Wetland Baseline & Impact Assessment for the proposed Tetra4 Cluster 2 Project

Virginia, Free State Province

April 2022

CLIENT

Prepared by:

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Report Name	**Wetland Baseline & Impact Assessment for the proposed Tetra4 Cluster 2 Project**
Submitted to	EIMS Environmental Impact Management Services
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	Rian Pienaar is an aquatic ecologist (Cand. Sci. Nat. 135544) with experience in wetland identification and delineations. Rian completed his M.Sc. in environmental science at the North-West University Potchefstroom Campus. Rian have been part of wetland studies for road and culvert upgrades, power station and dam construction.
Reviewer	**Andrew Husted**
	Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 13 years' experience in the environmental consulting field. Andrew has completed numerous wetland training courses, and is an accredited wetland practitioner, recognised by the DWS, and also the Mondi Wetlands programme as a competent wetland consultant.
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2014 (as amended). We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principles of science.

Declaration

I, Rian Pienaar declare that:

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

RPienaar

Rian Pienaar

Wetland Ecologist

The Biodiversity Company

April 2022

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1 Introduction

The Biodiversity Company was appointed by Environmental Impact Management Solutions (EIMS) to conduct a wetland baseline and impact (risk) assessment for the proposed Tetra 4 Cluster 2 gas exploration project in Virginia, Free State Province (see Figure 1-3).

1.1 Background

The following information was provided by EIMS:

In 2012, a Production Right (Ref: 12/4/1/07/2/2) was granted which spans approximately 187 000 hectares for the development of natural gas (Helium and Methane) production operations around the town of Virginia in the Free State Province. Within the approval of the Production Right, the 2010 Environmental Management Programme (EMPr) was approved which is applicable to a large portion of the Production Right area (Figure 1-1).

The activities in the Production Right include:

- Continued exploration activities;
- Drilling and establishment of further production wells throughout the entire production area (260 production wells);
- Installation of intra-field pipelines throughout the entire production area (~500km);
- Installation of boosters and main compressors; and
- Central gas processing plant (not approved in the original EIA and approved EMPr).

On 21 September 2017, the Department of Mineral Resources and Energy (DMRE) issued an integrated environmental authorisation ("Cluster 1 EA") (reference: 12/04/07) to Tetra4 in terms of the NEMA. The Cluster 1 EA (as amended by Cluster 1 EA amendments dated 26 August 2019 and 1 September 2020) authorises the development of "Cluster 1" of the Project. In this EA approval, various new wells and pipelines, booster and compressor stations, a Helium and LNG Facility and associated infrastructure was approved which comprises the first gas field for development within the approved Production Right area. The Cluster 1 EA also authorises certain waste management activities as per the List of Waste Management Activities (Government Notice 921, as amended) published under the National Environmental Management: Waste Act 59 of 2008 (NEMWA).

Furthermore, the following licences have been issued to Tetra4 in respect of Cluster 1 of the Project:

- Provisional Atmospheric Emission Licence (PAEL) dated 4 August 2017 (reference: LDM/AEL/YMK/014) for the Storage and Handling of Petroleum Products [Category 2: Subcategory 2.4 of the Listed Activities (Government Notice 893, as amended) published under the National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA)] by the Lejweleputswa District Municipality. A final atmospheric emission licence will be issued after operation of the plant which is currently under construction; and
- Water Use Licence (WUL) dated 22 January 2019 (reference: 08/C42K/CI/8861) for the construction of pipelines for the Project in terms of section 21(c&i) water uses of the National Water Act 36 of 1998 (NWA) by the Department of Water and Sanitation (DWS).

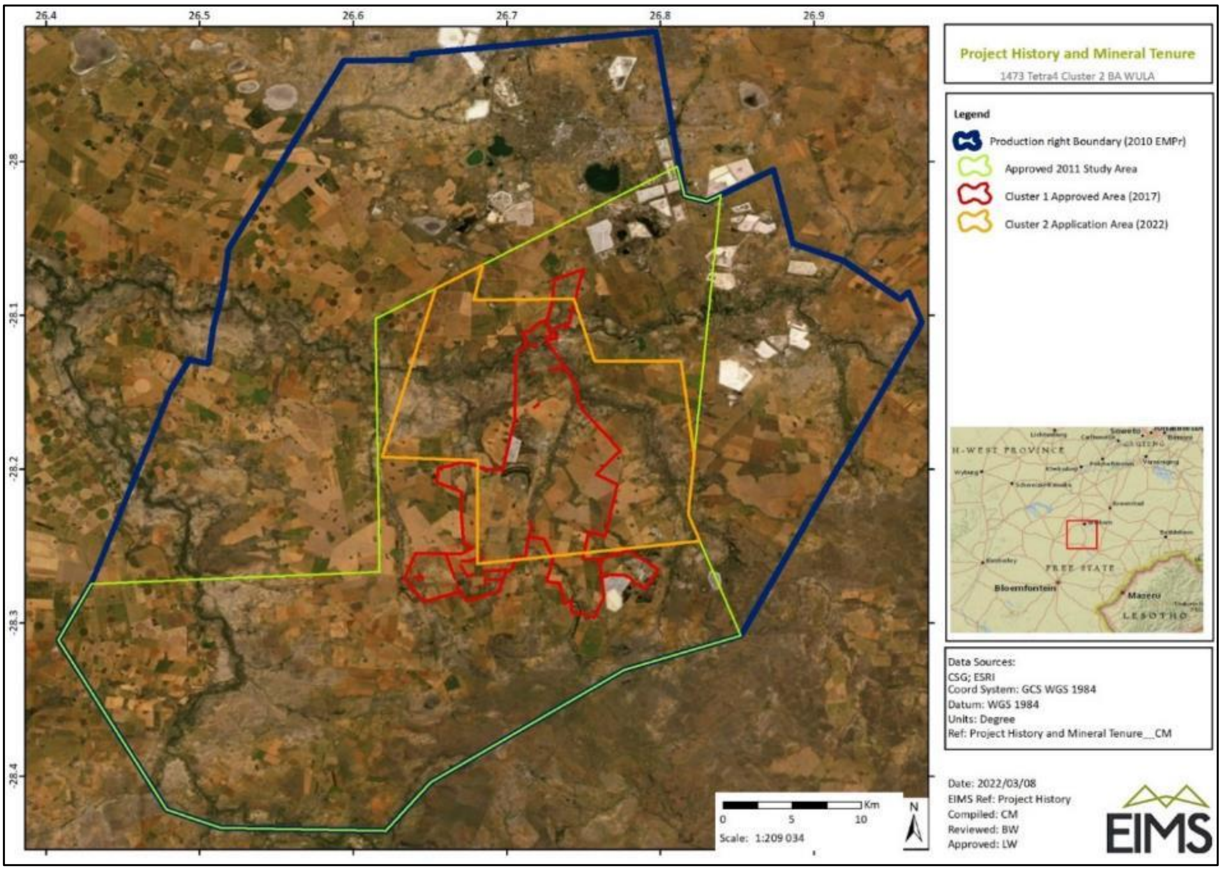

Figure 1-1 Project history and mineral tenure.

The following information is as provided by EIMS:

"Tetra 4 has a natural gas production right over a very large area in the Free State Province, near Virginia. They also have an existing environmental authorisation and associated water use licence for their current production activities (referred to as Cluster 1 above). Tetra 4 wishes to expand their current production operations onto other areas which still fall within the approved Production Right, but outside of the areas approved in the EA and WUL. The planned expansions will include the following (Figure 1-2):

- Expansions to the current LNG and Helium production plant located on the Farm Mond van Doorn Rivier. The planned expansions will be to increase the helium and LNG production capacities significantly (~30 fold increase) and increase the footprint of the existing approved plant by approximately 10ha.
- The drilling of new gas wells ~300 wells spread over a total study area (Cluster 2) of approximately 27500ha.
- The installation of trenched pipelines connecting the wells to localised booster compressors and then to in-field compressor stations (~3 sites) and subsequently the compressor stations to the main plant area.
- There will be a requirement to have short powerline and water connections to the compressor sites."

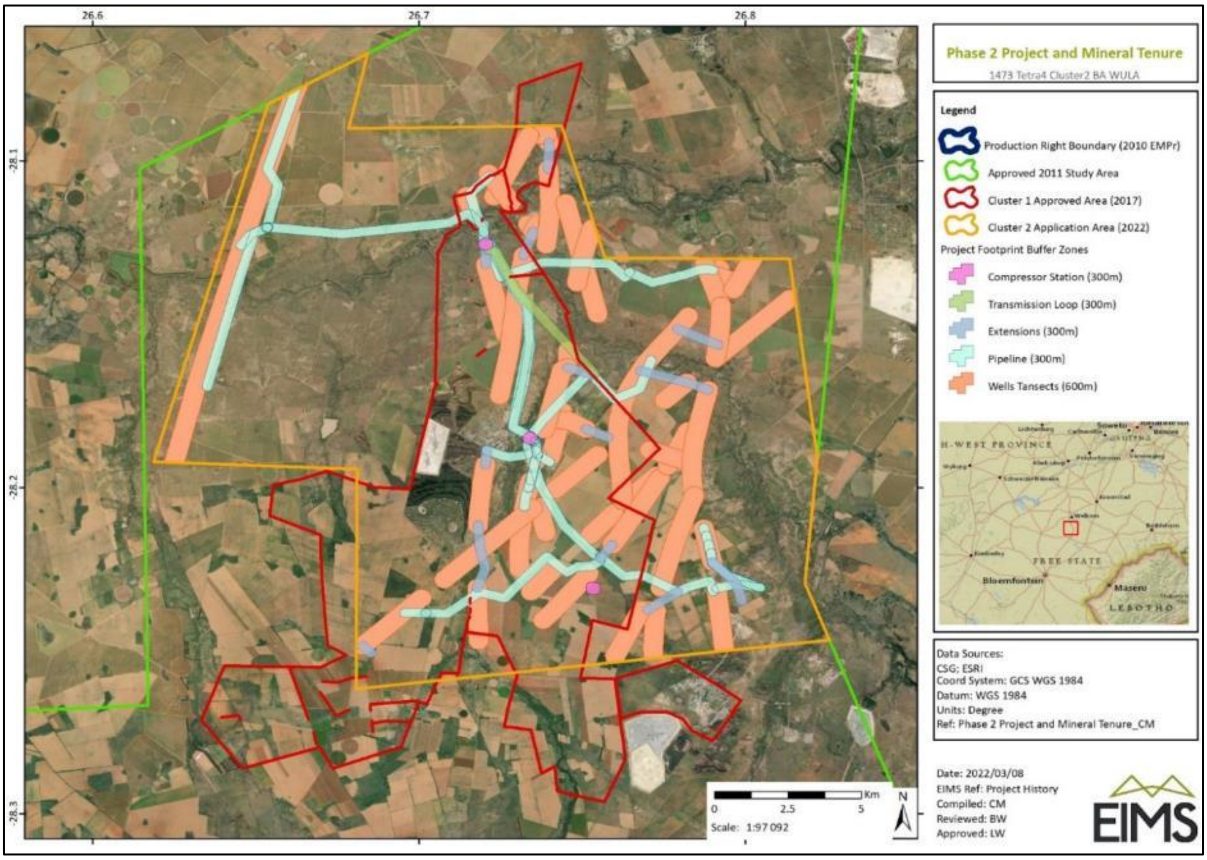

Figure 1-2 Cluster 2 study area and proposed infrastructure footprint buffer zones

A wet season wetland survey was conducted from the 14th of March 2022 to 18th of March 2022 by a freshwater ecologist. Furthermore, the identification and description of any sensitive receptors were recorded across the project area, and the manner in which these sensitive receptors may be affected by the activity was also investigated.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed development and to provide an opinion on whether or not environmental authorisation processes or licensing is required for the proposed development.

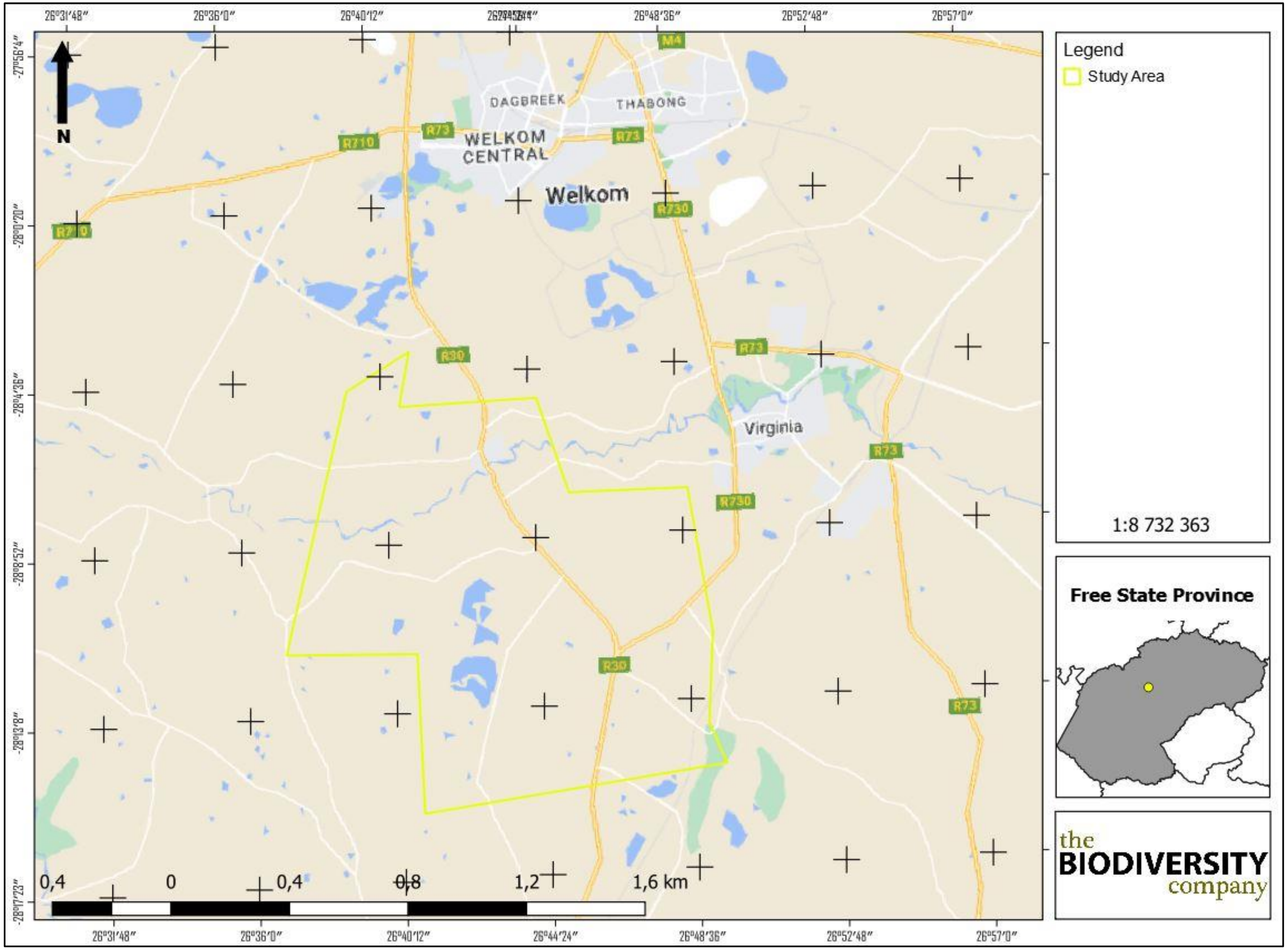

Figure 1-3 Map illustrating the location of the proposed Tetra 4 Cluster 2 project

1.2 Terms of Reference

The following tasks were completed in fulfilment of the terms of reference for this assessment:

- The delineation, classification and assessment of wetlands within 500 m of the project area;
- Conduct risk assessments relevant to the proposed activity;
- Recommendations relevant to associated impacts; and
- Report compilation detailing the baseline findings.

