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ENVIRONMENTAL

Environmental Authorisation and Integrated Water Use Licence Applications for the Proposed Water Treatment Plant at the Klipspruit Colliery, Mpumalanga Province

Aquatic Impact Assessment

Project Number:

SOU5014

Prepared for:

South32 SA Coal Holdings (Pty) Ltd

August 2018

Digby Wells and Associates (South Africa) (Pty) Ltd
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This document has been prepared by Digby Wells Environmental.

Report Type:	**Aquatic Impact Assessment**
Project Name:	**Environmental Authorisation and Integrated Water Use Licence Applications for the Proposed Water Treatment Plant at the Klipspruit Colliery, Mpumalanga Province**
Project Code:	**SOU5014**

Name	**Responsibility**	**Signature**	**Date**
Nathan Cook Cand.Sci.Nat (Pending)	Field surveyor, data collation and reporting		July 2018
Byron Bester Pr.Sci.Nat.	Technical review		August 2018

Declaration of the Specialist

I, Nathan Cook, as the appointed specialist, hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent, other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity;
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any of the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant, the Department and interested and affected parties, all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.

Signature of the specialist:

Nathan Gerard Cook

Full Name and Surname of the specialist:

Digby Wells Environmental

Name of company:

10/08/2018

Date:

EXECUTIVE SUMMARY

Digby Wells Environmental has been appointed by South32 SA Coal Holdings (Pty) Ltd to undertake a Scoping and Baseline Assessment as part of the Environmental Impact Assessment of the aquatic systems associated with the propose active water treatment plant located at the Klipspruit Colliery (KPS) in the province of Mpumalanga, South Africa.

KPS requires an active water treatment plant capable of treating 10 Mega litres of contaminated mine water from their balancing dam. The treated mine water will be to the release standard, meeting the catchment's water quality standards, and will be discharged into the immediate downstream tributary which is unclassified according to the Department of Water and Sanitation. However, the adjoining Sub-Quaternary Reach, known as the Saalklapspruit, is of concern and expected to be affected by the proposed Project.

Baseline Findings

The aquatic baseline assessment conducted in this study indicated that the unclassified tributary (i.e. Saalkspruit) directly associated with the proposed discharge of the Project is in a seriously impacted and modified state (Ecological Category F). Contributions to this categorisation include mining activities having mined through the upper reaches of the tributary compounded by sewage influences along the watercourse severely impacting on water quality.

Findings for the Saalklapspruit of concern as classified by the Department of Water and Sanitation (B20G-01099) indicate that this watercourse is in a largely modified state (Ecological Category D). Encroachment of agricultural activities and urbanisation of the downstream sections have partially resulted in the loss of sections of riparian vegetation and impacts on instream morphology and hydrology (e.g. farm dams along the reach, livestock activity and rural developments in riparian habitat). Furthermore, sewage input from the adjoining Saalkspruit has impacted on water quality of the downstream section of the watercourse. These impacts have consequently resulted in the largely modified macroinvertebrate Ecological Category determined in this study which has notably contributed to the overall modified Present Ecological Status of the Saalklapspruit tributary.

Key Impact Assessment Aspects

The aquatic impact assessment conducted for the Project indicated that the major focus area, relative to aquatic ecology, should be on the proposed pipeline and its discharge. Construction of the pipeline is expected to have minor impacts on aquatic ecology resulting from increased runoff and contaminant entry into the downstream watercourses compounded by minimal alteration of established aquatic related habitat. More importantly, the proposed discharge from the Water Treatment Plant is expected to alter the morphology hydrology of the downstream watercourses which, in turn, is expected to negatively impact on reference aquatic ecology. However, the proposed clean water from the discharge is expected to improve the overall poor water quality conditions of the downstream watercourses and possibly flush the known and observed sewage related issues. Lastly, minor water quality issues are expected to arise during the decommissioning of the established infrastructure as a result of runoff through the decommissioning footprint.

In order to conserve the downstream established Present Ecological Status of the Saalklapspruit and to potentially improve the degraded conditions of its tributary from the proposed Water Treatment Plant, the provided management actions should be implemented where possible. Furthermore, the provided Aquatics Monitoring Programme should be implemented in the existing biomonitoring scheme for the Project to commence to monitor for potential impacts associated with the project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 Introduction

Digby Wells Environmental (hereafter Digby Wells), as the independent Environmental Assessment Practitioner, has been appointed by South32 SA Coal Holdings (Pty) Ltd (hereafter South32) to undertake a Scoping and Environmental Impact Assessment (S&EIA) of the proposed modular water treatment plant (hereafter WTP) and ancillary infrastructure to treat mine-affected water at the Klipspruit Colliery (hereafter KPS), near the town of Ogies, Mpumalanga Province, South Africa.

The proposed activities at the South32-owned operation constitute Listed Activities in terms of GN R 983 (Listing Notice 1) and GN R 984 (Listing Notice 2), as amended. These activities require environmental authorisation prior to commencing as outlined by the Environmental Impact Assessment (EIA) Regulations (Government Notices R982; 983; 984 and 985, December 2014; amended in April 2017). Therefore, as a part of the process, an aquatic impact assessment report has been compiled in terms of Appendix 6 of the National Environmental Management Act (NEMA) EIA Regulations (2014), so as to aid in this environmental authorisation process, as well as the Water Use License Application deemed to be necessary.

1.1 KPS Project Description

Contaminated water that is being generated at KPS by mining activities exceeds the re-use capacity within the operations, whilst the storage capacity in mined out areas has reached its limits. The result of this is the risk of spillages or discharges to the natural environment. Effective management of this risk is subsequently essential to continued operations at KPS, ensuring access to coal resources, as well as securing and maintaining the requisite environmental licences and authorisations to operate and expand. Water treatment is thus a requirement.

The proposed WTP is to be established within the operational area of the mine in the south-eastern corner of the Mining Right boundary, adjacent to KPS project offices. The WTP will be modular in design and constructed in three phases, starting at a capacity of 2Ml/day, upgradeable to 3.3Ml/day and then increments of 3.3Ml/day to 10Ml/day. Contaminated water will be abstracted from the Balancing Dam at KPS and pumped to the WTP. After treatment, clean water that complies with the Resource Water Quality Objectives (RWQO) for the Wilge River catchment is proposed to be discharged into the Saalklapspruit at the northern boundary of the KPS operation adjacent to the N12 national highway.

The treatment process will be based on the use of membrane desalination with brine softening and will consist of the following steps:

- Pre-treatment of the feed water using pH adjustment and disinfection to remove organics from the system that can cause fouling and scaling of the membranes;
- Removal of the dissolved metals by chemical oxidation followed by the removal of precipitates and suspended solids using flocculation and coagulation unit processes;

- Ultrafiltration (UF) will be used to remove fine particles from the feed water to the Reverse Osmosis (RO) unit processes. This is necessary to prevent fouling and scaling of the RO membranes; and
- Product water conditioning is required to ensure the pH meets the discharge requirements.

This process will produce gypsum sludge and brine. The gypsum sludge will be dewatered at the WTP and then loaded onto trucks for off-site disposal at a licenced waste management facility designed for this type of material. The brine will be recycled back into the treatment process until the salinity requires that a portion be depleted from the system. This small volume of brine will be stored in tanks within the proposed WTP footprint from where it will be pumped into road tankers and transported to a third-party waste management site licenced to receive this waste.

