WETLAND AND AQUATIC IMPACT ASSESSMENT:

Proposed Eskom Agulhas 400/132 kV 2x500 Mva Substation Sites A, C, F, And G, Swellendam Local Municipality, Western Cape

OCTOBER 2016

Malachite specialist Services (Pty) Ltd

MALACHITE
SPECIALIST SERVICES

WETLAND AND AQUATIC IMPACT ASSESSMENT:

Proposed Eskom Agulhas 400/132 kV 2x500 Mva Substation Sites A, C, F, And G, Swellendam Local Municipality, Western Cape

Project Number	16-039
Version:	1
Version status:	**Final**
Client:	Nsovo Environmental Consulting 40 Lyncon Road Carlswald, Midrand 1684 Tel: 011 041 3689 Fax: 086 602 8821 Email: khuliso@nsovo.co.za
Prepared by:	**Malachite Specialist Services (Pty) Ltd** Company Number: 2016/146293/07 Cell: 078 023 0532 Email: rowena@malachitesa.co.za **Offset Industries** Umhlanga, KwaZulu-Natal Cell: 082 447 1698 Email:brett@offsetindustries.com
Author(s):	Rowena Harrison Brett Reimers

Citation:

Malachite Specialist Services and Offset Industries (2016) Wetland Impact Assessment and Rehabilitation Plan: Proposed Eskom Agulhas 400/132 kV 2x500 Mva Substation Sites A, C, F, And G, Swellendam Local Municipality, Western Cape. Durban

Declaration

I **Rowena Harrison,** declare that -

- I act as the independent wetland specialist in this matter;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- 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 National Environmental Management Act (Act 107 of 1998), (NEMA), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the NEMA Act, regulations and all other applicable legislation;
- As a registered member of the South African Council for Natural Scientific Professions in terms of the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003), I will undertake my professional duties in accordance with the Code of Conduct of the Council, as well as any other societies of which I am a member; and
- 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 report are true and correct.

Signature of the specialist: RHarrison

Date: 06/10/2016

Specialist:	Rowena Harrison for Malachite Specialist Services (Pty) Ltd
Contact person:	Rowena Harrison
Qualification:	MSc Soil Science (UKZN)
Telephone:	078 023 0532
E-mail:	rowena@malachitesa.co.za
Professional affiliation(s) (if any)	SACNASP *Pr.Sci.Nat*: 400715/15 Soil Science IAIAsa (No. 2516)

Declaration

I **Brett Reimers** declare that -

- I act as the independent aquatic specialist in this matter;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- 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 National Environmental Management Act (Act 107 of 1998), (NEMA), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the NEMA Act, regulations and all other applicable legislation;
- As a registered member of the South African Council for Natural Scientific Professions in terms of the Natural Scientific Professions Act, 2003 (Act No. 27 of 2003), I will undertake my professional duties in accordance with the Code of Conduct of the Council, as well as any other societies of which I am a member; and
- 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 report are true and correct.

Signature of the specialist:

Date: 06/10/2016

Specialist:	Brett Reimers for Offset Industries
Contact person:	Brett Reimers
Qualification:	MSc Applied Marine Science
Telephone:	082 4471698
E-mail:	brett@offsetindustries.com
Professional affiliation(s) (if any)	SACNASP Pr.Sci.Nat: 400166/16 Zoology and Biological Science

EXECUTIVE SUMMARY

Malachite Specialist Services (Pty) Ltd was appointed by Nsovo Environmental Consulting to undertake a Wetland and Aquatic Impact Assessment for the proposed Eskom Agulhas 400/132kV 2x500 Mva Substation Site, Swellendam Local Municipality, Western Cape. Four alternative sites were assessed in this investigation, namely Sites A, C, F, And G. The wetland and aquatic impact assessment forms part of the Environmental Impact Assessment and Water Use Licence Application in compliance with the National Environmental Management Act (Act 107 of 1998), the Environmental Impact Assessment (EIA) Regulations, 2014, GN R. 983, R. 984 and R.985 and the National Water Act (Act 36 of 1998).

The terms of reference for the current study were as follows:

- Identify and delineate any wetland areas and/or watercourses on and within the proposed substation sites, according to the Department of Water Affairs[1] "Practical field procedure for the identification and delineation of wetlands and riparian areas";
- Determine the Present Ecological Status (PES) and Functional Integrity of identified wetlands using the WET-Health and Wet-EcoServices approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWS;
- Using the tools developed under the River Health Program (RHP) determine the baseline conditions and Present Ecological Status (PES) of the aquatic ecosystems associated with the proposed development sites. These tools included:
  - Assessing the in situ water quality
  - Determining the suitability of habitat (using the invertebrate habitat assessment system (IHAS) and the intermediate habitat index assessment, IHIA).
  - Investigating the invertebrate community structure by means of the South African Scoring System version 5 (SASS5) as well as the Macroinvertebrate Response Assessment Index (MIRAI).

[1] Department of Water Affairs (DWA) is now named the Department of Water and Sanitation (DWS).

- o Assessment of the fish community structure was excluded from the terms of reference.
- Once the baseline had been determined each of the proposed sites was assessed for impacts that could potentially occur during the construction and operational phase.

The wetland assessment initially involved desktop investigations for the presence of wetland and watercourse systems within a 500m buffer around the proposed alternative substation sites. A subsequent field investigation identified the presence of one wetland on the southern boundary of Site A. This wetland system flows in an easterly direction eventually linking into a 'B' Section drainage channel. The wetland system was classified into a single hydrogeomorphic unit, namely a channelled valley bottom wetland.

The current status of the wetland system was assessed using the wetland health methodology and was categorised as seriously modified (PES Category E). There have been major modifications to the system as a result of the cultivation of wheat within this system as well as the creation of a number of agricultural dams. These anthropogenic activities have resulted in the alteration of the hydrological flow through the wetland systems, therefore having an effect on the geomorphological processes which govern the wetland system. The cultivation of soil within the wetland boundary and use of the wetland for agricultural production has led to the formation of erosion gullies within the wetland as well as the deposition of soil.

These modifications to the wetland system have further impacted the system's ability to provide ecological goods and services with scores for this assessment ranging from moderate to low. Functions relating to flood attenuation as well as the filtration of nutrients and toxicants received moderate scores. The use of the wetland system for wheat and therefore agricultural activities also received moderate scores. The use of the wetland for agricultural productivity has had a negative impact on the functional integrity of the channelled valley bottom wetland.

An Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank water resources in terms of provision of goods and service or valuable ecosystem functions which benefit people; biodiversity support and ecological value; and reliance of subsistence users (especially basic human needs uses). The very low Ecological Importance and Sensitivity score assigned to the wetland was primarily attributed to the degraded state of the channelled valley bottom wetland, therefore lowering its ability to provide natural resources to floral and faunal species; and its ability to maintain biodiversity within the larger landscape.

One ‘A’ Section channel and seven ‘B’ Section channels, with associated riparian areas were also delineated within a 500m buffer of all sites. ‘B’ Section channels are non-perennial systems that are in contact with the zone of saturation often enough to be associated with a riparian zone. They are therefore, considered to be hydrologically sensitive areas.

The riparian zones have been generally classified as moderately modified (PES Class C), with one drainage channel classed as largely modified (PES Category D). The riparian zones are predominantly intact, with limited impacts exerted on these sensitive ecotones from the surrounding agricultural activities. Modifications to all systems are associated with a reduction in water quality as a result of the high influx of fertilisers into the watercourses. Agricultural dams which have been built in the drainage channels have also caused the removal of the riparian zone at these points within the drainage channel system.

Baseline aquatic assessments were conducted as part of the aquatic impact assessment on the Kluitjieskraal River. Tributaries associated with the Freek Botha River could not be undertaken due to low flows and site access concerns.

The Kluitjieskraal River was determined to be largely to seriously modified when assessed using the tools and indexes of the RHP. The primary impact throughout the sites assessed appears to be water quality related. This is likely due to the intense agricultural practises that occur in the area.

A 25m buffer has been calculated for all delineated water resource systems in order to provide protection from the proposed substation development for the functions these water resources perform. This buffer is situated within portions of Substation Sites A and C and must be maintained with vegetation basal cover and not developed. Substation sites F and G are not situated within any of the buffer zones identified. The 132kv distribution lines will however cross a number of the wetlands and watercourses delineated.

The impact assessment identified the following negative impacts associated with the proposed development on the wetland and watercourses; (i) soil erosion and sedimentation of the wetland and watercourses, and (ii) pollution of the wetland, watercourses and soil as a result of construction and the degradation of these wetland during operational activities. When assessing the current land use and its impact on the aquatic systems within the parameters of the study it was demonstrated that current land management practises place a large burden on the aquatic systems. In comparison the construction and operational activities of the proposed substation are unlikely to unduly impact on the aquatic ecology of the area. During both the construction and operational phases the impacts were assessed to be of a low environmental significance. Mitigation measures were proposed and focus on trapping sediment when the site is cleared and slowing runoff rates when surfaces are hardened.

Site F and G are recommended from a wetland and watercourse perspective as these sites pose the least risk to any water resource system. Site F and G will only impact water resources along the 132kv distribution line. There is a lower risk posed by the construction of the pylons associated with the 132 kv distribution line when compared to the risk posed by the construction of the substation. Provided the pylons associated with the distribution line are constructed outside of the 25m recommended buffers this risk will be considered to be low for Site F and G.

All alternative sites will however cross a water resource and whichever site is approved, the client will need to obtain a Water Use License for the construction of this substation, 132kv distribution line and the transmission line project.

Provided the mitigation measures specified in this report are implemented and the continued monitoring and rehabilitation of eroded areas is undertaken, the proposed construction of the substation and loop-in loop-out lines is not expected to have a limited long term negative impact on the receiving environment.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

1. INTRODUCTION AND BACKGROUND

1.1. Project Background and Locality

Malachite Specialist Services (Pty) Ltd was appointed by Nsovo Environmental Consulting to undertake a Wetland and Aquatic Impact Assessment for the proposed construction of the Eskom Agulhas 400/132kV 2X500 MVA Transmission substation and loop-in loop-out lines. The proposed project is located within Swellendam Local Municipality, 20km south west of Swellendam, Western Cape Province.

Eskom Holdings SOC Ltd is proposing the construction of the Agulhas 400/132kV Main Transmission Substation (MTS) with the construction footprint of the development being 600m x 600m. The project will include the construction of a 400kV loop-in loop-out overhead power lines which will feed into the existing 400kV Bacchus-Proteus power line and ultimately into the new substation. The proposed development will form part of the Vryheid Network Strengthening project with the primary aim of increasing the power output within the area. The establishment of the Agulhas Transmission substation will assist in resolving the transmission capacity constraints at Bacchus substation and will play an important role in addressing the energy transmission problems within the Swellendam Municipality.

The study site is located on the Farms 253, 257 and 524 and Portions 5 & RE of the Farm Kluitjeskraal 256 within the Swellendam Local Municipality, Western Cape Province (**Figure 1**). The site is located approximately 20 km from Swellendam along the N2 and R319. There are four proposed site alternatives, namely Site A, C, F and G, all of which are situated within the quarter-degree square 3420AB. The proposed development sites are bounded by agricultural land including both Canola and Wheat crops as well as grazing land.

The wetland and aquatic impact assessment forms part of the Environmental Impact Assessment and Water Use Licence Application in compliance with the National Environmental Management Act (Act 107 of 1998), the Environmental Impact Assessment (EIA) Regulations, 2014, GN R. 983, R. 984 and R.985 and the National Water Act (Act 36 of 1998).

The primary aim of the study is to provide a description of the current ecological integrity and impacts pertaining to any wetland and watercourse systems that may be impacted by the proposed substation development and associated power line infrastructure as well as providing appropriate management recommendations to mitigate the impacts on these water resources.

1.2. Scope of the assessment

1.2.1. Wetland Assessment

The terms of reference for the current study were as follows:

- Identify and delineate any wetland areas and/or watercourses on and within the proposed substation sites, named Site A, C, F and G, according to the Department of Water Affairs[2] "Practical field procedure for the identification and delineation of wetlands and riparian areas";
- Determine the Present Ecological Status (PES) and Functional Integrity of identified wetlands using the WET-Health and Wet-EcoServices approach;
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands using the latest applicable approach as supported by the DWS;
- Identify possible impacts and recommend mitigation measures of the proposed project on the wetland and watercourses within the study site.

1.2.2. Aquatic Assessment

The terms of reference for the aquatic ecology report were as follows:

- Using the tools developed under the River Health Program (RHP) determine the baseline conditions and Present Ecological Status (PES) of the aquatic ecosystems associated with the proposed development sites. These tools included:
    - o Assessing the in situ water quality
    - o Determining the suitability of habitat (using the invertebrate habitat assessment system (IHAS) and the intermediate habitat index assessment, IHIA).
    - o Investigating the invertebrate community structure by means of the South African Scoring System version 5 (SASS5) as well as the Macroinvertebrate Response Assessment Index (MIRAI)
    - o Assessment of the fish community structure was excluded from the terms of reference.

---

[2] Department of Water Affairs (DWA) is now named the Department of Water and Sanitation (DWS).

- Once the baseline had been determined each of the four proposed sites was assessed for impacts that occur during the construction and operational phase.

Typically surface water attributed to wetland systems, rivers and riparian habitats comprise an important component of natural landscapes. These systems are often characterised by high levels of biodiversity and fulfil various ecosystems functions. As a result, these systems are protected under various legislation including the National Water Act, 1998 (Act No. 36 of 1998) and the National Environmental Management Act, 1998 (Act No. 107 of 1998).

1.3. Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations or assumptions. The following apply to this study:

i. The findings, results, observations, conclusions and recommendations provided in this report are based on the authors' best scientific and professional knowledge as well as available information regarding the perceived impacts on the water resources.
ii. A hand held Garmin eTrex 30x used to delineate wetland, watercourse and riparian boundaries has an accuracy of 3-6m.
iii. The assessments of the identified wetland and watercourse systems were based on a two-day field investigation. Site visits should ideally be conducted over differing seasons in order to better understand the hydrological and geomorphologic processes driving the characteristics of the watercourses and the functional integrity of the wetland and watercourse systems.
iv. Site access was a limiting factor and in an effort not to disturb land owners, certain watercourses were forfeited. This did not have an impact on the overall integrity of the assessment.