2 Key Legislative Requirements

2.1 National Water Act (NWA, 1998)

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

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

A watercourse is defined in the NWA as:

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

The NWA recognises that the entire ecosystem and not just the water in isolation, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS. Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) and (i).

2.1.1 National Water Act, 1998 – General Notice 704 (1999)

Restrictions on locality; no person in control of a mine or activity may – except in relation to a matter contemplated in regulation 10, carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100 m from any watercourse or estuary, whichever is greatest.

2.1.2 National Water Act, 1998 – Section 21: (c) and (i) water uses for General Authorisation – GN 509 of 26 August 2016

The DWS, is of the view that any activity within the 500 m Regulated Area or radius from the boundary (temporary zone) of any wetland or pan, or within the outer edge of the 1 in 100 year flood line or riparian habitat measured from the middle of the watercourse from both banks, requires a risk assessment to determine whether a Water Use Licence (WUL) or General Authorisation (GA) for a section 21(c) and (i) water use is required (DWS, 2016a).

2.2 National Environmental Management Act (NEMA, 1998)

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

3 Methodologies

3.1 Desktop assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- LiDar imagery;
- Vegetation and climate information (Mucina & Rutherford, 2006);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The inland water dataset;
- Topographical river line data;
- The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer *et al*., 2018); and
- Contour data (5 m).

3.2 Identification and Mapping

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 3-1. The outer edges of the wetland areas were identified by considering the following four specific indicators:

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

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

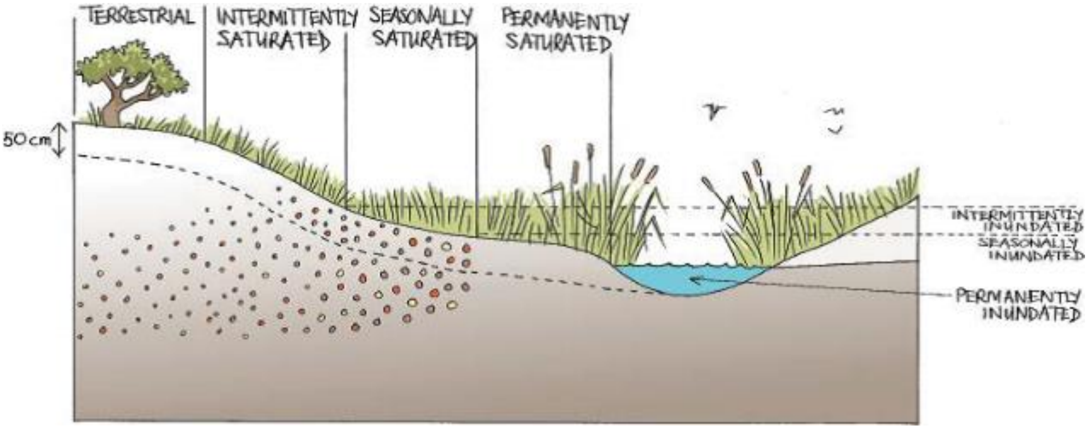

Figure 3-1 Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al. 2013)

3.3 Delineation

The wetland indicators described above are used to determine the boundaries of the wetlands within the project area. These delineations are then illustrated by means of maps accompanied by descriptions.

3.4 Functional Assessment

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

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze et al. 2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 3-1).

Table 3-1 Classes for determining the likely extent to which a benefit is being supplied

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

3.5 Present Ecological Status

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 3-2.

Table 3-2 The Present Ecological Status categories (Macfarlane, et al., 2009)

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

3.6 Ecological Importance and Sensitivity

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 3-3 (Rountree et al., 2012).

Table 3-3 Description of Ecological Importance and Sensitivity categories

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

3.7 Ecological Classification and Description

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

3.8 Determining Buffer Requirements

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

3.9 Limitations

The following limitations are applicable:

- Areas characterised by external wetland indicators have been focussed on for this study. Areas lacking these characteristics, i.e. disturbed areas, developed areas etc. have not been focussed on;

- Due to the size of the proposed area only the key areas where infrastructure is located were focused on, the remaining areas were predominantly delineated through means of desktop; and

- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side

4 Project Area

4.1 Vegetation Types

The proposed development overlap with four vegetation types, Vaal-Vet Sandy Grassland, Highveld Alluvial Vegetation, Central Free State Grassland and Western Free State Clay Grassland (Figure 4-1). The threat status and conservation targets of each vegetation type is shown in Table 4-1.

Table 4-1 The Threat Status and Conservation Targets of each vegetation type (EN= Endangered, LC =Least Concerned, VU= Vulnerable)

Vegetation Type	Mucina and Rutherford Conservation Status (2007)	NBA Threat Status (2018)	Conservation Target (NBA, 2018)
Vaal-Vet Sandy Grassland	EN	EN	24%
Highveld Alluvial Vegetation	LC	LC	31%
Central Free State Grassland	VU	LC	24%
Western Free State Clay Grassland	LC	LC	24%

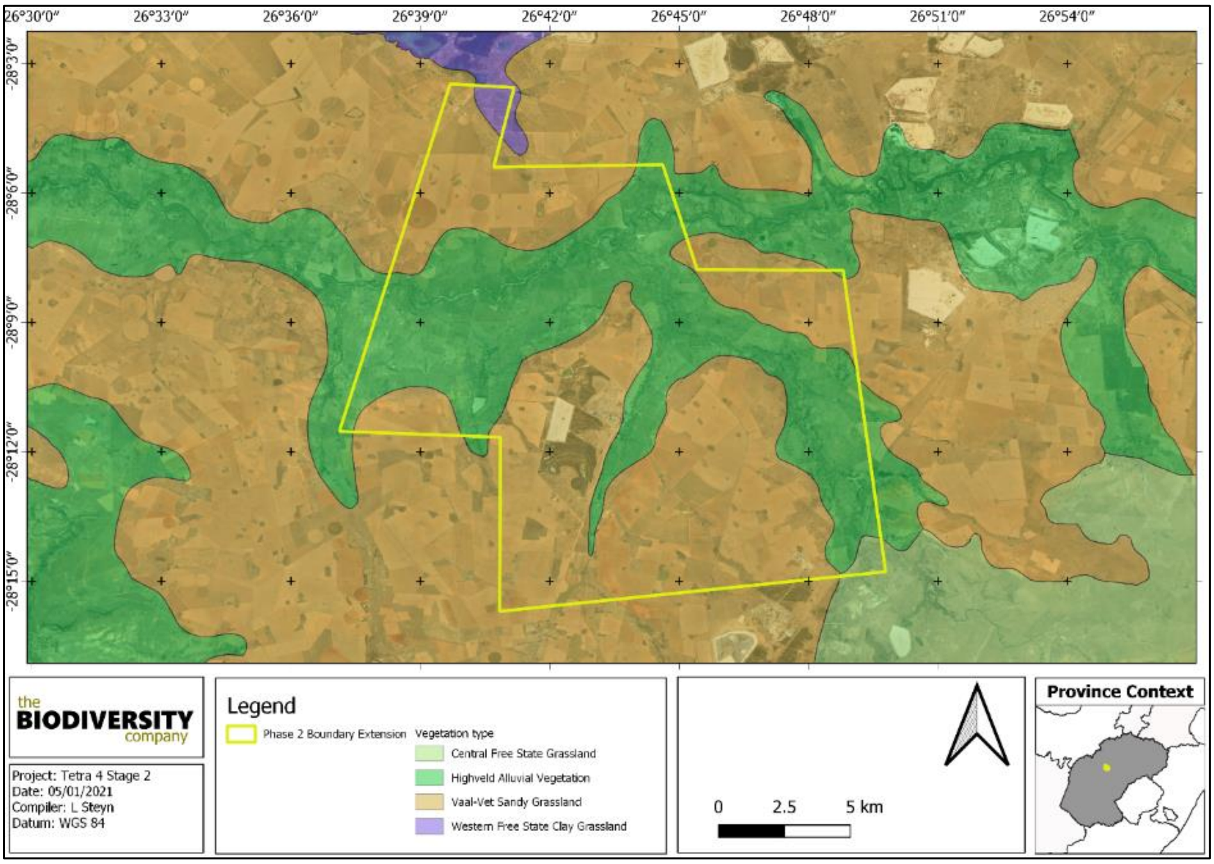

Figure 4-1 Map illustrating the vegetation type associated with the assessment area

4.2 Soils and Geology

According to the land type database (Land Type Survey Staff, 1972 - 2006), the project area is characterised by the Bd20 and the Dc8 land type. The Bd20 land type is characterized by plinthic catena as well as upland duplex and margalitic soils which rarely occur. Eutrophic, red soils are not widespread without the project area. As for the Dc8 land type, the soils within this land type are characterised by prismacutanic and/or pedocutanic diagnostic horizons with the addition of one or more of the following; Vertic, melanic and red structured diagnostic horizons.

The geology of this area is characterised by aeolian and colluvial sand which overlies mudstone, sandstone and shale of the Karoo Supergroup. Older Ventersdorp Supergroup basement gneiss and andesite is located to the north. Soil forms associated with the project area includes the Bd, Bc, Ae and Ba land types, which correlates with the findings from the land type database (Mucina & Rutherford, 2006).

4.3 Climate

This region is characterised by a warm-temperate summer rainfall climate with the average annual precipitation being approximately 530 mm (see Figure 4-2). High summer temperatures are common for this region with severe frost occurring throughout the winter (on average 37 days per year) (Mucina & Rutherford, 2006).

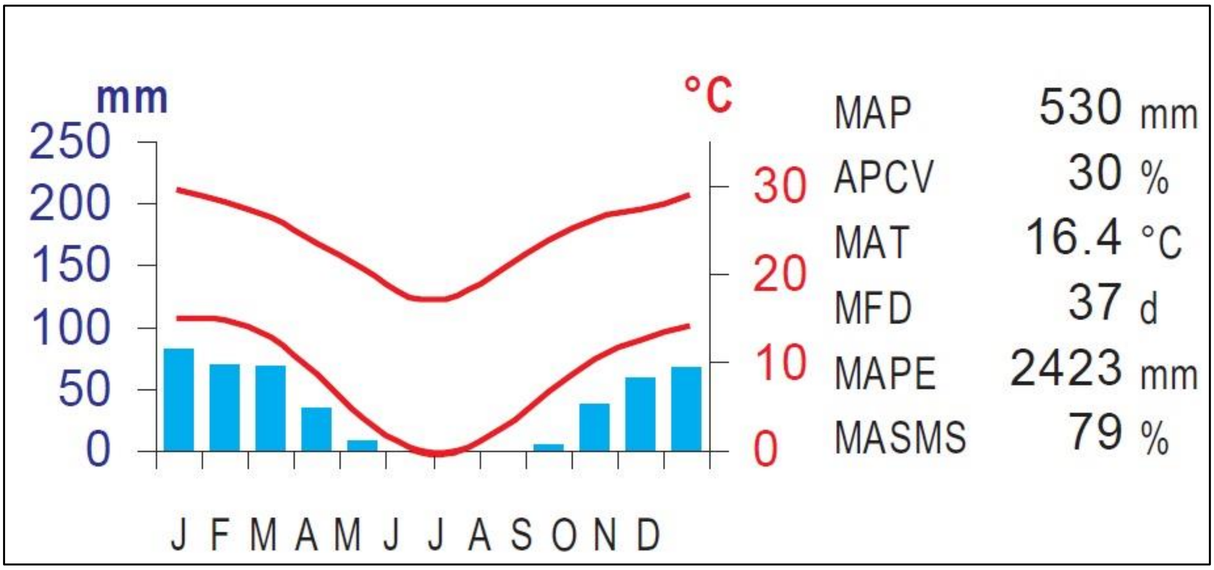

Figure 4-2 Climate for the Vaal-Vet Sandy Grassland (Mucina & Rutherford, 2006)

4.4 Topographical Inland Water and River Line Data

Multiple perennial and non-perennial streams have been identified within the proposed project area by means of the "2826" quarter degree square topographical river line data set. Multiple inland water areas ranging from natural dams to sewerage works has also been identified within the 500 m regulated area (see Figure 4-3).

