PROPOSED EXPANSION OF THE ELANDSPRUIT QUARRY NEAR LADYSMITH

KWAZULU-NATAL PROVINCE

SPECIALIST WETLAND ASSESSMENT REPORT

February 2017

Prepared for:

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DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

- » act/ed as the independent specialist in this application;
- » regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- » do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- » have and will not have no vested interest in the proposed activity proceeding;
- » have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- » am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- » have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- » am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 982.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
February 2017

**PROPOSED EXPANSION OF THE ELANDSPRUIT QUARRY NEAR LADYSMITH, KWAZULU-NATAL PROVINCE
WETLAND ASSESSMENT REPORT**

1 INTRODUCTION

1.1 Applicant

Raubex KZN (Pty) Ltd.

1.2 Project

The project will be known as: *The proposed expansion of the Elandspruit Quarry*.

1.3 Proposed Activity

The existing quarry pit located on the property has been historically used to obtain aggregates for road building. The applicant (Raubex KZN) wishes to expand this quarry pit by making use of the open-cast mining method. The proposed mining area is approximately 5 ha in extent and the applicant intends to mine the area for at least three years.

The mining activities will consist of the following:

» Stripping and stockpiling of topsoil
» Blasting,
» Excavation,
» Crushing,
» Stockpiling and transporting,
» Sloping and landscaping upon closure of the site,
» Replacing the topsoil and vegetation from the disturbed area.

The mining site will contain the following:

» Drilling Equipment,
» Excavation Equipment,
» Earth Moving Equipment,
» Mobile Crushing and Screening Plant,
» Mobile Office and Ablution Facilities.

Access Route:

- » The existing farm road (turning from Collings Pass road) will be used to gain access to the proposed mining area. Non mining equipment of vehicles will access the N11 directly from the mining area.
- » Haul roads, inside the approved mining area, will be extended as mining progress.

1.4 Terms of reference

ECO-Care Consultancy was appointed by Greenmined Environmental to undertake an independent assessment of the wetland system located south of the proposed development footprint area, as well as to conduct an assessment of the potential impacts of the development on the wetland.

The focus of the work involved the following tasks:

- » Desktop identification and delineation of potential wetland areas which may potentially be affected by the proposed development using latest available aerial photography and river/wetland coverage's in a Geographical Information System (GIS):
- » Site-based delineation of the outer wetland boundary of wetland areas within the project focal area;
- » Classification of wetlands and riparian areas and assessment of conservation significance based on available datasets:
- » Assessment of PES (Present Ecological State/Condition) and EIS (Ecological Importance and Sensitivity) of wetlands, informed by an understanding of existing wetland and catchment impacts;
- » Determination and discussion of ecological wetland buffer zones;
- » Impact assessment and identification of mitigation measures to reduce the significance of potential aquatic impacts for both the construction and operational phases of the pipeline project;
- » Compilation of a specialist wetland assessment report detailing the methodology and findings of the assessment, together with relevant maps and GIS information.

The following terms of references are associated with this wetland investigation:

- » The identification and demarcation of wetlands present within the study area that are consistent with the definition of a watercourse in terms of the National Water Act, 1998 (NWA), Act No. 36 of 1998. The specific watercourse definitions focused on include:
  - A river or spring.
  - A natural channel in which water flows regularly or intermittently.
  - A wetland, lake or dam into which, or from which water flows.

1.5 General assumptions and limitations

1.5.1 *General assumptions*

- This study assumes that the project proponents will always strive to avoid, mitigate and/or offset potentially negative project related impacts on the environment, with impact avoidance being considered the most successful approach, followed by mitigation and offset. It is further assumed that the project proponents will seek to enhance potential positive impacts on the environment.
- GIS spatial datasets used as part of the field surveys (site demarcation) and analyses are accurate.
- The project proponents will commission an additional study to assess the impact(s) if there is a change in the size, location and/or extent of the study area that is likely to have a potentially highly significant and/ or unavoidable impact on the natural environment

1.5.2 Limitations

The following refers to general limitations that affect the applicability of information represented within this report (also refer to Conditions of the Report):

- This report specifically focuses on the identification, delineation, and classification of the various hydrological features characterising the study area.
- Accuracy of the maps, routes and desktop assessments is based on the current 1:50 000 topographical map series of South Africa;
- Accuracy of Global Positioning System (GPS) coordinates was limited to 5m accuracy in the field.
- A single survey limited the amount of biota identified at the site;
- While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that that is possible. The nature of the vegetation, seasonality, human intervention etc. limit the veracity of the material presented.
- Hydrological assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS) as well as the Water Research Council (WRC) based on site conditions and applicability. These techniques are however largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration.
- Most of the wetland and watercourse systems located within the study area form part of larger systems expanding well beyond the focus area. Although their extent and down- / upstream nature and functions were taken into

account, the focus of the study was restricted to the affected farm properties and the immediate surrounding landscape.

» This specific study area is affected by a variety of disturbances (historic and active) which restricts the use of available wetland indicators such as hydrophytic vegetation or soil indicators. Hence, a wide range of available indicators including historic aerial photographs are considered to help determine boundaries as accurately as possible.

1.6 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

2 RELEVANT ENVIRONMENTAL LEGISLATION

2.1 Legislation pertaining to wetlands

In response to the importance of wetland systems, protection of wetlands has been campaigned at national and international levels. This has led to the development of various policies and promulgation of a range of legislation to help protect wetland systems.

At an International level wetland protection is emphasized through the following conventions and agreements:

The RAMSAR Convention	Emphasis is placed on protecting wetlands and implementing initiatives to maintain or improve the state of wetland resources.
Convention on Biological Diversity	Countries are to rehabilitate or restore degraded ecosystems through the formulation of appropriate strategies and plans.
United Nations Convention to Combat Desertification	South Africa has responded to the UN Convention to Combat Desertification by developing a National Action Plan. The aim of the NAP is to implement at current and future policies that affect natural resource management and rural development, and establish partnerships between government departments, overseas development agencies, the private sector and NGOs.
New Partnerships for Africa's Development (NEPAD)	Wetland conservation and sustainable use is one of the eight themes, under the environmental initiative.

