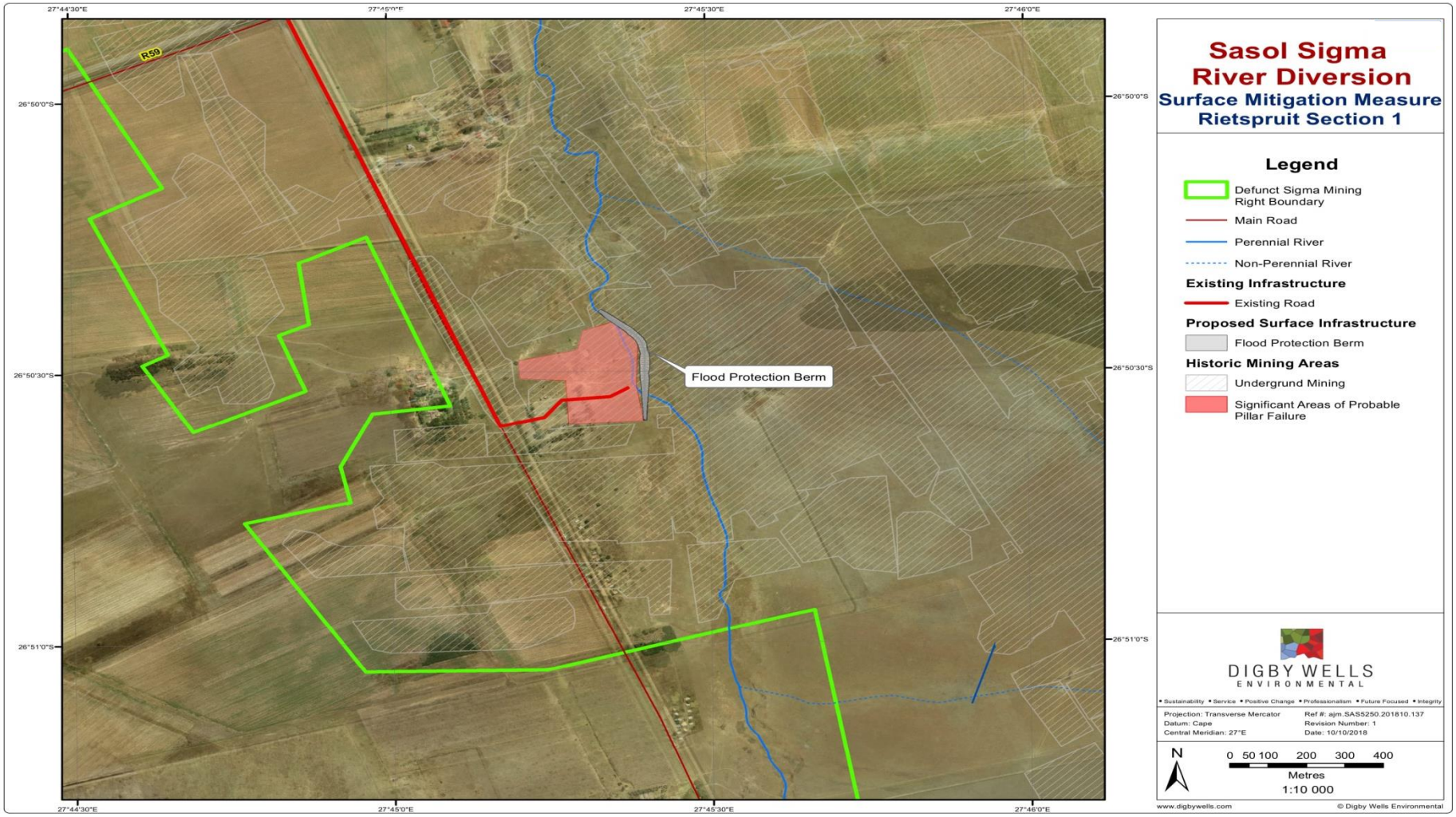

Figure 5-12: Rietspruit Section 1 Surface Mitigation Measures

5.2.6 Construction Material

Material to be utilised for the surface mitigation measures is proposed to be predominately sourced from the earth work operations at the various sections. Fill material will be obtained from necessary excavations on site, rather than importing material, or establishing borrow pits. The material that will be excavated is divided into topsoil, soft and hard material and unsuitable material. It is proposed that the unsuitable material which cannot be utilised for the surface mitigation measures will be used to rehabilitate areas which have already subsided, utilised in the open cast areas or as backfill behind the berms. Table 5-4 provides a summary of the material required to construct the surface mitigation measures and where the material will be sourced from.

Table 5-4: Material distribution between work areas

Surface Mitigation Measure Areas	Suitable material volume (factorised) (m^3)	Total fill required (m^3)	Direct cut to fill placement (m^3)	Suitable material volume remaining (m^3)	Cut to fill from other sections (m^3)	Material Source	Material from new borrow pit (m^3)
Leeuspruit 2	0	20 450	0	0	460	Leeuspruit 4	19 990
Leeuspruit 3	39 170	55 400	39 170	0	16 230	Leeuspruit 4	0
Leeuspruit 4	60 590	43 900	43 900	16 690	0	N/A	0
Rietspruit 1	0	9 650	0	0	0	N/A	9650
Total	**99 760**	**129 490**	**83 070**	**16 690**	**16 690**	**-**	**29 640**

The soil needed for the diversion canals and flood protection berms will be sourced from Leeuspruit Section 3 and 4. Material for the construction of the flood protection berms at Leeuspruit Section 2 and 3 will be sourced from excess material from Leeuspruit Section 4. Approximately 17 000m^3 of material will be hauled from Section 4 to section 2 and 4 over a distance of approximately 3 to 6.5km.

It is estimated that 30 000m^3 of soil may need to be externally sourced or obtained via the establishment of a borrow pit should the necessary excavations at Leeuspruit Section 3 and 4 not yield suitable material. It is envisaged that the borrow area will be within the planned opencast mining area. The borrow pit will have a depth of 1.5m and will be no larger than 2ha.

5.2.7 Laydown Area / Construction Area

A laydown area will be established during the construction phase to store material and machinery needed to undertake the surface mitigation measures. The laydown area will be constructed at the Wonderwater opencast mine where existing infrastructure is already located. It is estimated that the laydown area will be approximately 1ha.

It is proposed that ClearVu (or similar) fencing will be utilised at each river section as well as around the laydown area to prevent unauthorised access of animals and people.

5.2.8 Batching Plants

Three batching plants are proposed to be constructed and will be utilised for the mixing of material for the implementation of the mitigation measures. Plan 5 in Appendix B indicates the locations of where the batching plants are proposed to be located. It is estimated that the size of the batching plants will be approximately 0.25ha each.

5.2.9 Access Roads

Roads will be utilised to gain access to the various sections along the Leeuspruit and Rietspruit where surface mitigation measures are proposed. As far as possible existing roads will be utilised however, where new roads will need to be constructed material to construct the road will be sourced from the borrow pits (less than 5 ha) as well as imported from commercial sources. The location of the roads is indicated on Plan 5 in Appendix B.

5.2.10 Waste Management Facilities

All waste will be handled in accordance to the general and hazardous waste provisions of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA).

5.2.10.1 Industrial Waste

Industrial waste includes steel, used oil, petroleum and cleaning material. The industrial waste is isolated and temporarily stored in clearly marked skip bins before disposal where:

- Salvageable material is sent to a redundant materials management site and sold to employees or external recyclers; and
- Recyclable material is transported by recycling contractors off-site.

5.2.10.2 Domestic Waste

Domestic waste generated will be collected into labelled bins and skips and temporarily stored on site in designated areas. Domestic waste will be disposed at an accredited disposal site. There are a number of waste management and recycling companies contracted by Sasol.

5.2.10.3 Hazardous Waste

All the hazardous waste is collected and temporarily stored in clearly marked appropriate disposal structures (bins and drums) and is removed from the site by a contracted waste company and disposed of at a licenced landfill site.

5.2.11 Employment

The surface mitigation measure project will generate approximately 60 to 90 employment opportunities during the construction phase. The construction phase will be approximately twelve months. The operational phase will involve monitoring and maintenance of the diversion canals and berms. This will be undertaken for a three year period thereafter no further intervention will be required unless any issues are identified within this monitoring period. Jobs will be created during the operational phase as and when required.

6 Policy and Legislative Context

This section provides a description of the policy and legislative context within which the project is being proposed. The table indicates what legislation is applicable to the project and how it has been complied as discussed in Table 6-1.

Table 6-1: Policy and Legislative Context

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
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 – i. Prevent pollution and ecological degradation; ii. Promote conservation; and iii. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development	In support of the Constitution, the environmental management objectives of the proposed surface mitigation measure project aims to ensure the protection of ecologically sensitive areas and support sustainable development and the use of natural resources, whilst promoting justifiable socio-economic development in the project area.
National Environmental Management Act, 1998 (Act No. 107 of 1998)	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.* The EIA Regulations, 2014 (as amended). Together with the EIA Regulations, the Minister also published GN R.327 (Listing Notice No. 1 which requires a basic assessment process), GN R.325 (Listing Notice No. 2 which requires an EIA process) and GN R.324 (Listing Notice No. 3 which requires a basic assessment process) in terms of sections 24(2) and 24D of the NEMA, as amended.	Environmental authorisation for the proposed surface mitigation measure project is required as listed activities in terms of the EIA Regulations, 2014 (as amended) of the NEMA are triggered. The listed activities are indicated in Table 5-1. No activities identified in Listing Notice 2 apply to the proposed surface mitigation measure project, and therefore a BA Process is being followed to obtain the required authorisation.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
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. **GN R704 National Water Act, 1998 (Act No. 36 of 1998)** Regulations 6 of the regulation on use of water for mining and related activities aimed at the protection of water resources, Government Notice Regulation 704 (GN R No. 704) published in June 1999.	An IWUL application with its associated IWWMP for the proposed surface mitigation measure project will be submitted to the DWS to apply for the water use activities. . The IWUL application will aim to apply for the following water uses: ▪ Section 21 (c): impeding or diverting the flow of water in a watercourse; and ▪ Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.
National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA)	The National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) is the overarching legislation that protects and regulates the management of heritage resources in South Africa. The Act requires that Heritage Resources be managed and conserved by a Resource Authority, either nationally, by the South African Heritage Resources Agency (SAHRA) or by the relevant provincial Agency. In this case, the Provincial Heritage Resources Authority Mpumalanga (PHRA-M) is responsible for the identification, conservation and management of heritage resources throughout the province.	No heritage/archaeological resources associated with the project site have been identified within the footprint of the surface mitigation measure project. However the conservation of heritage resources has been considered as part of this project. A Notice of Intent to Develop (NID) has been compiled and has been submitted to South African Heritage Resource Agency (SAHRA) and the Heritage Free State (HFS). The report has been attached as Appendix H.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
Mineral and Petroleum Resource Development Act. 2002 (Act No. 28 of 2002)	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. In accordance with the EIA regulations, 2014 (as amended) and one environmental management system, all environmental authorisations and EMPs that relate to any mining activity must be submitted to the DMR for consideration and authorisation.	Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the DMR. During its operations, Sigma Defunct Colliery supplied coal to Sasolburg Operations from its underground and open cast mining operations. Mining was ceased in 2006 when the relevant old order mining rights lapsed due to a decision not to submit applications for conversion of these rights. A BA application to undertake the surface mitigation measure project was submitted to the Free State Regional office of the DMR in Welkom on 30 August 2018 detailing the activities being undertaken as part of the project. A BA Process has been undertaken which includes the compilation of a BA report where the impacts associated with the activities being undertaken have been determined. The proposed measures in which to mitigate and manage the impacts are also detailed as part of this process (Part B: Section 5 and 6). A monitoring programme has also been compiled to ensure the project does not result in significant environmental damage during the construction of the surface mitigation measure project (Part B: Section 8).

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
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 to 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 NEMBA 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 (GN R.152 in GG 29657 of 23 February 2007); 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).	As part of this project, flora, fauna and wetlands have been investigated to determine the current status of the environment and to determine any potential ecological sensitivity to be avoided and/or mitigated. The study focused specifically on where the surface mitigation measures are proposed to be implemented as well as the impact associated with the implementation of the project. No applications have been submitted in terms of NEMBA for the project as no protected species were identified where the surface mitigation measures are proposed to be conducted and therefore permits are not required to relocate them. The flora, fauna, wetlands and aquatics assessment details the area where the surface mitigation measures will be implemented as well as the impact associated with undertaking the project on these environmental aspects. The study has determined the ecological importance of the area. The findings of the assessments in the form of the impacts and the proposed mitigation measures for the project are detailed in Part A: Section 15 and Part B: 5 and 6 of this report. The project is not anticipated to impact on any protected species. One area was identified to have species that may potentially be protected however this was not confirmed during the site visit, mitigation measures have been proposed to ensure these protected species, should they occur in the area, are not impacted by the project by designating that area a No-Go area.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)	On 29 November 2013, the list of waste management activities published under GN R718 of 3 July 2009 (GN R718) was repealed and replaced with a new list of waste management activities under GN R921 of 29 November 2013. Included in the new list are activities listed under Category A, B and C. These activities include inter alia the following: ▪ Category A describes waste management activities requiring a Basic Assessment process to be carried out in accordance with the EIA Regulations supporting an application for a waste management licence; ▪ Category B describes waste management activities requiring an EIA process to be conducted in accordance with the EIA Regulations supporting a waste management licence application; and ▪ Category C describes waste management activities that do not require a WML but these activities will have to comply with the prescribed requirements and standards as prescribed by the Minister, which includes the Norms and Standards for Storage of Waste, 2013. These activities include the storage of general waste at a facility with a capacity to store in excess of 100 m^3 and storage of hazardous waste in excess of 80 m^3. The Waste Classification and Management Regulations published under GN R 634 of November 2013 require that all wastes be classified according to SANS10234 and managed according to its classification. The National Norms and Standards for the Assessment of Waste for Landfill Disposal were published under GN R635 on 23 August 2013 and prescribe the requirements for the assessment of waste prior to disposal to landfill in terms of Regulation 8(1)(a) of the Waste Classification and Management Regulations. The National Norms and Standards for the Disposal of Waste to Landfill were published under GN R 636 of 23 August 2013 and determine the requirements for the disposal of waste to landfill as contemplated in Regulation 8(1)(b) and (c) of the Waste Classification and Management Regulations.	No listed waste activities in terms of the NEMWA will be triggered by the proposed surface mitigation measure project. Waste will be managed in accordance with the NEMWA and its associated waste regulations to ensure no impact to the environment occurs during the construction phase when waste will be generated. No waste generation is anticipated to occur during the operational phase.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
National Environmental Management: Protected Areas Act, 2003 (Act. 57 of 2003)	The act aims to provide protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas.	A Flora, Fauna, Wetlands and Aquatic Specialist Studies have been undertaken to determine whether any protected areas are located within the project site. It has been determined that the Sigma Defunct Colliery does not fall within a protected area. The nearest protected area is 35km to the east of the Sigma Defunct Colliery called "Vaal Dam Nature Reserve". The Vaal Dam Nature Reserve is not expected to be impacted on by the surface Mitigation Measure project.
Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA)	CARA aims to provide for the conservation of the natural agricultural resources of the country through the maintenance of the production potential of land, by combatting and preventing erosion and the weakening of water sources. In addition, this Act aims to protect vegetation, while combatting weeds and invader plants	Section 12 of the CARA details the maintenance of soil conservation in which every land user will be responsible for the maintenance and conservation of soil. The mitigation measures recommended as part of this BAR aim to prevent the compaction, erosion and degradation of the soil resources. An invasive species management plan has been developed as part of the project and will be implemented to mitigate against the spread of these invasive species.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA)	According to the NEMAQA 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 NEMAQA. A fundamental aspect of the new approach to the air quality regulation, as reflected in the NEMAQA 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.	Air Quality has been considered for the project. The activities proposed to take place do not trigger any air quality activities and therefore no Air Emissions License will be applied for. The mitigation and management measures to be implemented as part of the project aim to manage and prevent potential impacts to air quality. Dust suppression will be implemented during the construction phase as necessary. In the operational phase the surface mitigation measure project is not expected to contribute to generation of dust or any other emissions.
The National Freshwater Ecosystem Priority Areas (NFEPA)	The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or DWS), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to: ▪ Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and ▪ Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.	The strategic spatial priorities were considered for conserving the country's freshwater ecosystems and supporting sustainable use of water resources contained therein to evaluate the importance of the wetland areas (Nel *et al*. 2011). The wetland types that dominate the landscape are floodplains, unchannelled valley bottoms and unchannelled valley bottoms associated with the Leeuspruit and Rietspruit. Wetlands within the area are ranked 5 or 6.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
Free State Biodiversity Plan (2015)	The Free State Biodiversity Plan (2015) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The Free State Biodiversity Plan was published in 2015, and like those of the other provinces, identifies and maps the protected areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) to aid management guidelines for the Free State. Currently there is only a terrestrial component for the plan; however, the aquatic component is expected in 2018.	Most of the area impacted by mitigation measures are classified by the Free State Biodiversity Plan as degraded. However, there are small pockets within Leeuspruit Section 4 which are classified as 'ESA 2'. Leeuspruit Section 5 has large areas classified as 'ESA 2' as well as 'ESA 1. Rietspruit Section 1 is closely bordered by 'CBA 2'. This will need to be updated, once the aquatic component is published.
The National Protected Areas Expansion Strategies (NPAES)	The National Protected Areas Expansion Strategies (NPAES) are areas designated for future incorporation into existing protected areas (both National and Informal protected areas). These areas are large, mostly intact areas required to meet biodiversity targets, and suitable for protection. They may not necessarily be proclaimed as protected areas in the future and are a broad scale planning tool allowing for better development and conservation planning. NPAES have been developed to coordinate the expansion of protected areas in order to ensure that a representative sample of all ecosystems as well as key ecological processes are included in the protected area network.	The proposed surface mitigation measure project is located approximately 60km from the Vaal Grasslands, 45km from Free State Highveld Grassland and approximately 60km from Gauteng Bushveld.

7 Need and Desirability of the Proposed Activities

Section 24 of the Constitution stipulates that everyone has the right to an environment that is not harmful to their health or well-being and to have the environment protected through reasonable legislation and other measures that prevents pollution and ecological degradation.

Sasol Sigma Defunct Colliery commenced with mining in 1952 and was subsequently decommissioned in 2006. Decommissioning and rehabilitation activities started in 2005 and are still continuing to date. Due to historic underground mining of the Sigma Defunct Colliery, a potential for pillar failure has been identified. To effectively manage the residual risk in a responsible manner, further mitigation measures are required to reduce this risk to an acceptable level.

Sasol Mining have been applying best practice principles (with reference to current South African Legislation) to ensure compliance with the Sigma Defunct Colliery EMPr and Closure Plan.

Based on a Risk Assessment completed by Sasol and J&W, areas of significant risk to pillar failure which may result in subsidence has been identified beneath the Leeuspruit and Rietspruit. Surface mitigation measures have been proposed with the aim of diverting these rivers (Leeuspruit Sections 2 – 4 and Rietspruit Section 1) away from the areas of risk or implementing measures which will reduce the potential for pillar failure (Leeuspruit Section 1). This application seeks authorisation to implement these surface mitigation measures which will reduce the impact to surface associated with pillar failure to an acceptable and manageable risk.

The proposed construction and operation of the surface mitigation measure project is crucial to the success of the remediation efforts and to ensure compliance with the EMPr and Closure Plan with the aim of obtaining a closure certificate. It is important to reiterate that the purpose of the project is to ensure effective protection of natural resources on site (e.g. soil, water, biodiversity etc.) and the surrounding environment. Additionally, the project aims to minimise any potential health and safety risks to the surrounding community.

The project aims to implement sustainable measures to preserve and protect environmental resources for future generations that would have been destroyed by historic mining activities should the project not be undertaken.

Furthermore, the commencement of the surface mitigation measure project will result in the following:

- Reduce the impact of pillar failure on surface water resources (Leeuspruit and Rietspruit);
- Reduce the negative impacts associated with historical mining on the community living in close proximity to the mine;

- Create an environment that is left in a safe manner that is not harmful to the people or the environment; and
- Ensure a sustainable land use is achieved.

7.1 Socio-Economic Consideration

The aim of the surface mitigation measure project is not to create jobs or create economic benefit to Sasol Mining or the surrounding community but rather preserve the surface water resources for future generations. It should be understood that the project does not aim to prevent pillar failure from occurring but rather reduce the impact on surface by relocating the Leeuspruit and Rietspruit away from these areas. The Leeuspruit and Rietspruit flow into the Vaal River which is considered to be the third largest River in South Africa.

The Vaal River supplies water to a large part of Gauteng and is utilised by the communities, mining and power generation companies, Sasolburg Operations and for farming practices. The Vaal River is made up of 50km of navigable water. The river basin thus offers a range of leisurely water activities that attract local and international tourists throughout the year. Should the project not be implemented the Mean Annual Runoff (MAR) of water that flows into the Vaal River will cease thereby negatively impact on the Vaal River. The Vaal River is currently being impacted on by various other activities therefore any additional negative impact to the river system has a cumulative negative effect of the Vaal River which can indirectly impact on the country with regards to water supply and tourism.

7.2 Environmental Consideration

Pillar failure has been identified as a potential hazard throughout the mining lease area. Priority areas have been identified beneath the Rietspruit and Leeuspruit Rivers which are the main rivers which run through the Sigma Defunct Colliery and feed into the Vaal River.

If no intervention is implemented, pillar failure may occur which will result in subsidence which would lead to a catastrophic impact on the Leeuspruit and Rietspruit that feed into Vaal River. In general, the surface water will be lost to the groundwater and underground mine workings. This will have a direct negative impact on the quantity of water entering the Vaal River, wetlands and aquatic ecosystems which rely on these rivers for ecological functioning. The negative impact to the environment has been discussed further in Section 9 should a no-go approach be implemented. The wetlands, surface water resources, aquatic environments and fauna and flora provide specific important environmental functioning. The implementation of the project will help preserve this functionality which could be completely destroyed should the project not receive its required environmental authorisation. An impact assessment (Section 15) has been undertaken for this project. The impacts through the implementation of this project although considered to be significant outweigh the impact that would occur if the project is not implemented and a reactive approach is required.

Additionally, it is not known when exactly the identified pillars will fail as it could occur at any time. Should it occur, no mitigation measures can be implemented to rectify the damage caused from subsidence to the environment. **This provides motivation for an urgent proactive approach as opposed to a reactive approach.**

8 Motivation for the Overall Preferred Site, Activities and Technology Alternative

Alternatives have been investigated and discussed in detail in Section 9. Various alternatives to the proposed surface mitigation measures have been investigated to ensure the most suitable and preferable alternatives are selected. The investigation aims to ensure the least number of impacts on the environment occur, and that those impacts that are unavoidable are managed to an acceptable level of significance. The motivation for the preferred alternatives has been discussed in Section 9.

9 Full Description of the Process followed to reach the Proposed Preferred Alternatives within the Site

9.1 Details of the Development Footprint Alternatives Considered

Alternatives are different means of meeting the general purpose and need of a proposed activity. Alternatives aid in identifying the most appropriate method of developing the project, taking into account location or site alternatives, rehabilitation alternatives, as well as the no-project alternative. Alternatives also aid in selecting the activity with the least environmental impact.

9.1.1 Location Alternative

Areas which have a significant potential for pillar failure which can result in subsidence have been identified with specific reference to the areas beneath the Leeuspruit and Rietspruit. The location of where these surface mitigation measures must be implemented is in relation to these significant risk areas and therefore no alternative locations can be provided for the surface mitigation measures.

9.1.2 Ash Backfilling / Stabilisation Alternative

This option investigates the use of pumping ash slurry (mixture of ash and water) into the underground workings to stabilise the pillars. The ash will help strengthen the pillars which will prevent it from failing and thereby preventing pillar failure from occurring and subsequent subsidence. The ash backfilling mitigation measure has been considered and will be implemented beneath certain areas within the Leeuspruit (authorised as part of a separate project). However, ash backfilling cannot be the only mitigation measure implemented to reduce the significant risk. Some areas beneath the Leeuspruit and Rietspruit which was allowed by historic licences permitted Sigma Colliery to utilise high extraction mining to abstract the coal. Ash backfilling cannot be implemented where the high extraction mining

method was utilised as no pillars currently exist to improve the strength of the pillars and stability.

9.1.3 Surface Mitigation Measure Alternatives

As indicated previously the surface mitigation measures have been divided into various sections. Alternative mitigation measures to be implemented at each surface water section to reduce the risk / impact of pillar failure to the environment was investigated. A weighted selection methodology was utilised to determine the preferred alternative mitigation measure for each of the sections which will result in the least impact to the environment.

9.1.3.1 Leeuspruit Section 2 / Rietspruit Section 1

To mitigate the risk associated with pillar failure beneath the Leeuspruit Section 2 / Rietspruit Section 1 various mitigation measures were investigated as shown in Table 9-1.

Table 9-1: Leeuspruit Section 2 alternative mitigation measures

Mitigation Measure	Description	Preferred / Not Preferred Option
Flood Protection Berm	The construction of the flood protection berm will result in a slight change to the natural flow of the river to prevent the water entering an area identified to have a potential for pillar failure. This is considered to be the preferred option as it will have the least impact on the environment in comparison to a full stream diversion.	**Preferred Option**
Full Stream Diversion	Only one area of risk was identified within this area therefore should a full stream diversion be selected it will result in unnecessary impact to the environment where a simple solution such as the construction of one flood protection berm would reduce the risk. A full steam diversion is not considered to be a suitable alternative as it will result in unnecessary negative impacts to the surrounding environments (surface water, wetlands and aquatic ecology) which can be avoided through the simple construction of one flood protection berm.	Not Preferred Option

9.1.3.2 Leeuspruit Section 3

To mitigate the risk associated with pillar failure beneath the Leeuspruit Section 3 various mitigation measures were investigated as shown in Table 9-2.

Table 9-2: Leeuspruit Section 3 alternative mitigation measures

Mitigation Measure	Description	Preferred / Not Preferred Option
Full Stream Diversion (proposed location as indicated in Figure 5-6)	Since the adjacent areas, either side of the Leeuspruit within this section, also have a high probability of failure, the stream alignment cannot deviate significantly from the existing stream location. The location provided for the proposed stream diversion has been selected as it is the only location for the river to go to avoid the identified risk areas. No other alternative surface mitigation measures for this area can be provided.	**Preferred Option**

9.1.3.3 Leeuspruit Section 4

To mitigate the risk associated with pillar failure beneath the Leeuspruit Section 4 various mitigation measures were investigated as shown in Table 9-3.

Table 9-3: Leeuspruit Section 4 alternative mitigation measures

Mitigation Measure	Description	Preferred / Not Preferred Option
Full Stream Diversion (proposed location as indicated in Figure 5-8)	This section is located west of Sasolburg and includes 1.3km of the Leeuspruit, from the Leeuspruit Primary School to just south of the R59 road. The land use on the western side of the stream is predominantly agricultural (grazing), whilst the eastern side is residential. Most of the area to the west of the Leeuspruit has been identified to have a significant potential for pillar failure therefore preventing the river diversion to be relocated to this area. The only other location is to relocate the Leeuspruit to the east, which is in close proximity to the Sasolburg Town. The canal proposed to be constructed will need to be narrowed due to space constrains which will increase the velocity of the water. Additionally, health and safety factors must be considered when constructing the canal due to the close proximity of the river to the residential area. Due to space constraints and potential for pillar failure as mentioned above, no other mitigation measure alternative / location can be proposed. It is however noted that the canal has been constructed in such a way to address the health and safety concerns.	**Preferred Option**

9.1.4 No Go Alternative

The No-Go alternative refers to an option where the project is not commenced with. The No-Go alternative in this particular instance refers to a situation where the proposed surface mitigations are not implemented. The aim of the project is to implement the proposed flood protection berms and river diversions to divert the Leeuspruit and Rietspruit away from areas where subsidence may occur, thereby preventing surface water ingress to the groundwater and underground workings.

The No-Go alternative has been quantitatively assessed in accordance with each environmental aspect to determine the resulting impact that would occur should the project not be commenced with. Additionally, the impacts were reassessed to demonstrate the impact that would occur should the project be commenced with and the surface mitigation measures implemented. Therefore, providing an understanding of the overall impact the project will have on the environment.

As discussed previously the proposed project will not prevent pillar failure (subsidence) from occurring but rather reduce the impact to surface should it occur. Any slight improvements to the environment is considered to be a positive when compared to the resulting negative impact that would occur if the project in not implemented. The No-Go alternative has been assessed from a worst-case scenario where all the pillars will fail.

9.1.4.1 Fauna and Flora No-Go Alternative

In the event that the proposed surface mitigation measures are not implemented, the potential loss of surface water flow could have larger reaching impacts to fauna and flora. The impacts associated with the surface mitigation measure project with respect to fauna and flora will be highly localised and overtime through the implementation of rehabilitation measures the impacted areas should recover. The proposed surface mitigation measures will ensure that the system as a whole still functions for the long term.

Species that are dependent on terrestrial, aquatic, and semi-aquatic habitats can be indirectly impacted if these environmental aspects are directly impacted upon. The loss of vegetation units and habitat functionality as a result in the loss of surface water flow to the system will occur should the project not be implemented. This is considered to be a detrimental impact on the fauna and flora in the project site as it is covered by the Soweto Highveld Grassland and Central Free State Grassland, which are both vulnerable and considered to be Endangered at a National level. The no-go alternative impacts described are rated in Table 9-4.

Table 9-4: Impact Rating for the No-Go Alternative (Fauna and Flora)

Dimension	Rating	Motivation	Significance
Impact Description: Loss of vegetation units and habitat functionality as a result of loss of surface water flow to the system.			
Prior to Mitigation/Management			
Duration	Permanent (7)	The impact is irreversible and will remain after the life of the project. Freshwater resource habitat and function will be destroyed.	Major (negative) (-114)
Extent	Province/Region (5)	The no-go option may have a regional impact as the water will be prevented from reaching the Vaal River.	
Intensity x type of impact	Very significant impact on the environment. Irreparable damage to species, habitats and ecosystems (7)	Loss of ground surfaces, alterations of flow regimes and water quality for both ground and surface water, loss of habitats and loss of connectivity between habitats.	
Probability	Almost certain to occur (6)	In the event that the proposed surface mitigation measures are not implemented these impacts are almost certain to occur	
Nature	Negative		
Mitigation Measures			
Implement the proposed surface mitigation measures which includes the construction of flood protection berms and canals			
Post-Mitigation			
Duration	Permanent (6)	The impact is irreversible and will remain after the life of the project. Vegetation units habitats and faunal species will be permanently lost	Moderate (negative) (-90)
Extent	Municipal area (4)	Habitat loss within the canals will affect entire ecosystems	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate (5)	The effectiveness of the rehabilitation will determine the intensity; however, some vegetation units will be permanently lost. Serious loss of sensitive habitats and species due to alien vegetation colonisation may also occur	
Probability	Almost certain (6)	Should the proposed project proceed, impacts on the terrestrial ecology of the project site will remain	
Nature	Negative		

9.1.4.2 Soil, Land Use and Land Capability No-Go Alternative

If the proposed surface mitigation measures are not implemented there is a high probability of pillar failure which can result in subsidence which could lead to loss of wetland soils, subsequently leading to alterations/loss of flow regimes and water quality in both ground and surface water.

The no-go alternative impacts described are rated in Table 9-5.

Table 9-5: Impact Rating for the No-Go Alternative (Soil, Land Use and Land Capability)

Dimension	Rating	Motivation	Significance
Impact Description: Collapsed underground mine roof could potentially cause significant surface subsidence. This may restrict post mining land capability and agricultural productivity. Surface cracking and subsidence will occur due to large areas that could be affected by the high extraction. Due to this the land capability will potentially be altered.			
Prior to Mitigation/Management			
Duration	7	Because of the mining method it is expected that the impact would be beyond the project life without mitigation adopted.	Major (negative) - 133
Extent	5	Without mitigation the impact is expected to occur within the region.	

Dimension	Rating	Motivation	Significance
Intensity	7	Serious impacts to the land capability and land use will occur because of mining and adopting no mitigation because of potential potential for pillar failure which can result in subsidence.	
Probability	7	The impact on soils will occur.	
Nature	Negative		
Mitigation Measures			
Implement the proposed surface mitigation measures which includes the construction of flood protection berms and canals			
Post-Mitigation			
Duration	6	With mitigation the duration would be limited to the project life	
Extent	4	With mitigation the duration of the impact would be limited to the project area.	
Intensity	6	Even with mitigation being adopted there will be a serious loss of agricultural productivity	Moderate (negative) - 96
Probability	6	It is expected that the impact is likely to occur.	
Nature	Negative		

9.1.4.3 Surface Water No Go Alternative

Areas that have a significant potential for pillar failure can result in subsidence in those areas that will lead to seepage/flow from the Leeuspruit and Rietspruit into the underground workings. In general, should the project not be commenced with an impact to the catchment yield downstream will occur due to flow losses to the underground workings.

The impact of not going ahead with the project is therefore much higher than the impacts expected during construction of the proposed surface activities. If the project goes ahead some impacts to the floodplains, water quality and erosion will occur, but this can be mitigated and managed. The impact on the volumes of flow and the catchment yield is negligible compared to the loss of water if pillar failure occurs resulting in subsidence and the stream flow is lost to the underground workings. This last-mentioned event will almost certainly reduce catchment yield and flow from the Leeuspruit and Rietspruit to zero.

Thus, although negative impacts do exist they are short term and can be mitigated. The no-go alternatives impacts cannot be mitigated.

The impact rating for the no go alternative for surface water is provided in Table 9-6. If the project does not go ahead the impact will be of major significance. If the project does go ahead impacts will still exist but be of shorter duration with less intensity and thus have less of an impact (moderate impact).

Table 9-6: Impact Rating for the No-Go Alternative (Surface Water)

Dimension	Rating	Motivation	Significance
Impact Description: No-go alternative – potential pillar failure which could result in subsidence beneath the river systems			
Prior to Mitigation/Management			
Duration	Permanent (7)	The impact may be irreversible and has the potential to remain after the life of the project. Freshwater resource habitat and function may be destroyed.	Major (negative) - 126
Extent	Region (5)	The no-go option may have a regional impact due to decreased catchment yield to the Vaal River.	
Intensity x type of impact	Irreplaceable loss or damage to biological resources, limiting ecosystem function (6)	Loss of water, decline in water quality and loss of natural habitat may be irreplaceably lost, thereby limiting ecosystem form and function throughout the system and reducing the habitat for instream ecology	
Probability	Definite (7)	Severe impacts to the system may occur should no mitigation measures be implemented.	
Nature	Negative		
Mitigation Measures			
Implement the proposed surface mitigation measures which includes the construction of flood protection berms and canals			
Post-Mitigation			
Duration	Permanent (7)	The impact is irreversible and will remain after the life of the project. Freshwater resource habitat and function will be destroyed.	Moderate (negative) -98
Extent	Local (3)	Habitat loss within the canals will affect the local watercourse and river reaches directly downstream.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Serious loss and of biological resources or moderately sensitive environments, limiting ecosystem function. (4)	Impact on water quality and siltation of the rivers will still cause some serious impacts to the ecology and wetlands.	
Probability	Definite (7)	Severe impacts to the system may occur	
Nature	Negative		

9.1.4.4 Wetlands and Aquatics No-Go Alternative

Should the project not be commenced with and the surface water is lost to the underground workings there may be a potential loss of freshwater habitat and a disruption, and sometimes a complete sever, in the hydrological links between freshwater systems on site, resulting in a desiccation of some areas.

The degradation of wetlands and aquatic habitats will reduce biodiversity, increase erosion and reduce the capacity of wetlands to provide services such as nutrient cycling, water purification and flood attenuation. Should the subsidence result in the merging of surface and groundwater, this could result in contamination of the wetland and freshwater systems. The no-go alternative impacts described are rated in Table 9-7.