4.5 NFEPA Wetlands

Seven types of NFEPA wetlands were identified within the study area, namely channelled valley bottom, depression, flat, floodplain, seep, unchannelled valley bottoms as well as valley head seep wetlands (see Figure 4-4).

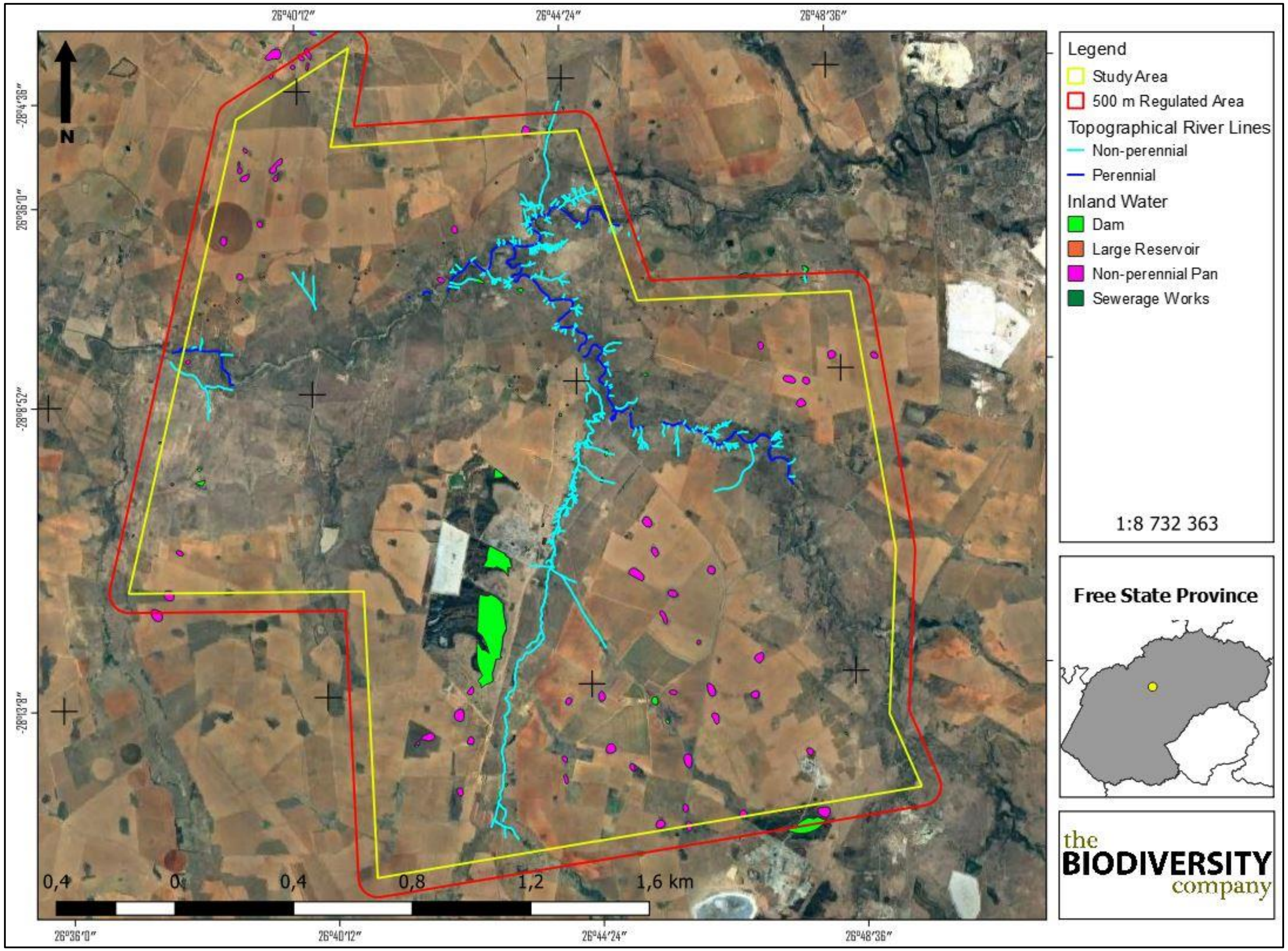

Figure 4-3 Illustration of topographical river lines and the inland water area located within the study area

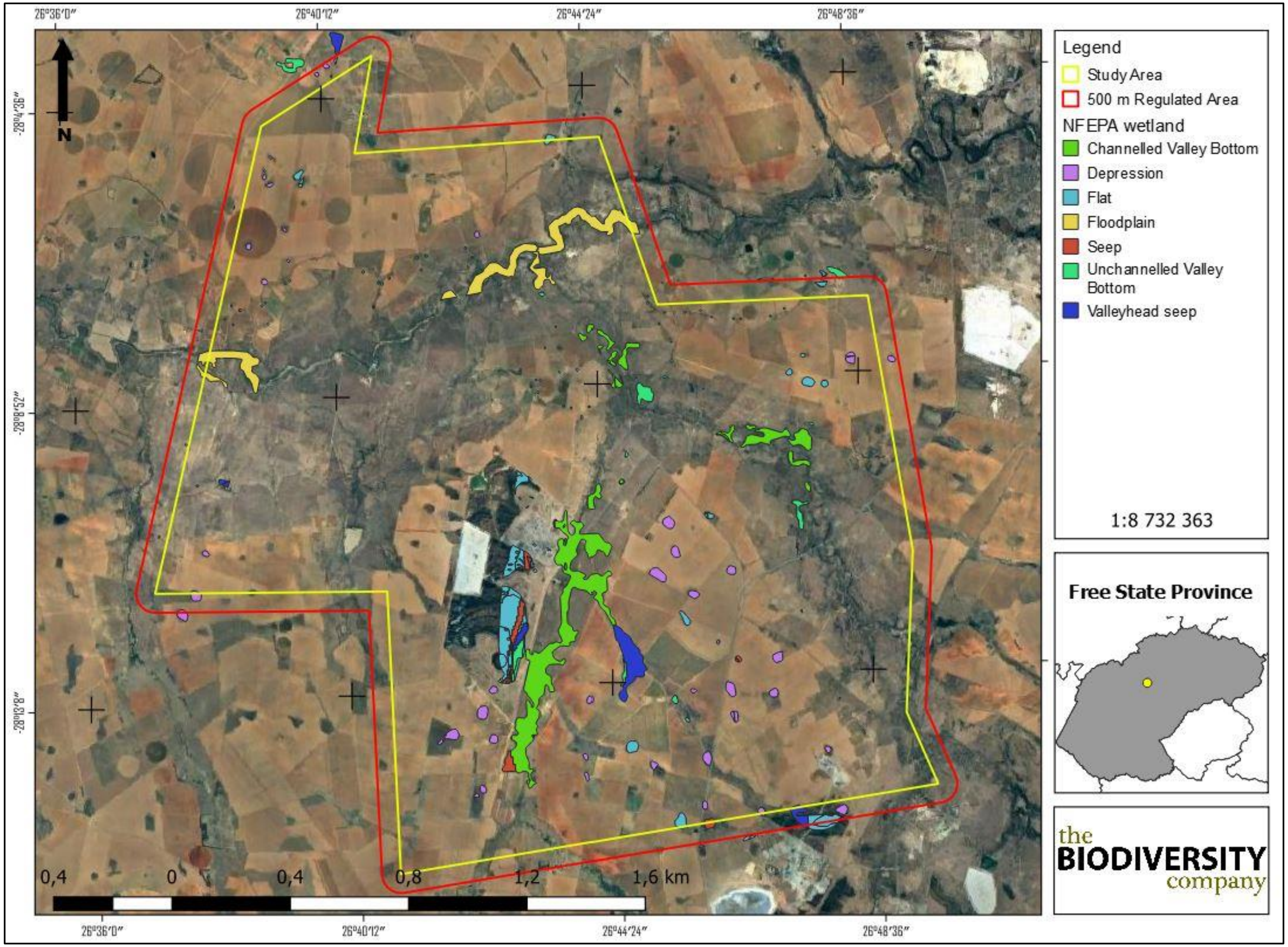

Figure 4-4 NFEPA wetlands within the project area and its surroundings

4.6 Terrain

The terrain of the 500 m regulated area has been analysed to determine potential areas where wetlands are more likely to accumulate (due to convex topographical features, preferential pathways or more gentle slopes).

4.6.1 Digital Elevation Model

A Digital Elevation Model (DEM) has been created to identify lower laying regions as well as potential convex topographical features which could point towards preferential flow paths. The 500 m regulated area ranges from 1272 to 1410 MASL. The lower laying areas (generally represented in dark blue) represent area that will have the highest potential to be characterised as wetlands (see Figure 4-5).

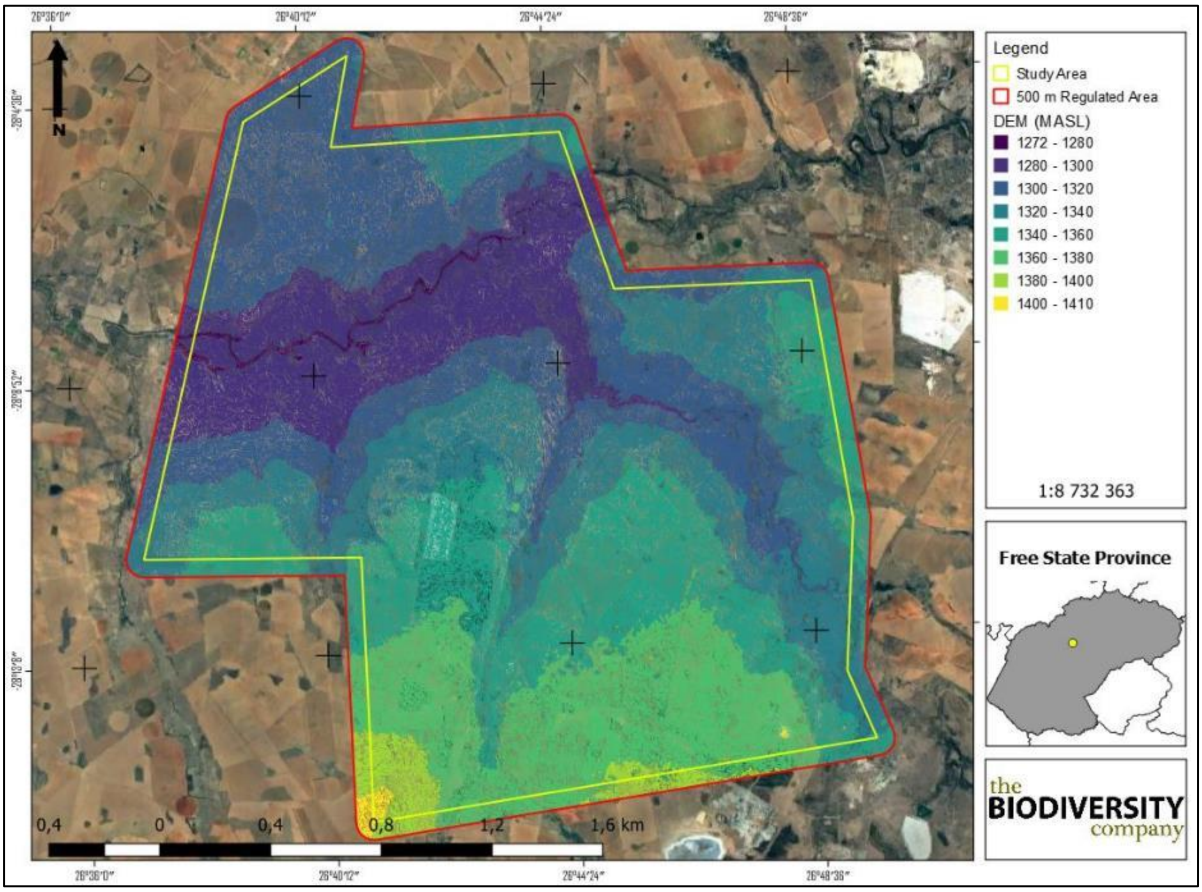

Figure 4-5 Digital Elevation Model of the 500 m regulated area

5 Results & Discussion

5.1 Delineation and Description

During the site visit four different wetland types were delineated in accordance with the DWAF (2005) guidelines. The four different types were classified as being channelled valley bottoms, unchannelled valley bottoms, hillslope seeps and depression wetlands.