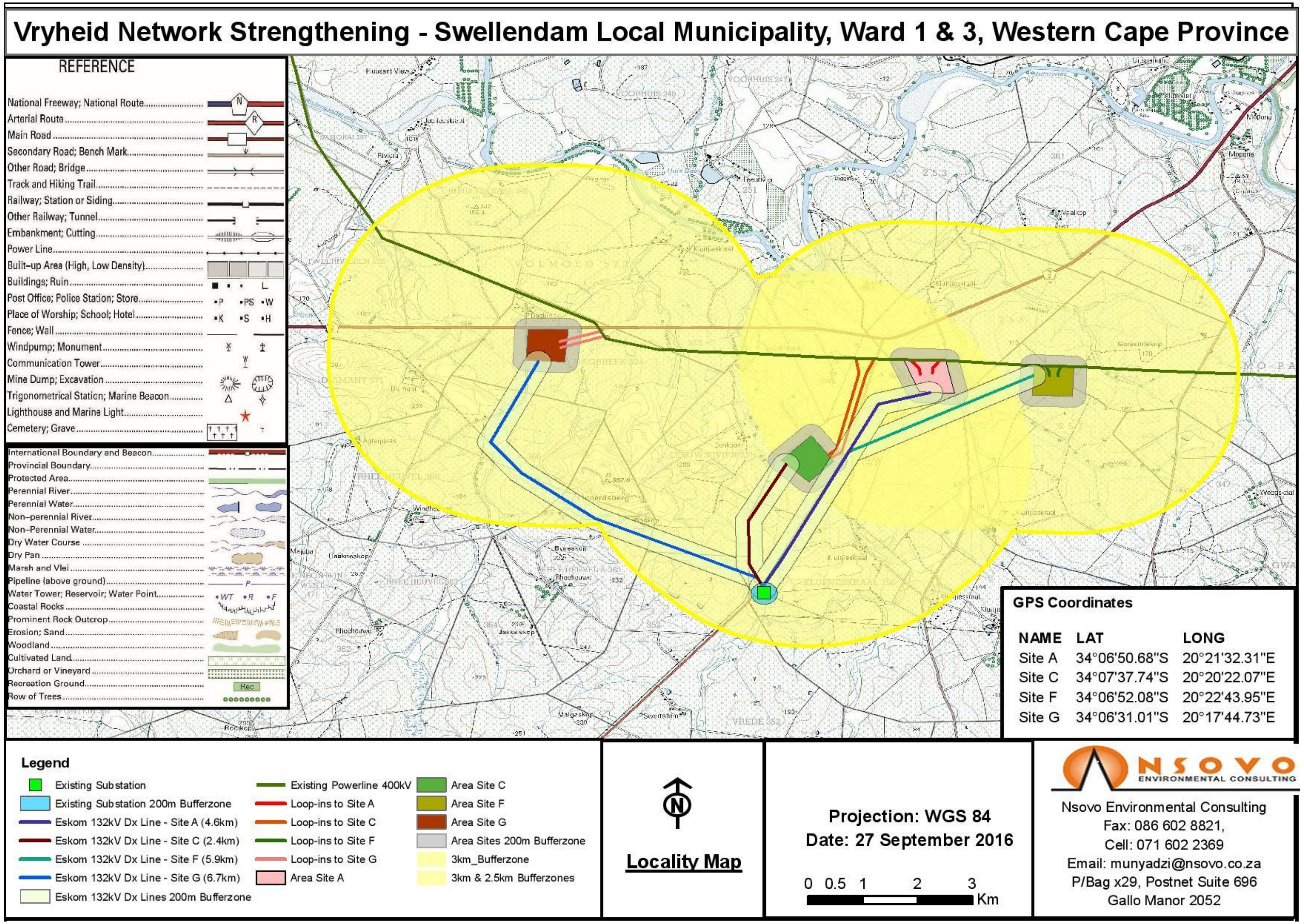


Figure 1: Site locality of the alternative substation sites

2. METHODOLOGY

2.1. Assessment techniques and tools

The following techniques and tools were used in the assessment:

2.1.1. Baseline data

The desktop study conducted for the proposed project involved the examination of aerial photography, GIS databases including the NFEPA and South African National Wetland maps as well as literature reviews of the study site, in order to determine the likelihood of wetland and watercourse systems within the area.

The study made use of the following data sources:

- Google Earth™ satellite imagery was used at the desktop level;
- Relief dataset from the Surveyor General was used to calculate slope and in the desktop mapping of watercourses;
- The NFEPA dataset from (Driver, *et al*., 2011) was used in determining any priority wetlands and rivers;
- Geology dataset was obtained from AGIS[3] ,
- Vegetation type dataset from (Mucina & Rutherford, 2006) and SANBI 2012 vegetation map was used in determining the vegetation type of the study area; and
- In field data collection was taken on the 5th and 6th of August 2016.

2.1.2. Wetland Definition & Delineation Technique

For the purpose of this assessment, wetlands are considered as those ecosystems defined by the National Water Act as:

> *"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."*

[3] Land type information was obtained from the Department of Agriculture's Global Information Service (AGIS) January 2014 – www.agis.agric.za

The study site was assessed with regards to the determination of the presence of wetland areas according to the procedure described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (DWAF, 2005).

2.1.3. Wetland Health and Functional Integrity Assessment Techniques

As per the requirements of the Environmental Impact Assessment (EIA) process and Water Use License Application (WULA) for the proposed project a Level 2 Wet-Health Assessment to determine the Present Ecological State (PES) as well as a Level 2 Wet-EcoServices Assessment to determine the Functional Integrity of each wetland unit was assessed. Further to this the Ecological Importance and Sensitivity (EIS) of each delineated wetland unit was determined.

2.1.4. Riparian Assessment Techniques

The riparian ecological integrity was assessed for all drainage channels using the Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al., 2007).*

Detailed methodology for the wetland delineation, health, provision of ecosystem goods and services (functional integrity), and ecological importance and sensitivity is given in Appendix A.

2.1.5. Aquatic Assessment Methodology

The scope of work for the aquatic ecology baseline assessment included:

- *In situ* water quality;
- Aquatic habitat assessment.
    - Including the intermediate habitat assessment index, and
    - Invertebrate Habitat Assessment Index;
- Macroinvertebrate health assessment
    - South African Scoring System version 5, and
    - Macroinvertebrate Response Assessment Index.

Detailed methodology for all components of the Aquatic Assessment is presented in Appendix B.

2.1.6. Assessment of Impact Significance

Significance scoring assesses and predicts the significance of environmental impacts through evaluation of the following factors; probability of the impact; duration of the impact; extent of the impact; and magnitude of the impact.

The significance of environmental impacts is then assessed taking into account any proposed mitigations. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required[4]. Each of the above impact factors have been used to assess each potential impact using ranking scales.

Unknown parameters are given the highest score (5) as significance scoring follows the Precautionary Principle. The Precautionary Principle is based on the following statement:

> *'When the information available to an evaluator is uncertain as to whether or not the impact of a proposed development on the environment will be adverse, the evaluator must accept as a matter of precaution, that the impact will be detrimental. It is a test to determine the acceptability of a proposed development. It enables the evaluator to determine whether enough information is available to ensure that a reliable decision can be made.'*

Table 1: Significance scoring used for each potential impact

PROBABILITY	DURATION
1 - very improbable 2 - improbable 3 - probable 4 - highly probable 5 - definite	1 - very short duration (0-1years) 2- short duration (2-5 years) 3 - medium term (5-15 years) 4 - long term (>15 years) 5 - permanent/unknown
EXTENT	**MAGNITUDE**
1 - limited to the site 2 - limited to the local area 3 - limited to the region 4 - national 5 - international	2 – minor 4 – low 6 – moderate 8 – high 10 – very high

The following formula was used to calculate impact significance:

[4] *Impact scores given "with mitigation" are based on the assumption that the mitigation measures recommended in this assessment are implemented correctly and rehabilitation of the site is undertaken. Failure to implement mitigation measures during and after construction will keep the impact at an unacceptably high level.*

Impact Significance: (Magnitude + Duration + Extent) x Probability

The formula gives a maximum value of 100 points which are translated into 1 of 3 impact significance categories; Low, Moderate and High as per **Table 2**.

Table 2: Impact significance ratings

Significance Points	Significance Rating
<30 points	Low environmental significance
31 – 59 points	Moderate environmental significance
>60 points	High environmental significance

The impact assessment is discussed in more detail in **Section 8**.

3. BASELINE BIOPHYSICAL DESCRIPTION

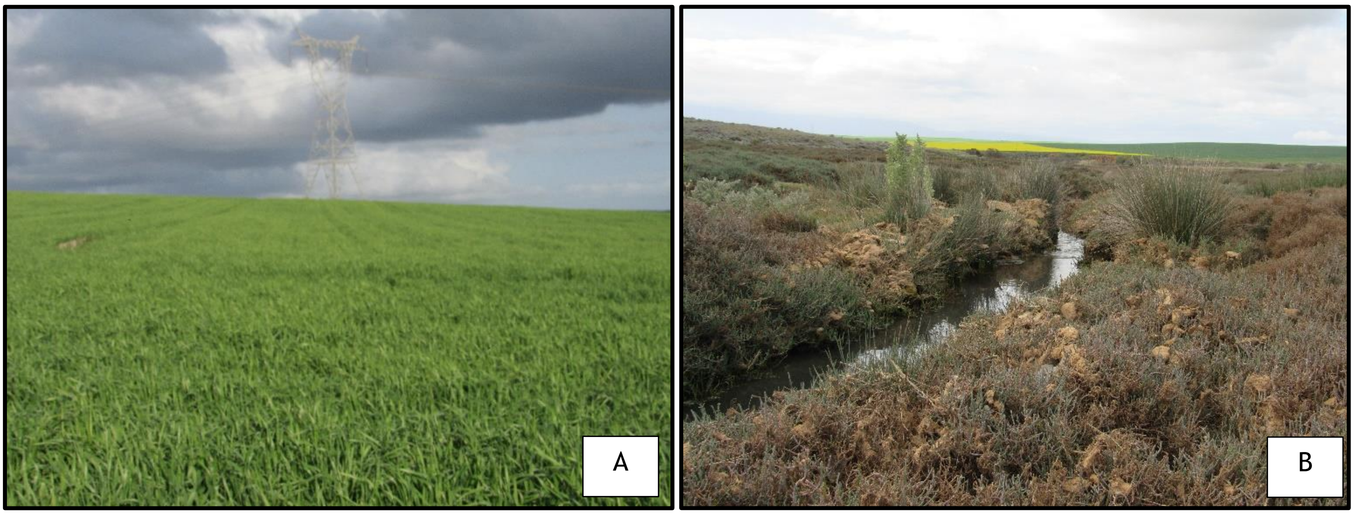
3.1. Climate

The Swellendam area is characterised by a winter rainfall pattern with some rain occurring in summer. The mean annual precipitation is approximately 462mm per year. It receives the lowest rainfall in June (23mm) and the highest in August (48mm). The average daily maximum temperatures range from 17.1 °C in July to 27.5 °C in January. The region is the coldest in July with minimum temperatures of 5.0 °C (Mucina and Rutherford 2006). First frosts are normally experienced after June and continue through to the beginning of September.

3.2. Vegetation structure and composition

The study site is located within the Eastern Ruens Shale Renosterveld vegetation type. This vegetation type is characterised by low to moderately tall grassy shrubland dominated by Renosterbos. It is considered critically endangered with at least 80% transformed mostly by cultivation and croplands (Mucina and Rutherford, 2006). Small fractions are conserved within the Bontobok National Park and the De Hoop Nature Reserve.

The vegetation cover at all alternative substation sites has been completely transformed as a result of agricultural activities including crop production and livestock grazing. A number of well-vegetated drainage channels with remaining indigenous Eastern Ruens Shale Renosterveld vegetation surround the proposed construction sites (**Photograph 1**).



Photograph 1: General vegetation composition of the site showing the extensive cultivated lands (A) and remaining indigenous vegetation along watercourse systems (B)

3.3. Geology and topography

The geology of the study area is situated on the Bokkeveld Group Shales dominated by clay and loamy soils. Soils are both shallow and well drained including the Mispah and Glenrosa soil forms (Agis Agric).

The main topographical unit within the proposed study area consists of moderately undulating hills and plains which are characteristic of the area (**Photograph 2**).

Photograph 2: Undulating hills and plains of the study area

3.4. Catchment characteristics and watercourses

The proposed project falls within the quaternary catchment H70A with Substation Site G situated on the boundary of H70A and H60L. Both quaternary catchments are part of the Lower Breede Sub Water Management Area and the Breede Water Management Area. The Breede Water Management Area is the southern-most water management area in South Africa. The greater part of the area is drained by the Breede River and its main tributary, the Riviersonderend River. Major impacts to the Breede River are associated with river channel modification, alien species infestation, natural flooding impacts, flow modification and water quality deterioration.

Land use within the Lower Breede Sub Water Management Area is generally associated with dry crop cultivation particularly wheat and canola, as well as livestock grazing.

3.5. NFEPA

The National Freshwater Ecosystem Priority Areas (NFEPA) is a project that was developed to provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs (Driver, et al., 2011).

3.5.1. Wetlands

An examination of the NFEPA wetland database revealed a number of wetland flats, seeps and channelled valley bottom wetlands within a 500m buffer around the proposed substation sites (**Figure 2**). The majority of these have been classified as artificial in nature as they are agricultural dams. This was confirmed during the site investigation as a number of dams have been created with the majority of water courses within the larger study area.

3.5.2. Rivers

The Kluitjieskraal River falls within an upstream management area where anthropogenic activities need to be managed to prevent the degradation of downstream FEPAs. These areas are of strategic important for future water management (Nel *et al*., 2011).

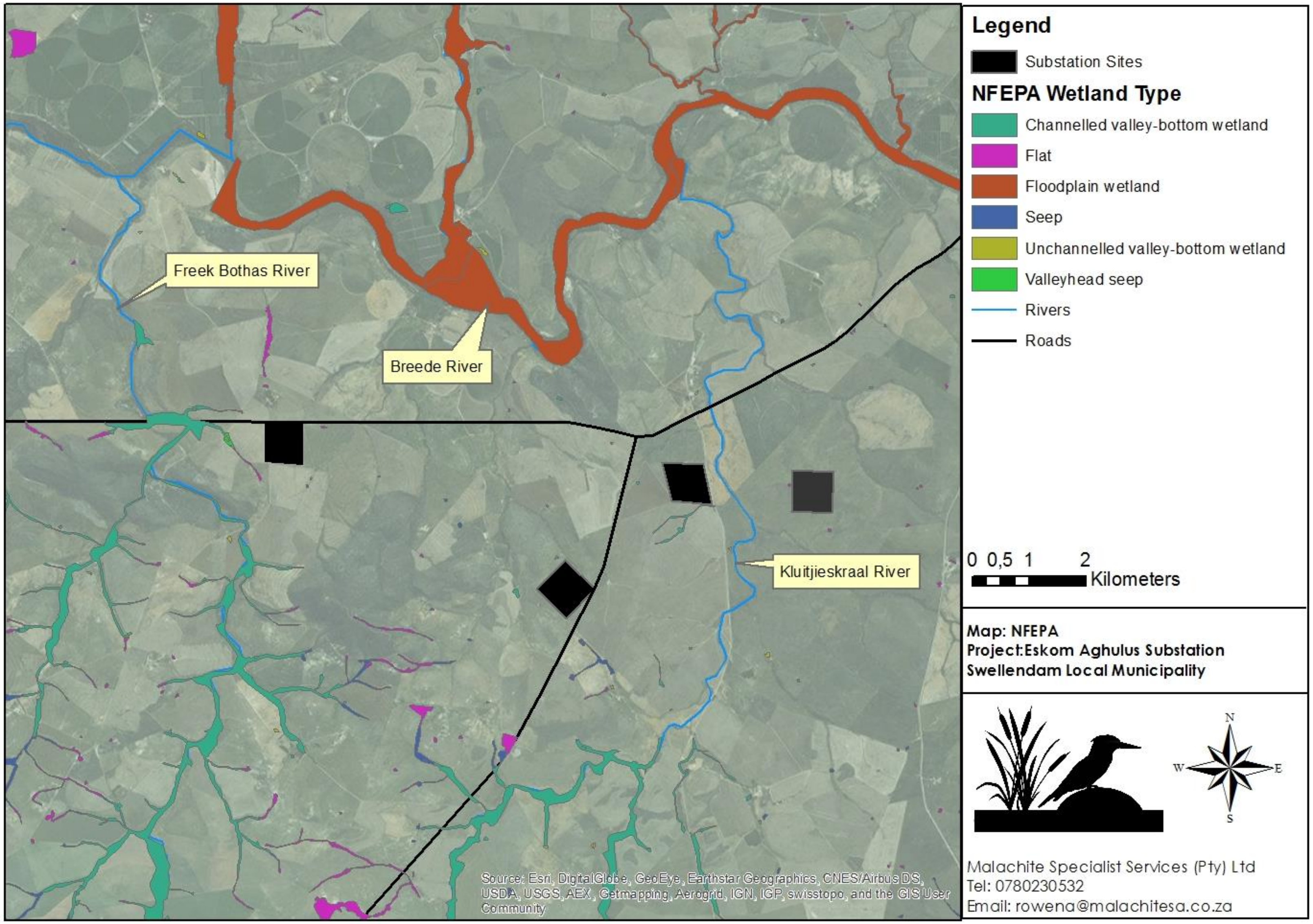


Figure 2: FEPA wetlands and rivers within the study area

4. WETLAND ASSESSMENT RESULTS

4.1. Soil Wetness and Soil Form Indicator

Soil samples were taken throughout the assessment area. The soil samples taken in these areas were examined for the presence of hydric (wetland) characteristics. Hydric soils are defined as those that typically show characteristics (redoximorphic features) resulting from prolonged and repeated saturation. Redoximorphic features include the presence of mottling (i.e. bright insoluble iron compounds); a gleyed matrix; and/or Mn/Fe concretions (**Photograph 3**).