The World Summit on Sustainable Development (WSSD)	The implantation Plant highlights actions that reduce the risk of flooding in drought-vulnerable countries by promoting the restoration and protection of wetlands and watersheds.

At a National level, there are a plethora of policies and legislation dealing either directly or indirectly with wetland protection and management. These include:

South African Constitution 108 of 1996	This includes the right to have the environment protected through legislative or other means.
National Environmental Management Act 107 of 1998	This is a fundamentally important piece of legislation and effectively promotes sustainable development and entrenches principles such as the 'precautionary approach', polluter pays', and requires responsibility for impacts to be taken throughout the life cycle of a project.
Environmental Impact Assessment (EIA) regulations	New regulations have been promulgated in terms of Chapter 5 of NEMA and were published on 18 June 2010 in Government Notice No. R. 543. In addition, listing notices (GN 544-546) lists activities which are subject to an environmental assessment. A number of activities listed in the regulations have relevance to wetlands including a range of activities within 32m of a watercourse (which includes wetlands).
The National Water Act 36 of 1998	This Act imposes 'duty of care' on all landowners, to ensure that water resources are not polluted. The following Clause in terms of the National Water Act is applicable in this case: **19(1)** "An owner of land, a person in control of land or a person who occupies or uses the land on which (a) any activity or process is or was performed or undertaken; which causes, has caused or likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring" Chapter 4 of the National Water Act is of particular relevance to wetlands and addresses the user of water and stipulates the various types of licensed and unlicensed entitlements to the use of water. Water use is defined vary broadly in the Act and effectively requires that any activities with a potential impact on wetlands (within a distance of 500m upstream or downstream of a wetland) be authorised.
General Authorisations (GAs)	These have been promulgated under the National Water Act and were published under GNR 398 of 26 Marched. Section **21(c)** or **(i)** Water Use Authorisation has been revised under GNR Notice 509 of 2016. Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water Affairs and Forestry
National Environmental Management: Biodiversity Act No 10 of 2004	The intention of this Act is to protect species and ecosystems and promote the sustainable use of indigenous biological resources. It addresses aspects such as protection of threatened ecosystems and imposes a duty of care relating to listed alien invasive species.
Conservation of Agricultural Resources Act 43 of 1967	The intention of this Act is to control the over-utilization of South Africa's natural agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.

At the Provincial level there is little legislation. The following guidelines and ordinance are however relevant:

Guidelines for development activities that may affect wetlands released by KwaZulu-Natal Department of Agriculture and Environmental Affairs	- This includes a draft set of norms and standards for the avoidance and mitigation of impacts to wetlands in urban areas.
Natal Nature Conservation Ordinance 15 of 1974 & KwaZulu Nature Conservation Act 29 of 1992	Makes extensive provision for protected areas (including private nature reserves) and protection of flora and fauna (including marine and freshwater fish.)

Other pieces of legislation that are also of some relevance to wetlands include:

» The National Forest Act 84 of 1998;
» The Natural Heritage Resources Act 25 of 1999;
» The National Environmental Management: Protected Areas Act 57 of 2003;

3 APPROACH AND METHODOLOGY FOLLOWED

3.1 Approach

The approach to the assessment involved three phases:

1. Collation and refinement of baseline information on the affected environment: Wetlands potentially impacted by the proposed expansion of existing aggregate quarry were identified at a desktop level using available digital imagery and datasets in a Geographical Information System (GIS). These were then verified in the field in order to determine:
   - The extent of wetland habitat (detailed wetland delineation taking place within a 500m radius of the proposed development boundary);
   - Condition of wetland areas; and
   - Ecological importance and sensitivity (including ecological processes and ecosystem services).
2. The identification and assessment of potential impacts: An assessment of potential ecological impacts was undertaken based on the development information provided by the client with respect to the baseline status of habitat/ecosystem. In order for the potential impacts of the development to be assesses in accordance with the above mentioned ecosystem status use was made of the Department of Water and Sanitation’s Risk Assessment model to determine whether any streams or wetlands were likely to be placed at risk as a result of the construction and operational processes.

3. Recommendations for mitigation: Site-specific management and mitigation recommendations were compiled to assist with addressing the range of impacts identified and other ecological concerns related to actions, activities and processes associated with the proposed development.

3.2 Data sources consulted

The following data sources and GIS spatial information provided in Table 1 below was consulted to inform the assessment. The data type, relevance to the project and source of the information has been provided.

Table 1: Information and data coverage's used to inform the wetland assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
Colour Aerial Photography (2009)	Mapping of wetlands and other features	National Geo-Spatial information
Latest Google Earth™ imagery	To supplement available aerial photography where needed	Google Earth™ On-line
Proposed location of quarry and boundaries of proposed expansion area.	Shows location of the existing quarry and the proposed expansion boundaries	Client
5m Elevation Contours	To assist with desktop mapping of wetlands, delineation of catchments and calculation of slope/gradients.	Surveyor General
NFEPA wetland coverage	Shows location of FEPA river and wetland sites.	EKZNW (2010)
Freshwater Systematic Conservation Plan of KZN	Used to identify and interrogate aquatic biodiversity concerns at a desktop level	EKZNW (2010)
National Land Cover 2014	Used to identify land use in catchment	EKZNW (2010)
KZN Vegetation Layer 2012	Vegetation coverage for the province showing the location, extent and status of vegetation	EKZNW (2010)
Vegetation Layer based on Mucina & Rutherford (2014)	Vegetation coverage for the province showing the location, extent and status of vegetation	BGIS

3.3 Methods used

3.3.1 Wetland and riparian areas delineation

The outer boundary of wetlands occurring within a 500m radius of the proposed development boundary was identified and delineated according to the Department of Water Affairs wetland delineation manual: 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Available wetland indicators were investigated including hydromorphic features, presence of hydrophytic plant species, and terrain unit features (e.g. valley bottom settings and "key points"). The broader wetland systems were delineated using aerial photography and contour information at a desktop level.