Table 9-7: Impact Rating for the No-Go Alternative (Wetlands and Aquatics)

Dimension	Rating	Motivation	Significance
Impact Description: No-go alternative – potential pillar failure resulting in subsidence beneath the river systems			
Prior to Mitigation/Management			
Duration	Permanent (7)	The impact may be irreversible and has the potential to remain after the life of the project. Freshwater resource habitat and function may be destroyed.	Major (negative) - 126
Extent	Region (5)	The no-go option may have a regional impact due to decreased catchment yield to the Vaal River.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Irreplaceable loss or damage to biological resources, limiting ecosystem function (6)	Loss of water, decline in water quality and loss of natural habitat may be irreplaceably lost, thereby limiting ecosystem form and function throughout the system and reducing the habitat for instream ecology	
Probability	Definite (7)	Severe impacts to the system may occur should no mitigation measures be implemented.	
Nature	Negative		
Mitigation Measures			
Implement the proposed surface mitigation measures which includes the construction of flood protection berms and canals			
Post-Mitigation			
Duration	Permanent (7)	The impact is irreversible and will remain after the life of the project. Freshwater resource habitat and function will be destroyed.	Moderate (negative) -98
Extent	Local (3)	Habitat loss within the canals will affect the local watercourse and river reaches directly downstream.	
Intensity x type of impact	Serious loss and of biological resources or moderately sensitive environments, limiting ecosystem function. (4)	Habitat loss within the canals will affect entire watercourse and river reaches.	
Probability	Definite (7)	Severe impacts to the system may occur	
Nature	Negative		

10 Details of the Public Participation Process followed

A Public Participation Process (PPP) is a statutory requirement in terms of the NEMA and the EIA regulations, 2014 (as amended). The main objective of PPP is to provide a platform for the applicant, Interested and Affected Parties (I&APs) and relevant organs of state to work together to enable the relevant authorities to make an informed decision on the project. Through the PPP, I&APs are able to contribute local knowledge and raise comments applicable to the project planning and design.

The PPP consists of three phases, namely:

- Formal project announcement;
- Public comment period for the Draft BAR; and
- Announcement of the Decision (granting or not granting of the Environmental Authorisation by the DMR).

The activities undertaken during each phase are described below. All PPP documentation which has been distributed to I&APs has been incorporated within Appendix C.

10.1 Formal Project Announcement

As part of the announcement phase, details of the project together with availability of the Draft BAR were provided to stakeholders. Below are the key activities undertaken for the PPP Announcement Phase.

10.1.1 Identification of Stakeholders

Stakeholders interested in or affected by the project were identified by means of the methods indicated below:

- Conducting Windeed and related desktop searches in and around the project area to verify land ownership and occupancy and obtain landowner contact details;
- Use of Sasol Sigma Defunct Colliery existing stakeholder databases;
- Responses on the distribution of the Background Information Document (BID), site notices or newspaper advertisement placed; and
- Telephonic consultations with landowners to identify additional I&APs.

Stakeholders for the project were grouped into the following categories:

- **Government:** National, Provincial, District and Local authorities;
- **Landowners and occupants:** Directly affected, adjacent or indirectly affected landowners and occupants;
- **Parastatals:** Transnet and SANRAL;

- **Non-Governmental Organisations (NGOs):** Environmental and social organisations; and
- **Business:** Small and medium enterprises, mining and industrial companies.

A stakeholder database was compiled and will be updated throughout the environmental regulatory process (Appendix C).

10.1.2 Public Participation Media

Considering the legislative requirements and good practice, the following methods have been implemented to make project information available to stakeholders:

- **Background Information Document:** a BID which included a project description, information about the relevant legislation, the competent authorities and details of the appointed EAP was prepared and distributed on 15 October 2018. The BID was also accompanied by a Registration and Comment Form for stakeholders to use for formal registration as I&APs or to submit comments. Information regarding the availability of the Draft BAR was also provided, and I&APs were asked to comment. The BID has been included in Appendix C.
- **Newspaper advertisement:** a newspaper advertisement was placed in the Sasolburg Ster and Vaalweekblad, on 16 October 2018, which are local newspapers that distributes to Sasolburg and surrounding areas. The advert was published in English and included a brief project description, information about the relevant legislation, the competent authorities, details of the appointed EAP, registration process for I&APs, and information regarding the availability of the Draft BAR for public comment. Evidence of the placement of the newspaper will be included in the Final BAR.
- **Site notices:** Site notices were put up at various places on 15 October 2018. The site notices contained a brief project description, information about the relevant legislation, the competent authority and details of the EAP, registration process for I&APs and information regarding the availability of the Draft BAR for public comment. Evidence of the placement of these site notices will be included in the Final BAR.

The Draft BAR was made available for a public comment period of 30 days from Tuesday, 16 October 2018 to Wednesday, 14 November 2018 at the Zamdela and Sasolburg Public Library and on the Digby Wells website: www.digbywells.com (under Public Documents). Due to various stakeholders and different landowners within the project area, focus group and one-on-one discussions will be undertaken during this commenting period in order to obtain comments and to identify any issues raised by individuals.

Once the end of the commenting period is reached the Draft BAR will be updated and submitted to the DMR for consideration. Simultaneously, the Final BAR will be made available to I&APs on the Digby Wells website and I&APs will be informed of such by means

of a letter (email and post). This enables I&APs to verify that their comments have been captured and responded to.

10.1.3 Public Participation Activities undertaken

Table 10-1 below provides a summary of the PPP activities undertaken thus far, together with referencing materials included as annexures in Appendix C.

Table 10-1: Public Participation Activities

Activity	Details	Reference in Report
Identification of stakeholders	A project specific stakeholder database was developed which was developed utilising the existing Sasol Mining database for Sigma Colliery which represents various sectors of society, including directly affected and adjacent landowners, in and around the project area.	Appendix C1 Stakeholder Database
Distribution of BID	A BID with registration and comment form was emailed and posted to stakeholders on 15 October 2018. An SMS was also sent to stakeholders on 16 October 2018 announcing the availability of the Draft BAR.	Appendix C2: BID, letter with registration and comment sheet
Placing of newspaper advertisement	An English advert was placed in the Vaalweekblad and Sasolburg Ster on 16 October 2018.	Appendix C3 Advertisement
Putting up of site notices	Site notices were put up at the project site, Zamdela and Sasolburg Public Library and Sigma Defunct Colliery (3 Shaft Complex) on 15 October 2018.	Appendix C4: Site Notice
Announcement of the Draft BAR availability	Announcement of availability of the Draft BAR was emailed and posted to stakeholders together with the formal project announcement on 16 October 2018. Copies of the Draft BAR were available to stakeholders at Zamdela and Sasolburg Public Library. The Draft BAR was available on the Digby Wells website: www.digbywells.com (under Public Documents). *(The comment period for the Draft BAR was from 16 October 2018 to 14 November 2018)*	Appendix C2: BID Appendix C3: Advert Appendix C4: Site Notice
Obtained comments from stakeholders	Comments, issues of concern and suggestions received from stakeholders will be captured in the CRR once received.	N/A

10.2 Decision-Making

Once the competent authority has made a decision regarding the project, results thereof, together with information about the regulated appeals procedure, will be communicated to stakeholders as prescribed under the NEMA legislation. Notification to stakeholders will be done by means of a letter via email and post.

10.3 Summary of Issues raised by I&APs

No comments have been received to date for the proposed project. Once comments are received this will be included in the Final BAR and within Appendix C.

11 The Environmental Attributes associated with the Alternatives

A summary of the baseline environment in the proposed project area is provided in the sections below. The flowing specialist studies have been undertaken for the proposed project:

- Wetlands and Aquatics Specialist Study (Appendix D);
- Fauna and Flora Specialist Study (Appendix E);
- Surface Water Specialist Study (Appendix F);
- Soil, Land Use and Land Capability Specialist Study (Appendix G);
- Heritage Specialist Study (Appendix H); and
- Rehabilitation Specialist Study (Appendix I).

11.1 Climate

The project site is situated 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 490mm (Worldwide Fund for Nature-South Africa, 2016), this area experiences moderately high mean rainfall of approximately 644mm per annum (i.e. long-term average between the years 1951 and 2012). Furthermore, the project area is located within the Highveld ecoregion (Level II ecoregion 11.03), which has been noted to attain an average temperature range of 8.9-20°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). The average monthly rainfall for the quaternary catchments C22K and rainfall zone C2C is illustrated in Table 11-1.

Table 11-1: Summary of Rainfall Data extracted from the WR2012

Months	Rainfall (mm)
January	112.4
February	83.3
March	77.7
April	44.6
May	18.7
June	7.3
July	6.0
August	8.0
September	21.4
October	66.6
November	94.5
December	103.3
MAP	**644**

11.2 Air Quality

The Vaal Triangle Airshed is known for its poor air quality and was therefore declared a priority area owing to the mosaic of pollutants (particulates, noxious and offensive gases). Studies have been conducted in the past, and some are on-going, looking at the pollutants and possible sources in the Vaal Triangle Airshed.

An air quality management plan for the Vaal Triangle Airshed Priority Area (VTAPA) was developed in 2007 in compliance with the NEMAQA. The status of air quality within the area was assessed for three criteria pollutants (PM_{10}, SO_2 and NO_2) using dispersion modelling. The VTAPA model results were evaluated by comparing highest hourly, daily and annual average model-predicted values and the number of exceedances with measured data at selected ambient monitoring stations, taking into account the United States Environmental Protection Agency (US-EPA) specified range of model uncertainty [-50%; 200%]. It was found that predicted ground level concentrations compared well with measured data for highest hourly and daily averaging periods, but that annual averaged predictions showed weaker correlation (Vaal Triangle Air-shed Priority Area Air Quality Management Plan – Baseline Characterization 2007).

The main sources of emissions in the project area are petrochemical processes. According to the Vaal Triangle Priority Area baseline study (Liebenberg-Enslin et al., 2007) more than 90% of the SO_2, NO and NO_2 emissions in the project area are due to petrochemical processes (Sasol and Natref). For PM_{10} emissions within the area, petrochemical processes contribute 70% and mining activities 18%. Secondary sources are domestic fuel burning,

fugitive emissions from opencast coal mining operations, windblown dust emissions from ash dumps, and vehicle tailpipe emissions.

11.3 Noise

A baseline assessment for Sigma Defunct Colliery was undertaken in 2013 at two locations on the western boundary of Sasolburg to determine the ambient noise levels at the surrounding areas. The criteria that were used for the siting of the measurement locations was:

- The locations nearest noise sensitive receptors; and
- Suitable reference points for the measurement of ambient sound levels surrounding of the Sigma Defunct area.

The noise measurement locations cover residential areas that represent a comprehensive soundscape of the urban district of Sasolburg. The measurement location at Leeuspruit Primary School was chosen because it was important to know what the sound level at the school was.

The list of noise measurement locations can be seen in Table 11-2.

Table 11-2: Noise Measurement Locations

Site ID	Location	Category of receiver	GPS coordinates
N1	Sasolburg correctional services	Urban	-26.817047° and 27.801124°
N2	Leeuspruit Primary School	Urban	-26.827020° and 27.818174°

It was found that the existing ambient noise levels on the western boundary of Sasolburg are characteristics of urban surroundings. The noise levels measure between 52dBA and 53dBA during the daytime and between 42dBA and 44dBA during the night time.

11.4 Geology

The Sigma Defunct Colliery is found within the Sasolburg–Vereeniging Coalfield, which is part of the Karoo Supergroup. The lava and dolomite of the Ventersdorp and Transvaal Systems underlie the Sigma Basin. The Sigma Basin is approximately 9.5km wide and trends approximately 129km north to south from the Vaal River to beyond Dover Station.

Four mineable coal seams are found in the Sigma basin (DWE, 2018). They are numbers 1, 2A, 2B and 3 coal seams, as identified from the base upwards (Figure 11-1). The coal seams are situated at between 20m to 250m below surface and extend over an area of approximately 300km^2. The general southward dip of the strata, together with a northward sloping land surface which drains towards the Vaal River, can be seen to have caused the wide variation in depth below surface.

Throughout the basin, number 2A, 2B and 3 coal seams can be found. The distance between the coal seams vary and increases towards the south from number 2B and 3 coal seams. Between number 2A and 2B seams there is rarely more than a 100 cm of mudstone and in some areas, there is no parting between these two seams. This results in a combined seam thickness of approximately 6m. Generally, the overburden consists of medium to coarse grained sandstone, dolerite, siltstone, mudstone and shale and in the far northern regions a thick, unconsolidated sand unit can be found (DWE, 2018). Between 65 and 85 metres below surface, two dolerite sills have displaced the strata at Sigma Defunct Colliery and relatively small faults with a maximum displacement of about 5m have been encountered underground (DWE, 2018).

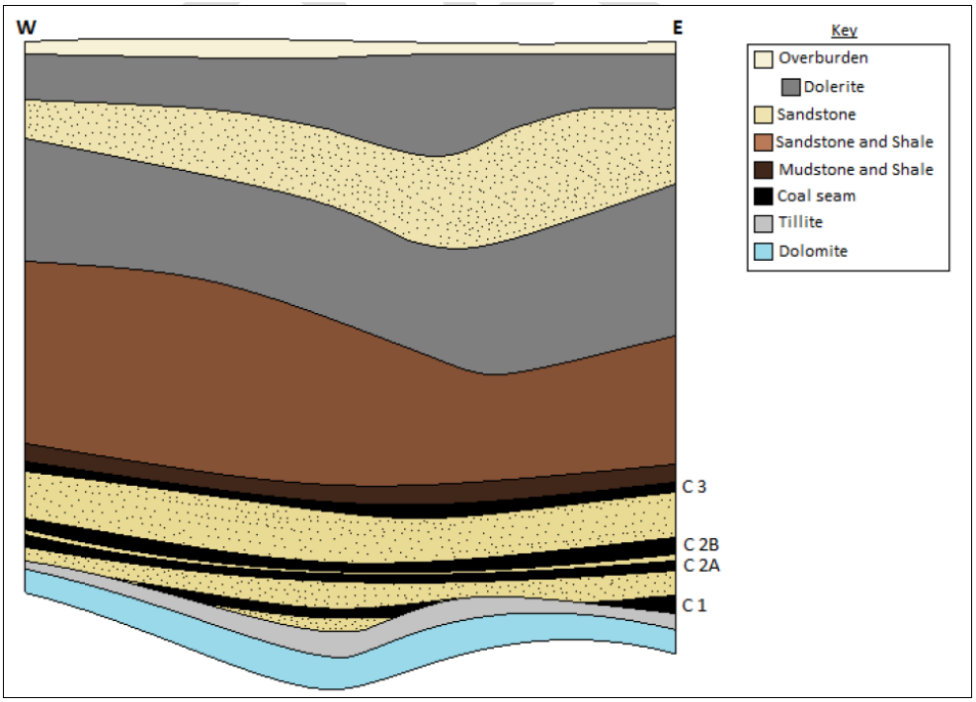

Figure 11-1: Simplified geological profile found within Sigma Defunct Colliery

(Source: IGS, 2018)

11.5 Biodiversity

From a biodiversity perspective, the Southern Temperate Highveld global freshwater ecoregion is delineated by the South African interior plateaux sub-region of the Highveld aquatic ecoregion, of which the main habitat type (in terms of watercourse) is Savannah-Dry Forest Rivers (Darwall *et al*., 2009). Aquatic biota within this bio-region has mixed tropical and temperate affinities and share many species between the Limpopo and Zambezi systems (Skelton, 1990; Skelton *et al*., 1995; Darwall et al., 2009). The level of biological and ecological investigation within this ecoregion was noted to be high, while the threats to this ecosystem integrity are also relatively well known, which have broadly been attributed to surface water abstraction and impacts associated with the human development and/or 'footprint' (Scott, 2015).

In accordance with the National Freshwater Ecosystem Priority Areas (NFEPA) it was found that the wetland types that dominate the landscape are floodplains, unchannelled valley bottoms and channelled valley bottoms associated with the Leeuspruit and Rietspruit.. Additionally most of the area impacted by the proposed surface mitigation measures are classified by the Free State Biodiversity Plan as degraded. However, there are small pockets within Leeuspruit Section 4 which are classified as 'Ecological Support Areas (ESA) 2'. Leeuspruit Section 5 has large areas classified as 'ESA 2' as well as 'ESA 1. Rietspruit Section 1 is closely bordered by Critical Biodiversity Areas '(CBA) 2'. This will need to be updated, once the aquatic component is published which is proposed to be at the end of 2018.

11.5.1 Wetlands

A wetland assessment was completed in 2016 by Digby Wells. For the detailed report, please see Appendix A of the wetland and aquatic report (Appendix D of this report). An update by Wetland Consulting Services (WCS) was undertaken in 2017. Furthermore, a site visit was conducted by Digby Wells on the 23rd and 24th of July 2018 to determine the impacts that the proposed project will have on the existing wetland systems. Each wetland system has been assessed in accordance with each section of the surface mitigation measure project.

The wetland's Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) for each section of the surface mitigation measure project have been determined. The impact scores and Present State categories are provided in Table 11-3. The overall EIS category of the wetland system is provided in Table 11-4.

The maps included for each individual section have been attached as part of the specialist study however Figure 11-2 and Plan 12 provides an overview of the assessment for all the wetland delineations.

Table 11-3: Impact Scores and Present Ecological State Categories used by WET-Health

Impact Category	Description	Combined Impact Score	PES Category
None	Unmodified, natural.	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D

Impact Category	Description	Combined Impact Score	PES Category
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

Table 11-4: Interpretation of Overall EIS Scores for Biotic and Habitat Determinants

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

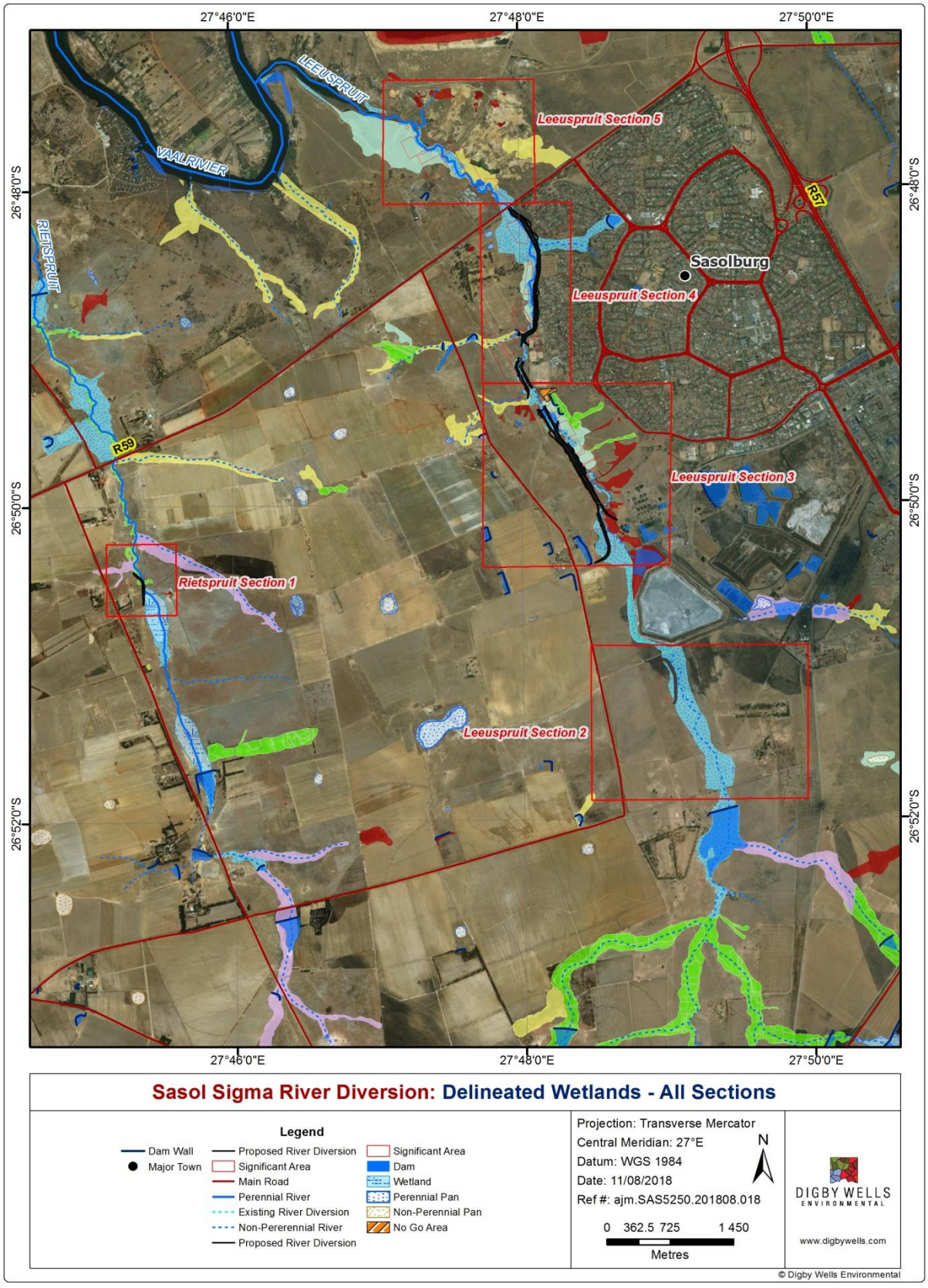

Figure 11-2: Wetland Delineation of the entire Surface Mitigation Measure Area

The description of all the wetland found within the project site is described in Table 11-5.

Table 11-5: Description of all the wetland found within the project site

River Section	Wetland Description
Leeuspruit Section 2	Leeuspruit Section 2 consists of 44.2ha of floodplain wetland, where the berm will be located, and a small portion of seep which will remain unaffected by the proposed project. Impacts to the system include the Peeters dam upstream, the FAD, various road crossings and invasive species, which have impacted on the health and functioning of the wetland. The PES and EIS of Section 2 are considered largely modified (D) and 'moderate', respectively.
Leeuspruit Section 3	Leeuspruit Section 3 consists of a floodplain predominantly (24.8 ha), however there are also channelled valley bottoms, hillslope seeps and artificial wetlands present. The impacts to the systems includes subsidence, which has already occurred, various road crossings, berms, pipeline crossings, stormwater entry points and infrastructure associated with a school, which has impacted the floodplain wetland to a large extent. The PES and EIS of Section 3 are considered largely modified (D) and 'moderate' respectively. It is important to note that a large patch of Kniphofia species was observed to the north of Section 3. The individuals on site could not be identified to species level as it was not the flowering season, however, it is important that this area (identified in the Impact Assessment) be considered a no-go area and warrants further investigation as some Kniphofia species are classified as Critically Endangered (Species listed in terms of section 56(1)(a)). Plan 13 in Appendix B indicates the No-Go Area.
Leeuspruit Section 4	Leeuspruit Section 4 is a highly channelled floodplain wetland (35.2 ha) with associated hillslope seeps (8.2 ha), which will be impacted on by the proposed surface mitigation measures. Pans are also present, along with an artificial wetland and a channelled valley bottom, however, these will be unaffected by the proposed project. The floodplain wetland is highly channelized and is impacted by subsidence in areas as well as road crossings and infrastructure. These have impacted on the health and functionality of the wetland to a great extent. The PES and EIS of the impacted wetlands in Section 4 are considered largely modified (D) and 'moderate' respectively.

River Section	Wetland Description
Leeuspruit Section 5	Leeuspruit Section 5 is characterised by a floodplain wetland and associate seeps. Artificial wetlands are also present. This section has been heavily impacted on most notably by a sand mining operation as well as channelization due to the R59 culvert upstream and a large pipeline crossing. The PES value of the impacted wetlands in Section 5 are considered to be a D for all systems aside from the seep which has been categorised as an E. The EIS for the system may be regarded as moderate aside for the seep, which is categorised as low. This section will not be directly impacted on by surface mitigation measures. Backfilling will be done and this has been addressed in a separate authorisation application and report.
Rietspruit Section 1	Rietspruit 1 is characterised by a floodplain wetland and a channelled valley bottom wetland which is fed by two unchannelled valley bottom wetlands. An artificial wetland is also present. The wetland has been impacted on by excavations, grazing and road crossings. The PES is considered a D for the impacted system and the EIS is considered to be a moderate, with the exception of the artificial wetland.

11.5.2 Aquatic Ecology

A brief description of key aquatic ecology features observed at each site is indicated in Table 11-7 below. The location of where sampling was undertaken is described in Table 11-6 and Plan 15 in Appendix B.

Table 11-6: Location and description of the selected aquatic biomonitoring points

Site	Co-Ordinates	Description	Relevant field assessments
SRD1	26°51'48.41"S 27°49'22.59"E	Situated upstream of Leeuspruit Section 2. Located on the Leeuspruit, directly downstream of the impoundment and road crossing.	Visual assessment; Water quality; MIRAI; FRAI
SRD2	26°47'17.27"S 27°46'32.80"E	This point is located on the upper reaches of the Leeuspruit, directly downstream of a gravel road crossing and upstream of the impoundment.	Site dry, visual assessment only.
SRD3	26°53'8.34"S 27°49'31.80"E	Located on the upper reaches of the Leeuspruit, directly upstream of the impoundment.	Site dry, visual assessment only
SRD4	26°50'56.40"S 27°49'1.21"E	Situated on Leeuspruit Section 2. Located along the Leeuspruit directly upstream of a gravel road and the Sasol Sigma TSF.	Visual assessment; Water quality; MIRAI; FRAI
SRD5	26°50'32.15"S 27°45'22.74"E	Situated on the Rietspruit Section 1. Located along the Rietspruit. Site is situated on a small gravel road within a farm field mainly utilised for cattle grazing purposes.	Site dry, visual assessment only
SRD6	26°49'41.96"S 27°45'11.19"E	Situated downstream of the Rietspruit Section 1. Located along the Rietspruit, on a farm directly upstream of the R59.	Site dry, visual assessment only
SRD7	26°48'59.15"S 27°47'32.56"E	Situated on the Leeuspruit Section 4. Located along a gravel road, on a tributary of the Leeuspruit.	Site dry, visual assessment only
SRD8	26°52'13.88"S 27°49'24.05"E	Situated on the Leeuspruit Section 1. Located on the impoundment situated downstream of SRD2 and SRD3 and upstream of SRD1	Visual assessment; Water quality; FRAI

Site	Co-Ordinates	Description	Relevant field assessments
SRD9	26°49'21.47"S 27°48'6.58"E	Situated downstream of the Leeuspruit Section 3 and upstream of the Leeuspruit Section 4. Located on the Leeuspruit, within a game farm area adjacent to the town of Sasolburg	Visual assessment; Water quality; MIRAI; FRAI
SRD10	26°48'7.64"S 27°47'56.67"E	Situated on the Leeuspruit Section 4. Located on the Leeuspruit at the R59 road crossing.	Visual assessment; Water quality; MIRAI; FRAI
SRD11	26°47'50.14"S 27°47'31.86"E	Situated on the Leeuspruit Section 5. Located on the Leeuspruit, directly upstream of a conveyor bridge crossing.	Visual assessment; Water quality; MIRAI; FRAI

Table 11-7: Visual assessment of the selected aquatic biomonitoring points

Site	Photograph	Aspect	Description
SRD1		Water clarity and odour	Discoloured, no odour.
		Flow characteristics	Flow at this point was slow, dominated by pool-like habitat.
		Substrate characteristics	Some stones out of current were present; however, benthic substrate was dominated by deposits of mud and organic matter.
		Bank cover and erosion potential	Vegetation cover was high on both banks, with little potential for erosion under high flow conditions.
		Other observations	Proliferation of the alien (*Azolla filiculoides*) and dense stands of *Populus X canescens* were observed at this point.
SRD2		Water clarity and odour	▪ Site was dry; ▪ Some stones were observed; however, benthic substrate will be dominated by mud and organic deposits at times of flow; ▪ Little potential for erosion due to the gradual gradient of the banks at this point and the relatively high basal cover observed.
		Flow characteristics	
		Substrate characteristics	
		Bank cover and erosion potential	
		Other observations	

Site	Photograph	Aspect	Description
SRD3		Water clarity and odour	Site was dry; Benthic substrate will be dominated by mud and organic deposits at times of flow; Little potential for erosion due to the gradual gradient of the banks at this point and the relatively high basal cover observed; Trampling by livestock.
		Flow characteristics	
		Substrate characteristics	
		Bank cover and erosion potential	
		Other observations	
SRD4		Water clarity and odour	Discoloured, no odour
		Flow characteristics	Extremely slow to still, the site consisted of a large pool at the time of the assessment.
		Substrate characteristics	Benthic substrate consisted of mud and sad deposits, with some isolated stones out of current.
		Bank cover and erosion potential	High basal cover on the banks, thereby reducing the potential for erosion at this point under high flow conditions.
		Other observations	None.

Site	Photograph	Aspect	Description
SRD5		Water clarity and odour Flow characteristics Substrate characteristics Bank cover and erosion potential Other observations	Site was dry; Benthic substrate will be dominated by mud and organic deposits at times of flow; Little potential for erosion due to the gradual gradient of the banks at this point and the relatively high basal cover observed; Trampling by livestock.
SRD6		Water clarity and odour Flow characteristics Substrate characteristics Bank cover and erosion potential Other observations	Site was dry; Benthic substrate will be dominated by mud and organic matter during times of flow; High potential for erosion due to loss of bankside cover as a result of livestock trampling and grazing activities.

Site	Photograph	Aspect	Description
SRD7		Water clarity and odour	As with site SRD6, the site was dry; Benthic substrate will be dominated by mud and organic matter during times of flow; High potential for erosion due to loss of bankside cover as a result of livestock trampling and grazing activities.
		Flow characteristics	
		Substrate characteristics	
		Bank cover and erosion potential	
		Other observations	
SRD8		Water clarity and odour	Opaque, no odour.
		Flow characteristics	No flow; this site comprises of an artificial dam.
		Substrate characteristics	Benthic substrate is dominated by mud deposits.
		Bank cover and erosion potential	High basal cover along the banks of the dam, thus limiting the potential for erosion under high flow conditions.
		Other observations	None

Site	Photograph	Aspect	Description
SRD9		Water clarity and odour	Clear, No odour.
		Flow characteristics	Moderate to low flows. The stream at this point was characterised by faster flowing glides, smaller, more gentle riffles and some pool habitat in the backwaters.
		Substrate characteristics	Large cobbles and boulders were present instream, with deposits of sand and gravel in some areas. Isolated deposits of mud.
		Bank cover and erosion potential	High basal cover on both banks, erosion potential at this point is very low.
		Other observations	None
SRD10		Water clarity and odour	Opaque, slight odour
		Flow characteristics	Flow at this point was moderate, the river was characterised by pools and slow laminar flows
		Substrate characteristics	Benthic substrate was dominated by mud and sand deposits, with isolated deposits of gravel under the bridge.
		Bank cover and erosion potential	Vegetation was absent in some areas, thus increasing the potential for erosion at this point under high flow conditions.
		Other observations	Some accumulation of debris in isolated areas.

Site	Photograph	Aspect	Description
SRD11		Water clarity and odour	Discoloured, no odour.
		Flow characteristics	Moderate flows; site was characterised by still pools and slow laminar flows at the time of the assessment.
		Substrate characteristics	Benthic substrates are dominated by mud deposits and sand towards the main channel.
		Bank cover and erosion potential	High basal cover, with little to no potential for erosion under high flow conditions.
		Other observations	None.

11.5.2.1 *In Situ Water Quality*

In situ water quality variables are important for the interpretation of results obtained during biological investigations, as aquatic organisms are influenced by the environment in which they live. Table 11-8 provides the *in situ* water quality data obtained at each site assessed at the time of the field survey in July 2018.

Table 11-8: *In situ* water quality variables recorded in July 2018

Site	Time	Temp. (°C)	pH	Electrical Conductivity (µS/cm)
TWQR*		**-**	**6.0 – 8.0**	**<700 µS/cm**
SRD1	10h25	11.5	9.19	1281.0
SRD4	12h30	15.1	8.80	1212.0
SRD8	08h00	10.1	9.16	1306.0
SRD9	09h30	8.0	9.09	1293.0
SRD10	11h30	9.0	9.01	2009.0
SRD11	13h15	11.4	9.18	1894.0

* Target Water Quality Range (TWQR), as described in (Department of Water Affairs and Forestry, 1996)

The results indicate that the system is considered to be alkaline. The electrical conductivity values recorded at the time of the survey were observed to be high which is expected within a system inherently dominated by wetland habitat. However, the increase in electrical conductivity observed between sites SRD9 and SRD10 of 55.4% may be regarded as notable. This may be caused from the residential area adjacent to the Leeuspruit between sites SRD9 and SRD10 however it cannot be confirmed. The temperatures were determined to be natural in accordance with the time the measurements were taken.

11.5.2.2 *Invertebrate Habitat Assessment System*

The scoring system for Invertebrate Habitat Assessment System (IHAS) is traditionally split into two sections, namely the sampling habitat (comprising 55% of the total score) and the general stream characteristics (comprising 45% of the total score), which are summed together to provide a percentage and then categorized according to the values in Table 11-9.

Table 11-9: Adapted IHAS Scores and associated description of available aquatic macroinvertebrate habitat

IHAS Score (%)	Description
>75	Excellent
65-74	Good
55-64	Adequate / Fair
<55	Poor

Due to the nature of the valley-bottom and floodplain wetlands within the project site, which is largely derived from the topography of the area, stones as an available biotope were absent and the occurrence of hydraulic diversity within these wetlands systems was low. Each of the assessed sampling sites, with the exception of Site SRD9, exhibited poor habitat availability with varying degrees of marginal and aquatic vegetation, as well as gravel-sand-mud, being the dominant biotopes present (Table 11-10).

Table 11-10: Adapted IHAS values obtained during the July 2018 assessment

Site	Adapted IHAS Value (%)	Description
SRD1	38	Poor
SRD4	31	Poor
SRD9	69	Good
SRD10	47	Poor
SRD11	40	Poor

11.5.2.3 Aquatic Macroinvertebrates

A total of approximately 50 different aquatic macroinvertebrate families were expected within the project site (Inferred from Dr C. Thirion, pers. comm., 2017 and specialist opinion based on site structure and experience). Of these aquatic macroinvertebrate families, a total of only 25 taxa were collected at the time of the survey (including an alien Physidae), ranging from six families at the Site SRD10 to 17 families at Site SRD4 (Table 11-11).

The SASS5 scores were determined and found to range from a low 21 to moderate 84. The highest Average Score Per Taxon (ASPT) values were found to be at Sites SRD4 and SRD9 along the Leeuspruit. The worse scores were found downstream of Site SRD9. The lowest macroinvertebrate diversity obtained at the time of the survey was observed at Site SRD10.

Only five taxa that were generally regarded as moderately sensitive to water quality impairment were collected, namely *Hydracarina* (Water Mites), *Aeshnidae* (Emperor Dragonflies), *Hydroptilidae* (Cased Caddisflies), *Ancylidae* (Limpets) and *Hydraenidae* (Minute Moss Beetles).

Table 11-11: SASS5 data obtained during the July 2018 assessment

Site	SASS5 Score	Number of Taxa	ASPT*
SRD1	53	13	4.1
SRD4	84	17	4.9
SRD9	64	13	4.9
SRD10	21	6	3.5
SRD11	28	8	3.5

* Average Score Per Taxon

Both the SASS5 and ASPT scores indicate that the Leeuspruit system has been significantly impacted upon. The results of both the water quality assessment as well as the observed ASPT values, which are an indication of the general sensitivity of the colonised macroinvertebrate communities, serve as an indication, that water quality is a major driver within the Leeuspruit system.

11.5.2.4 Present Ecological State

The PES for aquatic ecology is evaluated based on Table 11-12.

Table 11-12: Allocation protocol for the determination of the Present Ecological State for aquatic macroinvertebrates following application of the MIRAI

MIRAI (%)	Ecological Category	Description
90-100	A	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	B	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	C	Moderately modified. Community structure and function are less than the reference condition. Community composition is lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	D	Largely modified. Fewer species present than expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	E	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	F	Critically modified. Few species present. Only tolerant species present, if any.

The SASS5 data obtained was used to determine the PES, or Ecological Category of the associated macroinvertebrate assemblage making use of the MIRAI (Table 11-13).

Table 11-13: Results obtained following the application of the Macroinvertebrate Response Assessment Index (MIRAI) at selected sampling sites during the July 2018 assessment

Site	REC*	MIRAI Value	Ecological Category	Description
SRD1	**D**	27.5	**E**	Seriously modified
SRD4	**E**	30.9	**E**	Seriously modified
SRD9	**E**	27.9	**E**	Seriously modified
SRD10	**E**	11.4	**F**	Critically modified
SRD11	**E**	19.9	**E/F**	Seriously to critically modified

* Recommended Ecological Category, as per historical data for the C22K-01812 sub-quaternary reach.