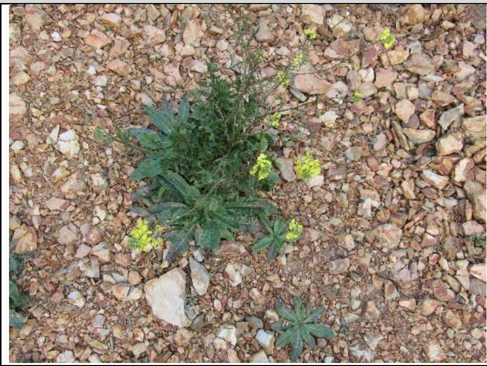
The presence of redoximorphic features are the most important indicator of wetland occurrence, as these soil wetness indicators remain in wetland soils, even if they are degraded or desiccated (DWAF, 2005). It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric, or non-hydric (Collins, 2005).

Photograph 3: Examples of hydric characteristics used as indicators for wetland conditions

Iron deposits (mottling) and a gleyed horizon were identified within soil samples taken within the wetland area and this soil classified as hydric in nature. This soil form is categorised as the Katspruit soil form. Alluvial deposits were generally noted along the drainage channels.

Terrestrial soils identified outside of the wetland and watercourse areas were dominated by the shallow Mispah soil form, as well as apedal soils of the Clovelly and Hutton form. Soil properties identified on site are shown below (**Table 3**).

Table 3: Soil data used to inform the wetland assessment

Soil Form and Defining Horizons		Defining Soil Colour	Soil Texture	Zone of Wetness	Observations	Photograph
Hydric Soil						
Katspruit	Orthic A	10YR 2/1	Clay loam	Permanent/ Seasonal/ Temporary	Identified within the channelled valley bottom system. Katspruit soils are typically associated with a high clay percentage and a gleyed matrix as a result of anaerobic conditions within the soil profile.	
	G					
Terrestrial Soil						
Mispah	Orthic A	7.5YR 4/6	Sandy	None	Identified outside of the wetland and watercourse areas. Shallow in nature and not hydric.	
	Hard rock					

Soil Form and Defining Horizons		Defining Soil colour	Soil Texture	Zone of wetness	Observations	Photograph
Clovelly	Orthic A Yellow-brown Apedal B	10YR 5/6	Sandy-Loam	None	Apedal (structureless) soil identified outside of the wetland and watercourse systems. Generally shallow in nature. No hydric properties were identified in these soils.	
Hutton	Orthic A Red Apedal B	5YR 4/4	Clay-Loam	None	Apedal (structureless) soil identified outside of the wetland and watercourse systems. No hydric properties were identified in these soils.	

4.2. Vegetation Indicator

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act (Act 36 of 1998). However, using vegetation as a primary wetland indicator requires undisturbed conditions (DWAF, 2005); vegetation within the study site has been disturbed as a result of agricultural practices particularly associated with the cultivation of wheat. This has led to the removal of the majority of vegetation species within the wetland boundary. The wetland could therefore not be delineated through the use of this indicator and relied heavily on the examination and identification of soil hydric properties.

Remnant patches of the Eastern Ruens Shale Renosterveld vegetation remain along the drainage channels delineated during the site assessment. This vegetation unit is used a buffer between the agricultural practices and the water resource. Dominant species included a number of *Restio* species, *Helichrysum* species, and *Juncus* species (**Photograph 4**). There is no significant encroachment of alien invasive species within these riparian zones, with only *Pennisetum setaceum* (Purple fountain grass) identified in areas where the riparian zone crosses road networks.

Photograph 4: Large scale transformation of vegetation in the study area (A) and intact Eastern Ruens Shale Renosterveld along the drainage channels (B)

4.3. Terrain Indicator

The topography of an area is generally a good practical indicator for identifying those parts in the landscape where wetlands are likely to occur. Generally, wetlands occur as a valley bottom unit however wetlands can also occur on steep to mid slopes where groundwater discharge is taking place through seeps (DWAF, 2005). In order to classify a wetland, the localised landscape setting must be taken into consideration through ground-truthing of the study site after initial desktop investigations (Ollis *et al*., 2014).

The four alternative substation sites are situated on undulating hills and plains which give rise to drainage networks between slopes. (**Photograph 5**). An investigation of the aerial photography of the sites shows a number of watercourses and associated riparian areas within the study area. These areas identified during the desktop assessment were then assessed in more detail during the field investigation. Upon completion of the site visit the majority of these areas were confirmed to be drainage channel systems.

Photograph 5: Drainage channel networks and associated riparian zones

4.4. Wetland Delineation & Hydrogeomorphic (HGM) Classification

The hydrogeomorphic classification system categorises wetland systems based on their geomorphological and hydromorphological characteristics. There are five recognised wetland systems based on the abovementioned system and are depicted in the diagram below (**Figure 3**).

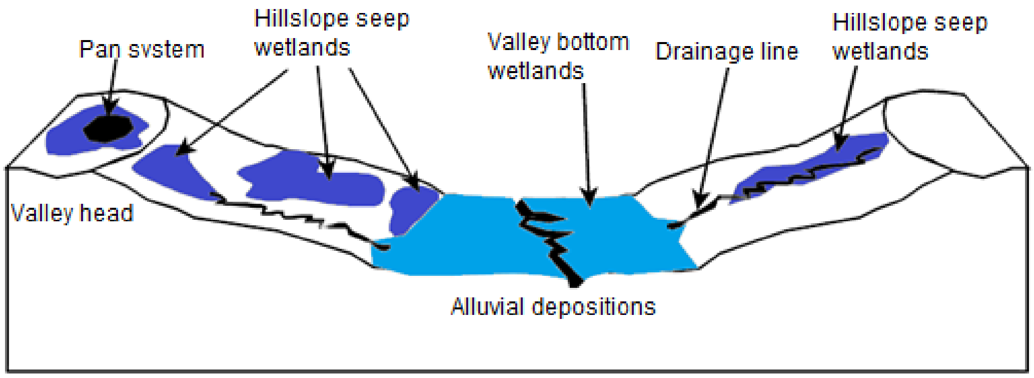


Figure 3: Diagrammatic representation of common wetland systems identified in Southern Africa (based on Kotze *et al*., 2007)

One wetland system was identified on the southern boundary of Site A. This wetland was categorised into a single hydrogeomorphic (HGM) unit, namely a channelled valley bottom wetland (**Figure 4, 5 and 6**). An HGM unit is a recognisable physiographic wetland-unit based on the geomorphic setting, water source of the wetland and the water flow patterns (Macfarlane *et al.*, 2008).

Channelled valley bottom wetlands are characterised by their location on valley floors and the presence of a river or stream channel flowing through the wetland. Dominant water inputs to these wetlands are derived from the channels flowing through the wetland either as surface flows resulting from flooding or as subsurface flow. Water generally moves through the wetland as diffuse surface flow although occasionally as short-lived concentrated flows during flood events (Ollis *et al.*, 2013). A description of this wetland type is provided in **Table 4**.

Table 4: Wetland hydrogeomorphic (HGM) types (Kotze *et al.*, 2008; Ollis *et al.*, 2013)

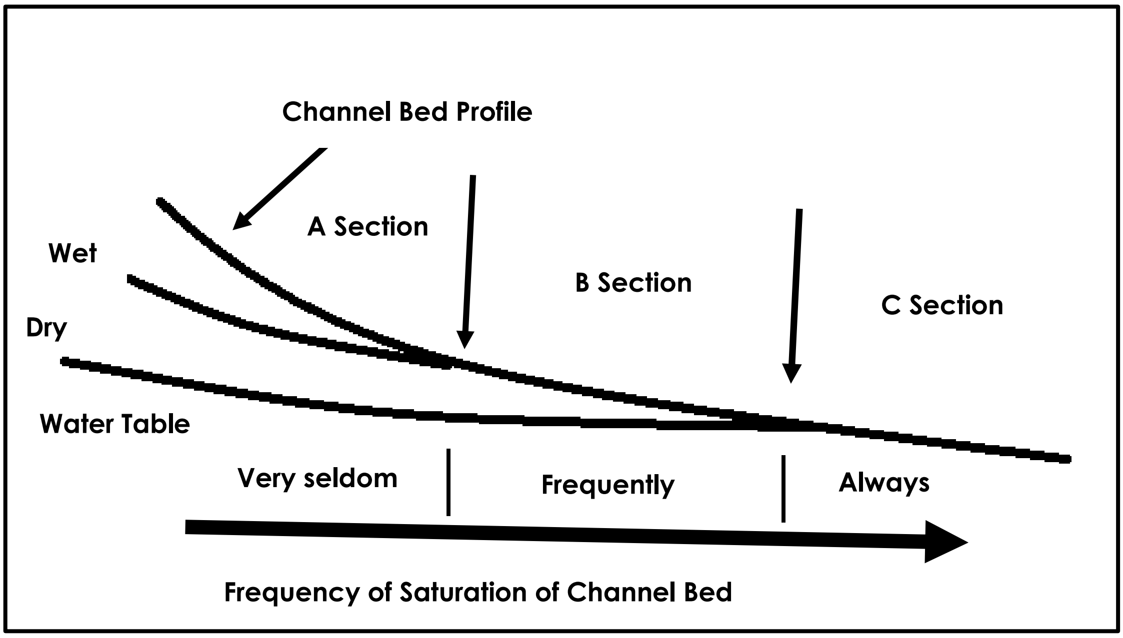
HGM UNIT	DESCRIPTION	SOURCE OF WATER MAINTAINING THE WETLAND[5]	
		SURFACE	SUBSURFACE
Channelled Valley bottom 	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***

[5] Precipitation is an important water source and evapotranspiration an important output in all of the above settings
Water source:
* Contribution usually small
*** Contribution usually large
*/ *** Contribution may be small or important depending on the local circumstances

4.5. Riparian Ecological Assessment

Riparian areas were delineated based on topographic setting, vegetative indicators as well as the presence or absence of alluvial soils as described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (DWAF, 2005) requirements. This manual separates the classification of watercourses into three (3) separate types of channels or sections defined by their position relative to the zone of saturation in the riparian area. The classification system separates channels into:

- those that do not have baseflow (**'A' Sections**)
- those that sometimes have baseflow (**'B' Sections**) or non-perennial
- those that always have baseflow (**'C' Sections**) or perennial.



One 'A' Section channel and seven 'B' Section channels were delineated within a 500m buffer around the proposed alternative substation sites (**Figure 4, 5, 6**).

'A' Section channels convey surface runoff immediately after a storm event and are not associated with a riparian zone. 'B' Section channels are categorised as channels that sometimes have baseflow, dependant on rainfall events and are therefore non-perennial. They are in contact with the zone of saturation often enough to have vegetation associated with saturated conditions as well as gleyed soil within the channel confines. 'B' Section channels are considered hydrologically sensitive as they are associated with riparian habitats.

The National Water Act defines a riparian habitat as:

> *"Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."*

Riparian areas perform numerous vital functions including the protection and enhancement of water resources through the following resources:

- Aiding in the storage of water and flood prevention;
- stabilising stream banks;
- improving water quality by trapping sediment and nutrients;
- maintaining natural water temperatures for aquatic species;
- providing foraging and roosting habitats for birds and other animals;
- providing corridors for dispersal and migration of different species; and
- acting as a buffer between aquatic ecosystems and adjacent land uses.

