Water Resource Assessment for the proposed Middledrift Water Supply Scheme - Update

Mthungeni, KwaZulu-Natal

March 2019

CLIENT

IN ASSOCIATION WITH INKANYEZI YETHU

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Report Name	**Water Resource Assessment for the proposed Middledrift Water Supply Scheme - Update**	
Reference	**Middledrift Update**	
Submitted to		
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Executive Summary

The Biodiversity Company was commissioned to conduct a water resource assessment, consisting of a baseline aquatic and wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed Middledrift Water Supply Scheme (WSS) near Nkandla, KwaZulu-Natal. Environmental authorisation has been granted for the WSS, which included a total of 67 drainage line crossings, however, due to amendments to layout of the infrastructure, an updated aquatic and wetland study was required for these crossings in order to meet the requirements of the water authorisation. A single wetland and aquatic site visit was conducted the week of the 26th of February 2019. The assessments constituted a wet season survey.

Wetland

A total of eighteen (18) wetlands were identified, of these five (5) HGM units were identified and delineated for the study.

The PES of the wetland systems varied from moderately modified (class C) to largely modified (class D). The Ecological Importance & Sensitivity for the two wetland types were calculated to have a Moderate (C) level of importance. The Hydrological Functionality for the two wetland types were determined to have a Moderate (C) level of importance. The Direct Human Benefits were calculated to have a Marginal (D) level of importance.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the pipeline construction.

Aquatic Ecology

The current state of the river reaches, associated with the proposed Middledrift WSS are in an unmodified state. This is predominantly due to the largely natural to slightly modified state of the instream and riparian habitats resulting in largely intact local aquatic biota. According to *in situ* water quality analysis, water quality within the two river reaches was considered good. The condition of the local aquatic macroinvertebrates within the Tugela River reach are considered in a largely natural state, predominantly due to slightly modified instream habitat as a result of sedimentation and an absence of instream vegetation. The fish community structure indicates largely natural conditions within the system. The condition of the local aquatic macroinvertebrates within the Nsuze River reach are considered in a natural state, predominantly due to unmodified instream habitat. The fish community structure indicates largely natural conditions within the system.

Summary of Risks

The proposed WSS will have no direct impact on the Tugela and Nsuze Rivers, however, the associated tributary network may be impacted on by the proposed project. The risks associated with digging a trench through the watercourses to bury the pipeline were determined to be moderate and should be avoided. It is recommended that the construction of the new water pipeline avoid aquatic areas by using support piers located outside of watercourses with the pipeline spanning these systems. The risks associated with this preferred option were determined to be low provided mitigation measures are adhered to.

The proposed project was determined to have low to moderate impacts on the wetland areas. The risk assessment considered the current state and functioning of the wetland areas, and

the nature of the project which is for the installation of a water pipeline. The wetland areas are in a moderately to largely modified state, and the proposed project will not have a direct impact on the selected wetland systems.

Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local wetland systems, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low.

During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

Aspect	Sig.	Risk Rating
Clearing of areas for infrastructure	**54**	**Low**
Piers located outside of drainage lines	**57.5**	**Moderate**
Use of temporary structures for river crossings	**33.75**	**Low**
On-site vehicle and machinery activities	**49**	**Low**
Ablutions and waste handling	**36**	**Low**
Excavation of pipeline route	**78**	**Moderate**
Removal and stockpiling of soils	**77**	**Moderate**
Compaction of soil profile	**36.75**	**Low**
Additional associated infrastructure	**36**	**Low**
Operation of pipeline	**47.25**	**Low**

It is the opinion of the specialists that the project may be favourably considered and allow for the construction of the pipeline to proceed. Authorisation must be based on the implementation of the prescribed mitigation measures.

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DECLARATION

I, Wayne Jackson declare that:

- I act as an 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 relevant Acts, 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 48 of the EIA Regulations, 2014 (as amended).

Wayne Jackson

Wetland Specialist

The Biodiversity Company

27 February 2019

DECLARATION

I, Dale Kindler declare that:

- I act as an 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 relevant Acts, 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 48 of the EIA Regulations, 2014 (as amended).

Dale Kindler

Aquatic Specialist

The Biodiversity Company

27 February 2019

1 Introduction

The Biodiversity Company was commissioned by EnviroPro to conduct a water resource assessment, consisting of a baseline aquatic and wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed Middledrift Water Supply Scheme (WSS) near Nkandla, KwaZulu-Natal. Environmental authorisation has been granted for the WSS, which included a total of 67 drainage line crossings, however, due to amendments to the layout of the infrastructure, an updated aquatic and wetland study was required for these crossings in order to meet the requirements of the water authorisation.

A single wetland and aquatic site visit was conducted the week of the 26th of February 2019. The assessments constituted a wet season survey.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed development and to provide an opinion on the whether any environmental authorisation process or licensing is required for the proposed activities.

1.1 Objectives

The aim of the assessment is to provide information to guide the proposed Middledrift WSS project with respect to the current state of the associated water resources in the area of study. This was achieved through the following:

- Determining the ecological status of the local watercourses;
- The delineation and assessment of wetlands within 500 m of the project area;
- 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 & 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 Middledrift WSS is situated in the V40D and V40E quaternary catchments, within the Pongola - Mtamvuna Water Management Area (WMA 4) (NWA, 2016) and North Eastern Uplands Ecoregion (Dallas, 2007). The study area is located in the villages of Ezimbidla, Mthungeni and Mzwaneni, near Nkandla in the province of KwaZulu-Natal, South Africa.

The proposed project is for the construction of a new water supply scheme in close proximity to the Tugela and Nsuze River systems (Figure 1). The area surrounding the proposed project site consists of open mountainous land, small scale agricultural and livestock activities, and small rural settlements. The activities in the area and local land uses have had impacts to the water resources and there were visible disturbances, with large scale erosion observed during the survey.

The WMA is situated along the eastern coast of South Africa, mainly within the province of KwaZulu-Natal, and borders on Lesotho to the west. The region has a mean annual precipitation rate of 800 to 1 500 mm and is considered humid. The terrain is characterised with rolling hills with the Drakensburg escarpment as the main topographic feature. A number of parallel rivers drain the Mvoti to Umzimkulu WMA, of which two originate in the Drakensberg Mountains at the border with Lesotho. The area is characterised as rural, and activities include subsistence and commercial farming (StatsSA, 2010).

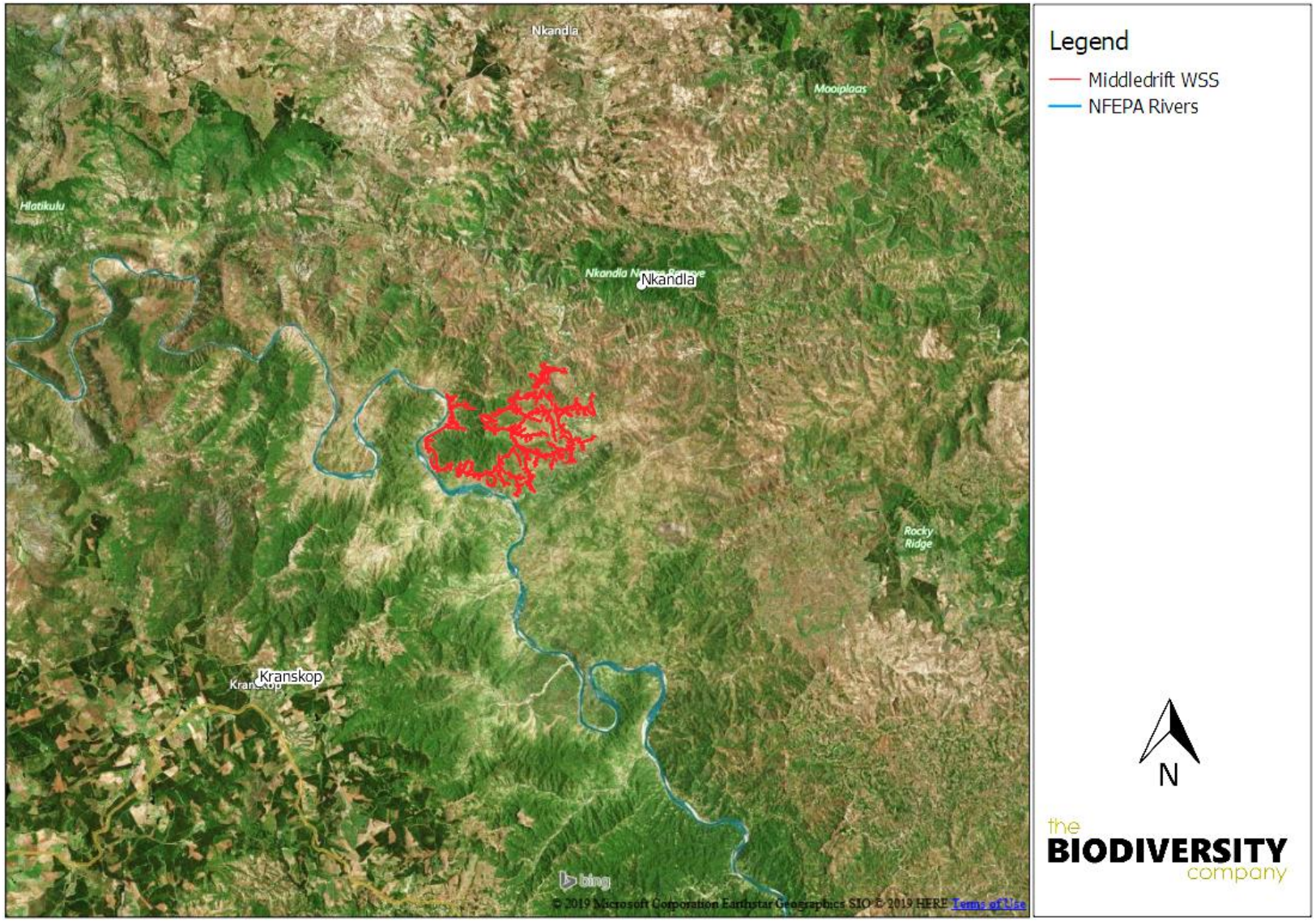

Figure 1: The regional layout of the proposed Middledrift WSS

4 Limitations

The following aspects were considered as limitations;

- This report represents an update of the Aquatic and Wetland Assessments conducted in 2017 for the Middledrift WSS (TBC, 2017). This report includes relevant findings from the initial survey;
- Only wetlands that were likely to be impacted by proposed development activities were assessed in the field. Wetlands located within a 500 m radius of the sites but not in a position within the landscape to be measurably affected by the developments were not considered as part of this assessment;
- Previous studies were considered for the project, assuming the data (delineations at the least) to be true and accurate. We attempted to confirm or amend delineations and update ecological descriptions where necessary;
- Field assessments were completed to assess as much of the site as possible with focus on the proposed directly impacted and downstream areas;
- 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;
- Flooding conditions within the systems were observed during the survey. These conditions do represent stable conditions in which the Present Ecological State can be determined. Therefore, the data presented reflects flooding conditions and findings should be interpreted accordingly;
- The information regarding the activities to be completed on the site, only allowed for the completion of a general assessment on the impacts and the buffer requirement; and
- Invertebrates were only identified to Family level and thus a defined species list for aquatic invertebrates was not completed.