The key infrastructure components of the project scope are as follows:

- A Feed Water Line comprising of a pump station and 1.5 km High Density Poly Ethylene (HDPE) pipeline from the Balancing Dam to the WTP site capable of pumping 10 Ml/day;
- A return water system from the WTP to the Balancing Dam along the same route as the Feed Water Line for the management of treated water that does not comply with the requirements for release to the catchment;
- A WTP Area with a footprint of approximately 1.5 ha for the establishment and operation of a modular WTP with a maximum throughput of 10 Ml/day. This includes the development and use of facilities for the storage and handling of hazardous chemicals used in the treatment process;
- A Discharge Line comprising of a 4 km HDPE pipeline along the eastern boundary of KPS to transfer the treated water for discharge to the Saalklapspruit. Two pipeline routes are required to accommodate advancing mining and rehabilitation activities along the proposed pipeline servitude, and will be implemented at different stages of the project; and
- A dissipation structure at the proposed discharge point, alongside the N12 National Highway.

Supporting services such as the new powerline and change houses and ablution facilities (connected to KPS's existing sewage line) are also included in the project.

2 Details of the Specialist

This Specialist Report has been compiled by the following specialists (Table 2-1). Curriculum Vitae (CVs) of the Project Team available upon request, should additional details regarding professional experience and/or qualification need to be reviewed.

Table 2-1: Details of the relevant specialists who prepared this report

Responsibility	**Field Work and Report Writer**
Full Name of Specialist	Nathan Cook
Highest Qualification	BSc Environmental Science
Years of experience in specialist field	2
Registration	South African Council for Natural Scientific Professionals: *Candidate Natural Scientist* (Reg. No. 119160- Pending)
Responsibility	**Technical Review**
Full Name of Specialist	Byron Bester
Highest Qualification	MSc Aquatic Health
Years of experience in specialist field	7
Registration(s):	South African Council for Natural Scientific Professionals: *Professional Natural Scientist* (Reg. No. 400662/15)

3 Scope and Purpose of this Report

This Aquatic Impact Assessment report serves to provide the baseline description of the aquatic systems associated with the proposed Project (as outlined in Section 1.1) and identify potential impacts (if any) on the associated aquatic ecology prior to commencement of the Project. Appropriate mitigation measures to prevent, minimise and/or reduce any potential impacts are also included within this report.

4 Study Limitations

The study comprised only of a single survey during the month of May 2018 (i.e. a late-autumn survey). Therefore, any potential seasonal variations to the associate aquatic ecology within the assessed river reaches could not be definitively determined. The results originating from the most recent summer survey for the concurrent aquatic biomonitoring studies (Ecology International, 2017) were utilised in this study as a comparative basis (where necessary), as well as for the purpose of defining the baseline conditions prior to initiation of the Project.

Furthermore, the upstream sampling site (i.e. Site K3) was not accessible at the timing of the survey, as it was considered unsafe by the relevant Health and Safety personnel. However, no outflow from this site was observed during the field survey and thus, it was considered to be dry for this study. This was supported by the conclusions that this site had insufficient water levels for effective macroinvertebrate sampling throughout the study area, including the Summer 2017 survey.

5 Project Locality and Study Area

The proposed location of the WTP is situated in the KPS boundary in the province of Mpumalanga, South Africa. The locality and proposed infrastructure can be observed in Figure 5-1.

The main watercourse of concern, according to the Sub-Quaternary Reaches (SQRs) classified by the Department of Water and Sanitation (DWS, 2018), is the Saalboomspruit (B20G-01099 SQR). However, this reach will be referred to as the Saalklapspruit for consistency purposes. It is also important to note that this SQR is fed by an unclassified tributary originating from within KPS (hereafter Saalkspruit), which is also identified as the receiving watercourse for proposed discharge.

Thus, sampling sites outlined in Table 5-1 below and displayed in Figure 5-2 were determined in order to establish baseline conditions for the Saalklapspruit SQR of concern and based on previous aquatic biomonitoring studies (i.e. Ecology International, 2017). Photographs of the sampling sites are provided for in Appendix A.

Table 5-1: Global positioning system coordinates and descriptions of sampling sites

Site	Coordinates	Description
K3	26°01'18.3'' S 29°01'38.9'' E	Located upstream of the N12 highway crossing on a first order tributary of the Saalklapspruit watercourse. This site appears to be the *initial receiving point* of the proposed WTP discharge along the tributary considered as the Saalkspruit in this study.
K4	26°00'55.2'' S 29°01'03.1'' E	Site located in the upper reaches of the Saalklapspruit SQR flowing parallel to the potential discharge receiving tributary (i.e. Site K3). Site situated in a channelled valley bottom wetland with limited flow. Furthermore, the instream habitat at the site comprised mainly of sections of aquatic vegetation but completely lacked the cobble biotope.
K5	26°00'29.6'' S 29°01'29.9'' E	Site located along the Saalklapspruit SQR downstream of the confluence with the tributary receiving the proposed WTP discharge and the upper reaches of the Saalklapspruit. Erosion visible at the site possibly a result of livestock activity in the area.

Past studies have indicated low water levels observed at Site K3, as the upper reaches have been mined through and as such, conditions of this site have deviated notably from reference conditions (Ecology International, 2017).

