Water Resource Assessment for the proposed Tugela Ferry siphon rehabilitation and abstraction project

Msinga, KwaZulu-Natal

September 2018

CLIENT

IN ASSOCIATION WITH INKANYEZI YETHU

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Report Name	**Water Resource Assessment for the proposed Tugela Ferry siphon rehabilitation**	
Reference	**Tugela Ferry Siphon Rehab and Abstraction**	
Submitted to	**EnviroPro Environmental Consulting (Pty) Ltd**	
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The Tukhela River at S2 (September 2018)

EXECUTIVE SUMMARY

Existing canals and siphons conveying freshwater are leaking which have resulted in minor to severe erosion. A planned project proposes to refurbish and replace the concrete siphons of the canal network. Inline with these rehabilitation actions, an additional pipeline/siphon will replace the existing leaking structures. Further rehabilitation actions include the upgrading and overhaul of a pump station which seeks to abstract water at 352 m^3/hour. Considering the proposed activities, the proposed project has triggered several environmental listed activities. Inline with this application, The Biodiversity Company (TBC) was commissioned to conduct a water resource assessment, consisting of a baseline water resource and wetland assessment, as part of the environmental authorisation process which includes and Water Use Licence Application (WULA) for the proposed project.

The project is located in the Msinga area within the KwaZulu-Natal Province. The project area falls within the quaternary catchments V60G and V60H, within the Pongola to Mtamvuna Water Management Area (WMA 4). The proposed project will directly affect the V60H-3431 Sub Quaternary Reach (SQR) of the Thukela River. In addition, the siphon construction and operation measures will directly affect the V60H-3436 SQR. The applicable Instream Flow Requirement and Reserve node is located approximately 17 km downstream of the proposed abstraction point at the monitoring point IFR 5 (DWAF, 2001).

A single water resource survey was completed between the 30th of August and 2nd of September 2018. Standard methods were utilised to derive the Present Ecological Status (PES) and delineations of wetland and riverine areas. In addition, standard rapid hydrological cross sections were completed for this study.

Wetland

The survey included a high-level investigation and site assessment. One (1) Hydro geomorphic (HGM) type was identified within the 500m project assessment boundary. The identified wetland HGM was determined to be a River HGM type. Two River HGM units were delineated in the project area. Several drainage lines were also identified in the project area.

The Thukela River was determined to be a river channel with large rocks within in the channel and smaller cobble-like rocks on the banks. The river did not present indicators of wetlands and the riparian habitat was dispersed along a narrow margin on the banks of the river. The largest disturbance of the riparian zone was the establishment of rural housing areas and roads. The development of the town centre was also found to border within the riparian zone.

The identified HGM units are not considered wetlands and as such the PES, Ecosystem Services and EIS could not be assessed. The primary focus of this assessment was therefore the riverine assessments, or aquatic ecology.

Aquatic Ecology

The results of the PES assessment derived moderately modified (class C) conditions in the river reach considered in this assessment. The modified conditions were largely attributed to cumulative habitat level impacts which have resulted in the modification of riparian conditions. The results of the EIS assessment derived a very high EIS for the river reach assessed.

Areas associated with the various existing siphon consisted largely of drainage lines. The drainage lines had limited riparian zones with extensive erosion and sedimentation.

Hydrology

Overall discharge measured at the site S2 was 5.4 m^3/s, this was within range of the established discharges in the Instream Flow Requirements study during the representative season. The 90% flow curve for surety indicates that the Reserve in September was 1.1 m^3/s. The current discharge measured indicates that the Reserve was currently being met during the survey. The proposed abstraction of 0.09 m^3/s therefore represents 1.6% of the total discharge observed. A mean of 5.3 m^3/s (n= 39) for the periods for August 14th to September 22nd 2017 was recorded at the V6H002 gauging weir. This provides an indication that short term flows support the established Reserve. Considering this, it is unlikely that the abstraction would result in a significant impact on the available Reserve.

Risk Assessment

The results of the risk assessment indicate that the siphon construction component of the proposed project would not result in any significant long terms impacts to local watercourses. Impacts associated with the construction component of this proposal will be limited to the construction phase where river banks will be disturbed. Positive bank stabilisation at sites associated with the project can be expected during the operational phase. Furthermore, during the operational phase, limited impacts can be anticipated for general maintenance activities.

The proposed construction footprint for the abstraction pump is located within the riparian zone. It is recommended that this permanent structure is moved outside the delineated riparian area. It is further recommended that the 1:100 year floodline is delineated and used as a guide for the choice of the pump station location.

The risk for water abstraction was determined to be moderate. This moderate risk was related to the alterations of water volumes in the Thukela River. However, when considering the Reserve with the measured hydrology completed for this study, the abstraction is unlikely to have a significant impact. It is however recommended that this is compared with the relevant developments within the Thukela River system.

The siphon construction aspect of the proposed project is anticipated to have a positive cumulative impact. The abstraction component of this proposed project was determined to have a limited impact on the overall established Reserve. Considering this, the overall cumulative impact of the abstraction will be limited, should the Reserve be maintained. Further, impoundments and water transfer schemes within the Thukela River system have been planned (Jana and Mielietuin Dam's), however these have been planned in accordance with the established Reserve and therefore are anticipated to have a limited impact in conjunction with the proposed project.

Specialist Recommendation

Through the completion of this study, the location of the pump station was determined to be located in an unfavourable location. It has therefore been recommended that this pump station is relocated. Should the pump-station be relocated, and the recommended mitigation actions implemented, no significant fatal flaws, in relation to the specialist studies conducted in this study, could be identified for the proposed project.

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DECLARATION

I, Ndumiso Dlamini declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Ndumiso Dlamini

Wetland Specialist

The Biodiversity Company

1/10/2018

DECLARATION

I, Russell Tate declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Russell Tate

Aquatic Specialist

The Biodiversity Company

01/10/2018

1 Introduction

Existing canals conveying freshwater are leaking which have resulted in minor erosion. A planned project proposes to refurbish and rehabilitate the concrete canals and siphons. Inline with these rehabilitation actions, an additional pipeline will replace the existing leaking structures. Further rehabilitation actions include the upgrading and overhaul of a pump station which seeks to abstract water at 352 m^3/hour. Considering the proposed activities, the proposed project has triggered several environmental listed activities. Inline with this application The Biodiversity Company (TBC) was commissioned to conduct a water resource assessment, consisting of a baseline water resource and wetland assessment, as part of the environmental authorisation process which includes and Water Use Licence Application (WULA) for the proposed project.

This report, after taking into consideration the findings and recommendation provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making with regards to the proposed activity.

The aim of this study was to provide information to guide the proposed project with respect to the current state of the associated water resources. This was achieved through the following:

- Determining the ecological status of the local watercourses;
- The identification, delineation and assessment of wetlands and riparian zones within 500m of the project area;
- The determination of the hydrology and water availability (Reserve) in the Thukela River;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Key Legislative Requirements

2.1 National Water Act (Act No. 36 of 1998)

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

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

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;

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

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS.

For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998): “Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”.

Wetlands have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

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

2.2 National Environmental Management Act (Act No. 107 of 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in April 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

2.3 Water Management

The National Water Act No 36 of 1998, makes provision for the determination of the Reserve in terms of Section 14 (1) (b) and 17 (1) (b) of the National Water Act, 1998.

The management of national water resources must be compatible with an overarching strategy. In reference to this proposed project, the Preliminary Determination of the Reserve and Resource Class in terms of Section 14 (1) (b) and 17 (1) (b) of the National Water Act, 1998 is the most up to date Reserve that was used in this assessment (DWAF, 2004).

3 Project Area

The project is located in the Msinga area within the KwaZulu-Natal Province. The project area falls within the quaternary catchments V60G and V60H, within the Pongola to Mtamvuna Water Management Area (WMA 4). It is noted that the WMA was previously known as Thukela WMA, which was amalgamated into the Pongola to Mtamvuna WMA (NWA, 2016) (Figure 3-1). The proposed siphon upgrade component of the project will directly affect the V60G-3436 Sub Quaternary Reach (SQR) of the Thukela River. The applicable Instream Flow

Requirement and Reserve node is located approximately 17 km downstream of the proposed abstraction point at the monitoring point IFR 5 (DWAF, 2001).

The area surrounding the proposed project site consists of irrigated agricultural and livestock activities. Dense residential areas, which are accessed through numerous low water crossings are prevalent throughout the immediate catchment areas. The rural nature of the area and high density of the settlements have resulted in the overgrazing of the immediate landscape. Considering the modified nature of the catchments considered in this assessment, erosion and water quality modifications were observed and anticipated as will be discussed in this report.

In order to assess the nature of the baseline riverine environments, two sampling points on the Thukela River and several additional observational points were studied during the survey (Table 3-1).

