DIGBY WELLS
ENVIRONMENTAL

Environmental Regulatory Processes relating to the Thubelisha, Trichardtsfontein and Vaalkop Mining Right Areas

Wetland Ecological Assessment

Project Number:

SAS3869

Prepared for:

Sasol Mining (Pty) Ltd

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Digby Wells and Associates (South Africa) (Pty) Ltd
Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 069 6801, info@digbywells.com, www.digbywells.com

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Name	**Responsibility**	**Signature**	**Date**
Kathryn Roy	Field work and report writing		17 August 2017
Anton Linstrom	Field work and technical review		18 August 2017
Danie Otto	Field work and EXCO review		18 August 2017

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EXECUTIVE SUMMARY

Wetlands are sensitive ecosystems that perform many complex functions. These functions include *inter alia* the maintenance of biodiversity and water quality, toxicant assimilation, carbon storage, streamflow regulation, flood attenuation, and various social benefits.

Sasol Mining (Pty) Ltd (hereinafter Sasol) appointed Digby Wells Environmental (hereinafter Digby Wells) to provide specialist studies in support of the national legislative process for the consolidation of their Twistdraai Colliery: Thubelisha Shaft (TCTS), Trichardtsfontein and Vaalkop Mining Right areas (“the Project”). The proposed consolidation of the Mining Right areas will be completed in terms of Section 102 of the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA).

Initial mining methodologies approved by the Department of Mineral Resources (DMR) for Trichardtsfontein Mine comprised conventional bord-and-pillar undermining. Sasol now propose to include high extraction mining methodologies across all three aforementioned Mining Right areas. To this effect, Sasol must consider the potential impacts that may result from this amendment, specifically the increased risk of surface subsidence.

The aim of this study was to conduct an assessment on the natural wetland habitats in relation to the proposed amendments. This report is specifically associated with the Vaalkop area of the Project for incorporation with previous wetland studies. The assessment adhered to recognised methodologies. These included delineation of all wetlands within the Vaalkop Mining Right area using:

- Soil and vegetation indicators;
- Classification of wetlands into hydrogeomorphic units according to the terrain; and
- Ecological health assessment.

The results of the wetland delineation were considered against the proposed amendments to complete the impact assessment and propose realistic and feasible mitigation measures.

The Project area is characterised by large areas of wetlands; totalling 6080.1 hectares (ha). These include three major types of wetlands, being:

- Channelled valley bottom systems;
- Hillslope seeps; and
- Floodplains.

All identified wetland types function differently. Many of these wetlands are mapped as National Freshwater Ecosystem Priority Areas (NFEPA) and thus are recognised for the role they play in supporting and provisioning services to the surrounding area and country.

Additionally, these wetlands are identified as Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESA) according to the Mpumalanga Biodiversity Sector Plan (2013). These classifications are reiterated by the Mining and Biodiversity Guideline Report (2013). Within this report, the wetlands are designated as having the highest biodiversity importance status in support of the national biodiversity strategic goals. The Mine Plan indicates that approximately 3406.2 ha of wetlands, most of these highlighted as being at highest risk from mining within the Mining and Biodiversity Guideline Report (2013), are proposed to be undermined. This area increases to 9072.4 if the 100m buffer is included). Although the mine surface infrastructure will not result in any direct destruction of wetlands, the indirect loss of wetlands due to altered hydrology from undermining activities cannot be quantified in detail. Furthermore, the impacts of subsidence will be very high where the shallow mining (30 – 100 m) is going to be taking place and will result in a complete loss of the undermined wetlands. Decant is likely to occur due to subsidence, uncapped boreholes and sinkholes, although it is not expected to occur at the shaft locations. The impact of decant on wetlands systems could potentionally be high if not mitigated through treatment options. The Project, therefore, has the potential to result in significant negative impacts on the natural wetlands and to alter the functioning of these systems and compromise their ecosystem services provided

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1 Introduction

Wetlands are defined according to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) 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."

Wetlands are sensitive ecosystems that perform many complex functions. These functions include inter alia the maintenance of biodiversity and water quality, toxicant assimilation, carbon storage, streamflow regulation, flood attenuation, and various social benefits. (Wet-EcoServices Manual, 2008). The Ramsar Convention on Wetlands refers to wetlands as one of the most important life support systems on earth owing to the services provided.

The regional ecosystem services are threatened by coal mining of Mpumalanga's extensive coal reserves. Coal mining causes destruction of wetlands through direct impacts such as removal of habitat, alteration of flow and contamination of water, but also indirectly through the drawdown of groundwater resources during the dewatering process. Impacts on water resources are significant and include the leaching of acid mine drainage into streams and rivers causing acidification and salinisation by dissolved sulfates. Wetland systems cannot be regarded as isolated entities but rather as complex interlinking systems; furthermore it is estimated that South Africa contains over 10 000 km^2 of hydraulically interlinked coal mines (Ochieng et al. 2010).

This report serves to detail the findings of the Wetland Impact Assessment for the Project, with a focus on the Vaalkop area not previously delineated. Sasol Mining (Pty) Ltd (hereinafter Sasol) appointed Digby Wells Environmental (hereinafter Digby Wells) as the independent environmental practitioner to undertake a Section 102 process in accordance with the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA).

2 Project Background

Sasol holds mining rights (MR) for the Twistdraai Colliery: Thubelisha Shaft (TCTS) and the Vaalkop mining area (Ref: MP30/5/1/2/2/138MR). Further to this, the MR for the Trichardtsfontein Mine (Ref: MP30/5/1/2/2/10056MR) was ceded from Glencore Operations South Africa (Pty) Ltd in accordance with Section 11 of the MPRDA to Sasol.

It is therefore required from Sasol that the Environmental Management Programme (EMPr) Reports for the aforementioned mines be consolidated and updated to reflect changes in the mining plans and methodologies and consider additional infrastructure requirements. Digby Wells is therefore proposing a submission in terms of the provisions of Section 102 of the MPRDA and Regulation 31 of the EIA regulations, 2014 (as amended) promulgated in accordance with the National Environmental Management Act, 1998 (Act No. 107 of 1998)

(NEMA) to obtain the required authorisation for both the amendment and consolidation process of the EMPrs (referred to in general as the Environmental Authorisation (EA) Amendment process). A basic assessment process will also be undertaken to obtain environmental authorisation for the construction and operation of the ventilation shafts. This will be undertaken as a consolidated process in accordance with the one environmental system.

The mining method proposed for the extraction of coal at the Trichardtsfontein Mine included the conventional bord-and-pillar method. Sasol now propose to include high extraction mining methodologies across all three aforementioned MR areas at an approximate depth of 200m below surface. To this effect, Sasol must consider the potential impacts that may result from this amendment, specifically the increased risk of surface subsidence. In addition, all waste rock and Run of Mine (RoM) coal will be conveyed directly from the mine workings to the TCTS, located adjacent to the Trichardtsfontein Mine. Additionally, two ventilation shafts have been proposed, which will assist in providing sufficient ventilation to the underground mining area. No listed activities will be triggered in accordance with the new Environmental Impact Assessment (EIA) Regulations, 2014 promulgated in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

Sasol also holds the MR for the Vaalkop Mining Area. Although the right was awarded to Sasol, specialist studies as well as an EMPr Report was not compiled. Therefore Sasol undertook the required specialist studies to determine the impact that may be experienced from bord-and-pillar mining method and high extraction mining.

3 Project Location

The Project is located between the town of Trichardt and Bethal in Mpumalanga Province. The town of Evander is 17 km to the west and Secunda is 10 km south west of the Project. Vaalkop is located 5 km south east of Bethal and 17 km south west of Trichardt. The Project area and coal reserve are located within the Highveld East Magisterial District, the Gert Sibande District Municipality and the Govan Mbeki Local Municipality.

The Project is situated within a region that is characterised by coal mining activities and cultivation which includes maize cropping and grazing. The Isibonelo and Syferfontein coal mines are situated to the north west of the Project area.

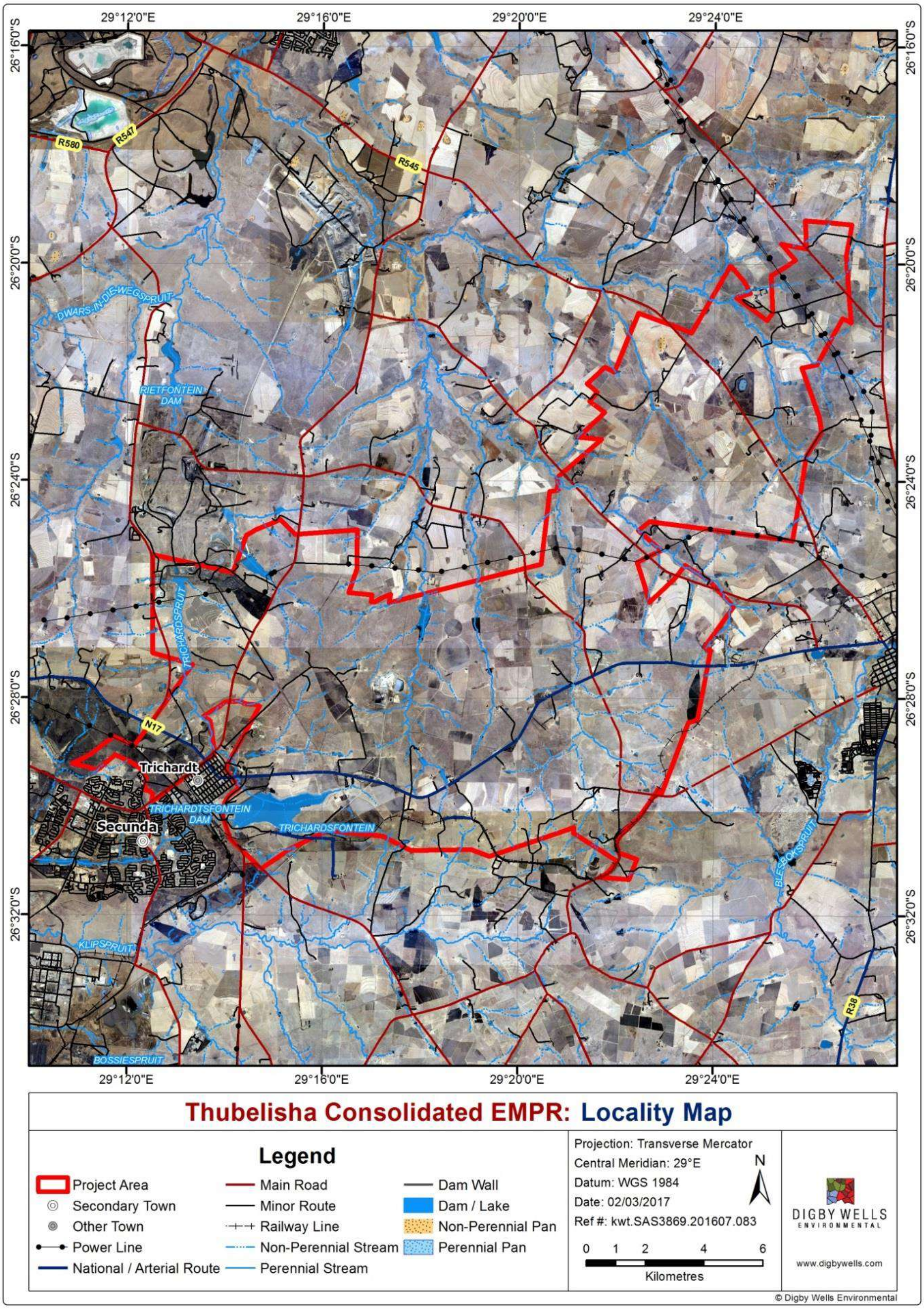


Figure 3-1: Locality

4 Terms of References

Digby Wells is required to compile a wetland assessment in support of the Section 102 process being completed in terms of the MPRDA.

A wetland assessment was completed by Wetland Consulting Services (Pty) Ltd (WCS) in 2007 on behalf of Oryx Environmental for TCTS, and an additional wetland assessment was completed for Trichardtsfontein in 2014. As a result, only the Vaalkop Project area requires a new wetland delineation. Digby Wells was therefore appointed to complete a wetland delineation and assessment for wetland ecosystems associated with the Vaalkop Project area. Digby Wells was also then required to consolidate this Vaalkop assessment with the wetland delineations for the other MRs and update the impacts associated with the proposed mining method and the construction of vent shafts.

5 Scope of Work

The following actions are required for this Scope of Work:

- The identification and the delineation of wetlands within the Vaalkop Project area (TCTS and Trichardtsfontein Project areas were previously delineated by WCS);
- A description and characterisation of the identified wetland areas;
- Determination of the wetland ecological health, importance and sensitivity;
- Assessment of potential impacts to the wetlands from the activities; and
- Discussion of recommended mitigation measures to be taken into account.

5.1 Policy and Legal Framework

The wetlands assessment aims to support the following regulations, regulatory procedures and guidelines:

- Section 24 of the Constitution of the Republic of South Africa ,1996 (Act No. 108 of 1996);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA);
- Section 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- Department of Water and Forestry (DWAF) Guidelines for the Delineation of Wetlands (2005);
- Mining and Biodiversity Guideline (DEA *et al*., 2013);
- Mpumalanga Biodiversity Sector Plan (MBSP) (MTPB, 2014);

- Wetland Management Series (published by Water Research Commission (WRC, 2007);
- National Freshwater Ecosystems Priority Areas (NFEPA, Nel *et al.,* 2011); and
- SANBI, in collaboration with the DWS report on "Wetland offsets: a Best-Practice Guideline for South Africa" (Macfarlane, *et al.,* 2014).

6 Details of Specialist

Kathryn Roy: Flora and Wetlands Consultant. Kathryn has 4.5 years of experience as an Ecologist. Kathryn received a Bachelor of Science in Ecology and Environmental Science and an Honours degree in Environmental Management from the University of Cape Town. She also has received her MSc in Restoration Ecology through the University of KwaZulu-Natal. She joined Digby Wells in February 2016 to form part of the Mine Closure and Rehabilitation Department where she was responsible for development of site specific rehabilitation plans, working closely with both the botany and soils specialists in Digby Wells.

Danie Otto: Director: Technical Services. Danie has over 20 years of experience in mining-related projects. Danie manages the Specialist Departments at Digby Wells and holds an M.Sc in Environmental Management with B.Sc Hons (Limnology, Geomorphology, GIS and Environmental Management) and B.Sc (Botany and Geography & Environmental Management). He is a biogeomorphologist that specialises in ecology of wetlands and rehabilitation. He has been a registered Professional Natural Scientist since 2002.

Anton Linstrom: Wetland Ecologist. Anton has a Master's Degree in Environmental Management focusing on river and wetland ecology and 24 years' experience as a professional conservationist. The majority of these years have been in Mpumalanga, although he has operated much further afield in Rwanda, Congo, Lesotho and Mozambique. Prior experience in conservation equipped him with a vast knowledge on wetland biota. He serve as a wetland ecologist as part of the Working for Wetland Rehabilitation Programme in the Mpumalanga Province. Anton is lecturing at the Advanced Wetland Course and the Wetland Rehabilitation Course through the University of the Orange Free State and lecturing in River Ecology at the University of Venda. Anton is registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (Registration number: 400275/11). He is also a member of the South African Wetland Society.

7 Aims and Objectives

The aim of the wetland study was to conduct an assessment on the natural wetland habitats associated with the Project area. This assessment determined the wetland boundaries and the baseline ecological state prior to the development. This information was to inform the Project on the risks associated with the wetland ecosystems so that mitigation measures can be carried out according to best practice and to set a baseline against which to monitor.

8 Methodology

8.1 Literature Review and Desktop Assessment

Wetland areas were identified and preliminary wetland boundaries were delineated at the desktop level using Google Earth Imagery (Google Inc.), along with 5m contours. Baseline and background information was researched and used to understand the area on a desktop level prior to fieldwork; this included but was not limited to:

- NFEPA (Nel *et al*., 2011);
- Water Management Areas (WMA) and Quaternary Catchments; and
- Mpumalanga Biodiversity Sector Plan (MBSP).

8.1.1 National Freshwater Ecosystem Priority Areas

The NFEPA project provides a collated, nationally consistent information source of wetland and river ecosystems for incorporating freshwater ecosystem and biodiversity goals into planning and decision-making processes (Nel *et al.* 2011). The spatial layers (FEPA's) include the nationally delineated wetland areas that are classified into hydrogeomorphic (HGM) NFEPA project types and ranked in terms of their biodiversity importance. These layers were assessed to evaluate the importance of the wetland areas located within the Project area.

Whilst being an invaluable tool, it is important to note that the NFEPA's were delineated and studied at a desktop and low resolution level. Thus, the wetlands delineated via the ground-truthing work done through this study may differ from the NFEPA layers. The NFEPA assessment does, however, hold significance from a national perspective. The NFEPA wetlands have been ranked in terms of importance in the conservation of biodiversity and Table 8-1 below indicates the criteria that were considered for the ranking of wetland areas.

Table 8-1: NFEPA Wetland Classification Ranking Criteria

Criteria	Rank
Wetlands that intersect with a RAMSAR site.	1
▪ Wetlands within 500 m of an IUCN threatened frog point locality; ▪ Wetlands within 500 m of a threatened water-bird point locality; ▪ Wetlands (excluding dams) with the majority of their area within a sub-quaternary catchment that has sightings or breeding areas for threatened Wattled Cranes, Grey Crowned Cranes and Blue Cranes; ▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of exceptional Biodiversity importance, with valid reasons documented; and ▪ Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands that are good, intact examples from which to choose.	2

Criteria	Rank
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing wetlands of biodiversity importance, but with no valid reasons documented.	3
Wetlands (excluding dams) in A or B condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion); and Wetlands in C condition AND associated with more than three other wetlands (both riverine and non-riverine wetlands were assessed for this criterion).	4
Wetlands (excluding dams) within a sub-quaternary catchment identified by experts at the regional review workshops as containing Impacted Working for Wetland sites.	5
Any other wetland (excluding dams).	6

8.1.2 Mpumalanga Biodiversity Sector Plan

The MBSP is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land-use and development planning, environmental assessment and regulation, and natural resource management. Strategically the MBSP enables the province to:

- Implement the NEM:BA, 2004 provincially, and comply with requirements of the National Biodiversity Framework, 2009 (NBF) and certain international conventions;
- Identify those areas of highest biodiversity that need to be considered in provincial planning initiatives, and
- Address threat of climate change (ecosystem-based adaptation).

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs). Wetlands in Mpumalanga Province have been extensively degraded and, in many cases, irreversibly modified and lost through a combination of inappropriate land-use practices, development and mining. Wetlands represent ecosystems of high value for delivering, managing and storing good quality water for human use, and they are vulnerable to harmful impacts. It is therefore in the interest of national water security that all wetlands are protected by law. The management objectives of these areas are summarised below.

Table 8-2: Mpumalanga Biodiversity Sector Plan Categories

Map category	Definition	Desired management objectives
PA	Those areas that are proclaimed as protected areas under national or provincial legislation, including gazetted protected environments.	Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.
CBAs	Areas that are required to meet biodiversity targets, for species, ecosystems or ecological processes. CBA Wetlands are those that have been identified as FEPA wetlands that are important for meeting biodiversity targets for freshwater ecosystems.	Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.
ESAs	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services. ESAs Wetlands are those that are non-FEPA and ESA Wetland Clusters are clusters of wetlands embedded within a largely natural landscape that function as a unit, and allow for the migration of species such as frogs and insects between individual wetlands.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorisation process that ensures the underlying biodiversity objectives are not compromised.
ONAs	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritised for biodiversity, they are still an important part of the natural ecosystem.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.

Map category	Definition	Desired management objectives
Heavily or Moderately Modified Areas	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritised for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximise ecological functionality and authorisation is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilised and restored where possible, especially for soil carbon and water-related functionality.

8.1.3 Mining and Biodiversity Guideline

The Mining and Biodiversity Guideline was developed collaboratively by the South African Biodiversity Institute (SANBI), the Department of Environmental Affairs (DEA), the Department of Mineral Resources (DMR), the Chamber of Mines and the South African Mining and Biodiversity Forum in 2013. The purpose of the guideline was to provide the mining sector with a manual to integrate biodiversity into the planning process thereby encouraging informed decision-making around mining development and environmental authorisations. The aim of the guideline is to explain the value for mining companies to consider biodiversity management throughout the planning process. The guideline highlights the importance of biodiversity in managing the social, economic and environmental risk of the proposed mining project. The country has been mapped into biodiversity priority areas including the four categories listed in Table 8-3 below, each with associated risks and implications.

Table 8-3: Mining and Biodiversity Guideline Categories (SANBI, 2013)

Category	Risk and Implications for Mining
Legally protected	Mining prohibited; unless authorised by ministers of both the DEA and DMR.
Highest Biodiversity Importance	Highest Risk for Mining: the EIA process must confirm significance of the biodiversity features that may be seen as a fatal flaw to the proposed project. Specialists must provide site-specific recommendations for the application of the mitigation hierarchy that informs the decision making processes of mining licences, water use licences and environmental authorisations. If granted, authorisations should set limits on allowed activities and specify biodiversity related management outcomes.
High Biodiversity Importance	High Risk for Mining: the EIA process must confirm the significance of the biodiversity features for the conservation of biodiversity priority areas. Significance of impacts must be discussed as mining options are possible but must be limited. Authorisations may set limits and specify biodiversity related management outcomes.

Category	Risk and Implications for Mining
Moderate Biodiversity Importance	Moderate Risk for Mining: the EIA process must confirm the significance of the biodiversity features and the potential impacts as mining options must be limited but are possible. Authorisations may set limits and specify biodiversity related management outcomes.