In relation to perceived reference conditions (Dr C. Thirion, pers. comm., 2017), it was determined that the ecological condition of the macroinvertebrate assemblages collected within the project site exhibited seriously to critically modified conditions (i.e. Ecological Category E to F). Further interrogation indices that the primary driver at each of the assessed sites was related to the limited available habitat present, which was to be expected for sites SRD1, SRD4 and SRD9, however, the results suggest some impact related to water quality at sites SRD10 and SRD11.

11.5.2.5 Fish Communities

Table 11-14 provides the results of the fish community integrity assessment as observed at the time of the July 2018 survey.

Table 11-14: Results obtained following the application of the Fish Response Assessment Index (FRAI) for the Leeuspruit during the July 2018 assessment

FISH RESPONSE ASSESSMENT INDEX	
Fish species present (Collected)	*Gambussia affinis* (Mosquitofish)
Abundance	Present at 3 sites
Health	Good
Fish included but not collected (Based on habitat and infield observations)	*Clarius gariepinus* (Sharptooth catfish)
	Tilapia sparrmanii (Banded tilapia)
FRAI Score	24.1
Ecological Category	E (Extensively modified)
Description	Seriously modified

Only one fish species, *Gambussia affinis* (Mosquitofish; Figure 11-3), was captured during the field assessment. However, an additional two species of fish are expected to exist in the area and were included in the application of the Fish Response Assessment Index (FRAI), *Clarias gariepinus and Tilapia sparrmanii*. An ecological category of E was thus assigned to this section of the Leeuspruit based on the results of the July 2018 survey.

Figure 11-3: *Gambussia affinis* (Mosquitofish)

11.5.3 Geomorphology

The general area and region is devoid of any major fourth order (4th order) landforms. The area is specifically lacking relief and areas of high gradient.

This is due to the surface geology dominated by Ecca sedimentary rock with some dolerite intrusions and specifically sills exposed to surface.

Continental scale landforms are first order, regional landforms like the Drakensberg range from second order with structures such as the Vaal River or Vredefort Dome forming third order landforms. Fourth order landforms are limited in this area. The ridge at Boschenvaal on the edge of the Vaal River is arguably one of the few fourth order landforms in the area. The Fine Ash Dam (FAD) and associated infrastructure is large enough to form an anthropogenic forth order landform.

There are some small andesite outcrops that form a ridge near Section 3 and the school. Dolerite formations are not as prominent. Previous mining and subsidence in wall mining areas probably form a larger geomorphological driver in the area than dolerite.

11.5.3.1 Leeuspruit Section 2

This section of the stream is impounded by a road with non or limited culverts or piping and then flows into the existing river diversion around the FAD. From a biogeomorphology point of view it forms an important wader area. The proposed berm will offset the permanently inundated section of the wetland to the south east, but the habitat will remain.

11.5.3.2 Leeuspruit Section 3

This floodplain has features that resemble oxbows in functionality and may have formed secondary channels at times. The driver in the area is the andesite outcropping to the east (south of the school) in conjunction with subsidence.

Below the outcrop, artificial systems have formed, driven by subsidence and fed by urban stormwater pipe outlets. This area has also formed habitats for Kniphofia plant species to be protected by a no-go zone.

11.5.3.3 Leeuspruit Section 4

In this area the stream channel is narrow and encroached upon by urban development. Subsidence has formed artificial pans that form habitats of some local significance in terms of biodiversity. There are not many pans in the general area and these offer specific habitats for water birds as observed during numerous site visits. Again, these features have similar functionality as oxbows.

In addition, the wall mining panels are visible through subsidence. This has significantly altered the floodplain and limits proposed mitigation activities of berms and diversion to the immediate stream channel area. The mined area cannot be used for mitigation structures like berms or the diversion.

The urban runoff impacts of Section 3 are applicable in this section of the project site as well.

11.5.3.4 Leeuspruit Section 5

The R59 culvert could increase water speed and pressure during floods and may lead to downstream erosion due to a water hammer or water canon effect. The water hammer or water canon effect refers to water being forced though a pipe or structure like a culvert which increases pressure and velocity, and this increases the erosional force of the water drastically. Dissipation measures and a species plan needs to be implemented for this section. Dissipation can be achieved through upright concrete structures in the form of small pillars/poles or blocks. The species plan proposed must contain specific species that will help protect against erosional forces.

11.5.3.5 Rietspruit Section 1

Quarrying has taken place within this area. Additionally, two roads with associated culverts have altered the Rietspruit. The berm will deflect flow from the quarry and a wading habitat may form. This refers to muddy flats or muddy ‘beach’ type riparian zones that many birds prefer as feeding areas.

11.6 Flora

Results from the 2018 field assessment along with those of a previous assessment done by Digby Wells (2013) indicate that a total of 63 plant species have been recorded (from 16 different families). The *Poaceae* (the grass family) is the best represented with 27 different species. A total of 12 tree species represented the woody layer, whereas the herbaceous layer is represented by 31 different herbs and 27 graminoid species. Common species identified during the most recent infield assessment include *Themeda triandra, Cynodon dactylon, Panicum coloratum* and *Heteropogon contortus.*

Seriphium plumosum (Bankrupt bush) encroachment was common in a number of areas in the Secondary Grassland unit. Bankrupt bush is an indigenous woody dwarf shrub that is noted for not being favoured by grazing livestock and their presence in overgrazed areas.

11.6.1 Species of Conservation Concern (SSC)

The Sigma Defunct Colliery falls within 2627DD QDS in terms of the 1:50 000 grid of South Africa. South African National Biodiversity Institute (SANBI) uses this grid system as a point of reference to determine any Red Data plant species or any species of conservation importance occurring in South Africa. Although Pretoria Computerised Information System (PRECIS) suggests that seven SSC (Table 11-15) may potentially occur within the project site, only one plant species of SCC was recorded, namely *Hypoxis hemerocallidea*. This species was categorised as declining thus the species must be considered for conservation protection. A *Kniphofia spp* colony was recorded in a wetland area during the infield assessment although it was not possible to identify it down to species level due to the timing of the assessment and the fact that *Kniphofia* species hybridize very easily. There is a possibility that it could be the protected species *Kniphofia typhoides Codd*, thus it is recommended that this is further assessed prior to clearing. Removal of this colony would require an on-site offset, which would require the creation of another suitable habitat for the *Kniphofia* plants and other *hygrophytic* herbs that occur, to which they would then need to be relocated.

Table 11-15: Red Data Plant species recorded in grid cell 2627DD which could potentially occur in the project site

Family	Scientific Name	Common Name	Threat status	Growth forms
Amaryllidaceae	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	Vaal River lily	Declining	Geophyte
Apiaceae	*Alepidea attenuata Weim.*	-	NT	Herb
Apocynaceae	*Brachystelma incanum R.A.Dyer.*	-	VU	Geophyte

Family	Scientific Name	Common Name	Threat status	Growth forms
Apocynaceae	*Stenostelma umbelluliferum (Schltr.) S.P.Bester & Nicholas.*	-	NT	Geophyte
Asphodelaceae	*Kniphofia typhoides Codd.*	-	NT	Herb
Fabaceae	*Indigofera hybrida N.E.BR.*	-	VU	Herb
Hypoxidaceae	*Hypoxis hemerocallidea Fisch., C.A.MEY. & Avé-lall.*	Star-flower	Declining	Geophyte

***** Raimondo et al., (2009) categorized C. bulbispermum and Hypoxis hemerocallidea Fisch as declining in South Africa based on the modified IUCN Red List Categories and Criteria version 3.1 of threatened species(IUCN,2001). According to Victor and Keith (2004) and Von Staden et al. (2009), a species listed as Least Concern (LC) under the IUCN Red List Categories and Criteria version 3.1 (IUCN, 2001) can additionally be categorized either as rare, critically rare or declining based on observations that suggest that the species must be considered for conservation protection over and above those that are threatened according to the IUCN. This equally applicable to the most recent version of the IUCN Red List Categories, version 13 (2017).

11.6.2 Vegetation Types

Four broad vegetation communities were identified during the infield assessment which has been discussed in Table 11-16 presented in Figure 11-4 and Plan 14.

Table 11-16: Vegetation Units

Vegetation Type	Description
Secondary Grassland	This was considered to be the primary vegetation unit found within the Sigma Defunct Colliery. Grasslands are vegetation types that are mainly characterized by open vegetation cover, made up of predominantly a continuous grassy layer. The grassland type in the project site was degraded grassland characterized by the presence of indigenous flora species such as *Hypoxis hemerocallidea* (Star-flower) and a range of dominant species. The figure below shows the secondary grassland vegetation and the associated plant species that were identified in this vegetation type. Species include Spear grass (*Heteropogon contortus*), Red grass (*Themeda triandra*), and the herbaceous species Star flower (*Hypoxis hemerocallidea*) amongst others. A full list plant species recorded in this vegetation type is included in section 5.3.1 of the fauna and flora report (Appendix E).  **Secondary Grassland vegetation type**

Alien vegetation	Pockets of alien and exotic trees were recorded throughout the project site and were mostly dominated by *Eucalyptus camaldulensis*. Along with the riparian areas, these pockets also contained species such as *Populus x canescens*, Salix *babylonica,* and *Eucalyptus camaldulensis*. A majority of these woody invasions occurred and persisted due to human interventions. These species generally out-compete indigenous vegetation for space, nutrients, water, and other environmental requirements required for growth. The result of these infestations often includes the transformation of the native ecosystem in such a manner that compromises the ecological integrity of the ecosystem that could lead to its eventual collapse if not addressed.  **Alien vegetation**

Woodland / Savanna	The Woodland/Savanna unit was encountered within the general grassland, in rocky relatively sheltered areas. The presence of the Woodland/Savanna unit within outcrops in the grassland unit can be attributed to the ruggedness of the outcrops which increased the soil moisture and excluded fires thus enabling trees to establish on and in the vicinity of these outcrops. This vegetation type was largely dominated by *Vachellia karroo– Asparagus laricinus* Woodland.  **Woodland/Savanna vegetation**
Riparian/Wetland	The riparian/wetland unit was identified to be within areas where drainage lines are present. This vegetation unit is mainly associated with the moderately deep, poorly drained, dark, moderately structured clay soils, with signs of permanent wetness in the subsoil or in other words drainage lines. A total of 413.9ha of wetlands were identified within the project site.

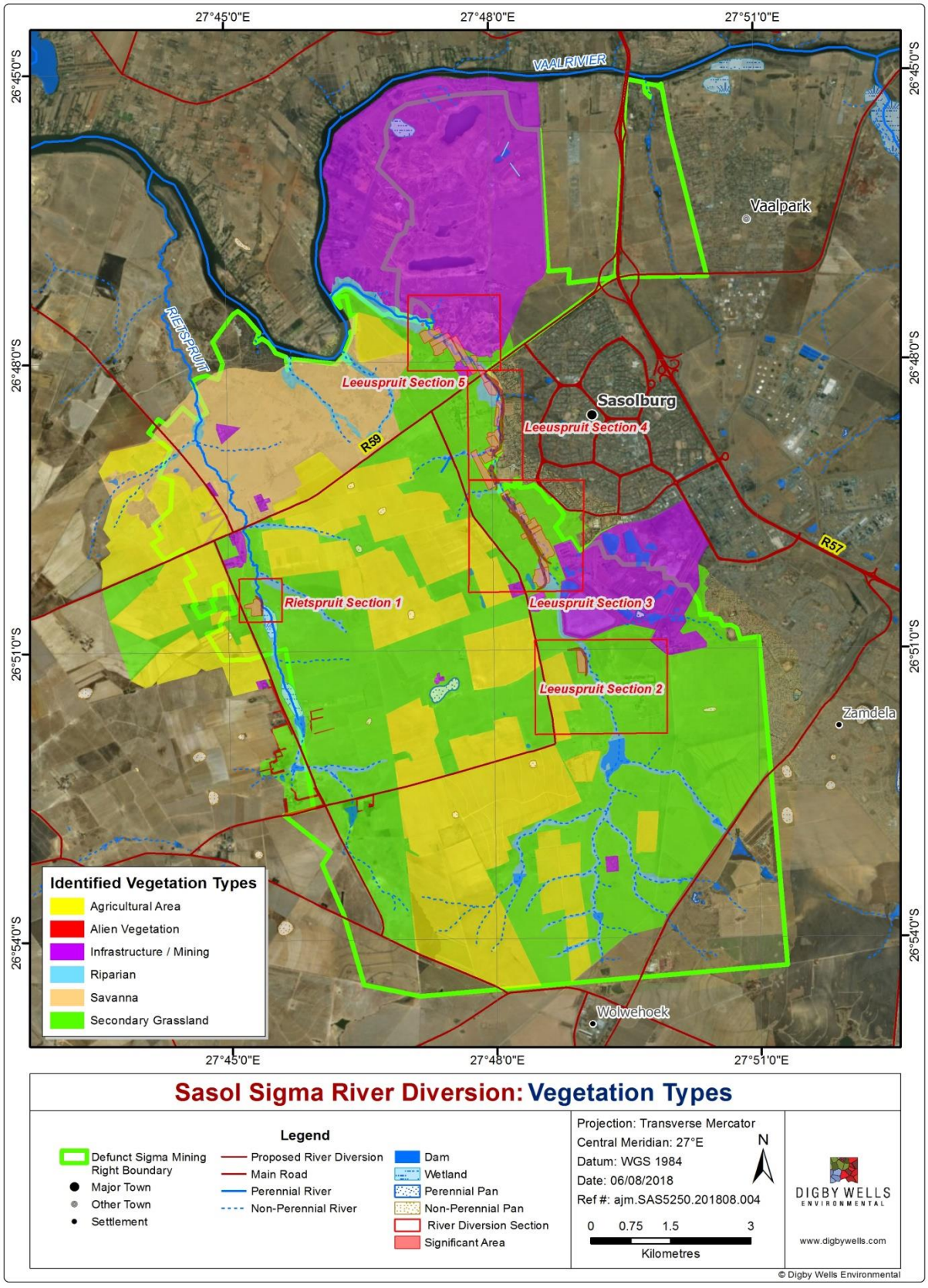

Figure 11-4: Identified Vegetation communities

11.7 Fauna

A description of the fauna located within the project site is described below in Table 11-17.

Table 11-17: Fauna description of project site

Mammals	The project site has a relatively low faunal diversity due to the disturbed nature of the site. Six mammal species were recorded during the infield assessment and all of these were within the Sasol Mining private game farm. A more rigorous search outside of the game farm might indicate additional species. A list of species that have been recorded for the broader area and could possibly occur within the project site are listed in Appendix F of the Fauna and Flora Specialist Study (Appendix E).
Avifauna	The diversity of avifauna is one of the most important ecological indicators to evaluate the quality of habitats. Several bird species respond to small changes in habitat structure and composition, therefore they are good proxies to measure the diversity and integrity of ecosystems as they tend to be near the top of the food chain, have large ranges, and the ability to move elsewhere when their environment becomes unsuitable (Sekercioglu, 2006). Forty-seven bird species were recorded during the infield assessment and these have been listed in Table 5 5 of the Fauna and Flora Specialist Study (Appendix E). It is also noted that no Important Bird and Biodiversity Area (IBA) were identified within the project site.
Herpetofauna	No reptiles were encountered during the 2018 dry season infield survey as well as the previous assessment done by Digby Wells (2013). Expected species are depicted in Appendix E of the Fauna and Flora Specialist Study (Appendix E).
Invertebrates	No invertebrate species were opportunistically sighted during the infield assessment. This is primarily due to sampling methods employed. The abundant presence of species such as the Yellow mongoose and several avifauna species which feed predominantly on insects and other invertebrates suggests that invertebrate numbers are significantly high on site It is worth noting that snouted harvester termite mounds were recorded throughout, the secondary grassland areas, these are now being used by burrowing animals. According to records from the According to the ADU (Animal Demographic Unit Virtual Museum), no butterfly species of conservation importance are known to occur in and around the project area. Butterfly species recorded by Mecenero *et al*. (2015) in the region indicates 57 species which are listed as least Concern.

11.8 Surface Water

11.8.1 Catchment Description

The proposed project area is located within the Water Management Area (WMA) of the Upper Vaal River system. The proposed area is located within the secondary drainage C2 in quaternary catchment C22K. The catchment characteristics for the C22K are presented in Table 11-18 and is summarised from the Water Research Commission (WRC), 2012.

The resultant MAR after evaporation and recharge is 3%. The MAP is 644mm with a Mean Annual Evaporation (MAE) of 1 625mm. The natural water balance is thus a negative one with evaporation being much higher than rainfall. However, recharge does contribute to the groundwater system which is important in the area.

Table 11-18: Summary of the C22K catchment attributes

Quaternary Catchment	Area (km_2)	Rainfall Zone	MAP (mm)	MAR (mm)	Evaporation Zone	MAE (mm)
C22K	434	C2C	644	20.9	11A	1625

The two main tributaries are the Leeuspruit (perennial) which drains the upper sections of the project site and the Rietspruit (non-perennial) draining the lower project boundary into the Vaal Barrage. The Leeuspruit and Rietspruit rivers flow parallel to each other towards Vaal Barrage. The Rietspruit presents well-defined dry river channels whilst the Leeuspruit is slow flowing with varying channel shapes. Pictures from the site visit is presented in Figure 11-5. The Taaibosspruit drains the area to the east of Sasolburg and the Kromelmboogspruit flows outside the project area to the west. Both these drainages are not influenced by the proposed activities.

Figure 11-5: Photographs of the Leeuspruit (Left) and the Rietspruit (Right) River Channels

11.8.2 Surface Water Quality

IGS was appointed by Sasol Mining (Pty) Ltd to conduct the water monitoring of the Sigma Defunct Colliery. This section constitutes a summary of the water quality descriptions based on the latest water quality analysis by IGS (January 2018) which outlines the results of the on-going bi-annual monitoring programme conducted for Sigma Defunct Colliery. The monitoring programme focuses on an integrated approach where all water resources are holistically monitored for potential impacts by mining. The water quality data obtained from

the Sigma Defunct Colliery was analysed in an accredited SANAS laboratory, and was verified by IGS. The components analysed are displayed in Table 11-19.

Table 11-19: Summary of the Parameters/Variables Analysed

Analysed Parameters[1]						
pH	EC	TDS	Ca	Mg	Na	K
P-Alk	M-Alk	Cl	SO_4	NO_2/NO_3 as N		Cd
Al	Fe	Mn	NH_4/NH_3	as	N	B
Cr	Co	Cu	Pb	PO_4	COD	DOC
phenols	TOC	Turbidity	Suspended Solids	Faecal Coliform	Si	F

In total, 64 surface water monitoring sites forms part of the monitoring program at Sigma Defunct Colliery. However, the two main surface water features discussed as part of this project is the Rietspruit and Leeuspruit as these watercourses will be directly impacted by the proposed surface mitigation project. In addition, for baseline purposes, the Vaal River monitoring results are also discussed. Monitoring locations that are discussed are listed in Table 11-20 and shown in Plan 15 in Appendix B.

During the site visit conducted by Digby Wells for the project it was noted that a borehole was leaking which was resulting in discharge to the environment. Further investigation into this discharge is currently being undertaken.

Data quality control was carried out by comparing the new data set with historic records to check for errors. Additionally, an ion balance error of ± 5% was used as an acceptable range after which the data was stored in the Sigma Defunct Colliery WISH database. The results reported in this section dates from June 2017 to January 2018 (given that a bi-annual monitoring program is being carried out at the defunct mine) and was sourced from the IGS reports.

Table 11-20: Surface Water Monitoring Points

AREA	SITE ID	STATUS	COMMENTS
Vaal River Barrage	Vaal Downstream	Monitored	Vaal river downstream
Vaal River Barrage	Vaal Upstream	Monitored	Vaal river upstream

[1] The units are mg/l except pH and EC measured in pH units and mS/m respectively.

AREA	SITE ID	STATUS	COMMENTS
Sigma	SIG/1	Monitored	Leeuspruit Downstream
Sigma	SIG/2	Monitored	Leeuspruit Upstream
Sigma	SIG/3	Monitored	Rietspruit Downstream
Sigma	SIG/4	Monitored	Rietspruit Upstream
Sigma	SIG/5	Monitored	Leeuspruit Tributary Upstream
Sigma	SIG/6	Monitored	Leeuspruit Tributary Downstream

11.8.2.1 Leeuspruit

Monitoring points SIG/1 (downstream) and SIG/2 (upstream) represents the water quality of the Leeuspruit. In addition, SIG/5 and SIG/6 monitors a tributary of the Leeuspruit that flows from the east and joins the Leeuspruit between the SIG/1 and SIG/2 monitoring points. This last-mentioned tributary as well as the Leeuspruit is directed past an ash dam and old coal stockpiles before joining each other at the confluence point directly downstream of the ash dam which can potentially influence the water quality of the Leeuspruit and change the chemistry slightly between SIG/2 and SIG/1.

The water type of both SIG/1 and SIG/2 can be described as sodium-bicarbonate water with SIG/1 (downstream) more enriched with SO_4 than that of the upstream point SIG/2. The upstream point of the tributary (SIG/5) also has a lower SO_4 concentration that the downstream point (SIG/6). The change in sulphate concentrations of the tributary is illustrated in its character that change from a calcium-bicarbonate water at the upstream point to a sodium-bicarbonate water at the downstream point. The effect of the ash dams and the associated activities are clear in the change of water quality with SO_4 concentration being a clear indicator element of seepage and runoff from an ash facility.

In addition, the water quality was compared against the Leeu/Taaiboschspruit Catchment water quality guidelines and is shown in Table 11-21 and Table 11-21.

The following can be concluded on the water quality of the Leeuspruit and its tributary:

- Changes in pH and occasional peaks in SO_4 for the downstream points above the guideline values confirms the conclusion that the ash dam does have some influence on the water quality during high rainfall and runoff periods;
- Cl and EC generally stay within the guideline concentration ranges for all monitoring points. However, in the last two monitoring runs a clear increase in these parameters are observed with EC increasing to above guideline values in SIG/1, SIG/2 and SIG/6. This correlates with the rainfall seasons at the end of the year and confirms the potential contribution of the ash dams and old coal stockpiles to the water quality;
- In general, from the trend graphs it can be concluded that in the last 12 months there is a general trend of deteriorating water qualities in a downstream direction of both

the Leeuspruit and its tributary that can be due to the contribution of the ash dam and coal stockpiles located at 3 Shaft Complex operated by Mooikraal Colliery;

- From the other parameters analysed and compared against the water quality guidelines in January 2018 all are within a tolerable range excluding sodium (Na), Mn, NO_3, PO_4 and TSS that are at unacceptable levels for the Leeuspruit and its tributary. Faecal coliform is also above guideline values in both drainages;
- 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. Faecal coliform, NO_3 and PO_4 are most likely from animal and farming activities (bird life and cattle around the drainage lines and pesticides); and
- 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

Potential current impacts in the upstream areas above Peeters Dam in the Leeuspruit as well as its tributaries that can have an influence on the above water quality are:

- Discharge from sewage plants in the upstream areas of the Leeuspruit; and
- Uncontrolled storm water from built up areas and informal communities.

Table 11-21: Leeuspruit water quality vs. the prescribed Leeu/Taaiboschspruit Catchment water quality guidelines

SiteName	EC	pH	Ca	Mg	Na	K	PAlk	MAlk	F	Cl	NO2(N)
SWQG	mS/m		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<70	6.5-8.5	N/S	<30	<100	N/S	N/S	N/S	<0.7	<150	<3.0
Tolerable	70-120	N/S	N/S	30-70	100-150	N/S	N/S	N/S	0.7-1.0	150-200	3.0-6.0
Unacceptable	>120	<6.5; >8.5	N/S	>70	>150	N/S	N/S	N/S	>1.0	>200	>6.0
SIG1	139	8.1	66	25	218	11.8	0	253	0.37	86	<0.1
SIG2	67	7.2	34	19	54	42.5	0	193	0.72	87	<0.01
SIG5	26	7.3	25	5	15	7.2	0	83	0.51	13	0.56
SIG6	119	8.1	53	13	190	26.7	0	277	0.51	97	<0.1
SiteName	NO3(N)	PO4	SO4	Al	Fe	Mn	NH4(N)	TDS	B	Si	Cd
SWQG	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<3.0	<0.4	<300	<0.3	<0.5	<0.5	<1.5	N/S	N/S	N/S	N/S
Tolerable	3.0-6.0	0.4-0.6	300-500	0.3-0.5	0.5-1.0	0.5-1.0	1.5-5.0	N/S	N/S	N/S	N/S
Unacceptable	>6.0	>0.6	>500	>0.5	>1.0	>1.0	>5.0	N/S	N/S	N/S	N/S
SIG1	<0.5	<1	337	0.034	0.032	0.029	0.12	992	1.178	1.083	<0.003
SIG2	0.17	<0.1	0	0.041	2.425	3.455	1.05	432	<0.040	16.333	<0.003
SIG5	0.73	1.08	14	0.333	0.578	0.122	0.09	170	<0.040	4.523	<0.003
SIG6	17.34	<1	125	0.244	0.161	0.023	0.06	857	0.459	4.774	<0.003
SiteName	Co	Cr	Cu	Pb	Turb	COD	Susp. Solids	Phenol	DOC	TOC	
SWQG	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/lO2	mg/L	
Acceptable	N/S	N/S	N/S	N/S	N/S	N/S	<30	N/S	N/S	N/S	
Tolerable	N/S	N/S	N/S	N/S	N/S	N/S	30-55	N/S	N/S	N/S	
Unacceptable	N/S	N/S	N/S	N/S	N/S	N/S	>55	N/S	N/S	N/S	
SIG1	<0.020	<0.020	0.020	0.001	12	65	27	<0.010	10	10	
SIG2	<0.020	<0.020	0.019	0.002	164	343	1160	<0.010	47	54	
SIG5	<0.020	<0.020	0.022	0.000	335	134	730	<0.010	10	14	
SIG6	<0.020	<0.020	0.026	0.001	>800	1280	1552	<0.010	10	12	

SWQG - Leeuspruit/Taaiboschspruit prescribed surface w ater quality guidelines
N/S - Not specified

(Source: IGS, 2018)

Table 11-22: Leeuspruit bacteriological analysis results

SiteName	Faecal Coliforms	E.Coli
SWQG	cfu/100ml	cfu/100ml
Acceptable	<126	N/S
Tolerable	126-1000	N/S
Unacceptable	>1000	N/S
SIG1	>2420	866
SIG2	1300	1300
SIG5	65	45
SIG6	1825	1380
SWQG - Leeuspruit/Taaiboschspruit prescribed surface w ater quality guidelines N/S - Not specified		

(Source: IGS, 2018)

11.8.2.2 Rietspruit

The upstream monitoring point of the Rietspruit is represented by SIG/4 with the downstream point being SIG/3. Mainly farming activities occurs between these two points with only underground mining that was part of the Sigma Defunct Colliery being the other activities.

From Table 11-23 and Table 11-24 the following can be concluded on the baseline water quality for the Rietspruit:

- Both sampling points show a calcium-bicarbonate water type with only a change in alkalinity from upstream to downstream. This can be due to various factors but none that will impact on the quality of the water;
- Analysis of the chemistry vs time trends show that the downstream point (SIG/3) generally remains stable with a decrease in pH over the last three monitoring runs. This can be due to high rainfall;
- The upstream point (SIG/4) is however more variable with spikes in parameters during certain periods. Periods of prominent increases in Cl and SO_4 are observed at SIG/4 and this can be due to evaporation during the dry winter months which increases salt concentrations;
- Generally, the water quality trends do however remain stable and the water quality shows no significant changes over time;
- Fluoride (F), aluminium (Al), iron (Fe), Mn, PO_4, ammonium (NH_4) and TSS exceed the recommended guideline limits. F, Al, Fe and Mn will be due to ion exchange reactions with the stream sediments. PO_4 and NH_4 will be from animal activity;
- Faecal coliforms exceed the guideline values, but this is normal for natural streams flowing through areas with human, farming and animal activities; and

- The Rietspruit water quality has generally remained stable and within the ranges of background data.

Table 11-23: Rietspruit water quality vs. the prescribed Leeu/Taaiboschspruit Catchment water quality guidelines

SiteName	EC	pH	Ca	Mg	Na	K	PAlk	MAlk	F	Cl	NO2(N)
SWQG	mS/m		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<70	6.5-8.5	N/S	<30	<100	N/S	N/S	N/S	<0.7	<150	<3.0
Tolerable	70-120	N/S	N/S	30-70	100-150	N/S	N/S	N/S	0.7-1.0	150-200	3.0-6.0
Unacceptable	>120	<6.5; >8.5	N/S	>70	>150	N/S	N/S	N/S	>1.0	>200	>6.0
SIG3	18	7.2	15	5	9	8.1	0	67	0.49	8	<0.01
SIG4	78	6.7	54	23	29	43.1	0	286	11.79	36	<0.01
SiteName	NO3(N)	PO4	SO4	Al	Fe	Mn	NH4(N)	TDS	B	Si	Cd
SWQG	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<3.0	<0.4	<300	<0.3	<0.5	<0.5	<1.5	N/S	N/S	N/S	N/S
Tolerable	3.0-6.0	0.4-0.6	300-500	0.3-0.5	0.5-1.0	0.5-1.0	1.5-5.0	N/S	N/S	N/S	N/S
Unacceptable	>6.0	>0.6	>500	>0.5	>1.0	>1.0	>5.0	N/S	N/S	N/S	N/S
SIG3	<0.05	<0.1	0	0.679	1.194	0.052	0.07	113	<0.040	6.391	<0.003
SIG4	0.22	10.29	1	0.046	1.635	2.824	17.75	495	<0.040	7.977	<0.003
SiteName	Co	Cr	Cu	Pb	Turb	COD	Susp. Solids	Phenol	DOC	TOC	
SWQG	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/IO2	mg/L	
Acceptable	N/S	N/S	N/S	N/S	N/S	N/S	<30	N/S	N/S	N/S	
Tolerable	N/S	N/S	N/S	N/S	N/S	N/S	30-55	N/S	N/S	N/S	
Unacceptable	N/S	N/S	N/S	N/S	N/S	N/S	>55	N/S	N/S	N/S	
SIG3	<0.020	<0.020	0.025	0.002	121	100	251	<0.010	21	23	
SIG4	<0.020	<0.020	0.039	<0.0006	>800	6810	8617	<0.010	77	94	

SWQG - Leeuspruit/Taaiboschspruit prescribed surface w ater quality guidelines
N/S - Not specified

(Source: IGS, 2018)

Table 11-24: Rietspruit bacteriological analysis results

SiteName	Faecal Coliforms	E.Coli
SWQG	cfu/100ml	cfu/100ml
Acceptable	<126	N/S
Tolerable	126-1000	N/S
Unacceptable	>1000	N/S
SIG3	>2420	52
SIG4	>2420	866

SWQG - Leeuspruit/Taaiboschspruit prescribed surface w ater quality guidelines
N/S - Not specified

(Source: IGS, 2018)

11.8.2.3 Vaal River Up- and Downstream

Both the Vaal Upstream and Downstream points are characterised as sodium-sulphate water. The water character of both points is almost identical.

From the data in Table 11-25 and Table 11-26 the following can be concluded:

- The SO_4 and EC trends of the upstream and downstream points follows the same trend;
- The downstream monitoring point does show occasional spikes in Cl and pH that can potentially be due to the influence of the Leeuspruit. This is however not frequent, and thus not proven;
- All other constituents are well within the recommended guideline ranges except for TSS. TSS can increase during periods when river flow rates and levels increase and decrease with the velocity of the river being at a rate at which suspended solids are transported downstream. This usually occurs at the start or end of the wet season; and
- Faecal coliform results are above the guideline values in the upstream sample. This can be due to sewage discharge as well as farming (livestock) activities upstream.

The general trend observed is that the upstream sampling point water quality is generally worse than that of the downstream point. This is unusual if you consider the contribution of the Leeuspruit and its tributary with the contaminated water from the ash dams and coal stockpiles. This does however show that the Vaal River is already impacted by upstream activities that include mining, sewage discharge and general human impacts from settlements.

From current data it can be concluded that water from the project area flowing down the Leeuspruit and Rietspruit does not have a significant impact on the Vaal River quality.

Table 11-25: Vaal River Barrage water quality vs. the prescribed Leeu/Taaiboschspruit Catchment water quality guidelines

SiteName	EC	pH	Ca	Mg	Na	K	PAlk	MAlk	F	Cl	NO2(N)
SWQG	mS/m		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<70	6.5-8.5	N/S	<30	<100	N/S	N/S	N/S	<0.7	<150	<3.0
Tolerable	70-120	N/S	N/S	30-70	100-150	N/S	N/S	N/S	0.7-1.0	150-200	3.0-6.0
Unacceptable	>120	<6.5; >8.5	N/S	>70	>150	N/S	N/S	N/S	>1.0	>200	>6.0
VAAL UPSTREAM	60	8.3	52	17	53	9.1	0	97	0.33	48	0.05
VAAL DOWNSTREAM	60	7.6	52	17	49	8.6	0	87	0.21	38	<0.1
SiteName	NO3(N)	PO4	SO4	Al	Fe	Mn	NH4(N)	TDS	B	Si	Cd
SWQG	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Acceptable	<3.0	<0.4	<300	<0.3	<0.5	<0.5	<1.5	N/S	N/S	N/S	N/S
Tolerable	3.0-6.0	0.4-0.6	300-500	0.3-0.5	0.5-1.0	0.5-1.0	1.5-5.0	N/S	N/S	N/S	N/S
Unacceptable	>6.0	>0.6	>500	>0.5	>1.0	>1.0	>5.0	N/S	N/S	N/S	N/S
VAAL UPSTREAM	2.71	0.21	130	0.109	0.082	<0.020	0.55	419	0.075	0.84	<0.003
VAAL DOWNSTREAM	1.58	<1	146	0.045	0.041	<0.020	0.57	402	0.085	0.46	<0.003
SiteName	Co	Cr	Cu	Pb	Turb	COD	Susp. Solids	Phenol	DOC	TOC	
SWQG	mg/L	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/lO2	mg/L	
Acceptable	N/S	N/S	N/S	N/S	N/S	N/S	<30	N/S	N/S	N/S	
Tolerable	N/S	N/S	N/S	N/S	N/S	N/S	30-55	N/S	N/S	N/S	
Unacceptable	N/S	N/S	N/S	N/S	N/S	N/S	>55	N/S	N/S	N/S	
VAAL UPSTREAM	<0.020	<0.038	0.016	<0.0001	25	55	141	<0.010	7	7	
VAAL DOWNSTREAM	<0.020	<0.037	0.017	0.000	5	42	13	<0.010	8	8	

SWQG - Leeuspruit/Taaiboschspruit prescribed surface w ater quality guidelines
N/S - Not specified

(Source: IGS, 2018)

Table 11-26: The Vaal River Barrage bacteriological analysis results

SiteName	Faecal Coliforms	E.Coli
SWQG	cfu/100ml	cfu/100ml
Acceptable	<126	N/S
Tolerable	126-1000	N/S
Unacceptable	>1000	N/S
VAAL UPSTREAM	326	135
VAAL DOWNSTREAM	82	2
SWQG - Leeuspruit/Taaiboschspruit prescribed surface water quality guidelines N/S - Not specified		

(Source: IGS, 2018)

11.8.3 Stream Flow Description

11.8.3.1 Calculated Peak Flows for Diversion and Berm Designs

Jones & Wagner calculated various flow peaks (from 1:2-year event up to 1:100-year event) for the design of the flood protection berms and diversion canals. The design criteria and flows used will ensure that (J&W, 2018):

- Downstream yield increase, or reduction will have a variance of less than 1%; and
- Change in peak flow rate will be less than 5%.

With the above design criteria, the proposed infrastructure will have almost no effect on the water volumes reporting downstream to the remaining Leeuspruit/Rietspruit sections as well as the Vaal River. However, flow velocities will increase and the floodlines will change from the current natural floodlines.

The following peak flows and expected velocity changes apply to the various sections (Table 11-27).