5 Methodology

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 2. 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.

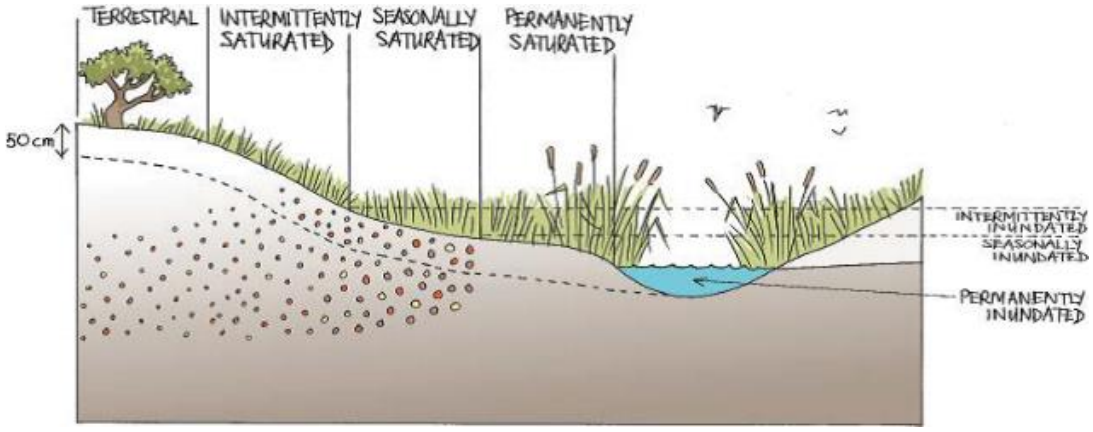

Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis, et al. 2013)

5.2.2 Present Ecological Status

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 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

Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands as well as humans. Eco Services serve as the main factor contributing to wetland functionality.

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze et al. 2008). 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 2).

Table 2: Classes for determining the likely extent to which a benefit is being supplied (Kotze, et al, 2008)

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

The method used for the Ecological Importance and Sensitivity (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 3.

Table 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 “Buffer zone guidelines for wetlands, rivers, and estuaries” (Macfarlane, D, & Bredin, I, 2017) 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: pH, electrical conductivity (µS/cm), 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 Tugela and Nsuze rivers. 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 4 and Table 5 respectively.

Table 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.

Criterion	Relevance
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: 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.

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 (Figure 3). 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. Ecological categories based on biological banding are presented in Table 6.

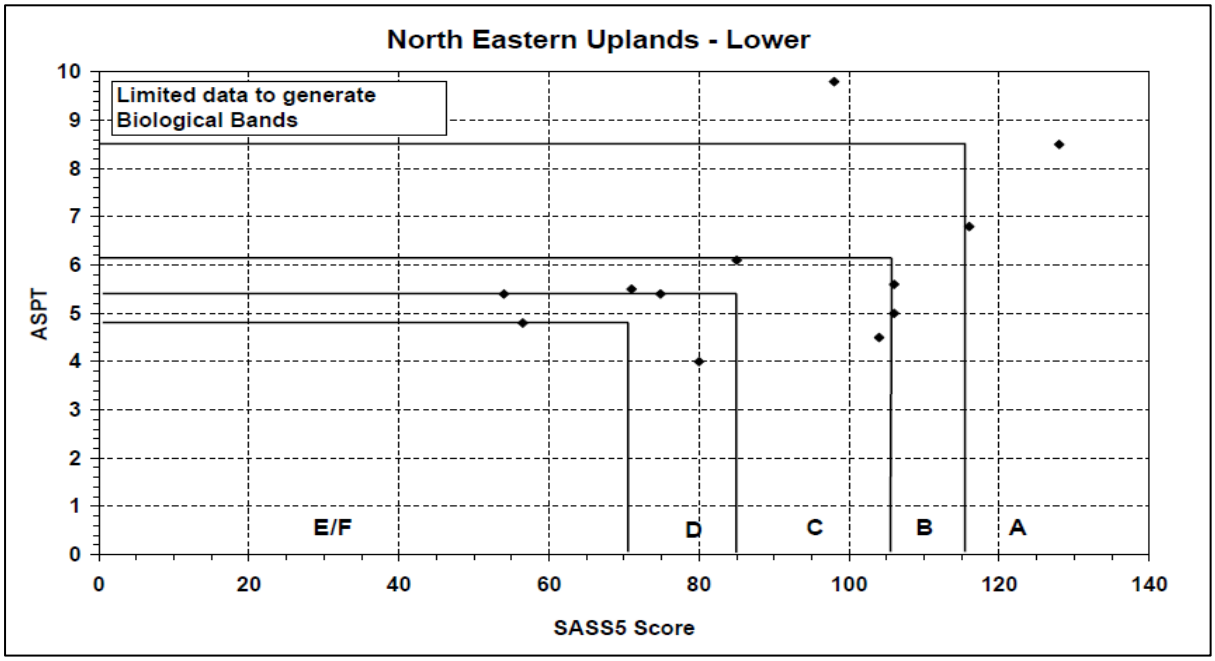

Figure 3: Biological Bands for the North Eastern Uplands - Lower Ecoregion, calculated using percentiles

Table 6: Biological Bands / Ecological categories for interpreting SASS data (adapted from Dallas, 2007)

Class	Ecological Category	Description
A	Natural	Unimpaired. High diversity of taxa with numerous sensitive taxa.
B	Largely natural	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.
C	Moderately modified	Moderately impaired. Moderate diversity of taxa.
D	Largely modified	Considerably impaired. Mostly tolerant taxa present.
E/F	Seriously Modified	Severely impaired. Only tolerant taxa present.

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 Sub-Quaternary Reach (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. Ecological categories for MIRAI are based on those presented in Table 6.

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).

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).

5.5 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 7.

Table 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 National Freshwater Ecosystem Priority Area Status for the Sub-Quaternary Reaches

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*., 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

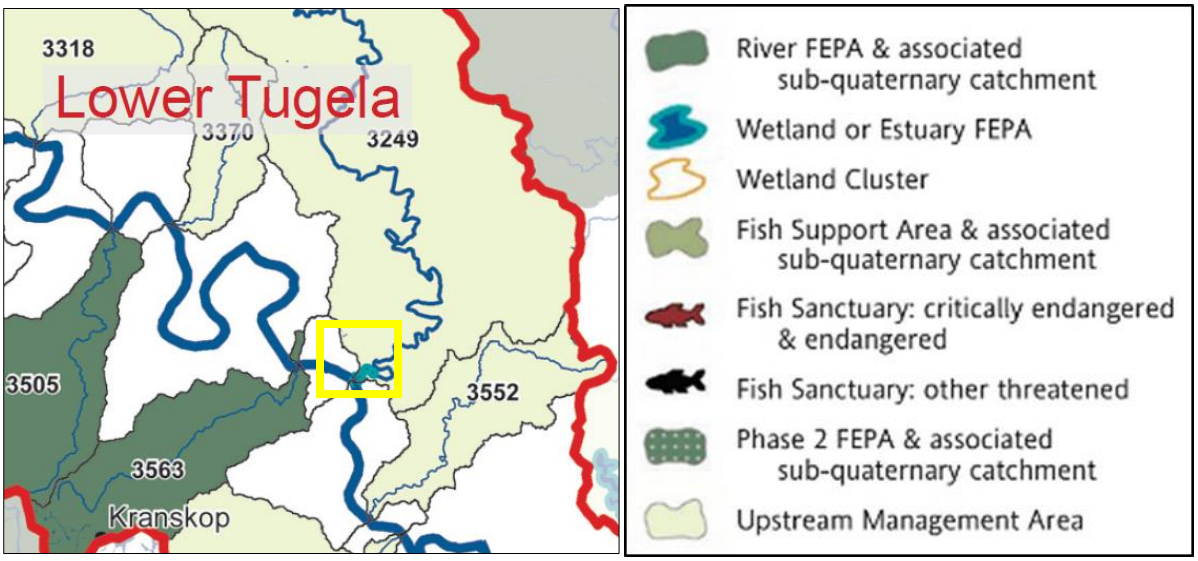

Figure 4: NFEPAs associated with the project area. Yellow square indicates location of proposed project (Nel et al., 2011)

The Thukela SQR V40E-3457 has no designated freshwater priority areas, while the Nsuze SQR V40D-3249 has 3 freshwater priority area designated to it. These are listed in Table 8. The Nsuze River SQR associated with Middledrift WSS serves as an important upstream management area, aiding in the protection of riverine habitat supporting fish species potentially occurring within the reach and the downstream FEPAs. The SQR's in which human activities occur need to be managed to prevent further degradation of downstream river FEPA's while still serving as fish support areas that serve as migration corridors for threatened fish species. These areas need to be managed to maintain water quality for downstream river and wetland FEPA's.

It is important to note that river FEPAs currently in an A or B ecological category may still require some rehabilitation effort, e.g. clearing of invasive alien plants and/or rehabilitation of

river banks. From a biodiversity point of view, rehabilitation programmes should therefore focus on securing the ecological structure and functioning of FEPAs before embarking on rehabilitation programmes.