8.2 Wetland Identification and Delineation

The wetland delineation procedure considers four attributes to determine the limitations of the wetland, in accordance with DWAF guidelines (now Department of Water and Sanitation (DWS) (2005)). The four attributes are:

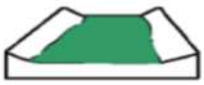
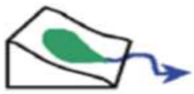
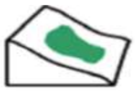
- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur;
- Soil Form Indicator – identifies the soil forms, which are associated with prolonged and frequent saturation;
- Soil Wetness Indicator – identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

8.2.1 Terrain Indicator

Terrain Unit Indicator (TUI) areas include depressions and channels where water would be most likely to accumulate. These areas are determined with the aid of topographical maps, aerial photographs and engineering and town planning diagrams (DWAF, 2005). The Hydro-geomorphic HGM Unit system of classification focuses on the hydro-geomorphic setting of wetlands which incorporates geomorphology; water movement into, through and out of the wetland; and landscape / topographic setting. Once wetlands have been identified, they are categorised into HGM Units as shown in Table 8-4

Table 8-4: Description of the Difference HGM Units for Wetland Classification

Hydromorphic wetland type	Diagram	Description
Floodplain		Valley bottom areas with a well-defined stream channel stream channel, gently sloped and characterised by floodplain features such as oxbow depression and natural levees and the alluvial (by water) transport and deposition of sediment , usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.

Hydromorphic wetland type	Diagram	Description
Valley bottom with a channel		Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from the main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from the channel entering the wetland and also from adjacent slopes.
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterised by colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.
Isolated hillslope seepage		Slopes on hillsides that are characterised by colluvial transport (transported by gravity) movement of materials. Water inputs are from sub-surface flow and outflow either very limited or through diffuse sub-surface flow but with no direct link to a surface water channel.
Pan/Depression		A basin-shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. It is inward draining). It may also receive subsurface water. An outlet is usually absent and so this type of wetland is usually isolated from the stream network.

8.2.2 Soil Form Indicator

Hydromorphic soils are taken into account for the Soil Form Indicator (SFI) which will display unique characteristics resulting from prolonged and repeated water saturation (DWAF, 2005). The continued saturation of the soils results in the soils becoming anaerobic and thus resulting in a change of the chemical characteristics of the soil. Iron and manganese are two soil components which are insoluble under aerobic conditions and become soluble when the soil becomes anaerobic and thus begin to leach out into the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils.

Resulting from the prolonged anaerobic conditions, iron is dissolved out of the soil, and the soil matrix is left a greying, greenish or bluish colour, and is said to be “gleyed”. Common in wetlands which are seasonally or temporarily saturated is a fluctuating water table, these results in alternation between aerobic and anaerobic conditions in the soil (DWAF, 2005).

Iron will return to an insoluble state in aerobic conditions which will result in deposits in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally of temporarily saturated (DWAF, 2005).

8.2.3 Soil Wetness Indicator

In practice, the Soil Wetness Indictor (SWI) is used as the primary indicator (DWAF, 2005). Hydromorphic soils are often identified by the colours of various soil components. The frequency and duration of the soil saturation periods strongly influences the colours of these components. Grey colours become more prominent in the soil matrix the higher the duration and frequency of saturation in a soil profile (DWAF, 2005). A feature of hydromorphic soils are coloured mottles which are usually absent in permanently saturated soils and are most prominent in seasonally saturated soils, and are less abundant in temporarily saturated soils (DWAF, 2005). The hydromorphic soils must display signs of wetness within 50cm of the soil surface, as this is necessary to support hydrophytic vegetation.

8.2.4 Vegetation Indicator

As one moves along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas plant communities undergo distinct changes in species composition. Valuable information for determining the wetland boundary and wetness zone is derived from the change in species composition. A supplementary method for employing vegetation as an indicator is to use the broad classification of the wetland plants according to their occurrence in the wetlands and wetness zones (Kotze and Marneweck, 1999; DWAF, 2005). This is summarised in Table 8-5 below. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2005). Areas where soils are a poor indicator (black clay, vertic soils), vegetation (as well as topographical setting) is relied on to a greater extent and the use of the wetland species classification as per Table 8-5 becomes more important. If vegetation was to be used as a primary indicator, undisturbed conditions and expert knowledge are required (DWAF, 2005). Due to this uncertainty, greater emphasis is often placed on the SWI to delineated wetland areas. In this assessment the SWI has been relied upon to delineate wetland areas due to the abundance of cropped and overgrazed areas. The identification of indicator vegetation species and the use of plant community structures have been used to validate these boundaries.

Table 8-5: Classification of Plant Species According to Occurrence in Wetlands (DWAF, 2005)

Type	Description
Obligate Wetland species (OW)	Almost always grow in wetlands: >99% of occurrences.

Type	Description
Facultative Wetland species (FW)	Usually grow in wetlands but occasionally are found in non-wetland areas: 67 – 99 % of occurrences.
Facultative species (F)	Are equally likely to grow in wetlands and non-wetland areas: 34 – 66% of occurrences.
Facultative dry-land species (FD)	Usually grow in non-wetland areas but sometimes grow in wetlands: 1 – 34% of occurrences.

8.3 Wetland Ecological Health Assessment

According to Macfarlane *et al*. (2009) the health of a wetland can be defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. A level 1 WET-Health assessment was done on the wetlands in accordance with the method described by Kotze *et al.* (2007) to determine the integrity (health) of the characterised HGM units for the Project area. Level 1 was selected due to the large size of the Project area. A Present Ecological State (PES) analysis was conducted to establish baseline integrity (health) for the associated wetlands. The health assessment attempts to evaluate the hydrological, geomorphological and vegetation health in three separate modules to attempt to estimate similarity to or deviation from natural conditions. The overall health score of the wetland is calculated using Equation 1, which provides a score ranging from 0 (pristine) to 10 (critically impacted in all respects). The PES is determined according to Table 8-6.

$$Wetland\ Health = \frac{3(Hydrology)\ + 2(Geomorphology) + 2(Vegetation)}{7}$$

Equation 1: Overall Wetland Ecological Health Score

Table 8-6: Impact Scores and Present Ecological State Categories used by Wet-Health

Description	Combined Impact Score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota has taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D

Description	Combined Impact Score	PES Category
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.	6-7.9	E
Modifications have reached a critical level and ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

8.4 Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term. The methodology outlined by DWAF (1999) and updated in Rountree and Kotze, (2012, in Rountree *et al.* (2012) was used for this study

In this method there are three suites of importance criteria; namely:

- **Ecological Importance and Sensitivity:** incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- **Hydro-functional Importance:** which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- **Importance in terms of Basic Human Benefits:** this suite of criteria considers the subsistence uses and cultural benefits of the wetland system.

These determinants are assessed for the wetlands on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. It is recommended that the highest of these three suites of scores be used to determine the overall Importance and Sensitivity category of the wetland system, as defined in Table 8-7.

Table 8-7: Interpretation of Overall EIS Scores for Biotic and Habitat Determinants

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological ; Management Class
Very high Systems that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Systems that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Systems that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Systems that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

8.5 Impact Assessment

The aim of the Impact Assessment is to strive to avoid damage or loss of ecosystems and services that they provide, and where they cannot be avoided, to reduce and mitigate these impacts (DEA, 2013). Offsets that compensate for loss of habitat are regarded as a last resort, after all efforts have been made to avoid, reduce and mitigate. The mitigation hierarchy is described in Table 8-8.

Table 8-8: Mitigation Hierarchy

↓	**Avoid or Prevent**	Refers to considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services and people. This is the best option, but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, mining should not take place. In such cases, it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation.
	Minimise	Refers to considering alternatives in the project location, sitting, scale, layout, technology and phasing that would minimise impacts on biodiversity, associated ecosystem services. In cases where there are environmental constraints, every effort should be made to minimise impacts.
	Rehabilitate	Refers to rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to near natural state or an agreed land use after mine closure. Rehabilitation may, however, fall short of replicating the diversity and complexity of natural systems.
	Offset	Refers to measures over and above rehabilitation to compensate for the residual negative impacts on biodiversity after every effort has been made to minimise and then rehabilitate the impacts. Biodiversity offsets can provide a mechanism to compensate for significant residual impacts on biodiversity.

The impact rating process is designed to provide a numerical rating of the various environmental impacts identified by use of the Input-Output model. As discussed above, it has to be stressed that the purpose of the EIA process is not to provide an incontrovertible rating of the significance of various aspects, but rather to provide a structured, traceable and defendable methodology of rating the relative significance of impacts in a specific context. This will give a greater understanding of the impacts of the proposed project and the issues that need to be addressed by mitigation. It will also provide the regulators information on which to base their decisions.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

Table 8-9: Impact Assessment Parameter Ratings

Rating	Severity	Spatial scale	Duration	Probability
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or eco system. Persistent severe damage. The positive impact will result in a significant improvement to the initial/post disturbance environmental status and will benefit ecological and natural resources.	International The effect will occur across international borders	Permanent: No Mitigation No mitigation measures of natural process will reduce the impact after implementation.	Certain/ Definite. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Significant impact on highly valued species, habitat or ecosystem. The positive impact is of high significance which will result in a vast improvement to the environment such as ecological diversification and/or rehabilitation of endangered species	National Will affect the entire country	Permanent: Mitigation Mitigation measures of natural process will reduce the impact.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate. The positive impact will be moderately high and will have a long term beneficial effect on the natural environment	Province/ Region Will affect the entire province or region	Project Life The impact will cease after the operational life span of the project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year. The positive impact on the environment will be moderate with visible improvement to the natural resources and regional biodiversity.	Municipal Area Will affect the whole municipal area	Long term 6-15 years	Probable Has occurred here or elsewhere and could therefore occur.

Rating	Severity	Spatial scale	Duration	Probability
3	Moderate, short-term effects but not affecting ecosystem functions. Rehabilitation requires intervention of external specialists and can be done in less than a month. The positive impact will be moderately beneficial to the natural environment, but will be short lived.	Local Local extending only as far as the development site area	Medium term 1-5 years	Unlikely Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. The positive impacts will be minor and slight environmental improvement will be visible.	Limited Limited to the site and its immediate surroundings	Short term Less than 1 year	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures
1	Limited damage to minimal area of low significance, (e.g. ad hoc spills within plant area). Will have no impact on the environment. The positive impact on the environment will be insignificant and will not result in visible improvements	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month	Highly unlikely/None Expected never to happen.

Table 8-10: Probability/Consequence Matrix

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 8-11: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a significant and usually a long-term change to the (natural and / or social) environment and result in major changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

9 Assumptions and Limitations

- As per the Scope of Works, only the Vaalkop Project area was delineated by Digby Wells. WCS delineated TCTS and Trichardtsfontein Project areas;
- Portions of the TCTS and Trichardtsfontein Project areas were only delineated by WCS at a desktop level and are indicated as such on the maps. PES and EIS were therefore not conducted for these areas. Ground truthing of these areas was not included in this scope of works, however, should Sasol require this, Digby Wells can provide a separate proposal for this;
- For the purpose of this report, it is assumed that all wetland boundaries identified by Wetland Consulting Services in 2007 in the report entitled: "Wetland Assessment Report for Twistdraai Colliery: Thubelisha Shaft 2007" were accurately delineated. Furthermore, it is assumed that the standardised methodology defined by DWAF (2005) was employed.
- Fieldwork for Vaalkop was undertaken in the winter of 2017; therefore grasses and forbs were not flowering and so were not always identifiable to species level. In addition, overgrazing, trampling, cultivation, and veld fires in some areas made identification of species impossible. As a result, the species richness will be lower than the actual;
- The Vaalkop area is large (~8000 ha) and therefore it was not possible to ground-truth all of the wetlands on site. Thus, there was some reliance on desktop delineation;
- The Soil, Land Use and Land Capability Report was not available at the time of the fieldwork; The Groundwater Report was not available at the time of writing this report and therefore probability of decant was unknown, but assumed high for the purposes of this report. The Wetland Impact Assessment will be updated once this information becomes available;
- The Rock Engineering Report was not available at the time of writing this report, so the probability of subsidence was unknown. For the purposes of this report, it was assumed to be high. The Wetland Impact Assessment will be updated once this information becomes available; and

10 Baseline Environment

10.1 Drainage and Quaternary Catchment

The water resources of South Africa have been divided into quaternary catchments, which are regarded as the principle water management units in the country (DWAF 2011). A quaternary catchment is a fourth order catchment in a hierarchical classification system in which the primary catchment is the major unit's.

The majority of the Project area falls within the primary drainage region B (Olifants River Catchment) with a small portion falling within primary catchment C (Vaal River Catchment).

More specifically, the Vaalkop area lies within the Quaternary catchment B11 A and B11C as shown in Figure 10-1 and is associated with the Olifants Water Management Area (WMA code 2). The water systems within the study area are linked to the Olifants River. TCTS and Trichardtsfontein lie within the quaternary catchment C12D (although no wetlands are identified in C12D), B11D but also in B11C (as with Vaalkop) and B11D with the major affected river is the Trichardspruit, including the Trichardtsfontein Dam.

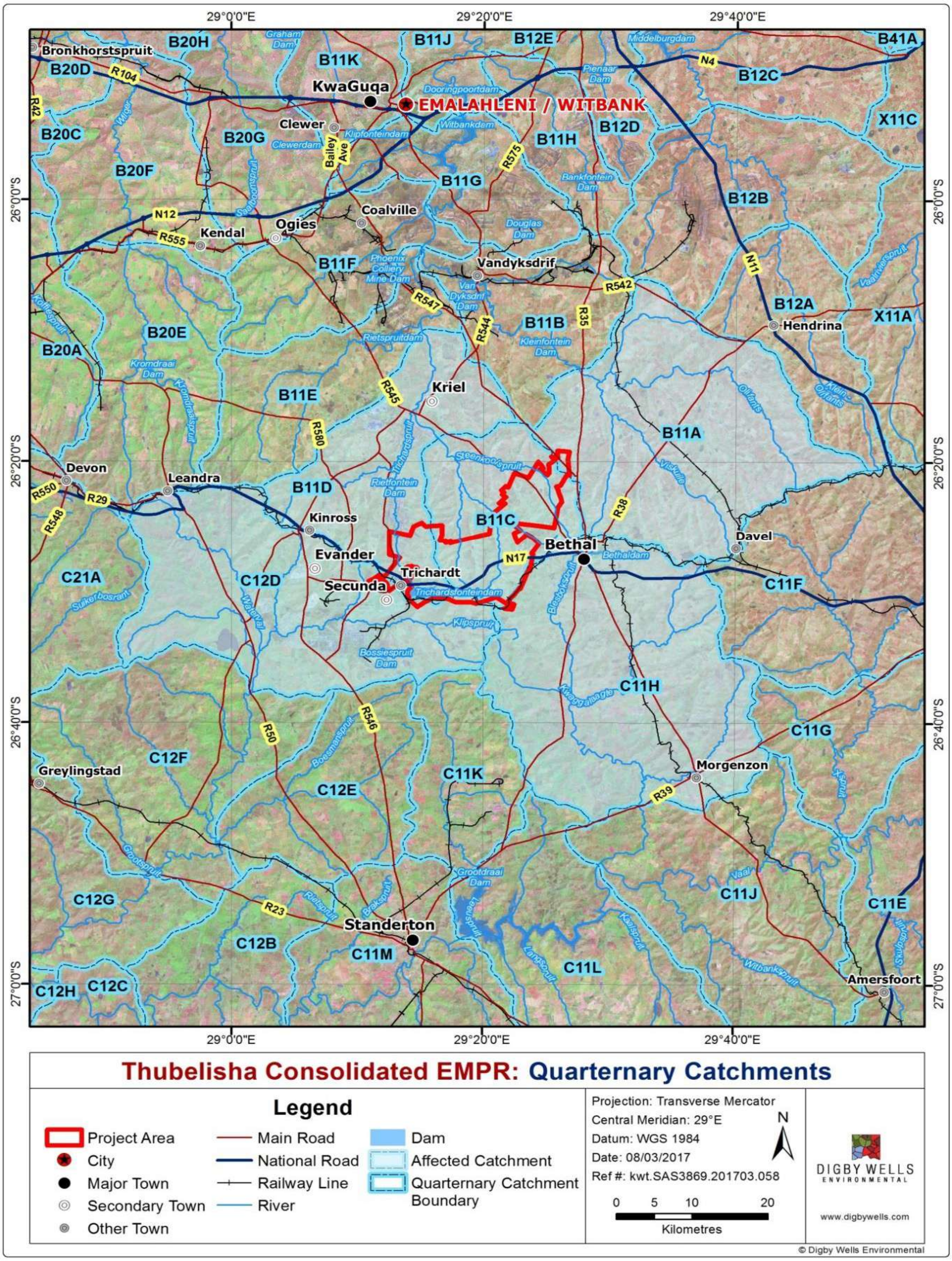


Figure 10-1: Quaternary Catchments

10.2 National Freshwater Ecosystem Priority Areas (NFEPA)

The NFEPA project provides information of wetland and river ecosystems for integrating into freshwater ecosystem and biodiversity planning and decision-making processes. The assessor considered the strategic spatial priorities for conserving the country's freshwater ecosystems and supporting sustainable use of water resources contained therein to evaluate the importance of the wetland areas located within the Vaalkop Mining Right (Nel *et al.* 2011).

Figure 10-2 demonstrates the distribution of NFEPA wetlands within the Project area. The wetland types that dominate the landscape are floodplain wetlands, channelled valley bottoms and seeps. In addition, there are some depression wetlands within the Project area. The largest wetland present is associated with the Steenkoolspruit that runs through the Project area.

The NFEPA wetlands have been ranked in terms of importance in the conservation of biodiversity. The Project wetlands are mostly of rank 4, 5 and 6. Rank 4 wetlands are those (excluding dams) in A, B or C PES and associated with more than three other wetlands. Rank 5 wetlands are those (excluding dams) within a sub-quaternary catchment containing impacted Working for Wetland sites. These wetlands are earmarked for future rehabilitation by the Working for Wetlands program. Rank 6 wetlands are all other wetlands that are identified as FEPA wetlands but do not fall within rank 1 to 5. Refer to Table 8-1 for more details on the ranking system of NFEPA wetlands.

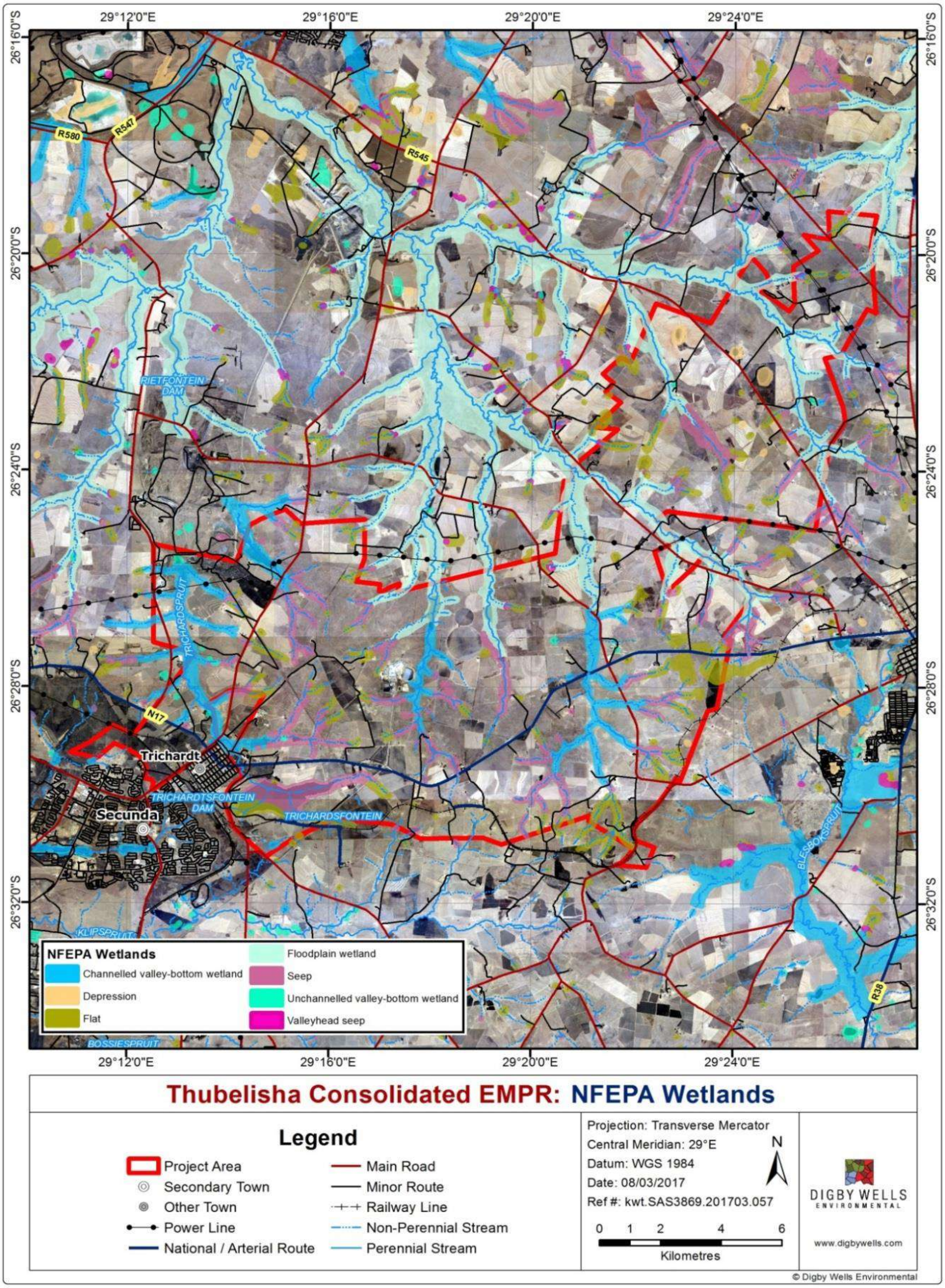


Figure 10-2: NFEPA Wetlands

10.3 Mpumalanga Biodiversity Sector Plan

The MBSP (2013) is a spatial tool that forms part of the national biodiversity planning. The terrestrial MBSP has delineated a considerable area within and immediately around the northern portion of Project area as 'CBA Irreplaceable' (shown as red in Figure 10-3). 'CBA Necessary' are also found within the Project area (yellow), with small pockets of ESA Local Corridors (orange). According to the guidelines from the MSBP, CBAs must be kept in a natural state with no further loss of habitat; where only low-impact, biodiversity-sensitive land-uses are appropriate. This is particularly an issue in the northern portion of the Vaalkop Area, and the central areas of Trichardtsfontein.