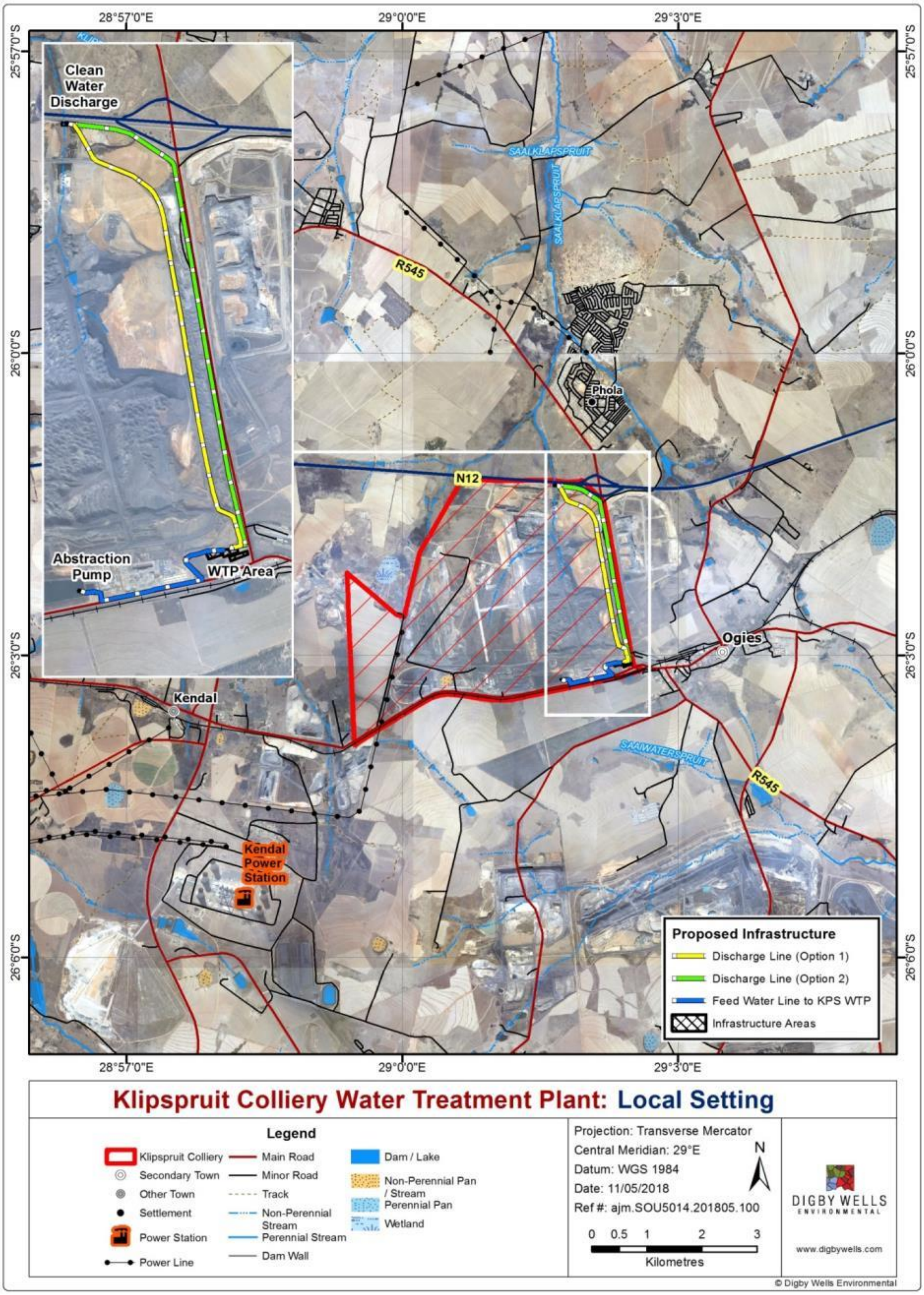

Figure 5-1: Locality of Proposed KPS WTP

Figure 5-2: Sampling site localities

6 Methodology

A single aquatic survey as requested by the Client was conducted during the month of May 2018 to fulfil the scope of the study. The subsections below outline the various methods utilised during the survey and in compilation of this Report.

6.1 Literature Review

Aquatic systems associated with the Project were identified and classified according to their specific SQR as described by the Department of Water and Sanitation (DWS, 2018). Thereafter, literature pertaining to the relevant SQR's was reviewed along with previous aquatic-related assessments conducted along the watercourses of concern in order to aid in the determination of baseline conditions.

6.2 Water Quality

Selected *in situ* water quality variables were measured at each of the selected sampling sites 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.

6.3 Index for Habitat Integrity

The Index for Habitat integrity (IHI) (Version 2, Kleynhans, C.J., *pers. comm.*, 2015) aims to assess the number and severity of anthropogenic perturbations along a river/stream/wetland and the potential inflictions of damage toward the habitat integrity of the system (Dallas, 2005). Various abiotic (e.g. water abstraction, weirs, dams, pollution, dumping of rubble, etc.) and biotic (e.g. presence of alien plants and aquatic animals, etc.) factors are assessed, which represent some of the most important and easily quantifiable, anthropogenic impacts upon the system (Table 6-1).

As per the original IHI approach (Kleynhans, 1996), the instream and riparian components were each analysed separately to yield two separate ecological conditions (i.e. Instream and Riparian components). However, it should be noted that the data for the riparian area is primarily interpreted in terms of the potential impact upon the instream component and as a result, may be skewed by a potentially deteriorated instream condition.

While the recently upgraded index (i.e. IHI-96-2; Dr. C. J. Kleynhans, *pers. comm.*, 2015) replaces the aforementioned comprehensive and expensive IHI assessment model developed by Kleynhans (1996), it is important to note that the IHI-96-2 does not replace the IHI model developed by Kleynhans et al. (2008a), which is recommended in instances where an abundance of data is available (e.g. intermediate and comprehensive Reserve Determinations). Accordingly, the IHI-96-2 model is typically applied in cases where a relatively few number of river reaches need to be assessed, the budget and time provisions are limited, and/or any detailed available information is lacking (i.e. rapid Reserve Determinations and for REMP/RHP purposes).

Table 6-1: Descriptions of criteria used to assess habitat integrity (Kleynhans, 1996; cited in Dallas, 2005)

Factors	Relevance
Water abstraction	Direct impact upon habitat type, abundance and size. Also impacted in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in the temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included
Water quality modification	Originates from point and diffuse sources. Measured directly, or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Alien/Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Alien/Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic

Factors	Relevance
	matter input will also be changed. Riparian zone habitat diversity is also reduced
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

In accordance with the magnitude of the impact created by the abovementioned criteria, the assessment of the severity of the modifications was based on six descriptive categories ranging between a rating of 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact; Table 6-2). Based on available knowledge of the site and/or adjacent catchment, a confidence level (high, medium, low) was assigned to each of the scored metrics.

Table 6-2: Descriptive of scoring guidelines for the assessment of modifications to habitat integrity (Kleynhans, 1996; cited in Dallas, 2005)

Impact Category	Description	Score
None	No discernible impact or the factor is located in such a way that it has no impact on habitat quality diversity, size and variability.	0
Small	The modification is limited to a very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1 - 5
Moderate	The modification is present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6 - 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced	11 - 15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability of almost the whole of the defined section are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity; the habitat quality, diversity, size and variability in almost the whole of the defined section are detrimentally influenced.	21 - 25

Given the subjective nature of the scoring procedure utilised within the general approach to habitat integrity assessment (including IHI-96-2), the most recent version of the IHI application (Kleynhans *et al*., 2008) and the Model Photo Guides (Graham and Louw, 2008) were used to calibrate the severity of the scoring system. It should be noted that the assessment was limited to observed and/or suspected impacts present within the immediate vicinity of the delineated assessment units, as determined through the use of aerial photography (e.g. Google Earth) and observations made at each of the assessed sampling points during the field survey. However, in cases where major upstream impacts (e.g. construction of a dam, major water abstraction, etc.) were confirmed, potential impacts within relevant sections were considered and accounted for within the application of the method.

Each of the allocated scores was then moderated by a weighting system (Table 6-3), which is based on the relative threat of the impact to the habitat integrity of the riverine system. The total score for each impact is equal to the assigned score multiplied by the weight of that impact. The estimated impacts (assigned score / maximum score [25] X allocated weighting) of all criteria are then summed together, expressed as a percentage and then subtracted from 100 to determine the Present Ecological State score (PES; or Ecological Category) for the instream and riparian components, respectively.

Table 6-3: Criteria and weightings used to assess habitat integrity

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality modification	14	Water abstraction	13
Inundation	10	Inundation	11
Alien/Exotic macrophytes	9	Flow modification	12
Alien/Exotic aquatic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	100	TOTAL	100

However, in cases where selected instream component criteria (i.e. water abstraction, flow, bed and channel modification, water quality and inundation) and/or any of the riparian component criteria exceeded ratings of large, serious or critical, an additional negative weight was applied. The aim of this is to accommodate the possible cumulative effect (and integrated) negative effects of such impacts (Kemper, 1999). The following rules were applied in this respect:

Impact = Large, lower the integrity status by 33% of the weight for each criterion with such a rating.

Impact = Serious, lower the integrity status by 67% of the weight for each criterion with such a rating.

Impact = Critical, lower the integrity status by 100% of the weight for each criterion with such a rating.

Subsequently, the negative weights were added for both facets of the assessment and the total additional negative weight subtracted from the provisionally determined integrity to arrive at a final habitat integrity estimate (Kemper, 1999). The eventual total scores for the instream and riparian zone components are then used to place the habitat integrity in a specific habitat integrity ecological category (Table 6-4).

Table 6-4: Ecological Categories for the habitat integrity scores

Ecological Category	Description	Score (% of Total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

6.4 Aquatic Macroinvertebrate Assessment

The subsections below outline the different macroinvertebrate associated assessments utilised in the study.

6.4.1 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 the South African Scoring System (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 6-5.

Table 6-5: 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**

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 6-5. Consequently, the assessment index describes the quantity, quality and diversity of available macroinvertebrate habitat relative to an “ideal” diversity of available habitat.