Table 8: NFEPA's for the project area

Type of FEPA map category	Biodiversity features
Nsuze SQR V40D-3249	
Number of wetland clusters	1 WetCluster FEPAs
FEPA: Wetland ecosystem type	Sub-Escarpment Savanna_Channelled valley-bottom wetland
FEPA: Wetland ecosystem type	Sub-Escarpment Savanna_Unchannelled valley-bottom wetland

Table 9 provides further desktop information regarding the Thukela SQR V40E-3457 and the Nsuze SQR V40D-3249 with regards to the PES including the Ecological Importance, Ecological Sensitivity and anthropogenic impacts within each SQR. Desktop information was obtained from DWS (2018).

Anthropogenic impacts identified within the sub-quaternary catchments included rural water abstraction, some sediments, rural communities, Alien and Invasive Plants, small dams in tributaries - cultivation, instream weir, road crossings.

Table 9: Summary of the status of the Sub-Quaternary Reaches

SQRs	V40E-3457 (Thukela)	V40D-3249 (Nsuze)
Present Ecological Status	Largely Natural (class B)	Natural/Close to Natural (class A)
Ecological Importance	High	Very High
Ecological Sensitivity	High	High

6.1.2 Desktop Soils

According to the land type database (Land Type Survey Staff, 1972 - 2006) the project area falls within the Fb308, Fb309 and Fa108 land types. Soils associated with the area are primarily Glenrosa and/or Mispah Soil Forms. Lime is generally considered to be rare or absent in upland soils, but present in low lying areas. The geology of the area is as follows:

- Quartz feldspar, serpentinite and gabbro of the Tugela Complex.
- Schist of the Tugela Complex.
- Serpentinite, metagabbro, amphibolite and granite gneiss of the Tugela Complex.

6.1.3 Desktop Vegetation

The project area falls within the Ngongoni Veld (SVs 4) and Eastern Valley Bushveld (SVs 6).

Ngongoni Veld (Vulnerable) is described by Mucina & Rutherford (2006) as being dense, tall grassland overwhelmingly dominated by unpalatable, wiry Ngongoni Grass (*Aristida junciformis*), with this mono-dominance associated with low species diversity. Wooded areas (thornveld) are found in the valleys at lower altitudes, where this vegetation unit grades into Kwazulu-Natal Hinterland Thornveld (Svs 3).

Eastern Valley Bushveld (Least Threatened) is described by Mucina & Rutherford (2006) as being semideciduous savanna woodlands with pockets of thickets in a mosaic pattern, often succulent and dominated by *Euphorbia* and *Aloes*. Most of the river valleys run along a northwest-southeast axis which results in unequal distribution of rainfall on respective north-facing and south-facing slopes since the rain bearing winds blow from the south. The steep north-facing slopes are sheltered from the rain and also receive greater amounts of insolation adding to xerophilous. The Endemic taxa include the tall shrub *Bauhinia natalensis* and the succulent herb *Huernia pendula* (Mucina and Rutherford 2006).

6.1.4 Wetland NFEPAs

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

The NFEPA wetlands that are found within 500m of the project area are presented in Figure 3. The NFEPA systems consist of seepage areas and both channelled and unchannelled valley bottom wetlands. These NFEPA wetlands are a Rank 4 and 6, inferring that some of these systems are in a relativey good state and associated with other wetlands (Rank 4) and other systems are not ecologically significant on a provincial or national level (Rank 6). Additionally, the NFEPA systems are also not regarded as ecological priority areas

Three (3) NFEPA wetlands were identified that are crossed or could be impacted on by the project. These are shown in the zoomed area of Figure 2. The wetlands were classified as artificial unchannelled valley bottom systems. The wetlands were determined to be a Rank 6 wetlands.

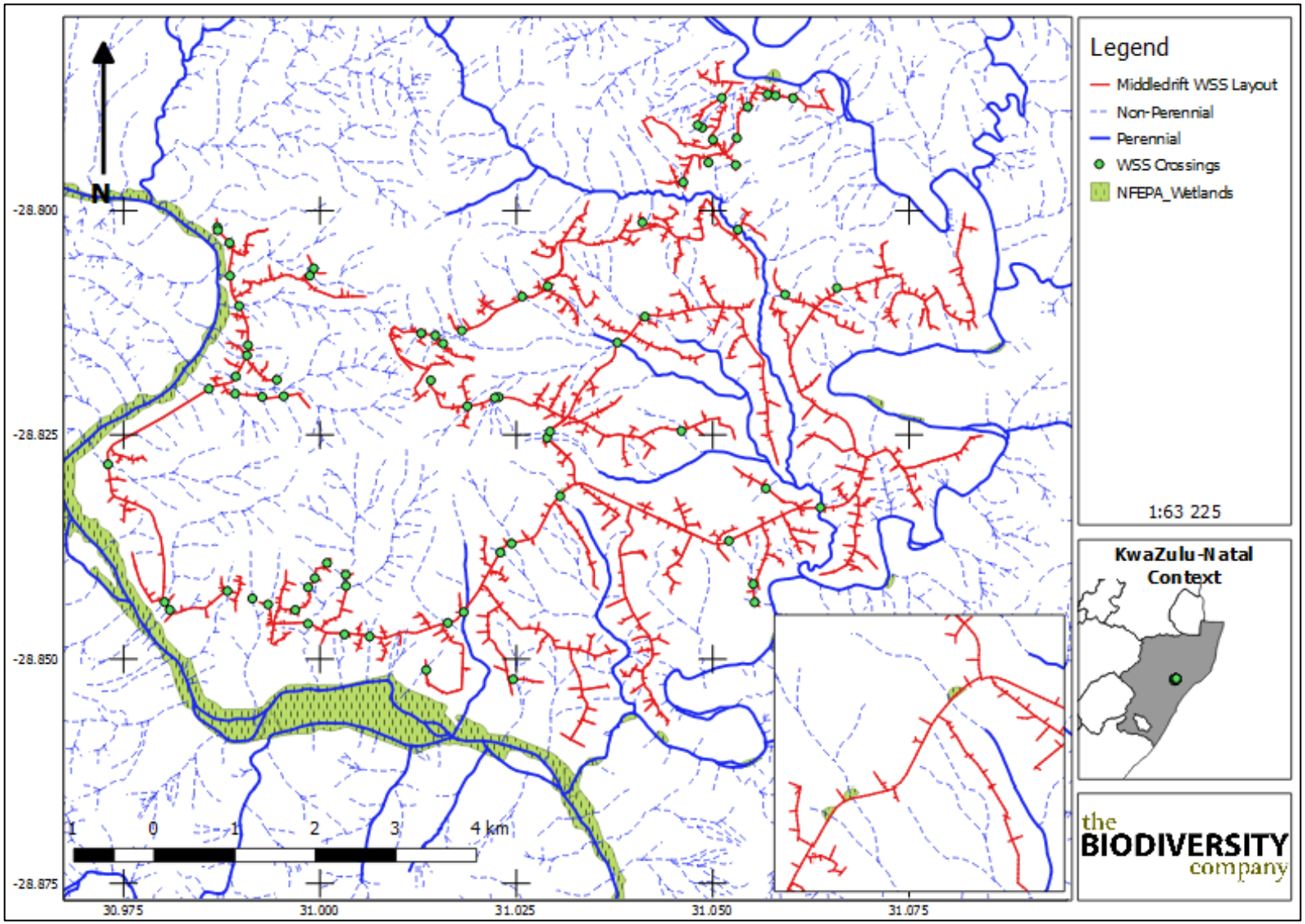

Figure 5: The NFEPA wetlands within the project area

6.2 Wetland Assessment

The survey included assessing all the wetland indicators as well as assessing the PES or health of the wetland, the wetland's ability to provide goods and services (eco-services) and the EIS of the wetlands.

According to DWAF (2005), many riparian areas display wetland indicators and should be classified as wetlands. Some riparian areas are not saturated long or often enough to develop wetland characteristics. In these instances, alluvial deposits can predominate and/or the water table is too deep for most of the year to produce hydromorphic features in the top 50 cm of the soil profile. These conditions do not support vegetation typically adapted to life in saturated soil and it is therefore important to delineate these riparian areas in addition to wetlands (DWAF, 2005).

A Topographical Wetness Index (TWI) was generated for the project area in order to identify potential wetland areas at a desktop level (Figure 6). The TWI also facilitated with the identification and classification of the types of channel networks for the area.

