Environmental Authorisation Process to Decommission a Conveyor Belt Servitude, Road and Quarry at Twistdraai East Colliery, Secunda, Mpumalanga Province

Baseline Aquatic Biodiversity and Impact Assessment

Project Number:

SAS5544

Prepared for:

Sasol Mining (Pty) Ltd.

January 2019

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Baseline Aquatic Biodiversity and Impact Assessment**
Project Name:	**Environmental Authorisation Process to Decommission a Conveyor Belt Servitude, Road and Quarry at Twistdraai East Colliery, Secunda, Mpumalanga Province**
Project Code:	**SAS5544**

Name	**Responsibility**	**Signature**	**Date**
Nathan Cook Cand.Sci.Nat.	Fieldwork/Reporting		January 2019
Byron Bester Pr.Sci.Nat.	Technical Review		January 2019

EXECUTIVE SUMMARY

Digby Wells Environmental has been appointed by Sasol Mining (Pty) Ltd to to undertake a Basic Assessment Process for the decommissioning of the Twistdraai East Shaft conveyor belt servitude, access road and quarry near Secunda, Mpumalanga. This document serves as the baseline aquatic biodiversity and impact assessment of the surrounding watercourses associated with the Twistdraai East Shaft conveyor belt servitude.

Standard River Health Programme (now referred to as River EcoStatus Monitoring Programme) and diatom sampling techniques were utilised in this study in an attempt to quantify the current health status and conditions of the associated aquatic ecosystems prior to the onset of the proposed decommissioning activities. A single survey during the month of November 2018 was allocated for the completion of the field survey and observations, whereby key findings are highlighted as follows:

Baseline Condition

Water quality in the assessed aquatic ecosystems indicated marginally elevated pH levels (i.e. above or close to 8) throughout the study area. These sites also expressed high conductivity readings, potentially indicating high dissolved solids content at the time of the aquatic survey. However, the aforementioned findings could both be attributed to the inherent wetland nature of each of the assessed monitoring sites. Although, a few notably elevated conductivity readings (i.e. exceeding 9 000 µS/cm) provided evidence of potential anthropogenic influence. On the contrary, oxygen levels recorded in all of the monitoring sites were fair, meeting the recommended guideline limits for aquatic life. Therefore, it was suspected that oxygen content would not be a limiting factor for the colonisation of sensitive aquatic biota.

Due largely to the inherent wetland nature of the associated watercourses and the non-applicability of the selected aquatic macroinvertebrate assessment indices (i.e. Invertebrate Habitat Assessment System, South African Scoring System, etc.), the aquatic macroinvertebrate assemblage supported by these systems was only deemed to be appropriate for application at a single monitoring site in the C12D-01663 Sub-Quaternary reach (Site 11B). In light of the poor habitat availability, a total of only 14 different taxa were sampled, comprising of mainly air breathing, tolerant families. The Macroinvertebrate Response Assessment Index conducted indicated that the assemblage at the site is seriously modified (i.e. Ecological Category E) from the determined reference conditions. This was somewhat to be expected due to the already disturbed nature of the monitoring site observed in the form of sedimentation and habitat deterioration.

In an effort to define the ecological condition of the other associated watercourses within the study area, a diatom assessment was conducted at sites with sufficient substrate for sampling. Each of the respective Ecological Categories defined ranged from largely modified (i.e. Ecological Category D) to minimally modified (i.e. Ecological Category B) at watercourse crossing points associated with the conveyor, its servitude and associated access roads. This assessment also shed light on the perceived water quality classes associated with the diatom assemblages recorded, ranging from Poor to Good conditions. These conditions form the basis of the aquatic baseline but are limited due to dry conditions observed at some of the sites needed for assessment.

Impact Assessment

The main focus of the aquatic impact assessment was the crossing points associated with the conveyor and its servitude. The roadway and quarry did not form part of this assessment due to its proximity to a major wetland system (i.e. see Digby Wells wetlands report for information pertaining to this specific infrastructure).

The findings of the impact assessment perceive that the major concern associated with the Project is the potential to erode and increase sediment load into the watercourses associated with the conveyor and servitude crossing points, including the exposed pipeline sections. In addition, habitat destruction and deterioration has also been highlighted as a potential cause for concern. It is predicted that the operation of heavy machinery during decommissioning will result in the compaction of surfaces, potentially increasing runoff, causing minor erosion and sedimentation of the downstream aquatic ecosystems. Physical machinery contact within the instream pathway of the watercourse crossing points (e.g. during the removal of structures such as culverts) as well as the proximity of operations to vegetation associated with the watercourses are predicted to result in the aforementioned habitat related impact.

Mitigation measures provided are predicted to limit the associated impacts from a minor concern to a negligible concern, especially as most of the watercourses crossing points are already impacted from a morphological perspective. However, the proposed rehabilitation activities are envisaged to greatly improve the habitat and water quality conditions as observed / recorded during the study.

Recommendations

An aquatic biomonitoring programme has been developed in this document and should be implemented for the entirety of the decommissioning project (i.e. minimum of three years of monitoring) and further continued until the re-seeded vegetation has established. It is also important for the appointed specialist to keep in mind the diatom assessment limitations encountered during the study (e.g. dry conditions). The specialist should attempt to sample diatoms at each of the watercourse crossing points associated with the conveyor and pipeline, as outlined in this study, as not all crossing points were assessable at the time of the baseline survey.

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1 Introduction

Digby Wells Environmental (hereinafter Digby Wells) has been appointed by Sasol Mining (Pty) Ltd to undertake a Basic Assessment Process for the decommissioning of the Twistdraai East Shaft conveyor belt and servitude road in Secunda, Mpumalanga.

1.1 Project Background

Sasol Mining (Pty) Ltd (hereinafter Sasol Mining), is the holder of a converted new order mining right, which was consolidated from several prospecting and mining rights (known as the Secunda Complex mining right) with Department of Mineral Resources (DMR) reference number: MP 30/5/1/2/3/2/1/138 MR.

Sasol currently operates six coal mines that supply feedstock for their Secunda (Sasol Synfuels) and Sasolburg (Sasolburg Operations) complexes in South Africa. Sasol's underground mining operations are at Bosjesspruit, Brandspruit, Middelbult, Syferfontein and Twistdraai (all in the Secunda area) and Sigma near Sasolburg which consist of Mooikraal (operational) and Sigma defunct which is in closure.

As part of daily management of the various shaft areas, the Secunda Complex has been subdivided with each of shaft areas having its own separate Environmental Management Programme (EMPR). The Twistdraai Colliery's EMPR (DMR Reference Number: MP 30/5/1/2/3/2/1(138) EM) was amended and submitted to the DMR in 2010, which was subsequently approved on 29 February 2012.

The Twistdraai Colliery is made up of three separate shafts, namely:

- Twistdraai West Shaft;
- Twistdraai East Shaft; and
- Twistdraai Central Shaft.

Of these three shafts, two (the Central and West Shafts) have been decommissioned, rehabilitated and renovated for alternative purposes. The Central Shaft was converted into a training facility and accommodation while West Shaft was given back to the farmer. The Twistdraai East shaft is the last shaft to be decommissioned with most of the infrastructure already having been removed. The decommissioning of each of these shafts was undertaken in accordance with its Amended Environmental Management Programme Report (EMPr), approved in 2012 (Ref No. MP 30/5/1/2/3/2/1(138) EM) where no additional listed activities were triggered.

This application relates specifically to the remaining decommissioning activities to be undertaken at Twistdraai East Shaft, which requires both an Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998) (NEMA), and a General Authorisation in accordance with the National Water Act (Act No. 36 of 1998) (NWA).

The following activities are to be undertaken, which may require environmental authorisation:

- Decommissioning and rehabilitation of an access road and associated culverts which was constructed between Mynpad Road and the Twistdraai East Shaft which permits access to the Shaft;
- Decommissioning and rehabilitation of the conveyer belt servitude including access road, water supply pipeline and culverts which was previously utilised to transport coal from Twistdraai Colliery to Twistdraai Export Plant; and
  - It must be noted that the decommissioning of the water supply pipelines will only be decommissioned where it daylights over various tributaries. The remaining pipelines which are located beneath ground level will not be disturbed or removed during the decommissioning process.
- Decommissioning and rehabilitation of a mine water supply pipeline located within the conveyor belt servitude. The proposed project is a decommissioning and rehabilitation project with the aim to ensure all mining infrastructure is removed with minimal impact to the surrounding environment and to ensure the area is rehabilitated to a more natural state. The project aims to have an overall positive impact on the surrounding environment.

The proposed project is a decommissioning and rehabilitation project with the aim to ensure all mining infrastructure is removed with minimal impact to the surrounding environment and to ensure the area is rehabilitated to a more natural state, thereby reducing the impact to the environment caused by previous mining activities. The local setting of the proposed project is displayed in Figure 1-1.