Table 11-27: Peak flow and average velocities of design

Section	Peak runoff (1:100) (m^3/s)	Average velocity (m/s)		
		Pre-construction	Post-construction	% increase
Leeuspruit Section 2	129	0.61	0.81	33%
Leeuspruit Section 3	239	0.89	3.52	296%
Leeuspruit Section 4	345	0.92	4.05	340%
Rietspruit Section 1	37	0.61	0.87	43%

(Source: J&W, 2018)

From Table 11-27 the biggest impact on the downstream surface water environment will not be the volumes reporting to the downstream catchments but the velocity at which they will occur. Due to the change in velocity and diversion of the water from its natural pathways this will also affect the floodlines.

11.8.3.2 Dry Weather Flow

11.8.3.2.1 Rietspruit

The Rietspruit has low flows of zero. It is non-perennial with stream flows during the wet season only. Flows during the dry season will only occur under abnormal winter rains and or discharge from dams or facilities upstream. It was dry during the fieldwork which was undertaken in the dry season.

11.8.3.2.2 Leeuspruit

The Leeuspruit is a perennial stream with water flow in the dry season as was observed during the site visit, which was undertaken in the dry season. This is mainly due to the various settlements, mining activities and dams upstream that contribute to flow in the dry season.

As per the groundwater study done for the Sigma Defunct Colliery, areas with a potential for pillar failure which can result in subsidence are potential decant points. Decant has been predicted in groundwater models in subsidence areas with an elevation of 1 424mamsl near the Leeuspruit. Should subsidence not occur, the decant elevation at the Leeuspruit is 1 426mamsl. Decant can also be a potential contributor to flow in the Leeuspruit.

11.9 Soils, Land Use and Land Capability

11.9.1 Land Type and Soils

The land type gathered suggested that the project area was dominated by land types Bb23 and Dc7 as described in Table 11-28. Figure 11-6 and Figure 11-7 indicates the types of soils found within the project site.

Table 11-28: Dominant land type and soils

Land Type	Description
Bb23	Unit Bb (dystrophic and/or mesotrophic, red soils not widespread) accommodate land where valley bottom is occupied by Rensburg and Arcadia soil forms.
Dc7	Unit Dc accommodate land where duplex soils are dominant. Also, the land type is made up of soils that have one or more of the following diagnostic horizons: vertic, melanic and red structured.

11.9.1.1 Rensburg Form

The Rensburg soil form is characterised by dark brown/black Vertic topsoil over a G-horizon. Rensburg soil forms are high in clay and have a sticky texture. These soils develop surface cracks and crusts in the dry state due to swelling pressures caused by water uptake. The G horizon is permanently wet, has still retained some clay and iron oxides or mottling and has a grey or gleyic colour pattern. Vertic soils are difficult to work with for crop production due to their shrink and swelling properties. However, success has been ascribed for the cotton plant as its rooting system can withstand shrinking and swelling movement in the soil.

11.9.1.2 Avalon Form

The Avalon Soil form consists of Orthic topsoil, 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. Mottling in the samples found within the project site was yellow-brown in colour and occupied at least 10% of the horizon. Avalon soils are highly suitable for crop production, particularly for growing maize. Fey *et al*. (2010) explains that this is due to the freely draining nature of the soil and soft plinthic B horizon which traps water and makes it available for root uptake.

Figure 11-6: Vertic soils found at Rietspruit (Section 1) and Leeuspruit (2, 3 and 4)

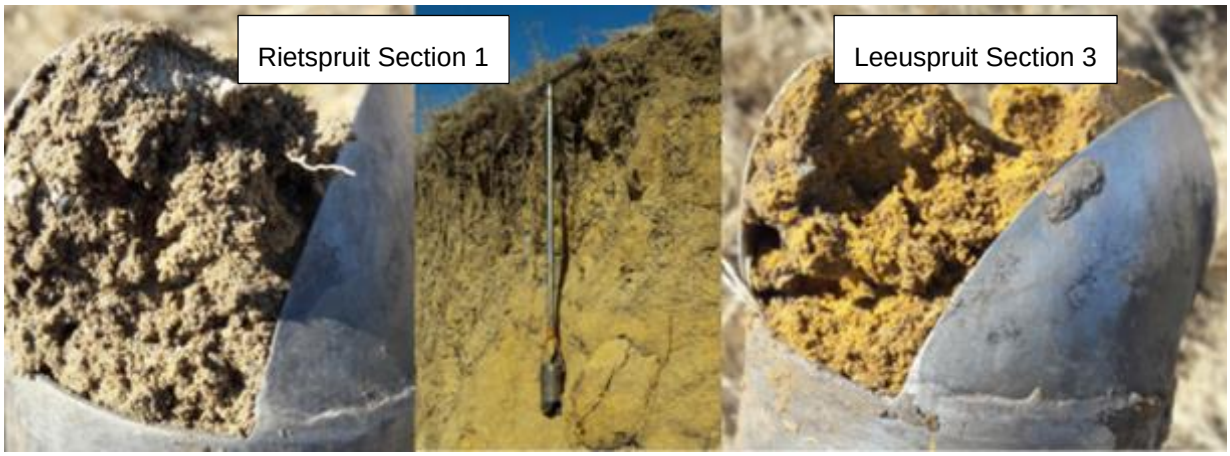

Figure 11-7: Yellow brown soils at Rietspruit (Section 1) and Leeuspruit (Section 3)

11.9.2 Land Capability

The approach used for the land capability assessment is used in agriculture and is recommended by Schoeman *et al* (2000) who defined land capability in terms of the combined effects of soil, terrain and climatic features. The defined land capability shows the most intensive long-term use of land for rain-fed agriculture and at the same time indicates the permanent limitations associated with different land use classes. The classification system is made up of land capability classes and land capability groups.

Land capability was determined by assessing a combination of soil, terrain and climate features. The dominant land capabilities based on the soils, texture and fertility status found at the project area was grazing (yellow brown soils) and wetland (black and greyish soils) (Table 11-29). Grazing land capability has severe limitations that restrict the choice of plants, require careful management or both. It may be used for cultivated areas, but more careful management is required and conservation practices are more difficult to apply and maintain. Wetland land capability has soils that are deeper; they have high clay content and shrink/swell properties, making them difficult to manage from an agricultural perspective. Limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops.

Table 11-29: Land capability classification

Land Type	Land Capability Class	Agricultural Potential
Bb23	Grazing	*Low to moderate
Dc7	Wetland	*Low

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

11.9.3 Soil Chemical and Physical Characteristics

A total of 16 soil samples were analysed for the chemical and physical properties. The objective of this section of the study is to characterise the soil's physico-chemical properties which included:

- Chemical properties (pH, cations & phosphorus); and
- Soil texture (Clay, Silt and Sand).

11.9.3.1 Soil pH

The soil pH is determined in the supernatant liquid of an aqueous suspension of soil after having allowed the sand fraction to settle out of suspension. Soil pH influences plant growth in the following manner:

- The direct effect of the hydrogen ion concentration on nutrient uptake;
- The mobilisation of toxic ions such as aluminium which restrict plant growth; and
- Indirect impacts that include the effect on trace nutrient availability.

The pH was measured to determine the oxidation potential of the soils. The soil pH ranged from 4.5 to 6.5 as presented in Table 11-30. These soils are acidic to slightly acidic (Table 11-31). The soil pH below 7 may be due to the acidic nature of the parent material from which the soils were derived and leaching of the nutrients. Lime is required to counteract acidity and to increase plant growth performance, should agricultural activities have taken place.

11.9.3.2 Exchangeable Cations

The levels of the basic cations Ca, Mg, K and Na are determined in soil samples for agronomic purposes through extraction with an ammonium acetate solution. In general, the amounts of exchangeable cations normally follow the same trend as outlined for soil pH and texture. For most soils, cations follow the typical trend Ca>Mg>K>Na.

Calcium, potassium and magnesium levels in the soil were generally high (Table 11-30) and adequate for crop production and these nutrients are not limiting any production on the site or considered to be toxic. Thus, there is no need to add calcium, potassium and magnesium in a fertiliser form as they might suppress levels of potassium during nutrient uptake by plants, should agricultural activities take place. The sodium levels ranged from 50 to 1500mg/kg and soils with sodium levels below 200mg/kg are considered not to be sodic (Sample 168, 203, 229 subsoils and 236 topsoil) (Table 11-30). These sodium levels are acceptable and are not of concern on the site. Soil dispersion is unlikely to occur and cause dense structure and drainage problems.

However, sample 165, 182, 224, 229 topsoil's, 236 subsoil and 246 had higher sodium levels when compared with soil fertility guidelines and therefore classified as strongly sodic due to higher levels of sodium. Soil dispersion is likely to occur and cause dense structure and drainage problems (de Villiers *et al*., 2003).

The clayey (black) soils are considerably better endowed with base cations, organic carbon, clay, and cation exchange capacity. The low available phosphorus (P) status of the clayey soils reflects a probable history of no cropping. Because of the high nutrient status and well buffered pH, soils with a vertic horizon are potentially very suitable for rehabilitation work. Although the black clay is potentially difficult to work because of unfavourable consistence, it has the advantage of a self-mulching habit meaning that clods will "weather" to a fine crumb structure due to shrinking and swelling with changes in water content. Also, the shrink-swell behaviour could potentially have a favourable effect in counteracting mechanical compaction caused by heavy machinery employed for rehabilitation. Vertic soils can be used successfully for crop and pasture production if managed judiciously (Fey *et al*, 2010).

11.9.3.3 Phosphorus

The Bray 1 extraction and analysis procedure for phosphorus is preferred for soils with pH levels below 7. The P levels encountered in the samples from the site were all very low according to the guidelines in Table 11-31, with most values being 1mg/kg and the maximum 8mg/kg (Table 11-30). Phosphorus will be a limiting factor in terms ecosystem function and rehabilitation if the soil was going to be used for agricultural purposes and at least 15mg/kg would be required. Phosphorus fertilisation would have been required to establish good crop stand and growth, should agricultural activities have taken place.

11.9.3.4 Soil Texture

The particle size distribution of the soil sampled in the areas was classed into the percentages of sand, silt and clay present. The textural classes were obtained from plotting the three fractions on a textural triangle (Figure 11-8). The soils can be described as clay, sandy clay loam, loam, clay loam and loamy sand. Clayey soils have a slow infiltration rate, but a good water retention capacity and these soils are more fertile than sandy soils due to high plant nutrient retention.

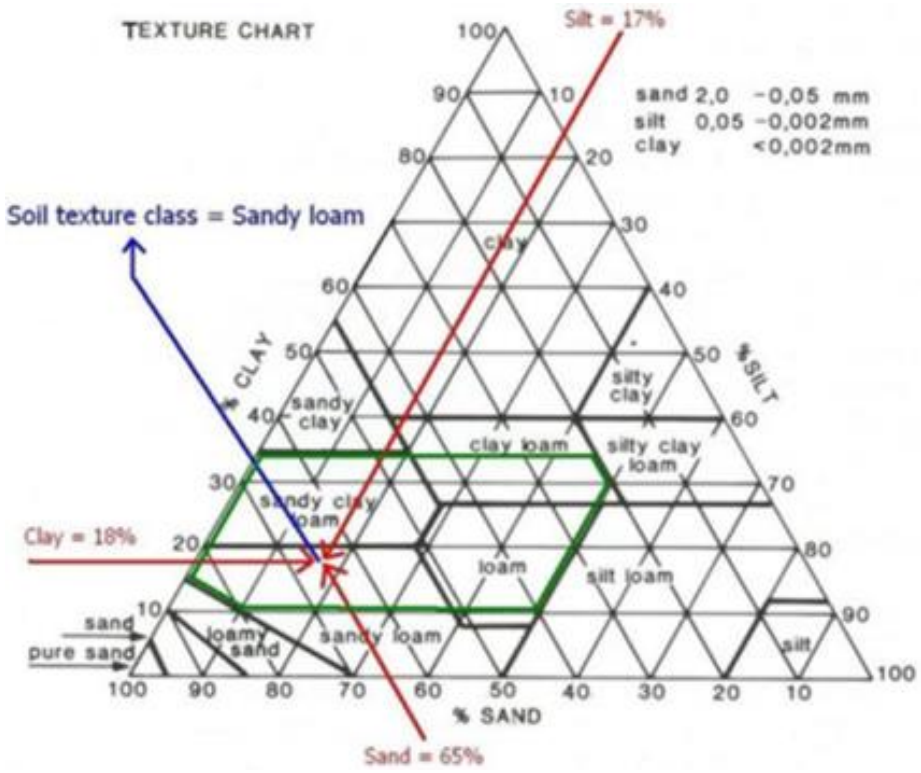

Figure 11-8: Soil textural triangle

(Source: SASA, 1999)

Table 11-30: Soil physico-chemical results

Sample ID Top (0–0.3m) & Sub (0.3–0.8m)	pH(KCl)	P(Bray1)	Na	K	Ca	Mg	Clay	Sand	Silt	Texture
		mg/kg					%			
165 Topsoil	5.31	1	303	139	1437	996	22	30	48	Loam
165 Subsoil	6.21	1	1446	98	1416	1512	34	24	42	Clay loam
168 Topsoil	5.01	3	178	187	671	480	14	37	50	Loam
168 Subsoil	6.12	1	182	132	1818	1115	34	27	39	Loam
182 Topsoil	5.33	2	360	203	4356	1480	38	38	24	Clay loam
182 Topsoil	5.82	1	576	176	4587	1333	46	33	21	Clay
203 Topsoil	6.25	3	50	140	2498	531	14	37	49	Loam
203 Topsoil	6.47	1	139	163	2959	1662	26	30	44	Loam
224 Topsoil	5.82	1	500	165	3713	1487	42	44	14	Clay
224 Subsoil	4.85	5	510	341	3829	2112	46	25	29	Clay
229 Topsoil	5.53	2	697	222	3130	2029	44	30	26	Clay
229 Subsoil	4.77	3	161	133	1833	827	24	57	19	Sandy clay loam

Sample ID Top (0–0.3m) & Sub (0.3–0.8m)	pH(KCl)	P(Bray1)	Na	K	Ca	Mg	Clay	Sand	Silt	Texture
		mg/kg					%			
236 Topsoil	4.97	8	169	163	1024	363	12	81	7	Loamy sand
236 Subsoil	6.30	1	1413	309	860	935	32	59	9	Sandy clay loam
246 Topsoil	5.90	2	304	265	3312	2762	42	39	19	Clay
246 Topsoil	6.46	1	789	204	3361	3839	46	38	16	Clay

Table 11-31: Soil fertility guidelines

Guidelines (mg per kg)					
Macro Nutrient			**Low**	**High**	
Phosphorus (P)			<5	>35	
Potassium (K)			<40	>250	
Sodium (Na)			<50	>200	
Calcium (Ca)			<200	>3000	
Magnesium (Mg)			<50	>300	
pH (KCl)					
Very Acid	**Acid**	**Slightly Acid**	**Neutral**	**Slightly Alkaline**	**Alkaline**
<4	4.1-5.9	6-6.7	6.8-7.2	7.3-8	>8

(Source: Fertiliser Association of South Africa, 2003)

11.10 Heritage

Anthropogenic activities have largely disturbed the site-specific project area through time. These include the establishment of historic farmsteads, development of Sasolburg Town, and operation of the Sigma Colliery, of which the Sigma Defunct Colliery forms a component. The subsequent cultural landscape baseline description must be read within this context.

The project site is underlain by the *Vryheid Formation* comprising lithologies of shale, sandstone and coal. The uppermost layers associated with the formation generally occur between 15 and 45m below the surface. Although coal was formed from thick accumulations of plants in a swampy environment during the Permian, the coal itself is of no palaeontological interest because the plant matter has been compressed and altered by heat to such an extent that no material is distinguishable. In some settings fossil leaf impressions are preserved in the carbonaceous shales between the coal seams but these tend to be rare and very difficult to find (Bamford 2018). This notwithstanding, the importance of the *Vryheid*

Formation is well established, and has been prescribed with a high palaeontological sensitivity (refer to Bamford, 2014, 2016, 2018).

While Digby Wells acknowledges the importance of the *Vryheid Formation*, the sparse distribution of *Glossopteris* flora and the nature of the Project suggest the potential for impacts to any potential fossil heritage is negligible. Furthermore, the review of relevant data sources did not yield any records for palaeontological resources within the project site.

The site records demonstrate the cultural landscape primarily comprises resources attributed to the historic built environment (*46.9% of the identified resources*) and burial grounds and graves (*25% of the identified resources*). Archaeological resources affiliated with Middle Stone Age (MSA), Later Stone Age (LSA) and Late Farming Community (LFC) periods are minimally represented in the records (*18.7% of the identified resources*). Figure 11-9 presents a summary of the heritage resource types identified within the greater project area.

The remainder of this chapter will present an abbreviated description of the cultural landscape as relevant to the known heritage resources primarily sourced from Du Piesanie & Nel (2014[2]), the outcomes of the pre-disturbance survey, the results of historical layering, and the data sources used in the development of this document.

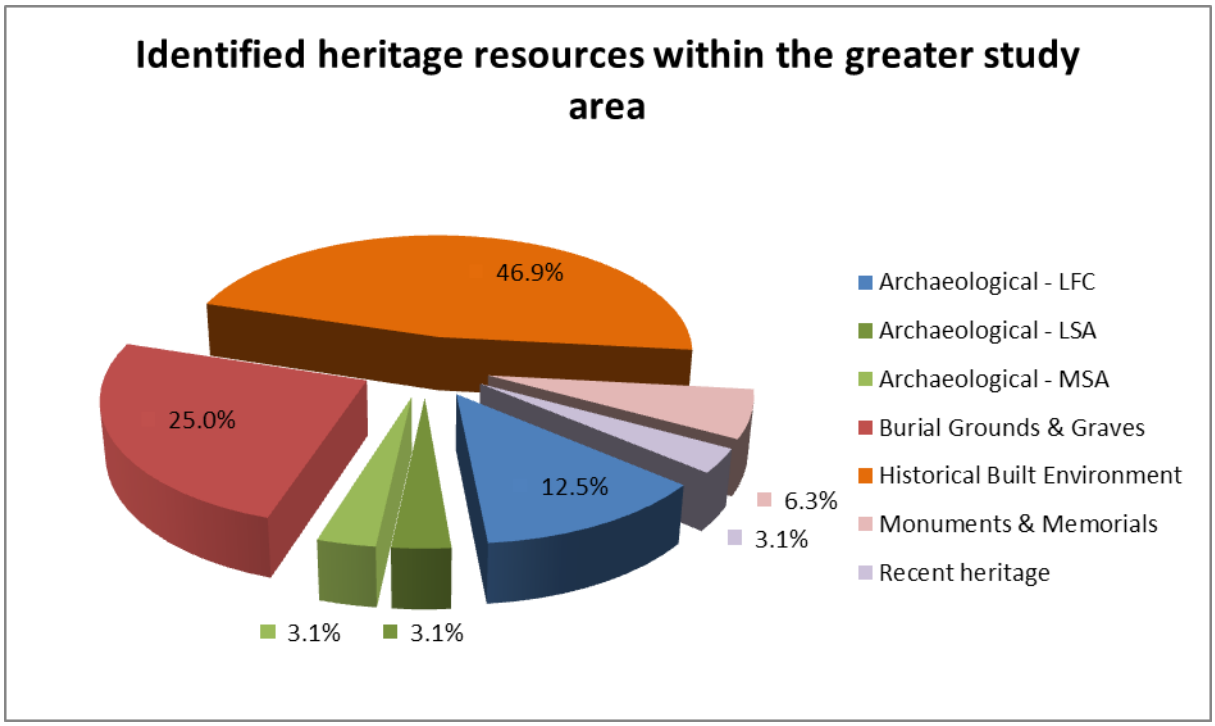

Figure 11-9: Heritage Resources Identified within the Greater Project Area

[2] Case ID 5035. Available at: http://www.sahra.org.za/sahris/cases/sasol-mining-sigma-colliery-ash-backfilling-project

The Stone Age is the earliest archaeological period and is divided into three phases:

- The Early Stone Age (ESA), from 2 million years ago (mya) to approximately 200 thousand years ago (kya);
- The MSA, between 250 kya to 20 kya[3]; and
- The LSA, between 20 kya to 500 Common Era (CE[4]) (Esterhuysen & Smith 2007).

No material associated with the ESA was identified within the greater research area and is therefore not considered further. The MSA is characterised by the presence of blades and points, which are created from good-quality raw materials. In some instances, MSA deposits produce bone tools, shell beads, pendants and evidence of ochre use. The LSA is characterised by microlithic technology. Microlithic tools are produced from very fine-grained material, such as chert or hornfels, and are often used as composite tools. Composite tools comprise of microliths which have been hafted to wooden implements. Rock art is often associated with the LSA (Deacon & Deacon 1999). No records of rock art have been identified within the project site.

The Stone Age within the regional project area primarily comprises representation of MSA and LSA low-density surface scatters (Van Schalkwyk *et al* 1996; du Piesanie & Nel 2014; Higgitt & du Piesanie 2015).

The Farming Community period follows the LSA. This period is characterised by the arrival of Bantu-speaking agro-pastoralists in southern Africa. These peoples lived in settled communities and cultivated crops and herded livestock (Huffman 2007). The Farming Community period is divided into two phases:

- Early Farming Community (EFC) which dates between 500 and 1400 CE; and
- Late Farming Community (LFC) which dates between 1100 and 1800 CE (Esterhuysen & Smith 2007).

No representations of the EFC were recorded within the regional project area. LFC settlements are identified through stonewalling or secondary tangible surface indicators such as ceramics (Huffman 2007). Stonewalling is the most visible indicator of LFC settlements and can attest to the complex processes of development and decline over several years (see for example Delius *et al* 2014). Different categories of stonewalling have been described through differences in the construction technique, coursing, height, shape and

[3] It should be noted that the generally accepted timeframes for the various archaeological periods do include some overlap. These periods of overlap should be seen as a transition phase, as the material culture represents more of one phase or the other. Additionally, these transition periods represent the innovation and/or uptake of different material culture by different communities in different places and at different rates. The timeframes presented here do not represent definite categories but should be viewed as a modern construct used for ease of comparison and reference within the archaeological past.

[4] Common Era (CE) refers to the same period as Anno Domini ("In the year of our Lord", referred to as AD): i.e. the time after the accepted year of the birth of Jesus Christ and which forms the basis of the Julian and Gregorian calendars. Years before this time are referred to as 'Before Christ' (BC) or, here, BCE (Before Common Era).

internal divisions. In this region, the most common stonewalling type is 'Type V' as described by Maggs (1976). Van Schalkwyk *et al* (1996) and Pelser and Van Vollenhoven (2008) recorded stonewalling within the broader project area. These resources account for 12.5% of the heritage resources identified in the region.

Historically, George William Stow had discovered coal in this area by 1879 (Pistorius 2008). This discovery resulted in a boom of mining, infrastructure and other development as populations flocked to the area (du Piesanie & Nel 2014). In particular, the road and rail networks expanded dramatically in the early 1900s, as mines were established in the area. Very little infrastructure had been developed in the project site at this stage. The closest areas of development at this time were Viljoendrift and Wolwenhoek. Viljoendrift included the Cornelia Coal Mine, court house, post office and railway station. Wolwenhoek included a railway station, post office and school.

The historical built environment and burial grounds and graves account for the majority of the heritage resources within the region (46.9% and 25 % respectively). Burial grounds and graves range from including ten or fewer graves to over one hundred graves (Van Schalkwyk *et al.* 1996; Dreyer 2005; Mngomezule 2016; Beater 2017; Marais-Botes 2017). The historical built environment is represented by structural remains, structural complexes (including *werwe*), industrial structures, functional structures and buildings (Dreyer 2005; Birkholtz 2008; Pelser & Van Vollenhoven 2008; Van Ryneveld 2008; du Piesanie & Nel 2014; Higgit & du Piesanie 2015; Beater 2017; Marais-Botes 2017; Hardwick & Du Piesanie 2018).

11.11 Social

11.11.1 Regional Administrative Overview

The project area falls under the jurisdiction of the Metsimaholo Local Municipality (MLM), which is situated in the northern part of the Fezile Dabi District Municipality (FDDM). The FDDM is one of five district municipalities in the Free State Province and its towns are Sasolburg, Deneysville, Oranjeville and Viljoensdrift. Fezile Dabi covers an area of about 21 300 km^2 and has a population of approximately 500 000 people (just less than a fifth of the province's population), resident in 38 different settlements, four of which are farming settlements, 15 formal urban towns, 17 urban townships and two informal urban settlements.

11.11.2 Regional and Local Socio-Economic Overview

The MLM has a total population of just more than 149 000 individuals divided into almost 45 800 households. About 62% of the local municipality's population are resident in the informal settlement of Zamdela. An additional 14% of the MLM's population resides in Sasolburg and 7% in Ward 14 (the ward in which the proposed Sasol Sigma surface mitigation measure project will be located).

11.11.3 Demographic Characteristics

The age distribution in the site-specific and local project site is largely similar: about a tenth of the population is aged five years or younger, roughly a fifth of school-going age (between six and 18 years), about two-thirds potentially economically active (aged 19 to 65 years), and between 3% and 6% are pensioners (aged 66 to 80 years). A very small percentage of the population (1% or less) is older than 80 years. The gender distribution is equal in all the areas under consideration, with the exception of Zamdela where 51% of the residents are male.

Afrikaans and Sesotho are the dominant languages in both the MLM and the project site under consideration: Afrikaans is spoken by 73% of residents in Ward 14 and 58% in Sasolburg. Sesotho is the first language of about 70% of the population in Zamdela, as well as about a fifth of Sasolburg's population. English is the first language of about 7% of residents in Sasolburg, 11% in Ward 14, and only 1% in Zamdela.

11.11.4 Education

Individuals resident in Ward 14 and Sasolburg are better educated than those in Zamdela, where only 36% of individuals have either completed their secondary or tertiary education (compared to nearly three-quarters in both Ward 14 and Sasolburg). The proportion of the population with either no schooling (5%), or only some primary schooling (14%) is also much higher in Zamdela than the other areas. However, indications are that this discrepancy is being addressed among the younger generation, as 94% of individuals in Zamdela aged six to 18 years were attending school in 2011, compared to 96% in both Sasolburg and Ward 14.

11.11.5 Employment and Income

At a local municipal level, 23% of the population between the ages of 15 and 65 is either unemployed or classified as "discouraged work-seekers", while a further 34% are not economically active. This leaves only 43% of the population actively contributing to the MLM's economy. These statistics mimic that of Zamdela, where only 40% of residents between 15 and 65 years are employed, 28% either unemployed or "discouraged work-seekers", and 31% not economically active. In Ward 14 and Sasolburg, 68% and 58%, respectively, are employed. Of those who are employed, almost 90% in Ward 14 and Sasolburg, and 76% in Zamdela are employed in the formal sector, likely due to Sasol Mining being a major employer in the area.

In the local project site, the average household income is lowest in Zamdela, where approximately 14% of households have no income, and a further 30% a monthly income of R1 600 or less. An additional fifth of the population have a monthly income of R3 180 or less.

The income levels of Ward 14 are comparable to that of Sasolburg, where the largest proportion of households receives a monthly income of between R12 821 and R25 630. Despite the higher average household income, these two areas are also confronted with poverty, evidenced by almost 10% of its households not receiving any cash income. Of

individuals between the ages of 19 and 64 years, 22% in Ward 14 have no income, 26% in Sasolburg and 47% in Zamdela.

11.11.6 Access to Infrastructure and Services

Sasolburg is the best serviced of the three areas under consideration; almost all the households (99% or more) resident in Sasolburg live in formal dwellings, and have access to electricity, a flush toilet, a refuse removal service and piped-water from a water scheme operated by the municipality or another water services provider. Service provision in Ward 14 is comparable to that of Sasolburg, with the exception of access to piped water and a refuse removal service. As the ward consists of mostly agricultural land, however, this is not necessarily a reflection of poor service provision; it is likely that households in this ward make use of borehole water.

As a lower-income residential area, it is not surprising that service provision is poorer in Zamdela than Sasolburg, although it is by no means unacceptable. More than 95% of household resident in Zamdela have access to electricity, refuse removal and piped water. However, there are more informal settlements in Zamdela (approximately 14% of dwellings), and about one in five households do not have access to a flush toilet.

With regards to housing, the MLM is experiencing a backlog of about 40 000 houses, which is increasing at the rate of about 3 000 houses annually (MLM, 2012). In Zamdela, there is an estimated need for about 15 000 houses. Both Sasolburg and Zamdela are currently constrained for future growth by the undermined areas and by future mining prospecting opportunities located in and around the town. In response to the housing provision backlog, many people often are drawn to settle illegally on private or public property and provide themselves with inadequate, informal and illegal housing in informal or illegal settlements (MLM, 2012).

11.12 Description of the current land uses

The present land use was identified using satellite images and visual observations during the site visit. The main land uses in the area are underground mining and veld for grazing (Figure 11-11 and Plan 17). The sampling points (166, 168, 182, 203, 224, 229, 236 and 246) were covered by grass and no current agricultural activities were taking place at the locations, however agricultural activities are taking place at other locations within the Sigma Defunct Colliery area.

Two transformed land uses were recorded on site (Figure 11-10) which included:

- Agricultural Fields; and
  - This transformed land unit mainly consists of old fields, cultivated areas and grazing areas which are collectively referred to as agricultural areas. A major factor contributing to the grassland habitat destruction in this area is the transformation of natural lands into agricultural fields. This vegetation unit is found throughout the area.

- Infrastructure and Mining.
  - The unit was made up of residential areas, Sasol owned infrastructure, a commercial feedlot, a tannery, farmhouses, a sand mining operation and property lent to privately owned businesses. This has resulted in habitat destruction and fragmentation.

The landscape is dominated by maize, wheat and livestock farming in the central, western and southern areas; urban built-up areas to the east and mining activities to the north and east. The general topography of the landscape in which the surface mitigation measure project is located can be described as undulating and sloping towards the Vaal River. The Digital Elevation Model (DEM) and slope models indicated that mining activities have significantly altered the topography and surface water flow in the north and east. Two gradual valleys carrying the Leeuspruit and Rietspruit streams run parallel to each other in a northwestern direction towards the Vaal River. Elevation within these river valleys varies from around 1 430m at the valley bottoms to 1 490m at the valley tops. Slopes are mostly flat across the landscape except for isolated pockets of steeper slopes along the banks of the Vaal River and where mining activities have taken place.

Years of underground Mining at the Sigma Defunct Colliery has resulted in large subsided areas with the potential for further subsidence occurring in the future.

Figure 11-10: Transformed lands located within the project area

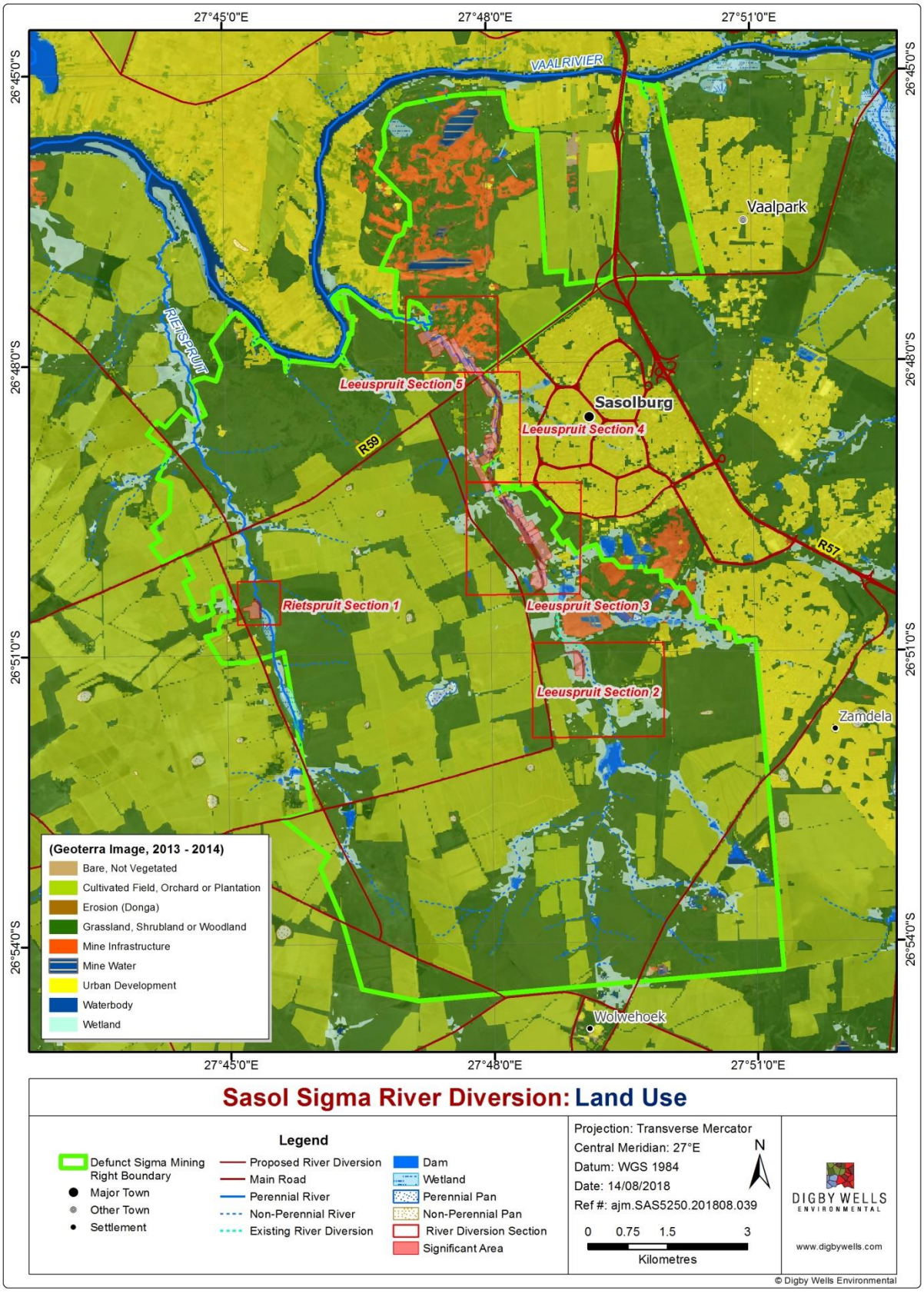

Figure 11-11: Land use at Sasol Defunct Colliery

11.13 Description of specific environmental features and infrastructure on the site

11.13.1 Infrastructure and Facilities

The following infrastructure is currently located onsite:

- Farmsteads with associated infrastructure;
- Dams;
- Bridges and culverts;
- Powerlines to supply power to the various farmers and industries being operated within the mining lease area;
- Regional and secondary roads;
- Historical mining voids, mine dumps and current mining operations (3 Shaft); and
- Rehabilitated areas which include shafts and open cast mining areas.

11.13.2 Water Resources

The proposed project area is located within the WMA of the Upper Vaal River system. The proposed area is located within the secondary drainage C2 in quaternary catchment C22K. MAR after evaporation and recharge is 3%. The MAP is 644mm with a MAE of 1 625mm. The natural water balance is thus a negative one with evaporation being much higher than rainfall. The area is characterised by warm summers and cold winters, rainfall occurs mainly during the summer months (December to February).

The current water uses are linked to land uses. Identified activities during the fieldwork were:

- Agricultural use for livestock;
- Wildlife;
- Industry;
- Domestic water uses at settlements; and
- Sand mining activities in the Leeuspruit catchment.

11.13.3 Wetlands

There are 413.9 hectares (ha) of wetlands within the project area. These wetlands have been categorised PES values ranging from D to E and EIS values ranging from C to D.

Approximately 51.5ha will be affected through the implementation of the surface mitigation measures at Sigma Defunct Colliery. Of this, 9.8ha is directly affected, and 41.7ha will be indirectly affected, where direct loss constitutes the loss due to the infrastructure footprint and indirectly constitutes the drying out of the floodplain portions due to separation from the main channel because of the proposed construction of the flood protection berms and

canals. These surface mitigation measures will result in a decline in the PES and EIS of the wetland hydro-geomorphic (HGM) units.

11.13.4 Cultural Heritage

No outcrops of palaeontological material were identified in the field. Four burial grounds and one historical structure were identified during the pre-disturbance survey. Table 11-32 provides a description of these resources (refer to Figure 11-12 and Plan 16 in Appendix B).