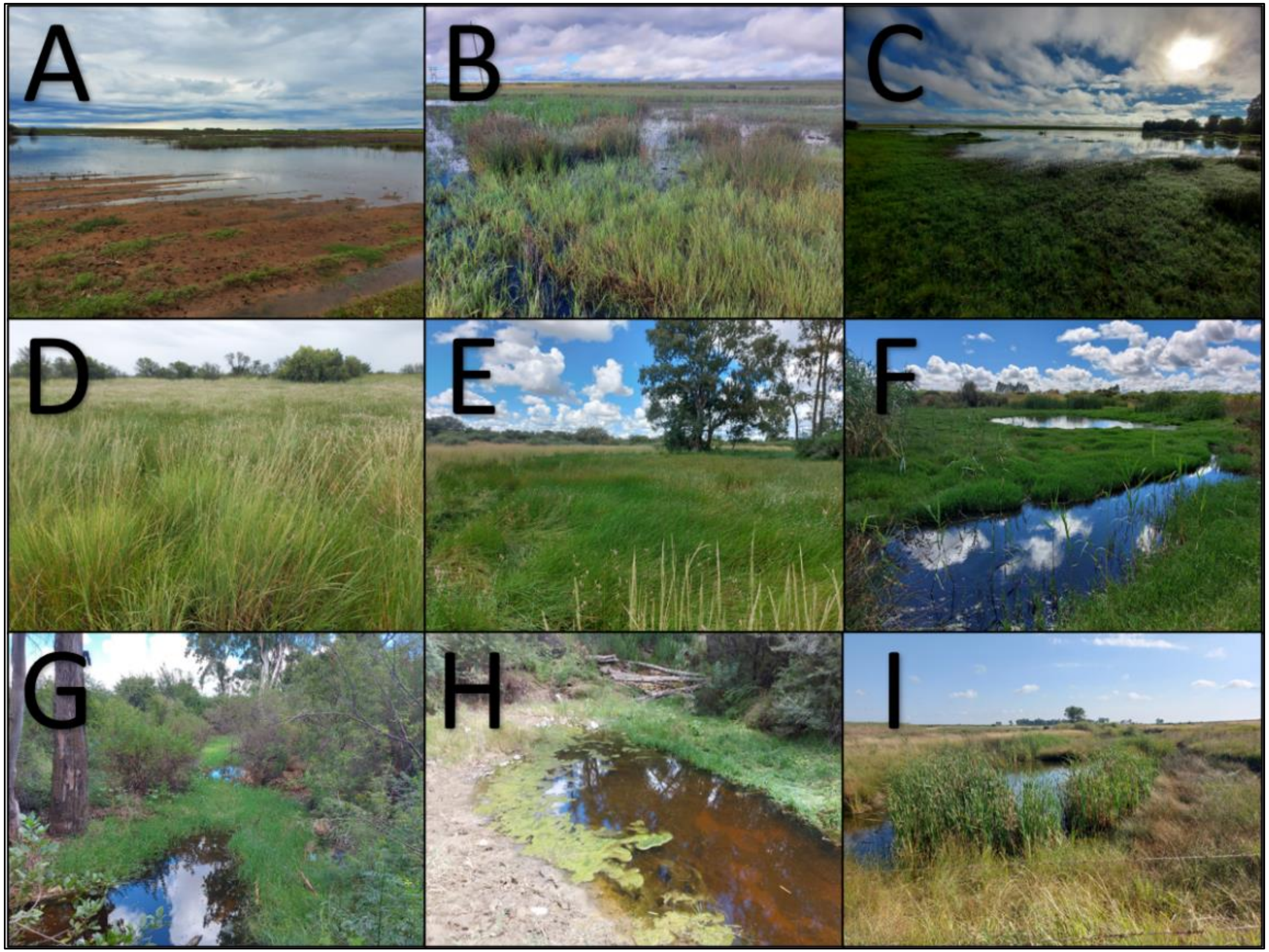

Figure 5-1 Photographical evidence of identified wetlands, A, B & C) depressions, D) Unchannelled valley bottom, E) seep and G, H & I) channelled valley bottoms

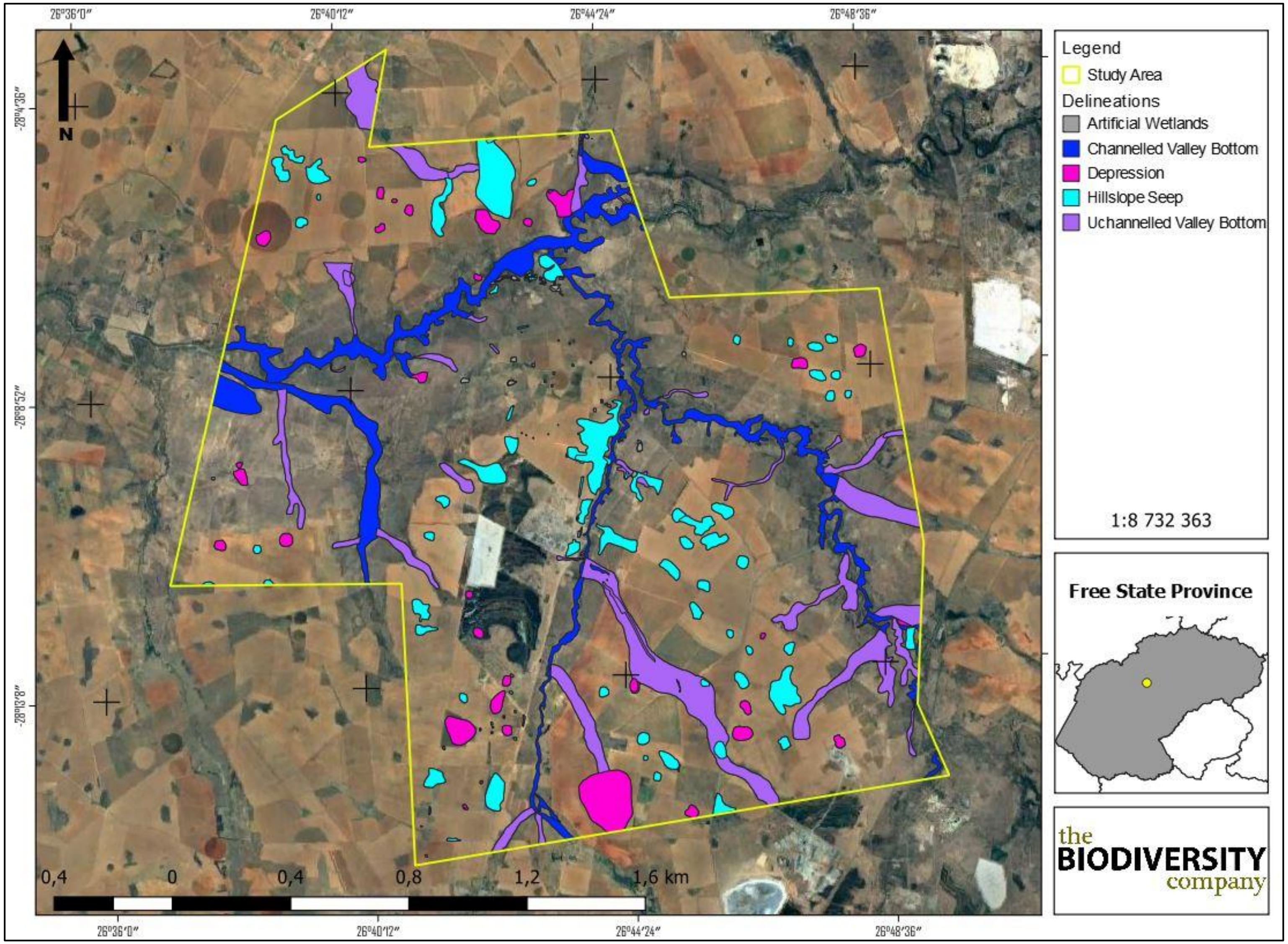

Figure 5-2 Delineation of wetlands within the study area

5.2 Unit Setting

The channelled valley bottom wetland is located on the “valley floor” landscape unit. Channelled valley bottom wetlands are typically found on valley-floors with a clearly defined, finite stream channel and lacks floodplain features, referring specifically to meanders. Channelled valley bottom wetlands are known to undergo loss of sediment in cases where the wetlands’ slope is high and the deposition thereof in cases of low relief. Figure 5-3 illustrates a diagram of the channelled valley bottom wetland, showing the dominant movement of water into, through and out of the system.

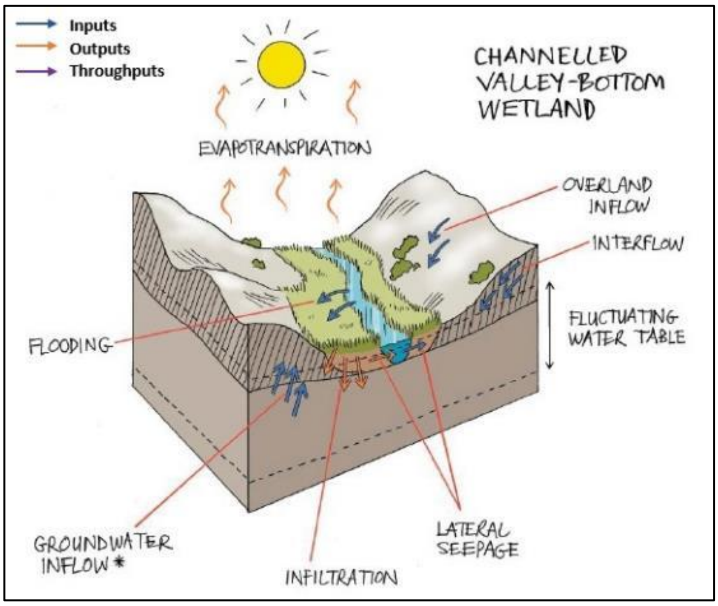

Figure 5-3 Amalgamated diagram of a typical channelled valley bottom wetland, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

Depression wetlands are typically located on the “valley-floor” landscape unit. Depressions are inward draining basins with an enclosing topography which allows for water to accumulate within the system. Depressions, in some cases, are also fed by lateral sub-surface flows in cases where the dominant geology allows for these types of flows. Figure 5-4 illustrates a diagram of a depression, showing the dominant movement of water into, through and out of the system.

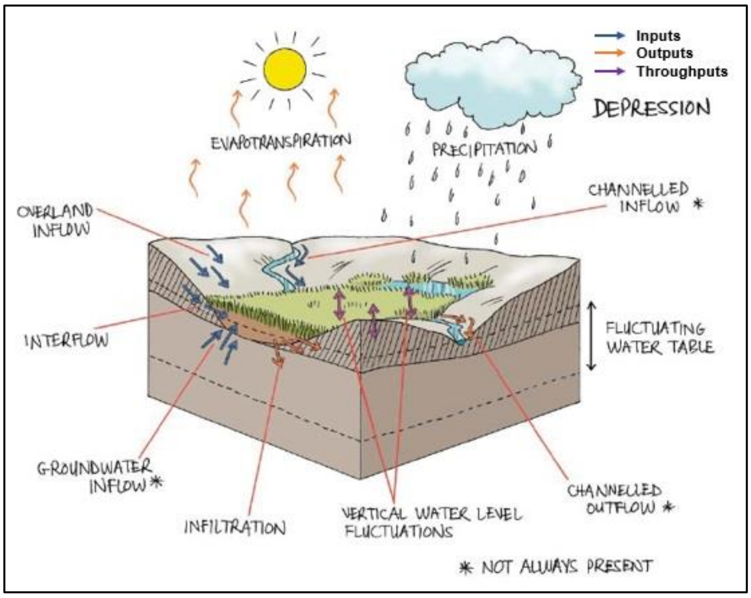

Figure 5-4 Amalgamated diagram of a typical depression wetland, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

Hillslope seeps are located within slopes, as mentioned in Figure 5-5. Isolated hillslope seeps are characterised by colluvial movement of material. These systems are fed by very diffuse sub-surface flows which seeps out at very slow rates, ultimately ensuring that no direct surface water connects this wetland with other water courses within the valleys. Figure 5-5 illustrates a diagram of the hillslope seeps, showing the dominant movement of water into, through and out of the system.

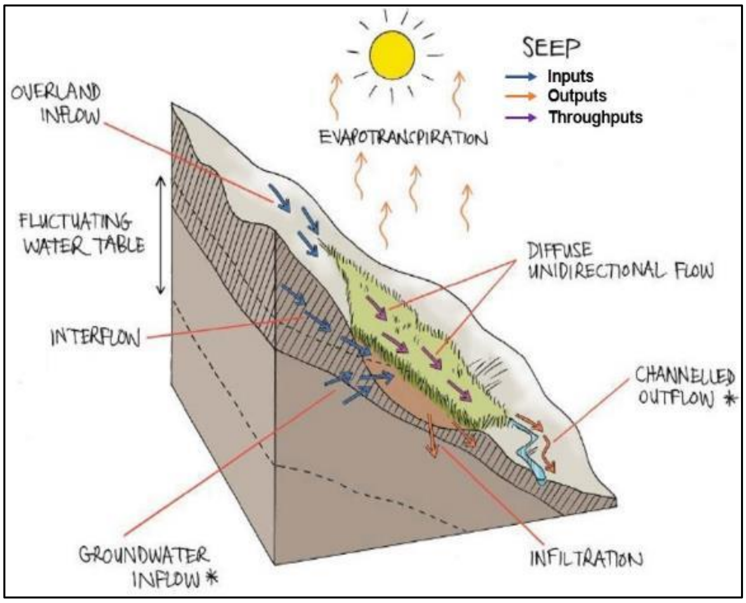

Figure 5-5 Amalgamated diagram of a typical hillslope seep wetland, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

The unchannelled valley bottom is located on the “valley floor” landscape unit. Unchannelled valley bottom wetlands are typically found on valley-floors where the landscape does not allow high energy flows. Figure 5-6 illustrates a diagram of a typical unchannelled valley bottom, showing the dominant movement of water into, through and out of the system.

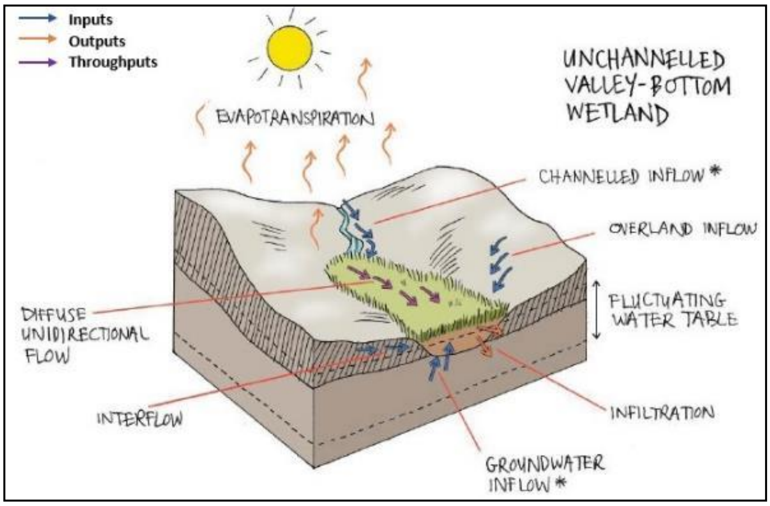

Figure 5-6 Amalgamated diagram of a typical unchannelled valley bottom wetland, highlighting the dominant water inputs, throughputs and outputs, SANBI guidelines (Ollis et al. 2013)

5.3 Indicators

According to (DWAF, 2005), a combination of hydromorphic soils and hydrophytic plants must be used to identify and accurately delineate wetland areas.