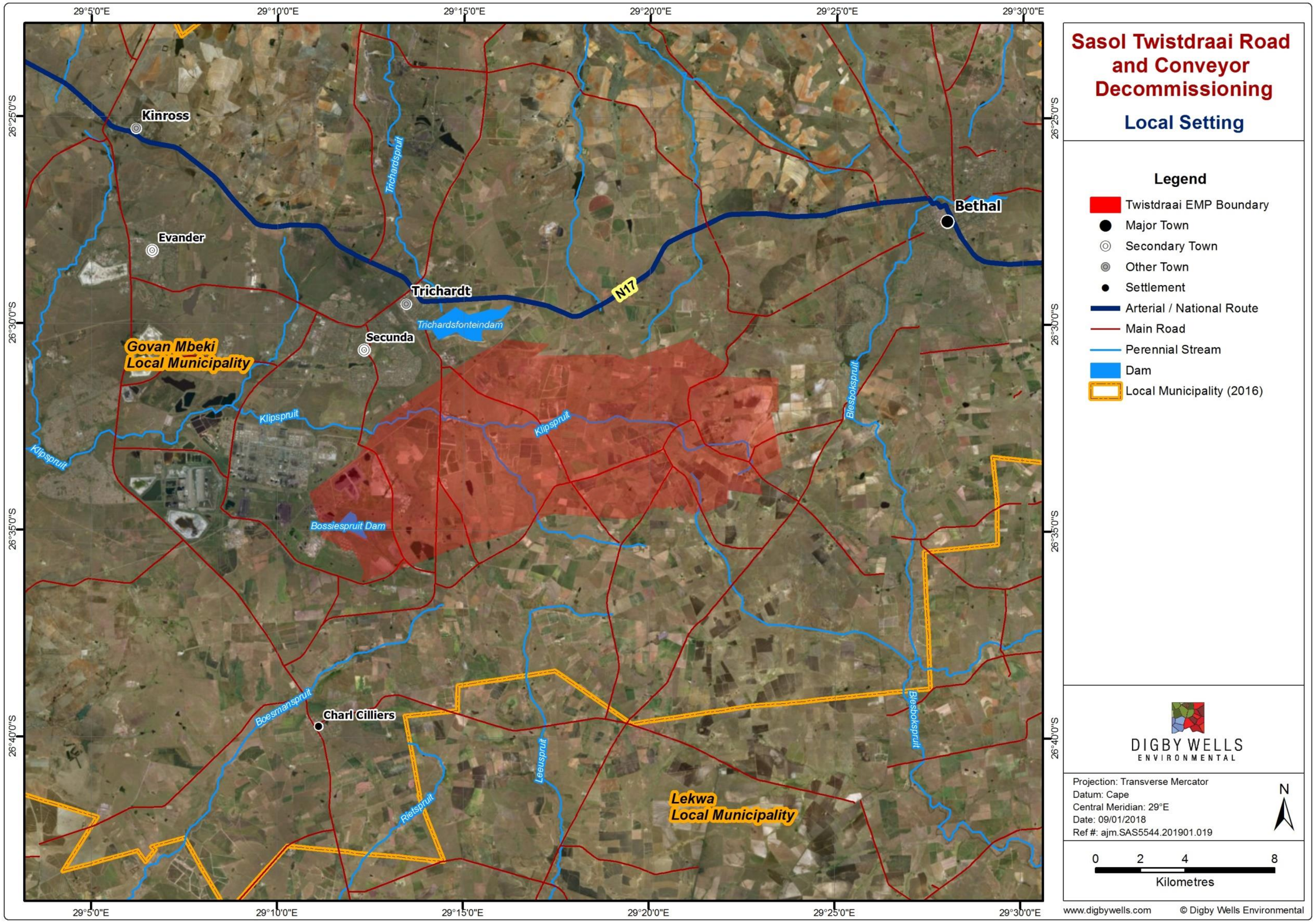

Figure 1-1: Local project setting

2 Details of the Specialist

This Specialist Report has been compiled by the following specialists (Table 2-1).

Table 2-1: Details of the Specialist(s) who prepared this Report

Responsibility	**Field work and report compilation**
Full Name of Specialist	Nathan Cook
Highest Qualification	BSc Hon in Aquatic Ecosystem Health
Years of experience in specialist field	2
Registration	South African Council for Natural Scientific Professionals: *Candidate Natural Scientist* (Reg. No. 119160)
Responsibility	**Report review**
Full Name of Specialist	Byron Bester
Highest Qualification	MSc in Aquatic Health
Years of experience in specialist field	8
Registration	South African Council for Natural Scientific Professionals: *Professional Natural Scientist* (Reg. No. 400662/15)

3 Conditions of this Report

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

No form of this report may be amended or extended without the prior written consent of the author and/or a relevant reference to the report by the inclusion of an appropriately detailed citation.

Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

4 Scope and Methodology of the Study

As a part of the Environmental Authorisation process for the proposed decommissioning project associated with the Twistdraai East Colliery (conveyor belt servitude, access road and quarry) (hereinafter the Project), an aquatic impact assessment was required to be undertaken within the surrounding aquatic ecosystems, in order to establish baseline conditions prior to the commencement of the Project. Furthermore, this study aims to determine the current aquatic biodiversity, aquatic ecological integrity and identify any potential aquatic-related impacts through a single aquatic survey as detailed below.

It is important to note that only channelled aquatic ecosystems, expressing some degree of riverine structure, were considered for the study. Therefore, the focus of this assessment consists solely on areas where the conveyor and its servitude crosses watercourses as well as where the water supply pipeline daylights over the watercourses. The access to the Twistdraai Colliery from the Mynpad Road was not included in this assessment as it is associated with a major wetland system (Figure 4-1) not applicable for aquatic studies (see the wetlands report – Digby Wells, 2019).

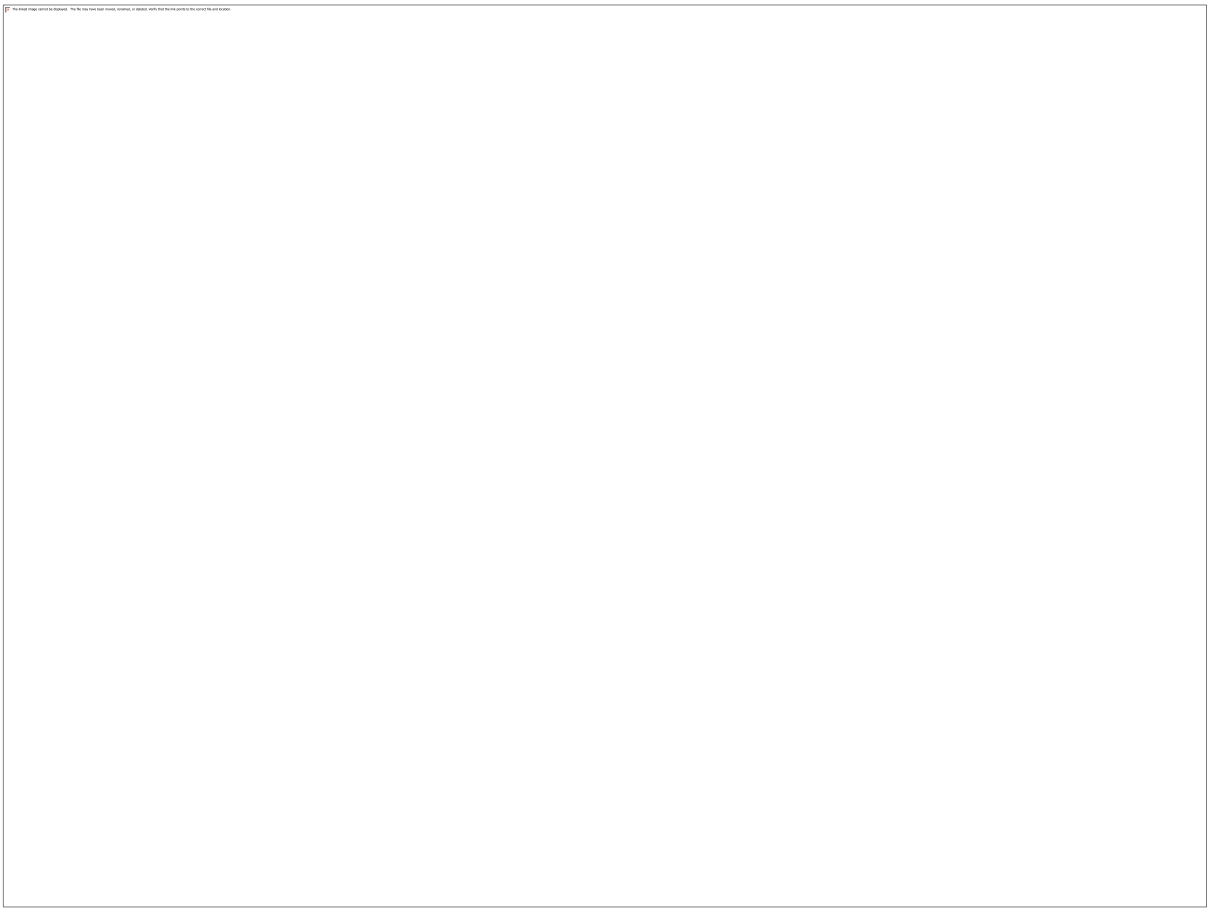

Figure 4-1: Major wetland system associated with the access road

Additionally, the quarry was not included in this assessment as it is associated with the aforementioned major wetland system. Therefore, refer to the wetlands assessment (Digby

Wells, Twistdraai Wetland, 2019) for information pertaining to this specific infrastructure and its relationship to the associated wetland. It is however, envisaged that physical disturbance of the nearby wetland systems may occur through the operation of heavy machinery during decommissioning of the quarry (see wetlands report for potential impact matters concerning the quarry; Digby Wells, Twistdraai Wetland, 2019).