6.4.2 South African Scoring System

The SASS 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 Recorded 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).

6.4.3 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.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES as outlined in Table 6-6.

Table 6-6: Present Ecological State (or Ecological Categories) 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 less than the reference condition. Community composition 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.

6.5 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this study the Present Ecological Status (PES) of tributaries considered in the study was derived through the characterisation of the various biophysical attributes as described in the following sections. The River Eco-status Monitoring Programme (REMP) Ecological Classification manual by Kleynhans and Louw (2007) was used in order to accomplish this task.

It is important to note that an adapted version of the Riparian Ecological Category surrogate (Dr. C.J. Kleynhans, *pers. comm.*, 2015) will be used in this assessment as follows:

*Riparian Vegetation EC = 100-(((IHI 'Natural vegetation removal')+(IHI 'Exotic Vegetation Encroachment'))/50*100)*

7 Findings and Interpretations

The sections below outline the findings from the various assessments and tasks conducted for the aquatic study.

7.1 Aquatic Desktop Information

According to the Present Ecological Status and Ecological Importance and Sensitivity (PESEIS) data gathered (DWS, 2018), the watercourse of concern consists of the upper reaches of the Saalklapspruit (i.e. B20G-01099 SQR). Furthermore, an unclassified tributary of this SQR is planned to receive the proposed KPS WTP discharge (DWS, 2018). Therefore, the quality of this proposed discharge, together with any associated potential impacts, should be of main focus in terms of preserving the aquatic ecology of the adjoining Saalklapspruit SQR. Table 7-1 below outlines the gathered PESEIS information pertaining to the Saalklapspruit SQR of concern.

Table 7-1: Desktop Information for the Upper Saalklapspruit SQR (B20G-01099)

Component	Obtained Data
SQR Length	41.57 km
Present Ecological Status	C (moderately modified)
Ecological Importance (EI)	High
Number of expected fish species	4
Number of expected macroinvertebrate taxa	39
Ecological Sensitivity (ES)	High
Fish and invertebrate sensitivity to physio-chemical modifications	Moderate
Invertebrate velocity sensitivity	High
Stream size sensitivity to flow and water level changes	High
NFEPA Status	None

According to the above gathered data (DWS, 2018), the Saalklapspruit SQR of concern is categorised as moderately modified (ecological category C). Impacts pertaining to this categorisation, relevant to their significance, include the following:

- **Small:** inundation, natural areas / reserves and roads;
- **Moderate:** abstraction, increased flows, algal growth, low water crossings, irrigation, urban effluent, small farm dams and vegetation removal;
- **Large:** agricultural lands, exotic vegetation and mining; and
- **Serious:** mining effluent.

Furthermore, the EI of the reach is considered to be high due to important expected invertebrate taxa rather than fish species (DWS, 2018). The ES of the reach is also considered to be high due to the expectance of flow-dependent invertebrates and additional vertebrates (i.e. fish) sensitive to flow and water level changes (DWS, 2018). Due to the small stream size of the river, sensitivity of the river to changes in flow and water levels has also been classified as high (DWS, 2018).

7.1.1 Saalkspruit Findings

According to the previous biomonitoring study (Ecology International, 2017); the Saalkspruit appears to be in a severely impacted state. Findings from the current study indicate similar conditions to the aforementioned study which categorised the habitat, according to the IHI, as Ecological Category F (critically modified) for both instream and riparian habitat. The KPS mining activities in upper reaches of this tributary has resulted in severe modification of the reference hydrology and morphology of the Saalkspruit (Ecology International, 2017).

Figure 7-1: Open sewage cover with signs of flow into the Saalkspruit

Furthermore, leaking sewage has been observed entering the system for an extending period of time with open man holes observed even during the current survey (Figure 7-1). This impact has almost certainly deteriorated the water quality of the tributary and the adjoining Saalklapspruit SQR.

7.2 *In Situ* Water Quality

In situ water quality testing took place at all of the aforementioned monitoring points with the exception of Site K3 due to the aforementioned accessibility issue for the site. Table 7-2 outlines findings from this assessment. It is important to note that no Resource Water Quality Objectives (RWQOs) have been set for the B20G quaternary catchment within which the watercourses of concern are located (DWS, 2016). Therefore, guidelines utilised in this study have been obtained from DWAF (1996).

Table 7-2: *In situ* water quality findings

Site	K3	K4	K5	Recommended Guidelines
Temperature (ºC)	DRY	18.2	16.0	-
pH		6.94	8.24	6.5-9
Conductivity (µS/cm)		139.2	317.0	<700
Dissolved Oxygen (mg/l)		5.87	7.03	-
Saturation Percentage		76.2	77.0	80-120
Red shading indicates constituents exceeding recommended guidelines as stipulated in DWAF (1996)				

All recorded constituents were within the recommended guidelines with the exception of the saturation percentages at both Sites K4 and K5. The *in situ* saturation values were recorded slightly below the recommended guideline value of 80% which can be regarded as problematic for aquatic biota if the conditions persist (DWAF, 1996). These findings are most likely prevalent due to the natural impounded wetland nature of the sampling sites, usually resulting in less flow and consequently lower oxygen levels, compounded by the KPS mining activities taking place in the upper reaches of the watercourse altering downstream hydrology at Site K5. In addition, sewage influences noted by Ecology International (2017) and current study have also impacted on the oxygen levels in the assessed watercourses.

The pH findings at both sampling sites (i.e. Sites K4 and K5) were recorded within the recommended guideline values (DWAF, 1996). The findings at Site K4 were similar to those recorded during the 2017 biomonitoring period (Ecology International, 2017), whereas the pH recorded at Site K5 increased notably from the previous study. A possible cause for this increase can be due to the lack of potentially acidic water flowing from the KPS upstream activities as noted in the Ecology International (2017) study. Conductivity findings at both Sites K4 and K5 were also below the recommended guideline value of 700 µS/cm (DWAF, 1996) and fairly similar to those recorded during the 2017 study (Ecology International, 2017).