5.3.1 Hydromorphic Soils

According to (DWAF, 2005), soils are the most important characteristic of wetlands in order to accurately identify and delineate wetland areas. Five dominant soil forms were identified within the identified wetland, namely the Katspruit, Kroonstad, Longlands, Westleigh and Mispah soil forms (see Figure 5-7) (Soil Classification Working Group, 2018).

The Katspruit soil form consists of an orthic topsoil on top of a gleyic horizon. The “2210” family group is applicable to this soil form given the grey colours, the firm texture and structure of the soil form and the absence of lime.

The Kroonstad soil form consists of an Orthic topsoil on top of an Albic horizon, which in turn is underlain by a Gleyic horizon. The soil family group identified for the Kroonstad soil form is “1110” due to the gleyed colour of the topsoil, the Albic horizon’s grey colours when in a wet condition as well as the non-calcareous nature of the soil.

The Longlands soil form consists of an orthic topsoil on top of an albic horizon. The soil family group identified for the Longlands soil form on-site has been classified as the “1000” soil family due to the grey colour of the soil in wet conditions.

The Westleigh soil form consists of an Orthic A-horizon on top of a Soft Plinthic B-horizon. The soil family group identified for the Westleigh soil form on-site has been classified as the Helena (1000) soil family given the lack of evidence pertaining to luvic processes.

The Mispah soil form consists of an orthic topsoil on top of a hard rock layer. The soil family group identified for the Mispah soil form on-site is that of *2120* due to the chromic properties of the topsoil, the absence of lime as well as the solid structure of the bedrock.

Orthic topsoils are mineral horizons that have been exposed to biological activities and varying intensities of mineral weathering. The climatic conditions and parent material ensure a wide range of properties differing from one orthic topsoil to another (i.e. colouration, structure etc) (Soil Classification Working Group, 2018).

Albic horizons are often characterised by uniform white-greyish colours from the residual clay and quartz particles making up the matrix of the horizon. The main characteristic of this diagnostic horizon is a bleached colouration, which is a resultant product of distinct redox and ferrolysis pedological processes combined with eluvial processes. According to the Soil Classification Working Group (2018), albic horizons often receive lateral sub-surface flows from hillslope processes.

Gley horizons that are well developed and have homogenous dark to light grey colours with smooth transitions. Stagnant and reduced water over long periods is the main factor responsible for the formation of a gley horizon and could be characterised by green or blue tinges due to the presence of a mineral called Fougerite which includes sulphate and carbonate complexes. Even though grey colours are dominant, yellow and/or red striations can be noticed throughout a gley horizon. The structure of a gley horizon mostly is characterised as strong pedal, with low hydraulic conductivities and a clay texture, although sandy gley horizons are known to occur. The gley soil form commonly occurs at the toe of hillslopes (or benches) where lateral water inputs (sub-surface) are dominant and the underlaying geology is characterised by a low hydraulic conductivity. The gley horizon usually is second in diagnostic sequence in shallow profiles yet is known to be lower down in sequence and at greater depths (Soil Classification Working Group, 2018).

The accumulations of iron (and in some cases manganese) as hydroxides and oxides with the presence of high chroma striations and concretions with black matrixes are associated with the Soft Plinthic horizon. This diagnostic horizon forms due to fluctuating levels of saturation. The iron and manganese concentration result in soft marks within the soil matrix which transform in concretions with high consistencies (Soil Classification Working Group, 1991).

If this process continues for long enough periods, a massive continues impermeable layer of hard plinthite forms. A Soft Plinthic horizon and a Hard Plinthic horizon can be distinguished from one another by means of a simple spade test. A Soft Plinthic horizon can be penetrated by means of a spade in wet conditions whereas a Hard Plinthic horizon cannot (Soil Classification Working Group, 1991).

According to Soil Classification Working Group (2018), this horizon commonly occurs as a result of hillslope hydrology in flat, sandy landscapes. This horizon is known to have an apedal structure together with the presence of concretions.

The hard rock layer disallows infiltration of water or root systems and occur in shallow profiles. Horizontally layered, hard sediments without evidence of vertical seems fall under this category.

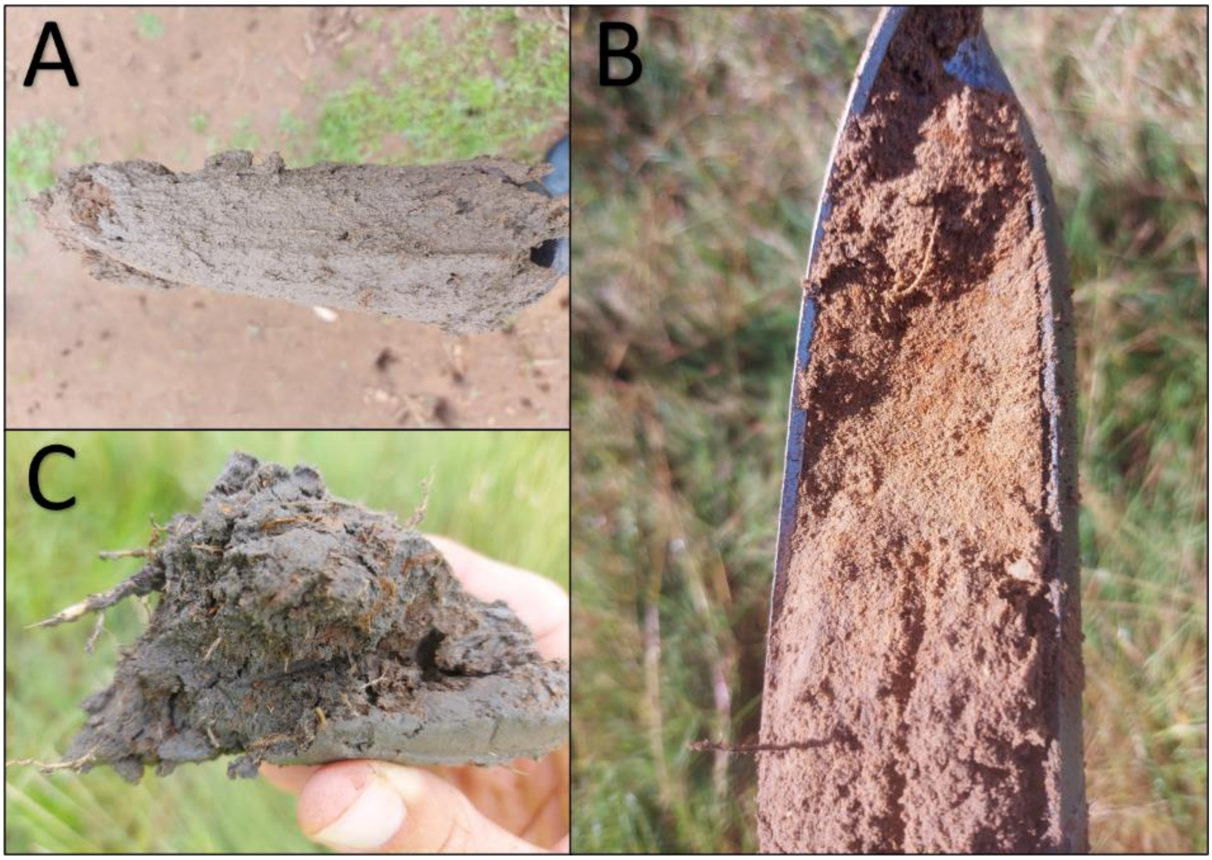

Figure 5-7 Different soils identified within the study area, A) Gley horizon, B) Orthic topsoil with signs of wetness, C) Orthic topsoil with mottles

5.3.2 Hydrophytes

Vegetation plays a considerable role in identifying, classifying and accurately delineating wetlands (DWAF, 2005). During the site visit, various hydrophytic species were identified (including facultative species). Examples include *Cyperus spp. Persicaria* spp., *Typha Capensis* (See Figure 5-8).

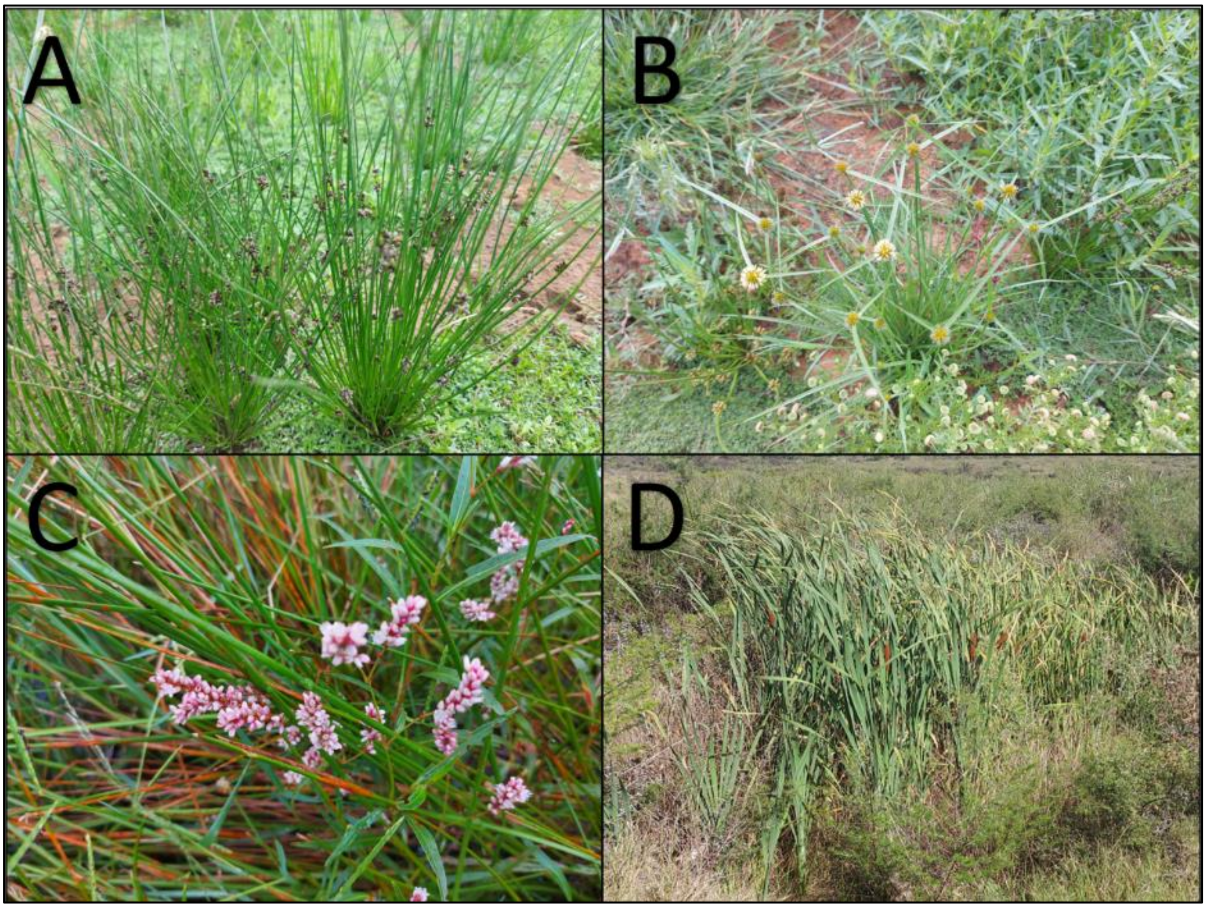

Figure 5-8 Hydrophytic vegetation identified within delineated watercourses. A) Cyperus spp. B) Kyllinga brevifolia C) Persicaria spp. D) Typha Capensis

5.4 General Functional Description of Wetland Types

Channelled valley bottom wetlands tend to contribute less to sediment trapping and flood attenuation than other systems. Channelled valley bottom wetlands are well known to improve the assimilation of toxicants, nitrates and sulphates, especially in cases where sub-surface flows contribute to the system's water source (Kotze et al., 2009).

The generally impermeable nature of depressions and their inward draining features are the main reasons why the streamflow regulation ability of these systems is mediocre. Regardless of the nature of depressions in regard to trapping all sediments entering the system, sediment trapping is another Eco Service that is not deemed as one of the essential services provided by depressions, even though some systems might contribute to a lesser extent. The reason for this phenomenon is due to winds picking up sediments within pans during dry seasons which ultimately leads to the removal of these sediments and the deposition thereof elsewhere. The assimilation of nitrates, toxicants and sulphates are some of the higher rated Eco Services for depressions. This latter statement can be explained the precipitation as well as continues precipitation and dissolving of minerals and other contaminants during dry and wet seasons respectively, (Kotze et al., 2009).

Hillslope seeps are well documented by (Kotze et al., 2009) to be associated with sub-surface ground water flows. These systems tend to contribute to flood attenuation given their diffuse nature. This attenuation only occurs while the soil within the wetland is not yet fully saturated. The accumulation of organic material and sediment contributes to prolonged levels of saturation due to this deposition slowing down the sub-surface movement of water. Water typically accumulates in the upper slope (above the seep). The accumulation of organic matter additionally is essential in the denitrification process involved with nitrate assimilation. Seeps generally also improve the quality of water by removing excess nutrient and inorganic pollutants originating from agriculture, industrial or mine activities. The diffuse nature of flows ensures the assimilation of nitrates, toxicants and phosphates with erosion control being one of the Eco Services provided very little by the wetland given the nature of a typical seep's position on slopes.

Unchanneled valley bottoms are characterised by sediment deposition, a gentle gradient with streamflow generally being spread diffusely across the wetland, ultimately ensuring prolonged saturation levels and high levels of organic matter. The assimilation of toxicants, nitrates and phosphates are usually high for unchanneled valley-bottom wetlands, especially in cases where the valley is fed by sub-surface interflow from slopes. The shallow depths of surface water within this system adds to the degradation of toxic contaminants by means of sunlight penetration.

It is however important to note that the descriptions of the above-mentioned functions are merely typical expectations. All wetland systems are unique and therefore, the ecosystem services rated high for these systems on site might differ slightly to those expectations.