4.1 Details of the site visit

A single site visit was allocated for the completion of the aquatic component to support the Basic Assessment Process. This site visit took place during the month of November 2018, which coincides with the onset of the rainfall period for the province (Figure 4-2). It was suspected that macroinvertebrate or other biotic assemblages (e.g. diatoms) would have had sufficient time to colonise the associated watercourses prior to the site visit. It was further envisaged that this would allow for sufficient understanding of the biotic conditions within the associated aquatic systems. In light of this, it is usually ideal to conduct biannual assessments during different seasons to fully understand the cyclic variation within an aquatic system.

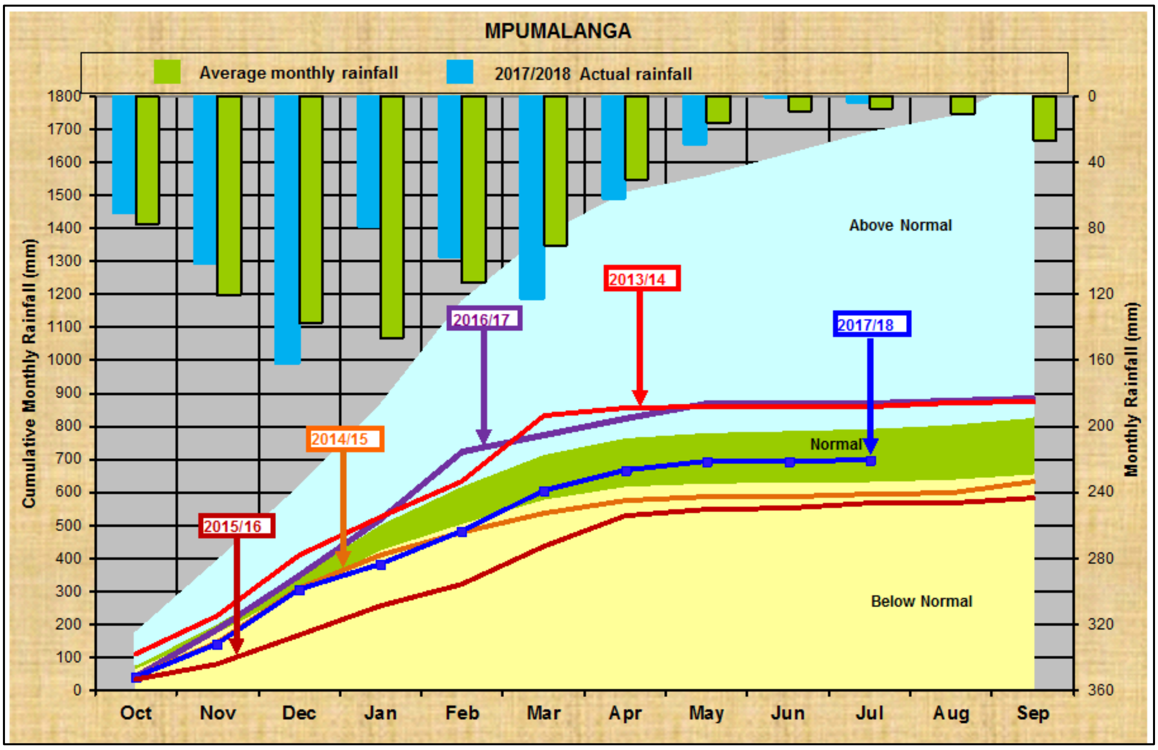

Figure 4-2: Annual Rainfall Trend for the Mpumalanga Province (DWS, 2019)

4.2 Baseline Determination

In order to complete this study the following indicators were evaluated as part of the assessment:

- Stressor Indicators:

  - *In situ* water quality.
- Habitat Indicators:
  - Macroinvertebrate available habitat, where applicable.
- Response Indicators:
  - Aquatic macroinvertebrates assemblages; and
  - Diatom assemblages.

4.2.1 Water Quality

Selected *in situ* water quality variables were measured at each of the selected sampling sites which had sufficient water levels using water quality meters manufactured by Extech Instruments, namely an ExStik EC500 Combination Meter and an ExStik DO600 Dissolved Oxygen Meter. Constituents considered include temperature (Cº), pH, electrical conductivity (µS/cm), dissolved oxygen concentration (mg/l) and saturation percentage.

Water quality guidelines used in this report are for Aquatic Ecosystems (DWAF, 1996).

4.2.2 Aquatic Macroinvertebrate Assessment

The subsections below outline the different macroinvertebrate associated assessments utilised in the study. It is important to note that only one site (i.e. Site 11B) was suitable for this assessment, as it had sufficient habitat and characteristics as a riverine site (i.e. flowing water). Biomonitoring assessments for the area conducted by Wet-Earth Eco-Specs cc (Wet-Earth, 2018) also noted similar limitations at the time of their survey (i.e. no flow at monitoring sites).

4.2.2.1 Integrated Habitat Assessment System

Due to the reliance and adaptations of aquatic biota to specific habitats, the availability and diversity of habitats is important to consider in aquatic assessments (Barbour et al., 1998). Assessment of the available habitat for aquatic macroinvertebrate colonisation at each of the sampling sites is vital for the correct interpretation of results obtained following biological assessments. It should be noted that the available methods for determining habitat quality are not specific to rapid biomonitoring assessments and are inherently too variable in their approach to achieve consistency amongst users.

Nevertheless, the Invertebrate Habitat Assessment System (IHAS) has routinely been used in conjunction with SASS as a measure of the variability of aquatic macroinvertebrate biotopes available at the time of the survey (McMillan, 1998). The scoring system was 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 were summed together to provide a percentage and then categorised according to the values in Table 4-1.

Table 4-1: Adapted IHAS Scores and associated descriptions

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

However, the lack of reliability and evidence of notable variability within the application of the IHAS method has prompted further field validation and testing, which implies a cautious interpretation of results obtained until these studies have been conducted (Ollis et al., 2006). In the interim and for the purpose of this assessment, the IHAS method was adapted by excluding the assessment of the general stream characteristics, which resulted in the calculation of a percentage score out of 55 that was then categorised by the aforementioned Table 4-1. Consequently, the assessment index describes the quantity, quality and diversity of available macroinvertebrate habitat relative to an "ideal" diversity of available habitat.

4.2.2.2 South African Scoring System

The South African Scoring System Version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS Score) and the Average Score Per Taxon (ASPT value).

Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" (Gerber and Gabriel, 2002). Identification of organisms was made to family level (Thirion *et. al*., 1995; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

4.2.2.3 Macroinvertebrate Response Assessment Index

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the Bushveld Basin. This does not preclude the calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;

- Water quality; and
- Energy inputs from the watershed riparian vegetation assessment.

4.2.3 Diatom Assessment

Due to the typical wetland nature of the selected monitoring sites, this assessment serves as the major focus for the aquatic baseline for the Project. Diatoms serve as important biomonitoring tools focused at the base of the food web in aquatic ecosystems (Taylor *et al*., 2007). Furthermore, they are highly representative of water quality and can be used to pin point specific changes related to water quality, such as organic pollution, eutrophication, acidification, metal pollution and changes in pH.

Diatom samples were collected and analysed according to the methodology described by Taylor *et al.* (2005). The Specific Pollution Sensitivity Index (SPI; CEMAGREF, 1982) was used in the diatom assessment where the SPI scores were used to determine the water quality class and Ecological Category of the assessed sites (Table 4-2).

Table 4-2: Adjusted Ecological Category boundaries for the Specific Pollution Index

Ecological Category	Water Quality Class	SPI Score
A	High	18-20
A/B		17-18
B	Good	15-17
B/C		14-15
C	Moderate	12-14
C/D		10-12
D	Poor	8-10
D/E		6-8
E	Bad	5-6
E/F		4-5
F		<4

In addition, the Percentage Pollution Tolerant Valves scores (%PTV; Kelly & Whitton, 1995) were used to indicate any signs of organic pollution that might potentially be occurring at assessed sites as outline in Table 4-3.

Table 4-3: Interpretation of the %PTV scores

%PTV	Interpretation
<20	Site free from organic pollution.
20 to <40	There is some evidence of organic pollution.
40 to 60	Organic pollution likely to contribute significantly to eutrophication.
>60	Site is heavily contaminated with organic pollution.

5 Existing Environment

The study area is located within the Vaal Water Management Area 5 (WMA 5), in the C12D quaternary catchment. This places the watercourses considered for assessment within the Highveld freshwater ecoregion. Six tributaries and two unclassified drainage lines intersecting the servitude and conveyor of concern are of main focus for the study. These watercourses drain into the Klipspruit, which ultimately joins with the Waterval River (also referred to as Sub-Quaternary Reach, SQR C12D-01685) approximately 17.76 km from the most downstream tributary under assessment (DWS, 2018; Figure 5-2).