Table 3-1: Monitoring Points Selected for the Riverine Assessment (September 2018)

Site Name	Location	Photograph
S1	-28.748673° 30.382751°	
S2	-28.759378° 30.412000°	

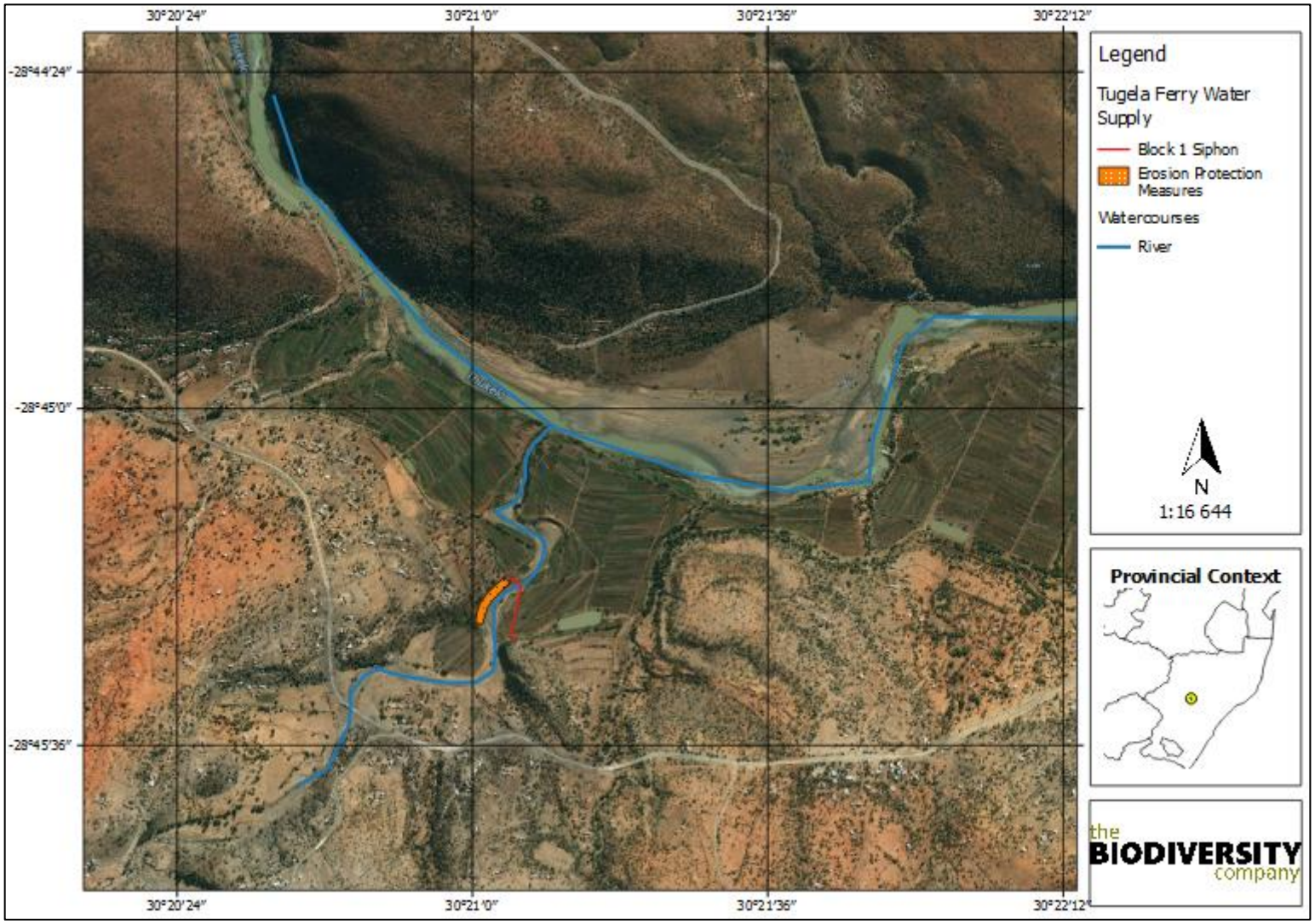


Figure 3-1: The regional layout of the project site

4 Limitations

The following aspects were considered as limitations;

- A single aquatic and wetland ecology site survey was completed for this assessment. Thus, temporal trends were not investigated.
- Channel morphology was largely based on available contour data and supplemented with the survey;
- No impoundment, sump or barrier will be constructed for this project;
- No detailed activity list for the proposed project was not provided and therefore the risk assessment has been completed based on presumptions for standard sand mining operations.
- Environmental flow requirements for the ecology were not determined and were based on established studies.
- No water was present in the V60G-3436 or V60H-3461 SQR, these rivers were therefore not considered for standard PES studies. To address this limitation the condition of the non-perennial river banks were assessed.
- No canal layout was available and only the points that the proposed infrastructure would intersect watercourses was available. The assessment focused on the points where infrastructure would intersect watercourses.
- As result of the footprint area and topography of the project area, the focus of the in-field assessment was on identified watercourse intersection points. These points were likely to be impacted by proposed development activities and were the priorities to assessed in the field.
- As result of the footprint area, the topography of the project area and the large number of identified watercourse intersection points; the aquatic survey identified sites that would represent the reach and focussed the in-field aquatic survey to these identified sites.
- Field assessments were completed to assess as much of the site as possible with focus on the proposed directly impacted and downstream areas;
- The site visit was conducted towards the end of the dry season (low flow) in September. The survey is considered a dry season survey and dry season conditions are anticipated in the field. Although the on-site conditions may still represent certain wet season conditions, many wetland plants had shed their flowering portions and could not be identified;
- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.

5 Methodology

Specialist surveys were conducted between the 30th of August and 2nd September 2018.

5.1 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel *et al*., 2011); and
- Contour data (5m).

5.2 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and also then includes structural features at the lower levels of classification (Ollis *et al.,* 2013).

5.2.1 Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 5-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
    - The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.

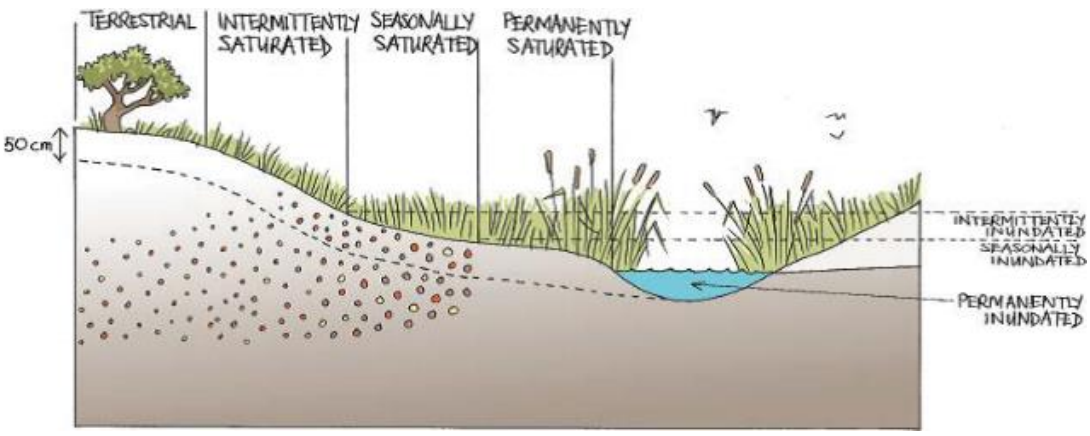


Figure 5-1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, Snaddon, Job, & Mbona, 2013)

5.2.2 Present Ecological Status (PES)

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 1.

Table 5-1: The PES categories (Macfarlane, et al., 2009)

Impact Category	Description	Impact Score Range	Present State Category
None	**Unmodified, natural**	**0 to 0.9**	**A**
Small	**Largely Natural** with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	**1.0 to 1.9**	**B**
Moderate	**Moderately Modified.** A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	**2.0 to 3.9**	**C**
Large	**Largely Modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred.	**4.0 to 5.9**	**D**
Serious	**Seriously Modified.** The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	**6.0 to 7.9**	**E**
Critical	**Critical Modification.** The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	**8.0 to 10**	**F**

5.2.3 Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze et al., 2009). An assessment was

undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 5-2).

Table 5-2: Classes for determining the likely extent to which a benefit is being supplied (Kotze et al., 2009)

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

5.2.4 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 5-3.

Table 5-3: Description of EIS categories.

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

5.3 Buffer Determination

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane, *et al.,* 2014) was used to determine the appropriate buffer zone for the proposed activity.

5.4 Aquatic Assessment

5.4.1 Water Quality

Water quality was measured in situ using a handheld calibrated Extech ExStik II meter. The constituents considered that were measured included: conductivity (µS/cm), pH, temperature (°C) and Dissolved Oxygen (DO) in mg/l.

5.4.2 Aquatic Habitat Integrity

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 were used to define the ecological status of the river reach.

The area covered in this assessment included a 10 km reach of the Thukela River. This habitat assessment model compares current conditions with reference conditions that are expected to have been present.

The IHIA model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 5-4 and Table 5-5 respectively.

Table 5-4: Criteria used in the assessment of habitat integrity (Kleynhans, 1998)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated 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 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 point sources. Measured directly or alternatively 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.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
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.
Indigenous 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 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.

Table 5-5: Descriptions used for the ratings of the various habitat criteria

Impact Category	Description	Score
None	No discernible impact or the modification 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 very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are 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 in almost the whole of the defined area 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 influenced detrimentally.	21-25

5.4.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

5.4.3.1 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 recorded Taxon (ASPT value).

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

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Uplands- Lower ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

5.4.3.2 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 SQR. 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;
- Energy inputs from the watershed; and
- 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.

5.4.4 Fish Community Assessment

The information gained using the Fish Response Assessment Index (FRAI) gives an indication of the PES of the river based on the fish assemblage structures observed. Fish were captured through minnow traps, cast nets and electroshocking. All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). The identified fish species were compared to those expected to be present for the quaternary catchment. The expected fish species list was developed from a literature survey and included sources such as (Kleynhans *et al.,* 2007) and Skelton (2001). It is noted that the FRAI Frequency of Occurrence (FROC) ratings were calculated based on the habitat present at the sites.

5.4.5 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 ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007). The spatial reference for this study was 2km upstream of the site S1 and 2km downstream of the site S2.

5.5 Rapid Habitat Assessment Method, River Morphology and Riparian Delineation

In order to gain a low-level understanding of the flows and sediment regimes, the Rapid Habitat Assessment Method (RHAM) was used to establish the baseline habitat characteristics of the physical habitat at the monitoring site S2. The method was carried out according to Louw and Kleynhans (2009). The location of the cross sections as well as the overall site layout for the RHAM assessment is provided in Table 5-6 and Figure 5-2. It is noted that the RHAM site selection was largely based on the suitability for the river reach to wadable conditions.