5.5 Ecological Functional Assessment

The ecosystem services provided by the wetland units identified on site were assessed and rated using the WET-EcoServices method (Kotze *et al.,* 2008). Due to the high number of wetlands identified within the study area the wetlands have not been classified into HGM units. The wetland ecosystem services scores ranges from “Moderately High” to “Moderately Low”. Ecosystem services contributing to these scores include flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation, erosion control, biodiversity maintenance and tourism and recreation.

The wetlands that scored “Moderately High” ecosystem services were mostly the channelled valley bottoms where water drains into from the catchment areas. The catchments of these systems are predominantly used for agricultural fields were pesticides and herbicides are used to help maintain crop yields These pesticides and herbicides are taken out of the watercourses through the wetlands to help provide cleaner drinking water for the people downstream. The channels also help with streamflow regulation to prevent erosion within the wetlands as well as to regulate flood attenuation. The channelled valley bottoms also have water throughout the year providing important habitat and resources all year round.

The majority of wetlands scored “Intermediate” ecosystem services scores within the project area. The reason for this score is due to the fact that the areas around the wetlands are predominately used for agriculture which will release pesticide and herbicides into the wetlands but toxicants from anthropogenic activities are minimal. The wetlands scored “Intermediate” instead of “Moderately High” due to the fact that the wetland have less vegetation cover and is also more temporarily wet. The lack of water during the dry season as well as the lack of vegetation cover take away habitat for species as well as resources for humans. The wetlands do however play a vital role in sediment trapping, streamflow regulation as well as flood attenuation and was thus score higher than some of the wetlands.

The wetlands that scored the lowest ecosystem services score in this project area of “Moderately Low” were predominantly depression and seep wetlands. Seeps and Depression wetlands do not play a major role in streamflow regulation, flood attenuation and sediment trapping and thus scores lower ecosystem services in general. During the site visit this was evident as well. The depression wetland situated inside the crop fields have little to no hydrophyte vegetation which limits their ability to accumulate toxicants out the water. The lack of vegetation also hinders the wetlands' ability to provide habitat for charismatic species and limits the available resources for human use.

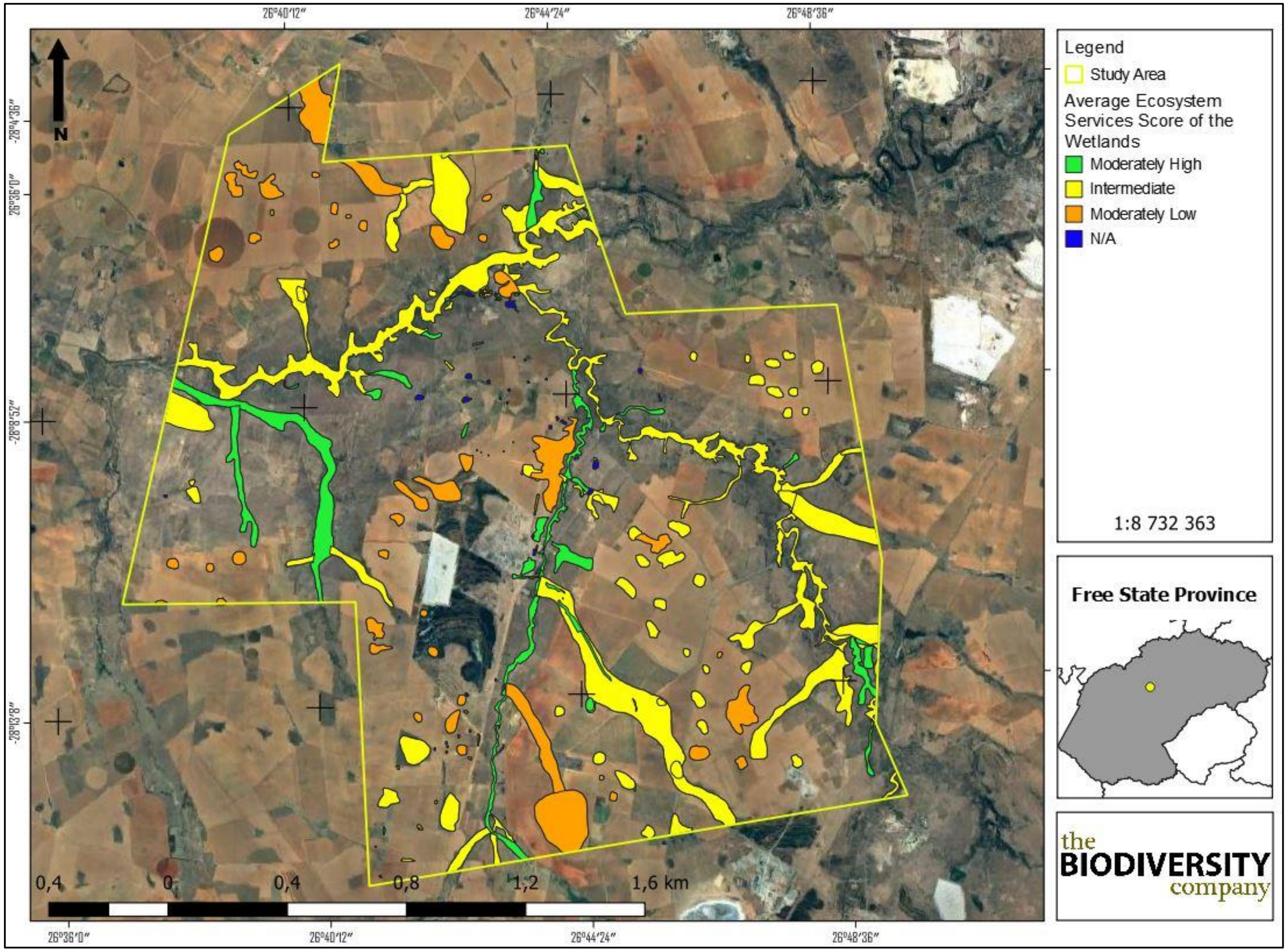

Figure 5-9 Average ecosystem service scores for the delineated wetland systems

5.6 Ecological Health Assessment

The PES for the assessed wetlands is presented in Figure 5-10. The delineated wetland systems have been scored overall PES ratings ranging of “Moderately Modified” (class C) to “Seriously Modified” (Class E). The wetlands were scored “Seriously Modified” due to multiple agricultural activities inside the wetlands. Many of the wetlands have been stripped of all vegetation and planting have taken place inside the wetland. The agricultural activities in the catchment areas of the wetlands which increased the overland flow of water and increase the possibility of flooding and erosion taking place. Multiple gravel roads, pipes and fences transverse through some of the wetlands modifying the water movement inside the wetlands.

The wetlands that scored “Moderately Modified” PES scores were located within the more natural areas of the study area. The wetlands are not subjected to agricultural activities and is thus in better ecological state. Although no agricultural activities take place inside the wetlands catchment the wetlands are still modified by human impacts. The largest modification will be through overgrazing by wildlife on the game farms. There are also roads and fences crossing through the wetlands and some anthropogenic activities taking place inside the wetlands.

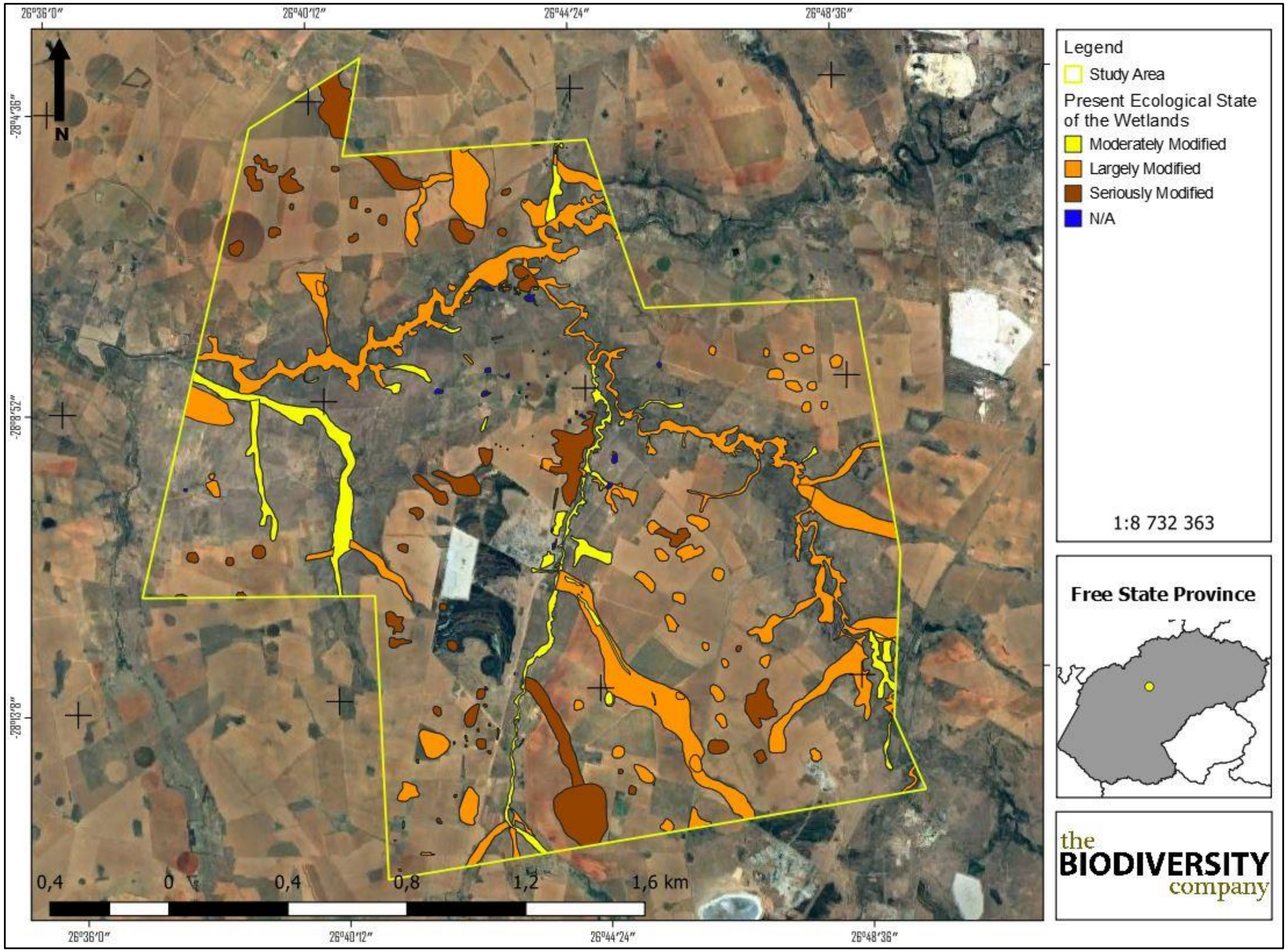

Figure 5-10 Overall present ecological state of delineated wetlands

5.7 Importance & Sensitivity Assessment

The results of the ecological IS assessment are shown in Table 5-1. Various components pertaining to the protection status of a wetland is considered for the IS, including Strategic Water Source Areas (SWSA), the NFEPA wet veg protection status and the protection status of the wetland itself considering the NBA wetland data set. The IS for all the different wetland types have been calculated to be "Moderate", which combines the relatively high protection status of the wet veg type and the low protection status of the wetland itself.

Table 5-1 The IS results for the delineated HGM unit

HGM Type	Wet Veg			NBA Wetlands			SWSA (Y/N)	Calculated IS
	Type	Ecosystem Threat Status	Ecosystem Protection Level	Wetland Condition	Ecosystem Threat Status 2018	Ecosystem Protection Level		
Channelled Valley Bottom	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	D/E/F Seriously Modified	Critical	Not Protected	N	**Moderate**
Depression	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	D/E/F Seriously Modified	Least Concern	Poorly Protected	N	**Moderate**
Hillslope Seep	Dry Highveld Grassland Group 3	Endangered	Not Protected	D/E/F Seriously Modified	Critical	Poorly Protected	N	**High**
Unchannelled Valley Bottom	Dry Highveld Grassland Group 3	Least Threatened	Not Protected	D/E/F Seriously Modified	Critical	Not Protected	N	**Moderate**

5.8 Buffer Requirements

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane et al. 2014) was used to determine the appropriate buffer zone for the proposed activities. After taking into consideration the different activities the buffer size for the delineated wetlands were calculated as 35 m (see Figure 5-11 and Table 5-2).