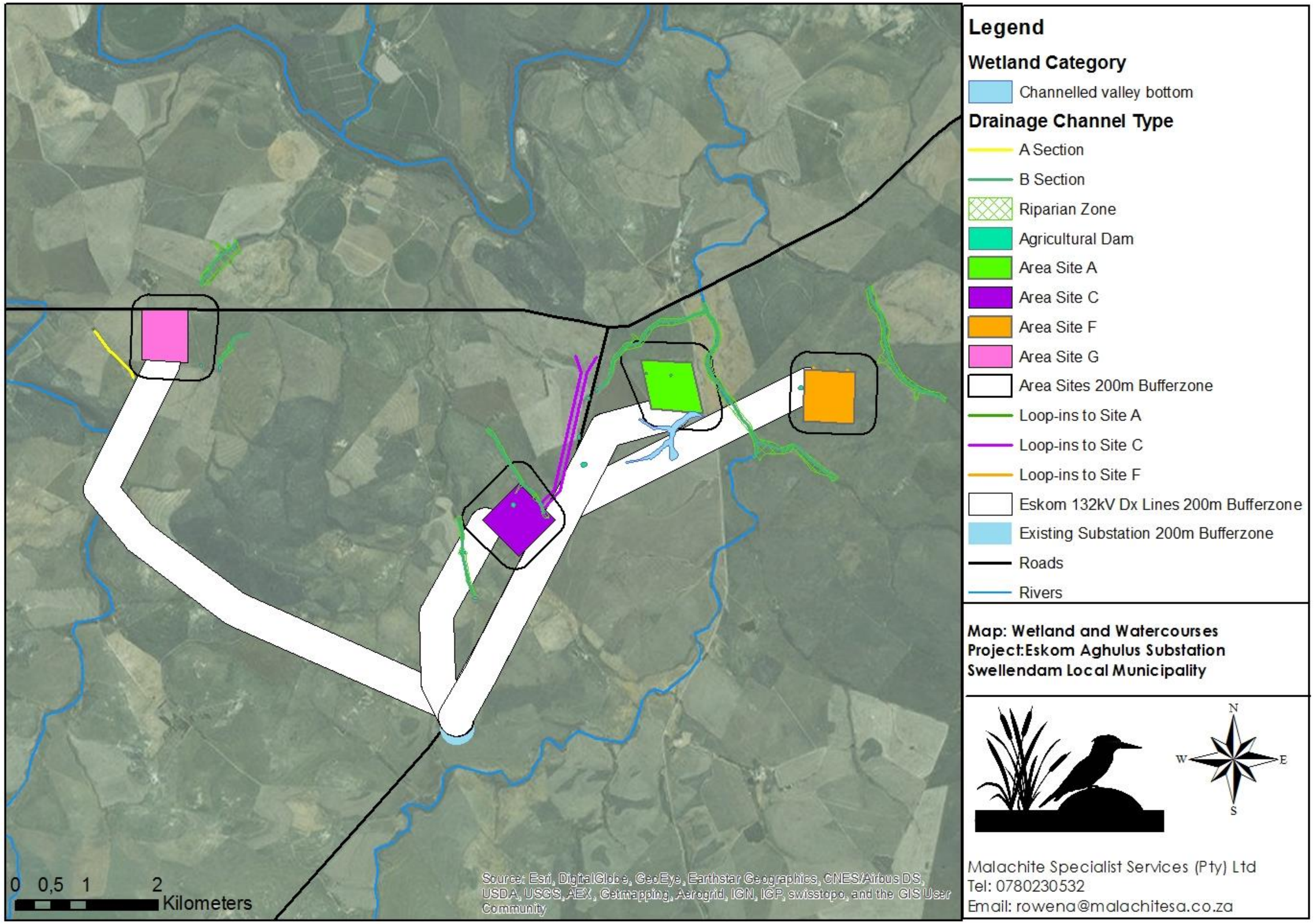


Figure 4: Wetland and watercourse systems delineated around all sites

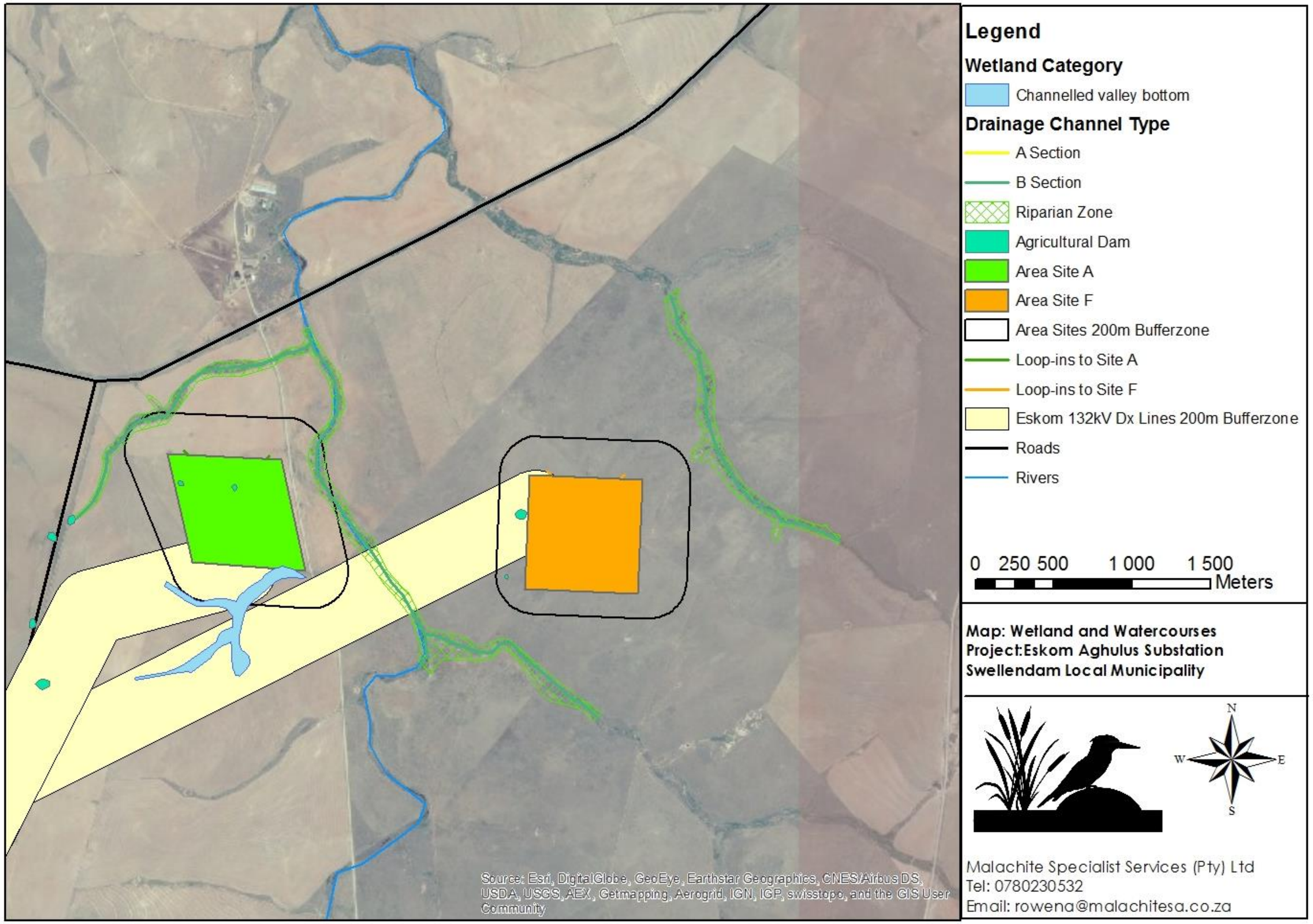


Figure 5: Closer view of the wetland and watercourses associated with Sites A and F

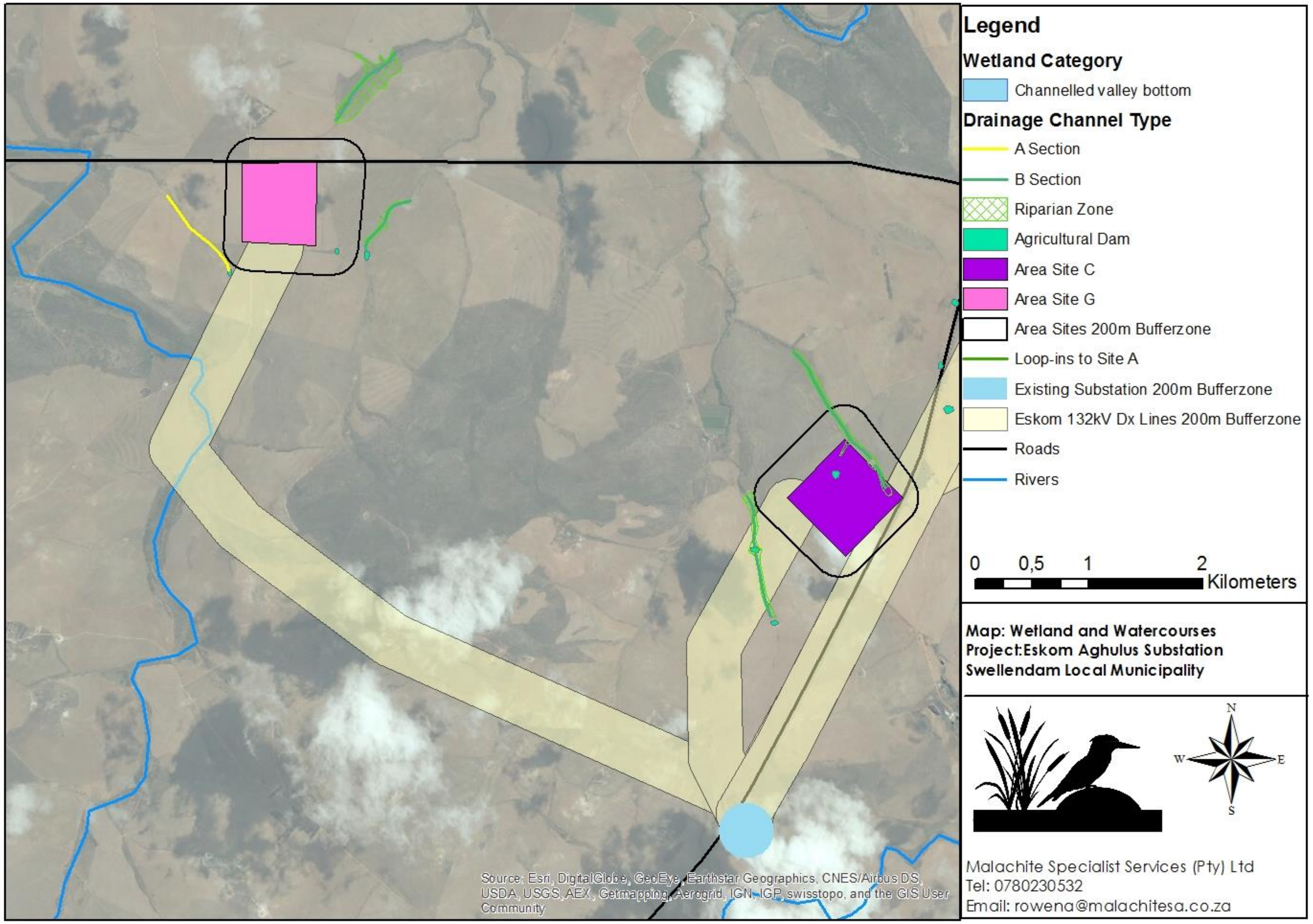


Figure 6: Closer view of the wetland and watercourses associated with Sites C and G

4.6. Present Ecological State (PES)

The channelled valley bottom was assessed in terms of its health and was categorised as seriously modified (PES Category E; **Table 5)**

There have been major modifications to the vegetation community and soil profile associated with this wetland as a result of the cultivation of wheat on the edge of and within the boundary of the wetland. This has affected the hydrological flow both into and through the wetland, having a knock on effect on the geomorphologic process which govern this system. These impacts on the wetland system have resulted in varying degrees of soil erosion and the deposition of sediment in the wetland system. Further to this two agricultural dams have been created within the wetland system impeding the hydrological flow through the wetland (**Photograph 6).**

Table 5: Summary of PES score

SIZE (HA)	HYDROLOGY	GEOMORPHOLOGY	VEGETATION	PES SCORE (CATEGORY)
8.11	5.5	6.3	7.2	**E (6.21)**

Photograph 6: Cultivation of wheat within the wetland and subsequent degradation of wetland system, including soil erosion (A) One of the agricultural dams (B)

4.7. Functional Assessment (Ecosystem Goods and Services)

Ecosystem goods and services were calculated for the wetland system. As shown in **Table 6** and **Figure 7** the wetland system received generally low scores with regards to wetland functionality. This is due to the seriously degraded state of the channelled valley bottom system.

Flood attenuation, sediment trapping and filtration properties received moderate scores. This is to be expected as channelled valley bottom systems attenuate flood waters releasing it slowly into the receiving environment. The trapping of sediment is associated with the removal of phosphates, nitrates and other toxicants increasing the filtration properties of the wetland system.

The use of the wetland system for the cultivation of wheat as well as the creation of two dams within the system increased the scores associated with 'Cultivated Foods' to a moderate score. This use of the wetland for agricultural productivity has had a negative impact on the functional integrity of the channelled valley bottom system.

Table 6: Summary of scores received from the Functional Assessment

Ecosystem Goods and Services	Channelled Valley Bottom System (0-4)	Category
Flood attenuation	2,1	Moderate
Streamflow regulation	1,2	Low
Sediment trapping	1,8	Low
Phosphate trapping	2,2	Moderate
Nitrate removal	1,6	Low
Toxicant removal	2,1	Moderate
Erosion control	1,4	Low
Carbon storage	0,3	Very low
Maintenance of biodiversity	0,7	Very low
Water supply for human use	1,4	Low
Natural resources	1,6	Low
Cultivated foods	2,2	Moderate
Cultural significance	0,0	None
Tourism and recreation	0,0	None
Education and research	0,0	None

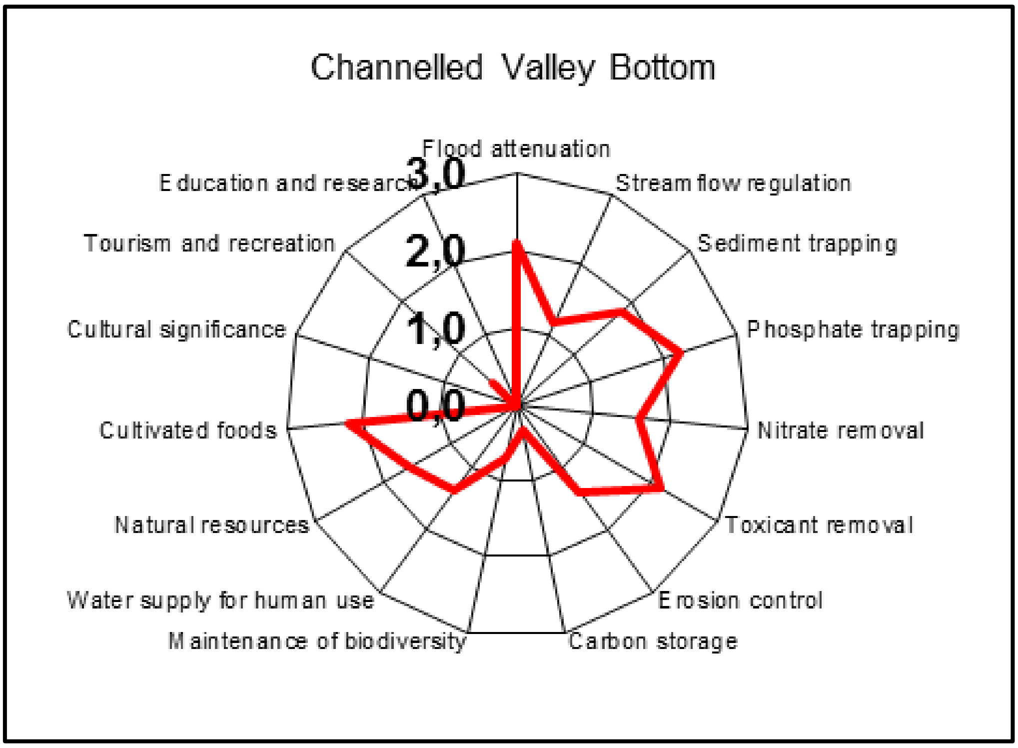


Figure 7: WET-EcoServices results

4.8. Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity of the wetland has been recorded as being very low[6] (**Table 7**) as a result of the disturbed nature of this wetland. The lack of basal cover as a result of the cultivation of wheat and the daily disturbance to the site lowers the importance of this wetland with regards to providing habitat for faunal and floral species. The open extent of water within the dam systems does however provide habitat for some avifaunal species which utilise the dams. The Hydrological Functional Importance of the channelled valley bottom has been recorded as low with the main provision of ecosystem goods and services being associated with flood attenuation and filtration of nutrients and toxicants.

Socio-Cultural Benefits for all systems are associated with the use of the wetland for the cultivation of wheat.

[6] A very low score indicates that the wetland system is not ecologically important and sensitive at any scale. The biodiversity of the wetland is ubiquitous and not sensitive to flow and habitat modifications. The wetland plays an insignificant role in maintaining biodiversity within its catchment.

Table 7: Summary of the Ecological Importance and Sensitivity

EIS	Score	Confidence	Category
Ecological Importance and Sensitivity	2.07	3.15	Very Low
Hydrological Functional Importance	1.59	3.00	Low
Direct Human Benefits	1.31	3.00	Low

4.9. Riparian Ecological Integrity

The riparian ecological integrity was assessed for the 'B' Section drainage channels using the Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al.*, 2007).

The results obtained for the riparian zone of the channels associated with the substation sites are shown in **Table 8** below.

Table 8: Riparian Ecological Category Scores

Riparian number	Type of channel	Score (%)	Class
1	B Section	65.4	**C**
2	B Section	68.7	**C**
3	B Section	64.2	**C**
4	B Section	63.8	**C**
5	B Section	61.3	**C**
6	B Section	56.1	**D**
7	B Section	68.9	**C**

The riparian zones have been generally classified as moderately modified (PES Class C), with one drainage channel classed as largely modified (PES Category D). The riparian zones are predominantly intact, with limited impacts associated with the surrounding agricultural activities having an impact on these sensitive ecotones. Modifications to all systems is associated with a decrease in water quality as a result of the high influx of fertilisers into the watercourses. Water quality has been further impacted by the sedimentation of some of the drainage channels from the cultivation of the surrounding lands leading to the washing of soil into the drainage systems. Agricultural dams which have been built in the drainage channels have caused the removal of the riparian zone at these points within the drainage channel system (**Photograph 7 and 8).**

Photograph 7: Relatively in-tact riparian zones associated with the drainage channels

Photograph 8: Sediment deposition within the drainage channel and riparian zone

5. AQUATIC ECOLOGY RESULTS

5.1. Aquatic Ecology Sampling Points

The study area falls within the Breede Water Management Area (or WMA 18). Two quaternary catchments, are associated with the proposed sites, namely H60L and H70A. Within these two quaternary catchments run the sub quaternary reaches (SQR) of H60L-09291 and H70A-091283, the Freek Bothas and Kluitjieskraal Rivers respectively. These are both tributaries of the Breede River.