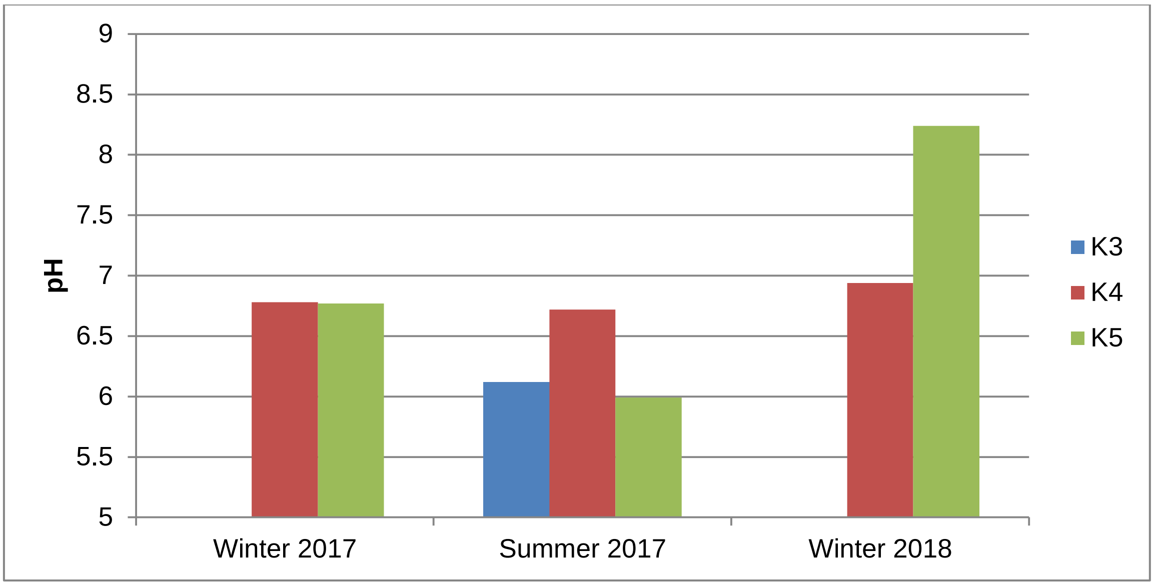

Figure 7-2: pH findings in comparison to the previous biomonitoring period

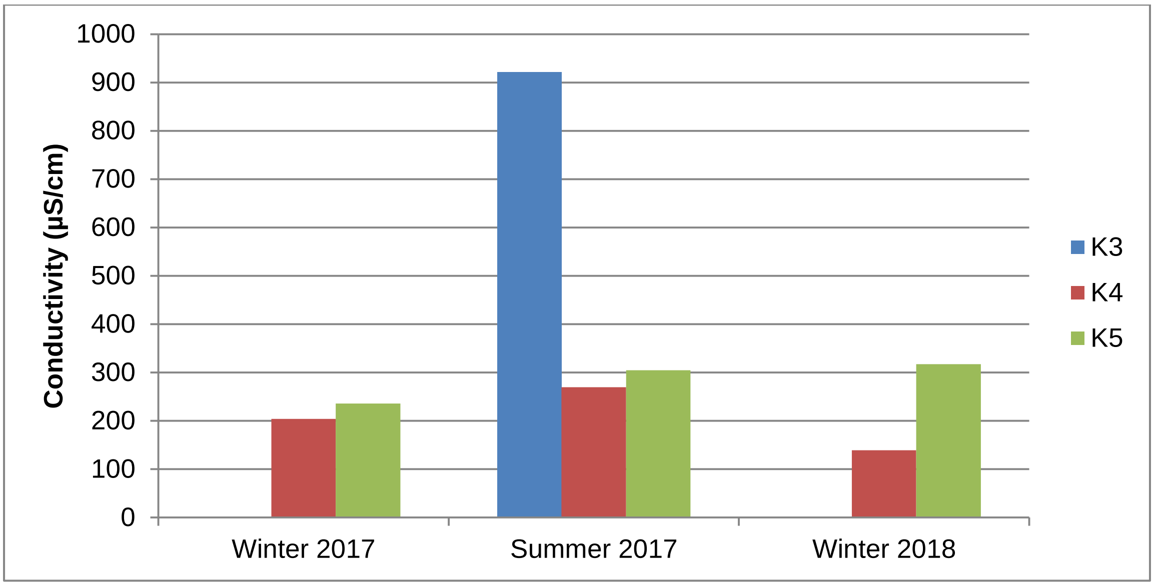

Figure 7-3: Conductivity findings in comparison to the previous biomonitoring period

Figure 7-2 and Figure 7-3 display the temporal and spatial variation of the pH and conductivity findings between the previous monitoring period and the current study. It is clear that the conductivity at downstream Site K5 is being influenced by water high in dissolved sold content flowing from the KPS upstream activities as indicated by the high conductivity recorded during the summer 2017 survey at Site K3. However, the conditions at Site K5 are most likely also influenced by the sewage input into the system.

7.3 Index for Habitat Integrity

The IHI was conducted on approximately 10 km of the Saalklapspruit SQR starting from upstream of Site K4 where the SQR runs parallel to the N12 highway. Observations from satellite imagery together with findings from the site visit were utilised in the IHI calculation. Results from the Saalklapspruit IHI are presented in Table 7-3 below.

Table 7-3: IHI findings for the watercourse draining from the KPS Colliery

Habitat Component	IHI Score	Ecological Category
Instream	42.37	D
Riparian	43.26	D

The results from the IHI indicate that both the instream and riparian habitat associated with the assessed reach are in a largely modified state (Ecological Category D). Instream modifications observed during the study include farm dams, road crossings and agricultural practices along the reach which appear to be impacting on the hydrology of the system. During the timing of the survey the upstream KPS mining activities appeared to have minimal impacts on the downstream hydrology as notable flow was observed at Site K5 even during, what is considered, the dry season (i.e. winter). Furthermore, raw sewage entering from the Saalkspruit has severely impacted on the water quality of the assessed Saalklapspruit SQR, contributing heavily to the modified instream score. Agricultural encroachment and urbanisation near the SQR has resulted in the removal of riparian vegetation. This impact together with the influence of livestock and exotic vegetation encroachment, have contributed to the largely modified score of the riparian habitat component.

7.4 Aquatic Macroinvertebrates

The sections below outline the findings from the various macroinvertebrate indices utilised in the study.

7.4.1 Integrated Habitat Assessment System

The results from the IHAS conducted during the study are presented in Table 7-4. It is important to note that summer findings from the previous biomonitoring study (Ecology International, 2017) have been utilised for seasonal comparative purposes.

IHAS findings during the summer 2017 survey (Ecology International, 2017) indicate poor macroinvertebrate habitat availability at both Sites K4 and K5. Similar findings were also recorded during the current study where the available macroinvertebrate habitat at the same sites was also classified as poor. The current low IHAS scores and overall poor classification of available macroinvertebrate habitat at both sampling sites can most likely be attributed to the lack of flow and cobbles (contributing largely to ideal macroinvertebrate habitat) compounded by algal presence, potentially forming from sewage input, observed at the sites.

Table 7-4: IHAS findings for the study

Site	K3	K4	K5
Summer 2017			
IHAS	Water level too low	43.64	50.91
Interpretation		Poor	Poor
Winter 2018			
IHAS	DRY	41.82	50.91
Interpretation		Poor	Poor

7.4.2 South African Scoring System

The SASS5 findings from the May 2018 survey are presented in Table 7-5

Table 7-5: SASS5 results for the May 2018 survey

Site	K3	K4	K5
SASS5 score	DRY	62	76
Number of taxa		14	19
Average score per taxa		4.43	4.00

The SASS5 assessment resulted in a total of 14 taxa being sampled at Site K4 with a total of 19 taxa sampled at Site K5. The SASS5 scores ranged from 62 at Site K4 to 76 at Site K5. This increase in SASS5 score at Site K5 in comparison to Site K4 can most likely be attributed to the higher IHAS score recorded at the site, despite the available macroinvertebrate habitat at both sites being poorly categorised (Table 7-4). The average sensitivity scores per sampled taxa at both sites were low ranging from 4.00 at Site K5 to 4.43 at Site K4. This indicates that the current macroinvertebrate assemblages in the assessed aquatic systems are comprised of tolerant families.

7.4.3 Macroinvertebrate Response Assessment Index

The results from the site based MIRAI conducted during the study are outlined in the respective tables below. The MIRAI findings for Site K4 indicate that the macroinvertebrate assemblage in a largely modified state (Ecological Category D). The largest contributing metric group to this modified score appears to be due to poor water quality at the site possibly resulting from sewage influences entering into the system from the Saalkspruit.