With respects to ESAs, the land use goal should be to maintain the ecosystem in a functional, near-natural state; however, some habitat loss is acceptable. This means that a greater range of land-uses over a wider extent is appropriate for these areas. This notwithstanding, they are subject to an authorisation process that ensures the underlying biodiversity objectives are not compromised. The remainder of the Project area is classified as either natural or modified areas. It is important to note that this is a large scale project and some local scale discrepancies may exist. Although natural areas were not pristine as they are subject to grazing and / or grass bailing, these areas are mapped and regarded as natural habitat for naturally occurring fauna and flora species. Refer to the Fauna and Flora Report (Digby Wells, 2017) for the mapped habitat zones for the Project area.

The freshwater MBSP is largely correlated with the NFEPA as this is one of the main technical layers used in the assessment. These are shown for the Project area in Figure 10-2.

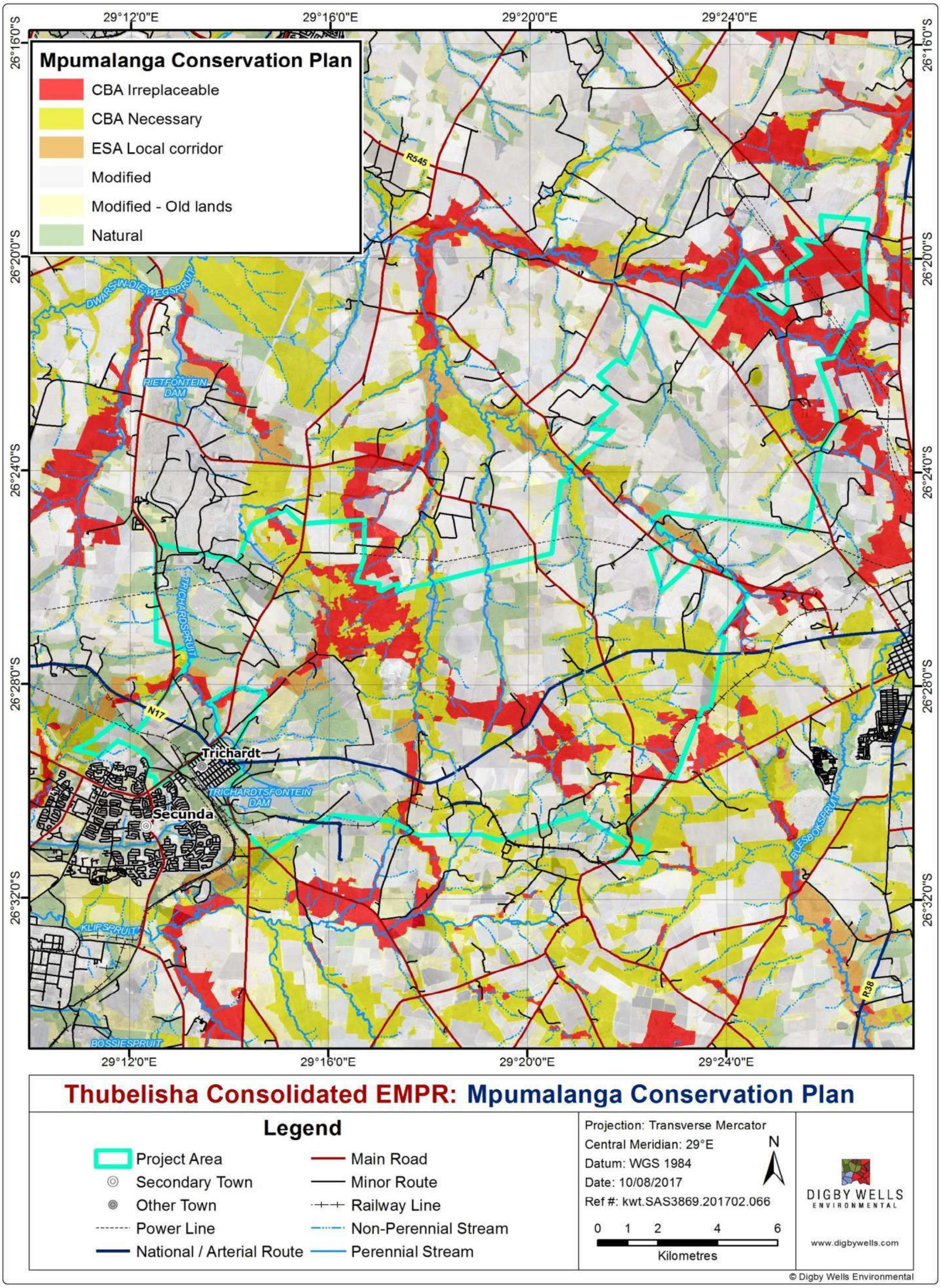


Figure 10-3: Mpumalanga Conservation Plan

10.4 Mining and Biodiversity Guidelines

The Mining and Biodiversity Guideline (2013) can be seen as a cumulative finding of all available biodiversity and ecological related information with a final mapped area. The assessment looks at NFEPA and regional biodiversity plans such as the MBSP. This is shown in Figure 10-4 below.

Large expanses of the Project area are designated as the 'Highest Risk for Mining'. A portion of the central area of Vaalkop is designated as 'Moderate Biodiversity Importance'. These are highly associated with the wetland bodies of the landscape and any remaining natural habitats.

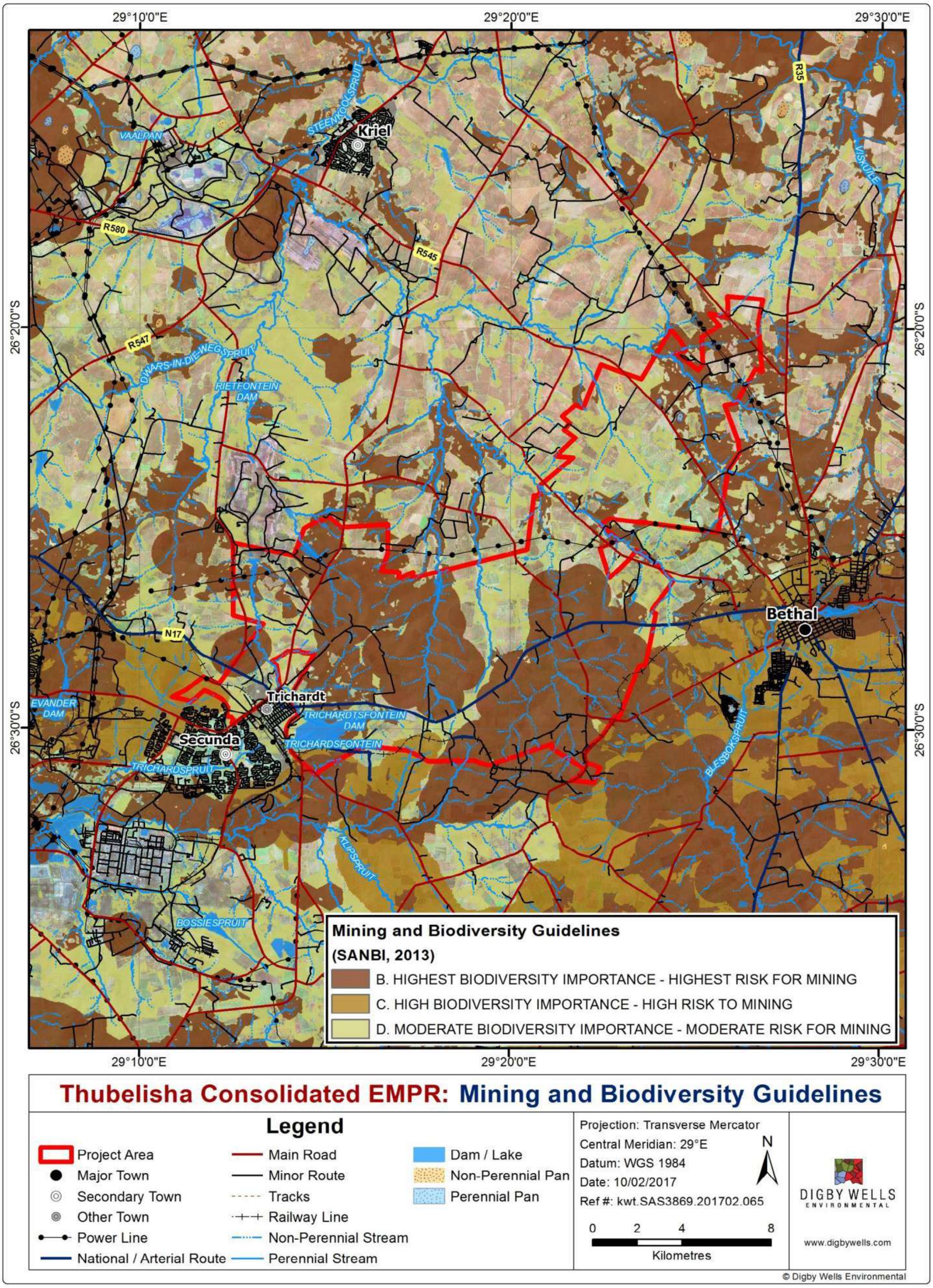


Figure 10-4: Mining and Biodiversity Guideline

10.5 Regional Vegetation

The Project area falls within the Grassland Biome (Mucina and Rutherford, 2012), one of the nine South African plant Biomes and the second most bio-diverse biome in South Africa. The Grassland Biome is situated primarily on the central plateau of South Africa, and the inland areas of Kwa-Zulu-Natal and the Eastern Cape provinces. This biome is rich in flora and fauna diversity but is under threat due to rapid urbanisation and expansion of mining and industrial activities.

The Project area occurs in the Eastern Highveld Grassland and Soweto Highveld Grassland regional vegetation types (Mucina and Rutherford, 2012), with Vaalkop characterised by the former and TCTS and Trichardtsfontein characterised by the latter (Figure 10-5). Table 10-1 list the species characteristic of the Eastern Highveld Grassland whilst Table 10-2 lists species characteristic of Soweto Highveld Grassland. The two vegetation types are distributed in the Gauteng and Mpumalanga Provinces, and are both recognised to be endangered with only a small fraction being conserved in state owned and private reserves. Most common grasses on the plains belong to the genera: *Themeda, Eragrostis, Heteropogon, and Elionurus.*

Table 10-1: Plant Species Characteristic of the Eastern Highveld Grasslands (Vaalkop)

Plant Form	Species
Graminoids	*Aristida aequiglumis, A. congesta, A. junciformis subsp. galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. capensis, E. curvula, E. gummiflua, E. patentissima, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata subsp. eckloniana, Andropogon appendiculatus, A. schirensis, Bewsia biflora, Ctenium concinnum, Diheteropogon amplectens, Harpochloa falx, Panicum natalense, Rendlia altera, Schizachyrium sanguineum, Setaria nigrirostris, Urelytrum agropyroides*
Herbs	*Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes, Pentanisia prunelloides subsp. latifolia, Selago densiflora, Senecio coronatus, Vernonia oligocephala, Wahlenbergia undulata.*
Geophytic herbs	*Gladiolus crassifolius, Haemanthus humilis subsp. hirsutus, Hypoxis rigidula var. pilosissima, Ledebouria ovatifolia*
Succulent Herbs	*Aloe ecklonis*

Plant Form	Species
Low Shrubs	*Anthospermum rigidum* subsp. *pumilum, Seriphium plumosum*

Table 10-2: Plant Species Characteristic of the Soweto Highveld Grassland (Trichardtsfontein and TCTS)

Plant Form	Species
Graminoids	*Andropogon appendiculatus, Brachiaria serrata, Cymbopogon pospischilii, Cynodon dactylon, Elionurus muticus, Eragrostis capensis, E. chloromelas, E. curvula, E. plana, E. planiculmis, E. racemosa, Heteropogon contortus, Hyparrhenia hirta, Setaria nigrirostris, S. sphacelata, Themeda triandra, Tristachya leucothrix, Andropogon schirensis, Aristida adscensionis, A. bipartita, A. congesta, A. junciformis subsp. galpinii, Cymbopogon caesius, Digitaria diagonalis, Diheteropogon amplectens, Eragrostis micrantha, E. superba, Harpochloa falx, Microchloa caffra, Paspalum dilatatum.*
Herbs	*Hermannia depressa, Acalypha angustata, Berkheya setifera, Dicoma anomala, Euryops gilfillanii, Geigeria aspera var. aspera, Graderia subintegra, Haplocarpha scaposa, Helichrysum miconiifolium, H. nudifolium var. nudifolium, H. rugulosum, Hibiscus pusillus, Justicia anagalloides, Lippia scaberrima, Rhynchosia effusa, Schistostephium crataegifolium, Selago densiflora, Senecio coronatus, Vernonia oligocephala, Wahlenbergia undulata.*
Geophytic herbs	*Haemanthus humilis subsp. hirsutus, H. montanus*
Herbeceous Climber	*Rhynchosia totta*
Low shrubs	*Anthospermum hispidulum, A. rigidum subsp. pumilum, Berkheya annectens, Felicia muricata, Ziziphus zeyheriana*

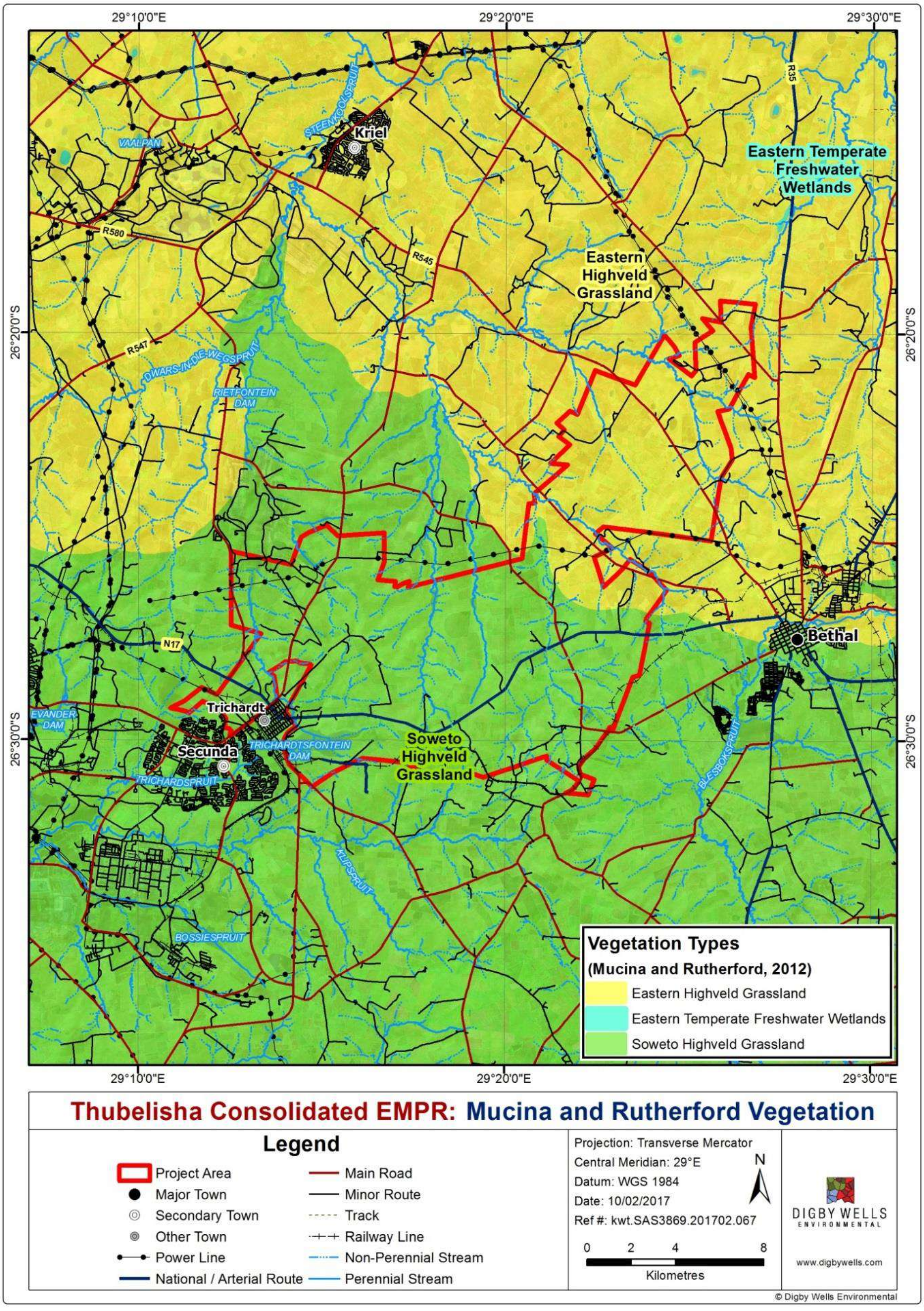


Figure 10-5: Vegetation Types

11 Wetland Assessment Findings

This section presents a summary of the previous Trichardtsfontein and TCTS wetland assessments. The following reports were referred to:

- 'Wetland Assessment Study: Twistdraai Colliery: Thubelisha Shaft (TCTS) Project' (Wetland Consulting Services, 2007); and
- Ecological Wetland Assessment for the Proposed Trichardtsfontein Mining Project.

Furthermore, the section discusses the results of the on-site verification completed for the Vaalkop mining area by the wetland specialists.

11.1 Trichardtsfontein and TCTS (WCS, 2007)

A summary of the results obtained from the 'Wetland Assessment Study: Twistdraai Colliery: Thubelisha Shaft (TCTS) Project' (WCS, 2007) are described below.

11.1.1 Delineation and Classification

WCS (2007) delineated 3076.8 hectares of wetlands (~18% of the TCTS area) with an additional 311.27 ha (~10% of the TCTS area) covered by dams.

Four different HGM types which were observed, namely:

- Channelled Valley Bottoms (48%);
- Un-channelled Valley Bottoms (11%);
- Floodplains (9%); and
- Hillslope seeps (32%).

Figure 11-1 and Figure 11-2 illustrate the delineation for TCTS and Trichardtsfontein.

11.1.2 Wetland Ecological Assessment

The TCTS and Trichardtsfontein areas are characterised by multiple wetland systems, totalling 3076.8 ha. The dominant land use of the area is agro-pastoral including large areas of cropland and natural grassland for grazing and grass-bailing. The wetlands have been impacted on and no pristine wetlands were found within the Project area. Examples of these impacts are discussed below.

- Crops: destruction of natural vegetation, construction of dams;
- Cattle: Grazing, creation of pastures and trampling;
- Proximity to towns; and
- Mining activities.

A summary of the PES scores for the area are detailed in Table 11-1 and illustrated in Figure 11-3 and Figure 11-4. The PES and EIS scores were no available for the desktop delineated area.

Table 11-1: Present Ecological Scores for TCTS and Trichardtsfontein

PES Score	Area (ha)	% of total wetlands (excl. desktop delineation area)
B	278	14%
C	1545	76%
D	219	11%

As noted in the WCS (2007) report, the majority of the wetlands within the TCTS and Trichardtsfontein fall within the upper Olifants River Catchment. Generally, wetlands within this catchment have been greatly impacted upon by mining, power stations, water abstraction, urbanization and agriculture. Therefore a high importance and conservation value is placed on wetlands within the catchment that have not been seriously modified as is the situation within the study area (WCS, 2007).

A summary of the EIS scores for the area are detailed in Table 11-2 and illustrated in Figure 11-5 and Figure 11-6.