3.3.2 Classification and assessment of conservation context

Wetlands were classified according to HGM (hydro geomorphic) type using the National Wetland Classification System which was developed for the South African National Biodiversity Institute (SANBI, 2009). The HGM classification system is based on three key parameters pertaining to the wetland: the geomorphic setting of the wetland, the source of water inputs into the wetland, and its hydrodynamics (how does water move through the wetland), (Brinson 1993; Kotze *et al.* 2005). Additionally, wetland types were also identified based on the NFEPA (CSIR, 2011) wetland vegetation group in which wetlands are located. The conservation context and associated conservation significance of the project area was described using available spatial datasets including the National Freshwater Ecosystem Priority Areas or NFEPA Project (CSIR, 2011) and the Aquatic Systematic Conservation Plant for the Province (EKZNW, 2007).

3.3.3 Wetland functional assessment

» ***<u>WET-Health Assessment (Wetland integrity/Present Ecological State)</u>***

The Wet-Health tool (Macfarlane *et al.* 2008) was used to assess the Present Ecological State (PES) of wetlands by highlighting specific impacts within wetlands and within wetland catchment areas. For the purposes of this study, a Level 1 assessment was undertaken. While this is a rapid assessment, it is regarded as adequate to inform an assessment of existing impacts on wetland condition.

The WET-Health tool provides an appropriate framework for undertaking an assessment to indicate the functional importance of the wetland system that could be impacted by the proposed development. The assessment also helps to identify specific impacts thereby highlighting issues that should be addressed through mitigation and rehabilitation activities. The Level 1 assessment, approach relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:

Hydrology: defined as the distribution and movement of water through a wetland and its soils.

Geomorphology: defined as the distribution and retention patterns of sediment within the wetland.

Vegetation: defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have impacted upon wetland functioning or condition. While the impacts considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 2). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component.

Table 2: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 - 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete" deviation from natural" (Condition F) as depicted in Table 3, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic ecosystems.

Table 3: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

PES CATEGORY	DESCRIPTION	RANGE
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitat and biota may have taken place.	1 – 1.9
C	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
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9
E	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable	6 – 7.9
F	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota	8 - 10

An overall wetland health score is calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

» **Overall health rating**
= [(Hydrology*3)+(Geomorphology*2)+(Vegetation*2)]/7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

» ***WET-EcoServices Assessment (functional importance)***

The WET-EcoServices tool (Kotze *et al*.,2009) was used to assess the demand for and supply of the wetland services under the broader categories of regulating and supporting services, provisional services and cultural services (Table 4). This was based on a rapid Level 1 assessment and was used to determine the importance of wetlands in providing different goods and services evaluated.

A Level 1 (rapid) WET-EcoServices tool is a suitable method for assessing the functioning of South African wetlands. Common wetland ecosystem goods and services that were evaluated using WET-EcoServices are described in Table 6, below.

Table 4: Descriptions of common wetland ecosystem goods and services (after Kotze *et al*., 2009)

ECOSYSTEM SERVICES	DESCRIPTION
Flood Attenuation	Refers to the effectiveness of wetlands at spreading out and slowing down storms flows and thereby reducing the severity of floods associated impacts.
Steam Flow Regulation	Refers to the effectiveness of wetlands in sustaining flows in downstream areas during low-flow periods.
Sediment Trapping	Refers to the effectiveness of wetlands in trapping and retaining sediments from sources in the catchment.
Nutrient & Toxicant Retention and Removal	Refers to the effectiveness of wetland in retaining, removing or destroying nutrients and toxicants such as nitrates, phosphates, salts, biocides and bacteria from inflowing sources, essentially providing a water purification benefit.
Erosion Control	Refers to the effectiveness of wetlands in controlling the loss of soil through erosion.
Carbon Storage	Refers to the ability of wetlands to act as carbon sinks by actively trapping and retaining carbon as soil organic matter.
Biodiversity Maintenance	Refers to the contribution of wetlands to maintain biodiversity through providing natural habitat and maintaining natural ecological processes.
Water Supply	Refers to the ability of wetlands to provide a relatively clean supply of water

	for local people as well as animals.
Harvestable Natural Resources	Refers to the effectiveness of wetlands in providing a range of harvestable natural resources including firewood, material for construction, medicinal plants and grazing material for livestock.
Cultivated Foods	Refers to the ability of wetlands to provide suitable areas for cultivation crops and plants for use as food, fuel or building materials.
Food for Livestock	Refers to the ability of wetlands to provide suitable vegetation as food for livestock.
Cultural significance	Revers to the special cultural significance of wetlands for local communities.
Tourism & Recreation	Refers to the value placed on wetlands in terms of the tourism-related and recreational benefits provided.
Education & Research	Refers to the value of wetlands in terms of education and research opportunities, particularly concerning their strategic location in terms of catchment hydrology.

The level of predicted importance of ecosystem services provided by wetlands was rated according to the rating table shown in Table 5, below. This was informed by wetland characteristics that affect the ability of wetlands to supply benefits and local and catchment context that affects the demand placed on wetlands to provide goods and services.

Table 5: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
Low	The wetland is not considered to be important for providing these service/benefits.
Low-Moderate	The importance of the wetland in providing ecosystem goods and services is regarded as moderately low.
Moderate	The wetland is considered important for providing this particular ecosystem service to a moderate degree.
Moderate-High	The wetland is considered important for providing this particular ecosystem service to a high degree.
High	The wetland is considered very important for providing this particular ecosystem service to a high degree.

» ***Wetland Ecological Importance and Sensitivity (EIS)***

The outcomes of the wetland functional assessment were used to inform an assessment of the importance and sensitivity of wetland systems using the Wetland EIS (Ecological Importance and Sensitivity) assessment tool. The Wetland EIS tool includes an assessment of three components:

- Biodiversity support;
- Landscape scale importance;
- Sensitivity of the wetland to floods and water quality changes.

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 6.

Table 6: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
None, Rating=0	Rarely sensitive to changes in water quality/hydrological regime.
Low, Rating=1	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate, Rating=2	Some elements sensitive to changes in water quality/hydrological regime.
High, Rating=3	Many elements sensitive to changes in water, quality/hydrological regime.
Very High, Rating=4	Vary many elements sensitive to changes in water quality/hydrological regime.