Table 7-6: MIRAI findings for Site K4

Invertebrate Metric Group	Score Calculated
Flow modification	52.7
Habitat	44.9
Water Quality	41.0
Ecological Score	**46.41**
Ecological Category	**D**

Figure 7-4 below displays signs of sewage contaminated water entering into the Saalklapspruit from the Saalkspruit. The habitat metric group is also largely influencing this modified score as numerous taxa with a preference for specific biotopes, such as cobbles, gravel and sand, were not sampled (e.g. Caenidae and Gomphidae). Flow modification, according to the MIRAI findings, is also prevalent and influencing the macroinvertebrate assemblages recorded during the study. This can partially be attributed to the KPS mining activities that have taken place in the upper reaches of the watercourse of concern. However, mining activities in the upper reaches of the Saalklapspruit and in a tributary upstream from the site (i.e. GPS coordinates: 26° 02'06.55"S 28°59'57.28"E) appear to be impacting the flow to a greater extent compared to the KPS mining activities.

Figure 7-4: Signs of dirty water flowing into the Saalklapspruit from the Saalkspruit

Table 7-7: MIRAI findings for Site K5

Metric Group	Score Calculated
Flow modification	49.4
Habitat	54.8
Water Quality	42.6
Ecological Score	**49.07**
Ecological Category	**D**

The MIRAI findings for Site K5 indicate that the macroinvertebrate assemblage in a largely modified state (Ecological Category D). The largest contributing metric group to this modified score appears to be due to poor water quality at the site. The aforementioned sewage related issue has been an ongoing event for some time and has even been noted in the previous aquatic biomonitoring study (Ecology International, 2017). This impact is most likely driving the low score observed in the MIRAI water quality metric and is contributing largely to the overall largely modified Ecological Category.

7.5 Present Ecological State

The PES for the B20G-01099 SQR was determined utilising data gathered from both Sites K4 and K5. The results from this determination are presented in Table 7-8. It is important to note that this PES constitutes only for the B20G-01099 SQR and not the unclassified tributary originating from Site K3.

Table 7-8: Present Ecological State for the B20G-01099 SQR

Metric Group	Ecological Score	Ecological Category
Riparian vegetation	40.00	D/E
Site K4 Macroinvertebrates	46.41	D
Site K5 Macroinvertebrates	49.07	D
Present Ecological State	**47.55**	**D**

The PES determination deduced that the assessed Saalklapspruit SQR (B20G-01099) is in a largely modified state (Ecological Category D) according to the riparian and macroinvertebrate data gathered for the SQR.

Future studies will be able to utilise the overall PES to determine if the WTP has impacted on the downstream reach as well as compare the MIRAI Ecological Categories from the upstream site (i.e. Site K4) to the downstream site (i.e. Site K5) to quantify potential changes from the determined conditions (Ecological Category D at both sites).

8 Impact Assessment Findings

The sections below outline the findings from the aquatic impact assessment (See Appendix B for Impact Assessment Methodology).

8.1 Potential Impacts Summary

The major foreseeable impact associated with the Project is the probable alteration of the hydrology of the receiving tributary of the proposed WTP discharge, as well as the hydrology of the downstream adjoining Saalklapspruit SQR. Furthermore, activities associated with the construction of the Project and minor impacts from the infrastructure once established are also predicted to alter the hydrology of the aforementioned downstream watercourses compounded with potential water quality impacts as outlined in Table 8-1 below.

Table 8-1: Foreseeable Potential Impacts

Activity	Potential Impact Description	Aquatic Ecology Implication
Site clearing for proposed infrastructure	Vegetation removal and bare surfaces resulting in increased flow and runoff into the downstream watercourses.	▪ Physical alteration of riparian habitat; ▪ Alteration of aquatic habitat through increased flow and water level; and ▪ Modification to stream morphology due to increased flow and runoff (i.e. increased erosion / sedimentation and bank instability).
Use of chemicals / contaminants	Substances harmful to aquatic biota entering the downstream reaches during construction - Increasing the toxicity of the associated water.	▪ Loss of aquatic biota sensitive to physio-chemical changes.
Increased impermeable surface area	Increased surface runoff, around the pipeline routes is expected at a small scale.	▪ Increase in contaminants entering the downstream watercourses compounded by erosion / sedimentation placing additional stress on aquatic biota.
Discharge of water from the treatment plant	Alteration of downstream hydrology, morphology and water quality. .	▪ Physical alteration of riparian habitat; ▪ Alteration of aquatic habitat through increased flow and water level; ▪ Modification to stream

Activity	Potential Impact Description	Aquatic Ecology Implication
		morphology due to increased flow and runoff (i.e. increased erosion / sedimentation and bank instability); and ▪ Improved water quality of the downstream reaches

8.2 Management Objectives

The objective for aquatic management throughout the entirety of the life of the Project is to preserve the PES of the Saalklapspruit SQR and prevent further degradation of the Saalkspruit as discussed in Section 7.1 (Saalkspruit Findings). This objective can be achieved through implementation of the management actions outlined in the specific Project Phase sections below.

8.3 Construction Phase

The key area of focus during the construction phase of the Project is the proposed WTP discharge pipelines. Activities associated with its construction having the potential to impact on the downstream aquatic ecology are outlined below:

- Site access and clearance for proposed pipeline infrastructure; and
- The use of chemicals / contaminants (e.g. hydrocarbons).

A detailed analysis of the aforementioned impacts are provided for in the below subsections.

8.3.1 Impact Description: Water and Habitat Quality Deterioration

Site access and the clearing of vegetation for pipeline infrastructure will most likely result in an increase in surface runoff, erosion and subsequently the amount of suspended and dissolved solids as well as pollutants (i.e. hazardous substances from the actual construction areas such as hydrocarbons) entering the downstream watercourse. These impacts will alter the hydrology and water chemistry of the affected watercourses and will negatively impact aquatic ecology as follows:

- Contaminant increases in watercourses will increase the potential toxicity of the water and place additional stress on the aquatic biota in the downstream 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 a 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 runoff, erosion and the physical removal / loss of aquatic habitat at construction sites.

8.3.2 Impact Ratings and Management Actions

General mitigation actions provided in the wetlands and surface water studies conducted by Digby Wells for the authorisation of the WTP Project should be used to guide the effective management of aquatic resources potentially affected by the project. However, in terms of attempting to focus on the aforementioned specific impacts on aquatic ecology, attention should be paid to Table 8-2 below.

Table 8-2: Potential Surface Runoff Impact of the Construction Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Site clearance and access for the construction of proposed pipeline infrastructure			
Impact Description: Vegetation and aquatic habitat (i.e. riparian) removal resulting in increased runoff, erosion, sedimentation and possible increase in contaminants / chemicals in the downstream watercourses.			
Prior to Mitigation/Management			
Duration	Project life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until removal of infrastructure or project closure.	Minor (negative) – 36
Extent	Limited (2)	Due to the usual dry nature of the upstream project area (Site K3) and the already mined through upstream area associated with the construction footprint, this impact is expected to be limited.	
Intensity x type of impact	Low - Negative (-2)	Due to the small footprint associated with the construction of the pipelines the proposed area for site clearance appears to be relatively small and is usually dry as indicated by Site K3 findings. Therefore, the intensity of runoff and its potential to carry contaminants is expected to be limited.	