Table 11-2: Ecological Importance and Sensitivity (EISC) for TCTS and Trichardtsfontein

EISC Score	Area (ha)	% of total wetlands (excl. desktop delineation area)
B	1192.98	70.7%
C	468.02	27.8%
D	25.71	1.5%

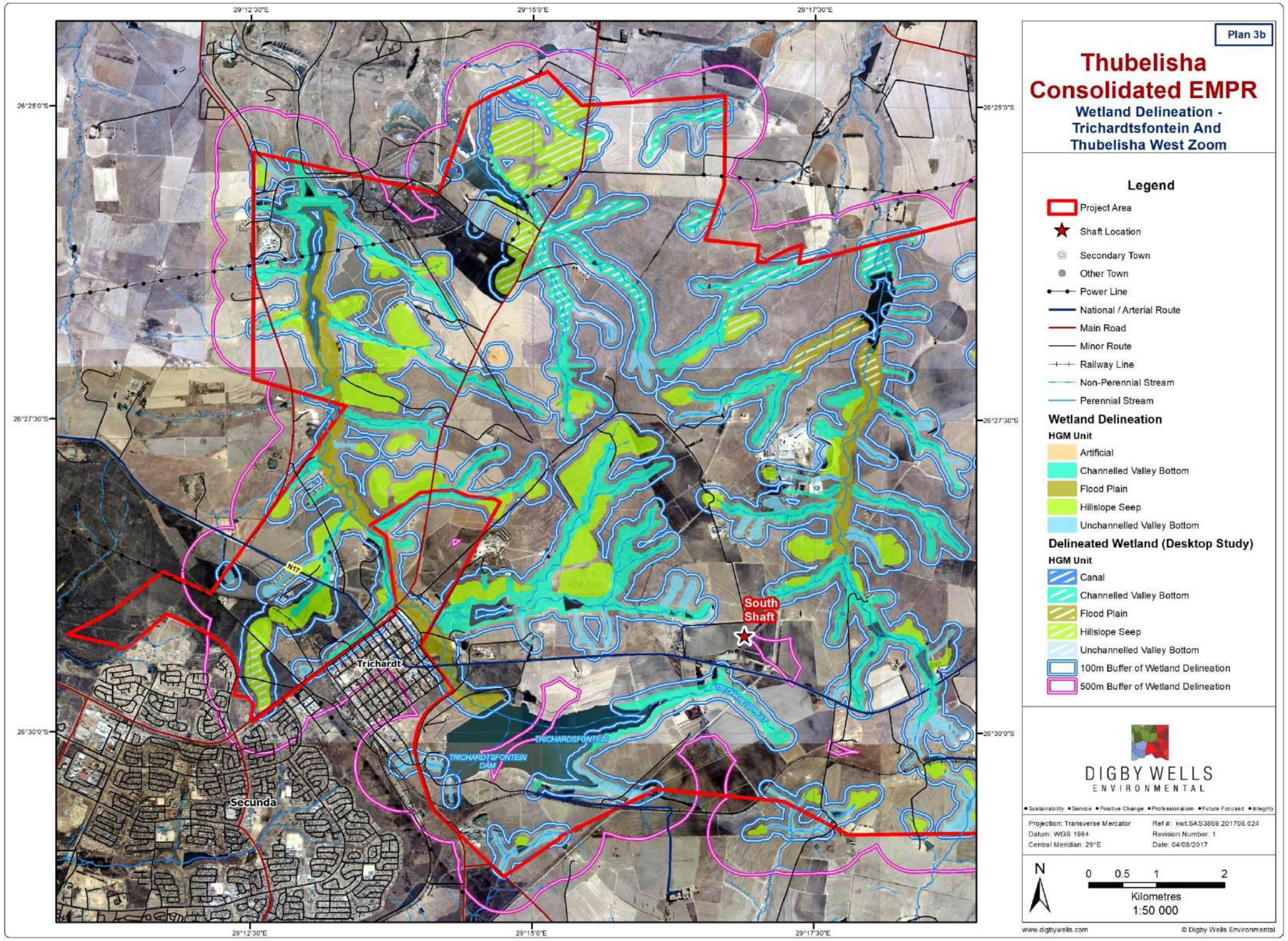


Figure 11-1: Wetland Delineation (Trichardtsfontein and Thubelisha West Zoom)

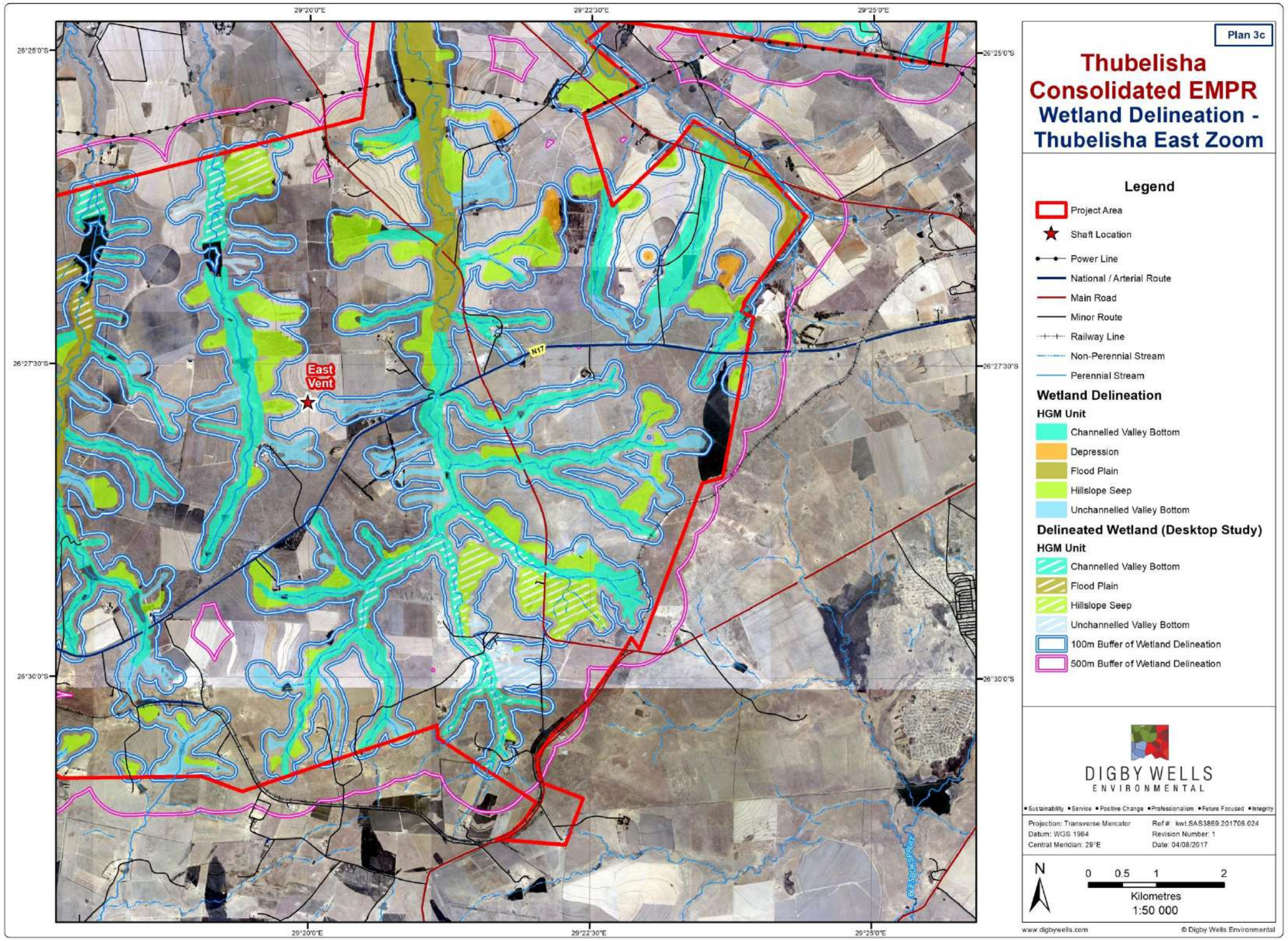


Figure 11-2: Wetland Delineation (Thubelisha East Zoom)

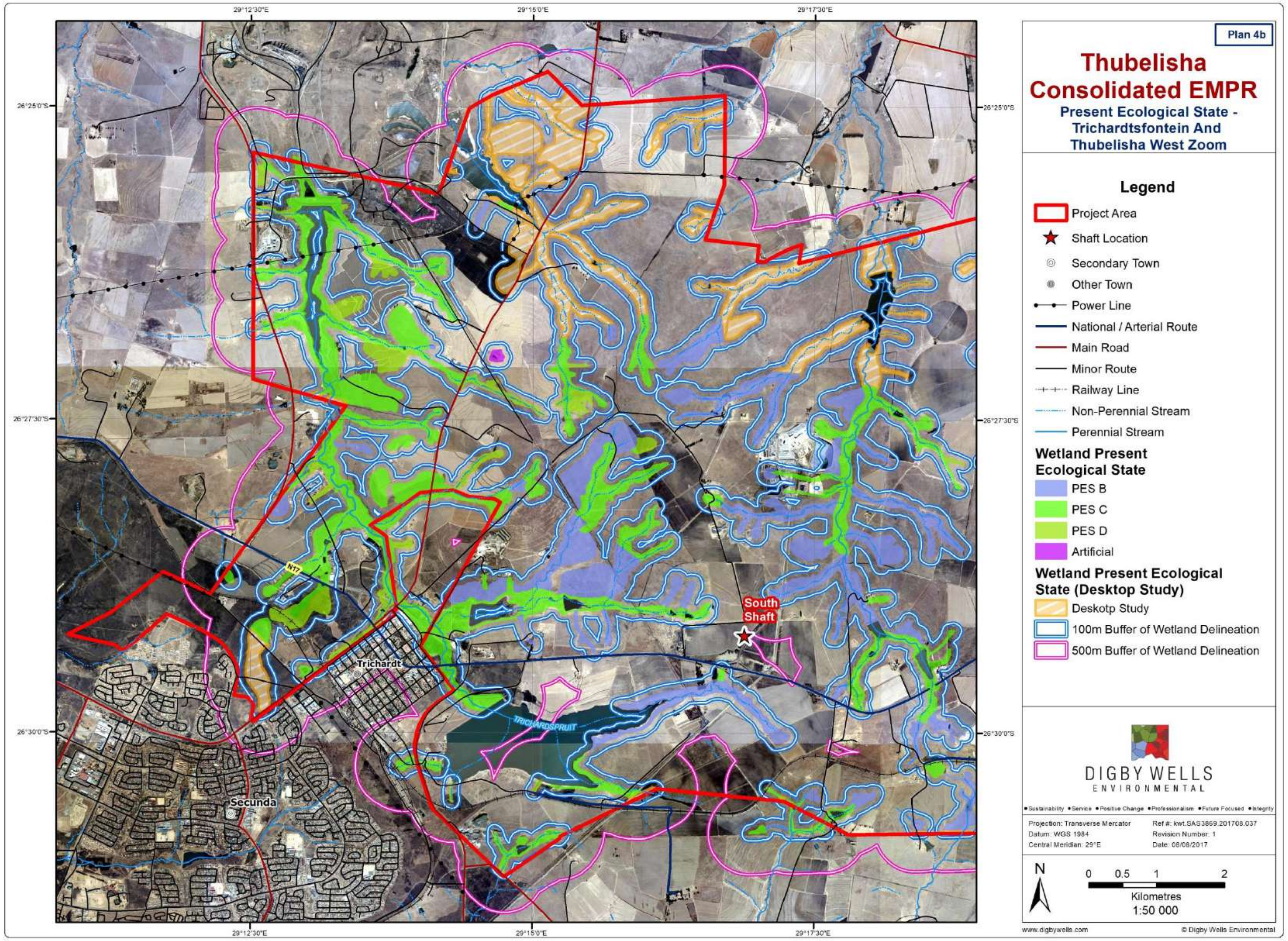


Figure 11-3: Wetland Present Ecological State (PES) Trichardtsfontein and Thubelisha West Zoom

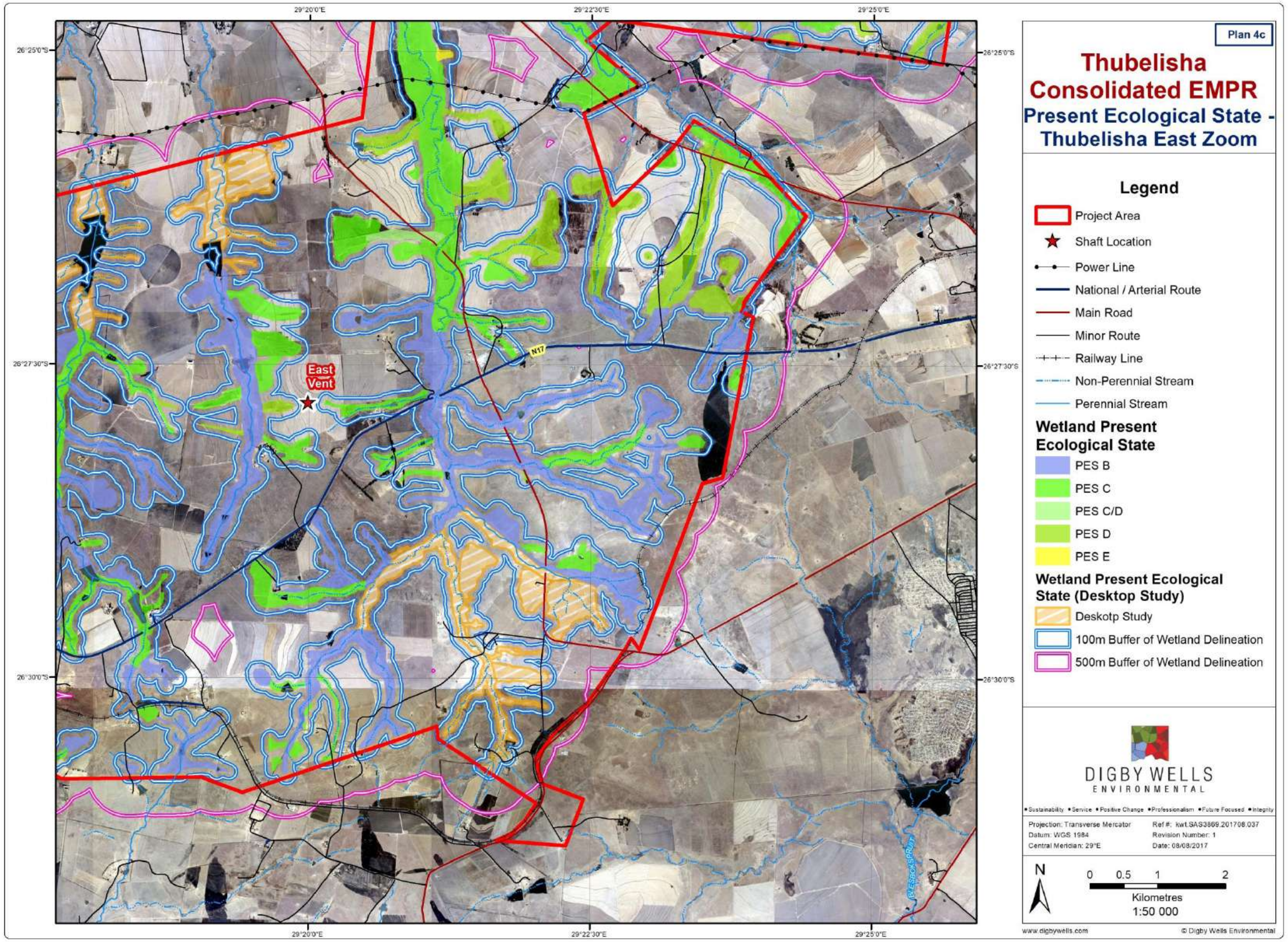


Figure 11-4: Wetland Present Ecological State (PES) Thubelisha East Zoom

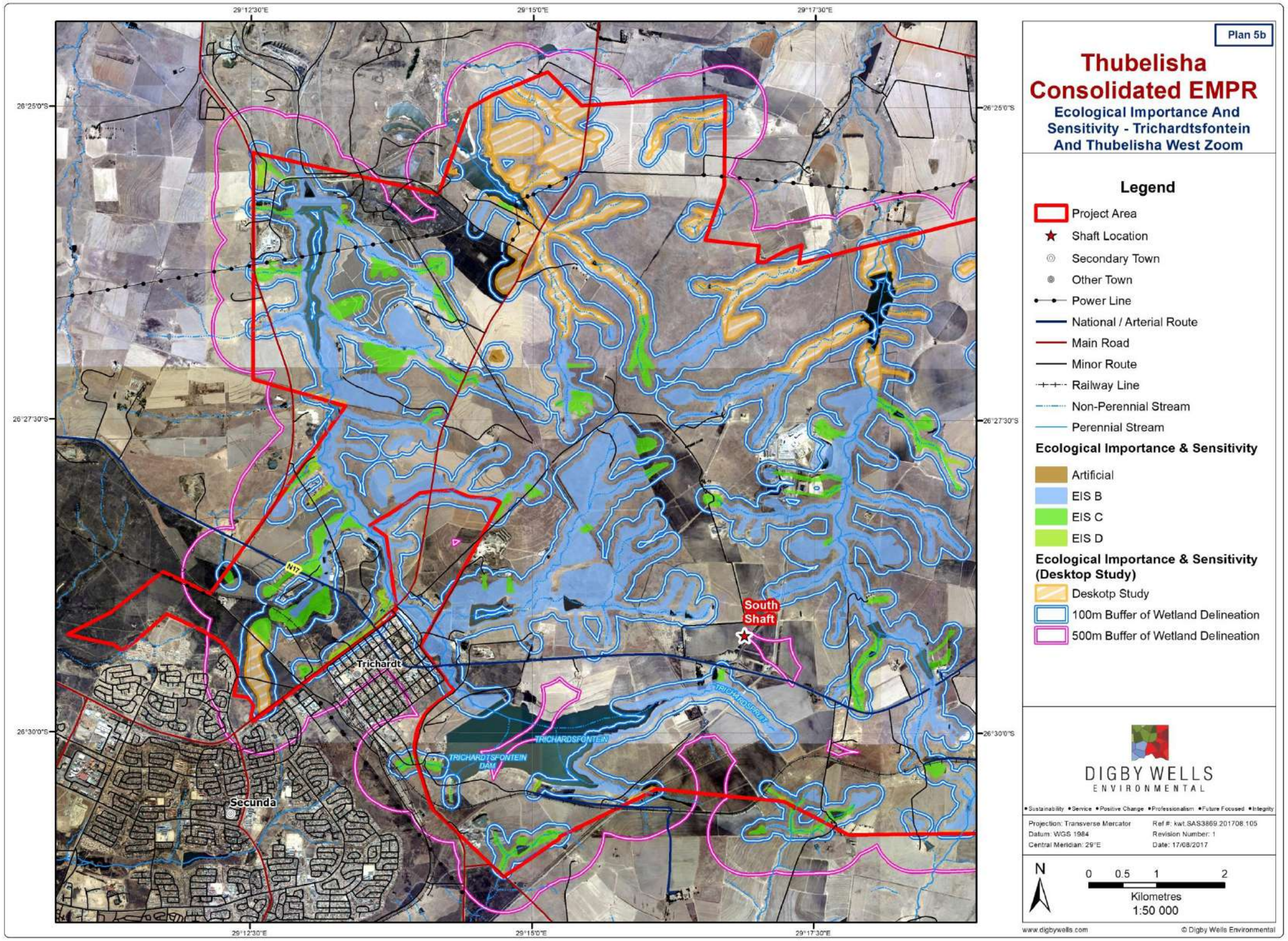


Figure 11-5: Wetland Ecological Importance and Sensitivity (EIS) Trichardtsfontein and Thubelisha West Zoom

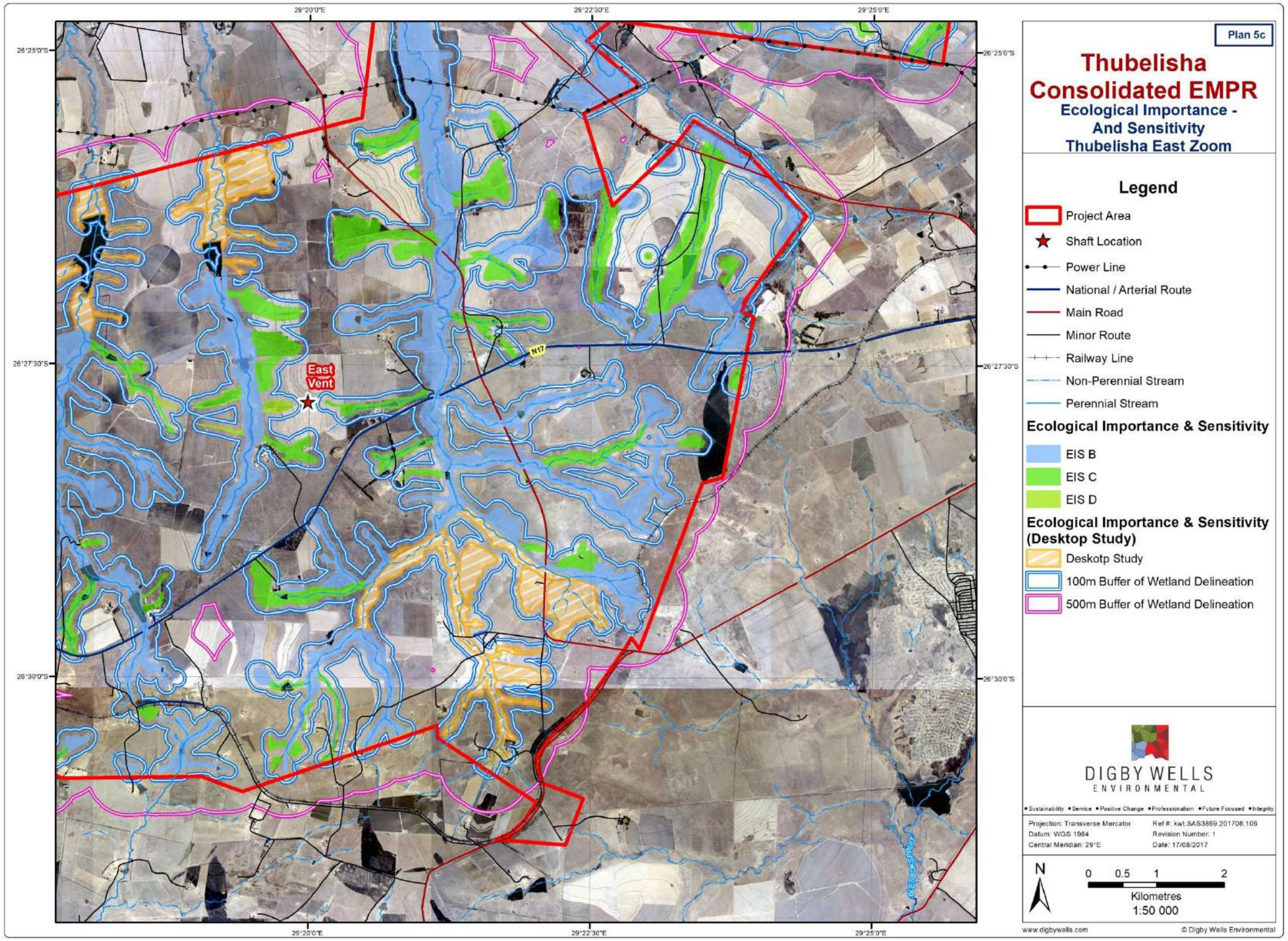


Figure 11-6: Wetland Ecological Importance and Sensitivity (EIS) Thubelisha East Zoom

11.2 Vaalkop Delineation and Classification

This section focuses on the Vaalkop Project area as a wetland assessment was not previously completed for the area. All wetland areas were assessed according to the methodology outlined in Section 8. Contours (5 m) were then used together with imagery and knowledge gained to extrapolate to all areas and give a final delineation of wetland areas; as well as to define their HGM unit.

The Vaalkop Project area was found to be extensively characterised by five wetland types: floodplain, valley bottom (channelled and un-channelled), hillslope seep and depression wetlands. Details of the indicative findings are detailed in the sub-sections that follow.

11.2.1 Indicators

11.2.1.1 Terrain Indicator

The topography is typical of the Highveld lower ecoregion with gentle slopes and many valley systems present. Detailed imagery and contours, coupled with in-field assessment, allows the geomorphic setting of the wetland and catchments to be understood and the HGM to be determined. This is important for understanding the specific functionality of the wetland and determining the potential risks from mining activities on the wetland.

11.2.1.2 Soils Indicators

Soils were a major indicator during the wetland assessments and examples of soils assessed are shown in Figure 11-7. Terrestrial soils were typically associated with Hutton, Avalon, Glencoe, Mispah and Clovelly soil forms whilst the wetlands were characterised by Arcadia, Rensburg, Katspruit, Kroonstad, Longlands and Wesleigh soil forms (Figure 11-7). A soils assessment has been completed and should be referred to for more detailed information (Soils, Land Use and Land Capability Report, Digby Wells, 2017).