Table 5-6: Location of the RHAM transect

Start Point	End Point
-28.759208° 30.411659°	-28.759684° 30.411952°

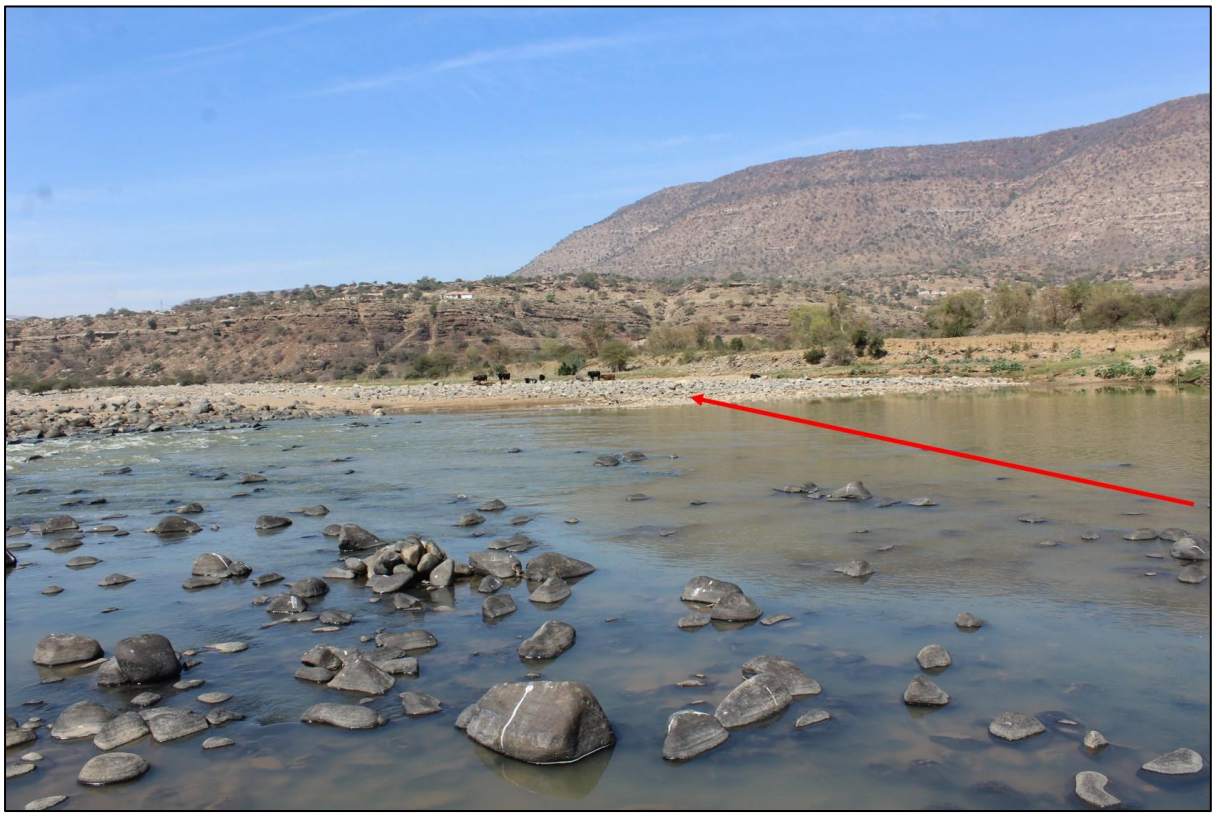


Figure 5-2: Transect Location for the RHAM (Red Line - September 2018)

The river morphology was delineated using aerial imagery and groundtruthed during the survey. The morphological descriptions used in this assessment are based on Figure 5-3.

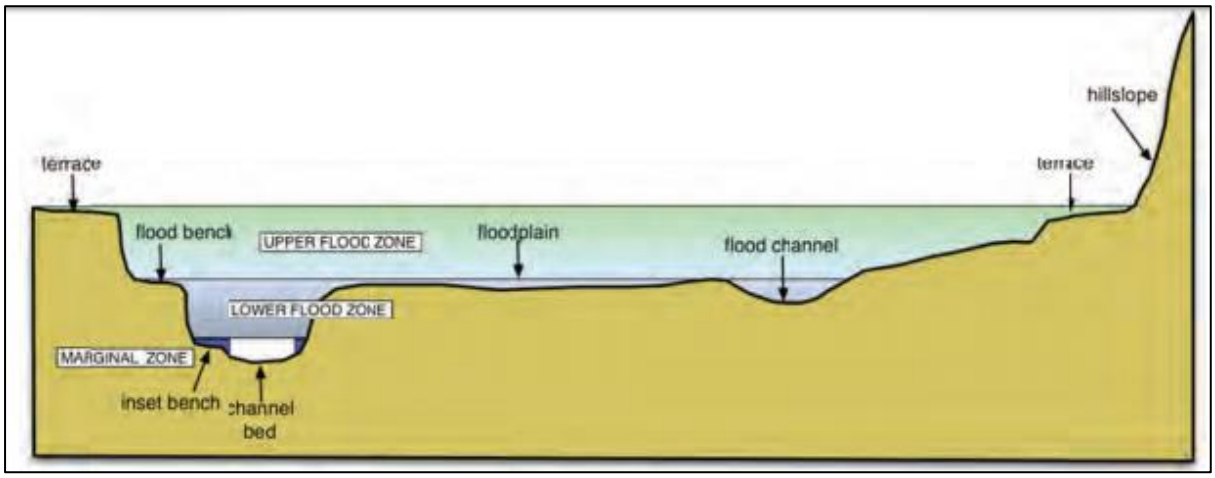


Figure 5-3: Channel morphological descriptions (Rowntree, 2013)

The riparian delineation was completed according to DWAF (2005a). Typical riparian cross sections and structures are provided in Figure 5-4.Indicators such as topography and vegetation were the primary indicators used to define the riparian zone. Contour data obtained from topography spatial data was also utilised to support the infield assessment.

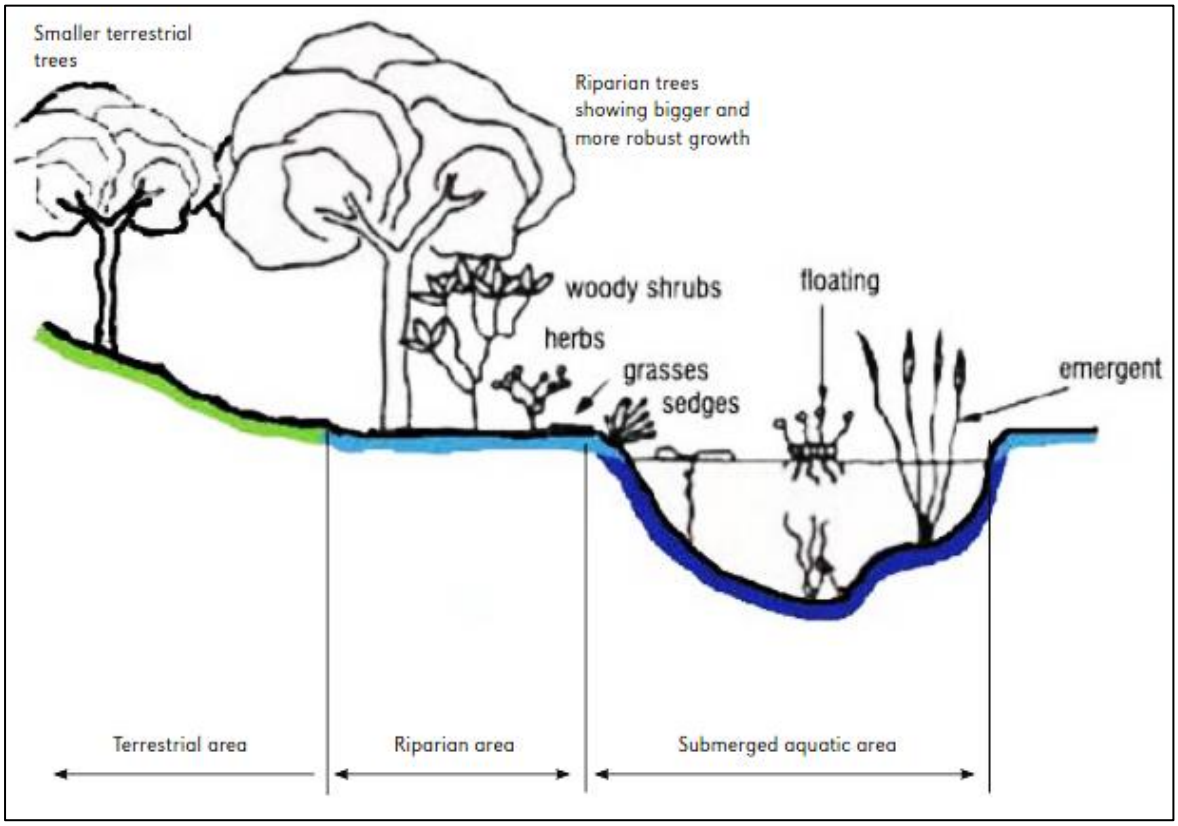


Figure 5-4: Riparian Habitat Delineations (DWAF, 2005a)

5.6 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The significance of the impact is calculated according to Table 5-7.

Table 5-7: Significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

6 Results and Discussion

6.1 Desktop Assessment

6.1.1 Climate

The project falls within a summer rainfall climate with occasional rainfall in the winter months. The Mean Annual Precipitation (MAP) ranges between 700 – 1100mm. Frost is not frequent in the area; however, may be found in low lying areas. The maximum temperature for the area is expected to be 38.2 ºC and the minimum temperature is -0.2 ºC.

6.1.2 National Freshwater Ecological Priority Areas for the Sub-Quaternary Reaches

The considered watercourses are located in a Fish Support NFEPA (Driver et al., 2011). The specific species which is supported in this area is *Enteromius anoplus*.

6.1.3 Status of Sub-Quaternary Reaches

Desktop information was obtained from DWS, 2018. The V60H-3431 SQR spans 2 km of the Thukela River. The desktop Present Ecological State (PES) of the river reach is a class D (largely modified), Ecological Sensitivity (ES) and Ecological Importance (EI) are rated as moderate and high respectively (Table 6-1). The desktop PES of the V60G-3436 and V60H-3461 SQR's were determined to be moderately modified (class C) with high ES and EI.

Anthropogenic impacts identified within the sub-quaternary catchment included rural communities, subsistence farming, over grazing, road crossings, increased nutrient inputs, bed modifications, sedimentation, bank erosion and water abstraction.

Table 6-1: Summary of the status of the Sub-Quaternary Reaches

SQRS	V60H-3431 (Thukela)	V60G-3436 (uMhlangana)	V60H-3461 (unnamed)
Present Ecological Status	Largely modified (class D)	moderately modified (class C)	moderately modified (class C)
Ecological Importance	Moderate	High	High
Ecological Sensitivity	High	High	High

6.1.4 Desktop Soils

The geology of the area is sandstone of the Vryheid Formation, Ecca Group, with small areas of dolerite.