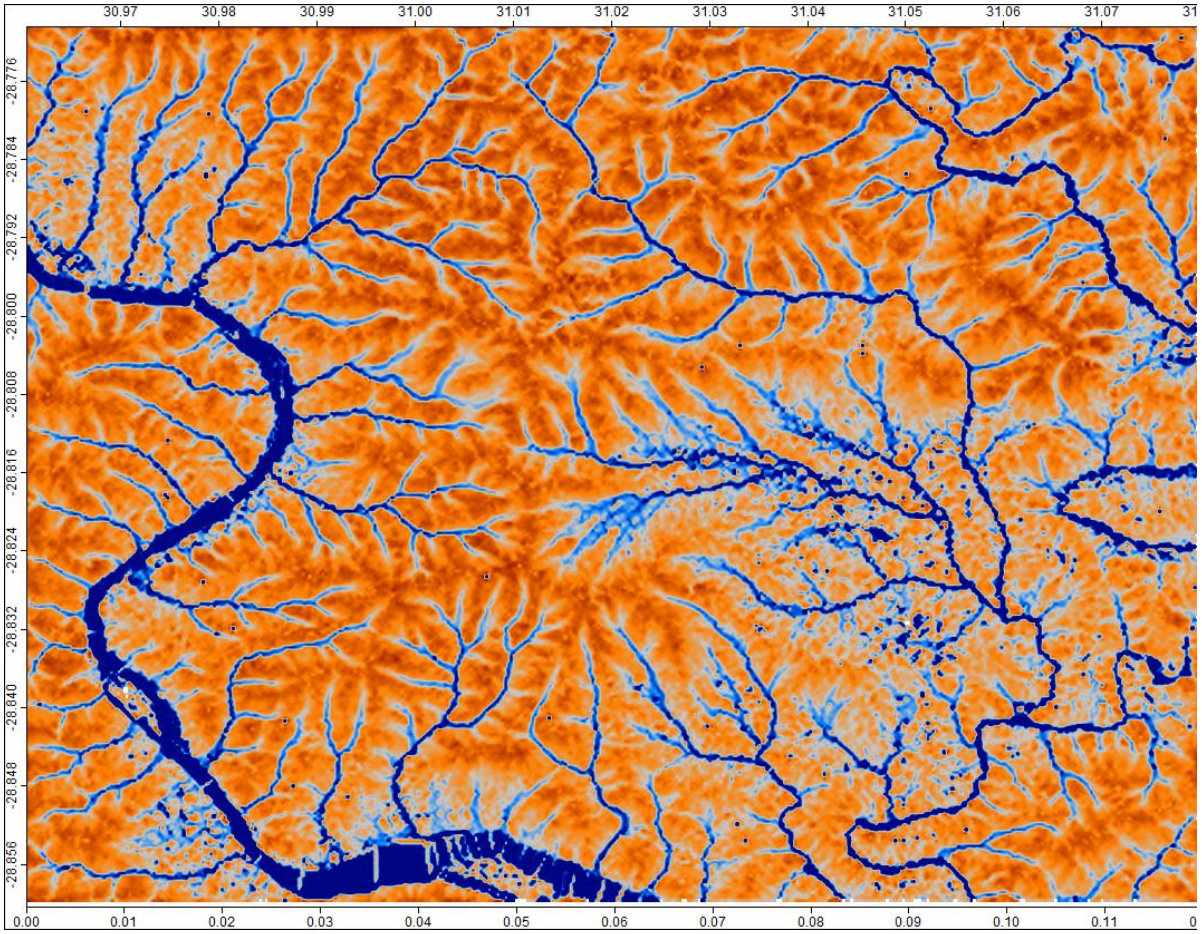

Figure 6: TWI generated for the project area

The channel network is typically divided into three types of channels in order to aid the delineation process, namely A Section, B Section, or C Section channels (DWAF, 2005). The notable difference between the channel Sections is the respective position relative to the zone of saturation in the riparian area. According to the DWAF (2005) guidelines, the saturated zone must be in contact with the channel network for baseflow to take place, with the

classification separating the channel sections that do not have baseflow (A Sections) from those that sometimes have baseflow (B Sections) and those that always have baseflow (C Sections). The following summary is provided for the respective channels:

- **A Sections:** Headward channels situated well above the zone of saturation and the channel bed is never in contact with the zone of saturation. These channels carry storm runoff but the flow is of short duration. These steep, eroding, headward watercourses do not have a riparian habitat due to limited deposition of alluvial (or hydromorphic) soils and are not flooded with sufficient frequency to support vegetation of a type that is distinct from the adjacent land areas (Figure 7).

- **B Sections:** Channels in the zone of the fluctuating water table with baseflow at any point in the channel when the saturated zone is in contact with the channel bed. The gradient of the channel bed is flat enough for deposition of material to take place and initial signs of flood plain development observed.

- **C Sections:** Always in contact with the zone of saturation and therefore always have baseflow. Channel gradients in these sections are very flat and a flood plain is usually present.

Figure 7: Photograph of a local drainage channel

The setting of the project area is characterised by all three channel networks. The project has attempted to identify and distinguish between these channels, delineating the wetland areas in the process.

The wetland areas associated with the project area were identified and delineated. Two HGM types were identified within the project area, namely channelled and unchannelled valley bottom wetlands. Areas resembling depressions have formed within the two HGM units due to inundation caused by the road network, but these systems have been classified as per the respective valley bottom HGM unit. The delineated wetland areas are shown in Figure 8.

The wetland classification as per SANBI guidelines (Ollis *et al.,* 2013) are shown in Table 10. Two (2) HGM types were identified within the project assessment boundary, namely:

- Channelled Valley Bottom (CVB); and
- Unchannelled Valley Bottom (UCVB).

The wetlands are described in the subsequent sections.

Table 10: Wetland classification as per SANBI guideline (Ollis et al., 2013).

Level 1	**Level 2**		**Level 3**	**Level 4**		
System	**DWS Ecoregion/s**	**NFEPA Wet Veg Group/s**	**Landscape Unit**	**4A (HGM)**	**4B**	**4C**
Inland	North Eastern Uplands	Sub-Escarpment Savannah	Valley Bottom	Channelled Valley Bottom	(N/A)	(N/A)
Inland	North Eastern Uplands	Sub-Escarpment Savannah	Valley Bottom	Unchannelled Valley Bottom	(N/A)	(N/A)

Some wetland indicators were identified for the project, where the soils did show signs of saturation, and also wetland vegetation is present. The delineated areas showing signs of wetness in relation to selected crossing points for the WSS are presented in Figure 6.