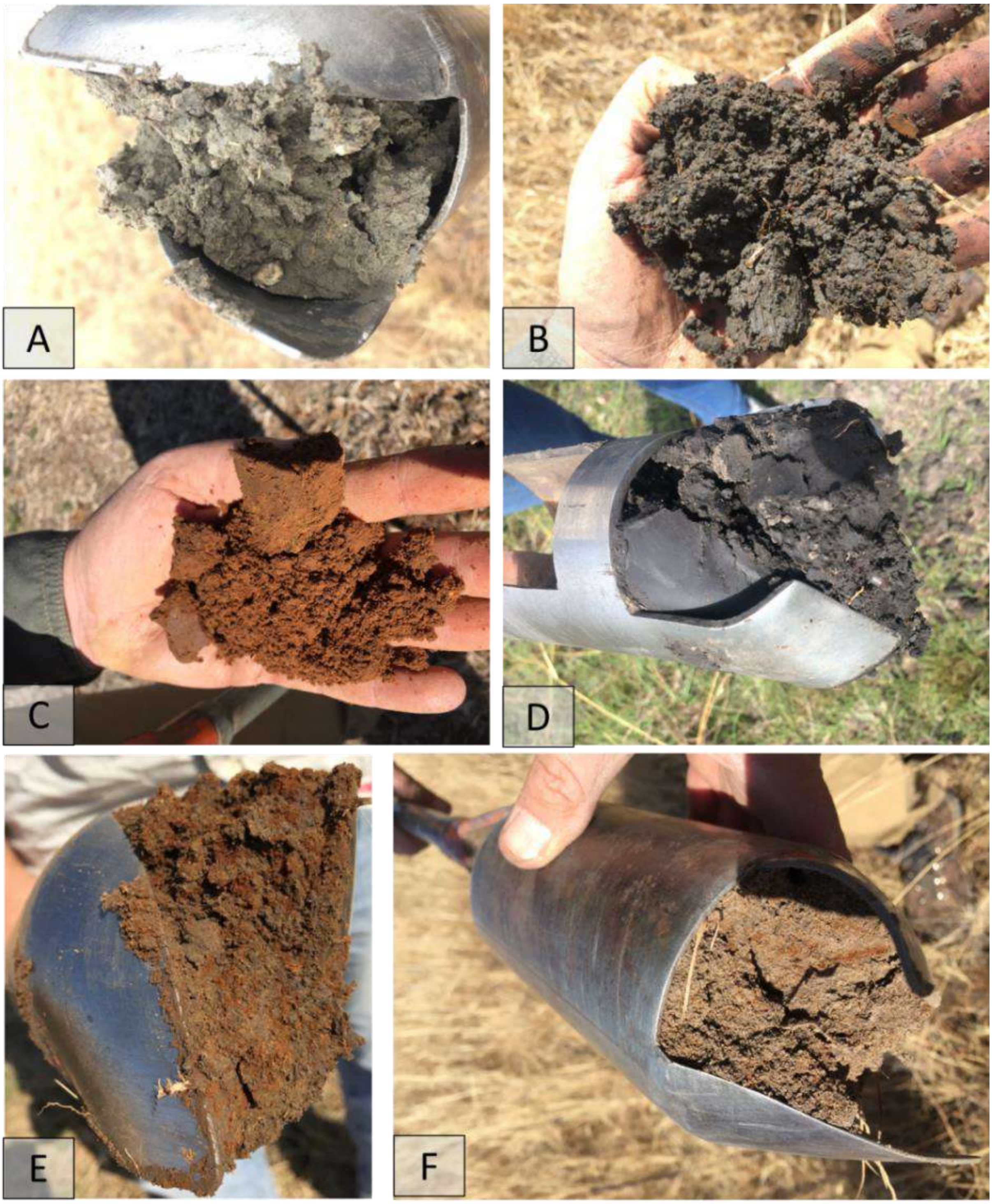


Figure 11-7: Examples of Soil Samples: A) Bonheim Wetland Soil; B) Swartland Soil; C) Terrestrial Red Uniform Soil; D) Arcadia Wetland Soil; E) Iron Mottling Indicating Seasonally Wet Soils; and F) Gleying And Mottling

11.2.1.3 Vegetation Indicators

The main floral indicators, identifiable at the time of sampling (June 2017), were *Agrostis lachnantha* (Bent Grass), *Setaria sphacelata* (Golden Bristle Grass), *Juncus effusus*, *Andropogon eucomus*, *Imperata cylindrica* (Cottonwool Grass), found in the seasonal and permanent wet zones, and *Typha capensis* (Bullrush), *Schoenoplectus brachycerus* and *Phragmites australis* (Common Reed). in the permanent wet zones. Much of the vegetation was unidentifiable due to the timing of the site visit and the fact that most areas have been grazed or cultivated. As a result, the soils were the major indicator for the delineation of the wetlands. A list of species identified within, and in proximity to, wetlands is detailed in Appendix A.

Figure 11-8: Common Characteristic Flora Species Associated with the Wetlands: A) *Juncus effusus*; B); *Agrostis lachnantha* (Bent Grass); C) *Imperata cylindrica* (Cottonwool Grass); D) *Berkheya erysithales*; E) *Eragrostis gummiflua* (Gum Grass); F) *Andropogon eucomus* (Snowflake Grass)

11.2.2 Wetland Delineation and Unit Identification

Wetlands cover approximately 3003.2 ha, which amounts to 38% of the Vaalkop Project area. The breakdown of the wetland types per area is detailed in Table 11-3 and illustrated in Figure 11-9.

The Vaalkop Project area is dominated by seeps that are drained by channelled valley bottoms. Some large floodplain systems are also present. The Vaalkop area also contained various depression wetlands, that were mainly absent in the Trichardtsfontein and TCTS areas.

Table 11-3: Wetland HGM Units

HGM unit	Area (ha)
Channelled Valley Bottom	777.7
Un-channelled Valley Bottom	266.4
Floodplain	611
Hillslope seeps	1230.8
Depression	117.1
Artificial	0.3
Total Wetlands (ha)	3003.2

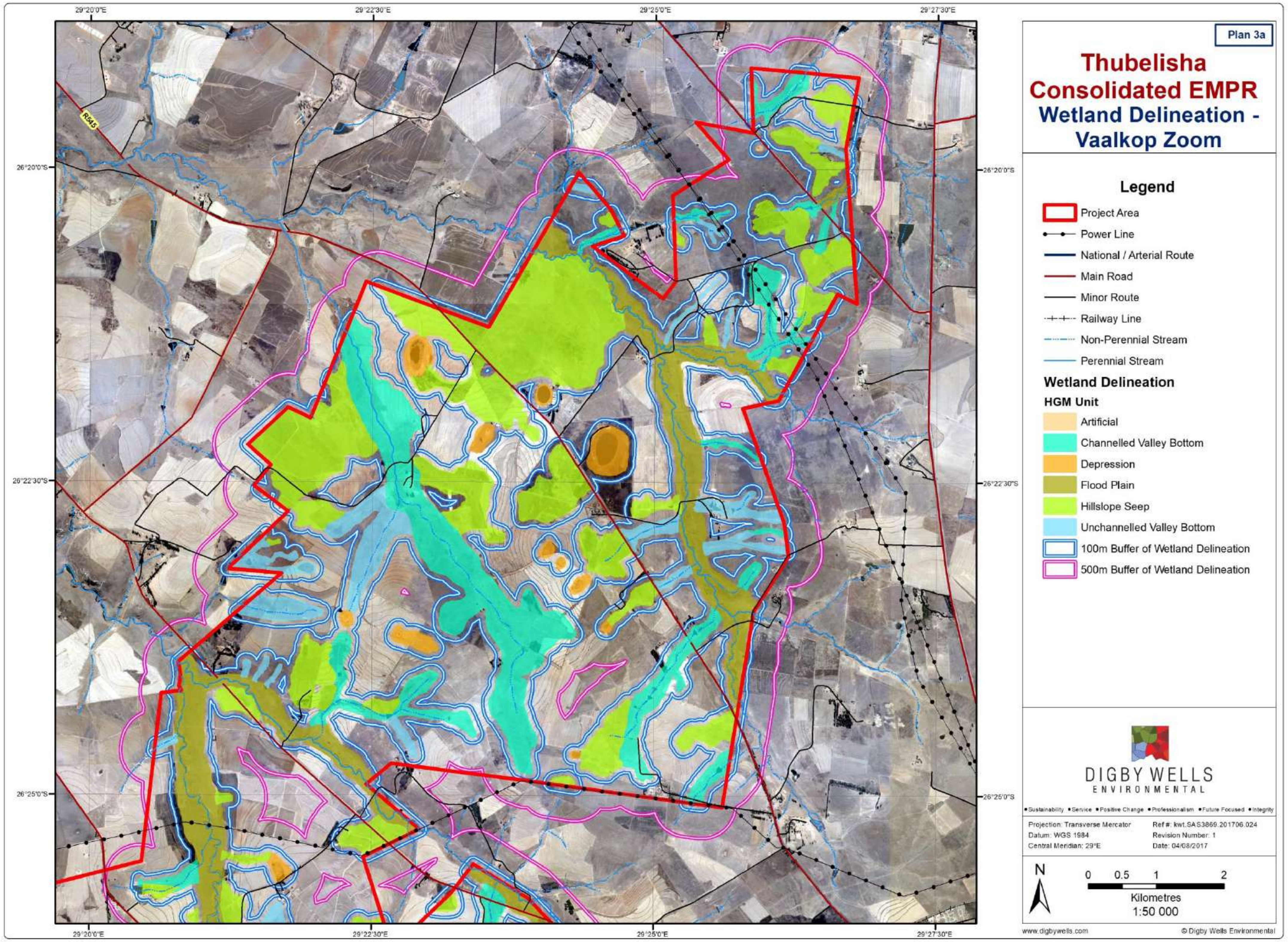


Figure 11-9: Wetland Delineation (Vaalkop Zoom)

11.2.3 Vaalkop Wetland Ecological Assessment

The Vaalkop mining area is characterised by multiple wetland systems, totalling 3003.2 ha. There are two major floodplain systems, which drain into one another to the west of the Project area. There is also a large channelled valley bottom system which drains into the northern floodplain system. The remainder of the area is characterised by extensive hillslope seeps that drain into the floodplains and valley bottom wetlands.

The dominant land use of the area is agro-pastoral including large areas of cropland and natural grassland for grazing and grass-bailing. The wetlands have been altered from their natural state as the area has been largely transformed by agricultural activities. Examples of these impacts recorded on site are shown in Figure 11-10 below.

- Croplands have replaced much of the naturally occurring vegetation and this has impacted the ability of wetlands to maintain biodiversity. Alternative farm practices such as the digging of deep trenches to drain wetlands were also observed.
- Cattle farming which has resulted in overgrazing in many areas, trampling, and erosion and has resulted in impaired water quality of the wetlands associated with the site. These activities cause increased sedimentation of the systems due to exposed substrate. Sedimentation alters the natural hydrological and geomorphological functioning of the wetlands and may have an impact on aquatic life. The impaired water quality may also result from additional loading of phosphates and nitrates.
- Dams were abundant and have impacted severely on the wetland integrity of the site, causing headcut erosion upstream and in-stream erosion downstream.
- This disturbance has also led to the establishment of alien and invasive plant species, particularly *Populus x canescens* (Grey Poplar), *Eucalyptus camaldulensis* (Red River Gum) in the wetter areas and *Tagetes minuta* (Khaki Bush) and *Bidens pilosa* (Black Jack), further limiting the ability of the hydromorphic grasslands to function.
- Many wetlands are impacted on by roads cutting through them.
- The presence of mining in the area (Anglo American, Exxaro etc.) urban developments and industrial infrastructure (such as powerlines) affect the ecological integrity of the wetlands and deter avifaunal populations.

The wetlands are important ecosystems within the Project area, and include most of the wetland habitat types (HGM units). The ecological functioning of these ecosystems is directly linked to their position in the landscape as well as their ecological condition. Wetlands of the Mpumalanga Province and Highveld region within the Grassland biome represent important ecosystems providing many services and goods to people (MPTA, 2014); however, this does lead often to over exploitation of these systems which compromises their ecological integrity.

Although the application of the WET-Ecoservices tool was beyond the scope of this Wetland Assessment, a few of the wetland ecosystem services noted on site are described below:

- Water supply for human use is an important service provided by these wetlands. Multiple farm dams are present in channelled valley bottoms, whilst pans collect water for livestock and provide water for water abstraction;
- Channelled valley bottoms aid in streamflow regulation, nutrient assimilation, and sediment trapping. Un-channelled valley bottoms also provide the aforementioned services, with the addition of slowing down of flood waters. These functions are strongly linked to the absence of a channel as water is spread throughout the wetland unit. Seeps sustain streamflow during the dry season as they are slowly fed with sub-surface flow that moves laterally into the valley floor and river systems. Due to the diffuse nature of water movement through seep systems, sediment trapping and nutrient assimilation is an important water quality enhancement benefit. Within their immediate catchment, pans play important roles such as sediment trapping, nutrient assimilation and carbon storage;
- Wetlands provide habitat for a variety of aquatic and terrestrial fauna and flora species. The gentle slopes of the seeps provide habitat for important species of the area such as African Grass Owl and Marsh Owl, both of which were observed on site. Floodplain and channelled valley bottoms provide habitat for aquatic species as well as birds (Blue Korhaan, Pied and Giant Kingfishers were observed utilising these wetlands), and mammals (spoor of the Cape Clawless Otter and Water Mongoose were observed) that feed off aquatic species. Pans provide unique habitat in the landscape for species. Greater Flamingos, which are a Species of Special Concern, were seen in a pan near the Project area; and
- Agriculture, cultural and aesthetic benefits.

Figure 11-10: Examples of Impacts to Wetlands. A) Cultivation in Wetlands; B) Road crossings; C) Culverts; D) Trenches to Drain Wetlands for Farming Practices; E) Roads Through Wetlands and Grazing By Cattle; F) Dams

There are over 100 HGM units identified within the Vaalkop Project area. For the purposes of this assessment it is impractical to calculate a separate PES for each HGM unit. Land use and in-field studies have shown that the Vaalkop catchments do not differ from each other from a catchment management perspective as they would be subject to similar overall land use impacts. Thus, it was considered practical to group HGM units by catchments that have similar land uses to calculate more accurate PES scores.

To this effect the wetlands are discussed herein according to their HGM setting in the landscape and land use impacts. These units are assessed using the methodology described in Section 8.3 to determine their PES and EIS.

The sub-sections below provide a summary of the ecological setting for each HGM unit and detail their ecological scores. Please refer to the Impact Assessment (Section 11.3) for detail on the area and type of wetlands associated with the Project.

11.2.4 Floodplains

The floodplain systems (611 ha) are characterised by meandering channels and ox bow lakes with many parts of this floodplain having exposed sandstone along the channel. There is no woody riparian zone associated with this river, typical of rivers in the grassland biome; except for the sporadic occurrence of bush-clumps of alien invasive tree species such a Grey Poplar and Red River Gum. Figure 11-11 below shows examples of the floodplain habitat found in the Project area.

The surrounding land use has had noticeable impacts on the natural state of the floodplain. There are multiple barriers upstream of and through this wetland including roads and dams, which affect the natural hydrology of the system. Water is abstracted from the river by many of the owners and the alien bush clumps will also have an impact on water availability.

Vertical and horizontal erosion is present, causing incision and channel widening respectively. There is no agriculture taking place in the floodplain; however crops occur within the buffer zone of 100 m. The floodplain is largely utilised by the livestock for grazing and drinking. The overall PES of the Floodplain systems was determined to be moderately- to largely modified from the natural state; with a PES of C/D (Table 11-4).

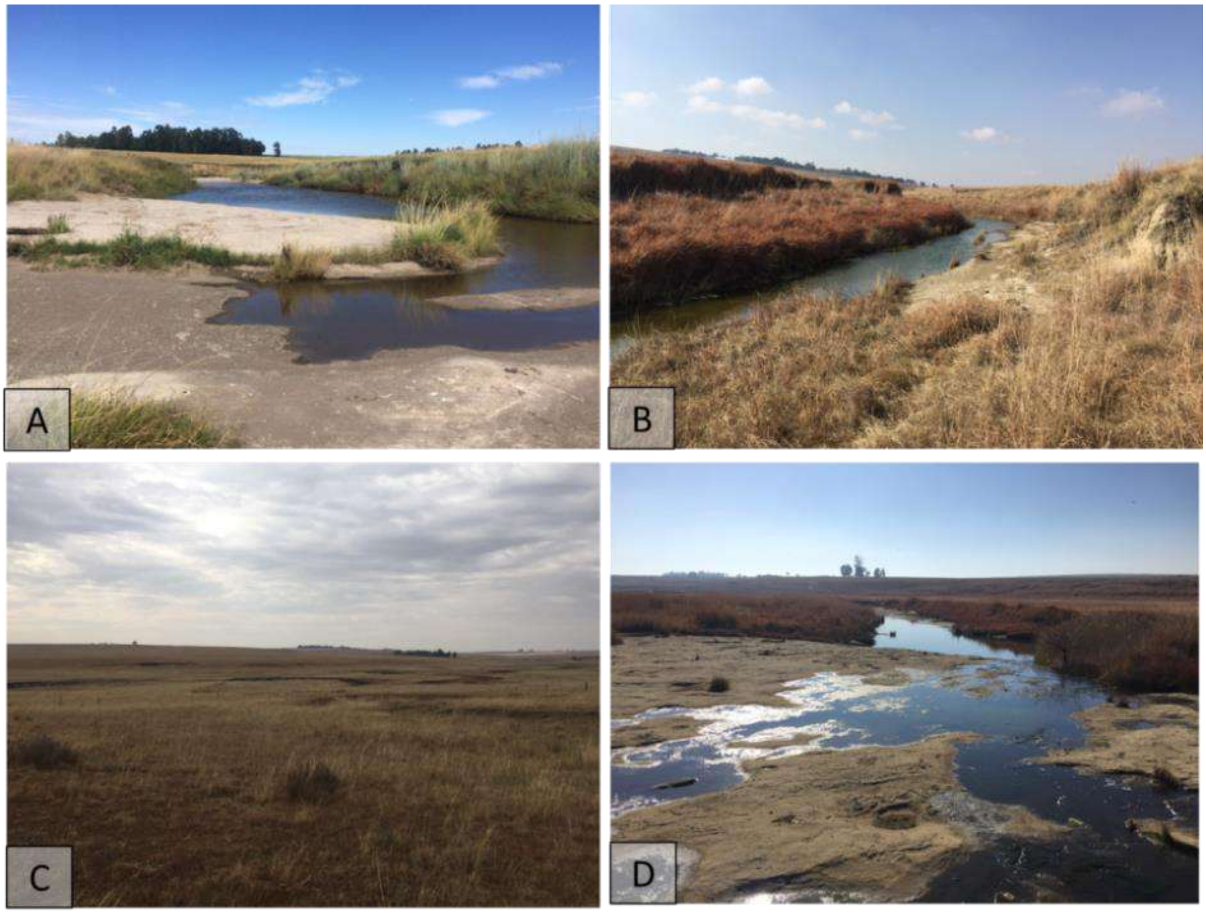


Figure 11-11: Floodplain Habitat in the Vaalkop Area

Table 11-4: Present Ecological Health Scores for the Floodplains

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
Floodplain	4	1.7	3.1	C

Table 11-5: EIS Scores for the Floodplains

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score
Floodplain	3.0	2.4	1.3	B

11.2.5 Un-channelled Valley Bottoms

Un-channelled valley bottoms are present in the Vaalkop Project area, albeit very few (266.4 ha). These are generally characterised by gentle slopes on either side. The agricultural impacts on these wetlands will ultimately result in the formation of a channel whereby the HGM unit will be converted to a channelled valley bottom where the associated ecosystem services will be lost. These may consist of overgrazing, establishment of farm roads and dams that initiate a process of erosion. Figure 11-12 below shows examples of the un-channelled valley bottom habitat found in the Project area.

The PES values of the un-channelled valley bottom systems was determined to be minimally (no dams or cultivation) to largely modified (dams and/or infrastructure and cultivation present) from the natural state; with a PES of B, C and D for the various wetlands (Table 11-6)

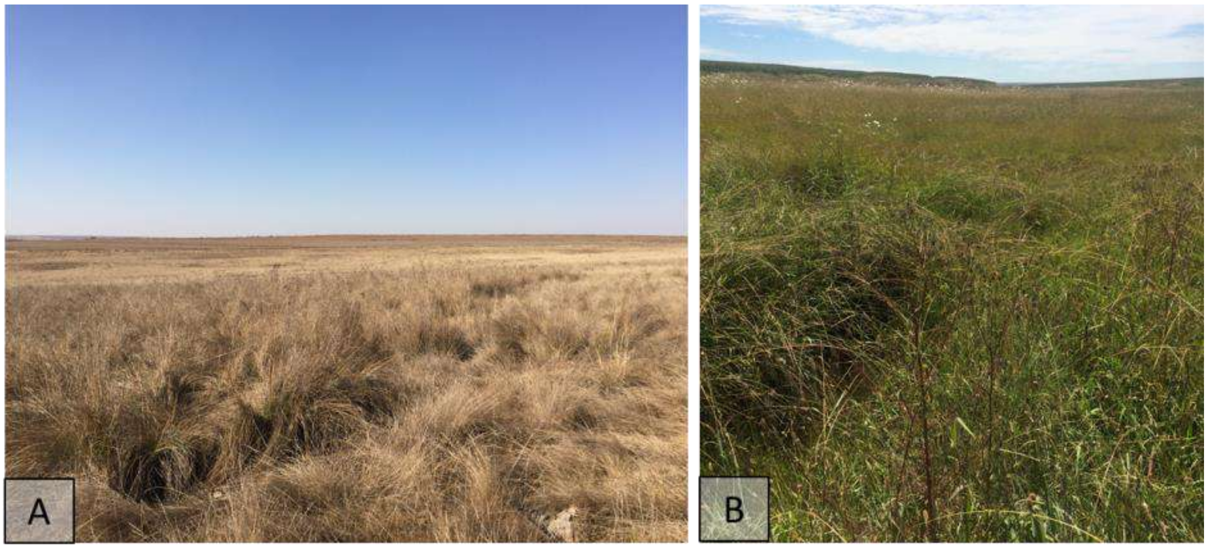


Figure 11-12: Un-channelled Valley Bottom Habitat in the Vaalkop Area

Table 11-6: Present Ecological Health Scores for the Un-channelled Valley Bottoms

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
No dams or cultivation	3.0	0.1	1.0	B
No dams, minimal cultivation and or infrastructure	3.0	0.2	2.4	C

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
Dams/ up to 50 % cultivation and or infrastructure with erosion	6.5	0.6	5.8	D

Table 11-7: EIS Scores for the Un-channelled Valley Bottoms

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score
Moderately impacted systems	3.0	2.4	1.3	B
Largely impacted systems	1.8	1.9	1.8	C

11.2.6 Channelled Valley Bottoms

Many channelled valley bottom systems are present within the Project area (777.7 ha), most of them draining into the Steenkoolspruit catchment. Extensive hillslope seep wetlands feed these systems. Figure 11-13 below shows examples of the channelled valley bottom habitat found.