3.3.4 Setting of management objectives

Management and mitigation measures will need to be employed to ensure that natural resources attain the desired future class. This should be informed by the management objective for the resource which, in the absence of classification, is typically based on the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of the resource (DWAF, 2007). Based on this approach, management objectives for natural resources will thus be to maintain the ecological class as indicated in Table 7.

Table 7: Management measures in the short-term.

			EIS			
			VERY HIGH	**HIGH**	**MODERATE**	**LOW**
PES	**A**	**Pristine**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Good**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Fair**	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	**Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

3.3.5 Assessment of ecological impacts (Risk Assessment)

The National Water Act (Act 36 of 1998) and its regulations call for the issue of a Water Use Licence under certain conditions where a development or other activity may impact on a water resource. Two key Sections in this regard are Section 21(c) which covers activities which may "impede or divert" the flow of water in a watercourse. The key trigger distances for consideration of an activity are 32m for a watercourse and 500m for a wetland.

In order for the potential ecological impacts of the proposed development to be assessed use was made of the Department of Water and Sanitation's Risk Assessment model to determine whether any streams of wetlands were likely to be placed at risk as a result of the construction process. This tool is a spread sheet-based model which considers the possible impacts of any activity on a water resource. Risks or other relevant conditions are assigned a numeric score and these scores are then manipulated to produce a final rating. See next few paragraphs for a brief description of this scoring system and how it is applied to the final rating. The ratings vary in value from 1 to 300 and are divided into three classes as shown in Table 9.

» ***Risk Assessment Matrix (Based on DWS 2015 publication: Section 21(c) and (1) water use Risk Assessment Protocol)***

The Risk Rating Table (Table 8) takes into account the nature of an impact and the potential severity of the described impact on the resource quality of the affected system expressed in terms of a combination of the following features: Flow Regime, Water Quality (Physiological & Chemical), Habitat (Geomorphological & Vegetation) and Biota.
The potential Consequence, Likelihood and finally Significance scores are then automatically calculated with the rest of the parameters according to respective Risk Rating Tables

Table 8: The Risk Rating Table.

					Severity								
No.	**Phases**	**Activity**	**Aspect**	**Impact**	**Flow Regime**		**Physico & Chemical (Water Quality)**		**Habitat (Geomorph + Vegetation)**		**Biota**		**Sensitivity**

Severity	**Spatial Scale**	**Duration**		**Consequence**		**Frequency of activity**	**Frequency of impact**	**Legal issues**	**Detection**		**Likelihood**	**Significance**	**Risk rating**	**Confidence Level**	**Control Measures**	**Borderline LOW/MODERATE Rating Classes**	**PES & EIS of Watercourse**

» ***The Risk Assessment Key (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

- The **severity** is an expression of how the mentioned aspects will impact on the quality (flow regime, water quality, geomorphology, biota and habitat) and a value of 1 to 5 is assigned as appropriate (with 1 being Insignificant/non-harmful and 5 being Disastrous/extremely harmful and/or wetland(s) involved)

* Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.

- The **spatial scale** is an estimation of how big the area is that is impacted on by the relevant aspect. A value of 1 to 5 is assigned as appropriate, where 1 is indicative of an area specific impact (at impact site) and 5 indicates that the impact is of a Global size (impacting beyond SA boundary).
- The **duration**, wherein the aspect's proposed impact on the environment and resource quality is:
  - On day to one month, PES, EIS and/or REC not impacted – assigned a score of 1;
  - One month to one year, PES, EIS and/or REC impacted but no change in status – assigned a score of 2;
  - One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation – assigned a score of 3;
  - Life of the activity, PES, EIS and/or REC permanently lowered – assigned a score of 4; and
  - More than life of the organisation/facility, PES and EIS scores, an E or F – assigned a score of 5.
    * PES and EIS (Sensitivity) must be considered.
- The **frequency of the activity** (how often is the activity executed?) is estimated on a scale of 1 to 5, where 1 is annually or less, 2 is six monthly, 3 is monthly, 4 is weekly and 5 is daily.
- **Frequency of the incident/impact** (how often does the activity impact on the environment?) is estimated on a scale of 1 to 5 where 1 is almost never / almost impossible / >20%; 2 is very seldom / highly unlikely / >40%; 3 is infrequent / unlikely / seldom / 60%; 4 is often / regularly / likely / possible / 80% and 5 is daily / highly likely / definitely / >100%.
- **Legal issues** refer to any activities which are governed by legislation. Where no legislation is applicable a value of 1 is assigned, whereas in the case where any form of legislation is applicable for the specified activity, a value of 5 should be assigned.
- The **detection of an impact/risk** refers to the time / degree of difficulty required to identify the impacts/risk (on resource quality etc.) caused by the specified activity. A value of 1 to 5 is assigned, depending on the time and difficulty, where:
  - 1 is immediately;
  - 2 is without much effort;
  - 3 is with some effort;
  - 4 is where observation is remote and difficult; and
  - 5 is for Covered

» ***The Risk Assessment Calculations and Formulas (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

- **Consequence**
  = Severity + Spatial Scale + Duration
- **Likelihood**
  = frequency of Activity + Frequency of Incident + Legal Issues + Detection
- **Significance/Risk**
  = Consequence X Likelihood

» ***The Calculated Risk/Significance (Based on DWS 2015 publication: Section 21(c) and 1 water use Risk Assessment Protocol).***

As mentioned the ratings vary in value from 1 to 300 and are divided into three classes, as shown in Table 9.
* In the case where a LOW risk class have been obtained for all mentioned activities a GA can be considered.

Table 9: Department of Water and Sanitation rating table for impacts on water resources.

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

3.3.6 Determination of Ecological Buffer Zones

Wetland buffers are areas that surround a wetland and reduce adverse impacts to wetland functions and values from adjacent developments. Buffers reduce wetland impacts by moderating the effects of storm water runoff including stabilising soil to prevent erosion, filtering suspended solid, nutrients, and harmful or toxic substances, and moderating water level fluctuations. Buffers also provide essential habitat for wetland-associated species for use in feeding, roosting, breeding and rearing of young, and cover for safety, mobility, and thermal protection. Finally, buffers reduce the adverse impacts of human disturbance on wetland habitats including blocking noise and glare; reducing sedimentation and nutrient input; reducing direct human disturbance from dumped debris, cut vegetation, and trampling; and providing visual separation. Wetland buffers are essential for wetlands protection.