The study area consists predominantly of typical Highveld grasslands with watercourses comprising mainly of wetland systems, lacking defined riparian zones (Figure 5-1). These watercourses are further characterised by incised channels with grassy edges and muddy substrate. The systems are also ephemeral and may have seasonal flow. Notable aquatic related impacts associated with this system vary, consisting of impacts such as road and conveyor crossings, lack of flows, agriculture and instream dams (DWS, 2018). These impacts have the potential to increase sediment content in associated aquatic systems and, in cases of instream dams, result in severe hydrological and morphological changes. Additionally, agricultural practices have the potential to increase nutrient content into associated aquatic systems which in turn, has the potential to alter the chemistry and quality.

Figure 5-1: Sampling site downstream from the road and conveyor of concern

The localities and descriptions of the sampling sites selected along the aforementioned watercourses have been outlined in Table 5-1 and are displayed in relation to the road and conveyor infrastructure in Figure 5-3. Additional desktop information pertaining to each of the six reaches has been provided for in the following subsection.

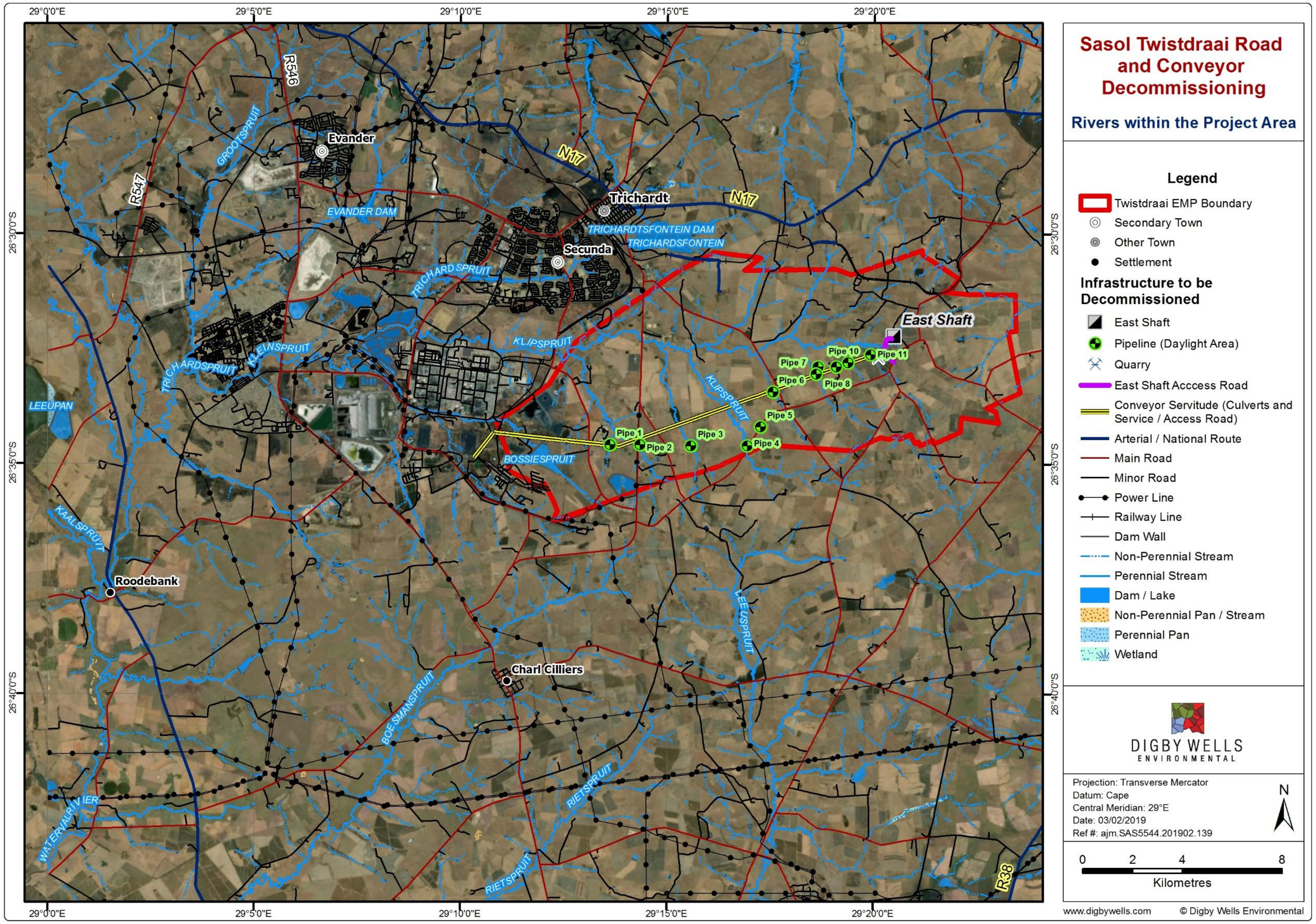

Figure 5-2: Watercourses associated with the project area

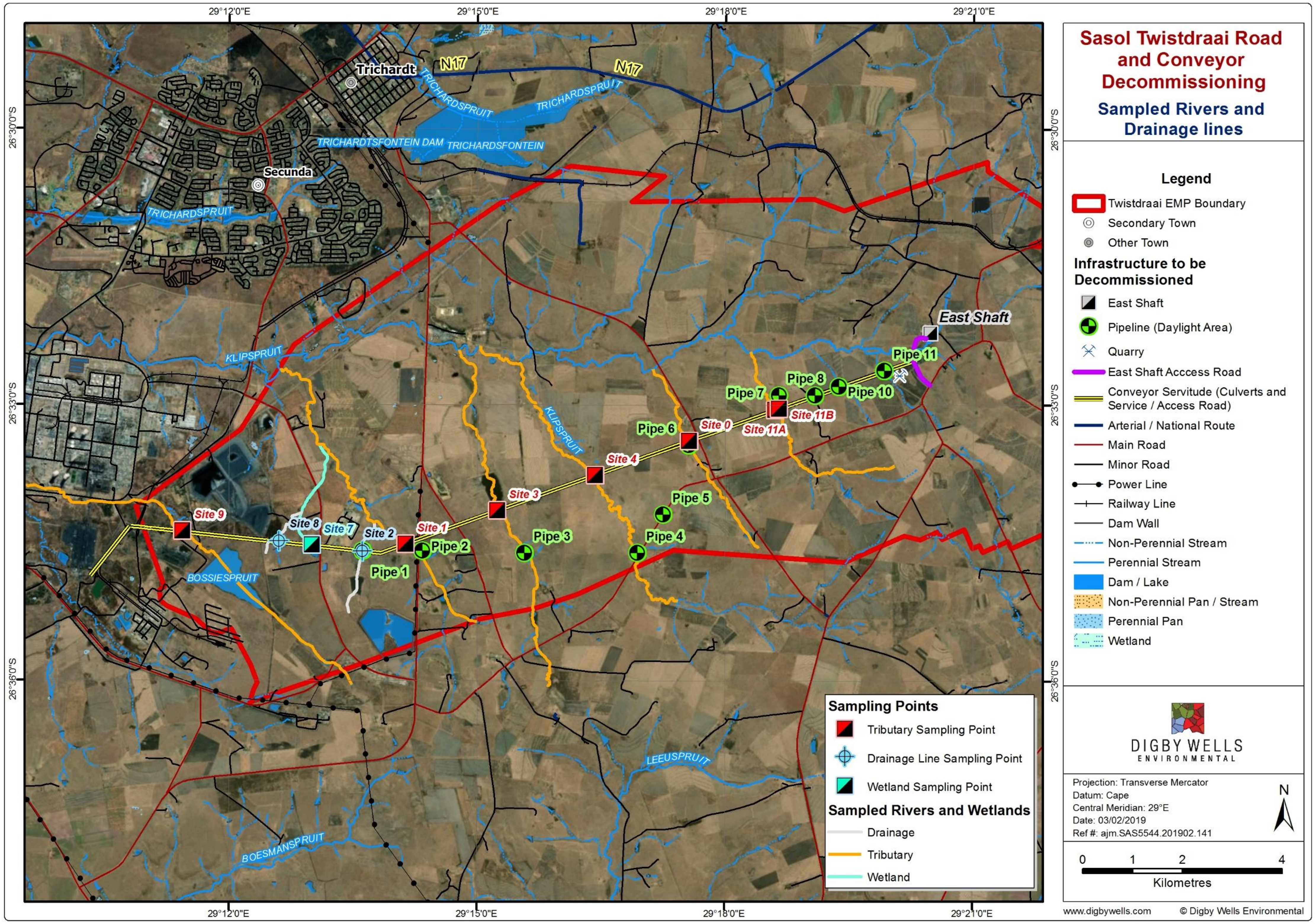

Figure 5-3: Sampling site localities in relation to the infrastructure proposed for decommissioning