Table 11-32: Summary of Identified Heritage Resources

Site ID	Type	Description	Distance from Development	Potential Impact
BGG-001	Burial Grounds and Graves	Three graves inside a fenced-off area in the garden of a farmhouse. The graves each have legible headstones.	250 m	None
BGG-002		Burial ground including fewer than 10 graves. Graves are marked with either an upright stone or a ring of small stones, or both. Burial ground is not demarcated.	790 m	
BGG-003		Burial ground including fewer than 10 graves. Graves are marked with an upright stone. Burial ground is not demarcated.	750 m	
BGG-004		Burial ground of more than 100 graves. Most graves have headstones, but not all are legible. Graveyard is overgrown and not demarcated.	670 m	
STE-001	Historic Built Environment	Foundations and ruins of a large square structure with internal divisions. Built of stone and some of the remaining portions of wall have been plastered.	240 m	

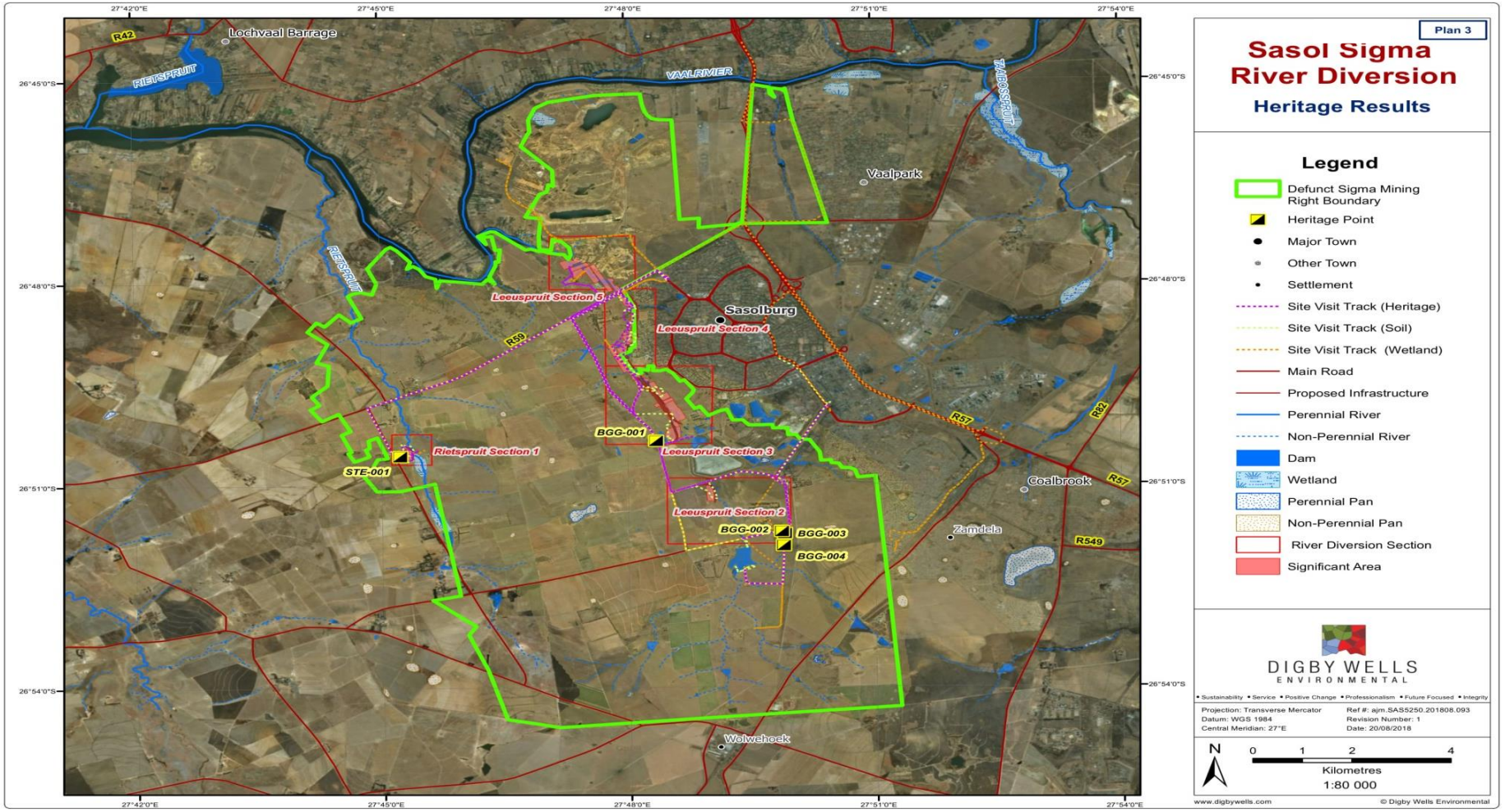

Figure 11-12: Result of the Heritage Pre-Disturbance Survey

11.14 Environmental and current land use map

Refer to the environmental and current land use map Plan 17 in Appendix B.

12 Impacts and risks identified including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts

The potential impacts and risks identified in this section are a result of both the environment in which the project activities take place, as well as the actual activities. The potential impacts and risks are discussed per aspect, per River Section and per each phase of the project i.e. the construction phase. It is also noted that although the impacts for the construction phase of the various sections may be different the operational phase is predicted to be relatively similar for each section therefore only one operational phase for each aspect has been assessed. No decommissioning phase will be assessed for this project as once the surface mitigation measures have been implemented these changes are proposed to be permanent.

The activities for the proposed river diversion project that will be assessed are listed in Table 12-1.

Table 12-1: Project Activities

Significant Risk Area	Phase	Project Activity
Leeuspruit Section 2- 5 and Rietspruit Section 1	General Construction Activities	▪ Contractor Camp / Laydown Area Establishment. ▪ Site clearing, including the removal of topsoil and vegetation. ▪ Excavation of soils and sediment from water course. ▪ Stockpiling of soil once excavated. ▪ Water Management (ensure flow of river is not significantly impacted). ▪ Construction activities within water courses and wetlands (Heavy vehicles and excavators). ▪ Temporary storage of hazardous products, including fuel. ▪ Storage of waste. ▪ Utilise existing roads to access the various river sections.
Leeuspruit Section 2	Construction Phase	▪ Construction of flood protection berm. ▪ Vegetation of flood protection berm.
Leeuspruit Section 3	Construction Phase	▪ Construction of flood protection berm. ▪ Vegetation of flood protection berm. ▪ Construction of formalised canal.

Significant Risk Area	Phase	Project Activity
Leeuspruit Section 4	Construction Phase	▪ Construction of flood protection berm. ▪ Vegetation of flood protection berm. ▪ Construction of formalised canal.
Leeuspruit Section 5	Construction Phase	▪ Ash backfilling has been assessed as a separate environmental authorisation project. Mitigation measures proposed from this project will be implemented in this section.
Rietspruit: Section 1	Construction Phase	▪ Construction of flood protection berm. ▪ Vegetation of flood protection berm.
Leeuspruit Section 2- 5 and Rietspruit Section 1	Operational Phase	▪ Revegetate area to ensure erosion does not occur ▪ Maintenance and monitoring activities. ▪ Removal of all machinery and equipment utilised during construction phase. ▪ Rehabilitate areas affected by laydown area and machinery. ▪ Removal of waste.

A list of unplanned events that may happen at the project site have been identified and the proposed mitigation plan are listed in Part B Table 10-2.

12.1 Construction, Operation and Decommissioning Phases

The potential impacts that may occur during the construction, operational and decommissioning phase are discussed below for each aspect.

12.1.1 Wetlands and Aquatics Impact Assessment

The potential impacts of the surface mitigation measures to the freshwater ecology are discussed in Table 12-2.

Table 12-2: Wetland and Aquatic Ecology Impact Assessment

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction Phase	Leeuspruit Section 2	Berm construction	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the wetlands and river reaches. A potential slight narrowing of the floodplain may take place as water is unlikely to flood over the berm area resulting in water contained within a smaller area and in turn, resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit. Approximately 3.5ha of floodplain are expected to be a potential loss, 1.3ha directly and 2.2ha indirectly, where the destruction of wetland for the berm footprint is considered a direct loss and the drying up of the floodplain portion that has been cut off from the main channel as indirect loss.	84	Moderate (negative)	44	Minor (negative)
Mitigation Measures							
▪ Sufficient drains need to be installed to facilitate seepage underneath berms.							

[5] Significance = Consequence x Probability;
- Consequence = Severity + Spatial Scale + Duration; and
- Probability = Likelihood of an impact occurring.

The explanation for how the significance for each impact was determined is provided in each specific specialist study

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Appendix I).							
Construction Phase	Leeuspruit Section 3	Construction of the canals	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a complete loss of wetland area as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Fragmentation of the system and loss of migration routes are also a risk. Approximately 15.2ha of floodplains (including a small portion of hillslope seep) are expected to be affected through construction of the berm and the canal, 4.8ha directly and 10.5ha indirectly, where the destruction of wetland for the berm and canal footprint is considered a direct loss and the drying up of the floodplain portion that has been cut off from the main channel as an indirect loss.	112	Major (negative)	112	Major (negative)
Construction Phase	Leeuspruit Section 3	Construction of the canals – instream ecology		84	Moderate (negative)	84	Moderate (negative)
Mitigation Measures							
▪ No mitigation measures proposed							
Construction Phase	Leeuspruit Section 3	Berm construction	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. The proposed activity is likely to result in the destruction of the portion of the wetlands (mostly floodplain and a small portion of hillslope	84	Moderate (negative)	44	Minor (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
			seep) where they are covered by the proposed berm, in turn, resulting in a direct loss of wetland. In addition, the bare soil could result in sedimentation and thereby alter water quality within the wetland.				
Mitigation Measures							
▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.							
Construction Phase	Leeuspruit Section 4	Construction of the canals – wetland ecology	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a complete loss of wetland area, as well as large impacts downstream such as erosion, sedimentation and altered water quality. The floodplain waters are to be directed into the canal and therefore the meanders that fall outside of the canal have the potential to be cut off from their supply and ultimately lost. A potential risk to the instream ecology exists in terms of loss of flow connectivity, loss of habitat provision and loss of natural migration routes for aquatic fauna.	112	Major (negative)	112	Major (negative)
Construction Phase	Leeuspruit Section 4	Construction of the canals – instream ecology		84	Moderate (negative)	84	Moderate (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
			Approximately 32ha of floodplain and hillslope seep are expected to be potentially affected through construction of the berm and the canal, 3.3ha directly and 28.7ha indirectly, where the destruction of wetland for the berm and canal footprint is considered a direct loss and the drying up of the floodplain portion that has been cut off from the main channel as an indirect loss.				
Mitigation Measures							
▪ No mitigation measures proposed.							
Construction Phase	Leeuspruit Section 4	Berm construction	The construction of flood protection berms at Leeuspruit Section 4 has the potential to result in an alteration in the seasonality and flow of the Leeuspruit. A narrowing of the floodplain may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water within a smaller area, resulting in an indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. The portion of the wetlands (mostly floodplain and a small portion of seep) that are covered by the berm will be destroyed, resulting in a direct loss of wetland. In addition, the bare soil could result in sedimentation and thereby alter water quality within the Leeuspruit.	84	Moderate (negative)	44	Minor (negative)
Mitigation Measures							
▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.							
Construction Phase	Rietspruit Section 1	Berm construction	The construction of flood protection berms at Rietspruit Section 2 has the potential to result in an alteration in the seasonality and flow of the wetlands and instream ecology. A narrowing of the floodplain and channelled valley bottom may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water, thus potentially resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. In addition, the bare soil of the berm could result in sedimentation and thereby alter water quality within the wetland. Approximately 0.8ha of floodplain and channelled valley bottom are expected to be potentially affected, 0.5ha directly and 0.3ha indirectly, where the potential destruction of wetland for the berm footprint is considered a direct loss and the drying up of the floodplain portion that has been cut off from the main channel as potential indirect loss.	90	Moderate (negative)	44	Minor (negative)
Mitigation Measures							
▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing.							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.							
Construction Phase	All Sections	Site access and disturbance	Activities associated with the construction of these river diversion measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems. Associated potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream. Among the impacts associated with the proposed construction phase are minor potential impacts to soil and water quality because of the ingress of hydrocarbons. Larger impacts include compaction of soils, potential loss of vegetation and the increased potential for erosion and sedimentation in the vicinity of any cleared areas and resulting in impacts further downstream. Removal of vegetation and disturbance of soils in the vicinity of the construction footprint is likely to give rise to an increased potential for encroachment by robust pioneer species and Alien Invasive Plants (AIPs), which are already prolific in the area, further altering the natural vegetation profiles of the freshwater resources encountered in the vicinity of the project footprint.	72	Minor (negative)	36	Minor (negative)
Construction Phase	All Sections	Instream freshwater biodiversity destruction	In terms of instream ecology, large potential impacts related to loss of flow connectivity, fragmentation of the system, loss of natural migration routes and the loss of natural habitat and substrates has the potential to limit the biodiversity of the instream ecology of this portion of the Leeuspruit.	112	Major (negative)	84	Moderate (negative)
Mitigation Measures							
▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms. ▪ Where the track has a slope of less than 2%, berms every 50m should be installed;							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Where the track slopes between 2% and 10%, berms every 25m should be installed; ▪ Where the track slopes between 10%-15%, berms every 20m should be installed; and ▪ Where the track has slope greater than 15%, berms every 10m should be installed. ▪ Limit the footprint area of the construction activities to what is essential to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ If it is unavoidable that any of the wetland or instream areas present (not withstanding those already accounted for in the proposed activities) will be affected, disturbance must be minimised and suitably rehabilitated. ▪ Ensure that no incision and canalisation of the wetland and instream features present takes place. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ Implement and maintain a suitable AIP control programme to prevent further encroachment because of disturbance to the surrounding terrestrial zones (see the Fauna and Flora Specialist Study for more information). ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon as a result of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. The No-go zone should be avoided. ▪ All vehicles must be regularly inspected for hydrocarbon leaks. ▪ Re-fueling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Wetlands should be monitored monthly during construction. ▪ The no-go area indicated in Plan 13 must be avoided by any construction activities or movement of vehicles in this area. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility. ▪ A wetland offset strategy should be developed to compensate for the loss of wetland and instream areas due to the canals and berms. Ideally, the PES and EIS of wetlands and instream areas within Sasol's mining lease area should be improved. ▪ All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel.							
Operational Phase	All Sections	Site access for maintenance and monitoring	The main activities during the operational phase that could result in impacts to the freshwater ecology of the area are associated with the monitoring and maintenance activities.	48	Minor (negative)	18	Negligible (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
		purposes	Associated potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems present. Further to this, the potential for ongoing contamination of the freshwater resources present are deemed likely based on the ingress of hydrocarbons associated with increased vehicular activity. Removal of indigenous vegetation is likely to give rise to an increased potential for encroachment by robust pioneer species and AIPs, further altering the natural vegetation profiles of the freshwater resources encountered in the vicinity of the project footprint. Hardened surfaces have the potential to result in sheet runoff and there is likely to be a loss in wetland service provision in terms of flood attenuation, sediment trapping and assimilation of toxicants and other pollutants. Storage of water, which is an important service, provided by wetlands in this area, will be compromised. Further alterations to the natural flow regimes will take place and is likely to result in the creation of preferential flow paths over time, which may give rise to erosion and sedimentation, thus affecting the instream ecology of this portion of the Leeuspruit and the downstream resources.				
Mitigation Measures							
▪ Berms ▪ Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section) thereby reducing the functionality and health of the wetlands. ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed. ▪ Berms should be monitored for erosion. Erosion must be remedied. If recurring erosion is taking place, alternatives should be explored. ▪ Canal ▪ Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years. ▪ Biomonitoring to be conducted by suitably qualified wetland and aquatic ecologists on a biannual basis for a minimum of three years. ▪ General ▪ Limit the footprint area of the operational activities to what is essential to minimise impacts as a result of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas).							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[5]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible. ▪ Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities. ▪ All erosion noted within the operational footprint as a result of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report). ▪ A suitable AIP control programme must be put in place to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones (see the Fauna and Flora Specialist Study for more information). ▪ All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel. ▪ No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads. ▪ All vehicles must be regularly inspected for hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Monitor all systems for erosion and incision. ▪ All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ If significant rehabilitation measures are required, mitigation measures of the construction phase must be implemented. ▪ Permit only essential personnel within the 100m zones of regulation for all freshwater features identified. ▪ Ongoing wetland rehabilitation is necessary during the operational phase as stipulated in the monitoring section (Section 8.1.1).							

12.1.2 Fauna and Flora Impact Assessment

The impacts of the surface mitigation measures to the fauna and flora are discussed in Table 12-3.

Table 12-3: Fauna and Flora Impact Assessment

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction Phase	Leeuspruit Section 2	Construction of flood protection berms require vegetation clearing	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. These impacts are however regarded to be low. It is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. Revegetation of areas upon completion of vegetation clearing will present the potential for establishment of grassland vegetation, if mitigation measures are strictly adhered to. The flood protection berm will typically comprise of suitable material (clayey sand, sandy clay) compacted in layers to the design level and reseeded (i.e. planting process using slurry of seed and mulch) to provide protection against erosion on the side-slopes of 1V:5H. The flood protection berm will extend up to the 1:100-year floodline on the upstream side to channel the 1:100-year flood away from the potential significant areas of pillar failure.	45	Minor (negative)	24	Negligible (negative)
Mitigation Measures							
▪ Limit clearing to areas that have been designated for the construction of the flood protection berms.							

[6] Significance = Consequence x Probability;
- Consequence = Severity + Spatial Scale + Duration; and
- Probability = Likelihood of an impact occurring.

The explanation for how the significance for each impact was determined is provided in each specific specialist study

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.							
Construction Phase	Leeuspruit Section 3 and 4	Construction of flood protection berms require vegetation clearing	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. The proposed flood protection berms in these sections of the proposed area however more extensive than those proposed in Section 2, thus the impact is expected to be higher and also influenced by the excavation of formalised canals that has been proposed in these sections.	50	Minor (negative)	40	Minor (negative)
Mitigation Measures							
▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. Refer to Section 10.3 for the Revegetation Plan in Appendix I. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.							
Construction Phase	Leeuspruit Section 3 and 4	Clearing and excavation for the construction of formalised canals	The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the excavation of the wetlands to construct the canals; this will result in the loss of wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland.	119	Major (negative)	119	Major (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Mitigation Measures							
▪ No mitigation measures proposed.							
Construction Phase	Leeuspruit Section 3 and 4	Clearing and excavation for the construction of formalised canals	The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. Although significant, the impact on secondary grassland is regarded to be lower in comparison to the impact on riparian/wetland vegetation unit, it is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small.	84	Moderate (negative)	77	Moderate (negative)
Mitigation Measures							
▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.							
Construction Phase	Rietspruit Section 1	Construction of flood protection berms require vegetation clearing	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. These impacts are however regarded to be low. It is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. Revegetation of areas upon completion of vegetation clearing will present the potential for establishment of grassland vegetation if mitigation measures are strictly adhered to.	45	Minor (negative)	24	Negligible (negative)
Mitigation Measures							
▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur)..							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.							
Construction Phase	All Sections	Site establishment and establishment of access and service roads	Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity. Potential impacts associated with this include the potential for pollution of important watercourses, wetlands or other waterbodies which may negatively impact on the fauna and flora on site. Other potential impacts include soil contamination due to fuel and chemical spills and, which may lead to vegetation disturbance and vegetation loss. During the construction phase, disturbance of native fauna due to noise or light pollution may also be expected. Other possible impacts during this phase of the project include fragmentation of habitats, road kills and contamination of adjoining habitats by dust.	65	Minor (negative)	35	Negligible (negative)
Mitigation Measures							
▪ Construction activities must be restricted to the project footprint. ▪ Designated construction areas must be clearly demarcated, and contractors must make use of existing access routes. ▪ Best practices noise control management measures must be applied to minimise noise during construction. ▪ Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction. ▪ Proper waste management must be implemented, and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ During site preparation, special care must be taken during the clearing of the work areas to minimise damage or disturbance of roosting and nesting sites. ▪ Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.							
Construction Phase	All Sections	Site establishment for camp laydown and construction	Alien plant species degrade the natural state of a habitat. Small areas of invader tree species were encountered throughout the project site. The secondary grassland unit was invaded by a number of woody and nonwoody species, whereas the riparian vegetation was mostly invaded by woody species, where the dominant tree species found	70	Minor (negative)	28	Negligible (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
		requires vegetation clearance	were *Eucalyptus* spp., *Populus* spp., *Acacia* spp., and *Pinus* spp. The clearing of vegetation and indirect loss of downstream habitat through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the project site. It is thus critical that newly cleared soils, especially in Section 3 and 4 of the Leeuspruit, will have to be re-vegetated and stabilised as soon as construction has been completed and there must be an on-going monitoring program to control and/or eradicate newly emerging invasive plant species.				
Mitigation Measures							
▪ Phased vegetation clearing must be implemented to minimise the extent of bare areas. ▪ An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species (Refer to Section 10.2 Appendix I rehabilitation specialist study). ▪ If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place. ▪ Indigenous vegetation must be utilised during the revegetation of disturbed areas. Refer to Section 10.3 for the Revegetation Plan in Appendix I.							
Operational Phase	All Sections	Destruction and disturbance through site access associated with routine maintenance	The stream diversion system is designed as a gravity flow system with no operational inputs required. Thus, the stream diversion system during the operational phase will not lead to direct impacts to fauna. The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present.	55	Minor (negative)	32	Negligible (negative)
Mitigation Measures							
▪ An Alien Plant Management Strategy must be implemented during the operational phase whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. ▪ Monitoring must preferably take place between November and March. ▪ All alien plant species must be identified, demarcated, and removed. ▪ Where possible, make use of existing roads rather than creating new access routes. ▪ The area must be kept clear of all invader plants as per the National Environmental Management: Biodiversity 2004 (Act No. 10 of 2004) (NEMBA). ▪ Rehabilitation measures must be employed until such a time as indigenous species is established.							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[6]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Suitable erosion control measures should be implemented.							

12.1.3 Surface Water

The impacts of the surface mitigation measures to the surface water are discussed in Table 12-4.

Table 12-4: Surface Water Impact Assessment

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction Phase	Leeuspruit Section 2	Berm construction	The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit.	63	Minor (negative)	30	Negligible (negative)
Construction Phase	Leeuspruit Section 2	Alteration in the seasonality and flow of the river reaches (floodlines)	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the river reaches (floodlines). The floodplain will potentially be pushed over to the east and encroach onto the area closer to the ash dump to the north east of the section. This can potentially increase capturing of contaminants from runoff from the ash dam.	91	Moderate (negative)	28	Negligible (negative)
Mitigation Measures							
▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint.							

▪ [7] Significance = Consequence x Probability;
▪ Consequence = Severity + Spatial Scale + Duration; and
▪ Probability = Likelihood of an impact occurring.

The explanation for how the significance for each impact was determined is provided in each specific specialist study

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.							
Construction Phase	Leeuspruit Section 3	Berm construction	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	63	Minor (negative)	30	Negligible (negative)
Construction Phase	Leeuspruit Section 3	Alteration in the seasonality and flow of the river reaches (floodlines)	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	91	Moderate (negative)	28	Negligible (negative)
Construction Phase	Leeuspruit Section 3	Canal Construction	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk. Approximately 15.2ha of floodplains (including a small portion of hillslope seep) are expected to be affected through construction of the berm and the canal.	105	Major (negative)	50	Minor (negative)
Mitigation Measures							
▪ Berms							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.							
Construction Phase	Leeuspruit Section 4	Berm construction	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	63	Minor (negative)	30	Negligible (negative)
Construction Phase	Leeuspruit Section 4	Alteration in the seasonality and flow of the river reaches (floodlines)	The construction of flood protection berms at Leeuspruit Section 4 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	91	Moderate (negative)	28	Negligible (negative)
Construction Phase	Leeuspruit Section 4	Canal Construction	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the	112	Major (negative)	50	Minor (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
			system is also a risk.				
Mitigation Measures							
▪ Berms: ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.							
Construction Phase	Leeuspruit Section 5	N/A	The backfilling of various polygons is planned for the Leeuspruit Section 5; no surface mitigation measures are planned. The backfilling has been addressed in a separate authorisation application and report. It must be noted, however, that should the R59 culvert not be sufficient for a 1:10 year flood (as is the current situation), it could cause damage to the bridge and road and this may impact on the flows and velocities in turn impacting on the floodplains, wetlands and the instream habitat in Leeuspruit Section 5.	N/A	N/A	N/A	N/A
Mitigation Measures							
▪ N/A							
Construction Phase	Rietspruit Section 1	Berm construction	Siltation of the Rietspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Rietspruit. This will further be impacted due to increased concentrated flow.	60	Minor (negative)	30	Negligible (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction Phase	Rietspruit Section 1	Alteration in the seasonality and flow of the river reaches (floodlines)	The construction of flood protection berms at Rietspruit Section 1 may result in an alteration in the seasonality and flow of the Rietspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	91	Moderate (negative)	28	Negligible (negative)
Mitigation Measures							
▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.							
Construction Phase	All Sections	Site access and disturbance	Activities associated with the construction of these surface mitigation measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems. Associated potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream. Among the impacts associated with the proposed construction phase are minor potential impacts to soil and water quality because of the ingress of hydrocarbons. More significant impacts include compaction of soils, potential loss of vegetation and the increased potential for erosion and sedimentation near any cleared areas and resulting in impacts further downstream.	66	Minor (negative)	32	Negligible (negative)

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Mitigation Measures							
▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms: ▪ Where the track has a slope of less than 2%, berms every 50m should be installed; ▪ Where the track slopes between 2% and 10%, berms every 25m should be installed; ▪ Where the track slopes between 10%-15%, berms every 20m should be installed; and ▪ Where the track has slope greater than 15%, berms every 10m should be installed. ▪ Limit the footprint area of the construction activities to what is essential to minimise impacts because of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon because of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. ▪ All vehicles must be regularly inspected for hydrocarbon leaks. ▪ Re-fueling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil. ▪ All spills should be cleaned up immediately and treated accordingly. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.							
Operational Phase	All Sections	Monitoring and maintenance	The only activities to take place during the operational phase are monitoring and maintenance. Once the construction phase is completed a loss of catchment yield during operation is not seen as probable due to the same volumes of water being transferred downstream with only changes to the route. The only change will be the velocity of the flow that will lead to potential increased erosion that will be mitigated through the implementation of the measures put in place during the construction phase. The main activities during the operational phase that could result in	N/A	N/A	N/A	N/A

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
			impacts to the surface water of the area are associated with the monitoring and maintenance activities. This include the site access and roads to be used for monitoring and maintenance as well as any minor earth works to rectify/maintain any changes to the berms/canals that was constructed due to high flow or extensive erosion. This will however be of short duration. If extensive maintenance activities on berms or canals are required (extensive damage from floods) the impacts identified for the construction phase will again be applicable. If the maintenance does occur the mitigation measured proposed during the construction phase should again be implemented.				
Mitigation Measures							
▪ Berms ▪ Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section 1) thereby reducing the functionality and health of the surface water environment. ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed. ▪ Berms should be monitored for erosion. Erosion must be remedied. If recurring erosion is taking place, alternatives should be explored. ▪ Canal ▪ Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years. ▪ General ▪ Limit the footprint area of the operational activities to what is essential to minimise impacts because of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas). ▪ If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible. ▪ Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities. ▪ All erosion noted within the operational footprint because of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report). ▪ No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads. ▪ Monitor all systems for erosion and incision. ▪ All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan.							

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[7]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ Permit only essential personnel within the 100m zones of regulation for all freshwater features identified.							

12.1.4 Soil, Land Use and Land Capability

The impacts that could affect the soils and land capability within the areas where activities will be undertaken are:

- Loss of the soil resource due to change in land use and removal of the soil;
- Loss of the soil resource due to wind and water erosion and which then leads to sedimentation of water streams/rivers;
- Change in soil characteristics (soil texture) due to compaction of areas during construction;
- Contamination of the soil resource due to hydrocarbons spillages; and
- Loss of the soil resource due to the disturbance and clearing of vegetation.

The impacts of the surface mitigation measures to the soil, land use and land capability are discussed in Table 12-5.

Construction activities on the site will lead to land clearing and disturbance of the soil. The clearing of vegetation, the exposure of soil during construction of the flood protection berms, canals and diversion, may lead to wind and water erosion. Vehicles will be utilised during construction of the flood protection berms and canals which may impact on the soil surface, thereby causing compaction of the soils. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil. The preparation of lay-down areas for stockpiling of soil removed will result in the impacting of soils around the area.

Soils should be handled with care throughout the project specifically during the construction phase.

Table 12-5: Soil, Land use and Land Capability Impact Assessment

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[8]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction Phase	Leeuspruit Section 2	Clearing of vegetation	A flood protection berm will be constructed to avoid one area where there is a high probability of pillar failure which can result in subsidence. The flood protection berm will be comprised of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations sourced within the Sigma area. Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.	48	Minor (negative)	35	Negligible (negative)
Construction Phase	Leeuspruit Section 3	Clearing of the vegetation	A flood protection berm will be constructed to avoid one area where there is a high probability of pillar failure which can result in subsidence. The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations sourced within the Sigma area. Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction. Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility. The removed soil will be stockpiled and can be lost if not managed correctly. Soil is susceptible to erosion because vegetation will be cleared before construction takes place in infrastructure areas. Soil is susceptible to compaction from heavy construction equipment and vehicles when soil is stripped and stockpiled. Soil compaction reduces	66	Minor (negative)	50	Minor (negative)

- [8] Significance = Consequence x Probability;
- Consequence = Severity + Spatial Scale + Duration; and
- Probability = Likelihood of an impact occurring.

The explanation for how the significance for each impact was determined is provided in each specific specialist study

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[8]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
			ability of plants to absorb water due to soil pores being decreased, reduces water infiltration rate and bulk density increases.				
Construction Phase	Leeuspruit Section 3	Construction of the flood protection berms and canal	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	98	Moderate (negative)	72	Minor (negative)
Construction Phase	Leeuspruit Section 4	Clearing of vegetation	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	78	Moderate (negative)	40	Minor (negative)
Construction Phase	Leeuspruit Section 4	Construction of the flood protection berms and canal	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	98	Moderate (negative)	72	Minor (negative)
Construction Phase	Rietspruit Section 1	Clearing of vegetation	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	48	Minor (negative)	35	Negligible (negative)

Mitigation Measures

- Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded.
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated.
- Restriction of vehicle movement over sensitive areas to reduce compaction.
- Minimise unnecessary removal of the natural vegetation cover.
- Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily.
- Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed.
- Only the designated access routes are to be used to reduce any unnecessary compaction.
- Limit the construction of new roads during construction phase, where possible.
- All vehicles must be regularly inspected for potential hydrocarbon leaks.

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[8]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Topsoil to a depth of 0.3m should be stripped first and stockpiled separately. ▪ The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence. ▪ Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place especially for soils that have high erosion potential. ▪ For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site. ▪ In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan). ▪ Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.							
Operational Phase	All Sections	Rehabilitation of the disturbed areas	Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery.	70	Minor (positive)	78	Moderate (positive)
Mitigation Measures							
▪ Effective soil cover and adequate protection from wind and water. ▪ Soil amelioration to enhance the growth capability of the soils. ▪ If erosion has occurred, usable soil should be sourced and replaced and shaped to reduce the recurrence of erosion. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Rehabilitate according to the rehabilitation plan. ▪ Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical. ▪ Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.							

12.1.5 Social

The impacts of the surface mitigation measures to social are discussed in Table 12-6.

Table 12-6: Social Impact Assessment

Phase	Surface Mitigation Measures Section	Activity Description	Impact Description	S[9]	Rating (Pre Mitigation)	S	Rating (Post Mitigation)
Construction / Operational Phase	All Sections	Implementation of surface mitigation measures	Creation of jobs during the construction and operational phases of the surface mitigation measure project.	30	Minor (positive)	42	Minor (positive)
Mitigation Measures							
▪ Where feasible, promote the creation of employment opportunities for women and youth. ▪ Where possible, workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities. ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy. ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.							

[9] Significance = Consequence x Probability;
- Consequence = Severity + Spatial Scale + Duration; and
- Probability = Likelihood of an impact occurring.

The explanation for how the significance for each impact was determined is provided in each specific specialist study

12.2 Cumulative Impacts

Cumulative effects caused by the accumulation and interaction of multiple stresses affect the parts and the functions of ecosystems. Of particular concern is the knowledge that ecological systems sometimes change abruptly and unexpectedly in response to apparently small incremental stresses. For purposes of this report, cumulative impacts have been defined as "the changes to the environment caused by an activity in combination with other past, present, and reasonably foreseeable human activities".

12.2.1 Wetland and Aquatic Ecology Cumulative Impacts

The freshwater resources in this area are currently impacted because of extensive historical (Sasol) and current mining (sand) activities in the area. This has caused altered topography including subsidence which has resulted in fragmentation of systems. In addition, other impacts to freshwater resources present in the vicinity of the proposed project include agricultural cultivation, urban settlements, industrial development, road construction, coal conveyors, powerlines and associated servitudes.

12.2.2 Fauna and Flora Cumulative Impacts

It is vital to consider the impacts that the development will have from a broad area perspective, by considering land-use and transformation of natural habitat in areas surrounding the site. Cumulative impacts are assessed by considering past, present and anticipated changes to biodiversity. The only construction and subsequent removal of vegetation that will occur is within the footprint of the River Diversion (after mitigation). Impacts occurring from site clearing, soil disturbance and subsequent removal of vegetation pose the most noteworthy cumulative impacts to the general area. This also includes the consequential risk of alien plant invasions that could possibly occur because of these activities.

13 Methodology used in determining and ranking the nature, significance, consequence, extent, duration and probability of potential environmental impacts and risks

Impacts and risks have been identified based on a description of the activities to be undertaken. Once impacts have been identified, a numerical environmental significance rating process will be undertaken that utilises the probability of an event occurring and the severity of the impact as factors to determine the significance of a particular environmental impact.

The severity of an impact is determined by taking the spatial extent, the duration and the severity of the impacts into consideration. The probability of an impact is then determined by the frequency at which the activity takes place or is likely to take place and by how often the type of impact in question has taken place in similar circumstances.

Following the identification and significance ratings of potential impacts, mitigation and management measures will be incorporated into the Environmental Management Programme (EMP).

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = CONSEQUENCE X PROBABILITY X NATURE

Where

Consequence = intensity + extent + duration

And

Probability = likelihood of an impact occurring

And

Nature = positive (+1) or negative (-1) impact

The matrix calculates the rating out of 147, whereby intensity, extent, duration and probability are each rated out of seven as indicated in Table 13-2. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation has been applied; post-mitigation is referred to as the residual impact. The significance of an impact is determined and categorised into one of seven categories (The descriptions of the significance ratings are presented in Table 13-3).

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, (i.e., there may already be some mitigation included in the engineering design). If the specialist determines the potential impact is still too high, additional mitigation measures are proposed.

Table 13-1: Impact Assessment Parameter Ratings

Rating	Intensity/ Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
7	Irreplaceable loss or damage to biological or physical resources or **highly** sensitive environments. Irreplaceable damage to **highly sensitive** cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or **moderate to highly** sensitive environments. Irreplaceable damage to cultural/social resources of **moderate to highly** sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur.>65 but <80% probability.

Rating	Intensity/ Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
5	Serious loss and/or damage to physical or biological resources or **highly** sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or **moderately** sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/ Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of **low to moderately** sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local including the site and its immediat surrounding area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	**Minor loss and/or effects** to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited extending only as far as the development site area.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low because of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/ Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
1	**Minimal to no loss** and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 13-2: Probability/Consequence Matrix

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

Table 13-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

13.1 The positive and negative impacts that the proposed activity (in terms of the initial site layout) and alternatives will have on the environment and the community that may be affected

The proposed project will only have an impact during construction phase and the operational phase as the surface mitigation measures proposed to be implemented is permanent and will not be removed once completed. A summary of the impacts both negative and positive is discussed below.

13.1.1 Construction Phase

The impacts associated with the construction phase are considered to range from major to minor depending on the activity taking place. Most of the construction activities are considered to have a negative impact on the environment except for social where jobs will be created.

The most significant impacts are associated with the construction of the canals at both Sections 3 and 4 of the Leeuspruit.