Table 5-2 Threats posed during the construction- and operational phase for the delineated wetlands

	Threat Posed by the proposed land use / activity	Specialist Rating	Refined Class
Construction Phase	Alteration to surface runoff flow volumes	N/A	N/A
	Alteration of patterns of flows (increased flood peaks)	Very Low	Very Low
	Increase in sediment inputs & turbidity	Low	Low
	Increased nutrient inputs	Very Low	Very Low
	Inputs of toxic organic contaminants	Very Low	Very Low
	Inputs of toxic heavy metal contaminants	Low	Low
	Alteration of acidity (pH)	Very Low	Very Low
	Increased inputs of salts (salinization)	N/A	N/A
	Change (elevation) of water temperature	Low	Low

	Pathogen inputs (i.e. disease-causing organisms)	Very Low	Very Low
Operational Phase	Alteration to flow volumes	Low	Low
	Alteration of patterns of flows (increased flood peaks)	Low	Low
	Increase in sediment inputs & turbidity	Low	Low
	Increased nutrient inputs	Very Low	Very Low
	Inputs of toxic organic contaminants	Low	Low
	Inputs of toxic heavy metal contaminants	Low	Low
	Alteration of acidity (pH)	Low	Low
	Increased inputs of salts (salinization)	Low	Low
	Change (elevation) of water temperature	Low	Low
	Pathogen inputs (i.e. disease-causing organisms)	Very Low	Very Low

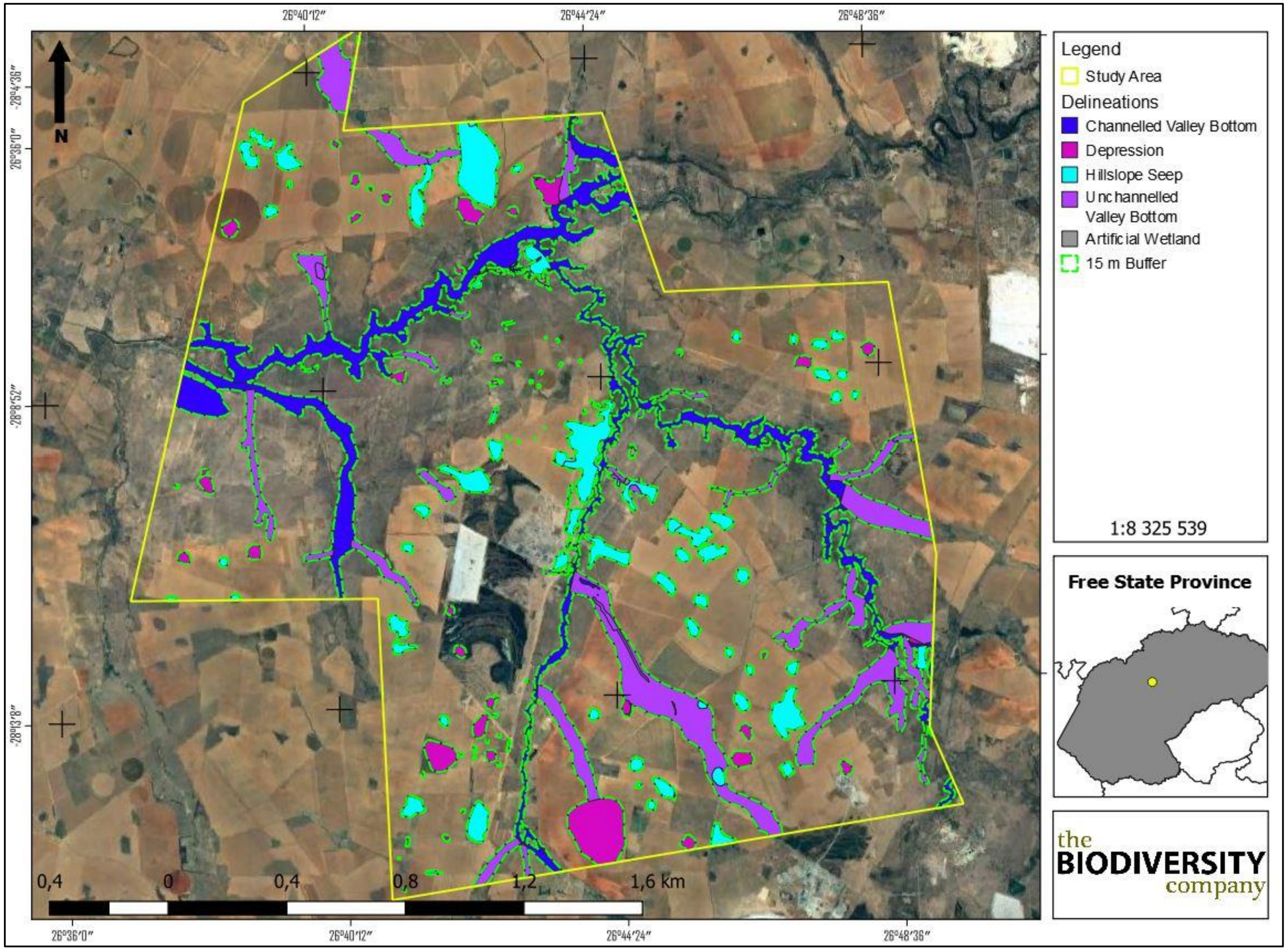

Figure 5-11 Extent of recommended buffer zones

6 Impact Assessment

Infrastructure within the study area includes compressor stations, gas pipelines, well heads and a transmission loop. The compressor stations are located outside of the wetland buffers but some indirect impacts can still affect the wetlands. The pipelines are expected to traverse the wetland systems. The well heads buffer will also impede into the wetlands but the well can be moved to stay clear of the wetland buffers, indirect impacts are still expected. The transmission loop will also transverse the wetlands. The linear structures (pipeline and transmission loop) will be assessed as one and the compressor station and wells will be assessed as one.

Impacts were considered in terms of the construction/operational phases, with no impacts on the watercourse receiving environment being identified that will occur during the decommissioning phase of the project. Mitigation measures were only applied to impacts deemed relevant.

6.1 Anticipated Activities

It is evident from the figure that the following may have a negative effect on more sensitive water resources, most impacts involve the water resources and the habitats connected to these:

- Expansions to the current LNG and Helium production plant located on the Farm Mond van Doorn Rivier. The planned expansions will be to increase the helium and LNG production capacities significantly (~30 fold increase) and increase the footprint of the existing approved plant by approximately 10 ha;
- The drilling of new gas wells ~300 wells spread over a total study area (Cluster 2) of approximately ~27 500 ha;
- The installation of trenched pipelines connecting the wells to localised booster compressors and then to in-field compressor stations (~3 sites) and subsequently the compressor stations to the main plant area; and
- There will be a requirement to have short powerline and water connections to the compressor sites."

6.2 Stakeholder Comments

No comments pertinent to wetlands were provided for a response.

6.3 Review of Cluster 1 EIA and EMPr

Several impacts were identified for the aquatic ecology and wetland assessment completed by Imperata Consulting CC (2017), which were also considered for the Cluster 2 gas exploration project. The impacts and mitigation measures from Cluster 1 that are still relevant/adequate are represented and discussed in Table 6-1.

Table 6-1 Cluster 1 Environmental Impacts and EMPr

#	Activities	Impact/ Aspect	Management/ Mitigation Measures	Suggested Amendment
15	All	Loss of watercourse habitat	Locate pipeline/ trunkline alignments/ compressors outside of buffered watercourses (sensitive watercourse habitat) as far as possible. Buffered watercourses within proximity to the construction footprints should be demarcated on site for the entire construction process to help indicate sensitive areas and prevent unauthorised access. Unavoidable crossings should ideally be located perpendicular to the direction of flow at the shortest possible crossing distances. Long crossings along the length of wetlands, rivers and drainage lines should be avoided as far as practically possible. Aboveground pipeline watercourse crossings that are suspended on plinths are recommended as opposed to the excavation, lowering and infilling of pipelines in watercourses. Tetra4 should make provision in the design phase for permanent access tracks/ roads that will be required for the maintenance of the pipeline. A construction method statement should be prepared by the contractor with input from a watercourse specialist prior to the start of construction.	The method statement must be reviewed on an annual basis, and here necessary, updated.
20	All	Disruption of watercourse hydrology	Pipeline crossings through wetlands and other watercourses should ideally be raised aboveground on plinths to prevent preferential flow along their length. In areas where this is not possible, trench breakers with a low hydrological conductivity should be used to reduce water movement in bedding and padding material along the buried pipeline in wetlands and other watercourses. Long and/or steep approaches that border watercourses (specifically wetlands) should receive trench breakers that will help to restrict the desiccation impact on wetlands due to preferential drainage. It is recommended that input be obtained from a geotechnical specialist or geohydrologist regarding the use and positioning of trench breakers along buried sections of the pipeline. Other crossings through depression (pan) and flat wetland require trench-breakers or other forms of underground barriers/plugs to prevent preferential drainage along the pipeline/trunkline alignment.	The cumulative loss of wetlands must be determined in consultation with a wetland ecologist. Should it be established that a notable loss is associated with the project, a wetland offset strategy must be produced for the project. This may include onsite rehabilitation of affected systems to provide suitable compensation. This strategy should be completed in association with land users who have contributed to the deterioration of the wetlands, and that can also contribute to the effective implementation of the strategy.
21	Processing facilities	Decrease in surface water quality	Design and implement a site-specific stormwater management plan for the compressor and helium/LNG plant that will enable dispersed release of runoff at outlets, with outlets located outside (upslope) of buffered watercourses (where possible). ensure separation of clean and dirty water and provide for adequate dirty water containment. Ensure that sufficient ablution facilities are available on site and that septic tanks are located outside of buffered watercourses. Stabilise new channels that form because of headcut erosion or other forms of erosion once they are recorded.	Implement a surface water monitoring programme.

48	All	Disruption of aquatic communities	Ideally, no vehicle access tracks/roads should transect through watercourses. Access tracks/roads should be designed in such a way to minimise overlap with watercourses. Use existing access roads/tracks as far as possible. Construction and unavoidable access tracks/roads through wetlands, rivers and other watercourses must provide habitat connectivity between upstream and downstream reaches (e.g. flume pipes and/or culverts) and to reduce the risk of scour erosion and channel incision within the watercourse. No unauthorised driving should be allowed through watercourses. Driving can only occur on specially designed tracks/roads that minimised the risk of erosion and surface flow concentration. No perched flumes should be present in temporary construction running tracks and/or permanent access tracks. In the case of aboveground pipelines, the pipeline should not be located 'flush' along the surface profile of the watercourse with no gap between the natural ground level and the pipeline. Aboveground pipelines should rather be suspended on plinths of a sufficient height that will allow the free movement of indigenous fauna present within the study area, such as tortoises, as recorded in the Bosluisspruit channel near existing well SPG3.	
49	All	Watercourse erosion	Prevent the use of only one or two flume pipes in access/running tracks located in watercourses, specifically unchannelled valley bottom wetland and seep wetlands where concentrated flows can result in headcut development and the formation of a channel. Surface flows should also be spread out in channelled watercourse crossings though the use of several flume pipes to prevent channel incision and scour erosion. Access tracks should be maintained during the entire construction process and removed once construction is completed. Flume pipes should be monitored and kept free of blockages. Construction in watercourses should ideally occur during the dry season. Any new erosion features identified should be stabilised during the construction process (soft interventions such as hay bales, rock packs, runoff control berms and 'bio-socks' are recommended). Erosion control features should be maintained. Keep vegetation clearing to a minimum on the adjacent slopes to prevent erosion on approaches bordering watercourses. Small temporary contour berms may be used to help control runoff on approaches should it be required. Drainage furrows that may be required to create dry working conditions should ideally be avoided as they can easily erode during high flow events. Development of a watercourse monitoring plan before the onset of the construction phase, and the development and implementation of a watercourse rehabilitation plan during the latter half of the construction phase to ensure the eroded wetlands and other watercourses are stabilised and rehabilitated. Dewatering discharges at construction sites should be done in a silt bay to prevent erosion and sedimentation in adjacent watercourses. Runoff from the construction footprint should be controlled on site to prevent	Watercourses should be monitored on an annual basis for signs of erosion. Any signs of erosion must be addressed to be prevent the worsening of the headcut.

			concentrated point releases of water into downslope watercourses. Care needs to be taken not to initiate or aggravate erosion in watercourses.	
55	All	Increase sediment loads	Progressive rehabilitation of disturbed land should be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff. Traffic and movement over stabilised areas should be controlled (minimised and kept to certain paths), and damage to stabilised areas should be repaired timeously and maintained. The total footprint area to be cleared for drilling should be kept to a minimum by demarcating the drilling areas and restricting removal of vegetation to these areas only.	
63	All	Pollution of wetland habitats	Control all waste sources emanating from proposed activities. Maintain minimum distances from aquatic and wetland habitats, where possible. Undertake activities in previously disturbed areas and/or habitats with lower sensitivity.	
64	All	Decrease in surface water quality in watercourses	Store all hazardous materials (Incl. hydrocarbons) in a bunded area, outside of buffered watercourses. Stripped and excavated subsoil and topsoil stockpiles should be stored outside of buffered wetland areas and be protected from erosion. This may not be possible for long wetland crossings in seep and other wetlands, in which case topsoil can be stored on low berms within the wetland on geotextile material. Topsoil and subsoil should however be protected from erosion. Approaches that border watercourses, particularly those along steep and long slopes, should receive runoff control measures to prevent siltation and concentrated flow into watercourses. Inspect vehicles for leaks and repair all leaks immediately. Any generators used in watercourses should be used with a functional drip tray. Ensure that sufficient ablution facilities are available on site and that they are located outside of buffered watercourses. Stabilise new channels that form as a result of headcut erosion or other forms of erosion once they are recorded. Sediment deposition should be prevented in watercourses and especially watercourse channels through the following measures: Implementing stormwater control measures around construction areas; and Dewatering during excavation activities in watercourses should be released in a silt bay with sufficient capacity that filters and retains sediment before the water is released into the watercourses. Sediment deposition events into watercourses should be evaluated by an experienced ECO/ wetland specialist and based on the magnitude of the impact recommendations can be made regarding the removal of deposited material.	
75	All	Watercourse erosion	Use existing access roads as far as possible. Unavoidable new permanent access roads/tracks in watercourses should be designed to prevent erosion downstream of the crossings by using several flume pipes, preferably culverts, or other structures, such as concrete fords. All temporary and permanent vehicle access tracks/roads in watercourses will require	

			approval from DWS in the form of a Water Use License. New permanent access roads/tracks should be located along existing infrastructure footprints as far as possible and at areas that will enable the shortage crossing distance through watercourses. Long crossings along the length of watercourses (parallel to its flow direction) should be avoided. Remnant erosion features that remain after the rehabilitation phase should be addressed until full rehabilitation and closure is achieved. Rehabilitation interventions should be considered with care and not worsen erosion once implemented [Amendment 2019/05]. Identified permanent access tracks should be maintained during the entire operational phase of the project and blockages should be removed, while erosion features should be repaired once observed. Concrete fords (low water bridges) are preferred as crossing structures in larger watercourse channels, compared to culverts and flume pipes, which are more likely to result in erosion and require more regular maintenance. The Helium plant should receive stormwater mitigation measures at its outlets that will prevent concentrated flow. Stormwater mitigation measures and flow outlets should be located outside of buffered watercourses.	
108	All	Encroachment/ invasion of alien plants (specifically into watercourses)	Restrict the clearing of watercourse vegetation as far as possible. Areas that have been cleared should be re-vegetated with indigenous species or other suitable plant species, such as *Eragrostis tef*, after construction and initial rehabilitation work (reinstatement of the geomorphological template) is completed. Compile and implement an alien plant control program with a particular focus on alien control in watercourses (including wetlands) during the rehabilitation phase of the project. Rehabilitate disturbed areas as soon as possible. Restrict new footprints to disturbed areas as far as possible. Regular monitoring should be undertaken in the watercourses to check any possible invasion by alien vegetation so that they can be weeded out before they grow and spread out.	