Table 5-1: Coordinates and Descriptions of the Selected Monitoring Sites

Site Name	Coordinates	Description
Major Tributaries		
Site 9	26°34'24.51"S 29°11'25.00"E	Site located along the Bossiespruit downstream from a large dam. As a result, a large quantity of water was entering from the dam into the site at the time of the survey. The site was split by a road crossing, where the upstream section was comprised of a deep pool which resulted in churning water downstream unsafe for sampling.
Site 1	26°34'32.89"S 29°14'07.02"E	Site impounded, forming a small pool after the servitude of concern. Road crossing is heavily eroded with large amounts of litter in the form of copper cables hidden under the crossing point in the flow pathway of the watercourse. A rubber conveyor belt was also observed to be lying across and in the channel.
Site 3	26°34'11.04"S 29°15'13.44"E	A large farm dam was developed just below the monitoring point which has resulted in the attenuation of flow at the site. Furthermore, silt and sediment have smothered the site as a result, creating a mud like substrate allowing no marginal vegetation growth.
Site 4	26°33'47.85"S 29°16'24.56"E	The site was observed as dry at the time of the survey, consisting of an incised channel with grassy edges below a road crossing. Rubble from the crossing was also observed within the pathway of the channel.
Site 0	26°33'25.39"S 29°17'32.68"E	The site was observed as dry at the time of the survey. It is situated after a road crossing, between a fenced off farmland. The substrate of the site consists of compacted sand and gravel and is surrounded by fairly dense wetland vegetation.
Site 11A	26°33'04.96"S 29°18'35.19"E	These sites are both situated along an unnamed tributary flowing under a road and conveyor crossing point. The tributary splits just before the conveyor crossing point and merges again approximately 100 m afterwards. Site 11A is made up of a small trickle of water insufficient for macroinvertebrate sampling. However, Site 11B was receiving a large amount of water from a burst dam wall situated upstream from the site.
Site 11B	26°33'04.29"S 29°18'37.87"E	
Unclassified Drainage Lines		
Site 8	26°34'31.14"S 29°12'35.16"E	The site was observed as dry at the time of the survey. It barely forms a channel after the road crossing but, becomes incised further downstream running along a fenced off area adjacent to the Twistdraai Export Plant.
Site 2	26°34'37.68"S 29°13'35.62"E	This site is situated below a road crossing in an incised channel. There was sufficient water at the site at the time of the survey to form a pool which contained sections of gravel and large cobbles.
Site 7	26°34'33.59"S 29°12'59.05"E	This site is situated between the aforementioned drainage lines. No channel was observed however, the site had sufficient water and vegetation for diatom sampling (see wetlands report for more information).

5.1 Ecological Importance and Sensitivity

Table 5-2 presents the desktop information obtained for the six classified SQR's considered in the study (DWS, 2018).

Table 5-2: Desktop Information for the Central and Eastern tributaries

Tributary / Site	Stream Order	Stream Length (km)	Present Ecological Status	Ecological Importance	Ecological Sensitivity
Groot-Bossiespruit (SQR C12D-01657) Site 9	1	14.04	E (Seriously modified)	Low	Moderate
Unnamed (SQR C12D-01662) Site 1	1	8.37	C (Moderately modified)	Moderate	Moderate
Unnamed (SQR C12D-01660) Site 3	1	8.45	C (Moderately modified)	Moderate	Moderate
Klipspruit (SQR C12D-01664) Site 4	1	12.94	C (Moderately modified)	Moderate	Moderate
Unnamed (SQR C12D-01668) Site 0	1	4.68	C (Moderately modified)	Moderate	Moderate
Unnamed (SQR C12D-01663) Site 11A and 11B	2	3.80	C (Moderately modified)	Moderate	Moderate

According to the gathered information most of the tributaries flowing under the road and conveyor crossing points are first order streams which have been moderately modified from natural conditions (Ecological Category C). As aforementioned, major changes to these systems have resulted from impacts such as mining, road crossings and instream dam construction (DWS, 2018).

Furthermore, the Ecological Importance and Sensitivity of all the systems, with the exception of Ecological Importance of the Groot-Bossiespruit (i.e. low), has been classified as moderate. These systems are expected to comprise of taxa (i.e. macroinvertebrates and fish) tolerant to physio-chemical changes and no-flow conditions. Additionally, these systems are not expected to support more than five indigenous fish species and are home to approximately 40 different macroinvertebrate taxa.

6 Limitations to the Study

The aquatic indices utilised in the study, such as SASS5 and IHAS, were developed for lotic watercourses of typical riverine nature. Additionally, as described in Dickens and Graham (2002), the SASS5 assessment is not suitable for non-perennial systems (i.e. having seasonal flow). As a result, these indices were limited to the application at only a single site. Therefore, more attention should be paid to the ecological categories determined through the diatom assessments, where successful.

7 Results and Discussion

The sections below summarise the findings from the survey conducted in November 2018 in attempt to establish the baseline conditions prior to commencement of the Project.

7.1 Water Quality

The results of the *in situ* water quality assessment are provided in Table 7-1.

Table 7-1: Water Quality Results Recorded During the Study

Site	Site 9	Site 8	Site 7	Site 2	Site 1	Site 3	Site 4	Site 0	Site 11A	Site 11B	Guideline Values
Temperature (˚C)	20.8	DRY	16.5	21.5	20.4	20.3	DRY	DRY	20.2	18.5	-
pH	7.96		**8.01**	**8.58**	**8.39**	**8.63**			7.78	**8.14**	6-8*
Conductivity (µS/cm)	1153		10610	1116	10050	9730			1317	10050	-
Dissolved Oxygen (mg/l)	9.21		8.21	8.51	8.50	9.24			7.42	9.42	5*
Saturation Percentage (%)	99.6		80.7	99.2	100.5	103.5			81.2	99.5	80-120*

*Red values indicate constituents exceeding guideline values (DWAF, 1996; Nebeker *et. al.*, 1996)

In situ water quality results could not be obtained for Site 8, Site 4 and Site 0 due to the dry conditions observed during the survey. Temperature readings at all of the monitoring sites showed no signs of concern, ranging from a low of 16.5 ˚C at Site 7 to a high of 21.5 ˚C at Site 2. Furthermore, the recorded oxygen constituents (i.e. dissolved oxygen and saturation percentage) also were within acceptable ranges, unexpectedly meeting the respective guideline values at all of the assessed monitoring sites. Usually, typical wetland systems tend to exhibit low oxygen values based on the lentic nature of said systems. Thus, it is suspected that an additional contributor to the good oxygen levels could be present (e.g. algal growth).

On the other hand, pH recordings at most of the monitoring sites exceeded the recommended guideline value of 8 (DWAF, 1996). Although only exceeding the guideline by a decimal value, the pH values at the sites of concern are expected to present some form of additional stress on aquatic biota. Limited knowledge is available on the effects of elevated pH on aquatic biota. However, pH values of greater than 8 are known to alter certain compounds from a non-toxic form to a highly toxic form, such as the conversion of ammonium to the highly toxic un-ionized ammonia (DWAF, 1996). Conductivity values were also recorded to be very high at all of the monitoring sites (i.e. > 1000 µS/cm) where values higher than 500 µS/cm are known to adversely affect aquatic life (U.S. EPA, 2010).

7.2 Macroinvertebrate Assessment

The subsections below summarise the findings of the various macroinvertebrate assessments. The assessments utilised for the assessment of macroinvertebrate assemblages are not applicable in lentic-wetland ecosystems (i.e. lack of flow). Therefore, limited macroinvertebrate data was obtained for this study.

7.2.1 Integrated Habitat Assessment System

The results of the IHAS are presented in the table below (Table 7-2).

Table 7-2: IHAS results recorded for the study

Sampling Site	IHAS Score (%)	Interpretation
Site 9	Not assessed due to safety constraints	
Site 8	DRY	
Site 7	N/A	
Site 2	N/A	
Site 1	N/A	
Site 3	N/A	
Site 4	DRY	
Site 0	DRY	
Site 11A	Insufficient water for sampling	
Site 11B	43.64	**Poor**
Impounded sites not applicable for the assessment indicated by symbol N/A		

As aforementioned, the only available IHAS score was obtained from Site 11B. Findings from the assessment and score of 43.64 % indicate that the availability of macroinvertebrate habitat at the time of the survey was poor. This is expected to negatively influence the macroinvertebrate diversity recorded at the site, especially in relation to a typical riverine system. However, this classification can be considered as natural due to the typical wetland nature of the sampling site, lacking a variety of sampling biotopes such as cobbles.

7.2.2 South African Scoring System

The following table (Table 7-3) outlines the results from the SASS5 assessment conducted during the November 2018 survey. It is important to note that only Site 11B was assessed due to the same reasoning indicated in Table 7-2. Therefore, only Site 11B has been included below.

Table 7-3: SASS5 result recorded during the study

Taxon	Abundance	Sensitivity Score
Baetidae 1species	A	4
Caenidae	A	6
Coenagrionidae	A	4
Aeshnidae	1	8
Belostomatidae*	A	3
Corixidae*	B	3
Gerridae*	A	5
Notonectidae*	A	3
Veliidae*	A	5
Dytiscidae*	A	5
Gyrinidae*	A	5
Hydrophilidae*	A	5
Ceratopogonidae	A	5
Chironomidae	A	2
Number of taxa	**14**	
SASS5 Score	**63**	
ASPT Score	**4.5**	
* = air breathing taxa. **Abundance**: A = 2-10; B = 10-100;		

A total of 14 different taxa were sampled at Site 11B, comprising of mainly air breathing, tolerant families (i.e. sensitivity score < 8). However, a single individual Aeshnid was sampled at the site (Figure 7-1). These invertebrates belong to the Odonata order (Dragonflies and Damselflies) and have a moderate requirement for unmodified physio-chemical conditions, providing some indication of fair water quality at the site.