From a wetland perspective these impact ratings are considered to be major (negative) to both the wetland and instream ecology for the duration of the construction phase. Approximately 51.5ha will be affected through the implementation of the surface mitigation measures at Sigma Defunct Colliery. Of this, 9.8ha is directly affected and 41.7ha will be indirectly affected, where direct loss constitutes the loss due to the infrastructure footprint and indirectly constitutes the drying out of the floodplain portions due to separation from the main channel because of the proposed construction of the flood protection berms and canals. These surface mitigation measures will result in a decline in the PES and EIS of the wetland hydro-geomorphic (HGM) units.

The impacts associated with fauna and flora is also considered to be major to moderate which is directly correlated to the impacts on wetlands. The implementation of the surface mitigation measures will likely result in a direct and indirect loss on secondary grasslands as well as riparian areas. Additionally, once construction has been commenced with the spread of alien invasive species will also occur if mitigation measures are not correctly implemented.

With regards to surface water impacts the most significant impacts are also associated with the implementation of the surface mitigation measures at Section 3 and 4 more specifically the construction of the canal. This activity is likely to result in a floodline change (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain, but the canalisation of water will increase the velocity, and this will increase erosion. It is observed however that although pre-mitigation impacts are considered to be high, with the implementation of the mitigation measures all the impacts are reduced to either a minor or negligible impact.

From a soil, land use and land capability perspective it was determined that construction activities on the site will lead to land clearing and disturbance of the soil. The clearing of vegetation, the exposing of soil during construction of the flood protection berms, canals and diversion, may lead to wind and water erosion. Vehicles will be utilised during construction of the flood protection berms and canals which may impact on the soil surface, thereby causing compaction of the soils. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil. The preparation of lay-down areas for stockpiling of soil removed will result in the impacting of soils around the area.

In general, the impacts that were found to be significant even after the implementation of mitigation measures were associated with wetland, fauna and flora and soil, land use and land capability. These impacts were associated with the construction of the canals at Sections 3 and 4 of the Leeuspruit which would result in the direct loss of these various aspects. Specific attention is given to wetlands which will be the most significantly impacted should the project be commenced with.

It should however be noted that the impact to these environmental aspects in terms of migration routes and flow connectivity is likely to be short-lived should the appropriate mitigation measures be implemented. In terms of wetland loss, the impact to portions of the wetlands lost will be irreplaceable, however, ultimately, the canals will serve to maintain the connectivity of the system in the long term.

The project must be implemented to reduce the impact to surface associated with pillar failure. The impact on these various environmental aspects if no surface mitigation measures are implemented is considered to be catastrophic to the functionality of the environmental system which far outweighs the impact that would be experienced from the implementation of this project.

13.1.2 Operational Phase

The only activities to be undertaken during the operational phase are monitoring and maintenance. From a surface water perspective once the construction phase is completed a loss of catchment yield during operation is not seen as probable due to the same volumes of water being transferred downstream with only changes to the route. The only change will be the velocity of the flow that will lead to potential increased erosion which will be mitigated through the implementation of the measures put in place during the construction phase.

Additional potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems. Disturbances to indigenous vegetation is likely to give rise to an increased potential for encroachment by robust pioneer species and alien invasive plants, further altering the natural vegetation profiles of the freshwater resources encountered in the vicinity of the project site. Hardened surfaces have the potential to result in sheet runoff and there is likely to be a loss in wetland service provision in terms of flood attenuation, sediment trapping and assimilation of toxicants and other pollutants. Storage of water, which is an important service, provided by

wetlands in this area, will be compromised. Further alterations to the natural flow regimes will take place and is likely to result in the creation of preferential flow paths over time, which may give rise to erosion and sedimentation, thus affecting the instream ecology of this portion of the Leeuspruit and the downstream resources.

If extensive maintenance activities on berms or canals are required (extensive damage from floods) the impacts identified for the construction phase will again be applicable. If the maintenance does occur the mitigation measured proposed during the construction phase should again be implemented.

13.2 The possible mitigation measures that could be applied and the level of risk

Mitigation measures for each identified impact have been proposed and are presented in Section 15.

13.3 Motivation where no alternatives sites were considered

A number of alternatives have been investigated and discussed in Section 9. The most suitable alternatives have been selected based on this investigation to ensure the least environmental impact occurs.

It is considered that no alternative was provided for site location. Areas which have a significant potential for pillar failure which can result in subsidence have been identified with specific reference to the areas beneath the Leeuspruit and Rietspruit. The location of where these surface mitigation measures must be implemented is in relation to these significant risk areas and therefore no alternative locations can be provided for the surface mitigation measures.

13.4 Statement motivating the alternative development location within the overall site

Alternatives have been investigated and discussed in Section 9. The most suitable alternatives have been selected based on this investigation to ensure the least environmental impact occurs.

14 Full description of the process undertaken to identify, assess and rank the impacts and risks the activity will impose on the preferred site (In respect of the final site layout plan) through the life of the activity

Alternatives were considered with regards to the surface mitigation measure project and have been investigated in detail as described in Section 9. Stakeholders will be given the opportunity during the public review period to provide comment on the alternatives provided in this report. Should comments be received the alternative will be revised where applicable. The impacts and risks discussed in Section 12 are applicable to the final site layout plan (Plan 5 in Appendix B).

15 Assessment of each Identified Potentially Significant Impact and Risk

Table 15-1 provides all identified impacts associated with each phase and each aspect of the project.

Table 15-1: Assessment of Each Identified Potentially Significant Impact

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
Berm construction	Leeuspruit Section 2	Alteration in the seasonality and flow of the wetlands and river reaches	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	Minor (negative)
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 2	Direct loss of floral species/vegetation	Fauna and Flora	Construction Phase	Minor (negative)	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.	Negligible (negative)
Berm construction	Leeuspruit Section 2	The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit.	Surface Water	Construction Phase	Minor (negative)	▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 2	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the river reaches (floodlines). The floodplain will potentially be pushed over to the east and encroach onto the area closer to the ash dump to the north east of the section. This can potentially increase capturing of contaminants from runoff from the ash dam.	Surface Water	Construction Phase	Moderate (negative)		Negligible (negative)
Construction of the canals	Leeuspruit Section 3	This activity is likely to result in a complete loss of wetland area as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Fragmentation of the system and loss of migration	Wetland and Aquatic Ecology	Construction Phase	Major (negative)	▪ No mitigation measures proposed.	Major (negative)
Construction of the canals	Leeuspruit Section 3		Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	▪ No mitigation measures proposed.	Moderate (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
		routes are also a risk.					
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of floral wetlands. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the excavation of the wetlands to construct the canals; this will result in a loss of a wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland.	Fauna and Flora	Construction Phase	Major (negative)	▪ No mitigation measures proposed.	Major (negative)

Berm construction	Leeuspruit Section 3	Alteration in the seasonality and flow of the Leeuspruit. The proposed activity is likely to result in the destruction of the portion of the wetlands (mostly floodplain and a small portion of hillslope seep) where they are covered by the proposed berm, in turn, resulting in a direct loss of wetland.	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	▪ Berms
						  ▪ Sufficient drains need to be installed to facilitate seepage underneath berms.
						  ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
						  ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan).
						  ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing.
						  ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings.
						  ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.
						▪ Canal
						  ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration.
						  ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system.
						  ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.
						  ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology.
						  ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.
							Minor (negative)

Construction of flood protection berms require vegetation clearing	Leeuspruit Section 3 and 4	Direct loss of floral species/vegetation of the Secondary Grassland Unit	Fauna and Flora	Construction Phase	Minor (negative)	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.	Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of secondary grassland. The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals.	Fauna and Flora	Construction Phase	Moderate (negative)	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	Moderate (negative)
Berm construction	Leeuspruit Section 3	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 3	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Negligible (negative)		Negligible (negative)
Canal Construction	Leeuspruit Section 3	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.	Surface Water	Construction Phase	Major (negative)		Minor (negative)
Construction of the canals – wetland ecology	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a complete loss of wetland area, as well as large impacts downstream such as erosion, sedimentation and altered water quality.	Wetland and Aquatic Ecology	Construction Phase	Major (negative)	▪ No mitigation measures proposed.	Major (negative)
Construction of the canals – instream ecology	Leeuspruit Section 4		Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	▪ No mitigation measures proposed.	Moderate (negative)
Berm construction	Leeuspruit Section 4	A narrowing of the floodplain may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water within a smaller area, resulting in an indirect loss of wetland habitat. The concentrated flow of water may also result in	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the	Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
		increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. The portion of the wetlands (mostly floodplain and a small portion of seep) that are covered by the berm will be destroyed, resulting in a direct loss of wetland				plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.	
Berm construction	Leeuspruit Section 4	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 4	The construction of flood protection berms at Leeuspruit Section 4 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Moderate (negative)		Negligible (negative)
Canal Construction	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.	Surface Water	Construction Phase	Major (negative)		Minor (negative)
Berm	Rietspruit Section 1	A narrowing of the floodplain and channelled	Wetland and	Construction	Moderate	▪ Sufficient drains need to be installed to facilitate seepage underneath berms.	Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
construction		valley bottom may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water, thus potentially resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Aquatic Ecology	Phase	(negative)	▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	
Construction of flood protection berms require vegetation clearing	Rietspruit Section 1	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system.	Fauna and Flora	Construction Phase	Minor (negative)	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	Negligible (negative)
Berm construction	Rietspruit Section 1	Siltation of the Rietspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Rietspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Rietspruit Section 1	The construction of flood protection berms at Rietspruit Section 1 may result in an alteration in the seasonality and flow of the Rietspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Moderate (negative)		Negligible (negative)

Site access and disturbance	All Sections	Activities associated with the construction of these river diversion measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems.	Wetland and Aquatic Ecology	Construction Phase	Minor (negative)	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation.
						▪ During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms:
						  ▪ Where the track has a slope of less than 2%, berms every 50m should be installed;
						  ▪ Where the track slopes between 2% and 10%, berms every 25m should be installed;
						  ▪ Where the track slopes between 10%-15%, berms every 20m should be installed; and
						  ▪ Where the track has slope greater than 15%, berms every 10m should be installed.
						▪ Limit the footprint area of the construction activities to what is essential to
							Minor (negative)

Instream freshwater biodiversity destruction	All Sections	In terms of instream ecology, large potential impacts related to loss of flow connectivity, fragmentation of the system, loss of natural migration routes and the loss of natural habitat and substrates has the potential to limit the biodiversity of the instream ecology of this portion of the Leeuspruit.	Wetland and Aquatic Ecology	Construction Phase	Major (negative)		Moderate (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
						minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ If it is unavoidable that any of the wetland or instream areas present (not withstanding those already accounted for in the proposed activities) will be affected, disturbance must be minimised and suitably rehabilitated. ▪ Ensure that no incision and canalisation of the wetland and instream features present takes place. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon as a result of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. The No-go zone should be avoided. ▪ All vehicles must be regularly inspected for hydrocarbon leaks. ▪ Re-fueling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Wetlands should be monitored monthly during construction. ▪ The no-go area indicated in Plan 13 must be avoided by any construction activities or movement of vehicles in this area. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility. ▪ A wetland offset strategy should be developed to compensate for the loss of wetland and instream areas due to the canals and berms. Ideally, the PES and EIS of wetlands and instream areas within Sasol's mining lease area should be improved. ▪ All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel.	
Site establishment and establishment of access and service roads	All Sections	Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity.	Fauna and Flora	Construction Phase	Minor (negative)	▪ Construction activities must be restricted to the project footprint. ▪ Designated construction areas must be clearly demarcated and contractors must make use of existing access route. ▪ Best practices noise control management measures must be applied to minimise noise during construction. ▪ Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction. ▪ Proper waste management must be implemented and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ During site preparation, special care must be taken during the clearing of the work areas to minimise damage or disturbance of roosting and nesting sites. ▪ Any excavated trenches and diversion canals will be inspected regularly for	Negligible (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
						fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.	
Site establishment for camp laydown and construction requires vegetation clearance	All Sections	The clearing of vegetation and Indirect loss of downstream habitat through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the project site.	Fauna and Flora	Construction Phase	Minor (negative)	▪ Phased vegetation clearing must be implemented to minimise the extent of bare areas. ▪ An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species (Refer to Section 10.2 Appendix I rehabilitation specialist study). ▪ If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place. ▪ Indigenous vegetation must be utilised during the revegetation of disturbed areas. Refer to Section 10.3 for the Revegetation Plan in Appendix I.	Negligible (negative)
Site access and disturbance	All Sections	Potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream.	Surface Water	Construction Phase	Minor (negative)	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon because of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.	Negligible (negative)
Clearing of vegetation	Leeuspruit Section 2	Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)	▪ Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded. ▪ If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated. ▪ Restriction of vehicle movement over sensitive areas to reduce compaction. ▪ Minimise unnecessary removal of the natural vegetation cover. ▪ Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Limit the construction of new roads during construction phase, where possible. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Topsoil to a depth of 0.3m should be stripped first and stockpiled separately. ▪ The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence. ▪ Soil erosion might pose a problem once vegetation cover is removed; thus,	Negligible (negative)
Clearing of the vegetation	Leeuspruit Section 3	Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction. Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)		Minor (negative)
Construction of the flood protection berms and canal	Leeuspruit Section 3	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Construction Phase	Moderate (negative)		Minor (negative)
Clearing of vegetation	Leeuspruit Section 4	Removal of vegetation may lead to dust generation and erosion, respectively. The	Soil, Land Use and Land	Construction Phase	Moderate (negative)		Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
		movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Capability			erosion monitoring should take place especially for soils that have high erosion potential. ▪ For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site. ▪ In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan). ▪ Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.	
Construction of the flood protection berms and canal	Leeuspruit Section 4	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Construction Phase	Moderate (negative)		Minor (negative)
Clearing of vegetation	Rietspruit Section 1	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)		Negligible (negative)
Implementation of surface mitigation measures	All Sections	Creation of jobs during the construction and operational phase of the surface mitigation measure project	Social	Construction / Operational Phase	Minor (positive)	▪ Where feasible, promote the creation of employment opportunities for women and youth. ▪ Where possible, workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities. ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy. ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	Minor (positive)

Site access for maintenance and monitoring purposes	All Sections	The main activities during the operational phase that could result in impacts to the freshwater ecology of the area are associated with the monitoring and maintenance activities.
		Associated potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems present.
			Wetland and Aquatic Ecology	Operational Phase	Minor (negative)	▪ Berms
						  ▪ Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section) thereby reducing the functionality and health of the wetlands.
						  ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed.
						  ▪ Berms should be monitored for erosion. Erosion must be remedied. If recurring erosion is taking place, alternatives should be explored.
						▪ Canal
						  ▪ Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years.
						  ▪ Biomonitoring to be conducted by suitably qualified wetland and aquatic ecologists on a biannual basis for a minimum of three years.
						▪ General
						  ▪ Limit the footprint area of the operational activities to what is essential to minimise impacts as a result of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas).
						  ▪ If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible.
						  ▪ Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities.
						  ▪ All erosion noted within the operational footprint as a result of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report).
						  ▪ All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel.
							Negligible (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Mitigation Type	Significance
						▪ No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads. ▪ All vehicles must be regularly inspected for hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Monitor all systems for erosion and incision. ▪ All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ If significant rehabilitation measures are required, mitigation measures of the construction phase must be implemented. ▪ Permit only essential personnel within the 100m zones of regulation for all freshwater features identified. ▪ Ongoing wetland rehabilitation is necessary during the operational phase as stipulated in the monitoring section (Section 8.1.1).	
Destruction and disturbance through site access associated with routine maintenance	All Sections	The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present.	Fauna and Flora	Operational Phase	Minor (negative)	▪ An Alien Plant Management Strategy must be implemented during the operational phase whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. ▪ Monitoring must preferably take place between November and March. ▪ All alien plant species must be identified, demarcated, and removed. ▪ Where possible, make use of existing roads rather than creating new access routes. ▪ The area must be kept clear of all invader plants as per the NEMBA. ▪ Rehabilitation measures must be employed until such a time as indigenous species is established. ▪ Suitable erosion control measures should be implemented.	Negligible (negative)
Rehabilitation of the disturbed areas	All Sections	Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery.	Soil, Land Use and Land Capability	Operational Phase	Minor (positive)	▪ Effective soil cover and adequate protection from wind and water. ▪ Soil amelioration to enhance the growth capability of the soils. ▪ If erosion has occurred, usable soil should be sourced and replaced and shaped to reduce the recurrence of erosion. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Rehabilitate according to the rehabilitation plan. ▪ Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical. ▪ Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.	Moderate (positive)

16 Summary of specialist reports

Table 16-1 provides a summary of the specialist studies that were undertaken for the proposed surface mitigation measure project.

Table 16-1: Specialist Studies that have been undertaken for the project

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
Wetlands and Aquatic Ecology Specialist Study - Appendix D	There are 413.9ha of wetlands within the project specific sections. These wetlands have been categorised PES values ranging from D to E and EIS values ranging from moderate to low. Approximately 51.5ha of wetlands have the potential to be affected through the implementation of the surface mitigation measures at Sigma Defunct Colliery. Of this, 9.8ha has the potential to be directly affected and 41.7 indirectly, where direct loss constitutes the loss due to the infrastructure footprint and indirectly constitutes the drying out of the floodplain portions due to separation from the main channel as a result of the berm and canal. These surface mitigation measures will result in a decline in the PES and EIS of the wetland HGM units. In addition to various mitigation measures, it is suggested that a Wetland Offset Strategy be implemented to account for the loss of wetlands due to the implementation of the project. It is suggested that monitoring take place monthly during the construction phase, quarterly for the first two years after construction and annually for three years thereafter. Armorflex or a similar product like Terraforce will be used and filled with soil and planted. Please see the wetland sections of this report and the Rehabilitation specialist report in this regard as well as the soils report for the berms. Special care will be required to minimise the loss of stream connectivity and fragmentation of the Leeuspruit system. In addition, strict monitoring will be required both in the project site as well as downstream of the proposed activities to ensure impacts are not expressed further downstream and to ensure no further loss to the ecological integrity of the system over the long term. It is, however, important to note that should the proposed project not be permitted to proceed, the impacts relating to potential for pillar failure which can result in subsidence of the Leeuspruit and Rietspruit systems have the potential to outweigh the impacts relating to the system should the proposed rehabilitation and mitigation measures be granted.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the wetland and aquatic ecologist specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Fauna and Flora Specialist Study - Appendix E	It is important that the site preparation and surface mitigation infrastructure lay down is done with these sensitive areas in mind. The risk assessment for the project indicates that certain activities of the construction phase pose a significantly risk of impacting negatively on the fauna and flora, some of which remain significant following mitigation such as clearance of natural habitat and excavation for canals. Habitat loss due to clearing and excavation for the construction of formalised canals (i.e. Leeuspruit Section 3 and 4) is the principal environmental impact of concern for this proposed project. It is however expected that the impacts of certain activities such as the construction of flood protection berms will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. In addition to this, the potential to recover certain secondary grassland landscapes will also be presented by re-vegetation on constructed surfaces. As no complete clearing will occur, sections of natural vegetation will be left relatively intact within the site, therefore it is expected that some of the faunal components will return to the site once the construction phase has been completed. It is the opinion of the specialist that the project may go ahead with the following conditions: ▪ During construction, all vehicles must make use of existing access routes. Where construction vehicles must traverse the site and make new access routes, these must be kept as narrow as possible and creating of multiple routes should be avoided. ▪ Vegetation clearing must be kept to a minimum, and this must only occur where it is necessary. ▪ Ensure that sufficient secondary grassland and wetland vegetation is retained to maintain ecological processes. ▪ The proposed activities associated with the alteration of the river banks must preferably take place during the drier period of the year and the associated disturbance within the river channel limited as far as possible, both spatially and temporally. ▪ Newly cleared soils will have to be re-vegetated and stabilised as soon as construction has been completed. ▪ Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directly away from the proposed infiltration berm location. ▪ Provision for adequate drainage on the flood protection berm is of paramount importance to ensure movement of water threw the berm. In addition to this, it is the instillation of adequate energy dissipation measures at each spillway outlet to reduce the risk of erosion. ▪ Rehabilitation of the river corridor must take place after the activities are complete to minimise the risk erosion and indigenous species should be utilised.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the fauna and flora specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
	▪ Monitoring activities of structural stability and integrity must take place directly after completion of the construction and then every second month during the first year. ▪ All mitigation measures prescribed in this document will be adhered to strictly.		
Surface Water Specialist Study - Appendix F	The following is recommended to manage the potential impacts of the proposed surface mitigation activities: ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Reprofile the slopes to mimic the natural topography. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon because of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. ▪ The proposed monitoring plan outlined in this report as well as the wetland, aquatic and soil specialist reports should be implemented.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the surface water specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Soils, Land Use and Land Capability Specialist Study - Appendix G	The risk assessment from the findings of this report indicates that most of the proposed activities pose a high probability of impacting the soils and wetlands over the longer term. Based on the findings of this of this report and the proposed mitigation measures, the anticipated impacts of the project can be reduced to a moderate to minor level of significance through implementation of the proposed integrated mitigation and management measures. The following recommendations are made to minimise the impact on the soils: ▪ Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded. ▪ If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated. ▪ Restriction of vehicle movement over sensitive areas to reduce compaction. ▪ Minimise unnecessary removal of the natural vegetation cover. ▪ Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily. ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that no blockages occur. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Wetlands should be monitored monthly during construction. ▪ Topsoil of 0.3m of the soil profile should be stripped first and stockpiled separately. ▪ The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to the Rehabilitation Plan). ▪ Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the Soils, Land Use and Land Capability specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Heritage Specialist Study - Appendix H	With the exception of the burial grounds and graves, which carry a high cultural significance, much of the archaeology in the greater project site is of low significance as determined in previously-completed heritage studies (Van Schalkwyk et al 1996; Dreyer, 2005; Birkholtz, 2008; Pelser & Van Vollenhoven 2008; Pistorius 2008; Van Ryneveld 2008; du Piesanie & Nel 2014; Higgit & du Piesanie 2015; Mngomezulu, 2016; Beater, 2017; Marais-Botes 2017; Hardwick & du Piesanie 2018). No geological outcrops or palaeontological resources were identified during the pre-disturbance survey, and only one historical structure and four burial grounds were recorded. Additional potential historical structures were identified through aerial imagery. The identified resources occur in excess of 250m distance from the proposed Project activities and development footprint. Considering the nature of the Project, the cultural landscape baseline, and distribution of known heritage resources.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the Soils, Land Use and Land Capability specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
	The following recommendation measure must be implemented: ▪ Sasol Mining establishes and maintains a buffer zone of at least 50m around the identified heritage resources. The buffers must be clearly demarcated and appropriate signage be placed during the construction phase. Where such a buffer cannot be maintained, Digby Wells proposes a Heritage Watching Brief be undertaken by a qualified and accredited archaeologist to ensure the identified heritage resources are not impacted upon; ▪ Sasol Mining must develop a project-specific Chance Finds Protocol (CFP) and Fossil Finds Protocol (FFP) for implementation during the establishment and construction phase of the Project; and ▪ The proponent immediately informs SAHRA of any chance finds identified and enlists the services of a qualified and accredited archaeologist to assess and recommend appropriate mitigation measures.		Sections 5 and 6 and the monitoring provided in Section 8.
Rehabilitation Specialist Study - Appendix I	The findings of specialist reports for this project indicate that most of the proposed activities pose a high probability of impacting the soils and wetlands over the longer term. Based on the findings of this of this report, the mitigation measures and the anticipated impacts of the diversion can be reduced from a high to moderate level of significance. The following recommendations are made to minimise the impacts: ▪ Strategic water management plans should be implemented to ensure that the effect on the environment in general and surface water in particular is minimised. The plans should be developed in consultation with stakeholders to ensure the sustainable development and management of the river diversion. ▪ Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directed away from the proposed flood protection berms locations in Leeuspruit Sections 2 to 4, and Rietspruit Section 1. ▪ To ensure efficiency of the system, protection berms and diversion canals have to be inspected for silting and blockages of inflows, pipelines for hydraulic integrity and the overall surface water flow performance monitored. ▪ Berms should be monitored after construction phase for erosion monthly for the first year, quarterly for the second year and bi-annually for the third year until sustainability is confirmed. ▪ If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated. ▪ Ensure that sufficient secondary grassland and wetland vegetation is retained to maintain ecological processes through monthly monitoring for the first year and quarterly for three years. If any issues are observed at the end of the three year period monitoring should continue annually for an additional two years. ▪ Minimise unnecessary removal of the natural vegetation cover. ▪ Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily. ▪ Newly constructed berms will have to be re-vegetated and stabilised as soon as construction has been completed. ▪ The proposed activities associated with the alteration of the river banks must preferably take place during the drier period of the year and the associated disturbance within the river channel limited as far as possible, both spatially and temporally. ▪ Use of accredited contractors for removal of construction equipment must be ensured, this will reduce the risk of waste generation and accidental spillages. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of a monitoring schedule ▪ Erosion should be monitored after construction phase monthly for the first year, quarterly for the second year and bi-annually for the third year until sustainability is confirmed. ▪ Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding water streams.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the Rehabilitation specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.

17 Environmental Impact Statement

17.1 Summary if the Key Findings of the Environmental Impact Assessment

The key findings from the environmental impact assessment were:

- The impacts that were found to be significant even after the implementation of mitigation measures were associated with wetland, fauna and flora and soil, land use and land capability. These impacts were associated with the construction of the canals which would result in the direct loss of these various aspects. Specific attention is given to wetlands which will be the most significantly impacted should the project be commenced with.
- A total of 51.5ha of wetlands will be affected through the implementation of the surface mitigation measures which will have a significant impact on the functionality of the wetland environment.
- The impact to the instream ecology in terms of migration routes and flow connectivity is likely to be short-lived should the appropriate mitigation measures be implemented. In terms of wetland loss, the impact to portions of the wetlands lost will be irreplaceable, however, ultimately, the canals will serve to maintain the connectivity of the system in the long term.
- The project must be implemented to reduce the impact to surface associated with pillar failure. The impact on these various environmental aspects if no surface mitigation measures are implemented is considered to be catastrophic to the functionality of the environmental system which far outweighs the impact that would be experienced from the implementation of this project.
- Monitoring and maintenance will be undertaken during the operational phase for a period of three years after completion of the construction phase. No significant impacts will be experienced during this phase of the project. Should effective mitigation measure be implemented that impact is considered to be negligible.

17.2 Final Site Map

The infrastructure layout plan for the project is provided in Plan 5 in Appendix B.

17.3 Summary of the positive and negative implications and risks of the proposed activity and identified alternatives

Table 17-1 identified all negative impacts associated with the project during the construction and operation phases while Table 17-2 identified all positive impacts associated with the project during the construction and operation phases.

Table 17-1: Summary of all negative Impact for the Project

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Berm construction	Leeuspruit Section 2	Alteration in the seasonality and flow of the wetlands and river reaches	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Minor (negative)
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 2	Direct loss of floral species/vegetation	Fauna and Flora	Construction Phase	Minor (negative)	Negligible (negative)
Berm construction	Leeuspruit Section 2	The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit.	Surface Water	Construction Phase	Minor (negative)	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 2	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the river reaches (floodlines). The floodplain will potentially be pushed over to the east and encroach onto the area closer to the ash dump to the north east of the section. This can potentially increase capturing of contaminants from runoff from the ash dam.	Surface Water	Construction Phase	Moderate (negative)	Negligible (negative)
Construction of the canals	Leeuspruit Section 3	This activity is likely to result in a complete loss of wetland area as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Fragmentation of the system and loss of migration routes are also a risk.	Wetland and Aquatic Ecology	Construction Phase	Major (negative)	Major (negative)
Construction of the canals	Leeuspruit Section 3		Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Moderate (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of floral wetlands. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the excavation of the wetlands to construct the canals; this will result in a loss of a wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland.	Fauna and Flora	Construction Phase	Major (negative)	Major (negative)
Berm construction	Leeuspruit Section 3	Alteration in the seasonality and flow of the Leeuspruit. The proposed activity is likely to result in the destruction of the portion of the wetlands (mostly floodplain and a small portion of hillslope seep) where they are covered by the proposed berm, in turn, resulting in a direct loss of wetland.	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Minor (negative)
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 3 and 4	Direct loss of floral species/vegetation of the Secondary Grassland Unit	Fauna and Flora	Construction Phase	Minor (negative)	Minor (negative)
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of secondary grassland. The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals.	Fauna and Flora	Construction Phase	Moderate (negative)	Moderate (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Berm construction	Leeuspruit Section 3	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 3	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Negligible (negative)	Negligible (negative)
Canal Construction	Leeuspruit Section 3	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.	Surface Water	Construction Phase	Major (negative)	Minor (negative)
Construction of the canals – wetland ecology	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to	Wetland and Aquatic Ecology	Construction Phase	Major (negative)	Major (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Construction of the canals – instream ecology	Leeuspruit Section 4	result in a complete loss of wetland area, as well as large impacts downstream such as erosion, sedimentation and altered water quality.	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Moderate (negative)
Berm construction	Leeuspruit Section 4	A narrowing of the floodplain may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water within a smaller area, resulting in an indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. The portion of the wetlands (mostly floodplain and a small portion of seep) that are covered by the berm will be destroyed, resulting in a direct loss of wetland	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Minor (negative)
Berm construction	Leeuspruit Section 4	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	Negligible (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 4	The construction of flood protection berms at Leeuspruit Section 4 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Moderate (negative)	Negligible (negative)
Canal Construction	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.	Surface Water	Construction Phase	Major (negative)	Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Berm construction	Rietspruit Section 1	A narrowing of the floodplain and channelled valley bottom may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water, thus potentially resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Wetland and Aquatic Ecology	Construction Phase	Moderate (negative)	Minor (negative)
Construction of flood protection berms require vegetation clearing	Rietspruit Section 1	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system.	Fauna and Flora	Construction Phase	Minor (negative)	Negligible (negative)
Berm construction	Rietspruit Section 1	Siltation of the Rietspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Rietspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	Minor (negative)	Negligible (negative)
Alteration in the seasonality and flow of the river reaches (floodlines)	Rietspruit Section 1	The construction of flood protection berms at Rietspruit Section 1 may result in an alteration in the seasonality and flow of the Rietspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase	Moderate (negative)	Negligible (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Site access and disturbance	All Sections	Activities associated with the construction of these river diversion measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems.	Wetland and Aquatic Ecology	Construction Phase	Minor (negative)	Minor (negative)
Instream freshwater biodiversity destruction	All Sections	In terms of instream ecology, large potential impacts related to loss of flow connectivity, fragmentation of the system, loss of natural migration routes and the loss of natural habitat and substrates has the potential to limit the biodiversity of the instream ecology of this portion of the Leeuspruit.	Wetland and Aquatic Ecology	Construction Phase	Major (negative)	Moderate (negative)
Site establishment and establishment of access and service roads	All Sections	Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity.	Fauna and Flora	Construction Phase	Minor (negative)	Negligible (negative)
Site establishment for camp laydown and construction requires vegetation clearance	All Sections	The clearing of vegetation and Indirect loss of downstream habitat through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the project site.	Fauna and Flora	Construction Phase	Minor (negative)	Negligible (negative)
Site access and disturbance	All Sections	Potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream.	Surface Water	Construction Phase	Minor (negative)	Negligible (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Clearing of vegetation	Leeuspruit Section 2	Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)	Negligible (negative)
Clearing of the vegetation	Leeuspruit Section 3	Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction. Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)	Minor (negative)
Construction of the flood protection berms and canal	Leeuspruit Section 3	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Construction Phase	Moderate (negative)	Minor (negative)
Clearing of vegetation	Leeuspruit Section 4	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Construction Phase	Moderate (negative)	Minor (negative)
Construction of the flood protection berms and canal	Leeuspruit Section 4	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Construction Phase	Moderate (negative)	Minor (negative)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Clearing of vegetation	Rietspruit Section 1	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Construction Phase	Minor (negative)	Negligible (negative)
Site access for maintenance and monitoring purposes	All Sections	The main activities during the operational phase that could result in impacts to the freshwater ecology of the area are associated with the monitoring and maintenance activities. Associated potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems present.	Wetland and Aquatic Ecology	Operational Phase	Minor (negative)	Negligible (negative)
Destruction and disturbance through site access associated with routine maintenance	All Sections	The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present.	Fauna and Flora	Operational Phase	Minor (negative)	Negligible (negative)

Table 17-2: Summary of all positive Impact for the Project

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Significance	Significance
Implementation of surface mitigation measures	All Sections	Creation of jobs during the construction and operational phase of the surface mitigation measure project	Social	Construction / Operational Phase	Minor (positive)	Minor (positive)
Rehabilitation of the disturbed areas	All Sections	Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery.	Soil, Land Use and Land Capability	Operational Phase	Minor (positive)	Moderate (positive)

18 Proposed impact management objectives and the impact management outcomes for inclusion in the EMPR

The EMPr seeks to achieve a required end state and describes how activities that have, or could have, an adverse impact on the environment will be mitigated, controlled and monitored.

The EMPr will address the environmental impacts during the construction and operational phases of the project. Due regard must be given to environmental protection during the entire project; a number of environmental recommendations are made to achieve environmental protection. These recommendations are aimed at ensuring that the contractor maintains adequate control over the project to:

- Minimise the extent of an impact during the life of the project;
- Ensure appropriate restoration of areas affected by the project; and
- Prevent long term environmental degradation.

19 Aspects for inclusion as conditions of authorisation

It is not foreseen that any additional aspects other that what has been included and discussed in this document, are required.

20 Description of any assumptions, uncertainties and gaps in knowledge

This section highlights the assumptions, uncertainties, limitations and knowledge gaps relevant to the various specialist studies undertaken.

20.1 Wetland and Aquatic Ecology

The following limitations were encountered during this study:

- The wetland impact assessment is based on a baseline wetland assessment completed by Digby Wells in 2016 with the participation of J&W and Wetland Consulting Services therefore a repeat of this work was not deemed necessary;
- The previous wetland assessment assigned EIS values for artificial wetlands. The tool is not designed for use in wetland systems; however, they are useful in terms of quantifying some of the services that these systems do supply;
- The composition of freshwater resources in the project site prior to major disturbance is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available;
- With ecology being dynamic and complex, certain aspects, some of which may be important, may have been overlooked. It is, however, expected that the project site has been accurately assessed and considered, based on the field observations

undertaken and the consideration of existing studies and monitoring data in terms of freshwater ecology;

- To obtain a comprehensive understanding of the dynamics of the aquatic biota present within a watercourse (e.g. migratory pathways, seasonal prevalence, breeding cycles, etc.), studies should include investigations conducted during different seasons, over many years and through extensive sampling efforts. Given the time constraints of the baseline assessment, such long-term research was not feasible and could not be conducted. Consequently, the findings presented are based on professional experience, supported by a literature review, historical knowledge of the site and extrapolated from the data collected at the time of the field survey; and
- Although selected assessment indices (i.e. SASS5) are not specifically designed and/or recommended for use in wetland systems (Chutter, 1998; Dickens and Graham, 2002), it was considered a valuable source of data in terms of species sensitivity and composition within the project site. For the purposes of this study, application was limited to the channelled systems that exhibited some evidence of riverine elements (e.g. flowing systems).

20.2 Fauna and Flora

The following limitations were encountered during this study:

- It is assumed that third-party information obtained and discussed in this report is the most recent and accurate at the time of the compilation of this report; and
- One dry season targeted survey was completed within the areas identified as high risk (Leeuspruit and Rietspruit sections), thus it is possible that although every effort is made to cover as much of the site as possible, representative sampling is done and it is possible that some plant and animal species that are present on site were not recorded during the field investigations, due to seasonality. However, enough previous assessments have been done to give an indication of what species may be present.

20.3 Soil, Land Use and Land Capability

The following assumptions and limitations have been made:

- The information provided in this report is based on information gathered from the site visit undertaken in July 2018 and information reviewed from previous studies;
- A total of 16 soil samples were collected at the proposed infrastructure areas; and
- The area surveyed is based on the preliminary layout presented by Sasol Defunct Colliery.

21 Reasoned opinion as to whether the proposed activity should or should not be authorised

21.1 Reasons why the activity should be authorised or not

The surface mitigation measure project aims to address issues associated with the current and future environmentally degraded state of the project site. It seeks to prevent further degradation of the environment and ensure a sustainable state is maintained once the project has been completed.