6.4 Wetland Impact Assessment

The development of the project will result in the loss of watercourse habitats where infrastructure traverses or is placed. The clearing topsoil and vegetation will be required for the installation and placement of infrastructure. The development across and/or within watercourses can also cause a disruption to the biotic community structure due to the fragmentation and deterioration of habitat. Thus, the loss, fragmentation and/or deterioration of wetland habitat will reduce the level of ecosystem service benefit provide by the affected systems. The development of the area in proximity of the watercourses would also create erosion hotspots which could contribute to the sedimentation of any receiving watercourses. Infrastructure in proximity to watercourses and located on a suitable slope could create preferential flow paths, causing increased surface run-off volumes and velocities causing erosion to the area. Sunken pipelines could also impede interflow, resulting in a decrease in water reporting to the downslope watercourse. Sedimentation of the watercourses will impede the ability of the system to provided beneficial ecosystem services which might include water quality improvement, habitat maintenance but also water availability. Water quality could also be impacted by spills and leaks from machinery, equipment and vehicles operating in proximity to wetlands. Any contaminants entering the system/s could contribute to the deterioration in water quality. Poor water quality will have a resulting impact on biota and vegetation dependent on the affected system as a water source.

The additional impacts associated with the proposed activities, which weren't considered covered in the existing approved Cluster 1 EIA and EMPr, are considered in this section. No 'new' impacts are expected for the Cluster 2 gas exploration project, except for the powerlines. Two powerlines have been considered for this assessment, specifically the 33kV (Figure 6-1) and 132kV (Figure 6-2) routes. The two powerlines both traverse channelled valley bottom (CVB) wetlands and are also adjacent to seepage (SEEP) systems. Similar impacts are expected for both powerlines.

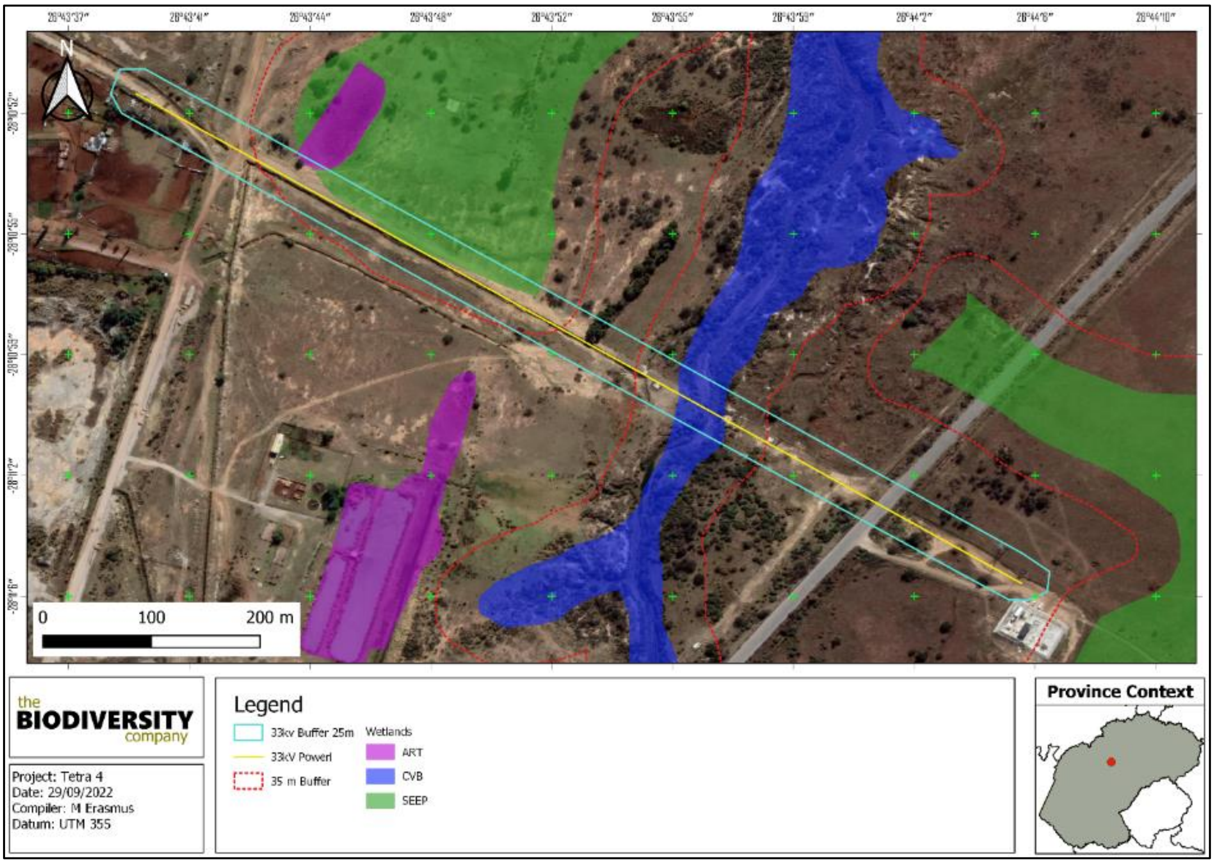

Figure 6-1 The location of the powerline in relation to the delineated water resources

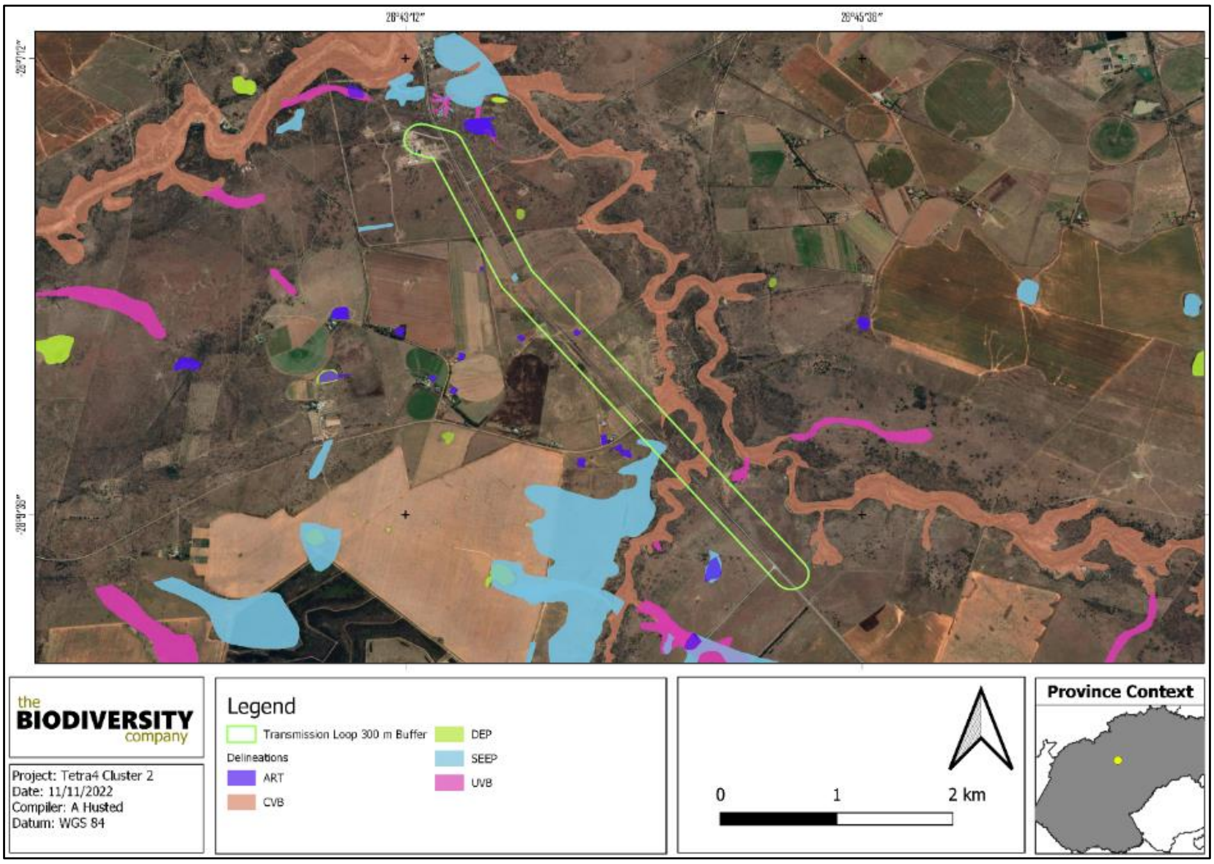

Figure 6-2 The location of the powerline in relation to the delineated water resources

Table 6-2 Impact assessment for the proposed 33kV and 132kV powerline

Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
Powerlines - Habitat	Construction	-5.5	-3	High	1	1	-3
Powerlines - Water Quality	Construction	-2	-1.25	High	1	1	-1
Powerlines - Flow	Construction	-2.5	-1.25	High	1	1	-1
Powerlines - Habitat	Operation	-5	-3.5	High	1	1	-4
Powerlines - Water Quality	Operation	-1	-1	High	1	1	-1
Powerlines - Flow	Operation	-1	-1.25	High	1	1	-1
Powerlines - Habitat	Decommissioning	-5	-3	High	1	1	-3
Powerlines - Water Quality	Decommissioning	-2	-1.25	High	1	1	-1
Powerlines - Flow	Decommissioning	-2.5	-1.25	High	1	1	-1

6.4.1 Mitigation Measures

The following mitigation measures are applicable for the powerline:

- Keep the number of towers in the wetland to a feasible minimum. The placement of towers in the assigned buffer (of 35 m) is preferred to minimise the number of towers placed within the wetland;

- Construction activities should be scheduled for the least sensitive periods, in order to avoid the migration, nesting and breeding seasons of SCC as far as practical;
- Locate powerline alignment outside of buffered watercourses (sensitive watercourse habitat) as far as possible;
- Buffered watercourses should be demarcated on site for the entire construction process to help indicate sensitive areas and prevent unauthorised access;
- The route should be located along existing infrastructure features, such as roads, dam walls and existing pipelines. Unavoidable crossings should ideally be located perpendicular to the direction of flow at the shortest possible crossing distances;
- The servitude width should be restricted in watercourse crossings to reduce the footprint of the impact;
- A construction method statement should be prepared by the contractor with input from a watercourse specialists prior to the start of construction. Conditions stated in the water use license should also be implemented; and
- Make provision in the design phase for permanent access tracks/roads that will be required for the maintenance of the powerline.

6.5 Recommendations

The following recommendations are provided for the project:

- No mitigation measures have been prescribed for the decommissioning phase of the project. It is recommended that the closure plan and objective be reviewed, and appropriate measures be included for the local water resources;
- Implement the “Working in Sensitive Areas” (document number T4-PP-SHERQ-051) detailed in the operating procedures document;
- Implement the “Erosion Control and Storm Water Management” (document number T4-PP-SHERQ-043) detailed in the operating procedures document;
- Once the pipeline has been installed, the disturbed area must be cleaned up in accordance with the Environmental Management Plan, and in accordance to the Tetra4 Rehabilitation Plan and Procedure; and
- All activities related to these works shall comply with all applicable Environmental Laws, Tetra4’s approved Environmental Management Programme (EMPR) and Tetra4’s Environmental Procedures when undertaking any works.

6.6 Monitoring Plan

The following monitoring programme is recommended.

Table 6-3 The recommended monitoring programme

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
The wetlands area (Area of Interest), prioritising wetlands within 50 m of land disturbance	Wetland Present Ecological State, Functioning & Ecological	Bi-annual for 2-years as a minimum, thereafter to be determined by the wetland specialist in agreement	Wetland WET-Series

	Importance & Sensitivity	with the relevant Department.	
	Determine if habitat quality deterioration is occurring.		Monitor for presence erosion, alien vegetation, wetland rehabilitation succession, and sedimentation
	Determine if water quality deterioration is occurring.	To be determined by the surface water monitoring programme	-

7 Conclusion

Natural wetlands classified as being channelled valley bottoms, depressions, hillslope seeps and unchannelled valley bottom as well as artificial systems were identified within the study area. The Present Ecological State (PES) of the wetlands ranges from "Seriously Modified" to 'Moderately Modified". The majority of modifications to wetlands in the study area is from agricultural activities taking place in the wetland and their respective catchments.

The Ecosystem Services of the wetlands range from "Moderately High" to "Moderately Low" for the study area. The valley bottom scored overall higher ecosystem services scores due to their ability to regulate streamflow, prevent flooding and helps with erosion control. The vegetation cover within the wetlands plays a major role in the ecosystem services scores. All the wetlands delineated within the study area were rate to be "Moderately" sensitive due to the relatively high protection status of the wet veg type and the low protection status of the wetland itself.

The buffer zone calculated for the delineated wetlands is 35 m. This buffer zone will ensure the conservation of the delineated wetlands from the proposed activities.

The impact assessment considered both direct and indirect impacts, to the water resources. It is evident that the pipeline and the transmission loop will encroach into the delineated wetland areas. The buffers around the wells and compressors also encroach into the wetland buffers but impacts can be avoided with the mitigation provided.

Although all of the risks were considered low (post-mitigation). No moderate post-mitigation risks are anticipated to occur for the proposed project. Overall, the impacts associated with this service development are unlikely to negatively impact water resources to any appreciable level provided that the suggested mitigations measures are effectively implemented. Additionally, the project focusses on conveying gas, thus risks associated with leaks are considered low.

7.1 Specialist Recommendation

It is the specialist's opinion that no fatal flaws have been identified, and that the proposed activities may proceed as have been planned. Given the fact that "Low" post-mitigation significance ratings were determined for various aspects of the proposed project, it's the specialist's opinion that a General Authorisation could be applied for.

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