Figure 7-1: Aeshnidae nymph sampled at Site 11B

7.2.3 Macroinvertebrate Response Assessment Index

The MIRAI was conducted utilising the SASS5 data obtained from Site11B. Findings from this assessment are outlined in Table 7-4.

Table 7-4: MIRAI scores determined for Site 11B

Invertebrate Metric Group	Score Calculated
Flow modification	43.2
Habitat	30.5
Water Quality	27.3
Ecological Score	**33.94**
Invertebrate Ecological Category	**E**

The MIRAI results indicate that the macroinvertebrate assemblage for the assessed site is seriously modified from reference conditions (Ecological Category E). It appears that poor water quality, most likely the high conductivity recorded, is a major driver behind this categorisation compounded by habitat modification.

It is further suspected that the wetland nature of the monitoring site might be influencing this determined category as the monitoring of macroinvertebrate (i.e. SASS5) is not truly applicable in wetland systems. Therefore, the wetland nature may be resulting in the fairly high score pertaining to habitat modification which may be misleading the overall ecological categorisation for the site. It is recommended that the diatom assessment receives more attention when perceiving an Ecological Category for the site.

7.3 Diatom Assessment

Diatom sampling took place at sites that had sufficient substrate (i.e. vegetation) for sampling and that had sufficient water levels suspected to sustain diverse diatom life. Thus, a total of five sites were sampled for diatoms as outlined in Table 7-5.

Table 7-5: Diatom findings from applicable sampling sites

Sites	%PTV	SPI	Ecological Category	Water Quality Class
Site 9	15.3	9.6	D	Poor
Site 8	DRY			
Site 7	0	10.9	C/D	Moderate
Site 2	Insufficient habitat for sampling			
Site 1	1.3	15.2	B	Good
Site 3	Insufficient habitat for sampling			
Site 4	DRY			
Site 0	DRY			
Site 11A	Insufficient cell count			
Site 11B	0	12.5	C	Moderate

It is firstly important to note that an insufficient cell count was obtained for the diatom samples at Site 11A. As previously stated, this site was comprised of a tiny trickle of water over limited aquatic vegetation. Therefore, it is suspected that diatoms did not have sufficient time to colonise the site, resulting in a lack of specimens in the sample. The data gathered from the adjacent Site 11B could potentially be inferred for that of Site 11A, as both sites receive water from the same upstream source. This should however be carefully interpreted as the sites do not comprise of the same habitat, which might influence the similarity of the diatom assemblages if they contained the same water level. Furthermore, as this index is better suited for wetland systems, it should be noted that the site is in fact not seriously modified as indicated by the Ecological Category determined from the MIRAI (Table 7-4).

All determined %PTV scores indicated that none of the sites expressed significant amounts of organic pollution (%PTV < 20%; Kelly & Whitton, 1995). The Ecological Categories for the diatoms ranged from Ecological Category D at Site 9 to Ecological Category B at Site 1 with water quality classes ranging from Poor to Good and the same sites. Site 9 was suspected to express the lowest scores out of the monitoring sites due to its proximity to the Twistdraai Export Plant activities. These activities, compounded by agricultural activities upstream from the monitoring site, appear to be contributing to the determined Poor Water Quality Class and Ecological Category D.

8 Impact Assessment

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

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 8-3. 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 measure proposed in this report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 8-2, which is extracted from Table 8-1. The description of the significance ratings is discussed in Table 8-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 8-1: Impact Assessment Parameter Ratings

Rating	Intensity/Replacability		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. <80% probability.

Rating	Intensity/Replacability		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/Replacability		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 extending only as far as the development site 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 to the site and its immediate surroundings.	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 as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/Replacability		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 8-2: Probability/Consequence Matrix

Significance																																						
Probability 7	-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
6	-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
5	-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
4	-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
3	-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
2	-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
1	-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	-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

Table 8-3: 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) (-)

9 Impact Assessment Findings

The potential activities that will negatively impact aquatic ecology in the watercourses associated with the Project are listed below. It is important to note that the Project consists of both decommissioning and rehabilitation activities. In light of these two processes/phases, it is highly recommended that the decommissioning of the infrastructure goes hand in hand with the rehabilitation of the immediate area in attempt to limit the amount of time surfaces of concern lie exposed and (or) vulnerable to erosion. Therefore, rehabilitation should be implemented as soon as possible after decommissioning over watercourse crossing points has been completed.

9.1 Decommissioning Phase

It is foreseen that this phase of the Project will focus on the physical removal of infrastructure associated with the conveyor and its servitude. From an aquatic ecology concern, this should include all manmade structures developed to support the conveyor crossing points assessed in this study. Additional structures associated with the conveyor crossing points that also should be removed are listed below:

- All concrete structures, slabs and any concrete remains;
- Culverts;
- Conveyor belt remains;
- Copper cables (especially noted at Site 1);
- Fence lines within the pathway of the crossing points (observed to be accumulating vegetation and blocking flow); and
- Any final waste material after decommissioning such as eroded rubble and plastic safety barriers (see Appendix A, Site 7).

Land manipulation and vegetation disturbance are the main foreseeable aquatic-related impacts associated with this Project phase. There is also a risk of contaminants entering the aquatic systems from the project workings (i.e. during the operation of machinery) and storage sites during the physical removal and rehabilitation activities.

9.1.1 Impact Description: Habitat and water quality disturbance

Land manipulation and the clearing of infrastructure will most likely increase surface runoff, erosion and subsequently increase the amount of suspended and dissolved solids, as well as potential pollutants, entering the associated watercourses. These impacts will alter both the water chemistry and morphology of the affected watercourses and supporting biota as follows:

- Increased concentration of potential contaminants within watercourses will increase the potential toxicity of the water and elicit additional stress on the aquatic biota and vegetation in the impacted systems;

- Dissolved solids concentration is one of the most influential water quality variables on aquatic biotic community structures (Dallas & Day, 2004). Thus, increases in this regard will result in loss of certain taxa if their specific salinity tolerances are exceeded;
- An increase in suspended solids will directly alter aquatic habitats after deposition (Wood & Armitage, 1997), which in turn will negatively impact biotic community structure. Suspended solids can also directly impact aquatic biota through the accumulation of silt on respiratory organs (i.e. gills) and by decreasing visibility which will affect feeding habits of specific taxa; and
- Habitat deterioration in the form of sedimentation; bed, channel and flow modification may occur due to the possible increased erosion and the physical removal / loss of aquatic related habitat at decommissioning sites, especially where machinery will be operating in the immediate area of watercourses.

By removing the infrastructure associated with the crossing points, it is envisaged that stream connectivity will improve. This in turn will hopefully improve the functioning of each aquatic ecosystem but will be limited without the proposed rehabilitation phase.

9.1.2 Management Objectives

The objective during decommissioning activities is to preserve the Ecological Categories determined for the various watercourses associated with the Project and prevent further degradation of local aquatic environments. However, the post rehabilitation of the affected areas is expected to hopefully improve the Ecological Categories determined for the various watercourses (see below).

9.1.3 Management Actions

General mitigation actions provided in the wetlands study conducted by Digby Wells (2019) should be incorporated to guide the effective management of aquatic resources potentially affected by the Project. However, more specific management actions/components aimed to support the aquatic ecology of watercourses of concern include:

9.1.3.1 Buffer zone establishment

The establishment of clearly marked buffer zones, which are defined as regions of natural vegetation between watercourses/wetlands and associated developments (or activities) is a key management action (WRC, 2014). These zones intend to provide the following aquatic related functions:

- Maintenance of aquatic processes;
- Reduction of impacts on water resources associated with upstream activities and adjoining land uses; and
- Provision of habitat.

According to the Water Research Commission (2014), the efficacy of a buffer is related to the distance between the aquatic system and the zone of disturbance. Thus, by increasing the width of a buffer, the potential impacts related to the proposed infrastructure/activity is reduced. However, it is certain that machinery will be operating in the immediate area of the watercourse crossing points, rendering the use of buffer zones impractical and not feasible. Therefore, it is strictly advised that physical machinery activities and removal operations are limited to the smallest area as possible, directly associated with the infrastructure of concern.

In light of this, it is still predicted that the Project will impact on the aquatic ecology of the associated watercourse even if limited to the smallest working area as possible. Thus, the following additional management action needs to be implemented in order to reduce associated impacts:

- Limit machinery access/activities to only the infrastructure footprint area where applicable (i.e. remain on the servitude proposed for decommissioning during the Project). Machinery operating off the servitude will damage the vegetation and as such, areas damaged by the operation of machinery should be re-vegetated as soon as possible with the exact affected species (see wetlands report for species information).

9.1.3.2 Limiting runoff and erosion

During the Project, it is envisaged that bare and ripped surfaces (i.e. soil) will be exposed at some point, especially during decommissioning activities. Compaction of surfaces will also occur due to the operation of heavy machinery. These surfaces will subsequently be vulnerable to increased runoff and erosion, which may result in the sedimentation of downstream watercourses as well as the entry of contaminants with special focus on the crossing points. Therefore in attempt to avoid such outcomes the following mitigation measures should be considered:

- High rainfall periods (usually December to March) should be avoided during the Project in order to possibly avoid increased surface runoff in attempt to limit erosion and the entering of external material (i.e. contaminants and / or dissolved solids) into associated watercourses;
- Environmentally friendly barrier systems, such as silt nets or in severe cases the use of trenches, can be used downstream from decommissioning sites to limit erosion and possibly trap contaminated runoff from the Project. Trapped silt or soil during decommissioning activities could potentially be used during rehabilitation (i.e. re-profiling of the area);
- Areas observed to be concentrating water flow need to be dispersed in such a manner to limit erosion and flow through the physical working area (i.e. use of baffles at the end of canals or trenches diverting major flow from decommissioning sites if applicable or needed); and

- Any water used at decommissioning sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses which, depending on its quality and quantity, could alter the natural conditions of the receiving environment.