According to the land type database (Land Type Survey Staff, 1972 - 2006) the development falls within the Fc308, Fc310 and Fc319 land type. The dominant soil types are Glenrosa and Mispah soil forms. Lime is present throughout the entire landscape. Most of the area is developed with roads, crop cultivation and residential housing. The land type characteristic is presented in Table 6-2.

Table 6-2: The land type data for the project

Broad Land Type Class	Description
Fc308	Glenrosa and/or Mispah forms (other soils may occur); Lime generally present in the entire landscape
Fc310	
Fc319	

6.1.5 Desktop Vegetation

The project area is spread is located within the Thukela Valley Bushveld vegetation unit. The vegetation unit is located in the KwaZulu-Natal province within the Central Thukela River Basin. The vegetation occurs at altitudes between 350m – 1000m above sea level (Mucina and Rutherford, 2006).

The unit is characterised by rocky rugged slopes and terraces covered mainly by deciduous trees of varying height. The valleys often have stream channels including the Bushmans, Buffels and Mooi River. *Vechelia tortilis, V. nilotica* and *V. natalita* are the main tree species.

The vegetation unit is considered Least Threatened with a conservation target of 25%. Less than 200ha is statutorily conserved in the Weenen Game Reserve. The vegetation has been considerably degraded resulting from overgrazing, erosion and several alien plants. *Opuntia imbricate* is the most widely spread invasive plant.

6.1.6 Wetland National Freshwater Ecological Priority Areas

One (1) FEPA wetland was identified within the 500m assessment buffer of the Tugela Ferry project. The FEPA wetland in the vicinity of the proposed construction site is presented in Figure 6-1. The FEPA sites within 500m are listed in *Table 6-3*.

The FEPA wetland was classified as a floodplain wetland associated with the Thukela River. The wetland was classified as a natural system with a vegetation condition of AB which indicated that more than 75% of the vegetation was natural. The FEPA wetland was rated as a Rank 2 FEPA wetland and had more than two associations with other wetlands and was within 500m of a critical bird habitat.

The NFEPA wetland information is a course data set and must be ground truthed.

During the field survey and the Google Earth historical imagery desktop assessment, it has been decided that the FEPA wetland was a river and not a floodplain wetland.

Table 6-3: The wetland classification of the FEPA wetlands

FEPA Wetland	Classification Levels				Wetland Vegetation Class	Natural / Artificial	Condition	Rank
	L1 (System)	L2 (Ecoregion)	L3 Landscape Position	L4 HGM Class				
Floodplain	Inland System	North Eastern Uplands	Valley Floor	Floodplain	Sub - Escarpment Grassland Group 2	Natural	AB – >75% Natural Vegetation	2 – Wetland associations

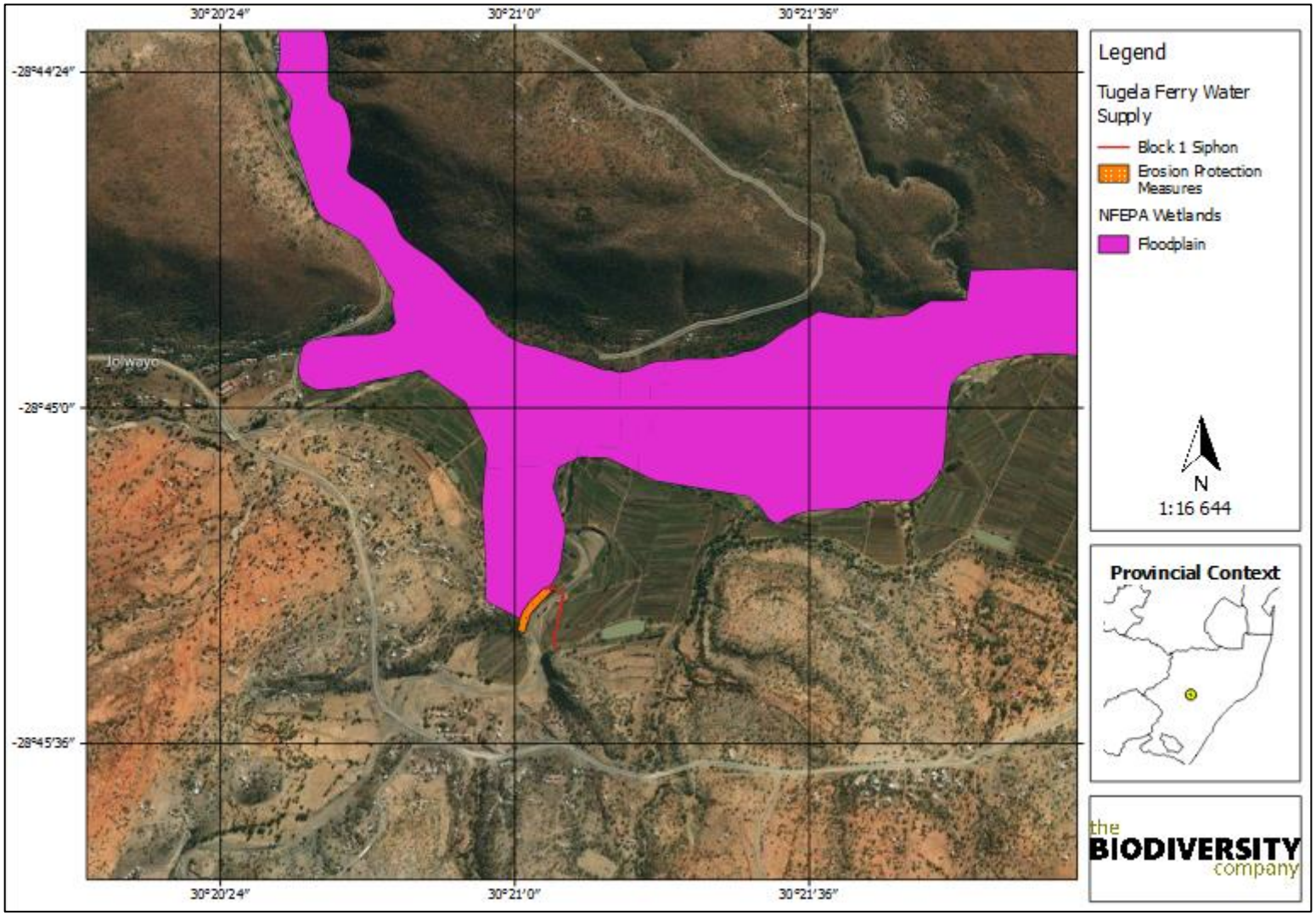


Figure 6-1: The NFEPA wetland areas associated with the project

6.2 Wetland Assessment

The wetland delineation is shown in Figure 6-2 and with the wetland classification as per SANBI guidelines (Ollis et al., 2013) in Table 6-4.

One (1) HGM type was identified within the 500m project assessment boundary. The identified wetland HGM was determined to be a River HGM. Two River HGM units were delineated in the project area. Several drainage lines were identified in the project area.

Table 6-4: Wetland classification as per SANBI guideline (Ollis et al., 2013)

Wetland Name	**Level 1**	**Level 2**		**Level 3**	**Level 4**		
	System	**DWS Ecoregion/s**	**NFEPA Wet Veg Group/s**	**Landscape Unit**	**4A (HGM)**	**4B**	**4C**
HGM 1	Inland	North Eastern Uplands	Sub - Escarpment Grassland Group 2	Valley Floor	River	Lowland River	Riparian Zone

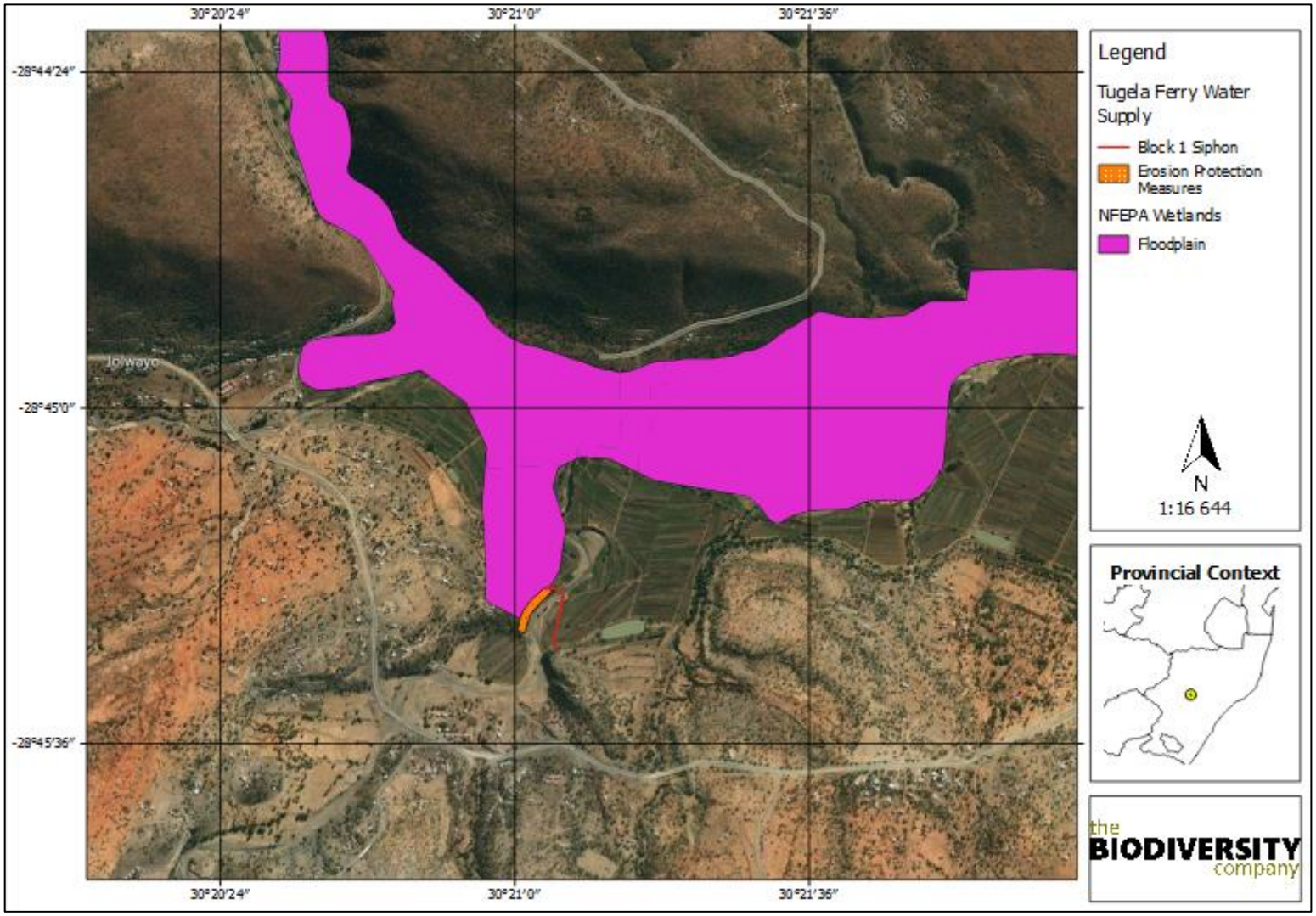


Figure 6-2: The identified wetlands at watercourse intersections associated with project

The Thukela River was determined to be a river channel with large rocks within in the channel and smaller cobble-like rocks on the banks (Figure 6-3). The river did not present indicators of wetlands and the riparian habitat was dispersed along the banks/margins of the river. The largest disturbance of the riparian zone was the establishment of rural housing areas and roads. The development of the town centre was also found to border within the riparian zone. The central characteristics of the drainage lines are illustrated in Figure 6-4.