<table>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td>Probability</td><td>Probable (4)</td><td>Runoff is likely to occur more than once during construction especially during high rainfall events.</td><td rowspan="2"></td></tr>
<tr><td>Nature</td><td colspan="2">Negative</td></tr>
<tr><td colspan="4">Mitigation/Management Actions
- Limit vegetation removal to the infrastructure footprint area only where removed or damaged vegetation areas (riparian or aquatic related) should be revegetated;
- Bare land surfaces downstream from construction activities should be vegetated to limit erosion from the expected increase in surface runoff from infrastructure;
- Environmentally friendly barrier systems, such as silt nets or in severe cases the use of trenches, can be used downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction if the aforementioned vegetation management action is not an option. In severe run off cases, only noticeable throughout construction, trenches might be the sole management option;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow (i.e. use of baffles at the end of canals or trenches if implemented);
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely from the site into downstream watercourses as this water will most likely be contaminated and high is suspended solids;
- Construction chemicals, such as paints and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions in order to attempt to limit entry into the downstream reaches; and
- High rainfall periods (i.e. usually December to March) should be avoided during construction 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 the downstream aquatic systems.</td></tr>
<tr><td colspan="4">Post-Mitigation</td></tr>
<tr><td>Duration</td><td>Project Life (5)</td><td>Once vegetation is cleared for infrastructure, no revegetation will occur until the closure phase of the project or removal.</td><td rowspan="2">Negligible (negative) – 16</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>Runoff will most likely be restricted after mitigation to the area before the N12 highway.</td></tr>
</table>

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Minor - Negative (-1)	If mitigation measures are all incorporated for the construction phase, the intensity of the impact should decrease, especially due to the dry nature observed in the upper reaches.	
Probability	Improbable (2)	The likelihood of runoff occurring will be reduced by the mitigation actions and should only result in extreme cases or unexpected rainfall events.	
Nature	Negative		

8.4 Operational Phase

The major foreseeable impact associated with the construction phase of the project appears to be the discharge of water into the downstream Saalkspruit. Runoff from the impermeable pipeline surface is also expected to impact marginally on the downstream systems but appears to be negligent due to the proposed discharge that shall occur throughout the operational phase. This proposed discharge will almost certainly alter the downstream hydrology from reference conditions by increasing the water levels and flow rate in the Saalkspruit and adjoining Saalklapspruit SQR. However, it also has the potential to improve water quality in the downstream aquatic systems if treated to water discharge standards. Therefore these two predictions have been assessed separately in the subsections below.

8.4.1 Impact Descriptions

The aforementioned outcomes of the proposed discharge have the potential to impact on aquatic ecology of the downstream watercourses as follows:

8.4.1.1 Alteration of downstream hydrology

Increased flow in the downstream watercourses from the proposed discharge will most likely alter the flow preferences of aquatic biota already established in the systems. The increased flow also has the potential to alter and destroy aquatic habitat, especially vegetation, depending on the magnitude of the flow. Furthermore, erosion, sedimentation and bank and channel modification might also result from the increased flows into the channelled valley bottom system (i.e. Saalkspruit).

8.4.1.2 Improved water quality

The proposed discharge is expected to be treated to appropriate discharge standards which will ultimately result in clean potable water entering the upper reaches of the Saalkspruit and the adjoining Saalklapspruit SQR. This water is also expected to flush/dilute the downstream watercourses, which has the potential to improve the sewage related issues as discussed in this Report. The expected improved water quality in the downstream watercourses will benefit sensitive aquatic biota and in general the overall conditions if the increased flow has a limited impact.

8.4.2 Impact Ratings and Management Actions

Impacts ratings associated with the alteration of hydrology associated with the discharge is outlined in Table 8-3 with the water quality benefit outlined in Table 8-4.

Table 8-3: Hydrological Related Impact of the Operational Phase

<table>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td colspan="4">Activity and Interaction: Increased flow in the downstream watercourses associated with the proposed WTP discharge</td></tr>
<tr><td colspan="4">Impact Description: High flow rates in the downstream watercourses will deter aquatic biota with a specific flow and habitat preferences and potentially result in erosion, sedimentation and bank and channel modification of said systems.</td></tr>
<tr><td colspan="4">Prior to Mitigation/Management</td></tr>
<tr><td>Duration</td><td>Project life (5)</td><td>Discharge shall continue until cessation of the project.</td><td rowspan="5">Minor (negative) – 44</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>The impact is expected to remain inside the municipal area.</td></tr>
<tr><td>Intensity x type of impact</td><td>Moderate - Negative (-3)</td><td>The discharge is expected to potentially benefit ecosystem functioning. However, the intensity of erosion, sedimentation and stream morphological modifications is expected to occur.</td></tr>
<tr><td>Probability</td><td>Probable (4)</td><td>High flow rates in systems that are characterised valley bottom wetlands has a relatively high probability of resulting in the described impacts</td></tr>
<tr><td>Nature</td><td colspan="2">Negative</td></tr>
</table>

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions ■ Ensure that the discharge does not directly enter the Saalkspruit system by allowing it to discharge before the river into a sump/basin before flowing, so as to limit potential erosion and sedimentation; ■ Armoured outlets utilising naturally occurring rocks can be installed to reduce the intensity of the flow from the pipeline outlet to attempt to limit immediate erosion; ■ Flow diffusing mechanisms should be implemented (e.g. baffles) to limit any potential erosion and sedimentation likely to be facilitated by the high discharge volume of the outfall; ■ Monitoring of the culvert from the discharge to under the N12 highway should take place in order to ensure no backfill or pools start to form. This might require maintenance depending if the impact occurs; and ■ Revegetation should occur in sections that have been washed out due to the increased flow. This should also occur in severe cases of erosion where rehabilitation of impacted watercourse banks should take place simultaneously with revegetation.			
Post-Mitigation			
Duration	Project Life (5)	Discharge shall continue to commence throughout the life of the project.	Negligible (negative) – 27
Extent	Local (3)	If the mitigation actions are implemented correctly, the extent of the impact is expected to occur only at areas immediately associated with the discharge.	
Intensity x type of impact	Very low - Negative (-1)	If the intensity of the flow is reduced the aforementioned stream modifications will most likely be reduced.	
Probability	Unlikely (3)	Alteration of hydrology and increased flow in the downstream reaches is expected to occur despite mitigation measures. However, the likelihood of the consequential impacts is expected to be reduced.	
Nature	Negative		

Table 8-4: Water Quality of the Operational Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Clean water being discharged into the degraded Saalkspruit			
Impact Description: Clean water is proposed to be discharged into the Saalkspruit and eventually enter the Saalklapspruit SQR of concern.			
Prior to Mitigation/Management			
Duration	Project life (5)	Clean water discharge shall continue until cessation of the project.	Minor (Positive) + 44
Extent	Local (3)	Due to the expected large volume of water to be discharged, the extent of the improved water quality is expected to occur outside of the development site area.	
Intensity x type of impact	Moderate - Positive (3)	Due to the severely poor water quality associated with the sewage influences in the Saalkspruit, the clean water discharge is expected to notably improve water quality conditions in the system and adjoining Saalklapspruit SQR. However, limited to the local area due to downstream mining activities.	
Probability	Probable (4)	Based on the poor water quality conditions of the Saalkspruit associated with the sewage input into the system, the clean water discharge has a high probability of improving downstream water quality conditions.	
Nature	Positive		
Mitigation/Management Actions No mitigation actions are required in order to improve the downstream water quality. However, it is essential that the water being discharged is in fact clean water that meets discharge standards. Hence, it is suggested that the discharge quality is closely monitored.			

8.5 Decommissioning Phase

Minor impacts such as the entry of contaminants (e.g. hydrocarbons) into the downstream aquatic systems as a result of the physical/mechanical removal of infrastructure are expected to be the main impact associated with the decommissioning phase of the project.

8.5.1 Impact Description

Similarly to the water quality and chemistry related impacts described in the construction phase of the project, mechanical activity throughout the phase are expected to impact on water quality and ultimately aquatic ecology of the downstream watercourses as outlined below. However, this is expected to be minimal due to the small footprint area of aquatic relevance associated with the infrastructure compounded by the expected high dilution potential of the downstream reaches after the proposed discharge.