The 'Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries' (Macfarlane *et al*., 2014) was used to determine the buffer zone for wetland types (HGM units) found within the project boundary. As this is a guideline tool, the author applied specialist opinion where relevant given the nature of the development and the environmental setting. The 'Buffer Zone Tool for the Determination of Aquatic Impact Buffers and Additional Setback Requirements for Wetland Ecosystems', founded by The Department of Water and Sanitation (DWS) and the Water Research Commission (WRC) was used in the regard (Macfarlane *et al.,* 2014). To properly implement this tool the following guidelines are recommenced:

- » Define objectives and scope to determine the most appropriate level of the assessment;
- » Map and categorize water resources in the study area (identify water resource type/boundaries);
- » refer to the DWS management objectives for mapped water resources or develop surrogate objectives (Present Ecological State, social and economic sensitivity);
- » Assess the risks from proposed developments and define mitigation measures necessary to protect mapped water resources in the study area (lateral land-use inputs);
- » Assess risks posed by proposed development on biodiversity and identify management zones for biodiversity protection (presence of biodiversity elements);

3.3.7 Identification of mitigation measures

'Mitigation' is a broad term that covers all components involved in selection and implementing measures to conserve/protect the environment and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on aquatic ecosystems, including rivers and wetlands, is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. Examples of mitigation can include changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites.

Specialist working knowledge and experience with similar types of development projects was used in compiling the recommended mitigation measures for this project, as well as by consulting following key documents:

» Best practice construction and mitigation procedures in wetlands and water-bodies (US Federal Energy Regulatory Commission, 2002);
» Guidelines and specification for developments affecting wetlands and general construction activities (DWAF, 2005b & DWAD, 2005c; and
» Generic construction EMP guidelines (eThekwini Municipality, 2009).

4 DESCRIPTION OF THE STUDY AREA

4.1 Locality

The proposed facility will be located on the Remaining Extent of the farm Elands Spruit 5523 which is situated approximately 26km north-east of Ladysmith (refer to Figure 3). The property is situated within the 2829BD Quarter Degree Grid (-28.367522°; 29.942099°), between Collings Pass road and the N11 national road. This area falls within the jurisdiction of the Emnambithi/Ladysmith Local Municipality (Uthukela District Municipality).

The area earmarked for the proposed mining is approximately 5ha in size and include an existing (historical) open cast aggregate quarry. The remaining area for development comprises out of land utilized as grazing (Figure 4).

The GPS coordinates of the existing quarry are as follows:

» A. -28.367829°; 29.940139°
» B. -28.368239°; 29.940294°
» C. -28.368235°; 29.940579°
» D. -28.367658°; 29.940729°

The GPS coordinates of the proposed mining area are as follows:

» 1. -28.368104°; 29.939899°
» 2. -28.368678°; 29.943691°
» 3. -28.367653°; 29.943804°
» 4. -28.367003°; 29.940268°

4.2 Climate and rainfall

The climate associated with the study area has been derived from recorded and extrapolated climatic data (http://en.climate-data.org/location/10843/) for

Ladysmith. The climate in Ladysmith is warm and temperate and is classified as Cwa by Köppen and Geiger. Annual rainfall for the region is around 740mm per year with the greatest amount of precipitation occurring in January (~140mm). The driest month is July with only ~7mm of rain. The average annual temperature in Ladysmith is 18.3°C with January being the warmest (~23.1°C) and June being the coldest (~11.1°C). Frost is infrequent in winter (mean frost days up to 15 days per year).

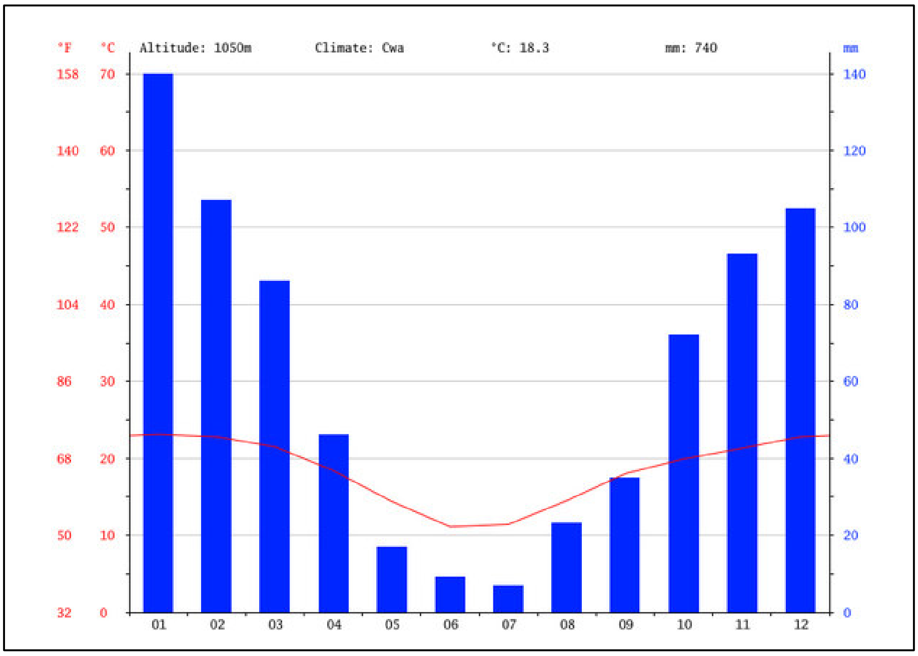

Figure 1: Climate graph of Ladysmith (https://en.climate-data.org/location/947/).

month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
mm	140	107	86	46	17	9	7	23	35	72	93	105
°C	23.1	22.8	21.5	18.4	14.4	11.1	11.4	14.5	18.0	19.9	21.3	22.8
°C (min)	16.6	16.3	14.9	10.9	5.9	2.1	2.0	5.3	9.5	12.6	14.2	16.0
°C (max)	29.7	29.3	28.1	25.9	22.9	20.2	20.8	23.7	26.5	27.3	28.5	29.7
°F	73.6	73.0	70.7	65.1	57.9	52.0	52.5	58.1	64.4	67.8	70.3	73.0
°F (min)	61.9	61.3	58.8	51.6	42.6	35.8	35.6	41.5	49.1	54.7	57.6	60.8
°F (max)	85.5	84.7	82.6	78.6	73.2	68.4	69.4	74.7	79.7	81.1	83.3	85.5

Figure 2: Climate table of Ladysmith (https://en.climate-data.org/location/947/).