Aquatic sampling took place at strategic locations within the larger study site in order to determine the current state of the water courses and establish potential impacts associated with the proposed project (**Figure 8**). Photographs of the aquatic ecology sampling points are displayed below in **Table 9**.

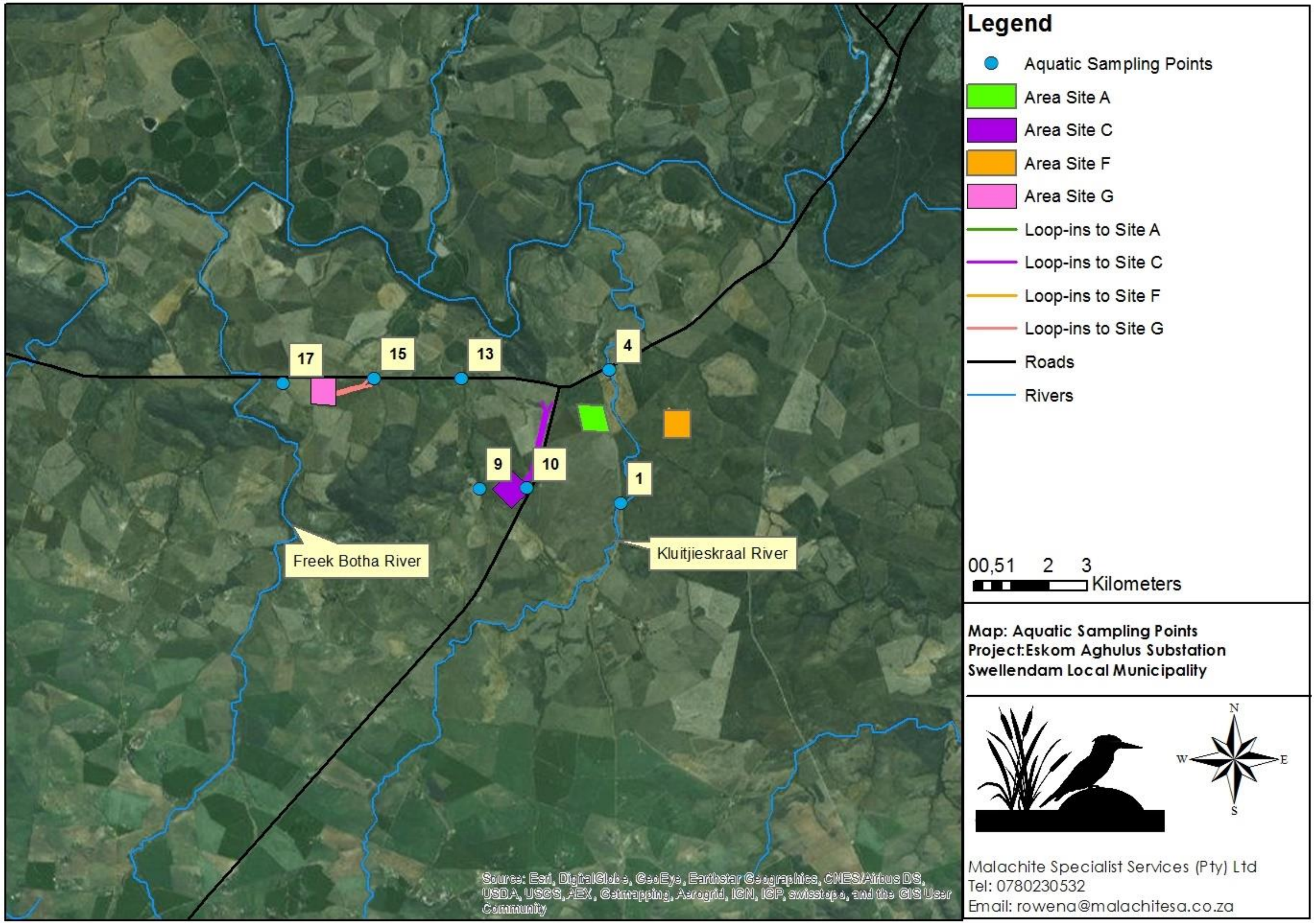


Figure 8: Aquatic Sampling Sites

Table 9: Aquatic sampling points and location data.

Site name	GPS co-ordinates	Photograph
1	34°7'50.49"S; 20°22'1.34"E	 
4	34°6'16.66"S; 20°21'43.98"E	

		
9	34°7'41.36"S; 20°19'53.23"E	 
10	34 7'40.26"S; 20°20'44.79"E	

		
13	34°6'22.86"S; 20°19'37.83"E	 
15	34°6'22.47"S; 20°18'23.58"E	

		
17	34°6'26.20"S; 20°17'5.16"E	 

5.2. In Situ water quality

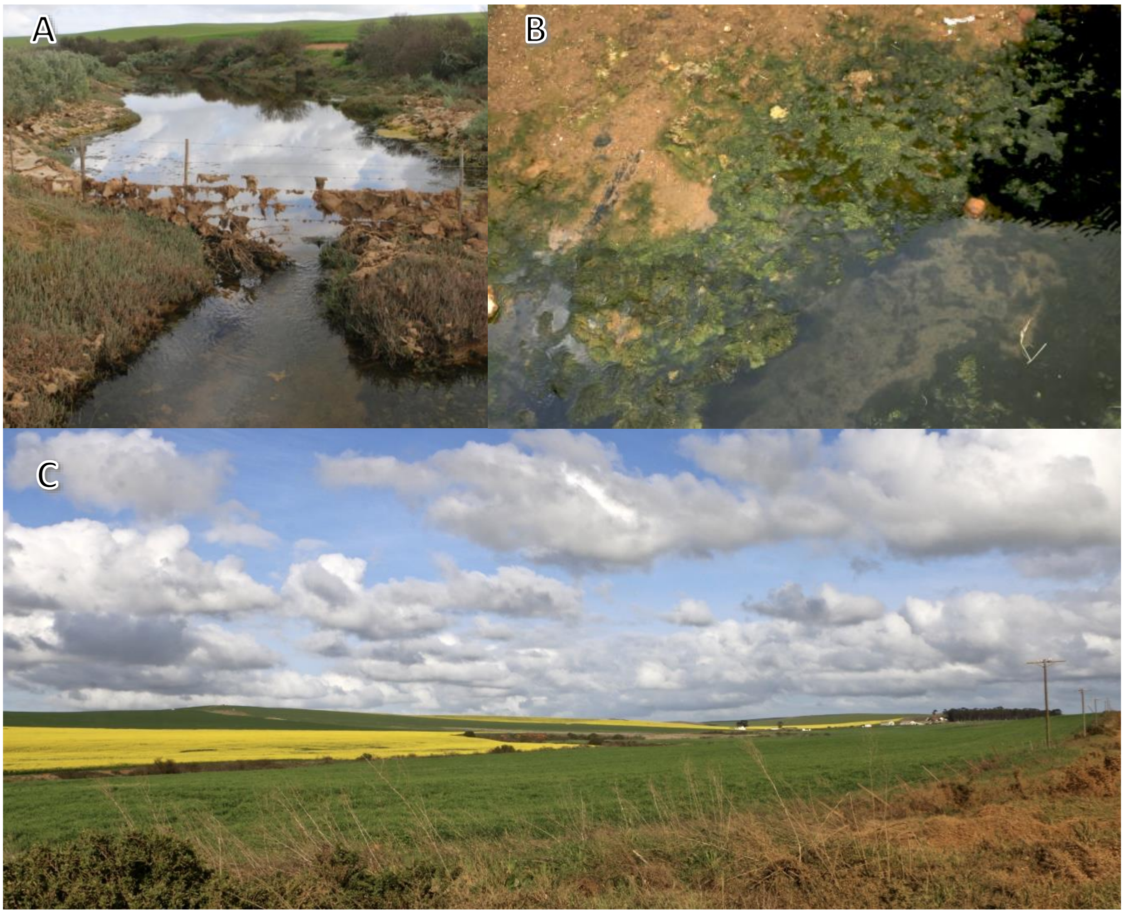
The in situ water quality results are presented below in **Table 10**.

Table 10: In situ water quality results

SITE	CONDUCTIVITY (µS/CM)	PH	TEMPERATURE (°C)
Reference	<700	6.5-9	5-30
1	18870	8.13	19.1
4	17900	8.29	19.9
9	193	7.68	19.5

10	4290	7.98	19.6
13	7440	7.61	19.4
15	9860	8.2	20
17	62.2	8.58	19.3

Water quality was found to be severely impacted at 5 of the sites assessed. Site 1, 4, 10, 13 and 15 were all recorded to have salt concentrations well over the recommended aquatic limit of 700 µS/cm. It is thought that this is as a result of agricultural return flows from the surrounding land uses. Salts from fertilisers dissolve in surface and subsurface water migrating down the slope where it enters into and collects in the watercourse systems. High organic sediments and large amounts of algae were also observed (**Photograph 9**).



Photograph 9: A and B show the presence of algae. C shows the scale of farming taking place within the catchment

5.3. Habitat Assessments

Two habitat assessments were conducted for the instream criteria and the riparian zone criteria and the results of these are detailed below.

5.3.1. Intermediate habitat assessment index

The IHIA results are displayed below in **Table 11**.

Table 11: IHIA results for the Kluitjieskraal River

INSTREAM CRITERIA	WEIGHT	AVERAGE	SCORE
Water abstraction	14	3.5	1.96
Flow modification	13	9.5	4.94
Bed modification	13	14.5	7.54
Channel modification	13	15.5	8.06
Water quality	14	17.5	9.8
Inundation	10	3.5	1.4
Exotic macrophytes	9	0	0
Exotic fauna	8	0	0
Solid waste disposal	6	7.5	1.8
TOTAL	100		64.5
Description	Class C (Moderately modified)		
RIPARIAN ZONE CRITERIA	**WEIGHT**	**AVERAGE**	**SCORE**
Indigenous vegetation removal	13	15.5	8.06
Exotic vegetation encroachment	12	7.5	3.6
Bank erosion	14	6.5	3.64
Channel modification	12	16	7.68
Water abstraction	13	5	2.6

Inundation	11	13.5	5.94
Flow modification	12	10.5	5.04
Water quality	13	23	11.96
TOTAL	100		51.48
Description	Class D (Largely modified)		

The instream and riparian criteria for the Kluitjieskraal River were found to be Class C or moderately modified and Class D, largely modified, respectively. Water quality was seen to be a large contributing factor to the reduction in scores. Additionally, channel modification from surrounding land use, in this case large scale farming has also reduced the scores.

5.3.2. Invertebrate Habitat Assessment System

Below gives the result of the IHAS assessment for the Kluitjieskraal River.

Table 12: IHAS results

SITE	1	4
Stones in current	13	10
Vegetation	7	5
Other Habitat	14	10
Stream condition	28	20
Total (%)	62	49
Description	Fair	Poor

The habitat was found to be 'Fair' upstream at point 1 and degenerated to 'Poor' at the downstream site (point 4). Although the assessment took place during the wet season, the stream was found to be running low. Further to this much of the riparian vegetation was identified outside of the stream reducing the vegetation component scores.

IHAS was only conducted for one river system as SASS sampling was not possible in tributaries related to SQR H60L-09291.

5.3.3. *Invertebrate Assessment*

5.3.3.1. South African Scoring System version 5

The results of the SASS5 assessment are presented below in **Table 13.**

Table 13: SASS 5 results

SQR	**H70A-09283**	
Site	**1**	**4**
SASS Score	41	27
Taxa	9	6
ASPT	4.5	4.5
Class	D/E	D/E

No other sites were found to be suitable or accessible to conduct the SASS5 assessment. Other potential sites associated with the proposed infrastructure related to aquatic ecosystems were either farm dams, too shallow or inaccessible. The sites assessed on the Kluitjieskraal River were both found to be in a Class D/E state (largely to seriously modified). No sensitive taxa were sampled during the site investigation. *Thiaridae* were highly abundant, in excess of 100 snails per SASS5 site. The abundance of other taxa were found to be low (Less than 10 species).

5.3.3.2. Macroinvertebrate response assessment index

The results of the MIRAI assessment are presented below in **Table 14.**

Table 14: MIRAI results

INVERTEBRATE EC METRIC GROUP		**METRIC GROUP CALCULATED SCORE**	**CALCULATED WEIGHT**	**WEIGHTED SCORE OF GROUP**	**RANK OF METRIC GROUP**	**%WEIGHT FOR METRIC GROUP**
FLOW MODIFICATION		33.9	*0.242*	8.227731864	2	80
HABITAT		35.6	*0.242*	8.61952862	2	80
WATER QUALITY		9.9	*0.303*	2.996254682	1	100
CONNECTIVITY & SEASONALITY		80.0	*0.212*	16.96969697	3	70
						330
INVERTEBRATE EC				36.81321213		
INVERTEBRATE EC CATEGORY				**E**		

The MIRAI score for the reach assessed, namely the Kluitjieskraal River, was found to be Class E or seriously modified. Results from Table 14 indicates that water quality is ranked as being the most impacted characteristic of the watercourse system. The watercourse habitat characteristic also shows signs of degradation; however, suitable surfaces are still provided in the watercourse for macroinvertebrates to colonise. Further to this, there are few barriers within the habitat with the exception of road crossings and associated culverts. It is suspected that increased sediment loads have contributed to the sedimentation of the watercourse system and this has covered some of the available habitat leading to its degradation.

The calculation of the MIRAI scores are reliant on the above SASS5 data, as no other sites could be assessed using SASS5. Only the SQR H70A-09283 could be assessed.

5.4. Present Ecological State

The Present Ecological State of the Kluitjieskraal River could be determined from the assessment, however the other tributaries associated with the project could not be assessed further than the in situ water quality.

The PES for the Kluitjieskraal River was determined to be Class D/E.

COMPONENT	SCORE
IHIA	**Class C/D**
SASS5	**Class D/E**
MIRAI	**Class E**
PES Class	**Class D/E**
PES description	**Largely to seriously modified**

The present ecological status of the Kluitjieskraal River was found to be largely to seriously modified. This is predominantly due to poor water quality and sedimentation from the surrounding land use.

The Freek Bothas River could not be assessed outside of a single site for *in situ* water quality. Water quality was found to be within acceptable limits however two dams had been constructed in close proximity and it is likely that the upstream dam contains much of the upstream impacts related to farming that were observed in the Kluitjieskraal River system.

6. BUFFERS REQUIREMENTS

The channelled valley bottom wetland and watercourse systems were assessed using the Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries, 2015, in relation to the proposed development of the substation. Buffer zones outside the boundary of wetlands and riparian habitats are required to ensure that the ecotones between aquatic and terrestrial environments are conserved. These ecotones have a high ecological significance and have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity (Macfarlane *et al*., 2014). These functions include:

• Maintaining basic aquatic processes;
• Reducing impacts on water resources from upstream activities and adjoining land uses;
• Providing habitat for aquatic and semi-aquatic species (species with a bi-phasic life cycle);
• Providing habitat for terrestrial species; and
• A range of ancillary societal benefits.

The buffer tool aims to provide a method for determining appropriate buffer widths for developments associated with wetlands, rivers or estuaries. This method takes into account a number of different factors in determining the buffer width including the impact of the proposed activity on the water resource, climatic factors and the sensitivity of the water resource.

The calculated results indicate that a 25m buffer is appropriate for the protection of the ecosystem services provided by the water resource systems (**Figure 9, 10 and 11**). This buffer is situated within portions of substation Sites A and C and must be maintained with vegetation basal cover and not developed. Substation sites F and G are not situated within any of the buffer zones identified.