9.1.4 Impact Ratings

The following tables outline the significance of the major foreseeable impacts associated with the Project prior and post mitigation measures as well as the significance rehabilitation will have for each impact.

Table 9-1 presents the impact ratings associated with vegetation disturbance predicted to occur during the physical operation of machinery and indirect impacts (i.e. erosion) during decommissioning at all of the watercourse crossing points.

Table 9-1: Physical habitat disturbance and deterioration from machinery operation

Dimension	Rating	Motivation	Significance
Activity and Interaction: Removal of infrastructure utilising heavy machinery in direct contact with aquatic / wetland habitat			
Impact Description: Direct habitat disturbance (i.e. instream morphological change) and destruction during decommissioning			
Prior to Mitigation/Management			
Duration	Medium term (3)	Once habitat (i.e. mainly vegetation) has been disturbed or destroyed, it will take a fair amount of time for it to re-establish.	Minor (-42)
Extent	Limited (2)	The aquatic related habitat that is expected to be influenced by the decommissioning activities is foreseen to be limited to the areas associated with the watercourse crossing points only (i.e. not any further up or downstream from the crossing points).	
Intensity x type of impact	Minor (-2)	The loss of aquatic related vegetation is expected to be minor as the impact will be occurring in systems which are of moderate sensitivity and are already disturbed.	
Probability	Probable (6)	It is almost certain that some form of disturbance to the aquatic habitat at the crossing points will take place as machinery will have to operate within the pathway of the watercourses in order to complete the Project.	
Nature	Negative		

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions ▪ *Limit machinery access / activities to only the infrastructure footprint area;* ▪ *Areas damaged by the operation of machinery should be vegetated as soon as possible (see wetlands report for species / seed mix);* ▪ *High rainfall periods (usually December to March) should be avoided during the operation of machinery; and* ▪ *Make use of environmentally friendly barrier systems, such as silt nets, to trap potentially runoff of unearthed sediment which has the potential to directly impact aquatic habitat.*			
Post-Mitigation			
Duration	Immediate (1)	If revegetation takes place, it should be immediate and less than a month after removal of the infrastructure.	Negligible (-20)
Extent	Very limited (1)	If the workings keep strictly to the infrastructure footprint only during low rainfall seasons and utilise silt barriers, the impact is most likely going to be very limited to only the immediate decommissioning areas and not extend downstream.	
Intensity x type of impact	Minor (-2)	The loss of aquatic related vegetation remains as minor but ecosystem functioning is however expected to improve post rehabilitation.	
Probability	Likely (5)	The likelihood of the impact occurring is reduced slightly from a sedimentation perspective only if the silt traps are utilised during decommissioning. Habitat disturbance is still likely as machinery has to operate within the pathway of the watercourses to complete the Project.	
Nature	Negative		

Table 9-2 presents the impact ratings associated with potential increased runoff and erosion into the downstream systems from the decommissioning sites at watercourse crossing points. It is predicted that this will result in sedimentation and potentially increase in contaminants entering the systems as previously outlined.

Table 9-2: Potential Chemical Impacts of the Decommissioning & Rehabilitation Phase

<table>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td colspan="4">Activity and Interaction: Physical removal of infrastructure unearthing sediment and compaction of surfaces using heavy machinery at watercourse crossing points</td></tr>
<tr><td colspan="4">Impact Description: Increase in sediment and potentially contaminants entering the watercourses at infrastructure crossing points</td></tr>
<tr><td colspan="4">Prior to Mitigation/Management</td></tr>
<tr><td>Duration</td><td>Medium Term (3)</td><td>Due to the limited flow observed in most of the systems as well as the typical wetland nature of the monitoring sites, it is predicted that sediment/contaminant input will remain for a longer period than in a typical riverine system.</td><td rowspan="5">Minor (-45)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>Due to the wetland nature of the systems associated with the infrastructure crossing points, sediment and potential contaminants will most likely be localised.</td></tr>
<tr><td>Intensity x type of impact</td><td>Moderate (-3)</td><td>Sedimentation and the potential increase of pollutants through increase surface runoff (i.e. runoff in contact with coal/hydrocarbons) are expected to have moderate impacts as the systems are already impacted (i.e. sedimentation has already occurred at most of the monitoring sites).</td></tr>
<tr><td>Probability</td><td>Probable (5)</td><td>The removal of infrastructure will almost certainly result in sediment / soils entering into the pathway of the watercourses as infrastructure removal will be taking place directly over watercourse crossing points.</td></tr>
<tr><td>Nature</td><td colspan="2">Negative</td></tr>
</table>

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions			
High rainfall periods should be avoided during the Project; *Bare surfaces in proximity to watercourses or areas damaged by the operation of machinery should be vegetated as soon as possible (see wetlands report for species / seed mix) in attempt to limit erosion;* *Environmentally friendly barrier systems, such as silt nets or in severe cases the use of trenches, can be used downstream from decommissioning sites to limit erosion and possibly trap contaminated runoff from the Project;* *Areas observed to be concentrating water flow need to be dispersed in such a manner to limit erosion and flow through the physical working area (i.e. use of baffles at the end of canals or trenches diverting major flow from decommissioning sites if applicable or needed);* *Any water used at decommissioning sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses which, depending on its quality and quantity, could alter the natural conditions of the receiving environment; and* *Ensure the correct storage of any chemicals needed near watercourse crossing points (e.g. machinery oils or hydrocarbons).*			
Post-Mitigation			
Duration	Medium Term (3)	The duration of the impact will remain the same if it occurs at the crossing points unless physical removal of additional sediment or contaminants takes place in the affected systems.	Negligible (-18)
Extent	Very limited (1)	If mitigation measures are applied the extent of the impact should be very isolated to only parts of the site with limited signs of increased runoff.	
Intensity x type of impact	Minor - Negative (-2)	If runoff is limited through the working and sediment remains contained from the downstream systems, the intensity of the impact will be minimal especially due to the already impacted nature of most of the sites.	
Probability	Unlikely (3)	The impact, especially some form of sedimentation, is predicted to occur in the immediate area associated with the watercourse crossing points. However, mitigation measures are predicted to reduce the likelihood of the impact occurring in the downstream systems.	
Nature	Negative		

9.2 Rehabilitation Phase

This Project phase includes the rehabilitation of areas affected by the infrastructure proposed for removal, with special attention to the watercourse crossing points assessed in this study. From an aquatic health perspective, it is proposed that the following steps are followed where the infrastructure crosses watercourses:

- Removal of remaining waste such as rubble, cables, fence lines, concrete, culverts and any other waste material where applicable. This also includes the exposed pipelines at monitoring Site 1 and Site 11B and anywhere else the pipeline daylights as well as any collapsed soil from the servitude;
- Re-profile the sites to ensure a natural flow and free drainage. Silt collected through the use of environmentally friendly silt traps could be utilised at this point, depending on its quality, aiding in the re-profiling of the land;
- Rip the servitude as well as any other compacted areas which might contribute to increased runoff into the downstream watercourses; and
- Revegetate any exposed soils as soon as possible including areas where previous infrastructure lay in attempt to continue and homogenous the aquatic/wetland systems (see wetlands report for species information; Digby Wells, 2019).

9.2.1 Impact Description: Habitat and water quality disturbance

Similarly to the decommissioning phase, land manipulation or disturbance through the use of heavy machinery, will most likely increase surface runoff, erosion and subsequently increase the amount of suspended and dissolved solids, as well as potential pollutants, entering the associated watercourses.

9.2.2 Management Objectives

The objective during rehabilitation activities is to preserve and hopefully improve the Ecological Categories determined for the various watercourses associated with the Project.

9.2.3 Management Actions

General mitigation actions provided in the wetlands study conducted by Digby Wells (2019) should be incorporated to guide the effective rehabilitation of the aquatic resources potentially affected by the Project, especially as most are of wetland nature. However, more specific management actions/components aimed to support the aquatic ecology of watercourses of concern include:

9.2.3.1 Limiting runoff and erosion

During the rehabilitation phase, the main focus should be to limit runoff from the ripping and profiling activities which consequently should limit erosion and sedimentation in the associated watercourses. Therefore in attempt to limit runoff and erosion the following mitigation measures should be considered:

- High rainfall periods (usually December to March) should be avoided during ripping activities to possibly avoid increased surface runoff in attempt to limit erosion and the entering of external material (i.e. contaminants and/or dissolved solids) into associated watercourses;
- Operators of machinery (i.e. tractors) should ensure that their own tracks have been ripped especially near watercourses and crossing points once concluding rehabilitation activities;
- Seeding near watercourses and especially at crossing points should take place by hand and not by machinery to limit the compaction of soil in attempt to limit runoff and subsequent erosion; and
- Ensure the correct plant species are being used as per the wetlands report (Digby Wells, 2019) recommendations for wetland plant species.