Sigma Defunct Colliery stopped operations in 2006. Significant efforts, since then, have been made to rehabilitate the defunct mine to a state that is able to support further development and growth specifically agriculture. As was indicated in the closure plan and EMPr, effort needed to be made to implement mitigation measures to reduce the significant risks which had been identified at the defunct colliery. It was determined that the most significant risk faced by Sasol at the Sigma Defunct Colliery was the potential for pillar failure which could result in subsidence. Subsidence occurs when the land beneath the surface gives way resulting in the ground collapsing into the underground workings. This poses a significant risk to both people and the environment (specifically surface water and the environmental aspects it supports i.e. wetlands and fauna and flora).

The surface mitigation measures are one of the proposed mitigation measures aimed to reduce the impact to surface should subsidence occur. It should however be noted that the surface mitigation measures are not the only mitigation measure proposed by Sasol Mining to address the issues surrounding subsidence. A combination of mitigation measures implemented by Sasol mining is proposed to reduce the impact of subsidence which includes ash backfilling and demolition of infrastructure located on areas where pillar failure could occur.

Although impacts have been identified from the implementation of the proposed project and found to be significant, should the mitigation measures proposed be implemented correctly these impacts in most cases will be reduced to an acceptable impact, excluding some of the impacts to wetlands, fauna and flora and soil, land use and land capability. However, it can be concluded that the potential for pillar failure which will have a catastrophic impact to each environmental aspect outweighs the impact associated with the implementation of the surface mitigation measure project.

Additionally, it must be noted that the proposed project is for the benefit of the people living in the area. Sasol will gain no economic benefit from this project as it is a remediation project. Therefore, based on the information presented in this report, Digby Wells recommends that an authorisation for this proposed project is granted.

21.2 Conditions that must be included in the authorisation

21.2.1 Construction Phase

21.2.1.1 Berms

- Sufficient drains need to be installed to facilitate seepage underneath berms.
- Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
- Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix I for the plant species plan).
- Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing.
- In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings.
- Limit clearing to areas that have been designated for the construction of the flood protection berms.
- During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation.
- Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction.
- Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.
- Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded.
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated.
- Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.

21.2.1.2 Canal

- It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration.

- Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system.
- Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.
- Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology.
- Armorflex or a similar product like Terraforce must be used and filled with soil and planted.
- Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur).
- Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided.
- Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan).

21.2.1.3 General

- Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation.
- During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has a slope of less than 2%, berms every 50m should be installed;
  - Where the track slopes between 2% and 10%, berms every 25m should be installed;
  - Where the track slopes between 10%-15%, berms every 20m should be installed; and
  - Where the track has slope greater than 15%, berms every 10m should be installed.

- Limit the footprint area of the construction activities to what is essential to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas).
- If it is unavoidable that any of the wetland or instream areas present (not withstanding those already accounted for in the proposed activities) will be affected, disturbance must be minimised and suitably rehabilitated.
- Ensure that no incision and canalisation of the wetland and instream features present takes place.
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan.
- Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction.
- All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information).
- Permit only essential personnel within the 100m zone of regulation for all freshwater features identified.
- No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained.
- No material may be dumped or stockpiled within any rivers, tributaries or drainage lines.
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon as a result of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. The No-go zone should be avoided.
- All vehicles must be regularly inspected for potential hydrocarbon leaks.
- Re-fueling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil.
- Hydrocarbon spills should be cleaned up immediately and treated accordingly.
- Wetlands should be monitored monthly during construction.
- The no-go area indicated in the map must be avoided.
- Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.
- A wetland offset strategy should be developed to compensate for the loss of wetland and instream areas due to the canals and berms. Ideally, the PES and EIS of wetlands and instream areas within Sasol's mining lease area should be improved.

- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel.
- Designated construction areas must be clearly demarcated and contractors must make use of existing access routes.
- Best practices noise control management measures must be applied to minimise noise during construction.
- Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction.
- Proper waste management must be implemented and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites.
- During site preparation, special care must be taken during the clearing of the work areas to minimise damage or disturbance of roosting and nesting sites.
- Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.
- An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species (Refer to Section 10.2 Appendix I rehabilitation specialist study).
- If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place.
- Indigenous vegetation must be utilised during the revegetation of disturbed areas. Refer to Section 10.3 for the Revegetation Plan in Appendix I.
- Only the designated access routes are to be used to reduce any unnecessary compaction.
- Limit the construction of new roads during construction phase, where possible.
- Topsoil to a depth of 0.3m should be stripped first and stockpiled separately.
- The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence.
- For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site.
- In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution.

21.2.2 Operational Phase

21.2.2.1 Berms

- Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section) thereby reducing the functionality and health of the wetlands.
- Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed.
- Berms should be monitored for erosion. Erosion must be remedied. If recurring erosion is taking place, alternatives should be explored.

21.2.2.2 Canal

- Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years.
- Biomonitoring to be conducted by suitably qualified wetland and aquatic ecologists on a biannual basis for a minimum of three years.

21.2.2.3 General

- Limit the footprint area of the operational activities to what is essential to minimise impacts as a result of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas).
- If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible.
- Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities.
- All erosion noted within the operational footprint as a result of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report).
- A suitable AIP control programme must be put in place to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones (see the Fauna and Flora Specialist Study for more information).
- All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel.
- No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained.

- No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads.
- All vehicles must be regularly inspected for potential hydrocarbon leaks.
- Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil.
- Hydrocarbon spills should be cleaned up immediately and treated accordingly.
- Monitor all systems for erosion and incision.
- All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan.
- Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation.
- All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information).
- If significant rehabilitation measures are required, mitigation measures of the construction phase must be implemented.
- Permit only essential personnel within the 100m zones of regulation for all freshwater features identified.
- Ongoing wetland rehabilitation is necessary during the operational phase as stipulated in the monitoring section (Section 8.1.1).
- Where possible, make use of existing roads rather than creating new access routes.
- Effective soil cover and adequate protection from wind and water.
- Soil amelioration to enhance the growth capability of the soils.
- Rehabilitate according to the rehabilitation plan (Appendix I).
- Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical.
- Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.

22 Period for which the environmental authorisation is required

It is proposed that the surface mitigation measures will be constructed within twelve months however a contingency has been provided should delays be experienced (due to economic circumstances, adverse weather conditions or other unforeseen circumstances). Therefore, the authorisation to complete the construction phase should be valid for twenty four months. Once constructed the surface mitigation measures will be permanent and will not be decommissioned therefore the proposed project must be authorised indefinitely.

23 Undertaking

Please refer to Part B, Section 12 for the complete undertaking applicable to the BAR and EMP sections of this report.

24 Financial provision

Sasol proposes to obtain environmental authorisation to implement surface mitigation measures which include designs for diversion canals and flood protection berms to channel the Leeuspruit and Rietspruit away from areas identified to have a significant potential for pillar failure which could potentially result in subsidence. It should be noted that R 542,885,649.00 (as calculated on 30 June 2017) has been secured through financial guarantee for the implementation of mitigation measures that are proposed to address the significant impact of subsidence and reduce the risk to insignificant. Of this R 542,885,649.00, R 425,780,183.90 Million has been allocated to the surface mitigation measure project for construction and operational phases. Table 24-1 provides a breakdown of the costing.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

24.1 Explain how the aforesaid amount was derived

The financial provision breakdown is provided in Table 24-1.

Table 24-1: Financial Provision for Surface Mitigation Measures (FY2017)

Site	Inventory Item	Work Item	Qty FY17	Rate FY17	Amount FY17
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit	1	246,041,879.47	246,041,879
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit - contingency	1	24,604,187.95	24,604,188
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit - P&G	1	32,477,528.09	32,477,528
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit	0.94	104,384,576.10	98,521,450
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit - contingency	1	10,365,168.54	10,365,169
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit - P&G	1	13,769,969.36	13,769,969
Total					**R425,780,183.90**

24.2 Confirm that this amount can be provided for from operating expenditure

The financial guarantee of R 542,885,649.00 has already been approved and provided for in Sigma Defunct Colliery financial provision for rehabilitation.

25 Specific Information required by the competent Authority

Compliance with the provisions of sections 24(4)(a) and (b) read with section 24 (3) (a) and (7) of the National Environmental Management Act (Act 107 of 1998) the EIA report must include the:-

25.1 Impact on the socio-economic conditions of any directly affected person

A number of positive social impacts associated with the project have been identified and summarised below:

- Creation of jobs during the construction and operational phase of the surface mitigation measure project;
- Ensure a safer environment which is able to sustain a long-term land use; and
- Prevent major impacts associated with pillar failure which may occur if the proposed project is not implemented.

25.2 Impact on any national estate referred to in section 3(2) of the National Heritage Resources Act.

A Heritage NID was compiled and submitted to the SAHRA and the Heritage Resource Authority of Free State. With the exception of the burial grounds and graves, which carry a high cultural significance, much of the archaeology in the greater project site is of low significance. No geological outcrops or palaeontological resources were identified during the pre-disturbance survey, and only one historical structure and four burial grounds were recorded. Additional potential historical structures were identified through aerial imagery.

The identified resources occur in excess of 250m distance from the proposed Project activities and development footprint. Considering the nature of the Project, the cultural landscape baseline, and distribution of known heritage resources, Digby Wells has requested exemption from further heritage assessment in terms of Section 38 of the NHRA.

26 Other matters required in terms of sections 24(4)(a) and (b) of the Act

Section 24(4)(b)(i) of the NEMA (as amended), provides that an investigation must be undertaken of the potential consequences or impacts of the alternatives to the activity on the environment and assessment of the significance of those potential consequences or impacts, including the option of not implementing the activity. The outcome of the investigation has been provided in Section 7 to Section 14 Part A of this BAR.

Part B: Environmental Management Programme Report

1 Details of the EAP

Digby Wells and Associates (South Africa) (Pty) Ltd (trading as Digby Wells Environmental – hereafter Digby Wells) has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the EIA process. The details of the EAP are provided in below.

Table 1-1: Contact Details of the EAP

Name of Practitioner:	Mr Danie Otto
Telephone:	011 789 9495
Fax:	011 069 6801
Postal Address	Private Bag X10046, Randburg, 2125, South Africa
Email:	Danie.Otto@digbywells.com

2 Description of the aspects of the activity

A summary of the baseline environment in the project area is provided in Part A: Section 11.

The flowing specialist studies have been undertaken for the proposed project:

- Wetlands and Aquatics Specialist Study (Appendix D);
- Fauna and Flora Specialist Study (Appendix E);
- Surface Water Specialist Study (Appendix F);
- Soil, Land Use and Land Capability Specialist Study (Appendix G);
- Heritage Specialist Study (Appendix H); and
- Rehabilitation Specialist Study (Appendix I).

3 Composite Map

The composite plan for the project area, indicating sensitive areas, heritage resources watercourse buffers, is included as Plan 18 in Appendix B.

4 Description of Impact management objectives including management statements

4.1 Determination of closure objectives

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 main objectives to ensure a sustainable environment is achieved:

- Achieve a final land use where no direct impact to the Leeuspruit and Rietspruit occurs even if pillar failure occurs;
- Maintain and monitor all surface mitigation measures and rehabilitated areas following re-vegetation;
- Monitor to ensure no impact to the water resources occur once surface mitigation has been completed;
- Comply with local, district and national regulatory requirements; and
- Follow a comprehensive consultation and communication process with all stakeholders.

As the project is considered to not have a decommissioning phase the rehabilitation and closure objectives have been tailored to the project at hand. Sasol Mining proposes to obtain environmental authorisation for the proposed project to reduce the impact to surface if pillar failure were to occur. It should be noted that R 517 Million has been secured through financial guarantee for mitigation measures that are proposed to address the significant impact of subsidence and reduce the risk to insignificant. Of this R 517 Million, R 425,780,183.90 has been allocated to the surface mitigation measure project for construction and operational phases.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

4.2 Volumes and rate of water use required for the operation

It is not considered that significant quantities of water will be utilised to both implement the construction phase of the project and during the operational phase of the project. Water will be utilised for drinking water for various contractors which will be brought on to site from an external supplier. No water from the water courses will be utilised to implement the surface mitigation project.

4.3 Has a water use licence has been applied for?

An IWUL application with its associated IWWMP for the proposed surface mitigation measure project will be submitted to the DWS to apply for the water use activities. The IWUL application will aim to apply for the following water uses:

- Section 21 (c): impeding or diverting the flow of water in a watercourse; and
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

5 Impacts to be mitigated in their respective phases

The following mitigation measures implemented to address the negative impacts associated with the proposed project is described in Table 5-1.

Table 5-1: Mitigation Measures to be implemented per Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
Berm construction	Leeuspruit Section 2	Alteration in the seasonality and flow of the wetlands and river reaches	Wetland and Aquatic Ecology	Approximately 3.5ha of floodplain are expected to be a potential loss	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 2	Direct loss of floral species/vegetation	Fauna and Flora	Local	Construction Phase	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Construction Phase
Berm construction	Leeuspruit Section 2	The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit.	Surface Water	Local	Construction Phase	▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
							BPG:G1 Storm Water Management.	
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 2	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the river reaches (floodlines). The floodplain will potentially be pushed over to the east and encroach onto the area closer to the ash dump to the north east of the section. This can potentially increase capturing of contaminants from runoff from the ash dam.	Surface Water	Local	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	Construction Phase
Construction of the canals	Leeuspruit Section 3	This activity is likely to result in a complete loss of wetland area as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Fragmentation of the system and loss of migration routes are also a risk.	Wetland and Aquatic Ecology	Approximately 15.2ha of floodplains (including a small portion of hillslope seep) are expected to be lost	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase
Construction of the canals	Leeuspruit Section 3		Wetland and Aquatic Ecology		Construction Phase	▪ No mitigation measures proposed.		Construction Phase

Berm construction	Leeuspruit Section 3	Alteration in the seasonality and flow of the Leeuspruit. The proposed activity is likely to result in the destruction of the portion of the wetlands (mostly floodplain and a small portion of hillslope seep) where they are covered by the proposed berm, in turn, resulting in a direct loss of wetland.	Wetland and Aquatic Ecology	Local	Construction Phase	▪ Berms
						  ▪ Sufficient drains need to be installed to facilitate seepage underneath berms.
						  ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
						  ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan).
						  ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing.
						  ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings.
						  ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.
						▪ Canal
						  ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration.
						  ▪ Suitable vegetation and river cobbles should be strategically placed
								Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
						in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.		
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of floral wetlands. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the excavation of the wetlands to construct the canals; this will result in a loss of a wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland.	Fauna and Flora	Local	Construction Phase	▪ No mitigation measures proposed.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Construction Phase
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 3 and 4	Direct loss of floral species/vegetation of the Secondary Grassland Unit	Fauna and Flora	Local	Construction Phase	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.		Construction Phase
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of secondary grassland. The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation	Fauna and Flora	Local	Construction Phase	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act,	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals.					1998 (Act No. 84 of 1998) Protected Trees.	

Berm construction	Leeuspruit Section 3	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Local	Construction Phase	▪ Berms
						  ▪ Sufficient drains need to be installed to facilitate seepage underneath berms.
						  ▪ Clearing of vegetation must be limited to the development footprint.
						  ▪ Dust suppression measures must be implemented on the cleared areas during construction.
						  ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
						  ▪ Berms should be reseeded with indigenous grasses to prevent erosion.
						  ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings.
						  ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.
						▪ Canal
						  ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration.
						  ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.
							▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119.
							▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.
								Construction Phase

Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 3	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Local	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	Construction Phase
Canal Construction	Leeuspruit Section 3	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion,	Surface Water	Local	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.					Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	
Construction of the canals – wetland ecology	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a complete loss of wetland area, as well as large impacts downstream such as erosion, sedimentation and altered water quality.	Wetland and Aquatic Ecology	Approximately 32ha of floodplain and hillslope seep are expected to be potentially affected	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase
Construction of the canals – instream ecology	Leeuspruit Section 4		Wetland and Aquatic Ecology	Approximately 32ha of floodplain and hillslope seep are expected to be potentially affected	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase

Berm construction	Leeuspruit Section 4	A narrowing of the floodplain may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water within a smaller area, resulting in an indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for	Wetland and Aquatic Ecology	Approximately 32ha of floodplain and hillslope seep are expected to be potentially affected	Construction Phase	▪ Berms
						  ▪ Sufficient drains need to be installed to facilitate seepage underneath berms.
						  ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
						  ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan).
						  ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing.
							▪ The NWA Section 21 (c) and (i).
							▪ Section 24 of the Constitution.
							▪ NEMBA.
							▪ NEMA.
							▪ DWAF guidelines for the delineation of wetlands (2005).
							▪ Mining and Biodiversity Guideline (DEA et al., 2013).
								Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		sedimentation downstream. The portion of the wetlands (mostly floodplain and a small portion of seep) that are covered by the berm will be destroyed, resulting in a direct loss of wetland.				▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.	▪ MTPB, 2014.	
Berm construction	Leeuspruit Section 4	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Local	Construction Phase	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	Construction Phase
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 4	The construction of flood protection berms at Leeuspruit Section 4 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Local	Construction Phase			Construction Phase
Canal Construction	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct	Surface Water	Local	Construction Phase		▪ Government Notice 704 (GN704).	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.					Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	
Berm construction	Rietspruit Section 1	A narrowing of the floodplain and channelled valley bottom may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water, thus potentially resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Wetland and Aquatic Ecology	Approximately 0.8ha of floodplain and channelled valley bottom are expected to be potentially affected	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase
Construction of flood protection berms require vegetation clearing	Rietspruit Section 1	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system.	Fauna and Flora	Local	Construction Phase	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Construction Phase
Berm construction	Rietspruit Section 1	Siltation of the Rietspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Rietspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Local	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119.	Construction Phase
Alteration in the	Rietspruit	The construction of flood protection	Surface	Local	Construction			Construction

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
seasonality and flow of the river reaches (floodlines)	Section 1	berms at Rietspruit Section 1 may result in an alteration in the seasonality and flow of the Rietspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Water		Phase	soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	Phase
Site access and disturbance	All Sections	Activities associated with the construction of these river diversion measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems.	Wetland and Aquatic Ecology	Local	Construction Phase	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms: ▪ Where the track has a slope of less than 2%, berms every 50m should be installed; ▪ Where the track slopes between 2% and 10%, berms every 25m should be installed; ▪ Where the track slopes between 10%-15%, berms every 20m should be installed; and ▪ Where the track has slope greater than 15%, berms every 10m should be installed. ▪ Limit the footprint area of the construction activities to what is essential to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ If it is unavoidable that any of the wetland or instream areas present (not withstanding those already accounted for in the proposed activities) will be affected, disturbance must be minimised and suitably rehabilitated. ▪ Ensure that no incision and canalisation of the wetland and instream features present takes place. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ Permit only essential personnel within the 100m zone of regulation for	▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEM:BA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase
Instream freshwater biodiversity destruction	All Sections	In terms of instream ecology, large potential impacts related to loss of flow connectivity, fragmentation of the system, loss of natural migration routes and the loss of natural habitat and substrates has the potential to limit the biodiversity of the instream ecology of this portion of the Leeuspruit.	Wetland and Aquatic Ecology	Local	Construction Phase		▪ The NWA Section 21 (c) and (i). ▪ Section 24 of the Constitution. ▪ NEMBA. ▪ NEMA. ▪ DWAF guidelines for the delineation of wetlands (2005). ▪ Mining and Biodiversity Guideline (DEA et al., 2013). ▪ MTPB, 2014.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
						all freshwater features identified. ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon as a result of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. The No-go zone should be avoided. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Wetlands should be monitored monthly during construction. ▪ The no-go area indicated in Plan 13 must be avoided by any construction activities or movement of vehicles in this area. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility. ▪ A wetland offset strategy should be developed to compensate for the loss of wetland and instream areas due to the canals and berms. Ideally, the PES and EIS of wetlands and instream areas within Sasol's mining lease area should be improved. ▪ All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel.		
Site establishment and establishment of access and service roads	All Sections	Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity.	Fauna and Flora	Local	Construction Phase	▪ Construction activities must be restricted to the project footprint. ▪ Designated construction areas must be clearly demarcated, and contractors must make use of existing access route. ▪ Best practices noise control management measures must be applied to minimise noise during construction. ▪ Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction. ▪ Proper waste management must be implemented, and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ During site preparation, special care must be taken during the clearing of the work areas to minimise damage or disturbance of roosting and nesting sites. ▪ Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
Site establishment for camp laydown and construction requires vegetation clearance	All Sections	The clearing of vegetation and Indirect loss of downstream habitat through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the project site.	Fauna and Flora	Local	Construction Phase	▪ Phased vegetation clearing must be implemented to minimise the extent of bare areas. ▪ An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species (Refer to Section 10.2 Appendix I rehabilitation specialist study). ▪ If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place. ▪ Indigenous vegetation must be utilised during the revegetation of disturbed areas. Refer to Section 10.3 for the Revegetation Plan in Appendix I	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Construction Phase
Site access and disturbance	All Sections	Potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream.	Surface Water	Local	Construction Phase	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon because of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility. ▪ Regular inspections of all boreholes must be undertaken to ensure the boreholes are not overflowing. Should the boreholes be found to be overflowing the borehole must be sealed and a valve and pressure sensor installed to monitor the pressure of the borehole. If a large spillage occurs where excess water is discharged to the Leeuspruit these incidents must be reported to the various departments within a suitable period of time in accordance with legislation.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
Clearing of vegetation	Leeuspruit Section 2	Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.	Soil, Land Use and Land Capability	Local	Construction Phase	▪ Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded. ▪ If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated. ▪ Restriction of vehicle movement over sensitive areas to reduce compaction. ▪ Minimise unnecessary removal of the natural vegetation cover. ▪ Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Limit the construction of new roads during construction phase, where possible. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Topsoil to a depth of 0.3m should be stripped first and stockpiled separately. ▪ The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence. ▪ Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place especially for soils that have high erosion potential. ▪ For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site. ▪ In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan). ▪ Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.	▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase
Clearing of the vegetation	Leeuspruit Section 3	Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction. Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility.	Soil, Land Use and Land Capability	Local	Construction Phase		▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase
Construction of the flood protection berms and canal	Leeuspruit Section 3	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Local	Construction Phase		▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase
Clearing of vegetation	Leeuspruit Section 4	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Local	Construction Phase		▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase
Construction of the flood protection berms and canal	Leeuspruit Section 4	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Local	Construction Phase		▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase
Clearing of vegetation	Rietspruit Section 1	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes	Soil, Land Use and Land Capability	Local	Construction Phase		▪ NEMA. ▪ CARA. ▪ NEMWA.	Construction Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		compaction which reduces the vegetation's ability to grow and as a result erosion could occur.						
All construction activities	All Sections	Impact to heritage resources	Heritage	Local	Construction Phase	▪ Sasol Mining establishes and maintains a buffer zone of at least 50m around the identified heritage resources. The buffers must be clearly demarcated, and appropriate signage be placed during the construction phase. Where such a buffer cannot be maintained, Digby Wells proposes a Heritage Watching Brief be undertaken by a qualified and accredited archaeologist to ensure the identified heritage resources are not impacted upon. ▪ Sasol Mining must develop a project-specific CFP and FFP for implementation during the establishment and construction phase of the Project. ▪ The proponent immediately informs SAHRA of any chance finds identified and enlists the services of a qualified and accredited archaeologist to assess and recommend appropriate mitigation measures.	▪ The National Heritage Resources Act, 1999 (Act No. 25 of 1999). ▪ Regulations to the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (GN R 548) (SAHRA Regulations). ▪ SAHRA Minimum Standards: Archaeological and Paleontological Components of Impact Assessment Reports.	Construction Phase
Implementation of surface mitigation measures	All Sections	Creation of jobs during the construction and operational phase of the surface mitigation measure project	Social	Local	Construction / Operational Phase	▪ Where feasible, promote the creation of employment opportunities for women and youth. ▪ Where possible, workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities. ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy. ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002). ▪ Mine Health and Safety Act (Act of 1996). ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS). ▪ International Human Rights Guiding Principles. ▪ IFC PS 4: Community Health, Safety and Security. ▪ National Environmental Management Act (Act of 1998).	Construction / Operational Phase

Site access for maintenance and monitoring purposes	All Sections	The main activities during the operational phase that could result in impacts to the freshwater ecology of the area are associated with the monitoring and maintenance activities.
		Associated potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural
			Wetland and Aquatic Ecology	Local	Operational Phase	▪ Berms
						  ▪ Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section) thereby reducing the functionality and health of the wetlands.
						  ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed.
						  ▪ Berms should be monitored for erosion. Erosion must be remedied.
							▪ The NWA Section 21 (c) and (i).
							▪ Section 24 of the Constitution.
							▪ NEM:BA.
							▪ NEMA.
							▪ DWAF guidelines for the delineation of wetlands (2005).
							▪ Mining and Biodiversity Guideline (DEA et al.,
								Operational Phase

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
		migration routes for instream fauna and further fragmentation of the systems present.				If recurring erosion is taking place, alternatives should be explored. ▪ Canal ▪ Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years. ▪ Biomonitoring to be conducted by suitably qualified wetland and aquatic ecologists on a biannual basis for a minimum of three years. ▪ General ▪ Limit the footprint area of the operational activities to what is essential to minimise impacts as a result of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas). ▪ If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible. ▪ Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities. ▪ All erosion noted within the operational footprint as a result of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report). ▪ All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel. ▪ No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Monitor all systems for erosion and incision. ▪ All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ If significant rehabilitation measures are required, mitigation measures of the construction phase must be implemented.	2013). ▪ MTPB, 2014.	

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Size and scale of disturbance	Phase	Mitigation Type	Compliance with standards	Time period for implementation
						▪ Permit only essential personnel within the 100m zones of regulation for all freshwater features identified. ▪ Ongoing wetland rehabilitation is necessary during the operational phase as stipulated in the monitoring section (Section 8.1.1).		
Destruction and disturbance through site access associated with routine maintenance	All Sections	The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present.	Fauna and Flora	Local	Operational Phase	▪ An Alien Plant Management Strategy must be implemented during the operational phase whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. ▪ Monitoring must preferably take place between November and March. ▪ All alien plant species must be identified, demarcated, and removed. ▪ Where possible, make use of existing roads rather than creating new access routes. ▪ The area must be kept clear of all invader plants as per the NEMBA. ▪ Rehabilitation measures must be employed until such a time as indigenous species is established. ▪ Suitable erosion control measures should be implemented.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1. ▪ NEMBA listed species. ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Operational Phase
Rehabilitation of the disturbed areas	All Sections	Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery.	Soil, Land Use and Land Capability	Local	Operational Phase	▪ Effective soil cover and adequate protection from wind and water. ▪ Soil amelioration to enhance the growth capability of the soils. ▪ If erosion has occurred, usable soil should be sourced and replaced and shaped to reduce the recurrence of erosion. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Limit the construction of new roads during construction phase, where possible. ▪ Rehabilitate according to the rehabilitation plan. ▪ Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical. ▪ Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.	▪ NEMA. ▪ CARA. ▪ NEMWA.	Operational Phase

6 Impact management outcomes

A description of impact management outcomes, identifying the standard of impact management required for the aspects contemplated in Table 6-1.

Table 6-1: Impact Management Outcomes

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
Berm construction	Leeuspruit Section 2	Alteration in the seasonality and flow of the wetlands and river reaches	Wetland and Aquatic Ecology	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 2	Direct loss of floral species/vegetation	Fauna and Flora	Construction Phase	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees
Berm construction	Leeuspruit Section 2	The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation of the freshwater resources downstream. In addition, the bare soil could potentially result in sedimentation and thereby alter water quality within the Leeuspruit.	Surface Water	Construction Phase	▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 2	The construction of flood protection berms at Leeuspruit Section 2 is likely to result in an alteration in the seasonality and flow of the river reaches (floodlines). The floodplain will potentially be pushed over to the east and encroach onto the area closer to the ash	Surface Water	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		dump to the north east of the section. This can potentially increase capturing of contaminants from runoff from the ash dam.				Government Gazette 20119. ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.
Construction of the canals	Leeuspruit Section 3	This activity is likely to result in a complete loss of wetland area as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Fragmentation of the system and loss of migration routes are also a risk.	Wetland and Aquatic Ecology	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014
Construction of the canals	Leeuspruit Section 3		Wetland and Aquatic Ecology	Construction Phase	▪ No mitigation measures proposed.	
Berm construction	Leeuspruit Section 3	Alteration in the seasonality and flow of the Leeuspruit. The proposed activity is likely to result in the destruction of the portion of the wetlands (mostly floodplain and a small portion of hillslope seep) where they are covered by the proposed berm, in turn, resulting in a direct loss of wetland.	Wetland and Aquatic Ecology	Construction Phase	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.	
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of floral wetlands. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the	Fauna and Flora	Construction Phase	▪ No mitigation measures proposed.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998)

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		excavation of the wetlands to construct the canals; this will result in a loss of a wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland.				Protected Trees
Construction of flood protection berms require vegetation clearing	Leeuspruit Section 3 and 4	Direct loss of floral species/vegetation of the Secondary Grassland Unit	Fauna and Flora	Construction Phase	▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.	
Clearing and excavation for the construction of formalised canals	Leeuspruit Section 3 and 4	Direct and indirect loss of secondary grassland. The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals.	Fauna and Flora	Construction Phase	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees
Berm construction	Leeuspruit Section 3	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management.
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 3	The construction of flood protection berms at Leeuspruit Section 3 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the	Surface Water	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.			any efforts at maintaining migration routes and flow connectivity.	▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Canal Construction	Leeuspruit Section 3	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.	Surface Water	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Construction of the canals – wetland ecology	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a complete loss of wetland area, as well as large impacts downstream such as erosion, sedimentation and altered water quality.	Wetland and Aquatic Ecology	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014
Construction of the canals – instream ecology	Leeuspruit Section 4		Wetland and Aquatic Ecology	Construction Phase	▪ No mitigation measures proposed.	▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014

Berm construction	Leeuspruit Section 4	A narrowing of the floodplain may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water within a smaller area, resulting in an indirect loss of wetland habitat. The concentrated flow	Wetland and Aquatic Ecology	Construction Phase	▪ Berms
					  ▪ Sufficient drains need to be installed to facilitate seepage underneath berms.
					  ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently.
					  ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant
						▪ The NWA Section 21 (c) and (i)
						▪ Section 24 of the Constitution
						▪ NEMBA
						▪ NEMA
						▪ DWAF guidelines for the

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream. The portion of the wetlands (mostly floodplain and a small portion of seep) that are covered by the berm will be destroyed, resulting in a direct loss of wetland			species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Suitable vegetation and river cobbles should be strategically placed in such a manner as to provide refuge and habitat to the various species likely to occur in this reach of the Leeuspruit system. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity. ▪ Indigenous species should be hand planted within the canal to provide habitat for freshwater ecology. ▪ Armorflex or a similar product like Terraforce must be used and filled with soil and planted.	delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014
Berm construction	Leeuspruit Section 4	Siltation of the Leeuspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Leeuspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	▪ Berms ▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan. ▪ Canal ▪ It should be ensured that energy dissipation measures be installed to slow and spread the flow of water at discharge points to reduce the potential for erosion and to assist with infiltration. ▪ Regular care and maintenance of the canal should be undertaken to ensure no build-up of litter and debris, which would affect the flow of the system and negate any efforts at maintaining migration routes and flow connectivity.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Alteration in the seasonality and flow of the river reaches (floodlines)	Leeuspruit Section 4	The construction of flood protection berms at Leeuspruit Section 4 may result in an alteration in the seasonality and flow of the Leeuspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Surface Water	Construction Phase		
Canal Construction	Leeuspruit Section 4	The largest potential impact is the excavation of the system to construct the canals. This activity is likely to result in a floodline changes (impact on wetlands) as well as large impacts	Surface Water	Construction Phase		▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		in the downstream reaches of the Leeuspruit such as erosion, sedimentation and altered water quality. Natural flow will remain but the canalisation of water will increase the velocity that will start to take place during construction and this will increase erosion. Fragmentation of the system is also a risk.				the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Berm construction	Rietspruit Section 1	A narrowing of the floodplain and channelled valley bottom may take place as the proposed berm area is likely to restrict water movement and result in the concentration and canalisation of the water, thus potentially resulting in a direct and indirect loss of wetland habitat. The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for sedimentation downstream.	Wetland and Aquatic Ecology	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion (see Appendix C in the Aquatic and Wetland Specialist Study Appendix D for the plant species plan). ▪ Cattle and other grazing animals must be kept off the erosion berms whilst vegetation is establishing. Non-palatable species have also been included in the species mix to deter grazing. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of an ongoing rehabilitation plan.	▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014
Construction of flood protection berms require vegetation clearing	Rietspruit Section 1	Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system.	Fauna and Flora	Construction Phase	▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary (areas as indicated in the maps where disturbance will occur). ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees
Berm construction	Rietspruit Section 1	Siltation of the Rietspruit because of increased soil exposure and disturbance during the construction of the flood protection berm can lead to impacts on the water quality of the Rietspruit. This will further be impacted due to increased concentrated flow.	Surface Water	Construction Phase	▪ Sufficient drains need to be installed to facilitate seepage underneath berms. ▪ Clearing of vegetation must be limited to the development footprint. ▪ Dust suppression measures must be implemented on the cleared areas during construction. ▪ Berms should be monitored after large rainfall events to ensure that they are draining sufficiently. ▪ Berms should be reseeded with indigenous grasses to prevent erosion. ▪ In high erosion areas, mulch or hessian should be used to protect the soil and growth of new seedlings. ▪ All erosion noted along berms should be remedied immediately and included as part of a rehabilitation plan.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management
Alteration in the seasonality and flow of the river reaches (floodlines)	Rietspruit Section 1	The construction of flood protection berms at Rietspruit Section 1 may result in an alteration in the seasonality and flow of the Rietspruit. A slight narrowing of the floodplain may potentially take place as the natural seasonal flooding over the berm area is considered unlikely, thus resulting in the containment of water within a smaller area and an indirect loss of flooded area (wetland within the floodplains). The concentrated flow of water may also result in increased erosion and potential for gulley formation, loss of vegetation and increased potential for	Surface Water	Construction Phase		

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		sedimentation downstream.				