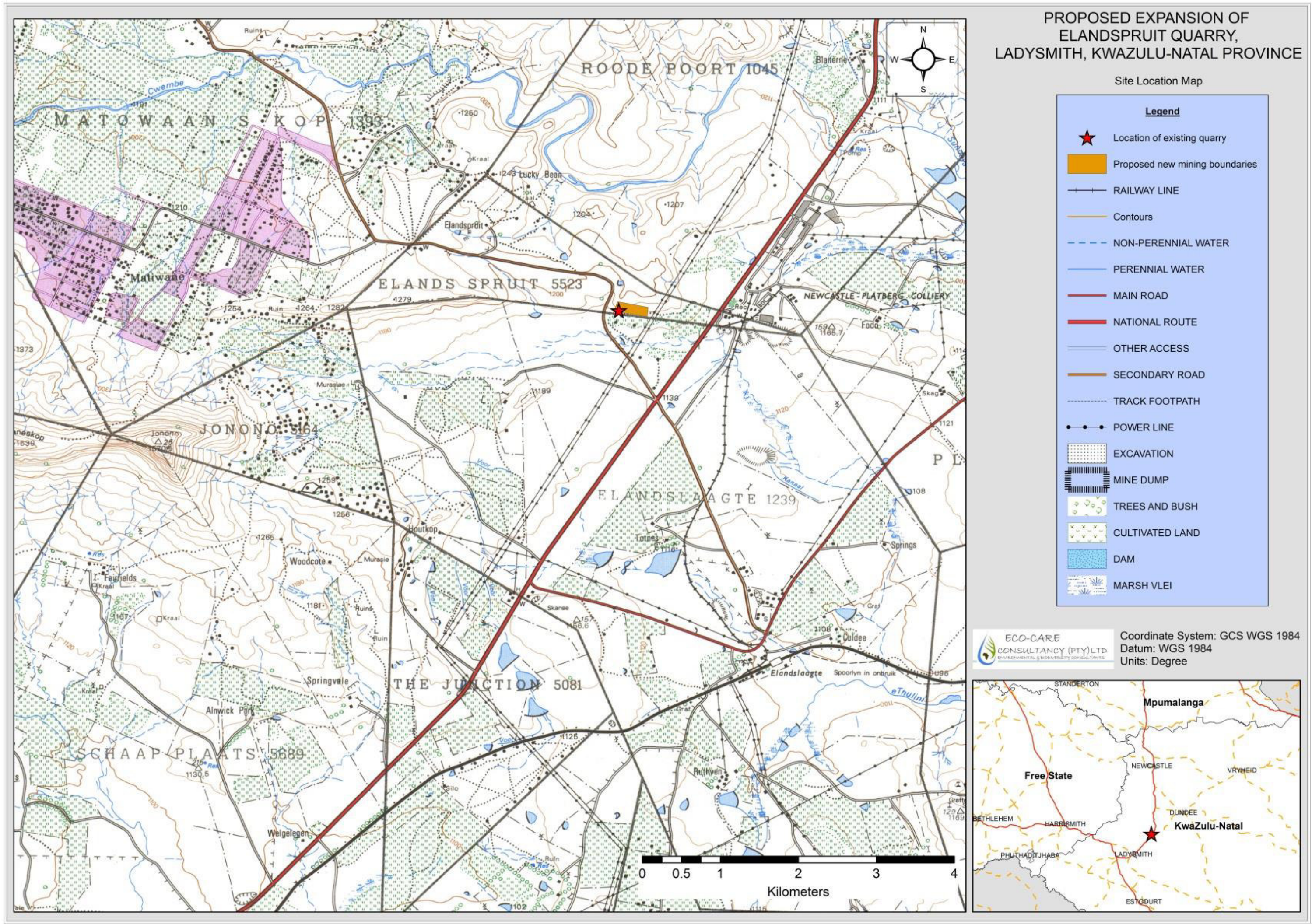

Figure 3: Locality map for the proposed Elandspruit Quarry.