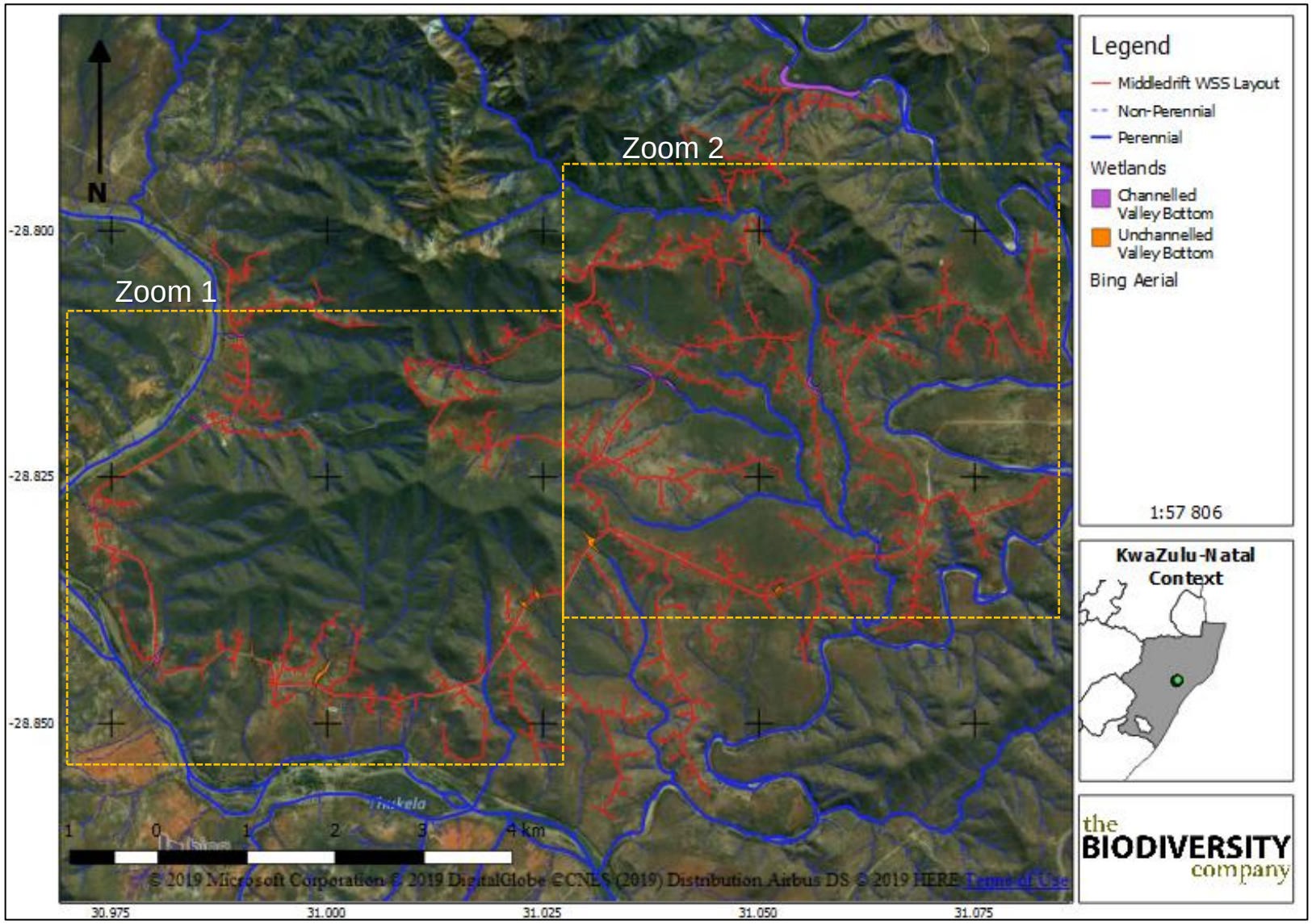

Figure 8: The delineated wetlands within the project area

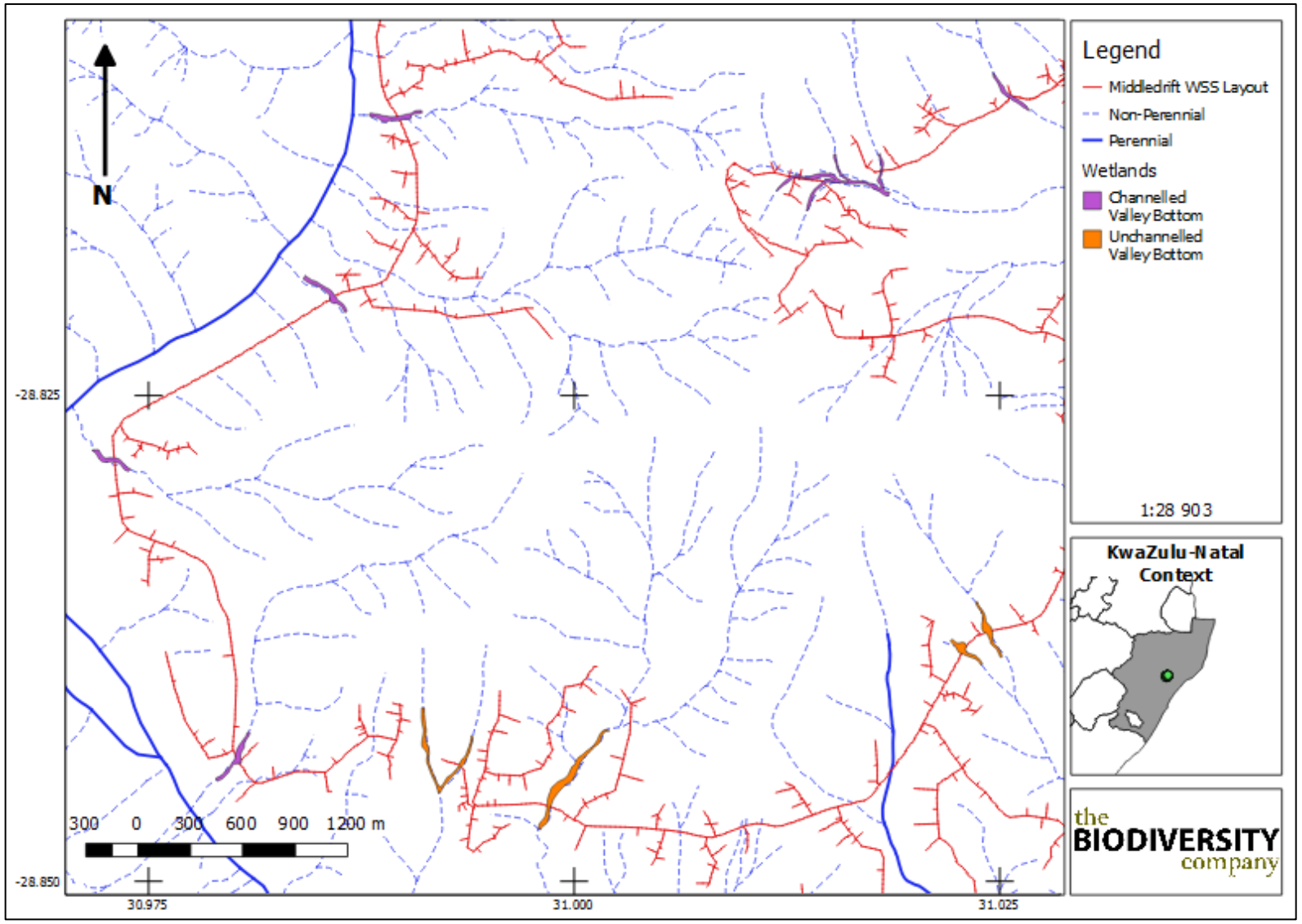

Figure 9: The delineated wetlands - Zoom 1

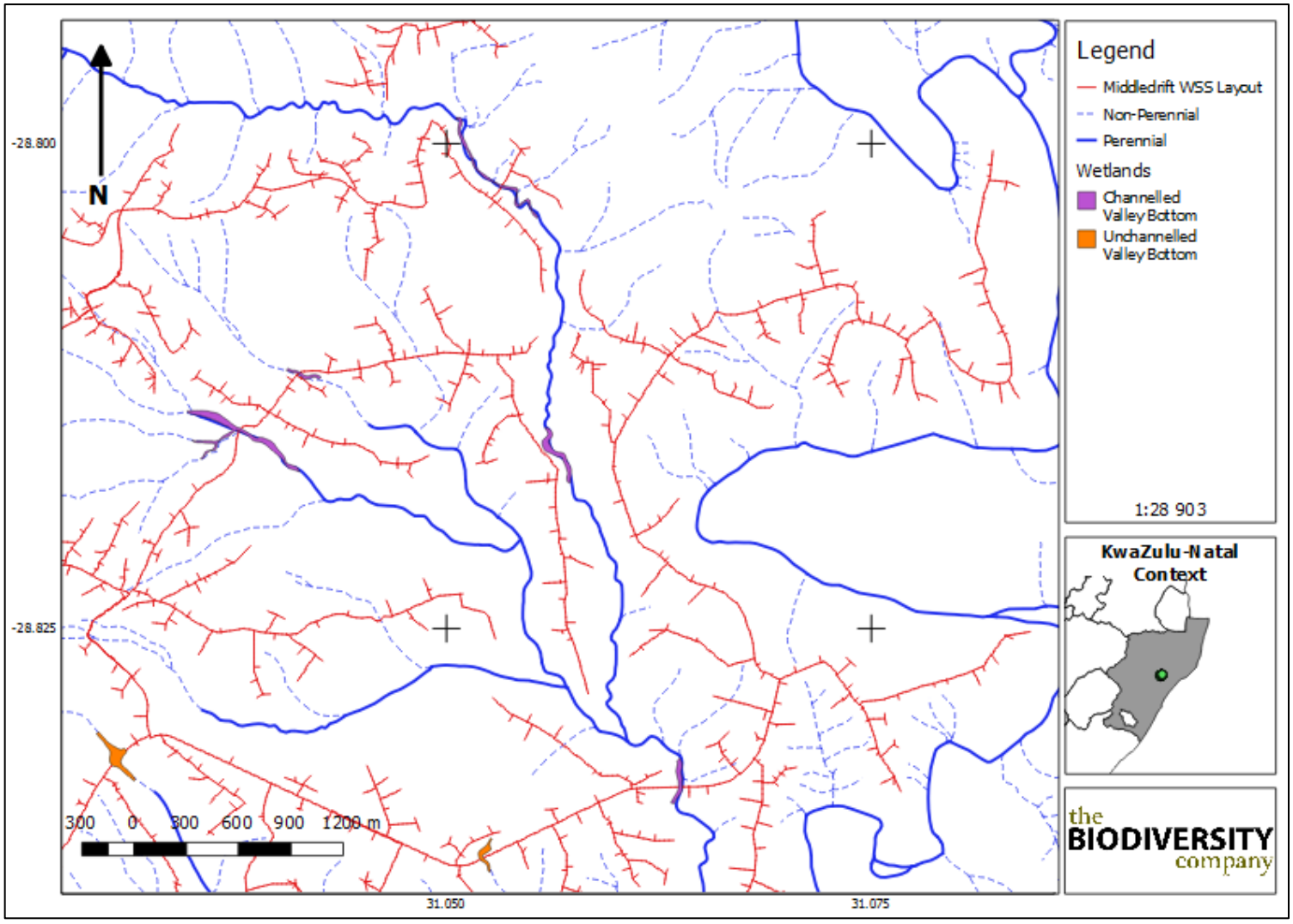

Figure 10: The delineated wetlands - Zoom 2

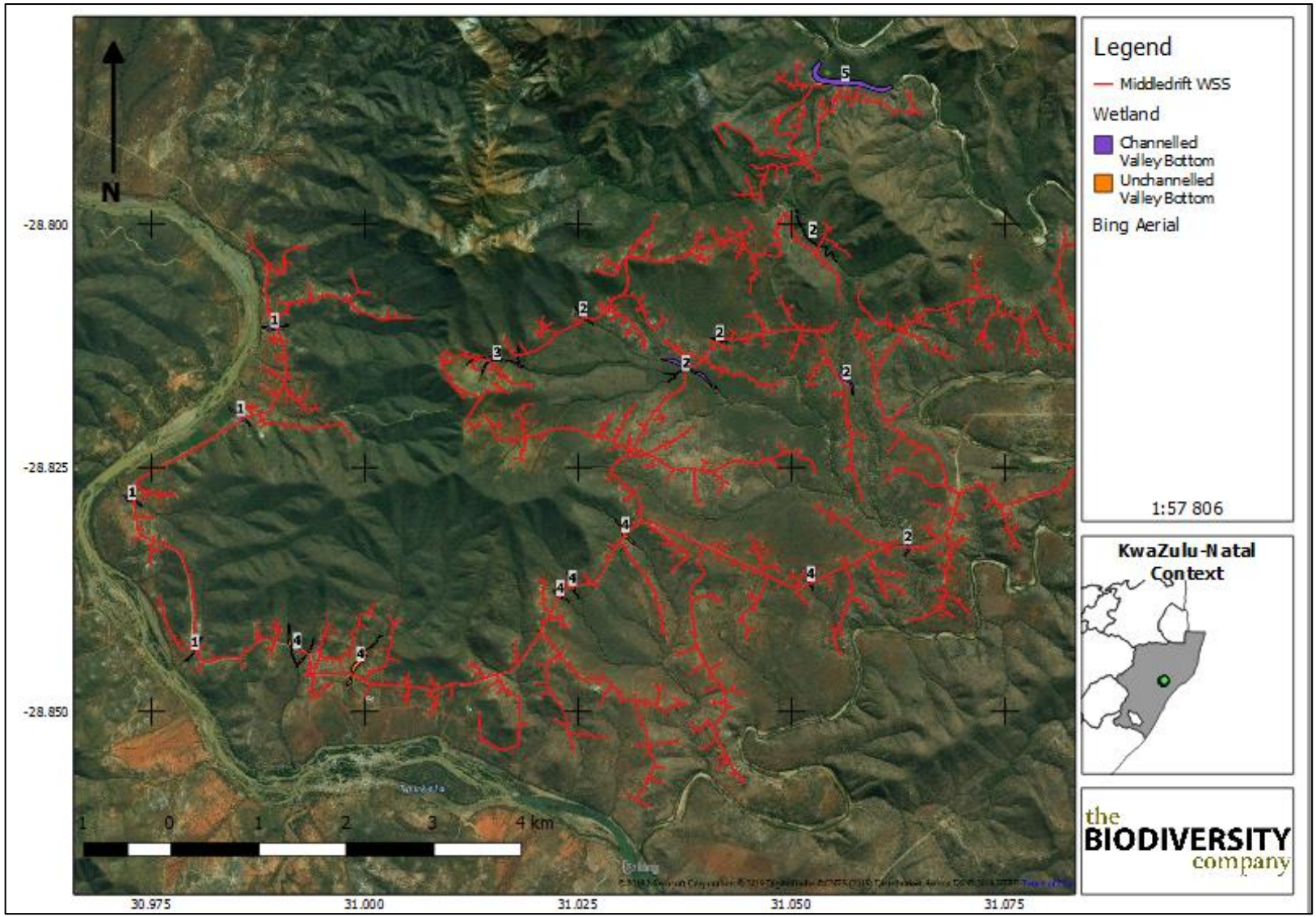

Figure 11: The wetland delineation with the HGM unit numbers

6.3 Present Ecological State

A total of eighteen (18) wetlands were identified, of these five (5) HGM units (Figure 11) were identified and delineated for the study. The PES for the assessed wetland systems is presented in Table 11.