Site access and disturbance	All Sections	Activities associated with the construction of these river diversion measures includes site clearing, soil disturbance, topsoil stockpiling, storage and dumping of building materials, compaction of soils and crossing of the wetland and river systems.	Wetland and Aquatic Ecology	Construction Phase	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation.
					▪ During the construction phase, erosion berms should be installed on roadways and downstream of stockpiles to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms:
					  ▪ Where the track has a slope of less than 2%, berms every 50m should be installed;
					  ▪ Where the track slopes between 2% and 10%, berms every 25m should be installed;
					  ▪ Where the track slopes between 10%-15%, berms every 20m should be installed; and
					  ▪ Where the track has slope greater than 15%, berms every 10m should be installed.
					▪ Limit the footprint area of the construction activities to what is essential to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas).
					▪ If it is unavoidable that any of the wetland or instream areas present (not withstanding those already accounted for in the proposed activities) will be affected, disturbance must be minimised and suitably rehabilitated.
					▪ Ensure that no incision and canalisation of the wetland and instream features present takes place.
					▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan.
					▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction.
					▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information).
					▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified.
					▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained.
					▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines.
					▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon as a result of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. The No-go zone should be avoided.
					▪ All vehicles must be regularly inspected for potential hydrocarbon leaks.
					▪ Re-fueling must take place at a diesel facility, on a sealed surface area away from wetlands to prevent ingress of hydrocarbons into topsoil.
					▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly.
					▪ Wetlands should be monitored monthly during construction.
					▪ The no-go area indicated in Plan 13 must be avoided by any construction activities or movement of vehicles in this area.
					▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.
						▪ The NWA Section 21 (c) and (i)
						▪ Section 24 of the Constitution
						▪ NEMBA
						▪ NEMA
						▪ DWAF guidelines for the delineation of wetlands (2005)
						▪ Mining and Biodiversity Guideline (DEA et al., 2013)
						▪ MTPB, 2014

Instream freshwater biodiversity destruction	All Sections	In terms of instream ecology, large potential impacts related to loss of flow connectivity, fragmentation of the system, loss of natural migration routes and the loss of natural habitat and substrates has the potential to limit the biodiversity of the instream ecology of this portion of the Leeuspruit.	Wetland and Aquatic Ecology	Construction Phase		▪ The NWA Section 21 (c) and (i) ▪ Section 24 of the Constitution ▪ NEMBA ▪ NEMA ▪ DWAF guidelines for the delineation of wetlands (2005) ▪ Mining and Biodiversity Guideline (DEA et al., 2013) ▪ MTPB, 2014

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
					▪ A wetland offset strategy should be developed to compensate for the loss of wetland and instream areas due to the canals and berms. Ideally, the PES and EIS of wetlands and instream areas within Sasol's mining lease area should be improved. ▪ All areas of increased ecological sensitivity should be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel.	
Site establishment and establishment of access and service roads	All Sections	Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity.	Fauna and Flora	Construction Phase	▪ Construction activities must be restricted to the project footprint. ▪ Designated construction areas must be clearly demarcated, and contractors must make use of existing access route. ▪ Best practices noise control management measures must be applied to minimise noise during construction. ▪ Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction. ▪ Proper waste management must be implemented, and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ During site preparation, special care must be taken during the clearing of the work areas to minimise damage or disturbance of roosting and nesting sites. ▪ Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees
Site establishment for camp laydown and construction requires vegetation clearance	All Sections	The clearing of vegetation and Indirect loss of downstream habitat through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the project site.	Fauna and Flora	Construction Phase	▪ Phased vegetation clearing must be implemented to minimise the extent of bare areas. ▪ An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species (Refer to Section 10.2 Appendix I rehabilitation specialist study). ▪ If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place. ▪ Indigenous vegetation must be utilised during the revegetation of disturbed areas. Refer to Section 10.3 for the Revegetation Plan in Appendix I.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees
Site access and disturbance	All Sections	Potential impacts include erosion and sedimentation, the potential further loss of biodiversity and habitat, fragmentation of the systems present a potential loss of catchment yields, loss of migration routes and surface water recharge to the systems further downstream.	Surface Water	Construction Phase	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction. ▪ Permit only essential personnel within the 100m zone of regulation for all freshwater features identified. ▪ No material may be dumped or stockpiled within any rivers, tributaries or drainage lines. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland or instream areas and their associated zones of regulation (notwithstanding those areas to be directly impacted upon because of the proposed activities). All vehicles must remain on demarcated roads and within the construction footprint. ▪ Hydrocarbon spills should be cleaned up immediately and treated accordingly. ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.	▪ Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119 ▪ Department of Water Affairs (DWA), 2006. Best Practice Guidelines series. BPG:G1 Storm Water Management

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
					▪ Regular inspections of all boreholes must be undertaken to ensure the boreholes are not overflowing. Should the boreholes be found to be overflowing the borehole must be sealed and a valve and pressure sensor installed to monitor the pressure of the borehole. If a large spillage occurs where excess water is discharged to the Leeuspruit these incidents must be reported to the various departments within a suitable period of time in accordance with legislation.	
Clearing of vegetation	Leeuspruit Section 2	Vegetation will be cleared during the construction of the flood protection berm which leads to soils being exposed and promoting erosion and compaction.	Soil, Land Use and Land Capability	Construction Phase	▪ Berms should be monitored for erosion monthly for the first year and quarterly for the second year to ensure they are not being eroded. ▪ If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place and where erosion has occurred should be rehabilitated. ▪ Restriction of vehicle movement over sensitive areas to reduce compaction. ▪ Minimise unnecessary removal of the natural vegetation cover. ▪ Plan excavations carefully and avoid moving of heavy machinery into sensitive areas unnecessarily. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Limit the construction of new roads during construction phase, where possible. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Topsoil to a depth of 0.3m should be stripped first and stockpiled separately. ▪ The subsoil of 0.4 – 1.2m should be stripped and stockpiled separately and replaced on berms in same sequence. ▪ Soil erosion might pose a problem once vegetation cover is removed; thus, erosion monitoring should take place especially for soils that have high erosion potential. ▪ For major spills, if soils are contaminated they must be stripped and disposed of at a licensed waste disposal site. ▪ In the event of a hydrocarbon spill, the spill must be cleaned up immediately to prevent further pollution. ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan (Refer to Rehabilitation Plan). ▪ Surface inspection on the fully rehabilitated flood protection berm and diverted areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.	▪ NEMA ▪ CARA ▪ NEMWA
Clearing of the vegetation	Leeuspruit Section 3	Vegetation will be cleared during the construction of the flood protection berm which leads to soils exposed and promoting erosion and compaction. Topsoil and subsoil will be removed from the soil profile; the profile loses effects rooting depth, water holding capacity and soil fertility.	Soil, Land Use and Land Capability	Construction Phase		▪ NEMA ▪ CARA ▪ NEMWA
Construction of the flood protection berms and canal	Leeuspruit Section 3	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Construction Phase		▪ NEMA ▪ CARA ▪ NEMWA
Clearing of vegetation	Leeuspruit Section 4	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur	Soil, Land Use and Land Capability	Construction Phase		▪ NEMA ▪ CARA ▪ NEMWA
Construction of the flood protection berms and canal	Leeuspruit Section 4	Removal of soil layers will impact on land capability and potential land use. During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.	Soil, Land Use and Land Capability	Construction Phase		▪ NEMA ▪ CARA ▪ NEMWA
Clearing of vegetation	Rietspruit Section 1	Removal of vegetation may lead to dust generation and erosion, respectively. The movement of heavy machinery on the soil	Soil, Land Use and Land Capability	Construction Phase		▪ NEMA ▪ CARA ▪ NEMWA

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
		surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur.				
All construction activities	All Sections	Impact to heritage resources	Heritage	Construction Phase	▪ Sasol Mining establishes and maintains a buffer zone of at least 50m around the identified heritage resources. The buffers must be clearly demarcated, and appropriate signage be placed during the construction phase. Where such a buffer cannot be maintained, Digby Wells proposes a Heritage Watching Brief be undertaken by a qualified and accredited archaeologist to ensure the identified heritage resources are not impacted upon. ▪ Sasol Mining must develop a project-specific CFP and FFP for implementation during the establishment and construction phase of the Project. ▪ The proponent immediately informs SAHRA of any chance finds identified and enlists the services of a qualified and accredited archaeologist to assess and recommend appropriate mitigation measures.	▪ The National Heritage Resources Act, 1999 (Act No. 25 of 1999) ▪ Regulations to the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (GN R 548) (SAHRA Regulations) ▪ SAHRA Minimum Standards: Archaeological and Paleontological Components of Impact Assessment Reports
Implementation of surface mitigation measures	All Sections	Creation of jobs during the construction and operational phase of the surface mitigation measure project	Social	Construction / Operational Phase	▪ Where feasible, promote the creation of employment opportunities for women and youth. ▪ Where possible, workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities. ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy. ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).

Site access for maintenance and monitoring purposes	All Sections	The main activities during the operational phase that could result in impacts to the freshwater ecology of the area are associated with the monitoring and maintenance activities.
		Associated potential impacts could include compaction of soils and hardening of surfaces, erosion and sedimentation, the potential loss of biodiversity and habitat, loss of natural migration routes for instream fauna and further fragmentation of the systems present.
			Wetland and Aquatic Ecology	Operational Phase	▪ Berms
					  ▪ Flood protection berms should be monitored after large rainfall events / monthly to ensure that they are not being eroded by the stream channels (Leeuspruit Section 2, Section 3 and Rietspruit Section) thereby reducing the functionality and health of the wetlands.
					  ▪ Slow release outlet pipes installed within the berm should be monitored to ensure that any blockages are discovered and removed.
					  ▪ Berms should be monitored for erosion. Erosion must be remedied. If recurring erosion is taking place, alternatives should be explored.
					▪ Canal
					  ▪ Monitoring the effectiveness of the canals by a suitably qualified engineer once a year and after extreme rainfall events for a period of five years.
					  ▪ Biomonitoring to be conducted by suitably qualified wetland and aquatic ecologists on a biannual basis for a minimum of three years.
						▪ The NWA Section 21 (c) and (i)
						▪ Section 24 of the Constitution
						▪ NEMBA
						▪ NEMA
						▪ DWAF guidelines for the delineation of wetlands (2005);
						▪ Mining and Biodiversity Guideline (DEA et al., 2013);
						▪ MTPB, 2014

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
					▪ General ▪ Limit the footprint area of the operational activities to what is essential to minimise impacts as a result of any potential vegetation clearing and compaction of soils (all areas but critically so in freshwater areas). ▪ If it is unavoidable that any of the freshwater areas present will be affected, disturbance must be minimised and rehabilitated where possible. ▪ Ensure that no incision and canalisation of the freshwater features present takes place because of the proposed operational activities. ▪ All erosion noted within the operational footprint as a result of any potential surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan (see Rehabilitation Report). ▪ All areas of increased ecological sensitivity should be designated as “No-Go” areas and be off limits to all unauthorised vehicles and personnel. ▪ No unnecessary crossing of the wetland features, instream areas and their associated buffers, as well as the constructed berms or canals should take place and the substrate conditions of the wetlands, instream areas and downstream stream connectivity must be maintained. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any freshwater areas and their associated zones of regulation. All vehicles must remain on demarcated roads. ▪ All vehicles must be regularly inspected for potential hydrocarbon leaks. ▪ Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil. ▪ Hydrocarbon Spills should be cleaned up immediately and treated accordingly. ▪ Monitor all systems for erosion and incision. ▪ All erosion noted within the footprint should be remedied immediately and included as part of an ongoing rehabilitation plan. ▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation. ▪ All soils compacted because of construction activities should be ripped/scarified (<300mm) and profiled (see the Soil Specialist Report for more information). ▪ If significant rehabilitation measures are required, mitigation measures of the construction phase must be implemented. ▪ Permit only essential personnel within the 100m zones of regulation for all freshwater features identified. ▪ Ongoing wetland rehabilitation is necessary during the operational phase as stipulated in the monitoring section (Section 8.1.1).	
Destruction and disturbance through site access associated with routine maintenance	All Sections	The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present.	Fauna and Flora	Operational Phase	▪ An Alien Plant Management Strategy must be implemented during the operational phase whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. ▪ Monitoring must preferably take place between November and March. ▪ All alien plant species must be identified, demarcated, and removed. ▪ Where possible make use of existing roads rather than creating new access routes. ▪ The area must be kept clear of all invader plants as per the NEMBA. ▪ Rehabilitation measures must be employed until such a time as indigenous species is established. ▪ Suitable erosion control measures should be implemented.	▪ South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 ▪ NEMBA listed species; and ▪ National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.

Activity	Surface Mitigation Measures Section	Potential Impact	Aspects Affected	Phase	Mitigation Type	Compliance with standards
Rehabilitation of the disturbed areas	All Sections	Revegetate disturbed areas to ensure erosion does not occur, rehabilitate areas affected by laydown and machinery.	Soil, Land Use and Land Capability	Operational Phase	▪ Effective soil cover and adequate protection from wind and water. ▪ Soil amelioration to enhance the growth capability of the soils. ▪ If erosion has occurred, usable soil should be sourced and replaced and shaped to reduce the recurrence of erosion. ▪ Use of slotted pipes installed within the berm should be monitored to ensure that any blockages are removed. ▪ Only the designated access routes are to be used to reduce any unnecessary compaction. ▪ Rehabilitate according to the rehabilitation plan. ▪ Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical. ▪ Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated.	▪ NEMA ▪ CARA ▪ NEMWA

7 Financial Provision

7.1 Determination of the amount of Financial Provision

7.1.1 Describe the closure objectives and the extent to which they have been aligned to the baseline environment described under the Regulation

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 main objectives for rehabilitation and closure:

- Make all areas safe for both humans and animals;
- Make all areas stable and sustainable;
- Maintain and monitor all rehabilitated areas following re-vegetation;
- Comply with local, district and national regulatory requirements; and
- Follow a comprehensive consultation and communication process with all stakeholders.

As the project is considered to not have a decommissioning phase the rehabilitation and closure objectives have been tailored to the project at hand. Sasol Mining proposes to obtain environmental authorisation for the proposed project to reduce the impact to surface if pillar failure were to occur.

7.1.2 Confirm specifically that the environmental objectives in relation to closure have been consulted with landowner and interested and affected parties

A separate closure plan does not form part of this BAR process. It should also be noted that the project will be permanent and will not be decommissioned once successfully implemented. The activities relevant to the surface mitigation project have been included in the Sigma financial provisioning. This BAR will be made available for public review for a period of 30 days.

7.1.3 Provide a rehabilitation plan that describes and shows the scale and aerial extent of the main mining activities, including the anticipated mining area at the time of closure

This section is considered to be not applicable. The surface mitigation measure project is considered to be a mitigation measure to ensure remediation of the Sigma Defunct Colliery mining lease area. A closure plan has been compiled by Golder Associates Inc. in 2009 and submitted to the DMR for consideration. The aim of the project is to implement mitigation measures with the aim of achieving closure for the Sigma Defunct Colliery.

7.1.4 Explain why it can be confirmed that the rehabilitation plan is compatible with the closure objectives

This section is considered to be not applicable. The surface mitigation measure project is considered to be a mitigation measure to ensure remediation of the Sigma Defunct Colliery mining lease area. A closure plan has been compiled by Golder Associates Inc. in 2009 and submitted to the DMR for consideration. The aim of the project is to implement mitigation measures with the aim of achieving closure for the Sigma Defunct Colliery.

7.1.5 Calculate and state the quantum of the financial provision required to manage and rehabilitate the environment in accordance with the applicable guideline

Sasol proposes to obtain environmental authorisation to implement surface mitigation measures which include designs for diversion canals and flood protection berms to channel the Leeuspruit and Rietspruit away from areas identified to have a significant potential for pillar failure which could potentially result in subsidence. It should be noted that R 542,885,649.00 (as calculated on 30 June 2017) has been secured through financial guarantee for the implementation of mitigation measures that are proposed to address the significant impact of subsidence and reduce the risk to insignificant. Of this R 542,885,649.00, R 425,780,183.90 Million has been allocated to the surface mitigation measure project for construction and operational phases. Table 7-1 provides a breakdown of the costing.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

The financial provision breakdown is provided in Table 7-1.

Table 7-1: Financial Provision for Surface Mitigation Measures (FY2017)

Site	Inventory Item	Work Item	Qty FY17	Rate FY17	Amount FY17
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit	1	246,041,879.47	246,041,879
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit - contingency	1	24,604,187.95	24,604,188
SID1 - Sigma Defunct Mitigation	SID1-011 Leeuspruit sections 2, 3, 5 (ingress)	Sigma: Leeuspruit - P&G	1	32,477,528.09	32,477,528
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit	0.94	104,384,576.10	98,521,450
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit - contingency	1	10,365,168.54	10,365,169
SID1 - Sigma Defunct Mitigation	SID1-012 Rietspruit (ingress)	Sigma: Rietspruit - P&G	1	13,769,969.36	13,769,969
Total					**R 425,780,183.90**

7.1.6 Confirm that the financial provision will be provided as determined

The financial guarantee of R 542,885,649.00 Million has already been approved and provided for in Sigma Defunct Colliery financial provision for rehabilitation.

8 Monitoring compliance with and performance assessment

Mechanisms for monitoring compliance with and performance assessment against the environmental management programme and reporting thereon is described below.

8.1 Monitoring of impact management actions

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented. The monitoring programmes have been discussed below.

8.1.1 Wetland Monitoring

Monitoring to be conducted by an independent suitably qualified wetland specialist. The specialist will be responsible for identify where wetland monitoring must be undertaken. The timing of such monitoring audits should be as follows:

- Monthly during the construction phase;
- Quarterly for the first three years after construction; and

- Annually for a minimum of two years should any ongoing issues be observed within the three years post-construction.

Wetland monitoring should monitor the change in PES and EIS. It is highly recommended that ongoing monitoring of the wetlands in the vicinity of the Sigma Defunct Colliery continue 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 to guide the management process going forward.

8.1.2 Aquatic Biomonitoring

Monitoring to be conducted by an independent suitably qualified aquatic specialist. The location for aquatic monitoring must be undertaken at the sites listed in Table 11-6. The timing of such monitoring audits should be as follows:

- Quarterly during the construction phase;
- Biannually for a minimum of three years thereafter.

Monitoring is required upstream and downstream of the proposed activities and should include as a minimum: water quality, macro-invertebrate integrity, fish community integrity (on the lower reaches of the Leeuspruit system) and habitat suitability assessments. It is highly recommended that ongoing monitoring of the instream integrity in the vicinity of the Sigma Defunct Colliery continue to identify any emerging trends in terms of improvements or degradations in the ecological integrity and functioning of these systems, with special relevance to maintenance of biodiversity. It is advisable that the same assessor be utilised for ongoing monitoring purposes to minimise fluctuations and irregularities in the results because of variations in sampling times and efficiency.

8.1.3 Fauna and Flora Monitoring

Upon completion of the construction phase, a vegetation rehabilitation programme for disturbed and degraded areas on site must be instituted and monitored accordingly. In addition to this, alien invasive plants must be monitored regularly and controlled through the use of an Alien Invasive Management Strategy as per NEMBA. The plan must include mitigation measures to reduce the invasion of alien species and ensure that the continuous monitoring and removal of alien species is undertaken. Refer to Section 10.2 Appendix I of the rehabilitation specialist study.

Aspects that will be monitored in the annual surveys will include species richness, vegetation composition i.e. proportion grasses, forbs and woody species, canopy height, cover percentage, the presence of Red Data or protected species, and presence of alien invasive species.

8.1.3.1 Vegetation Cover Monitoring

The vegetation cover established on the disturbed areas (berms and canals) needs to be monitored after construction phase has been completed as follows:

- Every second month for the first six months; and
- Thereafter, annually during the wet season for a period of two years.

Monitoring aims to ensure that the rehabilitation work has been successful in terms of stabilising the newly formed surfaces (preventing air and water erosion from affecting those surfaces), and that the newly established vegetation cover is trending towards convergence with the original vegetation cover found on the areas prior to disturbance (and on adjacent undisturbed areas) (Dawson, 2007).

Environmental indicators that need to be kept in mind to assess whether rehabilitation has been successful or not include the following:

- Increasing similarity between rehabilitated and undisturbed areas in terms of species composition and vegetation structure;
- Increasing species diversity of desired (local) species in rehabilitation cover over time;
- Reduction in presence of weed species over time;
- Increase in woody plant growth, and achievement of reproductive status and production of reproductive propagules (seed);
- Ability of the rehabilitation species populations to reproduce, indicated by the presence of seedlings of the rehabilitation species once the original generation has reached sexual maturity (“population recruitment”);
- Increase in vegetation basal cover and biomass; and
- Increase in soil organic matter.

If the vegetation cover remains static, or deteriorates; additional seeding, with locally harvested species, and possibly fertilisation, would be required as a mitigation measure.

8.1.3.2 Alien Vegetation Monitoring

During vegetation monitoring, the presence of alien species must also be detected. An active program of weed management, to control the presence and spread of invasive weeds, will need to be instituted.

Species likely to be problematic include those identified during the field assessment; namely *Acacia mearnsii, Cosmos bipinnatus Cortaderia selloana*, *Salix babylonica Persicaria lapathifolia*, *Solanum incanum*, *Solanum mauritianum* and *Targetes minuta* amongst others

The environmental indicator assessed in this instance is the reduction in presence of weed species over time, to the point where no invasive weed species are present, and no further population recruitment occurs.

8.1.4 Surface Water Monitoring

Sigma Defunct Colliery has an existing monitoring programme in place. It is proposed that monitoring should be implemented throughout the project (12 months) as well as during operation (at least three years or until impacts are not identified through monitoring). The impacts on water quality will be determined by benchmarking the monitoring data against the Leeu/Taaiboschspruit Water Quality Guidelines RWQO to determine any impact on the quality of water (positive/negative). The surface water monitoring plan is summarised in Table 8-1.

Table 8-1: Surface Water Monitoring Pan

Monitoring Element	Comment	Frequency	Responsibility
Water quality	Ensure water quality monitoring as per existing monitoring program and all the locations indicated in Table 11-20. Parameters should include but not limited to the components displayed in Table 11-19.	-Monthly during construction -Monitoring needs to carry on three years after the project has ceased, as is standard practice to detect residual impacts.	Environmental Officer
Physical structures (diversion channels and proposed berms)	Overflows and system malfunctions should be monitored by personnel and mitigated appropriately.	Continuous monthly process for at least 3 years after construction	Environmental Officer
	Protection berms and diversion canals are inspected for silting and blockages of inflow pipelines for hydraulic integrity;		

8.1.5 Soil, Land Use and Land Capability

The following items for soil, land use and land capability should be monitored monthly for the first year and quarterly for the second year and bi-annually for the third year until sustainability is confirmed. Monitoring should take place annually for a minimum of two years should any ongoing issues be observed within three years post-construction. :

- Soils:
  - Erosion status;

- Compaction;
- Runoff; and
- Contamination.

8.1.6 Rehabilitation

Routine inspections and maintenance is required to maintain the system in a good working condition. It is recommended that inspections be carried out monthly for the first year and quarterly for the second year and bi-annually for the third year until sustainability is confirmed. Monitoring should take place annually for a minimum of two years should any ongoing issues be observed within three years post-construction.

Monitoring must be undertaken at the start of the dry season. This allows maintenance activities to be carried out, as well as after major flood events (Jones & Wagener, 2018). Since no measuring stations are present within either of the two streams a major flood event is defined as any one of the following taken from Jones & Wagener (2018):

- Rain in excess of ± 70mm over a 24-hour period (1:5-year storm), or;
- Flood event causing either of the two streams to overtop the R59 tar road, or;
- Flood event causing the Leeuspruit to encroach into the town area past the fence erected in between the town and Section 4, or;
- Whenever any damage or excessive flooding is reported by the community.

The following inspection and maintenance activities (Table 8-2) need to be carried out during routine and post-flood inspections (Jones & Wagener, 2018).

Table 8-2: Required Routine Inspection and Maintenance Actions

Required Inspections	Maintenance Actions
Inspect all culverts for debris and siltation.	Remove debris or siltation.
Review condition of vegetation inside streams.	Remove excessive vegetation such as large shrubs and trees that may cause a flow obstruction. Remove loose vegetation (branches, driftwood, etc.). Revegetate ineffectively vegetated areas by hand-planting.
Inspect all structures, for example, berms, waterways, courses, and so forth for erosion and structural damage.	Inform responsible engineer to action appropriate repair work to re-establish structures.
Inspect entire stream for signs of subsidence, surface cracks, sinkholes or potholes.	Inform responsible engineer to action appropriate repair work.

Required Inspections	Maintenance Actions
Inspect fence in between Sasolburg Town and Leeuspruit Section 4.	Restore fence if damaged.
Inspect connections for damage to road or culvert / bridge structure.	Notify accountable authority to action correct repair work. In case of severe damage resulting in a road safety hazard notify traffic police and implement temporary warning signs.
Inspect the stream for any deviation to the normal design flow path (e.g. regular overtopping of banks, noteworthy deviation caused by silt deposition, etc.).	Notify accountable engineer to inspect and take appropriate action if required.

Note: The obligation and necessities for reviews and support should be reassessed if the framework is exchanged to another proprietor than Sasol, for instance upon definite conclusion of the mine. It is important that the framework be reviewed, and the support directed, by an appropriately qualified individual to guarantee it stays practical.

8.2 Monitoring and reporting frequency

Table 8-3 discusses the monitoring and reporting frequency.

8.3 Responsible persons

The roles and responsibilities associated with the monitoring programme are set out in Table 8-3.

8.4 Time period for implementing impact management actions

Table 8-3 captures the time period for implementing impact management actions.

8.5 Mechanism for monitoring compliance

Table 8-3 sets out the method of monitoring, the implementation of the impact management actions, the frequency of monitoring the implementation of the impact management actions, an indication of the persons who will be responsible for the implementation of the impact management actions, the time periods within which the impact management actions must be implemented and the mechanism for monitoring compliance with the identified impact management actions.

Table 8-3: Monitoring and Management of Environmental Impacts

Source Activity	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
All Activities	Wetlands	It is highly recommended that ongoing monitoring of the wetlands in the vicinity of the Sigma Defunct Colliery continue 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 to guide the management process going forward.	Independent suitably qualified wetland specialist	The timing of such monitoring audits should be as follows: ▪ Monthly during the construction phase; ▪ Quarterly for the first three years after construction; and ▪ Annually for a minimum of two years should any ongoing issues be observed within the three years post-construction.
All Activities	Aquatic Ecology	Monitoring is required upstream and downstream of the proposed activities and should include as a minimum: water quality, macro-invertebrate integrity, fish community integrity (On the lower reaches of the Leeuspruit system) and habitat suitability assessments. It is highly recommended that ongoing monitoring of the instream integrity in the vicinity of the Sigma Defunct Colliery continue to identify any emerging trends in terms of improvements or degradations in the ecological integrity and functioning of these systems, with special relevance to maintenance of biodiversity. It is advisable that the same assessor be utilised for ongoing monitoring purposes to minimise fluctuations and irregularities in the results because of variations in sampling times and efficiency.	Independent suitably qualified aquatic specialist	The timing of such monitoring audits should be as follows: ▪ Quarterly during the construction phase; ▪ Biannually for a minimum of three years thereafter.
Overall (Ongoing)	Establishment and spread of alien plant species	Alien invasive vegetation monitoring and control through Alien Invasive Management Plan, NEMBA and Best Practice Guidelines (Refer to Section 10.2 Appendix I of the rehabilitation specialist study) Indicators: ▪ Reduction in presence of weed species over time. ▪ No further population recruitment.	Environmental Control Officer	▪ Every second month for the first six months; and ▪ Thereafter, annually during the wet season for a period of two years.
Overall (Operational Phase)	Vegetation establishment and erosion	Vegetation monitoring through rehabilitation plan Indicators: ▪ Ability of the rehabilitation species populations to reproduce indicated by the presence of seedlings of the rehabilitation species once the original generation has reached sexual maturity (“population recruitment”). ▪ Increase in soil organic matter. ▪ Decrease in bare vulnerable areas. ▪ Increasing similarity between rehabilitated and undisturbed areas in terms of species composition and vegetation structure. ▪ Increasing species diversity of desired (local) species in rehabilitation cover over time.	Environmental Control Officer	▪ Every second month for the first six months; and ▪ Thereafter, annually during the wet season for a period of two years.
All Activities	Water quality	Ensure water quality monitoring as per existing monitoring program and all the locations indicated in Table 11-20. Parameters should include but not limited to the components displayed in Table 11-19	Environmental Control Officer	▪ Monthly during construction ▪ Monitoring needs to carry for three years after the project has ceased, as is standard practice to detect residual impacts.
Physical structures (diversion channels and proposed berms)	Surface Water	Overflows and system malfunctions should be monitored by personnel and mitigated appropriately.	Environmental Control Officer	Continuous monthly process for at least 3 years after construction
	Surface Water	Protection berms and diversion canals are inspected for silting and blockages of inflow pipelines for hydraulic integrity;	Environmental Control Officer	Continuous monthly process for at least 3 years after construction

Source Activity	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
Waste management	Soil, Land Use and Land Capability	Bins must be provided for disposal of waste during construction	Contractors, Environmental Control Officer and Project Manager	During construction phase
Equipment and storage areas	Soil, Land Use and Land Capability	Equipment maintenance must be done offsite. Storage areas must be within the fenced area and located away from all sensitive areas	Contractors, Environmental Control Officer and Project Manager	During construction phase
Hazardous materials	Soil, Land Use and Land Capability	Spillage plan must be developed. Refuelling must be done offsite to prevent potential soil pollution from spillage	Contractors and Environmental Control Officer	During construction phase to end
Soil erosion and sediment control	Soil, Land Use and Land Capability	Clearing activities must be restricted to the footprint of berms and canals	Contractors, Environmental Control Officer and Project Manager	During construction phase
Erosion and sediment control	Soil, Land Use and Land Capability	Removed soil must be stored away from drainage areas	Contractors, Environmental Control Officer and Project Manager	During construction phase
Stockpile management	Soil, Land Use and Land Capability	Stockpiled soils must not be located far away from replacement areas. Must be protected from potential erosion and limit the height. Must be kept clear of weeds and alien vegetation.	Contractors, Environmental Control Officer and Project Manager	During construction phase
Excavations	Soil, Land Use and Land Capability	Excavations must be undertaken carefully and taking into consideration of the weather conditions. If high rainfalls are expected, excavations should be put on hold.	Contractors, Environmental Control Officer and Project Manager	During construction phase
Soil management	Soil, Land Use and Land Capability	Topsoil and sub soil must be stored separately. Soil must not be stockpiled for more than 6 months. However, if stockpiled for more than 6 months the topsoil must be ameliorated prior to remediation.	Contractors, Environmental Control Officer and Project Manager	During construction phase
Audit Reports	Auditing against the construction conditions outlined within the approved EMP and Environmental Authorisation (EMP Performance Assessment)	To determine compliance to EMP conditions.	Internal Environmental Officer Independent Third Party (external ECO)	Daily monitoring by Internal Environmental Officer during construction phase Monthly monitoring by external ECO during construction phase
Audit Reports	Auditing against the operational conditions outlined within the approved EMP and Environmental Authorisation (EMP Performance Assessment)	To determine compliance to EMP conditions	Environmental Officer/Independent Third Party	Annual Performance Assessment (for a period of three years)
All activities	Rehabilitation activities during construction and operational phase	The purpose of monitoring is to ensure that the objectives of rehabilitation are met, and that the rehabilitation process is followed as discussed in Section 8.1.6.	Environmental Officer/Independent Third Party	It is recommended that inspections be carried out monthly for the first year and quarterly for the second year and bi-annually for the third year until sustainability is confirmed. Monitoring should take place annually for a minimum of two years should any ongoing issues be observed within three years post-construction. Monitoring must be undertaken at the start of the dry season.

9 Indicate the frequency of the submission of the performance assessment/ environmental audit report

Monitoring to be undertaken during the construction phase must be completed daily by the internal ECO appointed at Sigma Defunct Colliery and monthly by an external independent ECO. The reports must be submitted to the DMR on a monthly basis. A performance assessment report for the surface mitigation measure project during operation phase will be submitted on an annual basis to the DMR for a period of five years.

10 Environmental Awareness Plan

10.1 Manner in which the applicant intends to inform his or her employees of any environmental risk which may result from their work

Sasol Mining has developed internal Environmental, Health and Safety Policies. The Environmental Policy will be communicated to all personnel, whether they are contractors or permanent staff, and the policy will be displayed at Sigma Defunct Colliery and at the contractor's yard.

Employees will receive general environmental awareness training on specific items contained in this EMP, as well as on Best Possible Environmental Practices (BPEP).

10.1.1 Specific Environmental Training

Environmental Awareness Training will be undertaken to make employees and contractors aware of the following:

- The importance of conforming with the environmental policy and procedures and with the requirements of the EMP;
- The significant social and environmental impacts of their work activities and the environmental benefits of improved personal performance;
- Their roles and responsibilities in achieving conformance with the environmental policy and procedures and with the requirements of the environmental management system;
- The potential consequences of departure from specified operating procedures; and
- Possible archaeological finds action steps for mitigation measures, surface collections, excavations and communication routes to follow in the case of a discovery.

The guidelines for training are summarised below, which are in line with the ISO 14001:2004 guidelines with regards to training and awareness creation.

Table 10-1: Training Guidelines

Types of Training	Audience	Purpose
Raising awareness of the strategic importance of environmental management	Senior management	To gain commitment and alignment to the organisation's environmental policy.
Raising general environmental awareness	All employees	To gain commitment to the environmental policy and objectives and to instil a sense of individual responsibility.
Skill enhancement	Employees with environmental responsibilities	To improve performance in specific tasks.
Compliance	Employees whose actions can affect compliance	To ensure that regulatory and internal requirements for training are met.

The training programme will consist of the following elements:

- Identification of employee training needs;
- Development of a training plan to address defined needs;
- Verification of conformance of the training programme to regulatory or organisation requirements and standards;
- Training of target employee groups;
- Documentation of training received; and
- Evaluation of training received.

This training is undertaken on an annual basis for all personnel, together with the annual required induction programmes. The training material provided will be subject to annual review, based on issues such as incidents, accidents, new legislative requirements, modified processes and environmental and social aspects identified from time to time. This training is to be carried out and coordinated internally by Sasol Mining.

Sasol Mining will, therefore, develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets.

In addition, the Sigma Defunct Colliery Emergency Preparedness and Response Plan will be updated to include measures relevant to the surface mitigation measure project and communicated and trained to all site personnel during the induction process.

10.2 Manner in which risks will be dealt with in order to avoid pollution or the degradation of the environment

An Emergency Response Plan has been developed for the Sigma Defunct Colliery and will be updated and implemented for the proposed surface mitigation measure project. The approach used by Sasol Mining to respond to risks that may pollute or degrade the environment during the construction and operational phase is detailed in this internal procedure.

The unplanned events that may happen at the project site and the proposed mitigation plan are listed in Table 10-2.

Table 10-2: Unplanned Events, Risks and their Management Measures

Unplanned event	Mitigation / Management / Monitoring
Hydrocarbon spills from vehicles, heavy machinery and workshop areas.	▪ Hydrocarbons and hazardous substances must be stored in bunded areas and any refuelling should take place in contained areas; ▪ Vehicles and heavy machinery should be serviced and checked on a regular basis according to the maintenance plan of each to prevent leakages and spills; and ▪ All stationary vehicles must have drip trays placed beneath them to prevent any hydrocarbon contamination.
Spills form hazardous materials or waste storage facilities.	▪ Implementation of storm water management system around hazardous materials or waste storage facilities to contain spills; ▪ Provide sufficient capacities for the storage of waste (temporary waste bins for use by construction workers on the construction site; ▪ Ensure that an agreement is in place with a suitable qualified service provider to remove the waste on a regular basis; ▪ All hazardous waste should be removed by a suitably qualified service provider and disposed of to an approved permitted landfill site; ▪ Prevent any spills from occurring; ▪ If a spill occurs it should be cleaned up (Drizit spill kit/ Enertech type spill kit, Oil or Chemical spill kit) immediately and reported to the appropriate authorities; and ▪ Emergency response plans should be in place.
Accidents and structural failure	▪ Equipment and infrastructure must be designed to withstand natural phenomena as best possible; ▪ Regular inspections and maintenance must be carried out in all sections; and ▪ Impacts of natural hazards, such as flooding, must not be exacerbated;

11 Specific information required by the Competent Authority

No request for specific information has been requested for this project by the DMR to date.

12 Undertaking

The EAP herewith confirms:-

- the correctness of the information provided in the reports
- the inclusion of comments and inputs from stakeholders and I&APs ;
- the inclusion of inputs and recommendations from the specialist reports where relevant; and
- the acceptability of the project in relation to the finding of the assessment and level of mitigation proposed.

Signature of the Environmental Assessment Practitioner:	 Danie Otto
Name of Company:	Digby Wells Environmental
Date:	September 2018

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Appendix A: CV

Appendix B: Plans

Plan 1: Sigma Defunct Mine – Mining Layout Map

Plan 2: Regional Map

Plan 3: Local Map

Plan 4: Land Tenure Map

Plan 5: Proposed Surface Mitigation Measure Infrastructure

Plan 6: Location of where Pillar Failure is predicted to occur based on Risk Assessment

Plan 7: Surface Mitigation Measure – Leeuspruit Section 2

Plan 8: Surface Mitigation Measure – Leeuspruit Section 3

Plan 9: Surface Mitigation Measure – Leeuspruit Section 4

Plan 10: Surface Mitigation Measure – Leeuspruit Section 5

Plan 11: Surface Mitigation Measure – Rietspruit Section 1

Plan 12: Wetland Delineations

Plan 13: No Go Area for protected species

Plan 14: Identified Vegetation communities

Plan 15: Monitoring Locations for all Environmental Aspects

Plan 16: Result of the Heritage Pre-disturbance Survey

Plan 17: Land use at Sasol Defunct Colliery

Plan 18: Composite Map

Appendix C: Public Participation Process

Appendix D: Aquatic and Wetland Specialist Study

Appendix E: Fauna and Flora Specialist Study

Appendix F: Surface Water Specialist Study

Appendix G: Soil Specialist Study

Appendix H: Heritage Specialist Study

Appendix I: Rehabilitation Specialist Study