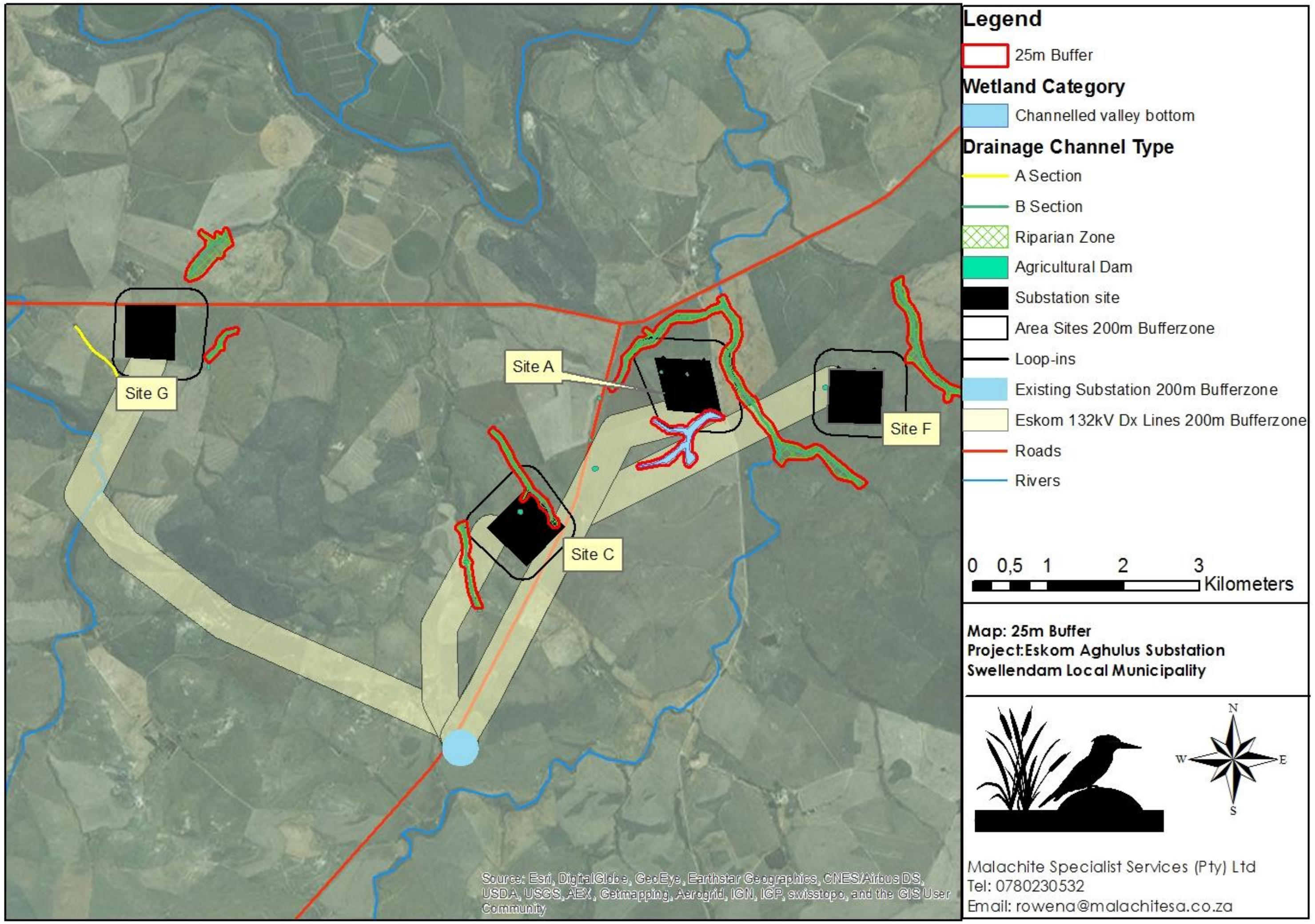


Figure 9: 25m buffer around the channelled valley bottom wetland and riparian zones

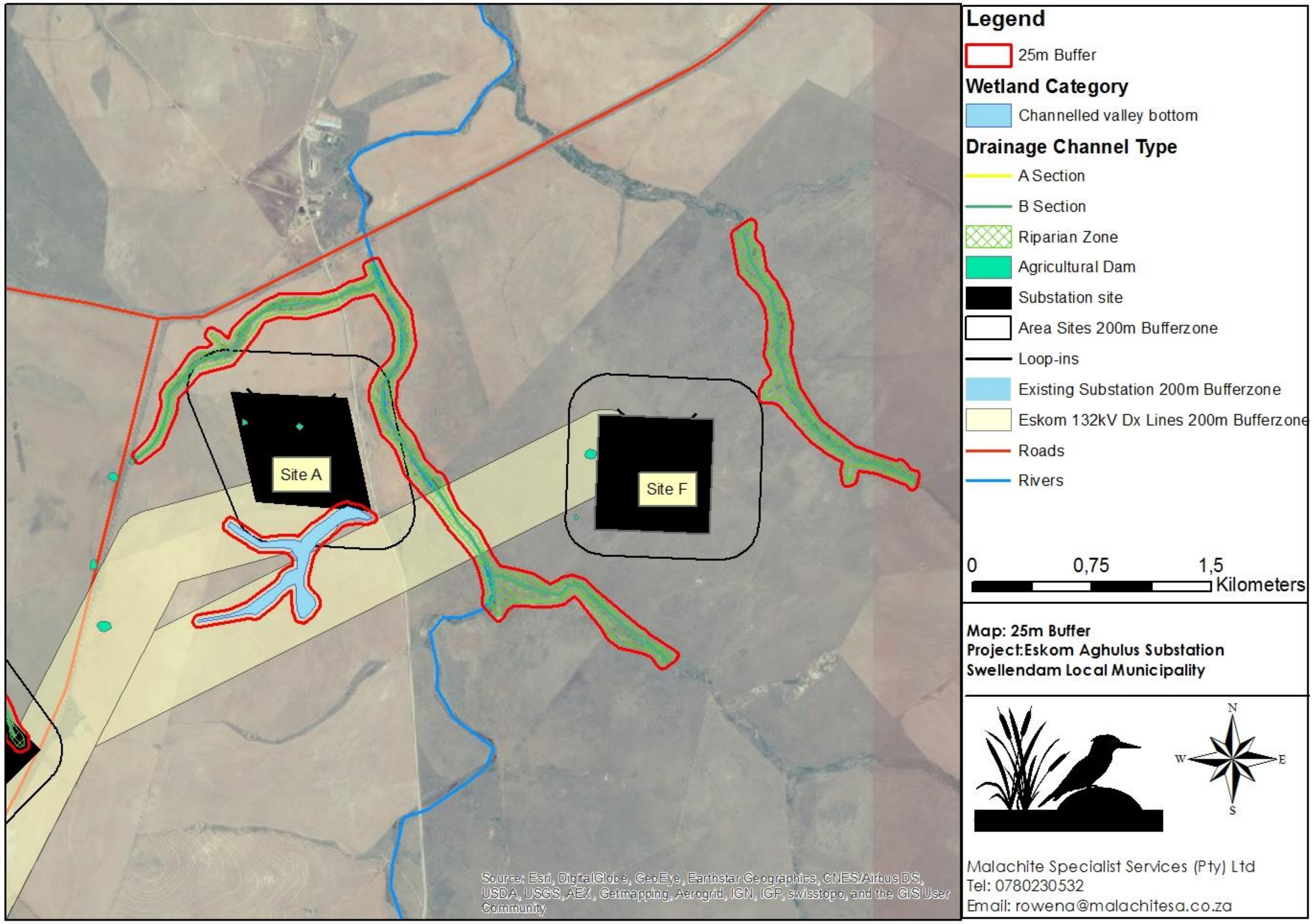


Figure 10: Closer view of the 25m buffer around the channelled valley bottom wetland and riparian zones associated with Site A and F

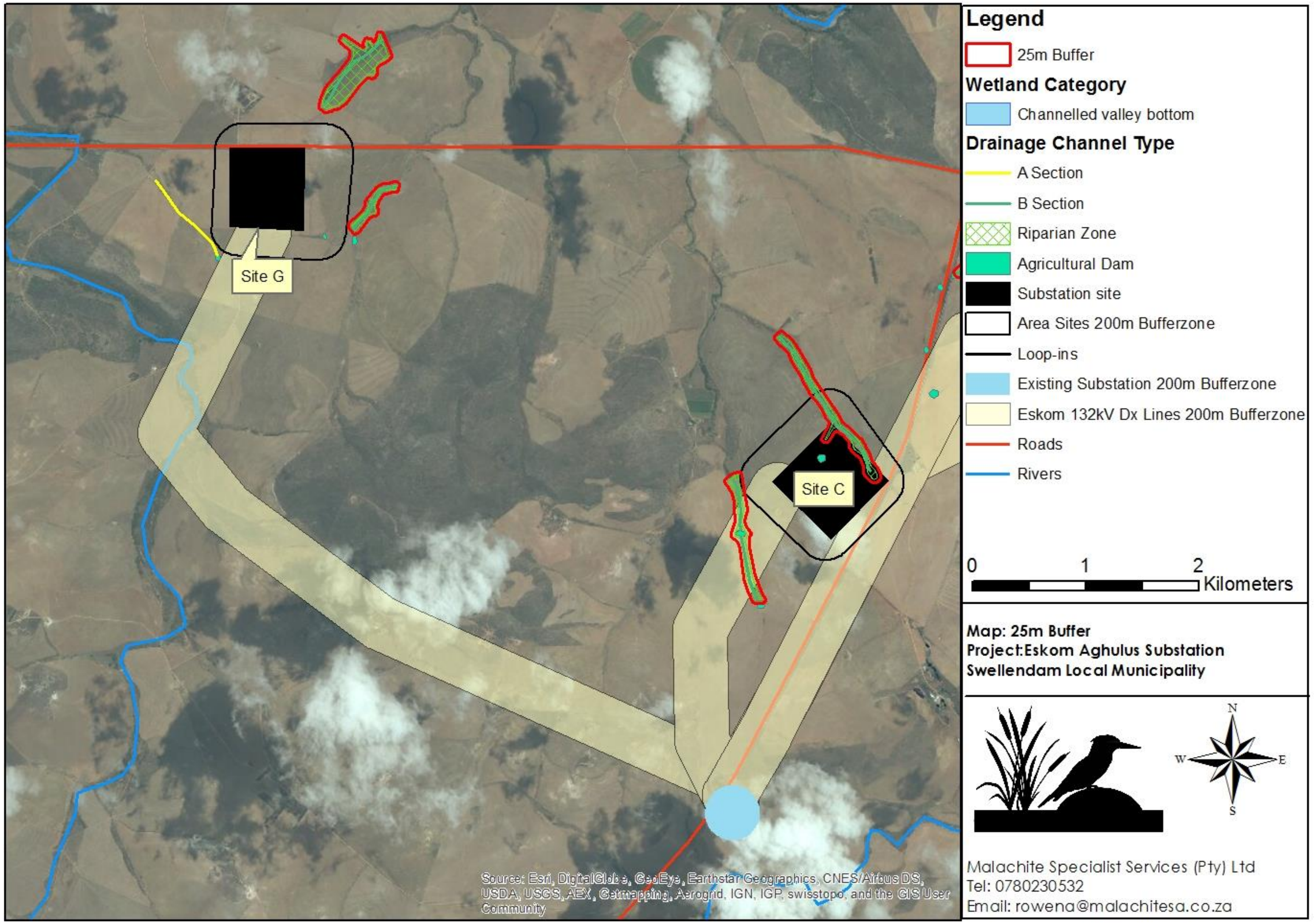


Figure 11: Closer view of the 25m buffer around the riparian zones associated with Site C and G

7. CONSIDERATION OF ALTERNATIVES

Substation Site A:

This site is largely transformed and located next to the existing 400kV overhead power line and within close proximity to the National road (N2). The channelled valley bottom wetland is situated on the southern boundary of the site and will be crossed by the 132kv distribution line. Two 'B' Section channels are located within a 500m buffer of the northern and eastern boundary of the site. The 25m buffer associated with the wetland system encroaches into the substation site in the south-eastern corner. This will need to be taken into consideration with regards to the layout of the substation should this site be chosen. The transmission loop-in loop-out lines will not cross any water resources.

Substation Site C:

This is located to the west of Site A and is situated in pasture land used for grazing. A 'B' Section channel and associated riparian zone is situated on the northern and western boundary of the substation site. A second 'B' Section channel is situated approximately 370m to the west of the Site. The substation site as well as the 'B' Section channels will be crossed by the 132kv Distribution line. Further to this an agricultural dam is situated within the central portions of the substation site. The 25m buffer associated with the riparian zone must be taken into consideration when developing the layout for the substation should this site be used. The transmission loop-in loop-out lines will also be crossed by the 132kv Distribution line.

Substation Site F:

This site alternative is located on elevated landform to the east of Site A. This is located within an agricultural area used for the cultivation of wheat. The existing 400kV power line and National road (N2) are located within close proximity of this site. There are no drainage channels or wetland areas within the substation site. Two 'B' Section channels are located to the east and west of the site approximately 670m and 415m respectively. The 'B' Section Channel to the west of the site will be crossed by the 132kv distribution line. The transmission loop-in loop-out lines will not cross any water resource.

Substation Site G:

This is the western most substation alternative, is used for the cultivation of the canola crop and is located adjacent to the N2. There are no drainage channels or wetland areas within the substation site. One 'B' Section channel is located approximately 440m to the east of the site. A second 'B' Section channel is located to the north of the site on the other side of the N2. The 132kv Distribution

Lines will cross the Freek Botha River situated approximately 880m south-west of the substation site. The transmission loop-in loop-out lines will not cross any water resources.

Site F and G are recommended from a wetland and watercourse perspective as these sites pose the least risk to any water resource system. Site F and G will only impact water resources along the 132kv distribution line. There is a lower risk posed by the construction of the pylons associated with the 132 kv distribution line when compared to the risk posed by the construction of the substation. Provided the pylons associated with the distribution line are constructed outside of the 25m recommended buffers this risk will be considered to be low for Site F and G.

All alternative sites will however cross a water resource and whichever site is approved, the client will need to obtain a Water Use License for the construction of this substation, 132kv distribution line and the transmission line project.

8. IMPACT DESCRIPTION, ASSESSMENT & MITIGATION

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed substation and loop-in loop-out lines and to provide a description of the mitigation required so as to limit the identified negative impacts on the receiving environment. The impact section has been divided into impact on the wetlands and watercourse environments and impacts on the aquatic ecological integrity of the water resource systems.

8.1. Wetland and Watercourse Impact Assessment

Negative impacts identified as part of the impact assessment are associated with (i) soil erosion and sedimentation of the water resources and (ii) pollution of the water resources and soil as a result of construction.

Soil Erosion, Sedimentation and degradation within water resource systems

IMPACTS ASSOCIATED WITH THE CONSTRUCTION PHASE OF THE ACTIVITIES										
Future Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Soil erosion and sedimentation	4	3	2	2	2	1	8	6	48 (moderate)	27 (low)
Operational Phase										
Degradation of water resources	2	1	5	5	2	1	4	2	22 (low)	8 (low)

Description of impact

Construction activities (i.e. excavations and vegetation clearing) expose soil to environmental factors including rainfall and wind. The exposure to these factors will result in the removal of topsoil and this subsequently leads to soil erosion and the deposition of sediment in the downslope watercourses. This increased high-suspended particulate matter within the wetlands can accumulate within the watercourses delineated, particularly during the wetter months. Sedimentation poses a risk to the geomorphological/functional integrity of wetland and watercourse systems, reducing the ecological integrity of the water resource outside of the impacted area.