Table 9-3 outlines the impact ratings associated with the rehabilitation plans for the Project with focus on the methodology outlined in the above Rehabilitation Phase description and wetlands report (Digby Wells, 2019). As land (i.e. conveyor servitude) near the watercourses and crossing points will be ripped for seeding, there is a potential risk for erosion and sedimentation of the associated aquatic systems. However, this component of the project is predicted to largely improve connectivity and potentially health status of said systems.

Table 9-3: Impact ratings associated with the planned rehabilitation activities

Dimension	Rating	Motivation	Significance
Activity and Interaction: Physical ripping operations and seeding activities near watercourses			
Impact Description: Potential for the compaction of land and increased surface runoff/erosion into associated watercourses during the planned rehabilitation			
Prior to Mitigation/Management			
Duration	Medium Term (3)	This component of the Project is suspected to last less than a year. However, if surfaces remain compacted without vegetation, the impact may last longer.	Negligible (-28)
Extent	Limited (2)	After re-profiling the land associated with the watercourse crossing points, ripping and seeding activities are expected to be limited to areas immediately associated with the crossing points. Furthermore, any potential runoff is suspected to be limited due to the wetland nature of the sites.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Minor (-2)	Machinery is suspected to be used close to the watercourse crossing points resulting in the potential for compaction of soil. However, this is suspected to be minor as the purpose of this activity is to rip compacted surfaces. Therefore, it is assumed that machinery operators during the process will ensure even their own compacted vehicular pathway is ripped.	
Probability	Probable (4)	Vehicular/machinery activity at most of the crossing points has already resulted in the compaction of sections of land, resulting in sedimentation in the downstream systems and immediate compacted area. Therefore, the impact is predicted to occur, especially if the reseeding takes place near the crossing points using machinery, but limited due to the accompanying planned ripping.	
Nature	Negative		
Mitigation/Management Actions ▪ *High rainfall periods should be avoided during ripping activities;* ▪ *Operators of machinery (i.e. tractors) should ensure that their own tracks have been ripped especially near watercourses and crossing points;* ▪ *Seeding near watercourses and especially at crossing points should take place by hand; and* ▪ *Use correct species for seeding as per the recommendations in wetland report (Digby Wells, 2019a).*			
Post-Mitigation / Rehabilitation			
Duration	Permanent (7)	The rehabilitation of the crossing points is suspected to be a permanent operation lasting after the life of the Project.	Minor (65)
Extent	Local (3)	Although the rehabilitation is occurring at localised sites (i.e. watercourse crossing points), the extent of its benefits are expected to be seen for the entirety of each specific reach even if minimal.	
Intensity x type of impact	Average (3)	Benefits will be ongoing but suspected to be felt by only some elements of the baseline especially as most of the indices used are aquatic in wetland systems.	

Dimension	Rating	Motivation	Significance
Probability	Likely (5)	The probability of the rehabilitation having positive impacts to the downstream systems is likely ensuring the upstream and downstream reaches from the crossing points are naturally homogenised.	
Nature	Positive		

9.3 Unplanned and Low Risk Events

There is a risk that watercourses associated with the infrastructure crossing points could be affected by the entry of hazardous substances, such as hydrocarbons, in the event of a spillage or unseen seepage from storage facilities.

Table 9-4 below presents mitigation measures that should be implemented for the aforementioned events of the Project.

Table 9-4: Unplanned Events and Mitigation Measures

Unplanned Risk	Mitigation Measures
Chemical / contaminant spills from working areas	▪ Ensure correct storage of all chemicals at operations as per each chemical's storage instructions (e.g. sealed containers for hydrocarbons); ▪ Ensure staff involved in the Project have been trained to correctly use and clean chemicals used at the sites; and ▪ Ensure spill kits (e.g. Drizit) readily available, especially near watercourse crossing points during the entirety of the Project.

10 Aquatic Biomonitoring Programme

An aquatic biomonitoring programme has been developed for the monitoring and preservation of the assessed aquatic systems. It is recommended that this programme is to be conducted for the entirety of the decommissioning phase and until rehabilitation has been proved successful by a SASS5 DWS-accredited practitioner. It is further recommended that monitoring takes place biannually for a minimum period of three years until the rehabilitation measures have been deemed successful. A single survey should be conducted during the wet season associated with the project area (i.e. within the months of November-January) and a single survey during the dry season (i.e. within the months of May-August) in attempt to understand the seasonal variations within the aquatic ecosystems.

Table 10-1 outlines the methodology/indices needed to be undertaken downstream from the decommissioning and rehabilitation activities at the monitoring points indicated in Table 5-1 in order to determine the PES of the assessed watercourses in this study and to monitor for potential impacts the Project may pose on the aforementioned aquatic ecosystems.

Table 10-1: Biannual Aquatic Biomonitoring Programme

Method / focus	Details
Water Quality	*In situ* water quality parameters as per this study
Habitat Quality	IHAS where applicable (wetland assessments will be more suited for habitat monitoring)
Macroinvertebrate Assemblages	SASS5 and MIRAI at sites where and if applicable. (wetland assessments will be more suited for habitat monitoring)
Diatom Assemblages	Biannual diatom sampling at all watercourse crossing points
Yellow shading indicates non-essential indices for monitoring which should be applied if deemed necessary by the approved SASS5 practitioner ; Green shading indicates indices that must be implemented	

11 Conclusion and Recommendations

A summary of the findings from the baseline and impact assessments is provided for below.

Baseline Condition

Water quality in the assessed aquatic ecosystems indicated marginally elevated pH levels (i.e. above or close to 8) throughout the study area. These sites also expressed high conductivity readings, potentially indicating high dissolved solids content, at the time of the aquatic survey. However, the aforementioned findings could both be attributed to the inherent wetland nature of each of the assessed monitoring sites. Although, a few notably elevated conductivity readings (i.e. exceeding 9 000 µS/cm) provided evidence of potential anthropogenic influence. On the contrary, oxygen levels recorded in all of the monitoring sites were fair, meeting the recommended guideline limits for aquatic life. Therefore, it was suspected that oxygen content would not be a limiting factor for the colonisation of sensitive aquatic biota.

Due largely to the inherent wetland nature of the associated watercourses and the non-applicability of the selected aquatic macroinvertebrate assessment indices (i.e. Invertebrate Habitat Assessment System, South African Scoring System, etc.), the aquatic macroinvertebrate assemblage supported by these systems was only deemed to be appropriate for application at a single monitoring site in the C12D-01663 Sub-Quaternary reach (Site 11B). In light of the poor habitat availability, a total of only 14 different taxa were sampled, comprising of mainly air breathing, tolerant families. The Macroinvertebrate Response Assessment Index conducted indicated that the assemblage at the site is seriously modified (i.e. Ecological Category E) from the determined reference conditions. This was somewhat to be expected due to the already disturbed nature of the monitoring site observed in the form of sedimentation and habitat deterioration.

In an effort to define the ecological condition of the other associated watercourses within the study area, a diatom assessment was conducted at sites with sufficient substrate for sampling. Each of the respective Ecological Categories defined ranged from largely modified (i.e. Ecological Category D) to minimally modified (i.e. Ecological Category B) at watercourse crossing points associated with the conveyor, its servitude and associated access roads. This assessment also shed light on the perceived water quality classes associated with the diatom assemblages recorded, ranging from Poor to Good conditions. These conditions form the basis of the aquatic baseline but are limited due to dry conditions observed at some of the sites needed for assessment.

Impact Assessment

The findings of the impact assessment perceive that the major concern associated with the Project is the potential to erode and increase sediment load into the watercourses associated with the conveyor and servitude crossing points, including the exposed pipeline sections. In addition, habitat destruction and deterioration has also been highlighted as a potential cause for concern. It is predicted that the operation of heavy machinery during decommissioning will result in the compaction of surfaces, potentially increasing runoff, causing minor erosion and sedimentation of the downstream aquatic ecosystems. Physical machinery contact within the instream pathway of the watercourse crossing points (e.g. during the removal of structures such as culverts) as well as the proximity of operations to vegetation associated with the watercourses are predicted to result in the aforementioned habitat related impact.

Mitigation measures provided are predicted to limit the associated impacts from a minor concern to a negligible concern, especially as most of the watercourses crossing points are already impacted from a morphological perspective. However, the proposed rehabilitation activities are envisaged to greatly improve the habitat and water quality conditions as observed/recorded during the study.

Recommendations

The aquatic biomonitoring programme developed in this document should be implemented for the entirety of the decommissioning project (i.e. minimum of three years of monitoring) and further continued until the re-seeded vegetation has established. It is also important for the appointed specialist to keep in mind the diatom assessment limitations encountered during the study (e.g. dry conditions). The specialist should attempt to sample diatoms at each of the watercourse crossing points associated with the conveyor and pipeline, as outlined in this study, as not all crossing points were assessable at the time of the baseline survey.

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Appendix A: Site Photographs

Conveyor Monitoring Sites:

Site 9

Site 8

Site 7

Site 2

Site 1

Site 3

Site 4

Site 0

Site 11A

Site 11B