Table 11: Summary of the scores for the wetland PES

Wetland	Hydrology		Geomorphology		Vegetation	
	Rating	Description	Rating	Description	Rating	Description
1	D	Largely Modified	D	Largely Modified	D	Largely Modified
Overall PES Class					**D: Largely Modified**	
2	D	Largely Modified	D	Largely Modified	D	Largely Modified
Overall PES Class					**D: Largely Modified**	
3	D	Largely Modified	C	Moderately Modified	C	Moderately Modified
Overall PES Class					**D: Largely Modified**	
4	D	Largely Modified	C	Moderately Modified	C	Moderately Modified
Overall PES Class					**D: Largely Modified**	
5	C	Moderately Modified	C	Moderately Modified	C	Moderately Modified
Overall PES Class					**C: Moderately Modified**	

The PES of the wetland systems varied from moderately modified (class C) to largely modified (class D). The following summaries are provided for the respective classes:

- **Moderately modified:** A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.
- **Largely modified:** A large change in ecosystem processes and loss of natural habitat and biota and has occurred.

6.4 Ecosystem Services Assessment

6.4.1 Channelled Valley Bottom

Channelled valley bottom wetlands resemble floodplains, however, they are characterized by less active deposition of sediment and also the absence of oxbows and other floodplain features such as natural levees and meander scrolls (Kotze *et al*., 2007). These systems are generally narrower and have a steeper gradient, with the contribution from lateral groundwater input relative to the main stream channel being generally greater. These systems contribute less towards flood attenuation and sediment trapping. Some nitrate and toxicant removal potential would be expected, particularly from the water being delivered from the adjacent hillslopes.

Figure 12: The channelled valley bottom wetland

6.4.2 Unchannelled Valley Bottom

The valley bottom wetlands without channels are located at the lowest position in a landscape where the water drained from the local slopes accumulate. These wetland systems play important functions such as sediment trapping, flood attenuation and nutrient-cycling. The valley bottom without a channel wetland on site receives extensive amounts of sediment and flow from the surrounding slopes. This allows an opportunity for contact between solute-laiden water and the wetland vegetation, thus providing an opportunity for flood and contaminant (nutrients, pesticides, herbicides) attenuation. Extensive areas of these wetlands remain saturated as stream channel input is spread diffusely across the valley bottom, even at low flows (Kotze *et al.,* 2007). These wetlands also tend to have a high organic content (Kotze *et al.,* 2007).

Figure 13: The unchannelled valley bottom wetland

6.4.3 Depression

The depressions identified on site are largely as a result of road networks which have obstructed flows, resulting in areas becoming inundated. These depressions are adjacent to the roads, within valley bottom systems, and are considered to be artificial. According to Kotze *et al*. (2007), depression (or pans) receive surface and groundwater which then accumulates due to a generally impermeable layer. The extent of surface and groundwater contribution is likely to vary amongst depressions. These systems offer limited flood attenuation services, however, these systems do capture runoff and thus reduce the volume of surface water that would otherwise reach the stream system during stormflow conditions (Kotze *et al.* 2007). Additionally, depression do not contribute significantly to streamflow regulation. Depressions are also not considered important for the trapping of sediments, due to the fact that these systems largely originate from wind erosion.

Figure 14: The depression adjacent to the road network

6.5 Ecological Importance & Sensitivity

The EIS assessment was applied to the HGM unit described in the previous section in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in Table 12.

The EIS for the two wetland types were calculated to have a Moderate (C) level of importance. The EIS was determined to be moderate as there were no signs of ecologically important taxa within the wetland and none had been recorded within the area. The Hydrological Functionality for the two wetland types were determined to have a Moderate (C) level of importance. The flood attenuation and streamflow regulation offered by the wetland contributes to the protection of the local area from flooding and drought. The Direct Human Benefits were calculated to have a Marginal (D) level of importance.

Table 12: The EIS results for the delineated wetland

Wetland Importance and Sensitivity	CVB	UCVB
Ecological Importance & Sensitivity	**C**	**C**
Hydrological/Functional Importance	**C**	**C**
Direct Human Benefits	**D**	**D**

6.6 Buffer Zones

The wetland buffer zone tool was used to calculate the appropriate buffer required for the Middledrift WSS. The model shows that the largest risks (Moderate) posed by the project during the construction phase is that of increased sediment inputs and turbidity. During the operational phase, the risks identified for the project included were considered low due to the pipeline being for the supply of clean potable water to residents in the area (Table 14).

According to the buffer guideline (Macfarlane, & Bredin, 2017) a high-risk activity would require a buffer that is 95% effective to reduce the risk of the impact to a low-level threat.

The risks were then reduced to Low with the prescribed mitigation measures and therefore the recommended buffer was calculated to be 15m (Table 13) for the construction and operational phases.

Table 13: Post-mitigation buffer requirement

Required Buffer after mitigation measures have been applied	
Construction Phase	**15 m**
Operational Phase	**15 m**

A conservative buffer zone was suggested of 15 m for the construction and operation phases respectively, this buffer is calculated assuming mitigation measures are applied.

The buffer zone will not be applicable for areas of the project that traverse wetland areas, however, for all secondary activities such as lay down yards, storage areas and camp sites, the buffer zone must be implemented.

Table 14: The risk results from the wetland buffer model for the proposed Middledrift WSS project

Threat Posed by the proposed land use / activity		Specialist Threat Rating	Threat Rating after Mitigation	Recommended Mitigation
Construction Phase	1. Alteration to flow volumes	Very Low	Very Low	
	2. Alteration of patterns of flows (increased flood peaks)	Low	Low	
	3. Increase in sediment inputs & turbidity	Very High	Medium	There are predominantly existing roads / crossings over the wetland areas. Dry season construction, silt traps, managed stockpiles, storm water management will reduce the risk of sedimentation during the construction. The pipeline will be attached to existing infrastructure over the watercourse areas.
	4. Increased nutrient inputs	Low	Low	
	5. Inputs of toxic organic contaminants	Medium	Very Low	
	6. Inputs of toxic heavy metal contaminants	Medium	Low	Off-site equipment vehicle fuelling and maintenance, storage in bunded area, no on-site fabrication, oil spill kits, equipment & vehicle inspections.
	7. Alteration of acidity (pH)	Low	Low	
	8. Increased inputs of salts (salinization)	N/A	N/A	
	9. Change (elevation) of water temperature	Very Low	Very Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	Very Low	Very Low	
Operational Phase	1. Alteration to flow volumes	Medium	Low	The proposed pipeline will be underground and will not impact on the surface hydrology during the duration of its operation. Furthermore, the proposed pipeline is for the supply of clean potable water to residents in the area, the risk of organic compounds and nutrients will be limited. An infrastructure monitoring plan will be devised to regularly check for leaks and remedy these.
	2. Alteration of patterns of flows (increased flood peaks)	High	Low	
	3. Increase in sediment inputs & turbidity	High	Low	
	4. Increased nutrient inputs	High	Low	
	5. Inputs of toxic organic contaminants	High	Low	
	6. Inputs of toxic heavy metal contaminants	High	Low	
	7. Alteration of acidity (pH)	High	Low	
	8. Increased inputs of salts (salinization)	High	Low	
	9. Change (elevation) of water temperature	Medium	Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	High	Very Low	

6.7 Aquatic Assessment

The aquatic assessment majority of the watercourses (WSS crossings) were expected to be non-perennial, and as a result of this, these ephemeral systems were assessed at a desktop level only. A comprehensive aquatic assessment was conducted for the perennial watercourses namely the Tugela and Nsuze Rivers. A total of two sites were assessed on the perennial watercourses, as presented in Figure 15. Site photographs and GPS coordinates are provided in Table 15.

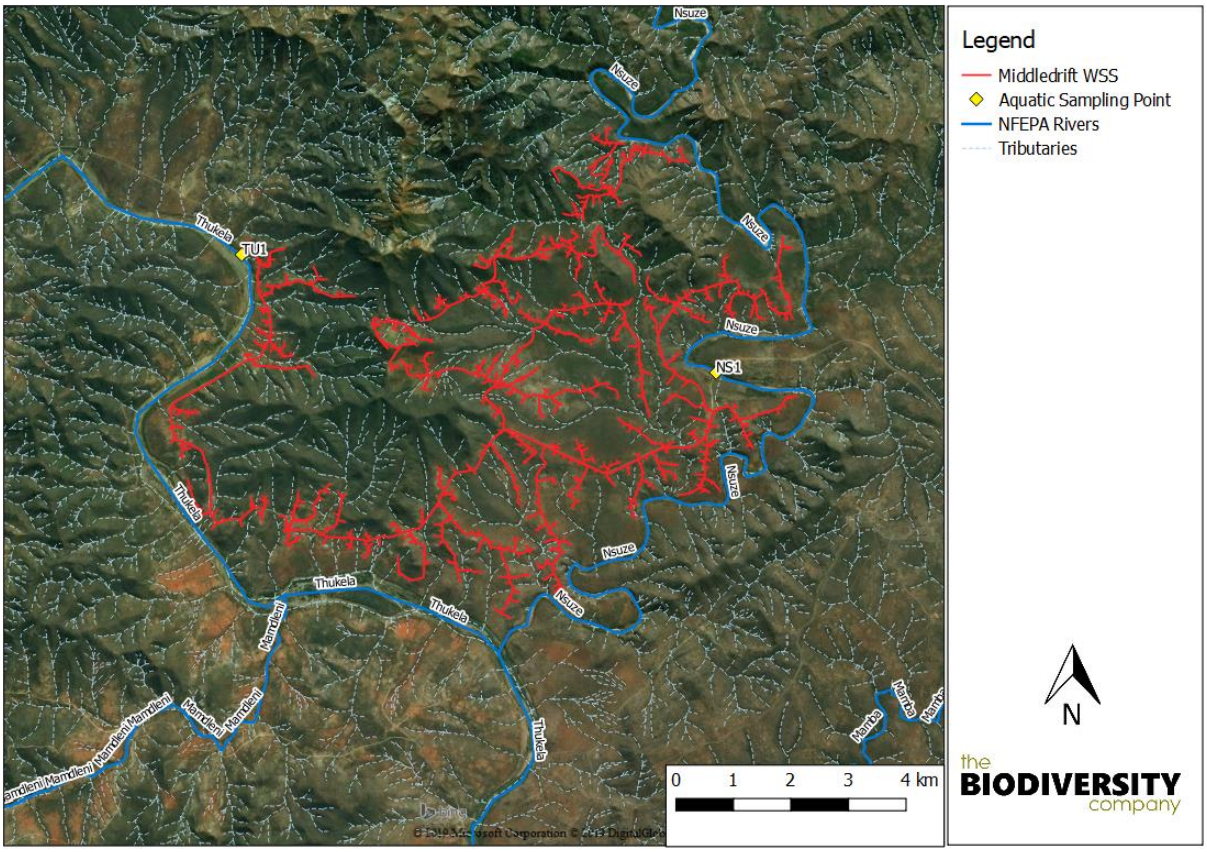

Figure 15: Illustration of sampling points

Table 15: Site photographs and GPS Coordinates for the sites sampled

	Upstream	Downstream
NS1		
GPS coordinates	28°47'7.86"S 31° 3'28.50"E	

Site description	Site NS1 is located on the Nsuze River. The site was characterised by a diversity of flow classes over stone in and out of current, bedrock, gravel, sand and mud biotopes, with moderate abundances marginal vegetation present.	
TU1	**Upstream**	**Downstream**
		