The channelled valley bottoms have been impacted on significantly by grazing and cultivation; cattle utilise the channel for drinking, leading to trampling and input of nutrients whilst cultivation has led to sediment and fertiliser inputs. Infrastructure such as roads, culverts and dams also impede flow and cause head cut erosion upstream, as well as reduced flow downstream.

The PES values of the channelled valley bottom systems were determined to be moderately- to severely modified from the natural state; with a PES of C, D and E (a 1 km stretch having three dams and significant amount of cultivation and various dirt roads passing through) for the various wetlands (Table 11-8).

Figure 11-13: Channelled Valley Bottoms in the Vaalkop Area

Table 11-8: Present Ecological Health Scores for the Channelled Valley Bottoms

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
Dam, minimal cultivation	4	0.3	4	C
Dams, less than 10 % cultivation and some erosion	6.5	0.5	3.9	D
Dams, significant cultivation and erosion	7.5	1.4	8.7	E

Table 11-9: EIS Scores for the Channelled Valley Bottoms

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score
Moderately impacted systems	3.0	2.4	1.3	B
Largely impacted systems	1.8	1.9	1.8	C

11.2.7 Hillslope Seeps Connected to the Valley Bottoms

Extensive hillslope seeps were identified, covering an area of 1230.8 ha, which amounts to 15.4% of the Vaalkop Project area. These wetlands are characterised by gentle slopes and hydromorphic grassland habitat, although much of this habitat has been removed and replaced with crops (maize, soya beans). Figure 11-14 below shows examples of the hillslope seep habitat found.

The hillslope seeps have been significantly impacted on by agriculture, more so by cultivation then by grazing. A large impact noted through on site investigation is the digging of trenches (for some kilometres) to drain the seeps. Other impacts include roads, culverts and erosion.

The PES values of the hillslope seeps were determined to be minimally- to largely modified from the natural state; with a PES of B, C and D for the various wetlands (Table 11-10).

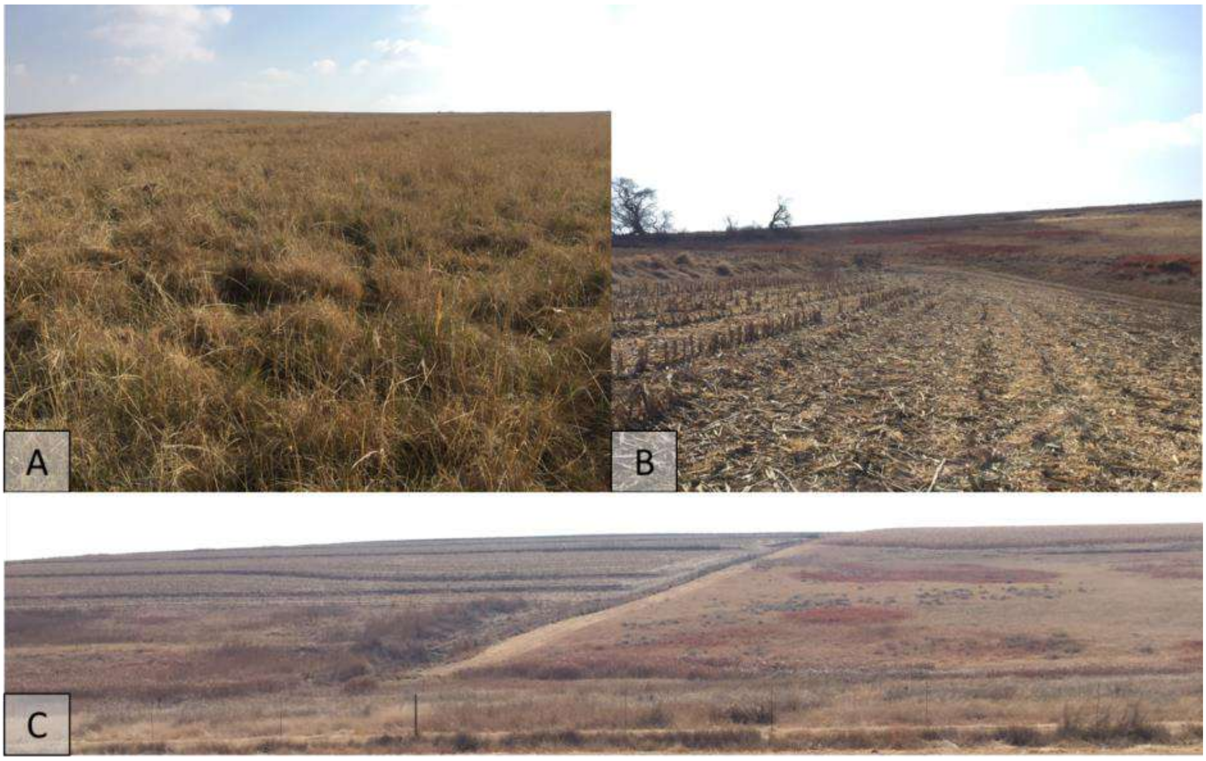


Figure 11-14: Hillslope Seep Habitat in the Vaalkop Area (A: Seep dominated by *Sporobolus* and *Agrostis lachnantha*; B: Cultivation through a Seep; C: A Seep Split By a Road, with the Left Hand Side Being Cultivated)

Table 11-10: Present Ecological Health Scores for the Hillslope Seeps

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
No cultivation or infrastructure	3	0.1	2.3	B
Small portion of cultivation with minimal infrastructure, drains etc	3	0.3	2.4	C
<75% Cultivation with infrastructure present	7.5	0.6	7.9	D

Table 11-11: EIS Scores for the Hillslope Seeps

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score
Hillslope Seeps	1	1.2	1.4	C

11.2.8 Depressions

Depressions are usually hydrologically disconnected from the stream network as they are inward draining wetlands. Most of the depressions within the Vaalkop Project area are heavily utilized and impacted on. Figure 11-15 below shows examples of the depression habitat found. There are a total of 117.5 ha of depressions found within Vaalkop.

Water abstraction and cattle watering take place from depressions that contain water. Depressions without open water are mostly cultivated. Other impacts on the depressions are trampling, overgrazing, roads either through or around depressions and the proliferation of invasive alien species.

The PES values of the depressions were determined to be largely- to severely modified from the natural state; with a PES of D and E for the various wetlands (Table 11-12).

Figure 11-15: Depression Habitat in the Vaalkop Area (A: Depression with Overgrazing and Water Abstraction Taking Place; B: Depression with Grazing Taking Place; C: Cultivation through a Depression)

Table 11-12: Present Ecological Health Scores for the Depressions

Aspect	Hydrological Health Score	Geomorphological Health Score	Vegetation Health Score	Final Ecological Health Score
Partially cultivated with alien species present and/ or infrastructure	6.5	3.2	4.4	D
Mostly cultivated, with drains	9	0.1	8.7	E

Table 11-13: EIS Scores for the Depressions

Aspect	Ecological Importance & Sensitivity	Hydrological/Functional Importance	Direct Human Benefits	Final EIS Score
	1	1.2	1.4	C

Although the current land use practices have compromised the natural ecological functioning and biodiversity maintenance role of these wetlands, these roles are still important as they are linked to the greater stream network and are protected by the NWA.

A large proportion of the Project area is characterised as the Highest Biodiversity Importance (Mining and Biodiversity Guidelines). Furthermore, the Mpumalanga Conservation Plan designates large areas as CBA irreplaceable and CBA necessary, while the Amersfoort-Bethal-Carolina Important Bird Area is in proximity to the Project area.

PES and EIS scores for Vaalkop can be seen in Figure 11-16 and Figure 11-17.

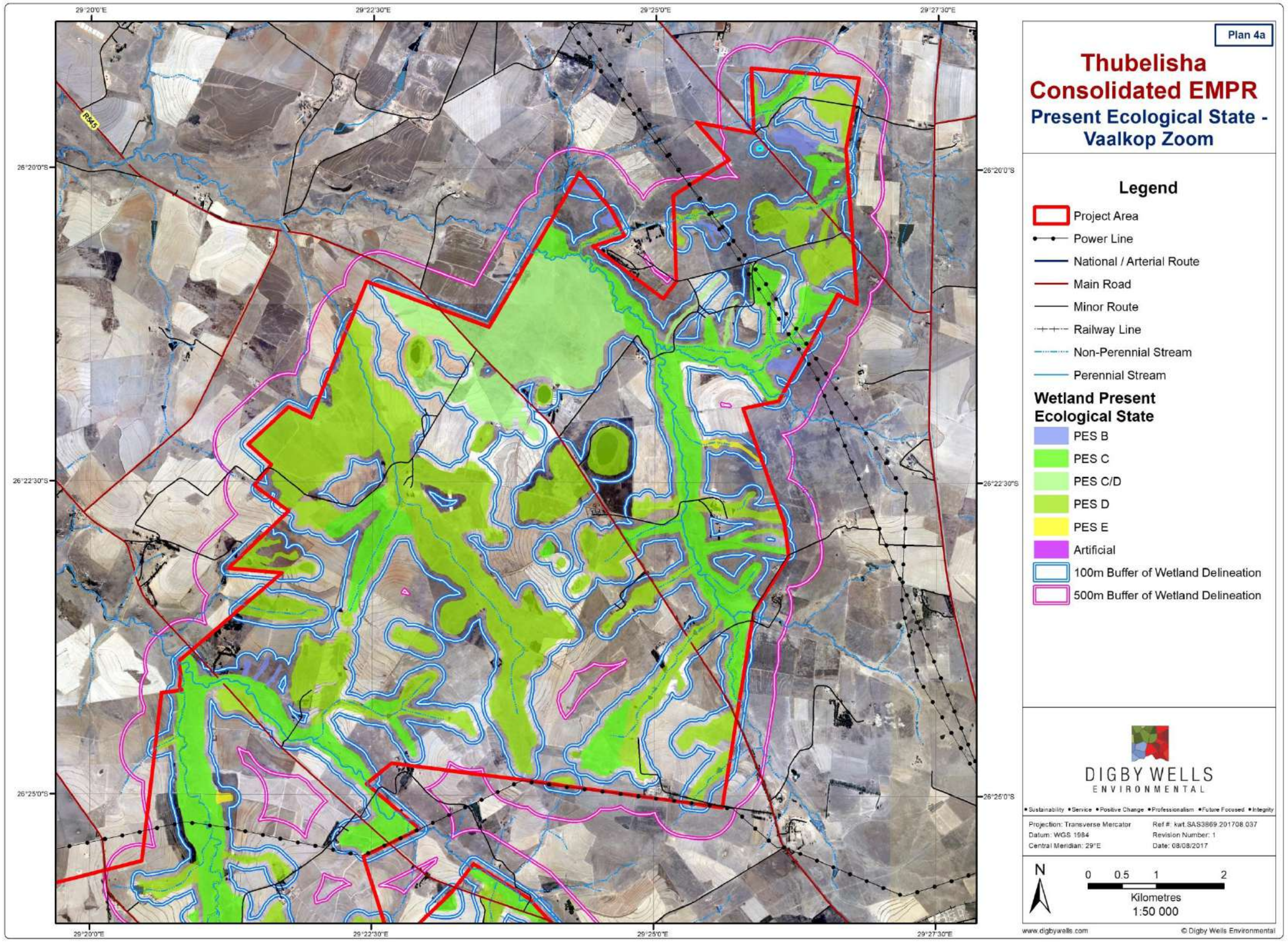


Figure 11-16: Wetland Present Ecological State (PES) Vaalkop Zoom

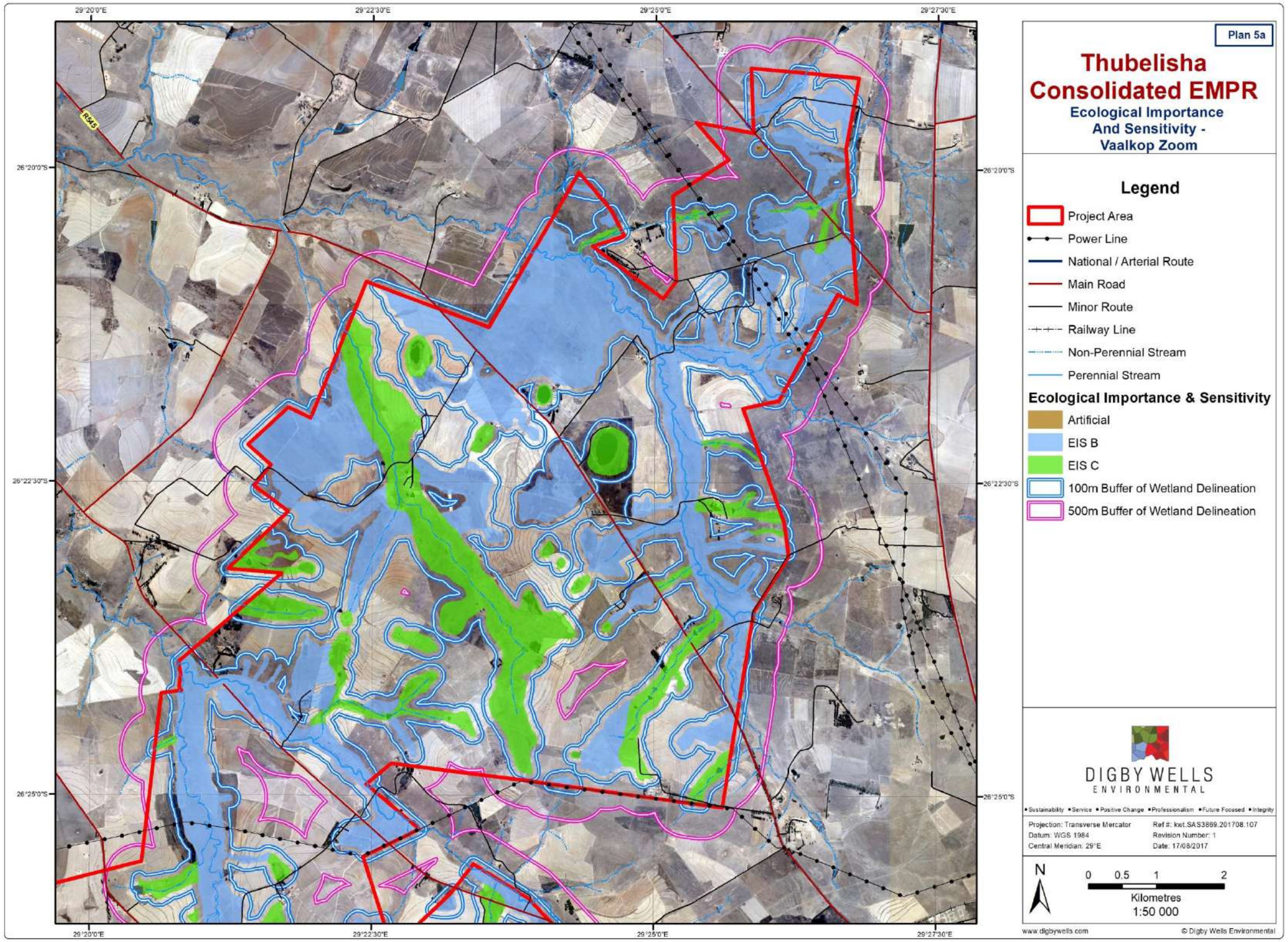


Figure 11-17: Wetland Ecological Importance and Sensitivity (EIS) Vaalkop Zoom

11.3 Summary for the Entire Project Area

The entire Project area is characterised by extensive wetlands, amounting to 6080.1 ha (26% of project area). The HGM units on site include channelled valley bottoms, un-channelled valley bottoms, floodplains, hillslope seeps, depressions and artificial wetlands. The consolidated HGM unit areas are tabulated in Table 11-14. Consolidated wetland delineation for all three MRs can be seen in Figure 11-18.

The majority of the wetlands are PES C (moderately modified), followed by PES D and PES B (Table 11-15; Figure 11-19).

Table 11-16 details the areas for the different EIS categories, with an EIS of B being the most prevalent. EIS are also illustrated in and Figure 11-20.

Table 11-14: Summary of the Wetland HGM Units

HGM unit	TCTS (ha)	Vaalkop (ha)	Total (ha)
Channelled Valley Bottom	1472.6	777.7	2250.3
Un-channelled Valley Bottom	338.0	266.4	604.4
Floodplain	269.2	611	880.2
Hillslope seeps	986.4	1230.8	2217.2
Depression	0	117.1	117.1
Artificial	10.6	0.3	10.9
Total Wetlands (ha)	**3076.8**	**3003.2**	6080.1

Table 11-15: Summary of the PES for the entire Project Area

PES Score	Description	TCTS (ha)	Vaalkop (ha)	Total (ha)
B	Largely natural	1088.6	38.9	1127.5
C	Moderately modified	1111.7	938.8	2050.5
C/D	Moderately to Largely modified	13.1	426.7	439.8
D	Largely modified	121.8	1588.6	1710.4
E	Severely modified	0	7.4	7.4

Table 11-16: Summary of the EIS for the entire Project Area

EIS	Description	TCTS (ha)	Vaalkop (ha)	Total (ha)
B	High	1743.7	2047.6	3791.3
C	Moderate	446.4	950.3	1396.7
D	Low/marginal	28.4	0	28.4