Figure 6-3: Identified River HGM – Thukela River (September 2018)

Figure 6-4: Identified drainage lines (September 2018)

The identified HGM units are not considered wetlands and as such the PES, Ecosystem Services and EIS could not be assessed.

6.2.1 Wetland Buffer Zones

No wetland areas were identified for the project area and as such, a buffer zone could not be determined.

6.2.2 Drainage Line Buffers

A 30 m buffer was applied to the drainage lines associated with the project. These areas should be avoided where possible

6.3 Aquatic Assessment

As noted in the project area description, the watercourses considered in this assessment consisted of the perennial Thukela River as well as several non-perennial watercourses and drainage lines. The physical characteristics of these watercourse types have been sufficiently described in the wetland assessment presented above. The perennial watercourse was therefore the primary watercourse considered in this PES study.

6.3.1 *In situ* Water Quality

In situ water quality analysis results from the September 2018 surveys are provided in Table 6-5.

Table 6-5: Water Quality Results September 2018

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	**6.5-9.5**	**-**	**>5.00**	**5-30**
S1	7.5	180	6.5	17
S2	7.4	181	6.5	20
***TWQR – Target Water Quality Range**				

The results of the water quality assessment indicated neutral pH ranges from 7.4 at S2 to 7.5 S1. The conductivity concentrations were determined to be at low concentrations and ranged from 180 µS/cm at S1 to 181 µS/cm at S2. These concentrations would not negatively affect local aquatic biota and are at low natural levels. The dissolved oxygen concentrations were found to be 6.5 mg/l at both sampling points and were above the established threshold values for aquatic ecology. The water temperatures observed during the survey ranged from 17°C at S1 to 20°C at S2. The temperature fluctuations were largely attributed to the time of day the sampling took place.

Considering the results of the *in situ* water quality assessment in the Thukela River, no negative effects to local aquatic ecology can be anticipated. However, it is anticipated that diffuse agricultural runoff has altered the nutrient loads of the Thukela River system. This result therefore serves as an effective baseline on which future assessments can be assessed. The various drainage lines have also been negatively impacted on through various domestic uses, nutrients are anticipated to be in excessive concentrations in the drainage lines (Figure 6-8).

6.3.2 Intermediate Habitat Integrity Assessment

The IHIA was completed for the assessed watercourse and is presented below (Table 6-6).

Table 6-6: Intermediate Habitat Integrity Assessment (September 2018)

Criterion	Average Score	Score
Instream		
Water abstraction	10.00	5.60
Flow modification	8.33	4.33
Bed modification	8.33	4.33
Channel modification	10.00	5.20
Water quality	5.00	2.80
Inundation	3.33	1.33
Exotic macrophytes	0.00	0.00
Exotic fauna	0.00	0.00
Solid waste disposal	10.00	2.40
Total Instream Score	**74**	
Instream Category	**class B**	
Riparian		
Indigenous vegetation removal	11.67	6.07
Exotic vegetation encroachment	11.67	5.60
Bank erosion	10.00	5.60
Channel modification	8.33	4.00
Water abstraction	10.00	5.20
Inundation	11.67	5.13
Flow modification	11.67	5.60
Water quality	5.00	2.60
Total Riparian Score	**60**	
Riparian Category	**class C**	

The results of the instream and riparian integrity assessment derived a class B (largely natural) status for the instream habitat of the watercourse considered in this assessment. Instream habitat impacts can largely be attributed to gauging weir impoundments compounded by sedimentation and abstraction (Figure 6-5). The riparian zone was determined to be moderately modified (class C) from reference conditions. The central factors negatively effecting the riparian zone included channel modification, vegetation removal and the presence of alien vegetation (Figure 6-6).

Figure 6-5: Impoundments used for water abstraction in the Tukhela River (S1; August 2018)

Figure 6-6: Alien vegetation in the riparian zone of the Tukhela River at the proposed abstraction point (August 2018)

The aquatic habitats associated with the various irrigation canal crossings was largely composed of typical ephemeral drainage line habitats. Steep channels as a result of erosion in the drainage lines has significantly altered the instream and marginal habitat conditions of the various drainage lines studied (Figure 6-7). The use of irrigation canal water for domestic purposes has also resulted in some water quality modification within the drainage line systems. This instream modification was compounded by solid waste which likely was a result of direct dumping and litter picked up during runoff events (Figure 6-8).

Figure 6-7: Erosion and habitat alteration in the drainage lines associated with the proposed project (August 2018)

Figure 6-8: Water quality impacts stemming from the use of irrigation channel water for domestic purposes (August 2018)

6.3.3 Aquatic Macroinvertebrates

The results of the SASS5 biotope assessment are provided in the table below (Table 6-7).

Table 6-7: Aquatic invertebrate biotope ratings (August/September 2018)

Biotope	S1	S2
Stones in current	4	3.5
Stones out of current	3	2
Bedrock	3	2
Aquatic Vegetation	1	1
Marginal Vegetation In Current	1	1
Marginal Vegetation Out Of Current	2	2
Gravel	1	1
Sand	1	2
Mud	0	1
Biotope Score	16	15.5
Weighted Biotope Score (%)	21	18
Biotope Category (Tate and Husted, 2015)	D	F

The watercourses assessed in this study were assigned a slope class E, indicating a lowland reach river system with typical lowland river features. Macroinvertebrate habitats consisted largely of marginal *Phragmites,* and submerged Pond Weed (*Potomageton crispus;*). Cobbled substrates in and out of current were also found to be abundant during the assessment. These habitats provide suitable aquatic biotopes for a wide diversity of aquatic macroinvertebrate types (Figure 6-9). Although substrates were suitable for invertebrate habitation, marginal vegetation was limited. This may reduce the overall presence of taxa belonging to the order Hemiptera. The absence of the marginal habitats was however considered to be related to natural factors.

Figure 6-9: Cobbled substrate at S2 (August 2018)

Table 6-8: SASS5 results for the aquatic sampling points in August/September 2018

Site	SASS5	Taxa	ASPT	Class (Dallas, 2007)
S1	141	23	6.1	class A
S2	158	24	6.6	class A

The SASS5 scores during the study period were found to vary from 141 at S1 to 158 at S2. The diversity of taxa found at the sites was 23 taxa at S1 to 24 at S2. The ASPT values obtained ranged from 6.1 at S1 to 6.6 at S2. The ecological classes according to Dallas (2007) was found to be class A for the sites assessed. The results of the reach based MIRAI was provided in the table below (Table 6-9).

Table 6-9: Macroinvertebrate Response Assessment Index for the watercourse based on results obtained in August/September 2018

Invertebrate Metric Group	Score Calculated
Flow Modification	81
Habitat	77
Water Quality	88
Connectivity	80
Ecological Score	81

The results of the MIRAI assessment indicates that a largely natural invertebrate community was present in the Thukela River system based on the August 2018 survey results. The habitat response metric was shown to be the limiting factor for the macroinvertebrate community. The modified invertebrate community was thus largely attributed to limited habitat availability with particular emphasis on the vegetation related biotopes. Several flow sensitive taxa were observed during the assessment and these included Heptageniidae and Perlidae.

6.3.4 Fish Assessment

The expected and observed fish community from the August/September 2018 survey is presented below (Table 6-10).

Table 6-10: Expected and observed fish species from the August/September 2018 survey

Expected Fish Species	Observed	IUCN Status
Awaous aeneofuscus	No	NA
Anguilla bicolor bicolor	No	NA
Anguilla bengalensis	No	NT
Anguilla marmorata	No	LC
Anguilla mossambica	Yes	NA
Enteromius gurneyi	No	LC
Enteromius paludinosus	Yes	LC
Enteromius viviparus	Yes	LC
Clarias gariepinus	Yes	LC
Glossogobius callidus	No	LC
Glossogobius giuris	No	LC
Labeobarbus natalensis	Yes	LC
Labeo molybdinus	Yes	LC
Labeo rubromaculatus	No	LC

Oreochromis mossambicus	Yes	NT
Pseudocrenilabrus philander	Yes	LC
Tilapia sparrmanii	Yes	LC
*IUCN: International Union for the Conservation of Nature NA: Not Assessed LC: Least Concern NT: Near Threatened		

As can be observed in the table above, a total of 17 fish species were expected in the SQR. It is noted however that several of the expected species are catadromous and therefore their anticipated occurrence at the survey points was derived to be low. A total of 8 fish species were sampled on the in the defined spatial extent of the project area. The eight sampled species represent 47% of the total expected fish community. It should be noted that it is anticipated that should sampling efforts increase, additional fish species would be observed. Two listed species are expected, with one observed during the survey. The listed species includes *Anguilla bengalensis* and *Oreochromis mossambicus*. *A. bengalensis* is listed due the decrease in populations across a wide distribution range. In a South African context however the species is not extensively harvested as it is in the rest of the world. *O. mossambicus* is listed due to the hybridisation with *O. niloticus*. The proposed project does therefore not pose a significant risk to the listed fish species. The results of the FRAI is presented below (Table 6-11).