GPS coordinates	28°48'26.21"S 30°59'14.08"E	
Site description	Site TU1 is located on the Tugela River. The site was characterised by flooding waters over stones in and out of current, bedrock, sand and mud biotopes, with a low diversity of marginal vegetation. The Tugela was in flood during the survey.	

6.7.1 *In situ* water quality

In situ water quality analysis was conducted at each sampled site. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. Results were compared to the Target Water Quality Range (TWQR) for aquatic ecosystems (DWS, 1996). The results of the survey are presented in Table 16.

Table 16: In situ water quality results for the high flow survey (February 2019)

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR*	**6.5-9.0**	**<700****	**>5.00**	**5-30**
NS1	7.89	-	6.35	20.3
TU1	7.17	-	6.58	27.5

*Target Water quality Range; **Expert opinion conductivity range

In situ water quality analysis of the Tugela and Nsuze rivers indicated adequate conditions during the high flow survey (Table 16). Both watercourses had adequate pH, Dissolved Oxygen (DO) and water temperatures, falling within the TWQR. During the survey, the water within the Tugela and Nsuze rivers was considered adequate to sustain aquatic biota and ecosystem function. During the site visit, the water quality meter experienced a probe malfunction, therefore electrical conductivity readings were unreliable and disregarded for this study.

6.7.2 Intermediate Habitat Integrity Assessment

The results for the instream and riparian habitat integrity assessment for the Tugela and Nsuze River reaches are presented in Table 17 and Table 18.

Table 17: Results for the instream habitat integrity assessment

Instream	Tugela		Nsuze	
	Average	Score	Average	Score
Water abstraction	6	3.36	4	2.24
Flow modification	0	0	0	0
Bed modification	11	5.72	0	0
Channel modification	2	1.04	0	0
Water quality	6	3.36	4	2.24
Inundation	0	0	0	0
Exotic macrophytes	0	0	0	0
Exotic fauna	0	0	0	0
Solid waste disposal	5	1.2	2	0.48
Total Instream		**85.32**		**95.04**
Category		**B**		**A**

Table 18: Results for the riparian habitat integrity assessment

Riparian	Tugela		Nsuze	
	Average	Score	Average	Score
Indigenous vegetation removal	10	5.2	5	2.6
Exotic vegetation encroachment	10	4.8	7	3.36
Bank erosion	6	3.36	5	2.8
Channel modification	11	5.28	0	0
Water abstraction	10	5.2	4	2.08
Inundation	15	6.6	3	1.32
Flow modification	7	3.36	0	0
Water quality	11	5.72	3	1.56
Total Riparian		**60.48**		**86.28**
Category		**C**		**B**

According to the IHIA results instream habitat integrity in the Tugela River reach is considered to be a class B, or largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. Riparian habitat integrity in the reach is considered to be a class C, or moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged. Impacts are few with minor bed modification, some solid waste and inundation of the riparian area due to clearing of indigenous vegetation for agricultural activities.

According to the IHIA results instream habitat integrity in the Nsuze River reach is considered to be a class A, or natural with no modification. Riparian habitat integrity in the reach is considered to be a class B, or largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. Impacts are largely limited with some solid waste present and inundation of the riparian area due to clearing of indigenous vegetation for agricultural activities. Small areas of exotic vegetation were present.

6.7.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate Habitat Assessment

A biological assessment was completed at each site in the considered river reaches. The available (sampled) macroinvertebrate habitat at each site was assessed using the South African Scoring System version 5 (SASS5) biotope rating assessment as applied in Tate and Husted (2015). The results of the biotope assessment are provided in Table 19. A rating system of 0 to 5 was applied, 0 being not available, and 5 being highly abundant and diverse. The weighting for typical lower foothills river zonation has been used for the Tugela River and was used for the Nsuze River (Rountree *et al.,* 2000).

Table 19: Biotope availability at each site

Biotope	Weighting	NS1	TU1
Stones in current (SIC)	18	4	2
Stones out of current (SOOC)	12	4	1
Bedrock	3	3	2
Aquatic vegetation	1	1	3.5
Marginal vegetation in current	2	2	1
Marginal vegetation out of current	2	3	2
Gravel	4	4	1.5
Sand	2	3	2.5
Mud	1	2	2
Biotope Score		26	17.5
Weighted Biotope Score (%)		73	34
Biotope Category (Tate and Husted, 2015)		**A**	**E**

Habitat availability within the Nsuze was rated as class A, indicating diversity biotopes within the system, and that habitat availability would not limit the macroinvertebrate assemblage diversity or abundances. Habitat diversity in the Tugela system was rated as class E, and considered poor. The low diversity of habitat was attributed to flooding conditions at the time of the survey. Sampling was limited to the margins of the river. Therefore, the habitat would be considered a limiting factor o the macroinvertebrate assemblage.

South African Scoring System

The aquatic macroinvertebrate results for the high flow survey are presented in Table 20. The SASS5 score for the Nsuze River was 137, with an ASPT of 7.6, indicating taxa collected during the survey were rated as semi-tolerant (6 - 10 sensitivity score). The SASS5 score for

the flooding Tugela River was 74, with an ASPT of 8.2, indicating taxa collected during the survey were rated as semi-tolerant (6 - 10 sensitivity score).

Table 20: Macroinvertebrate assessment results

Site	NS1	TU1
SASS Score	137	74
No. of Taxa	18	9
ASPT*	7.6	8.2
Category (Dallas, 2007) **	**A**	**B**

*ASPT: Average score per taxon; **North Eastern Uplands Lower Ecoregion

Biotic integrity for the project area was categorised as natural (class A) and largely natural (class B) for the Nsuze and Tugela rivers, respectively (Table 20). It should be noted that the Tugela River was in flood during the survey, and SASS5 protocol should not be applied during these events. The results present an indication of the community during the survey.

6.7.4 Fish Assessment

Expected Fish Species

The list of expected fish species is presented in Table 21 (Skelton, 2001; DWS, 2018). Based on this, a total of 13 fish species are expected to occur in the project area.

It should be noted that these expected species lists are compiled on a SQR basis and not on a site specific basis. It is therefore unlikely that all of the expected species will be present at every site in the SQR with habitat type and availability being the main driver of species present. Therefore, Table 21 should be viewed as a list of potential species rather than an expected species list. A single species of conservation concern is expected to occur within the project area, namely *Oreochromis mossambicus* (Mozambique tilapia) (IUCN, 2018).

Table 21: Expected species list for the two sub-quaternary catchments

Scientific name	Common name	IUCN Status
Anguilla marmorata	Giant Mottled Eel	LC
Anguilla mossambica	Longfin Eel	LC
Awaous aeneofuscus	Freshwater Goby	LC
Clarias gariepinus	Sharptooth Catfish	LC
Enteromius gurneyi	Redtail Barb	LC
Enteromius paludinosus	Straightfin Barb	LC
Enteromius trimaculatus	Three spotted Barb	LC
Enteromius viviparus	Bowstripe Barb	LC
Labeo molybdinus	Leaden Labeo	LC
Labeo rubromaculatus	Tugela Labeo	LC
Labeobarbus natalensis	Natal Yellowfish	LC

Oreochromis mossambicus	Mozambique Tilapia	NT
Tilapia sparrmanii	Banded Tilapia	LC
Total number of fish		**13**

LC - Least Concern; NT - Near Threatened

Sampled Fish Species

Fish sampling was conducted in in the Tugela and Nsuze Rivers. Fish were collected using electrofishing techniques in all available biotopes. Biotopes sampled were predominantly slow flowing water over gravel, sand and mud (dominant) biotopes. Cover features included marginal vegetation and undercut banks.

Four of the 11 expected fish species were collected during the February 2019 survey in the Tugela system (Table 22). The fish community collected would not be considered representative of the Tugela due to flooding conditions. A total of seven species were collected in the Nsuze River system, with species from the Cyprinidae family being dominant.

Table 22: Fish data collected during the high flow survey (February 2019)

Scientific name	Common name	IUCN Status	Site		Sensitivity	
			TU1	NS1	No-flow	Phys-chem
Clarias gariepinus	Sharptooth catfish	LC	1	1	**1.7**	**1.0**
Enteromius trimaculatus	Three spot barb	LC	1	1	**2.7**	**1.8**
Enteromius viviparus	Bowstripe barb	LC	0	1	**2.3**	**3.0**
Labeo cylindricus	Redeye labeo	LC	0	1	**3.1**	**3.1**
Labeo molybdinus	Leaden labeo	LC	1	1	**3.3**	**3.2**
Labeobarbus natalensis	Natal yellowfish	LC	1	1	**3.5**	**3.0**
Oreochromis mossambicus	Mozambique tilapia	NT	0	1	**0.9**	**1.3**
Number of species expected			**11**	**13**		
Number of species observed			**4**	**7**		

Table 23: Photographs of fish species collected during the survey

Oreochromis mossambicus

Clarias gariepinus

Enteromius trimaculatus

Enteromius viviparus

Labeo cylindricus

Labeo molybdinus

Labeobarbus natalensis

The sites sampled for the proposed Middledrift WSS is currently in a largely natural condition. This is largely due to the limited impacts to instream habitat and slightly modified biotic integrity of the system. Impacts observed within the project area include large scale erosion of various drainage lines (Figure 16) due to the removal of vegetation and collapse of soils. Sedimentation of the sampled river was witnessed as a result. Some agricultural and livestock activities were generally present.