The risk and potential impact of soil erosion will be moderate during the construction (removal of vegetation and creation of excavations) phase and this impact will decrease significantly during the operational phase provided rehabilitation of impacted areas is undertaken.

Mitigation Options

- No stockpiling of any materials may take place adjacent to any of the water resources. Erosion control measures must be implemented in areas sensitive to erosion, particularly in areas prone to erosion and where erosion has already occurred. These measures include but are not limited to - the use of sand bags, hessian sheets, silt fences, retention or replacement of vegetation and geotextiles such as soil cells which must be used in the protection of slopes;
- Do not allow surface water or storm water to be concentrated, or to flow down slopes without erosion protection measures being in place;

- The entire construction area must not be stripped of vegetation prior to commencing construction activities;
- All disturbed areas must be rehabilitated as soon as construction in an area is complete or near complete and not left until the end of the project to be rehabilitated;
- Any channel banks that will be affected must be re-profiled as per the original soil horizon structure and re-vegetated with indigenous species;
- Make use of existing access roads as much as possible and plan additional access routes to avoid vegetation communities;
- Minimise the extent of the work footprint as far as possible.

Pollution of water resources and soil

IMPACTS ASSOCIATED WITH THE CONSTRUCTION PHASE OF THE ACTIVITIES										
Potential impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	With out	With	With out	With	With out	With	With out	With		
Construction Phase										
Pollution of water resources and soil	5	4	2	2	2	1	8	4	60 (moderate-high)	28 (low)
Operational Phase										
Pollution of water resources and soil	2	1	5	5	2	1	6	4	26 (low)	10 (low)

Description of the impact

Sediment release from a construction site into the downstream aquatic environment is one of the most common forms of waterborne pollution. Furthermore, mismanagement of waste and pollutants including hydrocarbons, construction waste and other hazardous chemicals will result in these substances entering and polluting the sensitive natural downstream environments either directly through surface runoff during rainfall events, or subsurface water movement.

Further to this the linked nature of the wetlands and associated watercourses will result in pollutants being carried downstream from the construction site having consequences on further downstream users including aquatic faunal species. An increase in pollutants will lead to changes in the water quality of the wetlands, affecting their ability to act as ecological corridors in the larger landscape and reducing their ability to maintain biodiversity.

Mitigation Options

- Do not locate the construction camp or any depot for any substance which causes or is likely to cause pollution within a distance of 100m of the delineated water resources;
- All waste generated during construction is to be disposed of at an appropriate facility and no washing of paint brushes, containers, wheelbarrows, spades, picks or any other equipment adjacent to the watercourses is permitted;
- Proper management and disposal of construction waste must occur during the construction of the development;
- No release of any substance i.e. cement, oil, that could be toxic to fauna or faunal habitats within the watercourses;
- Spillages of fuels, oils and other potentially harmful chemicals must be cleaned up immediately and contaminants properly drained and disposed of using proper solid/hazardous waste facilities (not to be disposed of within the natural environment). Any contaminated soil must be removed and the affected area rehabilitated immediately;
- A spill contingency plan must be drawn up for the construction phase.

8.2. Aquatic Ecological Integrity Impact Assessment

The impacts for the aquatic ecological integrity assessment have been assessed per project phase, that is: 1) Construction Phase and 2) Operational phase. Different impacts can be anticipated for different construction activities. Within each phase the individual sites have been assessed.

Aquatic ecology impact falls predominantly within three categories; these are:

- Water quality impacts
    - Potential impacts that may reduce water quality, such as pollution events
- Water quantity impacts
    - Potential impacts that may alter the flow within a river by either reducing or increasing flows or changing the seasonality of the system (when it receives water)
- Habitat impacts
    - These impacts usually stem from construction activities that modify the stream channel or allow for increased sediment loads to enter the river.

8.2.1. Current land use

It is important to assess the impacts posed by the current land use in order to determine what impacts are currently present for comparison purposes and discover what additional pressure the proposed project may place on the associated ecosystems. These have been grouped together in order to give an overview of the impacts currently affecting aquatic ecosystems.

IMPACTS ASSOCIATED WITH THE CURRENT LAND USE					
Impact	Probability	Duration	Extent	Magnitude	Significance scoring without mitigation Significance scoring with mitigation
Current impacts					
Water quality impacts (e.g. fertiliser and nutrient loads)	4	5	3	8	64 (High environmental significance)
Water quantity impacts (e.g. abstraction)	3	3	3	2	24 (Low environmental significance)

8.2.2. Construction phase

<u>Description of the Impact</u>

Water quality impacts

Clearing the site removes vegetation that anchors the soil. Wind and rainfall events may then transport these sediments downslope where they will be deposited with the water resource. Agricultural fields contain a variety of fertilisers and organic nutrients to stimulate plant growth. When these chemicals enter the river they can increase the salinity of the system impacting on osmotic regulation of the aquatic fauna as well as stimulating algal blooms that later die and decompose reducing the oxygen levels within the system.

Water quantity impacts

The construction of berms and water control structures can either speedup or slow the flow of water from rainfall events changing the flood peak as well as the amount of water that reaches the water resource.

Habitat impacts

Typically, habitat impacts occur when sediments are deposited within a water course and cover otherwise available habitat. Changes in flow can also affect habitat availability by increasing erosion potential and thereby facilitating the collapse of river banks reducing the availability of vegetation biotopes within the watercourse.

Mitigation options

Water quality impacts

- No construction must take place within the riparian zone of the watercourse.
- All construction vehicles must avoid contact with sensitive aquatic ecosystems and the use of existing access roads must take priority. If access roads are to be built these must, where possible, not cross aquatic ecosystems.
- Vehicles must not be permitted to be cleaned or serviced in or near aquatic ecosystems. Vehicle servicing if necessary must take place offsite.
- Chemicals such as concrete and binding agents must be store in a covered bunded area. Exposure to the elements must be limited as far as possible.
- Construction must take place during the dry season to avoid the risk of rainfall events transporting construction chemicals downslope.
- Chemical toilets must be supplied for workers; these must be serviced regularly. Pit latrines may not be used.

Water quantity impacts

- No water is to be abstracted from the watercourses for any purpose or use within the proposed project.
- Rainfall must not be collected on site as this reduces the amount of water reaching the systems downstream.

Habitat impacts

- The smallest footprint necessary for construction must be cleared, this prevents excess surface area lying exposed.
- Sediment traps and berms must be used to reduce the threat of erosion during the construction phase.

8.2.2.1. Site A

Impacts associated with the construction phase of the activities for site F										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
Water quality impacts										
Site clearing	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Water quantity impacts										
Construction	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Habitat Impacts										
Site clearing leading to sedimentation	3	1	2	2	2	2	4	2	24 (low environmental significance)	6 (low environmental significance)

8.2.2.2. Site C

Impacts associated with the construction phase of the activities for Site C										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
Water quality impacts										
Site clearing	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Water quantity impacts										
Construction	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Habitat Impacts										
Site clearing leading to sedimentation	3	1	2	2	2	2	4	2	24 (low environmental significance)	6 (low environmental significance)

8.2.2.3. Site F

IMPACTS ASSOCIATED WITH THE CONSTRUCTION PHASE OF THE ACTIVITIES FOR SITE F										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
Water quality impacts										
Site clearing	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Water quantity impacts										
Construction	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Habitat Impacts										
Site clearing leading to sedimentation	3	1	2	2	2	2	4	2	24 (low environmental significance)	6 (low environmental significance)

8.2.2.4. Site G

Impacts associated with the construction phase of the activities for Site G										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	Without	With	Without	With		
Water quality impacts										
Site clearing	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Water quantity impacts										
Construction	3	2	2	2	2	2	4	2	24 (low environmental significance)	12 (low environmental significance)
Habitat Impacts										
Site clearing leading to sedimentation	3	1	2	2	2	2	4	2	24 (low environmental significance)	6 (low environmental significance)

8.2.3. Operation phase

Description of the Impact

Water quality impacts

None are foreseen during operation as it is unlikely chemicals will be kept on site.

Water quantity impacts

Increased runoff may give rise to increased flood peaks within associate river systems.

Habitat impacts

Increased runoff from hardened surfaces may increase the erosion potential down slope and thereby contribute to increased sediment loads entering the aquatic ecosystem.

Mitigation options

Water quality impacts

- As no water quality impacts are foreseen, no mitigation actions are proposed. However, if chemicals are used on site they must be stored off site and never left out in the open.

Water quantity impacts

- The use of SUDs will mitigate much of the hardened surface runoff and allow rainwater to seep into the subsurface flows.

Habitat impacts

- The use of SUDs as advocated for above will reduce the threat of increased surface runoff and allow for water to seep back into the subsurface flow regime.

8.2.3.1. Site A

Impacts associated with the operational phase of the activities for Site A										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	With out	With	Without	With		
Water quality impacts										
None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water quantity impacts										
Increased runoff	3	2	3	3	2	1	2	2	21 (low environmental significance)	6 (low environmental significance)
Habitat Impacts										
Erosion	3	2	3	3	1	1	2	2	18 (low environmental significance)	12 (low environmental significance)

8.2.3.2. Site C

Impacts associated with the operational phase of the activities for Site C										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	With out	With	Without	With		
Water quality impacts										
None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water quantity impacts										
Increased runoff	3	2	3	3	2	1	2	2	21 (low environmental significance)	6 (low environmental significance)
Habitat Impacts										
Erosion	3	2	3	3	1	1	2	2	18 (low environmental significance)	12 (low environmental significance)

8.2.3.3. Site F

IMPACTS ASSOCIATED WITH THE OPERATIONAL PHASE OF THE ACTIVITIES FOR SITE F										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	With out	With	Without	With		
Water quality impacts										
None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water quantity impacts										
Increased runoff	3	2	3	3	2	1	2	2	21 (low environmental significance)	6 (low environmental significance)
Habitat Impacts										
Erosion	3	2	3	3	1	1	2	2	18 (low environmental significance)	12 (low environmental significance)

8.2.3.4. Site G

Impacts associated with the operational phase of the activities for Site G										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without	With	Without	With	With out	With	Without	With		
Water quality impacts										
None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water quantity impacts										
Increased runoff	3	2	3	3	2	1	2	2	21 (low environmental significance)	6 (low environmental significance)
Habitat Impacts										
None	3	2	3	3	1	1	2	2	18 (low environmental significance)	12 (low environmental significance)

8.2.4. Aquatic ecology site recommendations.

All sites have similar impact profiles; this is due to the low risk nature of the project with regard to the aquatic ecosystems. However due to location the preference can be seen below:

1) *Site G*

Due to its easy access off the N2 the risk of crossing over or interacting with aquatic ecosystems is greatly reduced. The Site also has the largest buffer area which if an incident occurs will allow a larger margin of protection than the other sites. The 132kv Distribution Lines will cross the Freek Botha River situated approximately 880m south-west of the substation site.

2) *Site F*

Site F is the next most isolated site from an aquatic ecology perspective and therefore preferable to the two remaining sites.

3) *Site C*

Although it is closer to a tributary, this tributary was found to be dry, this would limit the chance that pollution or increased flows emanating from the construction site would encounter the main river system.

4) *Site A*

This is the least preferred alternative as it is closest to the Kluitjieskraal River. Additionally, construction vehicles would likely have to cross the tributary from the N2 to gain access to the site.

9. AQUATIC MONITORING

Due to the potential to further impact on the NFEPA upstream management areas aquatic biomonitoring is recommended for the project.

Biannual aquatic ecology assessments should be conducted during construction phase of the project. There after annual aquatic ecology biomonitoring should take place for two years during operations.

The table below (**Table 16**) details the monitoring components to be carried out. Depending on the final site selected additional sampling points may need to be considered.

Table 15: monitoring program

COMPONENT	PARAMETERS TO BE REPORTED ON
In situ water quality	Deterioration from baseline parameters
SASS5	Changes in class
MIRAI	Changes in class
IHIA	Changes in class
IHAS	Loss of available habitat
Erosion monitoring	Erosion gullies leaving the substation footing

10. CONCLUSION

The wetland assessment initially involved desktop investigations for the presence of wetland and watercourse systems within a 500m buffer around the proposed alternative substation sites. A subsequent field investigation identified the presence of one wetland on the southern boundary of Site A. This wetland system flows in an easterly direction eventually linking into a 'B' Section drainage channel. The wetland system was classified into a single hydrogeomorphic unit, namely a channelled valley bottom wetland.

The current status of the wetland system was assessed using the wetland health methodology and was categorised as seriously modified (PES Category E). There have been major modifications to the system as a result of the cultivation of wheat within the study area and associated wetland systems as well as the creation of a number of agricultural dams. These anthropogenic activities have resulted in the alteration of the hydrological flow through the wetland having an effect on the geomorphological processes which govern the wetland system. The cultivation of soil within the wetland boundary and use of the wetland for agricultural production has led to the formation of erosion gullies within the wetland as well as the deposition of soil.

These modifications to the wetland system have further impacted the system's ability to provide ecological goods and services with scores for this assessment ranging from moderate to low. Functions relating to flood attenuation as well the filtration of nutrients and toxicants received moderate scores. The use of the wetland system for wheat and therefore agricultural activities also received moderate scores. The use of the wetland for agricultural productivity has had a negative impact on the functional integrity of the channelled valley bottom wetland.

An Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank water resources in terms of provision of goods and service or valuable ecosystem functions which benefit people; biodiversity support and ecological value; and reliance of subsistence users (especially basic human needs uses). The very low Ecological Importance and Sensitivity score assigned to the wetland was primarily attributed to the degraded state of the channelled valley bottom wetland, therefore lowering its ability to provide natural resources to floral and faunal species; and its ability to maintain biodiversity within the larger landscape.

One ‘A’ Section channel and seven ‘B’ Section channels, with associated riparian areas were also delineated within a 500m buffer of all sites. ‘B’ Section channels are non-perennial systems that are in contact with the zone of saturation often enough to be associated with a riparian zone. They are therefore, considered to be hydrologically sensitive areas.

The riparian zones have been generally classified as moderately modified (PES Class C), with one drainage channel classed as largely modified (PES Category D). The riparian zones are predominantly intact, with limited impacts on these sensitive ecotones from the surrounding agricultural activities. Modifications to all systems are associated with a decrease in water quality as a result of the high influx of fertilisers into the watercourses. Agricultural dams which have been built in the drainage channels have also caused the removal of the riparian zone at these points within the drainage channel system.

Baseline aquatic assessments were conducted as part of the aquatic impact assessment on the Kluitjieskraal River. Tributaries associated with the Freek Botha River could not be undertaken due to low flows and site access concerns.

The Kluitjieskraal River was determined to be largely to seriously modified when assessed using the tools and indexes of the RHP. The primary impact throughout the sites assessed appears to be water quality related. This is likely due to the intense agricultural practises that occur in the area.

A 25m buffer has been calculated for all delineated water resource systems in order to provide protection from the proposed substation development for the functions these water resources perform. This buffer is situated within portions of Substation Sites A and C and must be maintained with vegetation basal cover and not developed. Substation sites F and G are not situated within any of the buffer zones identified. The 132kv distribution lines will however cross a number of the wetlands and watercourses delineated.

The impact assessment identified the following negative impacts associated with the proposed development on the wetland and watercourses; (i) soil erosion and sedimentation of the wetland and watercourses, and (ii) pollution of the wetland, watercourses and soil as a result of construction and the degradation of these wetland during operational activities. When assessing the current land use and its impact on the aquatic systems within the parameters of the study it was demonstrated that current land management practises place a large burden on the aquatic systems. In comparison the construction and operational activities of the proposed substation are unlikely to unduly impact on the aquatic ecology of the area. During both the construction and operational phases the impacts were assessed to be of a low environmental significance. Mitigation measures were proposed and focus on trapping sediment when the site is cleared and slowing runoff rates when surfaces are hardened.