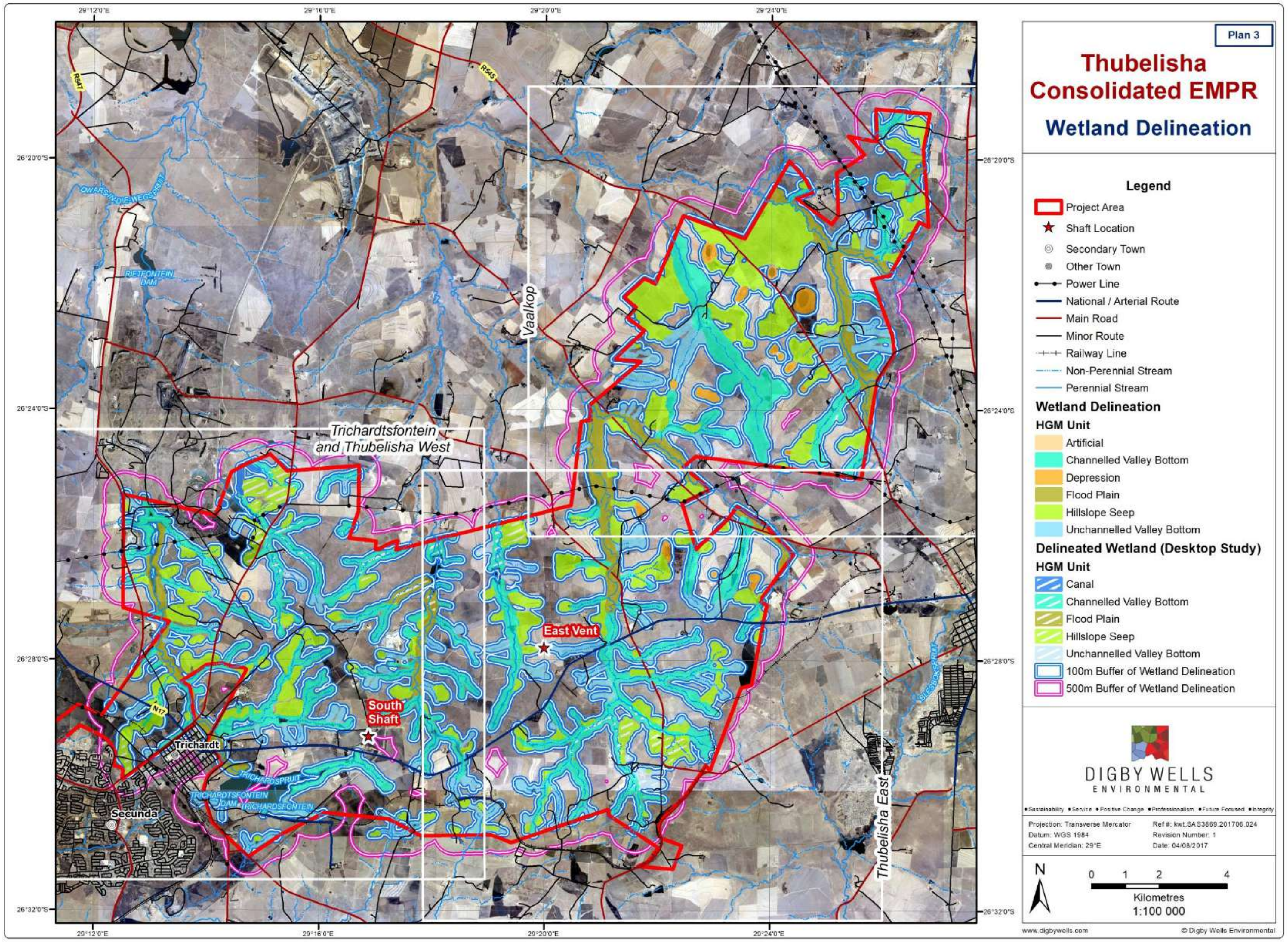


Figure 11-18: Wetland Delineation

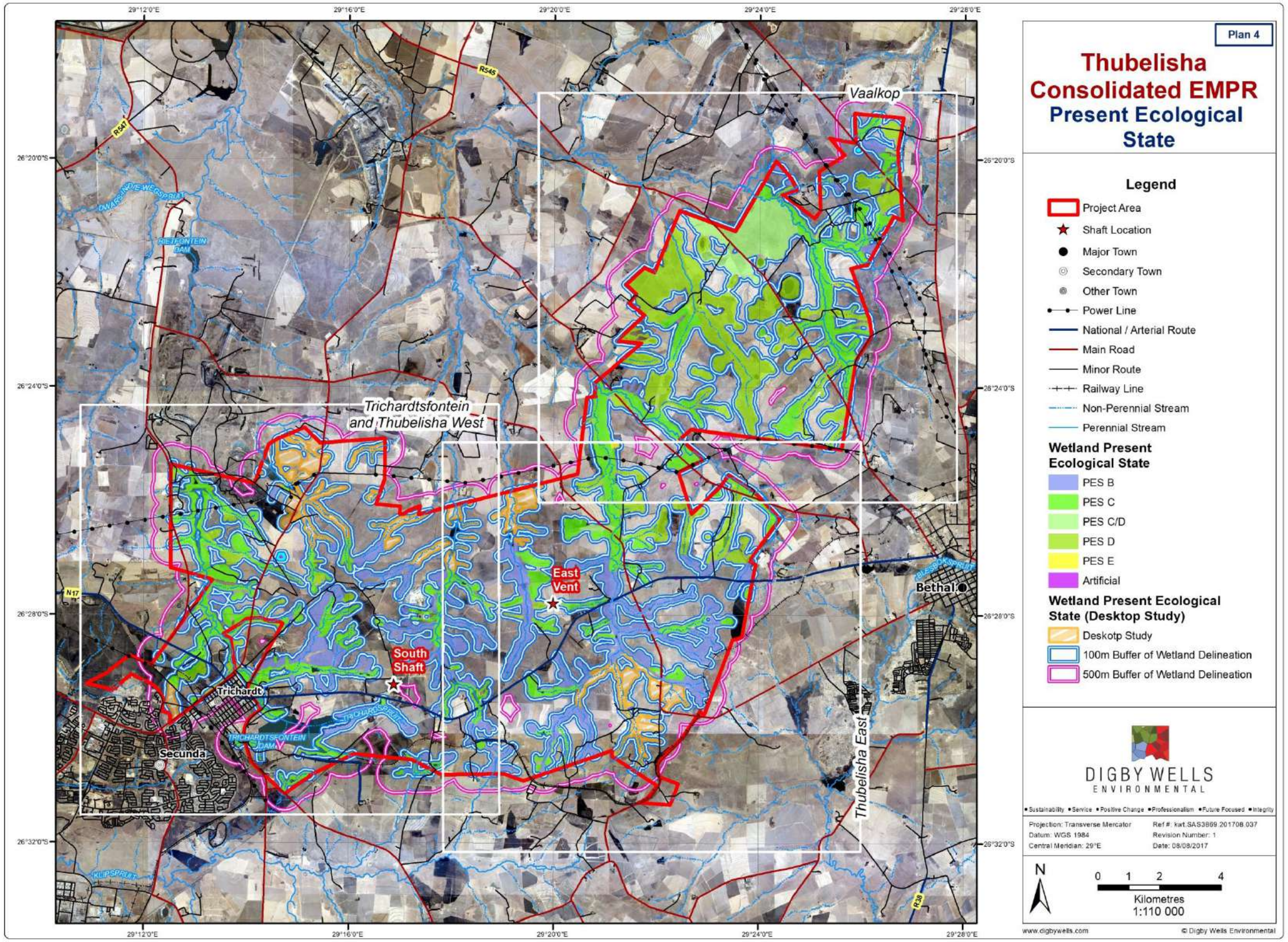


Figure 11-19: Wetland Present Ecological State (PES)

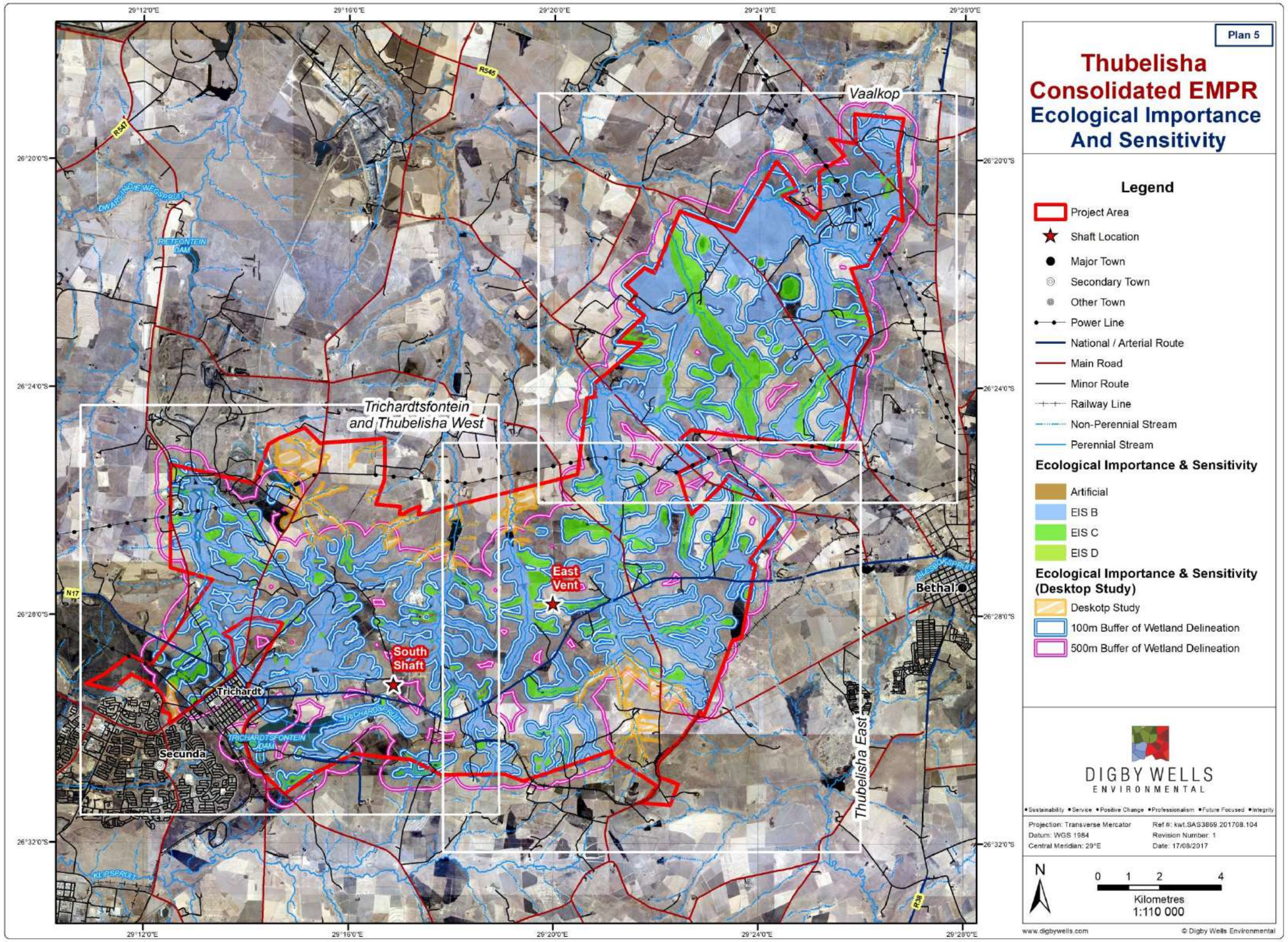


Figure 11-20: Wetland Ecological Importance and Sensitivity (EIS)

12 Impact Assessments for Wetlands

Refer to the project description for more information on the mining method. A brief summary is provided below:

- A high extraction method of mining using bord-and-pillar mining at a depth of 30 – 215 m . Stooping will occur outside of the 1:100 flood lines and developed areas;
- Two ventilation shafts (ventilation downcast shaft (0.25 ha) and ventilation upcast shaft (1.5 ha)) will be constructed at Trichardtsfontein.
- No surface infrastructure is proposed to be constructed at the Vaalkop Project area;

The major risk associated with underground mining is subsidence of unconsolidated sediments. Figure 12-1 represents the Life of Mine (LoM) plan against the wetland delineation and recommended buffers.

The impacts discussed below are the additional impacts to those discussed in the aforementioned previous wetland assessments considering the current proposed amendments and consolidation. No infrastructure is expected within the Vaalkop MR, therefore construction phase impacts are not applicable.

12.1 Summary of Proposed Project Interactions with Wetlands

Figure 12-1 below illustrates the wetlands that will be undermined. Figure 12-3 shows the vent shaft locations and their position in relation to the buffer zones. The Project interacts with wetlands as well as their ecological buffer areas (100 m and 500 m). The following outcomes must result from a comprehensive geotechnical investigation to reduce the overall impact:

- Provide appropriate design parameters for pillar and overburden stability, in line with the actual geotechnical rockmass properties,
- Indicate any areas (undermining of the wetlands) that may fall outside of these design parameters, and
- Following the geotechnical investigation, where required a provision must be made for the rehabilitation of these areas in the event of a possible risk of subsidence / intersection collapse.

Figure 12-2 indicates the subsidence risk. Areas of 30-50 m mining depth will have a definite risk of subsidence, 50-100 m mining depth has a high risk of subsidence and 100 or more has a low risk of subsidence. This is also based on the expected mining method for that area. •There are over 100 ha of wetland that will have a definite risk of subsidence. High risk areas include 608.4 ha of wetlands and low risk areas include 561.3 ha of wetlands (excluding the 100m buffer areas).

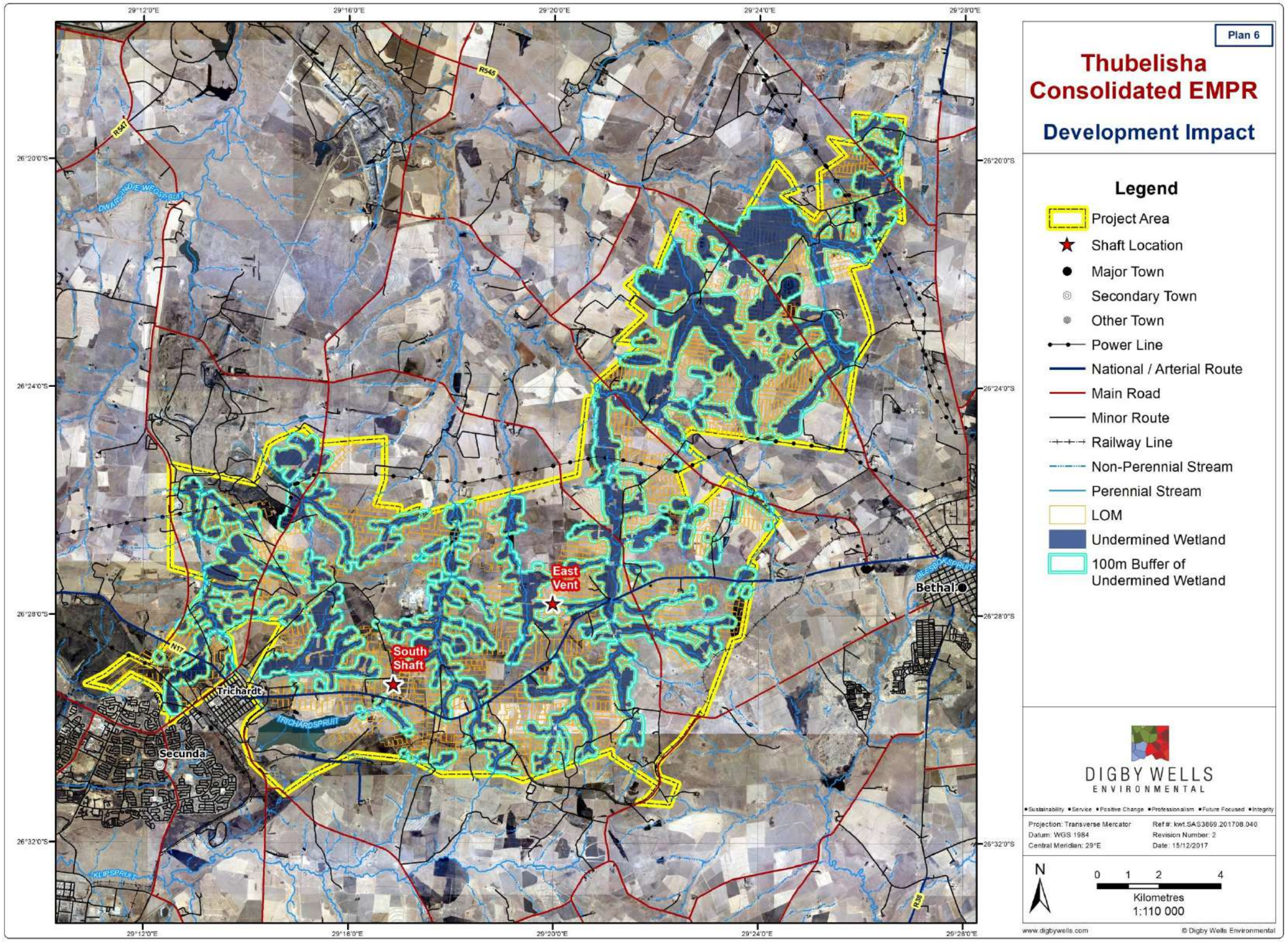


Figure 12-1: LOM Plan with Delineated Wetlands

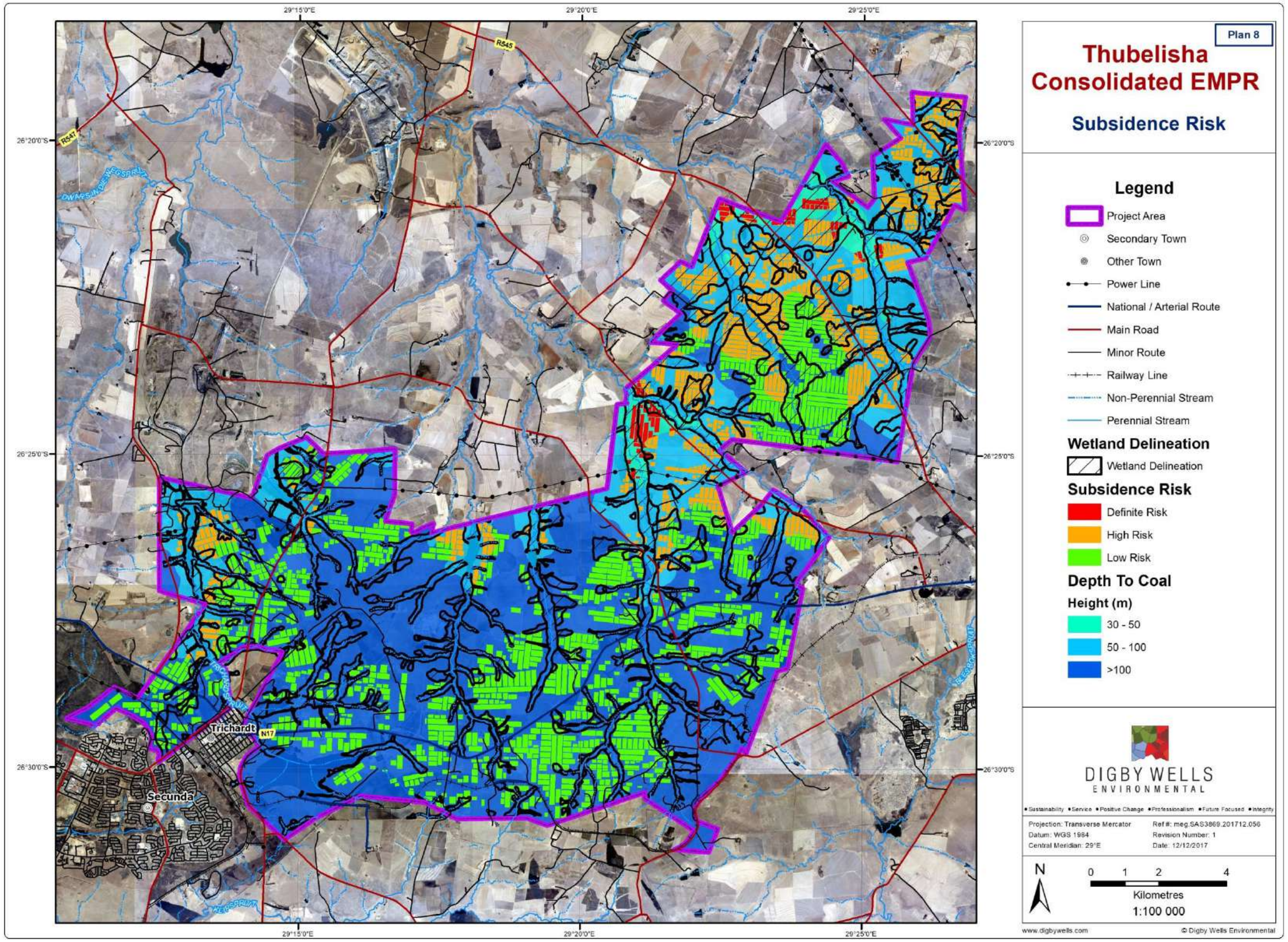


Figure 12-2: Subsidence Risk

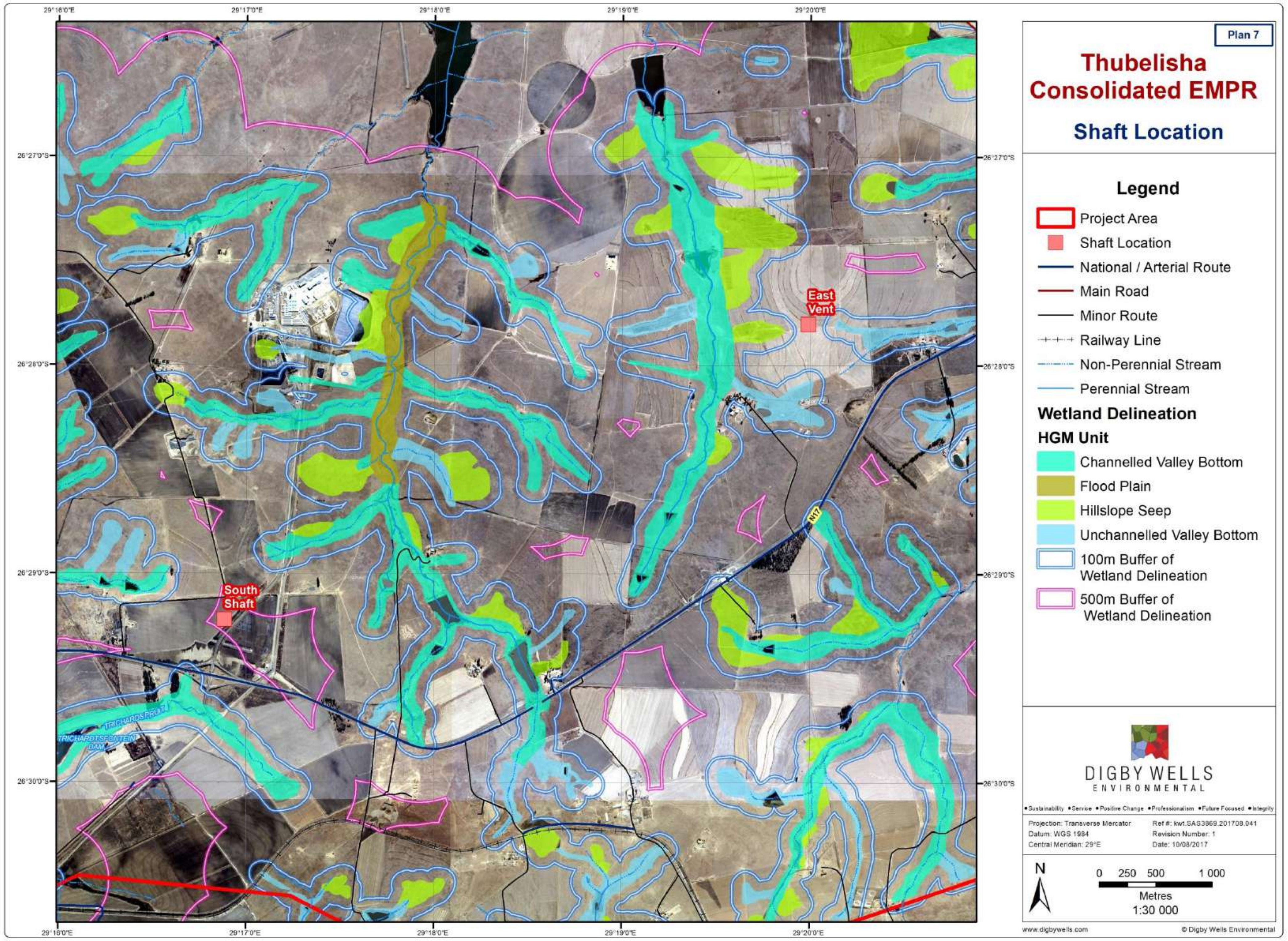


Figure 12-3: Vent Shaft Locations

12.2 Construction Phase Impacts

The proposed mining operation will require the removal of coal at a depth of between 30 and 215 m. Access to the mining areas will be from the adjacent underground workings and no surface entry is required. The only surface infrastructure required are two vent shafts. The construction of the vent shafts is outside of the 100 m wetland buffer and therefore will only have an indirect impact on the wetlands. The vent shafts are located within the 500 m WUL buffer and therefore a WUL will need to be applied for (see Figure 12-3).

12.3 Operational Phase Impacts

The operational phase activities that will have an impact on the wetlands are summarised below.

Table 12-1: Operational Phase Interactions with Wetlands

Interaction		Impact
1	High Extraction Underground Mining	Undermining of wetlands leading to hydrological and geomorphic changes to the functioning of the ecosystem; particularly related to subsidence and groundwater impacts.

12.3.1 Impact Description

Mining of coal within and around wetland ecosystems represents significant negative impacts to these ecosystems that function from a combination of surface and groundwater inputs. The undermining will occur between 30 – 215 m below ground level.