Table 6-11: Observed fish species (August/September 2018)

Fish Species	Photograph
Enteromius viviparus	
Labeobarbus natalensis	
Oreochromis mossambicus	
Pseudocrenilabrus philander	
Labeo molybdinus	

Table 6-12: Fish Response Assessment Index for the August/September 2018 survey

FRAI% (Automated)	82
EC FRAI	class B

The results of the FRAI derived a largely natural (class B) fish community structure. Taxa which were not sampled during the survey are expected to be present within the study area. As noted above, it is anticipated that should sampling effort increase all expected fish species would likely be sampled. Considering this the fish community is considered to be largely natural.

6.3.5 Riverine Present Ecological Status

The results of the PES assessment are provided in the table below (Table 6-13).

Table 6-13: Present Ecological Status of the river reach assessed in the August 2018 survey

Aspect Assessed	Ecological Category
Instream Ecological Category	74
Riparian Ecological Category	60
Aquatic Invertebrate Ecological Category	81
Fish Ecological Category	81
Ecostatus	**class C**

The results of the PES assessment derived moderately modified (class C) conditions in the river reach considered in this assessment. The modified conditions were largely attributed to cumulative habitat level impacts which have resulted in the modification of riparian conditions.

6.3.6 Aquatic Ecological Importance and Sensitivity

The overall Ecological Importance and Sensitivity (EIS) of the river reaches in this study were assessed according to Kleynhans (1999). The results of the EIS assessment are provided in the table below (Table 6-14).

Table 6-14: Ecological Importance and Sensitivity ratings for the Thukela River

Biological Determinants		
Determinant	**Rating**	**Comment**
Rare and endangered biota	4	2 listed fish species
Unique biota	2	*Enteromius gurneyi* and *Labeo rubromaculatus* are unique to the region
Intolerant biota	4	Invertebrate and fish communities intolerant of no flow conditions
Species richness	3	Rich on a national scale
Habitat Determinants		

Diversity of aquatic habitat	2	Not diverse in lowland sections of this river system
Refuge value of habitat types	4	On a local scale the reach of the river is intact and therefore provides refuge habitat
Sensitivity of habitat to flow modification	3	This particular lowland river reach is sensitive to flow modification
Sensitivity to flow related water quality changes	3	This particular lowland river reach is sensitive to flow related modification
Migration route corridor for instream and riparian biota	4	Definite migration corridor for Angullidae and some catadromous fish species
National parks and wilderness areas	1	The site is not present near to any national parks but is important on a local scale
Mean	3.0	
EIS class	Very High	

The results of the EIS assessment derived a very high EIS for the river reach assessed.

6.4 Rapid Habitat Assessment Model and River Morphology

The results of the semi-quantitative habitat assessment component of the RHAM are provided in the table below (Table 6-15).

As provided in the results below, the dominant velocity depth class at the site was determined to be the fast shallow velocity depth class. Substrate consisted largely of boulders, cobbles and GSM (Figure 6-10). The river zonation (morphology) and gradient conforms to the class E geoclass (lowland river) and therefore the project area is within a depositional zone. However, cobbled substrates with bedrock boulders were observed within the project area indicating that some rejuvenation may occur within the proposed project area (Figure 6-11).

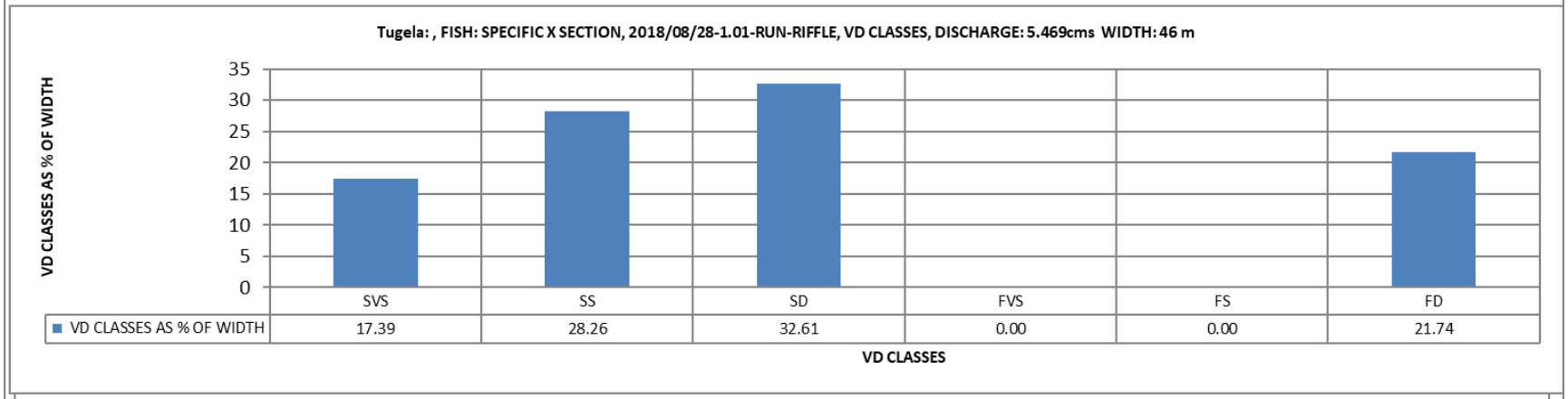
Overall discharge measured at the site was 5.4 m^3/s, this was within range of the established discharges in the IFR Study (DWAF, 2000).

Figure 6-10: Velocity Depth Class and Dominant Substrates at the S2 Transect (September 2018)

Figure 6-11: Channel Morphology Illustrating Steep Banks and Seasonal Floodplain Areas (S2, September 2018)

Table 6-15: Semi-quantitative habitat assessment results for the total RHAM site

Physical Habitat	
Velocity Depth Class	**Area (m^2) COVERED**
Slow Very Shallow (Speed: <0.29m/s; Depth<=0.1m)	**240**
Slow Shallow (Speed: <0.29m/s; Depth<0.1<=0.5m)	**240**
Slow Deep (Speed: <0.29m/s; Depth>0.5m)	**240**
Fast Very Shallow (Speed: >0.29m/s; Depth<=0.1m)	**120**
Fast Shallow (Speed: <0.29m/s; Depth<0.1<=0.5m)	**1200**
Fast Deep (Speed: <0.29m/s; Depth>0.5m)	**360**
Total Area	**2400**
Cover Features	
Total Bank Length	**100m**
Total Overhanging Vegetation + Root Wads	**22m**



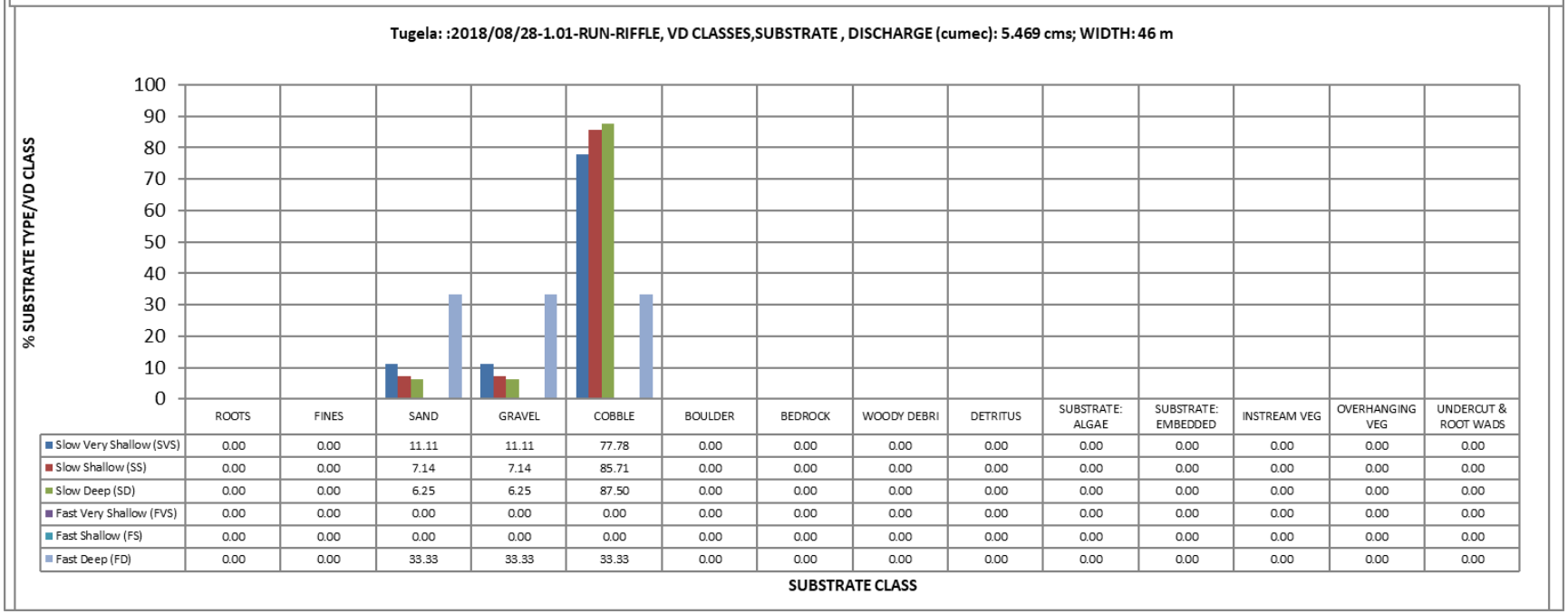
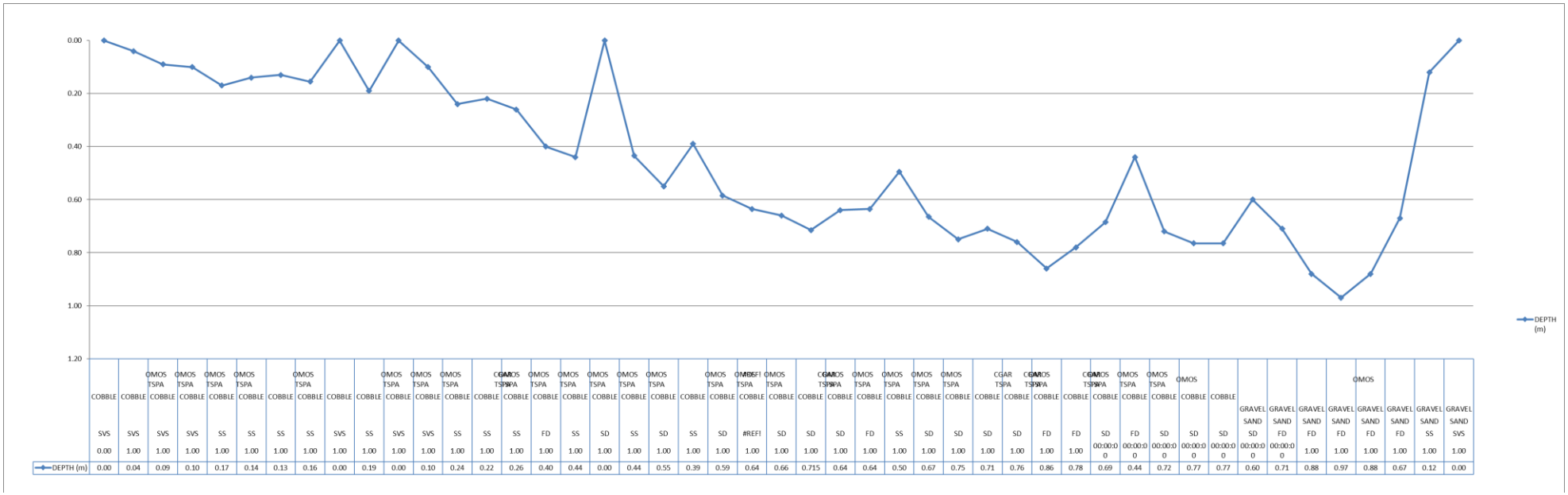