Site F and G are recommended from a wetland and watercourse perspective as these sites pose the least risk to any water resource system. Site F and G will only impact water resources along the 132kv distribution line. There is a lower risk posed by the construction of the pylons associated with the 132 kv distribution line when compared to the risk posed by the construction of the substation. Provided the pylons associated with the distribution line are constructed outside of the 25m recommended buffers this risk will be considered to be low for Site F and G.

All alternative sites will however cross a water resource and whichever site is approved, the client will need to obtain a Water Use License for the construction of this substation, 132kv distribution line and the transmission line project.

Provided the mitigation measures specified in this report are implemented and the continued monitoring and rehabilitation of eroded areas is undertaken, the proposed construction of the substation and loop-in loop-out lines is not expected to have a limited long term negative impact on the receiving environment.

11. REFERENCES

Collins, N.B. (2005). Wetlands: The basics and some more. Free State Department of Tourism, Environment and Economic Affairs.

Driver, A., Nel, J., Snaddon, K., Murray, K., Roux, D., Hill, L., & Swartz, E. (2011). *Implementation Manual for Freshwater Ecosystem Priority Areas. WRC Report No. 1801/1/11.* Pretoria: Water Research Commission.

DWAF, D. O. (2005). *A Practical Field Procudure for Identification and Delineation of Wetlands and Riparian Areas - Edition 1.*

Kotze, D., et al, Marneweck, G., Batchelor, A., Lindley, D., & Collins, N. (2007). *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08.* Pretoria: Water Research Commission.

Fey, M. (2010). Soils of South Africa. Their distribution, properties, classification, genesis, use and environmental significance. Cambridge University Press. Cape Town

Macfarlane, D., Kotze, D., Ellery, W., Walters, D., Koopman, V., Goodman, P., & Goge, C. (2007). *WET-Health: A Technique for rapidly assessing wetland health. WRC Report No TT 340/08.* Pretoria: Water Reseach Commision.

Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. 2015. Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.

Mucina, L., Rutherford, M.C. & Powrie, L.W. (eds). (2006). Vegetation Map of South Africa, Lesotho and Swaziland, edn 2, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria. ISBN 978-1-919976-42-6.

Ollis, D., Snaddon, K., Job, N., & Mbona, N. (2013). *Classification Systems for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22.* Pretoria: South African National Biodiversity Institute.

Soil Classification Working Group, (1991). Soil Classification: A Taxonomic System for South Africa. Department of Agriculture

Van Oudtshoorn F. 1992. Guide to grasses of South Africa. Briza Publications, Arcadia.

Water Resource Commission. 2011. Easy Identification of some South African Wetland Plants. WRC Report No TT 479/10.

12. APPENDICES

APPENDIX A – WETLAND AND RIPARIAN ASSESSMENT METHODOLOGY

Wetland Delineation Technique

For the purpose of this assessment, wetlands are considered as those ecosystems defined by the National Water Act as:

> *"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."*

The study site was assessed with regards to the determination of the presence of wetland areas according to the procedure described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (DWAF, 2005). This methodology requires the delineator to give consideration to the following four indicators in order to identify wetland areas; to find the outer edge of the wetland zone; and identify the different zones of saturation within the wetland systems identified:

i. **Terrain Unit Indicator:** helps to identify those parts of the landscape where wetlands are more likely to occur.
ii. **Soil Form Indicator:** identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
iii. **Soil Wetness Indicator:** identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation. Signs of wetness are characterised by a variety of aspects including marked variations in the colour of various soil components, known as mottling; a gleyed soil matrix; or the presence of Fe/Mn concretions. It should be noted that the presence of signs of wetness within a soil profile is sufficient to classify an area as a wetland area despite the lack of other indicators.
iv. **Vegetation Indicator:** identifies hydrophilic vegetation associated with frequently saturated soils.

In assessing whether an area is a wetland, the boundary of a wetland should be considered to be the point where the above indicators are no longer present. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland, to delineate the boundary of that wetland and to assess its level of functionality and health.

Assessment of the Wetland's Functional Integrity

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. These ecosystem services relate to:

- Flood attenuation;
- Streamflow regulation;
- Water purification (including sediment trapping and the assimilation of phosphates, nitrates and toxicants);
- Carbon storage;
- Maintenance of biodiversity;
- Provision of water for human and agricultural use;
- Cultural benefits (including tourism, recreation and cultural heritage).

Wetlands therefore affect the quantity and quality of water within a catchment (Mitsch and Gosselink, 1993). The importance of wetland conservation and sustainable management is directly related to the value of the functions provided by a wetland (Smathkin and Batchelor, 2005); An indication of the functions and ecosystem services provided by wetlands is assessed through the WET-EcoServices manual (Kotze *et al*., 2008) and is based on a number of characteristics that are relevant to the particular benefit provided by the wetland. The tool uses biophysical characteristics of the wetland and the level of disturbance within the wetland and its catchment to estimate the level of supply of ecosystem goods and services. A Level 2 WET-EcoServices assessment was undertaken for the wetlands identified along the power line corridor. A Level 2 assessment is the highest WET-EcoServices assessment that can be undertaken and involves an on-site assessment as well as desktop work.

Assessment of the Wetland's Present Ecological State (PES)

The Present Ecological State (PES) for wetlands which is defined as '*a measure of the extent to which human impacts have caused the wetland to differ from the natural reference condition*' is also an indication of each wetland's ability to contribute to ecosystem services within the study area. This was assessed according to the methods contained in the Level 2 WET-Health: *A technique for rapidly assessing wetland health* (Macfarlane, et al., 2009)

This document assesses the health status of a wetland through evaluation of three main factors -

- ***Hydrology:*** *defined as the distribution and movement of water through a wetland and its soils.*
- ***Geomorphology:*** *defined as the distribution and retention patterns of sediment within the wetland.*
- ***Vegetation:*** *defined as the vegetation structural and compositional state.*

The WET-Health tool evaluates the extent to which anthropogenic changes have impacted upon the functional integrity or health of a wetland through assessment of the above-mentioned three factors. The deviation from the natural condition is given a rating based on a score of 0-10 with 0 indicating no impact and 10 indicating modifications have reached a critical level. Since hydrology, geomorphology and vegetation are interlinked their scores are then aggregated to obtain an overall PES health score These scores are then used to place the wetland into one of six health classes (A – F; with A representing completely unmodified/natural and F representing severe/complete deviation from natural as depicted in **Table 17**.

Table 16: Health categories used by WET-Health for describing the integrity of wetlands

DESCRIPTION	IMPACT SCORE	HEALTH CATEGORY
Unmodified, natural.	0 – 1.0	A
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.	1.1 - 2.0	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2.1 - 4.0	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4.1 - 6.0	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6.1 - 8.0	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.1 - 10.0	F

Due to differences in the pattern of water flow through various hydro-geomorphic (HGM) types, the tool requires that the wetland is divided into distinct HGM units at the outset. Ecosystem services for each HGM unit are then assessed separately.

Assessment of Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) assessment was determined by utilising a rapid scoring system. The system has been developed to assess the 'Ecological Importance and Sensitivity' of the wetland within the larger landscape; the 'Hydrological Functional Importance' of the wetland; and the 'Direct Human Benefits' obtained from the wetland through either subsistence or cultural practices. The scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze *et al* (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool. The scores obtained were placed into a category of very low; low; medium; high; and very high as shown:

Very low: 0 – 1.0

Low: 1.1 – 2.0

Medium: 2.1 – 3.0

High: 3.1 – 4.0

Very High 4.1 – 5.0

Riparian Ecological Integrity Assessment

The riparian ecological integrity was assessed for all drainage channels using the Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al*., 2007). This VEGRAI uses a spreadsheet tool composed of a series of metrics and metric groups, each of which is rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian area:

- Removal of the riparian vegetation
- Invasion by alien invasive species
- Flow modification
- Impacts on water quality

Results from the lower and upper zones of the riparian vegetation are then combined and weighted with a value that reflects the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. These values are then summed to produce a score that reflects the overall habitat integrity of the riparian unit (WCS, 2010). The score is then placed into one of six classes (**Table 18**).

Table 17: Habitat Integrity Assessment Class

CLASS	DESCRIPTION	SCORE %
A	Unmodified	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

APPENDIX B – AQUATIC ASSESSMENT METHODOLOGY

The scope of work for the aquatic ecology baseline assessment is presented below, for ease of reading the detailed methodology can be found in the same order as it is presented below.

- *In situ* water quality;
- Aquatic habitat assessment.
    - Including the intermediate habitat assessment index, and
    - Invertebrate Habitat Assessment Index;
- Macroinvertebrate health assessment
    - South African Scoring System version 5, and
    - Macroinvertebrate Response Assessment Index.

In situ water quality

Water quality was assessed on site for the following parameters; the power of hydrogen (pH), Conductivity as well as temperature.

Habitat assessments

Due to the reliance and adaptations of aquatic biota to specific habitats, the availability and diversity of habitats is important to consider in aquatic assessments (Barbour et al., 1996). Habitat quality and availability assessments are typically conducted alongside biological assessments that utilise fish and macroinvertebrates. Aquatic habitat (habitat) was assessed through observations on each river system considered. The methods used for this general assessment are adapted from Bain and Stevenson (1990), Gerber and Gabriel (2002) and Scott, 2015.

Intermediate Habitat Integrity Assessment

In order to define the general habitat, for baseline purposes, the instream and riparian habitat was assessed and characterised according to "Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999".

The Intermediate Habitat Integrity Assessment (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 utilised in the assessment of habitat integrity in the current study are presented in **Table 19.**

Table 18: Criteria considered in the assessment of habitat integrity (Kleynhans, 1996)

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 (Gordon et al., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) 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 (Gordon et al., 1992).
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 (Gordon et al., 1992). Refers to physical removal for farming, firewood and overgrazing.

CRITERION	RELEVANCE
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.**

The criteria are then weighted and scored according to Kleynhans (1996), as seen in the tables below (**Table 20 and Table 21**).

Table 19: Table giving descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996)

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**

Table 20: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996)

INSTREAM CRITERIA	WEIGHT	RIPARIAN ZONE CRITERIA	WEIGHT
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	100	TOTAL	100

Scores are then calculated based on ratings received from the assessment. The estimated impacts of the criteria are then summed and expressed as a percentage to arrive at a provisional habitat integrity assessment. The scores are then placed into the Intermediate habitat integrity categories (Kleynhans, 1996) as seen in **Table 22**.

It should be noted that the IHIA was based on regions assessed in the current studies and therefore may only constitute the assessment of conditions within a 10 km length of the considered water courses.

Table 21: Intermediate habitat integrity categories (Kleynhans, 1996)

CATEGORY	DESCRIPTION	SCORE
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59

CATEGORY	DESCRIPTION	SCORE
E	**The loss of natural habitat, biota and basic ecosystem functions is extensive.**	**20-39**
F	**Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.**	**0-19**

Integrated Habitat Assessment System

The IHAS was specifically designed to be used in conjunction with benthic macroinvertebrate assessments and will be used for the current study. However, the IHAS has recently been shown to structure unreliable scores in regard to habitat suitability often producing varying results between geomorphological zones and biotype groups. Due to this limitation the results of the IHAS assessment should be taken into consideration with caution. The IHAS assesses the availability of the habitat biotopes at each site and expresses the availability and suitability of habitat for macroinvertebrates, this is determined as a percentage, where 100% represents "ideal" habitat availability. A description based on the IHAS percentage scores is presented in **Table 23**.

Table 22: Description of IHAS scores with the respective percentage category (McMillan, 1998)

IHAS SCORE (%)	DESCRIPTION
>75	**Very Good**
65–74	**Good**
55–64	**Fair/Adequate**
<55	**Poor**

The aim of the IHAS was to summarize and reflect the quantity, quality and diversity of biotopes available for aquatic biota to inhabit at a sampling site (McMillan, 1998).

Although the IHAS requires field validation the method is seen as useful for the quantification of available aquatic habitat at a site and therefore has been retained in this study. However, it is stated that IHAS results should be interpreted with caution.

Aquatic Macroinvertebrates

Aquatic macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have sedentary characteristics with relatively long lives (±1 year) (USEPA, 2006).

Macroinvertebrates are useful for their ability to integrate pollution effects over time, their detectable response to environmental impacts and the easy field sampling techniques involved in their collection. 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 (USEPA, 2006).

South African Scoring System version 5

The SASS 5 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 such as Oligochaeta and Cnidaria, to highly sensitive families like Oligoneuridae. SASS results are expressed both as an index score (SASS score) and the Average Score Per Recorded Taxon (ASPT value).

All SASS 5 and ASPT scores are compared with the SASS 5 Data Interpretation Guidelines (Dallas, 2007) for the relevant 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.

Sampled invertebrates were then 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 & Graham, 2002; Gerber & Gabriel, 2002).

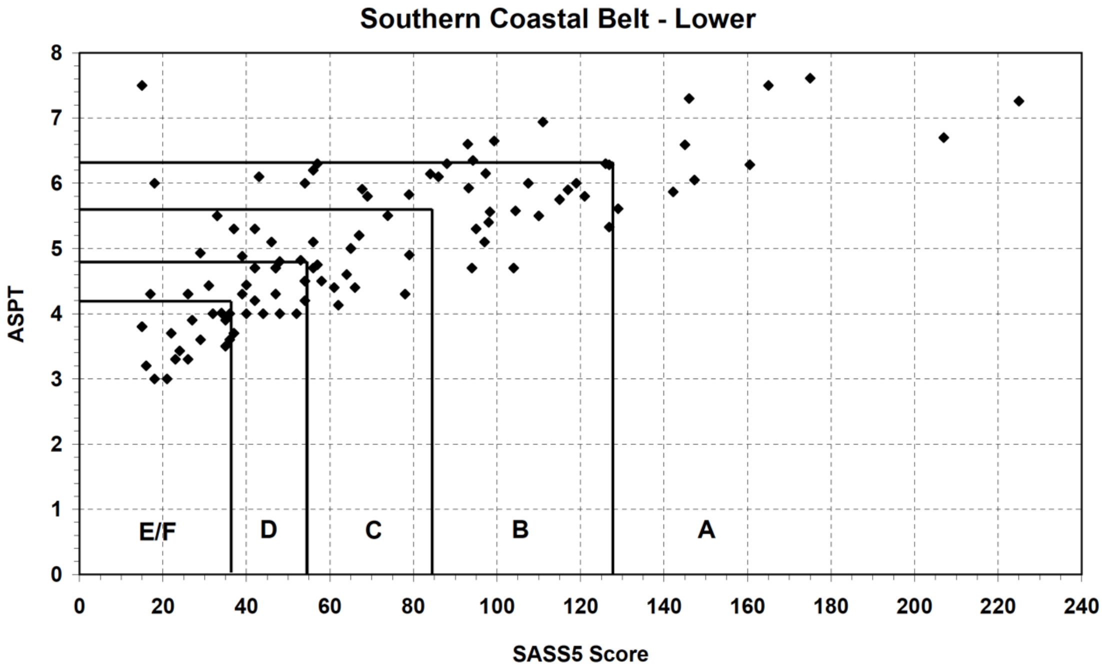


Figure 12: Biological banding for the Southern Coastal Belt-Lower (Dallas 2007)

2.2.1.1 Macroinvertebrate Response Assessment Index

The aim of the MIRAI is to provide a habitat-based cause-and-effect base to interpret the deviation of the aquatic invertebrate community from the reference condition. This assessment does not exclude the calculation of SASS scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic organisms are as follows:

- Flow modification
- Habitat
- Water quality
- Connectivity & seasonality.