High extraction mining and shallower mining activities will have greater negative impacts as the surface is at great risker from destabilisation, resulting in possible subsidence if mitigation measures are not carried out (therefore two separate impact tables are provided; Table 12-2 and Table 12-3). The 30-50 m mining depth will have a definite risk of subsidence, 50-100 m mining depth has a high risk of subsidence and 100 or more has a low risk of subsidence. Groundwater is a significant water source in the area and this is seen in the extensive hillslope seep wetlands.

12.3.2 Management Objectives

To prevent/minimise the loss of or further damage to natural wetland ecosystems and their buffer areas. This is important as the naturally occurring habitat and ecosystems play a major role in supporting a range of ecological processes in the region, even more so due to the fact that mining is prevalent in the area.

12.3.3 Management Actions and Targets

The Wetland Management Plan detailed in Section 17 must be used to inform management actions. However, specific important management actions for the operational phase of the Project are briefly discussed below:

- The highest safety factor as prescribed by the Rock Engineers must be adhered to;
- A geotechnical study would need to be compiled to determine the exact risk of subsidence;
- Wetland monitoring must be carried out to ensure no unnecessary impact to wetlands is realised; and if so that a remedy is put in place as soon as possible; and
- In addition, general mitigation and management actions provided in the specialist studies completed by Digby Wells as part of this Project should be used to guide the effective management of the ecological wetland resources affected.

12.3.4 Impact Ratings

Table 12-2: Potential Impacts of Operational Phase Interaction 1 on Wetlands: Underground Mining (30-100m below ground level)

Dimension	Rating	Motivation	Significance
Activity and Interaction 1: High Extraction Underground Mining			
Impact Description: Undermining of wetlands leading to hydrological and geomorphic changes to the functioning of the ecosystem; particularly related to groundwater impacts. Depth of mine is between 30 – 100 m below ground level.			
Prior to Mitigation/Management			
Duration	Permanent (7)	Undermining of sensitive wetlands may have an irreversible impact to the functioning of these ecosystems. The mining will also be a permanent change to the wetland setting and groundwater functioning as mine dewatering will result in the lowering of the water table. Lowering of the water table could result in depletion of aquifers.	-119 Major
Extent	Municipal (4)	The Olifants River Catchment is an important, highly impacted catchment and further impacts to this area may have municipal level significance. Total area at risk of being undermined is 3406.2 ha with 709 ha being at definite and high risk)	
Intensity	Irreplaceable loss of highly sensitive environments (6)	These rivers and wetlands are important for the ecological services they provide to society; particularly due to the high level of cumulative loss of wetland functioning in the area. Undermining of these wetlands may lead to the loss of some of these areas and this is seen as an irreplaceable loss of these highly sensitive systems.	

Dimension	Rating	Motivation	Significance
Probability	Certain/ Definite (7)	Subsidence is a definite risk in some areas, and so is the lowering of the water table.	
Nature	Negative (-)		
Mitigation/Management Actions			
▪ No mitigation measures will reduce the impact of definite subsidence. In this case, a wetland offset strategy would need to be compiled.			
Post-Mitigation			
Duration	Permanent (7)	Although mitigation measures may lessen the impact somewhat, the mining will be a permanent change to the wetland setting and groundwater functioning (decant, subsidenceetc.).	-119 Major
Extent	Municipal (4)	The Olifants River Catchment is an important, highly impacted catchment and further impacts to this area may have municipal level significance.	
Intensity	Irreplaceable loss of highly sensitive environments (6)	In the definite risk areas of subsidence, no mitigation will control the impact. There will be irreplaceable loss of those wetland habitats.	
Probability	Certain/ Definite (7)	Undermining of these wetlands will lead to subsidence.	
Nature	Negative (-)		

Table 12-3: Potential Impacts of Operational Phase Interaction 1 on Wetlands: Underground Mining (>100m below ground level)

Dimension	Rating	Motivation	Significance
Activity and Interaction 1: High Extraction Underground Mining			
Impact Description: Undermining of wetlands leading to hydrological and geomorphic changes to the functioning of the ecosystem; particularly related to groundwater impacts. Depth of mine is between >100 m below ground level.			
Prior to Mitigation/Management			

Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	Undermining of sensitive wetlands may have an irreversible impact to the functioning of these ecosystems. The mining will also be a permanent change to the wetland setting and groundwater functioning as mine dewatering will result in the lowering of the water table. Lowering of the water table could result in depletion of aquifers.	-85 Moderate
Extent	Municipal (4)	The Olifants River Catchment is an important, highly impacted catchment and further impacts to this area may have municipal level significance. Total area at risk of being undermined is 3406.2 ha with 561.3 ha being at low risk.	
Intensity	Irreplaceable loss of highly sensitive environments (6)	These rivers and wetlands are important for the ecological services they provide to society; particularly due to the high level of cumulative loss of wetland functioning in the area. Undermining of these wetlands may lead to the loss of some of these areas and this is seen as an irreplaceable loss of these highly sensitive systems.	
Probability	Likely (5)	Subsidence is a lower risk in some areas, however lowering of the water table is still likely. A geotechnical study would need to be completed to determine the exact risk of subsidence	
Nature	Negative (-)		
Mitigation/Management Actions			
▪ The highest safety factor as prescribed by the Rock Engineers must be adhered to. ▪ A geotechnical study would need to be compiled to determine the exact risk of subsidence; ▪ Wetland monitoring must be carried out to ensure no unnecessary impact to wetlands is realised; and if so that a remedy is put in place as soon as possible. ▪ A wetland offset strategy may need to be compiled.			
Post-Mitigation			
Duration	Permanent (7)	Although mitigation measures may lessen the impact somewhat, the mining will be a permanent change to the wetland setting and groundwater functioning (decant, subsidence etc.).	-68 Minor

Dimension	Rating	Motivation	Significance
Extent	Municipal (4)	The Olifants River Catchment is an important, highly impacted catchment and further impacts to this area may have municipal level significance	
Intensity	Irreplaceable loss of highly sensitive environments (6)	In the definite risk areas of subsidence, no mitigation will control the impact. There will be irreplaceable loss of those wetland habitats.	
Probability	Probable (4)	It is probable that the undermining of these wetlands will lead to subsidence, even with mitigation measures in place	
Nature	Negative (-)		

12.4 Closure and Rehabilitation Phase

12.4.1 Project Activities Assessed

Table 12-4: Closure and Rehabilitation Phase Interactions with Wetlands

Interaction		Impact
1	Underground mine closure and rehabilitation	Post-mining decant of groundwater will have negative impacts on the wetlands as this water is likely to be of a poor water quality.

12.4.2 Impact Description

This phase will require the removal of the infrastructure and the rehabilitation of the site to an acceptable and sustainable landscape that will be non-polluting in perpetuity. The post-mining landscape will have groundwater impacts due to decant being realised at some point as the mine voids fill up naturally with water once dewatering stops. Given the altered underground conditions, the water quality may be compromised. .

12.4.3 Management Objectives

Wetlands are especially sensitive ecological systems that provide important good and services to the benefit of society. The objectives of management actions are to prevent/minimise the loss of or further damage to natural wetland ecosystems and their buffer areas. This is important as the naturally occurring habitat and ecosystems play a major role in supporting a range of ecological processes and biodiversity in the region. The rehabilitation phase is important for managing and remediating negative impacts.

12.4.4 Management Actions and Targets

The Wetland Management Plan detailed in Section 17 must be used to inform management actions. However, specific important management actions are briefly discussed below:

- Wetland monitoring must be carried out on wetlands that could possibly be impacted on by activities during rehabilitation to ensure no unnecessary impact to wetlands is realised; and if so that a remedy is put in place as soon as possible. Transects should be set up through representative sites and monitored regularly;
- Decant will need to be treated with active or passive treatment (should it not be to the correct quality standards) and a Wetland Rehabilitation Plan will need to be compiled to rectify any damages; and
- In addition, general mitigation and management actions provided in the specialist studies compiled by Digby Wells as part of this project should be used to guide the effective management of the ecological wetland resources affected by the proposed project.

12.4.5 Impact Ratings

Table 12-5: Potential Impacts of Rehabilitation Phase Interaction on Wetlands: Underground mine closure and rehabilitation

Dimension	Rating	Motivation	Significance
Activity and Interaction : Underground mine closure and rehabilitation			
Impact Description: Post-mining decant of groundwater will have negative impacts on the wetlands as this water is likely to be of a poor water quality.			
Prior to Mitigation/Management			
Duration	Permanent (7)	Decant of polluted underground water into the catchment will have negative impacts beyond the project life and will be irreversible if no managed or mitigated against.	-114 Major
Extent	Regional (5)	The Olifants River Catchment is an important, highly impacted catchment and further impacts to this area may have a regional level significance.	
Intensity	Irreplaceable damage to highly sensitive environments (7)	These wetlands are sensitive receptors and this represents serious impacts to these systems that could lead to irreplaceable damage to and loss of ecological functioning.	
Probability	Highly Probable (6)	It is very likely to lead to the impacts described.	

Dimension	Rating	Motivation	Significance
Nature	Negative (-)		
Mitigation/Management Actions			
▪ Groundwater and wetlands must be monitored post-mining for potential decant (3 years or until the system has stabilised). ▪ Long-term water treatment options (passive or active) will need to be investigated by Sasol to prevent polluted decant water from entering the catchment, should this water not be to the correct standards. ▪ Collecting decant and treating it to river quality objectives before joining the streams and wetlands. ▪ Monitoring groundwater levels and decant (rate and quality).			
Post-Mitigation			
Duration	Permanent (7)	It is likely that the issue of polluted underground water will be a permanent catchment impact to manage.	--36 Minor
Extent	Local (3)	If adequate water treatment is carried out before discharge then the impact can be managed at the local site.	
Intensity	Minor loss and/or damage to biological resources (2)	These wetlands are sensitive receptors and altered water quality represents serious impacts to these systems that must be managed. Therefore if water is treated before entering the wetland systems, the impact will be reduced substantially.	
Probability	Unlikely (3)	If the decant is treated to the river quality objectives, its impact is unlikely/.	
Nature	Negative (-)		

13 Indirect Impacts

The construction of the vent shafts is proposed outside of the 100 m wetland buffer area however, they are located within the 500 m WUL buffer and therefore will likely only have indirect impact on the wetlands. A report titled: ‘Wetland Impact and Risk Assessment for two Proposed Ventilation Shafts at the Existing Twistdraai Colliery Thubelisha Shaft’ WCS, (2016) discusses two possible impacts:

- Temporary, localised drawdown of shallow groundwater resulting in temporary decreased flow; and
- Runoff from bare soil areas during construction resulting in increased turbidity and suspended sediment load.

14 Cumulative Impacts

Some of the major contributing factors to the decline of wetlands in South Africa include mining, industrial and agricultural activities as well as poor treatment of waste water from industry and mining (Oberholster *et al.*, 2011). Coal mining causes destruction of wetlands via direct impacts such as removal of habitat, alteration of flow and contamination of water, but also indirectly through the drawdown of groundwater resources during the dewatering process (van Der Walt, 2011).

Dewatering has cumulative impacts on wetlands, which are complex, interlinked systems in the Highveld. Underground mining, particularly in Mpumalanga due to bord and pillar methods, has frequently resulted in unplanned surface collapse (Ochieng *et al.* 2010). This collapse has been the cause of ground and surface water contamination due to acidification and/or salinisation of nearby aquifers. Coal mining is already prevalent in the region and 5 coal mines are located within a 30 km radius of the Project area, with more planned in the future. The Project is likely to continue to contribute to these cumulative impacts through added dewatering, potentially increasing the loss of wetlands in the Mpumalanga Province region.

15 Unplanned Events and Low Risks

The planned activities will have known impacts as discussed above; however, unplanned events may happen on any project that may have potential impacts which will need mitigation and management. Table 15-1 below is a summary of the findings from a wetlands perspective. Please note not all potential unplanned events may be captured herein and this must therefore be managed by Sasol throughout all phases.

Table 15-1: Unplanned Events, Low Risks and their Management Measures

Unplanned event / low risk	Potential impact	Mitigation/ Management/ Monitoring
Temporary, localised drawdown of shallow groundwater during construction of vent shafts	Temporary decreased flow.	▪ Seal shaft walls timeously to reduce drawdown timeframe
Runoff from bare soil areas during construction of vent shafts	Increased turbidity and suspended sediment load.	▪ Maintain 100 m buffer between construction footprint and wetland ▪ Minimise construction area ▪ Major earthworks to take place in dry season
PCD failure or spillage	Polluted seepage or overflow will have negative impacts on water quality and will increase sedimentation.	▪ Maintain infrastructure appropriately ▪ Maintain a freeboard that will suitably withstand a 1 in 100 year flood event ▪ Implement a toxicological monitoring programme

Unplanned event / low risk	Potential impact	Mitigation/ Management/ Monitoring
Runoff from emergency stockpile area	Polluted seepage or runoff from the stockpile area will have negative impacts on water quality and will increase sedimentation.	▪ Ensure facility is appropriately lined and bunded ▪ Monitor to ensure that no runoff is entering wetland areas ▪ Ensure that there is adequate separation of dirty and clean water systems

16 Environmental Management Plan

The objective of an Environmental Management Plan (EMP) is to present mitigation measures that (a) manage undue or reasonably avoidable adverse impacts associated with the development and (b) to enhance potential positives.

16.1 Project Activities with Potentially Significant Impacts

The following is a summary of the identified significant impacts to wetlands that will require mitigation measures for the Project to go ahead.

Table 16-1: Potentially Significant Project Impacts

Activity		Impact
Operational Phase		
1	Undermining of wetlands.	Hydrological and geomorphic changes to the functioning of the ecosystem; particularly related to groundwater impacts and subsidence. Total area of undermined wetlands is 3270.8 ha.
Rehabilitation and Closure Phase		
2	Post-mining decant of groundwater.	Negative impacts on the wetlands as this water is likely to be of a poor water quality.

17 Mitigation Measures

Table 17-1 provide a summary of the proposed Project activities, environmental aspects and impacts on the receiving environment. Information on the frequency of mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the EMP. All of the mitigation measures have been previously listed in the impact assessment tables as well.

Table 17-1: Mitigation and Management Plan

<table>
<tr><th>Activities</th><th>Potential Impact</th><th>Size and scale of disturbance</th><th>Phase</th><th>Mitigation Type/Measures</th><th>Compliance with standards/Standard to be achieved</th><th>Time period for Implementation</th></tr>
<tr><td>High Extraction Underground Mining</td><td>Undermining of wetlands leading to hydrological and geomorphic changes to the functioning of the ecosystem; particularly related to groundwater impacts.</td><td>3406.19 ha
(100 ha definite risk, 608 ha high risk, 561 ha low risk (excl. buffers)) with the remainder being areas that are not at risk of subsidence</td><td>Operational</td><td>▪ Subsidence monitoring and crack sealing</td><td rowspan="2">▪ The NWA
▪ Section 21 (c), (g) and (i) of the NWA
▪ Section 24 of the Constitution
▪ NEM:BA
▪ NEMA
▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005);
▪ Mining and Biodiversity Guideline (DEA et al., 2013);
▪ MTPB, 2014</td><td>Design and operational Phase</td></tr>
<tr><td>Underground Mine Closure and Rehabilitation</td><td>Post-mining decant of groundwater will have negative impacts on the wetlands as this water is likely to be of a poor water quality.</td><td>N/A</td><td>Closure and Rehabilitation</td><td>▪ Groundwater and wetlands must be monitored post-mining for potential decant.
▪ Long-term water treatment options will need to be investigated by Sasol to prevent polluted decant water from entering the catchment.
▪ Aim to improve the PES of wetlands as per the WUL</td><td>Closure and Rehabilitation Phase</td></tr>
</table>

18 Monitoring Plan

Monitoring of the wetlands and mining activities is important to detect any predicted or unforeseen impacts to these sensitive systems and to understand the impact so that a remedial action can be carried out. Mining is an important activity for the economic growth of South Africa but has the potential to have impacts far beyond the boundaries of the Project area and longer than the life of mine.

It is important to manage impacts to the environment and protect the ecosystem services that it provides; and this is particularly important with regards to wetlands and water resources. The below table summarises the recommended monitoring plan for the Project.

Table 18-1: Monitoring Plan

Activities	Impacts requiring monitoring programmes	Functional requirements for monitoring	Monitoring frequency
All activities	All impacts and threats to wetlands, predicted or not.	▪ Monitoring of activities through all phases to ensure all impacts are remediated as soon as possible; thus preventing and long term residual impacts to the system that compromises wetland functionality. ▪ The wetlands immediately adjacent to the vent shafts should be demarcated in the field as they are at particular risk of impacts.	**ECO:** Internal monitoring should be done as often as possible according to the management practices of the mine. **Independent wetland specialist:** regularly and when needed, i.e. after an incident.
High extraction underground mining	Hydrological and geomorphological impacts to wetlands and catchment.	▪ As mining progresses, wetlands that have the potential to be impacted on should be monitored for evidence of loss of functionality due to groundwater changes. ▪ Monitoring for all risks including uncontrolled erosion, hydrocarbon spills etc. and remediated where needed. ▪ Monitor subsidence. ▪ Fixed transects should be set up (5) over different wetland areas to monitor changes in wetlands through the mining process	**ECO:** Monitoring as often as possible according to the management practices of the mine during operation. Subsidence should be monitored annually. **Independent wetland specialist:** annually and when needed, i.e. after an incident. Independent groundwater specialist: groundwater quality should be monitored quarterly.
	Water levels	▪ Installation of piezometers to monitor water levels and wetland hydrology. ▪ Prior to piezometer installation, a thorough soil survey of the wetland is needed. This will enable the correlation of soil wetness with the monitored water levels and will inform the optimal locations for the piezometers. ▪ A vegetation assessment will also be required so that correlations between the vegetation composition/structure and the soil morphological features. This will allow an assessment of changes in the wetlands hydrological functioning.	Groundwater levels must be recorded on a quarterly basis to detect any changes or trends in groundwater elevation and flow direction
Mine closure and post-mining environmental status	Possible post-mining water decant and potential decant	▪ Monitor for all risks and remediate. If a greater extent of wetlands are destroyed due to decant, passive treatment of water will need to be considered along with rehabilitation and a wetland offset strategy.	**Independent wetland specialist:** Monitoring should be done annually and when needed, i.e. after an incident.

19 Recommendations and Conclusions

The Project area encompasses large wetland areas totalling 6080.1 ha (26% of the Project area). Approximately 3406.2 ha of wetlands are proposed to be undermined (100 ha definite risk, 608 ha high risk, 561 ha low risk (excluding buffers) with the remainder not being at risk of subsidence).

Although the mine surface infrastructure will not result in any direct destruction of wetlands, the indirect loss of wetlands due to altered hydrology from undermining activities cannot be quantified in detail. Furthermore, the impacts of subsidence will be very high where the shallow mining (30 – 100 m) is going to be taking place and will result in a complete loss of the undermined wetlands. Decant is likely to occur due to subsidence, uncapped boreholes and sinkholes, although it is not expected to occur at the shaft locations. The impact of decant on wetlands systems could potentially be high if not mitigated through treatment options.. The Project, therefore, has the potential to result in significant negative impacts on the natural wetlands and to alter the functioning of these systems and compromise their ecosystem services provided. The following is recommended:

-
- Wetlands in South Africa are protected under the NWA and a Water Use License is required for any development within a wetland or within 500m from a wetland;
- A buffer around wetlands of 100 m must be adhered to to avoid impacts on wetlands. Furthermore decant points must be kept outside of the 100m buffer; and
- Monitoring as described in the Monitoring Plan must be implemented throughout the Project life. Fixed point transects should be set up in at least 5 locations to monitor the wetlands and any impacts on these systems. Piezometers should be installed to determine wetland hydrology.

20 References

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Appendix A: Species List

Species	Common name
*Acacia decurrens**	Green Wattle
Acacia mearnsii *	Black Wattle
Agrostis lachnantha	Bent grass
Andropogon eucomus	Snowflake Grass
Aristida congestus	
Arundinella nepalensis	River Grass
Asclepias fruticosa	Milkweed
Berkheya radula	
*Bidens pilosa**	Black Jack
Cephalaria sp.	
Cirsium vulgare *	Spear Thistle
*Conyza albida**	Guernsey Fleabane
*Cosmos bipinnatus**	Cosmos
Cymbopogon plurinodis	
Cynodon dactylon	Couch Grass
Cyperus compressus	Flat Sedge
Cyperus esculentus	Yellow Nut Sedge
Cyperus marginatus	
Cyperus sp.	
Echinochloa sp.	
Eleocharis acutangula	
Eragrostis chloromelas	Curly Leaf (Narrow)
Eragrostis curvula	Weeping Love Grass
Eragrostis gummiflua	Gum Grass
Eragrostis plana	Tough Love Grass
Eragrostis sp.	
*Eucalyptus camaldulensis**	Red River Gum
Gnidia burchellii	
Gomphocarpus fruticosus	Milkweed
Hypoxis sp.	
Helichrysum aureonitens	Golden Everlasting
Helichrysum luteoalbum	Jersey Cudweed
Heteropogon contortus	Spear Grass
Hyparrhenia hirta	Common Thatching Grass
Imperata cylindrica	Cottonwool Grass
Juncus effusus	Soft Rush
Juncus oxycarpus	-

Species	Common name
Kyllinga alata	-
Lactuca serriola	Wild lettuce
Leersia hexandra	Rice Grass
Loudetia simplex	Russet grass
Panicum sp.	-
*Pennisetum clandestinum**	Kikuyu grass
Pennisetum macrourum	Riverbed Grass
Perotis patens	Cat's Tail
Phragmites australis	Common Reed
*Plantago sp.**	-
*Populus × canescens**	Grey Poplar
*Populus alba**	White Poplar
Pseudognaphalium luteo-album	Jersey cudweed
*Salix babylonica**	Weeping Willow
Schoenoplectus brachyceras	-
Schoenoplectus muriculatus	-
Seriphium plumosum	Bunkrupt Bush
Setaria sphacelata	Golden Bristlegrass
*Sonchus asper**	-
Sporobolus africanus	Rat's Tail Grass
*Tagetes minuta**	Khaki bush
Themeda triandra	Red Grass
*Trifolium repens**	White Clover
Typha capensis	Bulrush
*Verbena bonariensis**	Tall Verbena
*Xanthium strumarium**	Large cocklebur
*Galium spurium**	Catchweed

*Denotes alien species