Figure 6-12: Velocity depth classes for Transect T2



			OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA		OMOS TSPA			OMOS TSPA	OMOS TSPA
	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE
	SVS	SVS	SVS	SVS	SS	SS	SS	SS	SVS	SS	SVS	SVS
	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DEPTH (m)	0.00	0.04	0.09	0.10	0.17	0.14	0.13	0.16	0.00	0.19	0.00	0.10

	OMOS TSPA		CGAR TSPA OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA		OMOS TSPA	#REF! OMOS TSPA	OMOS TSPA
	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE
	SS	SS	SS	FD	SS	SD	SS	SD	SS	SD	#REF!	SD
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DEPTH (m)	0.24	0.22	0.26	0.40	0.44	0.00	0.44	0.55	0.39	0.59	0.64	0.66

		CGAR TSPA OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA	OMOS TSPA		CGAR TSPA	CGAR TSPA OMOS TSPA		CGAR TSPA OMOS TSPA	OMOS TSPA
	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE	COBBLE
	SD	SD	FD	SS	SD	SD	SD	SD	FD	FD	SD	FD
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	00:00:00	00:00:00
DEPTH (m)	0.715	0.64	0.64	0.50	0.67	0.75	0.71	0.76	0.86	0.78	0.69	0.44

	OMOS TSPA	OMOS						OMOS			
	COBBLE	COBBLE	COBBLE	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND	GRAVEL SAND
	SD	SD	SD	SD	FD	FD	FD	FD	FD	SS	SVS
	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	1.00	1.00	1.00	1.00	1.00	1.00
DEPTH (m)	0.72	0.77	0.77	0.60	0.71	0.88	0.97	0.88	0.67	0.12	0.00

Figure 6-13: Results for Transect S2

The riparian zone consisted of a river floodplain complex with limited marginal zones and an extensive floodplain zone. The upper riparian zone was confined to be macro channel and was dominated by *Vachellia* karoo. The delineation of the riparian areas in relation to the proposed project area for the perennial systems are provided in Figure 6-14. As noted above, the riparian zone of the drainage lines were limited to their immediate river banks. A standard buffer zone will be applied to these areas.

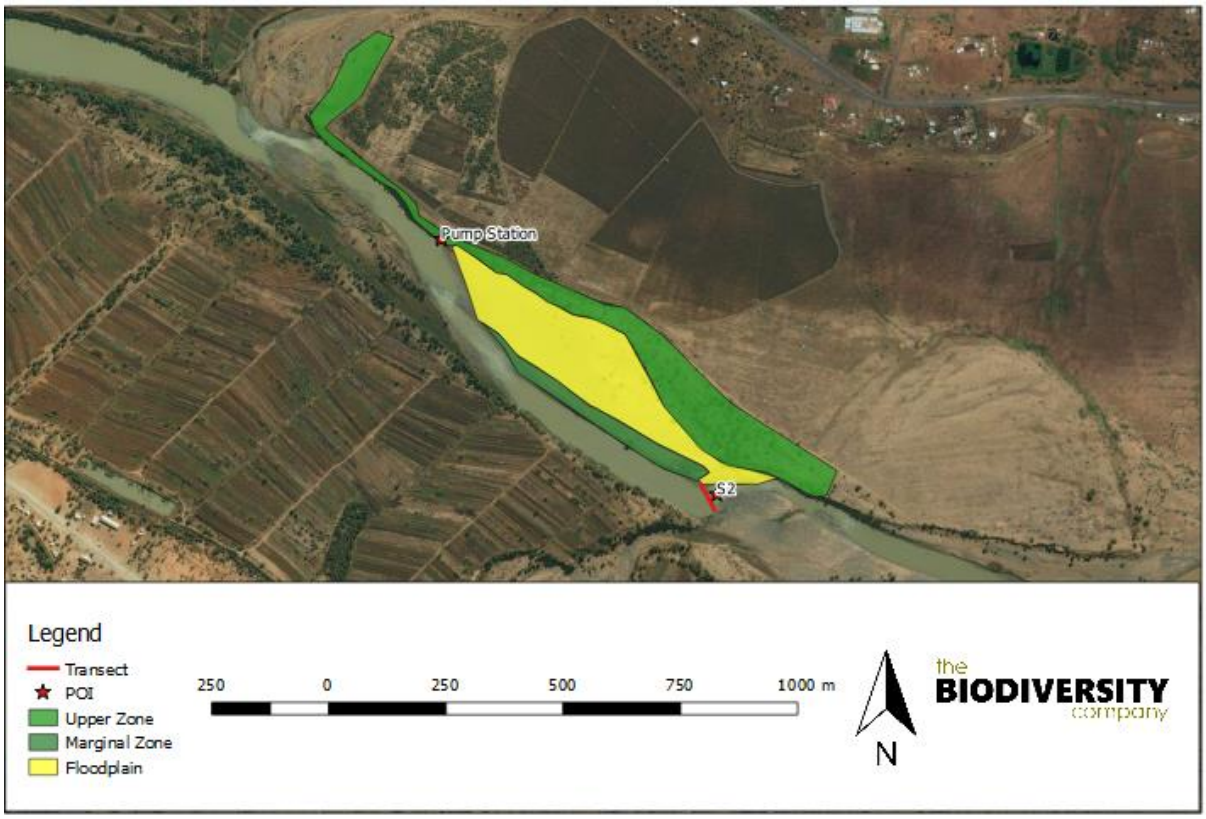


Figure 6-14: Riparian delineation for the proposed pump-station

7 Risk Assessment

The existing pipeline crossings consist of constructed concrete structures in the form of bridges and concrete pipe crossings (Figure 7-1).

Figure 7-1: Existing watercourse infrastructure crossings (September 2018)

The proposed siphon rehabilitation will take place on existing infrastructure. Considering this, no additional river banks will be extensively modified. River bank erosion was observed within the existing banks associated with the crossing points. Short term impacts can be anticipated during the rehabilitation actions. These impacts may include the disturbance of non-perennial river banks and sedimentation. It is however anticipated that these impacts will be limited to the construction phase with the conditions stabilising and improving following the completion of the construction phase.

The construction of the pump station was determined to be directly within the established upper riparian zone (Figure 7-3). The presence of the proposed site within the riparian zone will inevitably increase the potential negative effect of the construction and operational activities. Furthermore, the construction site appears to be located within the overall macro channel and therefore is susceptible to flooding in the long term

The proposed project will abstract up to 0.09 m^3/s. An extract of the Reserve at Tugela Ferry is presented below (Figure 7-2).

Reserve flows without High Flows										
Oct	3.828	3.809	3.768	3.681	3.521	3.256	2.882	2.451	2.083	1.912
Nov	4.663	4.636	4.576	4.453	4.222	3.843	3.307	2.690	2.163	1.917
Dec	5.488	5.455	5.379	5.223	4.932	4.453	3.776	2.997	2.332	2.022
Jan	8.671	8.626	8.525	8.316	7.926	7.284	6.379	5.336	4.444	4.029
Feb	11.214	11.159	11.036	10.780	10.303	9.518	8.410	7.134	6.043	5.536
Mar	9.830	9.783	9.679	9.463	9.060	8.396	7.459	6.381	5.459	5.030
Apr	7.522	7.494	7.430	7.300	7.056	6.655	6.088	5.435	4.878	4.618
May	5.984	5.959	5.903	5.787	5.572	5.217	4.716	4.139	3.646	3.416
Jun	4.666	4.646	4.599	4.502	4.321	4.023	3.603	3.119	2.706	2.514
Jul	3.828	3.810	3.770	3.686	3.529	3.271	2.906	2.487	2.129	1.962
Aug	3.588	3.570	3.529	3.445	3.287	3.028	2.662	2.240	1.879	1.712
Sep	3.589	3.572	3.533	3.453	3.304	3.058	2.711	2.312	1.970	1.811

Figure 7-2: Extract of the Reserve Flows at IFR9 – Tugela Ferry (DWAF, 2004; column represent10% points, flow provided in m^3/s)

As noted above the 90% curve for flow surety indicates that the reserve in September was 1.1970 m^3/s. The current discharge measured was 5.4 m^3/s indicating that the reserve was currently being met during the survey. The proposed abstraction of 0.09 m^3/s therefore

represents 1.6% of the total discharge observed. A mean of 5. 3 m^3/s (n= 39) for the periods for August 14th to September 22nd 2017 was recorded at the V6H002 gauging weir. This provides an indication that short term flows support the established Reserve. Considering this, it is unlikely that the abstraction would result in a significant impact on the available Reserve or local aquatic ecology.