Figure 16: Photograph illustrating typical level of erosion of many drainage lines within the project area

7 Risk Assessment

The proposed water supply scheme may make use of water pipeline structures that cross drainage channels as presented in Figure 16. These drainage channels may be inundated during periods of high flow. It is recommended that the pipeline span the drainage channel and not use 'instream' support piers.

The proposed WSS will have no direct impact on the Tugela and Nsuze Rivers, however, the associated tributary network may be impacted on by the proposed project. Impacts on the river systems and drainage channels that may be a result of the pipeline construction are as follows:

- Loss of habitat on riverbanks due to clearing of riparian vegetation. Clearing of indigenous vegetation during construction may also result in the proliferation of alien invasive plant species post construction;
- During the construction phase, there is potential for soil erosion as vegetation is removed, grading activities expose soils and make it more susceptible to erosion;
- During the construction phase, heavy machinery and vehicles will be operated in close proximity to the two major rivers identified as well as the 67 drainage line crossings,

this increases the risk of spills or leaks of hazardous substances (e.g. fuel spills or oil leaks) resulting in decreased water quality; and

- During the operational phase, leaks from the water pipeline may discharge potable water into the river. Potable water is not up to aquatic ecosystem water standards (DWAF, 1996). This may result in changed water quality and flow levels in the river system with degradation of aquatic macroinvertebrate community assemblages.

Findings from the DWS aspect and impact register / risk assessment are provided below:

Table 24: Potential risks associated with the project

Activity	Aspect	Impact
Construction & operation of water pipeline	Clearing of areas and digging trenches for infrastructure	Impeding the flow of water. Loss of aquatic habitat Siltation of watercourse. Erosion of watercourse. Sedimentation of the watercourse. Flow sediment equilibrium change Water quality impairment
	Piers located outside of drainage lines	
	Use of temporary structures for river crossings	
	On-site vehicle and machinery activities	
	Ablutions and waste handling	
	Additional associated infrastructure	
	Operation of pipeline	

Table 25: Risk rating assessment

Christian Fry (Pr. Sci, Nat 119082); Wayne Jackson (Pr. Sci, Nat Pending)								
Severity								
Aspect	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**
Clearing of areas and digging trenches for infrastructure	2	2	3	1	**2**	2	2	**6**
Piers located outside of drainage lines	0	1	2	0	**0.75**	2	3	**5.75**
Use of temporary structures for river/wetland crossings	2	2	2	1	**1.75**	1	1	**3.75**
On-site vehicle and machinery activities	1	2	2	3	**2**	2	3	**7**
Ablutions and waste handling	1	3	1	3	**2**	1	3	**6**
Excavation of pipeline route	3	2	3	2	**2.5**	2	2	**6.5**
Removal and stockpiling of soils	2	2	2	2	**2**	2	3	**7**
Compaction of soil profile	2	1	1	1	**1.25**	1	3	**5.25**
Additional associated infrastructure	1	1	1	1	**1**	1	2	**4**
Operation of pipeline	2	1	1	1	**1.25**	1	3	**5.25**

Table 26: Risk rating assessment continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Risk Rating
Clearing of areas and digging trenches for infrastructure	1	2	5	1	**9**	**54**	**Low**
Piers located outside of drainage lines	2	2	5	1	**10**	**57.5***	**Moderate***
Use of temporary structures for river crossings	1	2	5	1	**9**	**33.75**	**Low**
On-site vehicle and machinery activities	3	1	1	2	**7**	**49**	**Low**
Ablutions and waste handling	2	1	1	2	**6**	**36**	**Low**
Excavation of pipeline route	3	1	5	3	**12**	**78***	**Moderate***
Removal and stockpiling of soils	3	1	5	2	**11**	**77***	**Moderate***
Compaction of soil profile	2	2	1	2	**7**	**36.75**	**Low**
Additional associated infrastructure	2	1	5	1	**9**	**36**	**Low**
Operation of pipeline	1	2	5	1	**9**	**47.25**	**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 construction of the water pipeline does pose a risk to the identified aquatic systems, with the level of risk predominantly determined to be low. These low risk ratings may largely be attributed to the impacts occurring outside of aquatic areas, with the potential to address some of the potential impacts. The use of a spanned pipeline with support piers located outside of aquatic areas was re-allocated a moderate-low status (yellow) due to implementation of additional mitigation methodologies, while a single moderate risk of digging trenches through aquatic areas for the burying of the water pipeline may pose large problems to instream areas and should be avoided.

The proposed project was determined to have low to moderate impacts on the wetland areas. The risk assessment considered the current state and functioning of the wetland areas, and the nature of the project which is for the installation of a water pipeline. The wetland areas are in a moderately to largely modified state, and the proposed project will not have a direct impact on the selected wetland systems.

Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local water resources, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low.

During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

7.1 Pipeline installation

The excavation of a trench will be required for the installation of a pipeline in the bypass area. Additionally, excavations will be required for the installation of junction boxes. A summary of the construction activities is presented below:

Site preparation

- Trenches should be side dug (where possible) from the existing access routes / service roads. In the absence of access routes, temporary routes may be considered;
- Temporary access should be constructed to prevent rutting and degradation of the soil, to permit construction to proceed;
- Trenches should be dug on-line (where applicable) creating narrower trenches;
- Where trench breakers are required, these should be imported appropriately and installed by the backfill crew, ahead of backfilling;
- Careful separation of soil types/ strata as identified;
- The soils should be removed in such a way that they can be easily reinstated in the reverse order as detailed below;
- To ensure correct backfilling, the soil that is removed from the trench at its deepest point will be laid closest to the trench;

- It may be necessary to import small amounts of padding material upon which the pipe safely rests in the trench prior to backfilling. This material will be stored outside the wetland buffer (15 m) until it is required to be placed within the trench, and bunded with sandbags;
- Any large boulders encountered during trenching operations should not be returned to the trench, but removed off site; and
- Excess spoil should be temporarily windrowed over the trench to permit natural settling of the material prior to the reinstatement phase.

7.2 Mitigation Measures

The following water pipeline installation specific mitigation measures are provided:

- Pipeline trenches and sandy bedding material may produce preferential flow paths for water across the project area perpendicular to the general direction of flow instead of angle. This risk can be reduced by installing clay plugs at intervals down the length of the trench to force water out of the trench and down the natural topographical gradient;
- Pipelines crossing drainage areas, should preferably span the drainage lines above ground. This prevents disruptions to sub surface flow dynamics and allows the pipeline to be monitored for leaks;
- Pipelines underground crossing rivers and streams should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions, where flows can cause erosion;
- If pier support structures are needed for the pipeline to span a wide drainage line, then piers should be placed outside of preferential flow paths with the least number of pier structures used as possible; and
- During the excavation of trenches, flows should be diverted around active work areas where required. Water diversion must be temporary and re-directed flow must not be diverted towards any stream banks that could cause erosion.

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;
- The installation of the pipeline must make use of the minimum footprint area, avoiding unnecessary impacts to adjacent water resources;
- Laydown yards, camps and storage areas must be beyond the water resource areas. Where possible, the pipeline and crossings must take place from the existing areas of disturbance and not from within the water resource 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 stormwater channels and preferential flow paths should be filled with aggregate and/or logs (branches included) to dissipate and slow flows limiting erosion;
- Pre-cast piers should be made use of (where possible) to avoid the mixing of these materials on site, reducing the likelihood of cement in the river system;
- Prevent uncontrolled access of vehicles through the watercourses that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All chemicals and toxicants to be used for the pipeline construction must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- 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 contractors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- No dumping of construction material on-site may take place; and
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

8 Conclusion

Wetland

A total of eighteen (18) wetlands were identified, of these five (5) HGM units were identified and delineated for the study.

The PES of the wetland systems varied from moderately modified (class C) to largely modified (class D). The Ecological Importance & Sensitivity for the two wetland types were calculated to have a Moderate (C) level of importance. The Hydrological Functionality for the two wetland types were determined to have a Moderate (C) level of importance. The Direct Human Benefits were calculated to have a Marginal (D) level of importance.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the pipeline crossing.

Taking the proposed project and all the risks into consideration, the project itself and the current state and of the local wetland systems, the risk rating for each of the aspects was determined to vary from low to moderate, pre-mitigation. However, should the prescribed mitigation measures be implemented for the project, the associated risks are all expected to be low. During the operational phase of the project, no mitigation measures are expected to be required. Taking into account that the pipeline will be transporting water.

Aquatics

The current state of the river reaches, associated with the proposed Middledrift Water Supply Scheme are in an unmodified state. This is predominantly due to the largely natural to slightly modified state of the instream and riparian habitats resulting in largely intact local aquatic biota. According to *in situ* water quality analysis, water quality within the two river reaches was considered good. The condition of the local aquatic macroinvertebrates within the Tugela River reach are considered in a largely natural state, predominantly due to slightly modified instream habitat as a result of sedimentation and an absence of instream vegetation. The fish community structure indicates largely natural conditions within the system. The condition of the local aquatic macroinvertebrates within the Nsuze River reach are considered in a natural state, predominantly due to unmodified instream habitat. The fish community structure indicates largely natural conditions within the system.

Impacts

The proposed WSS will have no direct impact on the Tugela and Nsuze Rivers, however, the associated tributary network may be impacted on by the proposed project. The risks associated with digging a trench through the watercourses to bury the pipeline were determined to be moderate and should be avoided. It is recommended that the construction of the new water pipeline avoid aquatic areas by using support piers located outside of watercourses with the pipeline spanning these systems. The risks associated with this preferred option were determined to be low provided mitigation measures are adhered to. It is the opinion of the specialist that the project be favourably considered, and allow for the construction of the pipeline to proceed. It is recommended that an aquatic monitoring programme is implemented should the proposed development commence.

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