- Contaminant increases in watercourses will increase the potential toxicity of the water and place additional stress on the aquatic biota in the downstream systems;
- Dissolved solids concentration increases will most likely result in a loss of certain taxa if their specific salinity tolerances are exceeded; and
- 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.

8.5.2 Impact Ratings and Management Actions

Table 8-5 outlines the impact ratings and management actions associated

Table 8-5: Water quality of the Decommissioning Phase

Dimension	Rating	Motivation	Significance
Activity and Interaction: Removal of established infrastructure and site access associated with the decommissioning phase			
Impact Description: Workings and the use of machinery in the upstream area associated with the pipeline has the potential to degrade downstream water quality and chemistry depending on the extent of runoff from the decommissioning area.			
Prior to Mitigation/Management			
Duration	Medium Term (3)	The impact is only expected to take place during the decommissioning phase and can be reversed with minimal management.	Minor (negative) – 36
Extent	Municipal (4)	Runoff is expected to be limited. However, the expected increased volume of the downstream watercourses might influence the extent of water quality related impacts if contaminants from the decommissioning sites enter the systems.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Low - Negative (-2)	Due to the small footprint associated with the pipeline area associated with aquatic systems, infrastructure removal should be limited to a small enough area to have minimal implications to the downstream watercourses.	
Probability	Probable (4)	Runoff is likely to occur more than once during decommissioning especially during high rainfall events.	
Nature	Negative		
Mitigation/Management Actions ■ Limit infrastructure removal to the infrastructure footprint area only where removed or damaged vegetation areas (riparian or aquatic related) should be revegetated; ■ Bare land surfaces downstream from the decommissioning activities should be vegetated to limit erosion; ■ Drainage lines and compact natural areas / soils formed from vehicular use and general decommissioning activities should be rehabilitated to limit runoff; ■ Chemicals, such as machinery oils and hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions in order to attempt to limit entry into the downstream reaches; and ■ High rainfall periods (i.e. usually December to March) should be avoided during this phase 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) from the working area into the downstream aquatic systems.			
Post-Mitigation			
Duration	Medium term (3)	Runoff into the downstream watercourses will continue to occur throughout the decommissioning phase.	Negligible (negative) – 16
Extent	Limited (2)	The extent is most likely to drop slightly after mitigation actions are implemented. However, contaminants might extend past the immediate project area but will be limited if the runoff from decommissioning sites is reduced.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Very low - Negative (-1)	If runoff from the decommissioning sites is reduced, contaminants entering the downstream watercourses will be limited.	
Probability	Improbable (3)	The likelihood of runoff occurring will be reduced only slightly as the additional use of trenches and storm water diversion systems will not be utilised as it is the closure phase of the project.	
Nature	Negative		

8.6 Unplanned Events

Table 8-6 outlines identified unplanned events that might occur during the Project that have the potential to impact on the aquatic ecology of the downstream watercourses.

Table 8-6: Unplanned Events and Mitigation Measures

Unplanned Risk	Mitigation Measures
Chemical / contaminant spills from developments	▪ Ensure correct storage of all chemicals at operations (e.g. sealed containers for hydrocarbons); ▪ Ensure staff involved at the proposed developments and operations have been trained to correctly use and clean chemicals used at the sites; and ▪ Ensure spill kits (e.g. Drizit) readily available at proposed developments during construction and operation.
Spillage / leakage of water from pipeline infrastructure	▪ Install safety valves and emergency switches that can be used to seal off leakages from the pipe when noticed or triggered; ▪ Maintenance of the pipeline should be considered an ongoing basis where leakages or issues with the pipe should be reporting to acting Environmental Coordinator of the Resort immediately after notice; and ▪ Areas where severe leaks have occurred can be prone to erosion resulting in the sedimentation of downstream systems if not contained. Thus, attempts to limit runoff from leaks, especially if flowing through the mine operations, should be made.

9 Aquatics Monitoring Programme

An aquatic ecology monitoring programme has been developed for the monitoring and preservation of the assessed aquatic systems for the Project. Table 9-1 outlines the River Health Programme methods needed to be undertaken on an annual basis at the monitoring points indicated in Table 5-1 in order to determine the PES of the assessed rivers in this study and to determine if the proposed developments are impacting on the associated aquatic ecology. It is further insisted that an additional monitoring point be selected downstream of Site K3 along the Saalkspruit in order to obtain aquatic related data before the proposed WTP discharge reaches the adjoining Saalklapspruit SQR. This will allow for the comparison of aquatic conditions between the Saalkspruit and the upper Saalklapspruit SQR.

Table 9-1: Aquatic monitoring Programme

Method / focus	Details
Water Quality	*In situ* water quality parameters as per this study
Toxicity Testing	Single toxicity sample tested biannually to a minimum of three test biota downstream from the discharge
Habitat Quality	IHAS and the Index of Habitat Integrity
Macroinvertebrate assemblages	SASS5 and MIRAI

10 Conclusions and Recommendations

A summary of the baseline findings and key aspects needed to take into consideration regarding the aquatic impact assessment are provided for below.

10.1 Baseline Findings

Baseline findings from the study indicate that the tributary (i.e. Saalkspruit) directly associated with the proposed discharge of the Project is in a critically impacted and modified state (Ecological Category F). Contributions to this categorisation include mining activities having mined through the upper reaches of the tributary compounded by sewage influences along the watercourse severely impacting on water quality.

Findings for the SQR of concern as classified by the DWS (i.e. B20G-01099 SQR / Saalklapspruit) indicate that this watercourse is in a largely modified state (Ecological Category D). Encroachment of agricultural activities and urbanisation of the downstream sections have partially resulted in the loss of sections of riparian vegetation and impacts on instream morphology and hydrology (e.g. farm dams along the reach, livestock activity and rural developments in riparian habitat). Furthermore, sewage input from the adjoining Saalkspruit has impacted on water quality of the downstream section of the SQR. These impacts have consequently resulted in the largely modified macroinvertebrate Ecological

Category determined in this study which has notably contributed to the modified PES of the Saalklapspruit

10.2 Key Impact Assessment Aspects

The aquatic impact assessment conducted for the Project indicated that the major focus area, relative to aquatic ecology, should be on the proposed pipeline and its discharge. Construction of the pipeline is expected to have minor impacts on aquatic ecology resulting from increased runoff and contaminant entry into the downstream watercourses compounded by minimal alteration of established aquatic-related habitat. More importantly, the proposed discharge from the WTP is expected to alter the hydrology of the downstream watercourses which, in turn, is expected to negatively impact on reference aquatic ecology. However, the proposed clean water from the discharge is expected to improve the overall poor water quality conditions of the downstream watercourses and possibly flush the known and observed sewage related issues. Lastly, minor water quality issues are expected to arise during the decommissioning of the established infrastructure as a result of runoff through the decommissioning footprint.

To conserve the downstream established PES of the Saalklapspruit and to potentially improve the degraded conditions of the Saalkspruit, the provided management actions should be implemented, where possible. Furthermore, the provided Aquatics Monitoring Programme should be implemented in the existing biomonitoring scheme in order for the Project to commence to monitor for potential impacts associated with the project.

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Appendix A: Site Photographs

Table 1: Site photographs

Site	Photograph
K3	

K4	

K5	

Appendix B: Impact Assessment Methodology

1 Impact Assessment Methodology

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 1-3. 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 1-2, which is extracted from Table 1-1. The description of the significance ratings is discussed in Table 1-3.

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 1-1: 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 1-2: Probability/Consequence Matrix

Probability	Significance																																					
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
	-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 1-3: 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) (-)

Score	Description	Rating
-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) (-)