Findings from the DWS aspect and impact register / risk assessment are provided in Table 7-1, Table 7-2 and Table 7-3. A key consideration for the risk assessment is impacts to the riverine and drainage line areas.

Figure 7-3: The existing frame of a pump-station that is proposed to be upgraded (September 2018)

Table 7-1: Impacts assessed for the proposed project

Russell Tate	**Pr Sci Nat**	**(Pr. Sci. Nat. 400089/15)**
Activity	**Aspect**	**Impact**
Rehabilitation of siphon and crossings	Clearing and shaping of areas for infrastructure	Disturbance of interflow of water. Loss of aquatic habitat. Erosion of watercourse. Sedimentation and siltation of the watercourse, flow and sediment equilibrium change. Water quality impairment.
	Establishment of offices and workshop areas	
	Reshaping/stabilisation of banks	
	Placement of infrastructure over a watercourse	
	Construction material and fuel storage/management, soil stockpile management	
	Operation of equipment and machinery	

Construction of Pumphouse	Clearing of areas for infrastructure and shaping of construction site	Altered flow dynamics. Damage to riparian areas. Sedimentation and physico-chemical modifications.
	Reshaping of banks for installation of intake pipelines	
	Establishment of offices and workshop areas	
	Construction material and fuel storage/management, soil stockpile management	
	Operation of equipment and machinery	
Operation and of rehabilitated siphon	Bank stabilisation* No anticipated impacts	River bank stabilisation
Operation of pumphouse	Abstraction of water	Flow reduction, water quality modification
	Utilisation and storage of hydrocarbons	

Table 7-2: DWS Risk Impact Matrix for the proposed project

Aspect	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase								
Clearing and shaping of areas for infrastructure	2	2	1	1	1.5	1	2	4.5
Establishment of offices and workshop areas	2	2	1	1	1.5	1	2	4.5
Placement of infrastructure over a watercourse	3	2	1	1	1.75	1	2	4.75
Reshaping/stabilisation of banks	3	2	1	1	1.75	1	2	4.75
Construction material and fuel storage/management, soil stockpile management	0	2	1	1	1	1	2	4
Operation of equipment and machinery	2	2	1	1	1.5	1	2	4.5
Operational Phase								
Abstraction of Water	3	1	3	2	2.25	1	5	8.25
Operation and maintenance of siphon	2	2	1	1	1.5	1	2	4.5
Utilisation and storage of hydrocarbons	0	3	0	1	1	1	5	7

Table 7-3: DWS Risk Impact Matrix for the proposed project continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Clearing and shaping of areas for infrastructure	2	2	**1**	1	6	27	**Low**	**Low**
Establishment of offices and workshop areas	2	2	1	1	6	27	**Low**	**Low**
Placement of infrastructure over a watercourse	2	3	5	1	11	52.25	**Low**	**Low**
Reshaping/stabilisation of banks	2	3	5	1	11	52.25	**Low**	**Low**
Construction material and fuel storage/management, soil stockpile management	2	2	1	3	8	32	**Low**	**Low**
Operation of equipment and machinery	2	3	5	1	11	49.5	**Low**	**Low**
Operational Phase								
Abstraction of Water	5	5	5	3	18	148.5	**Moderate**	**Moderate**
Maintenance and Operation of Siphon	2	3	5	1	11	49.5	**Low**	**Low**
Utilisation and storage of hydrocarbons	5	1	1	1	8	56	**Moderate**	**Low**

(*) denotes - In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below.”

The results of the risk assessment indicate that the siphon rehabilitation component of the proposed project would not result in any significant long terms impacts to local watercourses. As noted above, impacts associated with the siphon rehabilitation component of this proposal will be limited to the construction phase where river banks will be disturbed. Positive bank stabilisation at sites associated with the siphon rehabilitation can be expected during the operational phase. Furthermore, during the operational phase, limited impacts can be anticipated for general maintenance activities.

The proposed construction footprint for the abstraction pump is located within the riparian zone. It is recommended that this permanent structure sit is moved outside the delineated riparian area. It is further recommended that the 1:100 year floodline is delineated and used as a guide for the choice of the pump station.

The risk for water abstraction was determined to be moderate. This moderate risk was related to the alterations of water volumes in the Thukela River. However, when considering the Reserve with the measured hydrology completed for this study, the abstraction is unlikely to have a significant impact. It is however recommended that this is compared with the relevant developments within the Thukela River system.

7.1 Mitigation Measures

The following general mitigation measures are provided:

- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the aquatic areas. Where possible, the construction of the pipeline and crossings must take place from the existing road servitudes and not from within the aquatic systems;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Temporary storm water channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Prevent uncontrolled access of vehicles through the drainage lines, river and wetland systems that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these

facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);

- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into drainage channels must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Temporary and permanent erosion control methods may include silt fences, flotation silt curtains, retention basins, detention ponds, interceptor ditches, seeding and sodding, riprap of exposed embankments, erosion mats, and mulching;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- The cleared surfaces should be re-vegetated with *Cynodon dactylon, Sporobolus aficana* and *Eragrostis curvula.*
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- An alien invasive plant management plan needs to be compiled and implemented post construction to control current invaded areas and prevent the growth of invasive on cleared areas.
- An infrastructure monitoring and service plan must be compiled and implemented during the operational phase.
- An Environmental Control Officer (ECO) must oversee the construction phase of the project, with wetland areas as a priority.
- The delineated riparian zones and 30m buffer zone for the drainage lines must be adhered to. This is only applicable for the laydown yards, offices, stockpiles, storage areas and the proposed pump station.
- Stockpiles must be covered with a tarp when not in use;
- Vegetation clearing should be limited to the actual footprint area;
- Indiscriminate use of heavy machinery in the buffer and riparian zones should not occur;
- Soils which have been compacted during the construction should be ripped and seeded with local vegetation;
- Storage areas for hydrocarbons should be located outside the delineated buffer zones and within a bunded area;

- The delineation of the 1:100 floodline must be completed. The pump-station should be located outside this floodline;
- Water abstraction will be completed in line with the Reserve. No further water volumes may be abstracted;
- It is recommended that hydrology and aquatic ecology is monitored at the sampling point S2 on an annual basis. Further monitoring should include the V6H002 monitoring station in Tugela Ferry to ensure compliance with the Reserve

7.2 Cumulative Impact Assessment

The current condition of the watercourses considered in this assessment are modified from reference condition. The siphon rehabilitation aspect of the proposed project is anticipated to have a positive cumulative impact. The abstraction component of this proposed project was determined to be a limited impact on the overall established Reserve. Considering this, the overall cumulative impact of the abstraction will be limited should the Reserve be maintained. Further, impoundments and water transfer schemes within the Thukela River system have been planned (Jana and Mielietuin Dams), however these have been planned in accordance with the established Reserve and therefore are anticipated to have a limited impact in conjunction with the proposed project.

8 Conclusion

Wetland

The survey included a high-level investigation and site assessment. One (1) HGM type was identified within the 500m project assessment boundary. The identified wetland HGM was determined to be a River HGM. Two River HGM units were delineated in the project area. Several drainage lines were identified in the project area.

The Thukela River was determined to be a river channel with large rocks within in the channel and smaller cobble-like rocks on the banks. The river did not present indicators of wetlands and the small riparian habitat was dispersed along the banks of the river. The largest disturbance of the riparian zone was the establishment of rural housing areas and roads. The development of the town centre was also found to border within the riparian zone.

The identified HGM units are not considered wetlands and as such the PES, Ecosystem Services and EIS could not be assessed.

Aquatics

The results of the PES assessment derived moderately modified (class C) conditions in the river reach considered in this assessment. The modified conditions were largely attributed to cumulative habitat level impacts which have resulted in the modification of riparian conditions. The results of the EIS assessment derived a very high EIS for the river reach assessed.

Hydrology

Overall discharge measured at the site S2 was 5.4 m^3/s, this was within range of the established discharges in the IFR Study (DWAF, 2000). The 90% curve for flow surety indicates that the Reserve in September was 1.1970 m^3/s. The current discharge measured indicates that the reserve was currently being met during the survey. The proposed abstraction

of 0.09 m^3/s therefore represents 1.6% of the total discharge observed. A mean of 5. 3 m^3/s (n= 39) for the periods for August 14th to September 22nd 2017 was recorded at the V6H002 gauging weir. This provides an indication that short term flows support the established Reserve. Considering this, it is unlikely that the abstraction would result in a significant impact on the available Reserve.

Risk Assessment

The results of the risk assessment indicate that the siphon rehabilitation component of the proposed project would not result in any significant long terms impacts to local watercourses. As noted above, impacts associated with the siphon rehabilitation component of this proposal will be limited to the construction phase where river banks will be disturbed. Positive bank stabilisation at sites associated with the siphon rehabilitation can be expected during the operational phase. Furthermore, during the operational phase, limited impacts can be anticipated for general maintenance activities.

The proposed construction footprint for the abstraction pump is located within the riparian zone. It is recommended that this permanent structure is moved outside the delineated riparian area. It is further recommended that the 1:100 year floodline is delineated and used as a guide for the choice of the pump station location.

The risk for water abstraction was determined to be moderate. This moderate risk was related to the alterations of water volumes in the Thukela River. However, when considering the Reserve with the measured hydrology completed for this study, the abstraction is unlikely to have a significant impact. It is however recommended that this is compared with the relevant developments within the Thukela River system.

The siphon rehabilitation aspect of the proposed project is anticipated to have a positive cumulative impact. The abstraction component of this proposed project was determined to be a limited impact on the overall established Reserve. Considering this, the overall cumulative impact of the abstraction will be limited should the Reserve be maintained. Further, impoundments and water transfer schemes within the Thukela River system have been planned (Jana and Mielietuin Dams), however these have been planned in accordance with the established Reserve and therefore are anticipated to have a limited impact in conjunction with the proposed project.

Specialist Recommendation

Through the completion of this study, the location of the pump station was determined to be located in an unfavourable location. It has therefore been recommended that this pump station is relocated. Should the pump-station be relocated, and the recommended mitigation actions implemented, no significant fatal flaws, in relation to the specialist studies conducted in this study, could be identified for the proposed project.

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