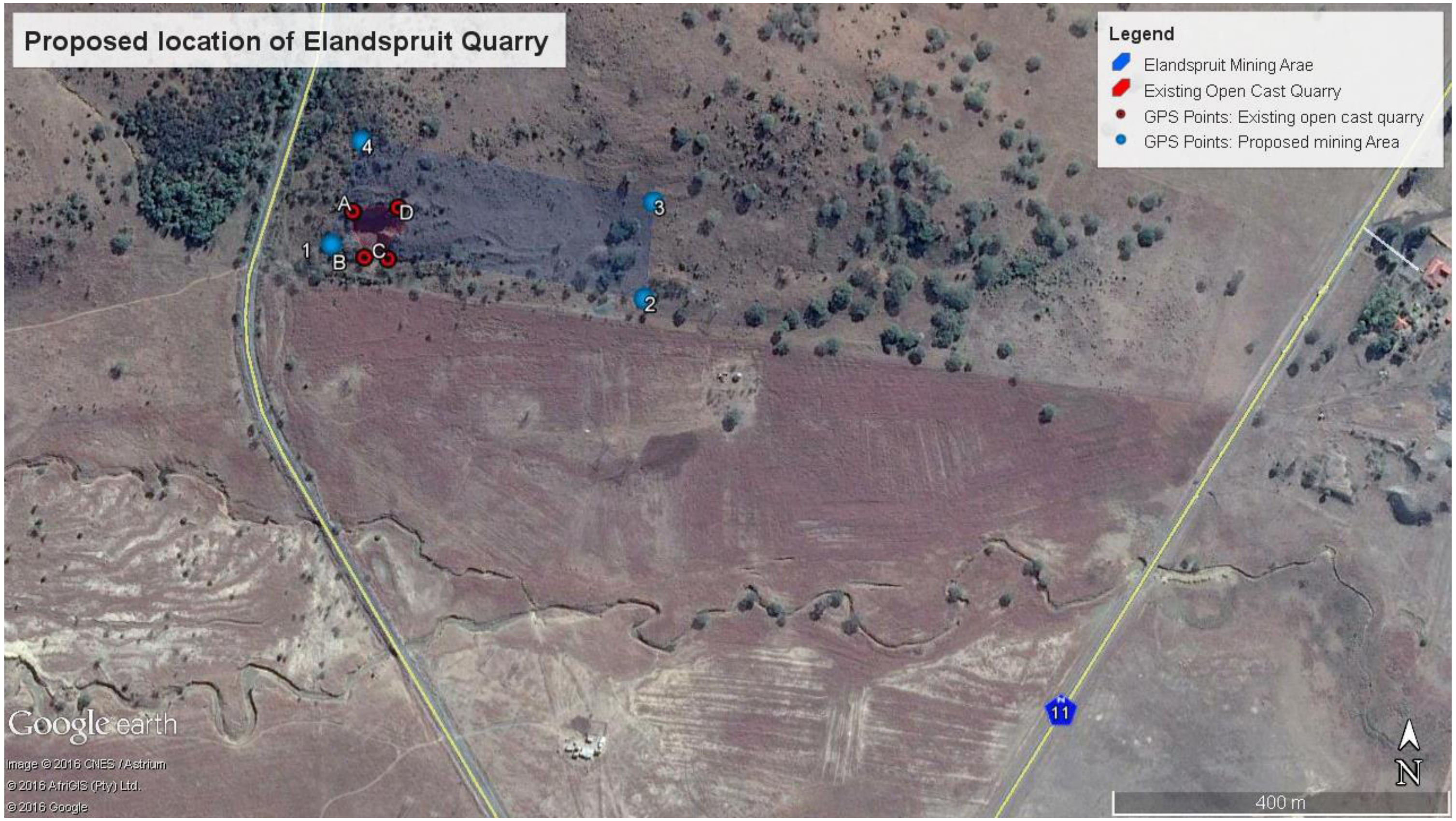

Figure 4: Proposed location of the new mining area as well as the old (historical) open cast aggregate quarry.

4.3 Physiography and soils

Landscape Features

According to Mucina and Rutherford (2006) the region can be described as a hilly, undulating landscape and broad valleys supporting tall tussock grassland usually dominated by *Hyparrhenia hirta*, with occasional savannoid woodlands with scattered *Acacia sieberiana* var. *woodii*.

According to AGIS, 2007 the landscape can be described as an undulating terrain characterised by large areas (more than 80%) with slopes less than 8%. The local relief varies between 30m and 90m. Percentage slope varies between the different terrain units with the midslopes averaging between 1- & 5%, footslopes between 1- & 4% and the valley bottoms averaging between 1- & 5%. The general terrain shape (slope shape) can be classified as Z-X (Concave to Straight).

At a finer scale using a Google elevation profile and available 5m contours for the study area (focus area) and immediate surroundings the area can be described as a gradual to moderate sloping landscape, sloping mainly in a southerly direction (Figure 5). Three clearly distinguishable terrain types can be distinguished namely, a Midslope region of a low hill along the northern boundary, transgressing into a relative narrow footslope region which finally terminates into a relative extensive valley bottom landscape containing lower lying watercourse channels. The proposed aggregate quarry will be situated mostly within the midslope region of the low hill, slightly encroaching into the upper parts of the footslope. To the west of the focus area the hill forms a slight notch or saddle within which the Collings Road passes over the hill (refer to Figure 5). The average elevation of the study area (focus area) is 1162.2 meters with the highest point recorded close to the top portion of the proposed quarry area (1202m) and the lowest point recorded within the wetland body located within the valley bottom portion. The average loss of elevation from the highest to the lowest point is ~58.3m with an average slope (southerly) of 4.6% (Max. Slope: 13.2%).

» The **Midslope** region is characterized mainly by a concave shape, although to the south of the focus area the terrain gradually changes into a slight convex shape. The average loss of elevation, from north (Max. Elevation: 1202m) to south (Min Elevation: 1169.3m), is ~26.2 meters. The average slope for this section is 10% (Max Slope: 15.2%)
» The **Footslope** region is more gradual with less steep slopes and can the terrain shape can be classified as mainly concave to slightly straight in some areas. The loss in elevation is also less than for the Midslope (~20.2m). The average slope is 7.2% with the maximum slope recorded being 15.3%.

» The **Valley Bottom** section forms a relative flat, outstretched piece of land with only small fluctuations in elevation due to the presence of channels (watercourses). The average north to south loss in elevation is only 4.56m, with an average slope of only 1.6% (Max Slope: 3.8%).

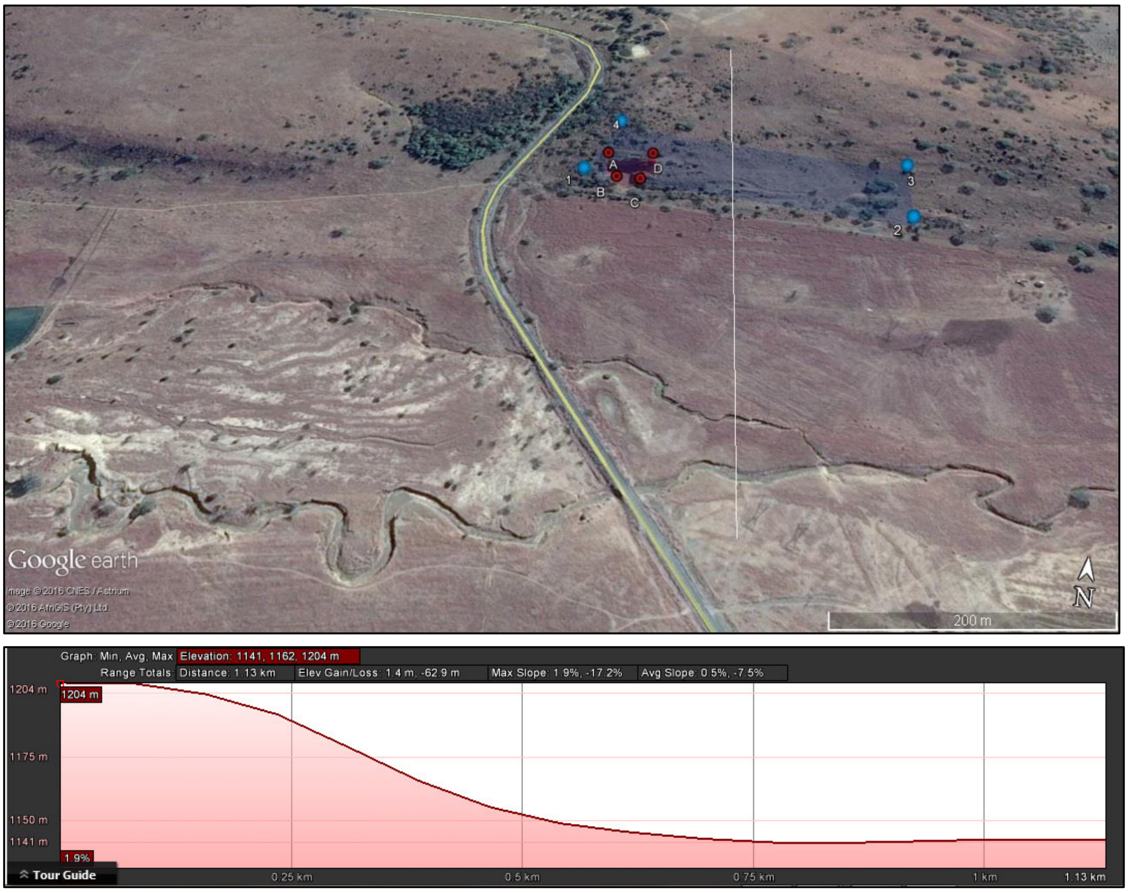

Figure 5: Elevation profile (north to south) of a section of the Study Area (Focus Area) – Generated within Google Earth.

Geology

The interior parts of KwaZulu-Natal is characterised by a variety of Karoo Supergroup rocks, including Dwyka, Ecca and Beaufort Groups (Mucina & Rutherford, 2006). The Karoo Supergroup preserves a wide spectrum of depositional paleoenvironments ranging from glacial to deep marine, deltaic, fluvial and aeolian. Within the Ladysmith region, including the receiving environment of the proposed aggregate quarry the dominant geological formation is the Vryheid Formation of the Ecca Group (Figure 6). The Vryheid Formation is a fluviodeltaic deposit comprising fine- to coarse-grained sandstone, shales, siltstones and subordinate coal beds (Whitmore *et al.,* 1999 & Cairncross *et al.,* 1998. Fractures and planes of weaknesses within these rocks acted as conduits to lava flow and the crystallisation of the magma within these fractures gave rise to Jurassic dolerite intrusion (dolerite sills and dykes). It is from such an intrusion where the aggregate will be mined from.

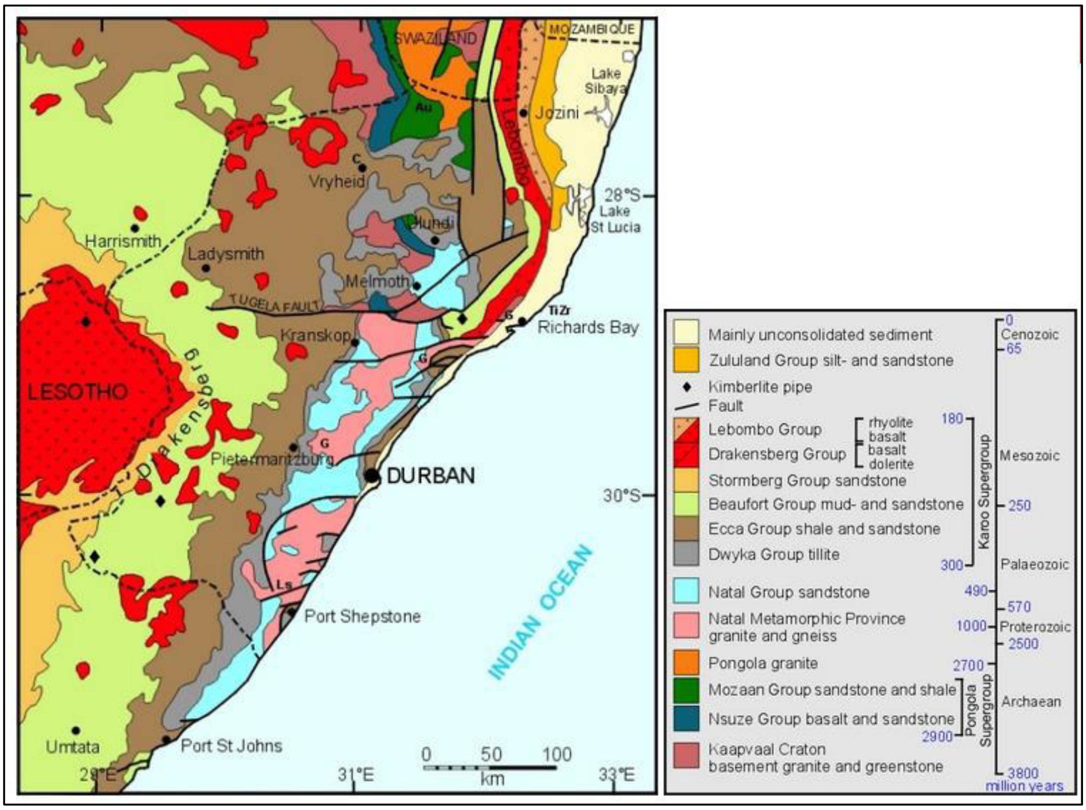

Figure 6: Regional geology of KZN (Withmore et al., 1999 & Geological Survey, 1984).

Soil and Land Types

Detailed soil information is not available for broad areas of the country. A surrogate land type data was used to provide a general description of soil in the study area (land types are areas with largely uniform soils, typography and climate). The study area is primarily divided into two sections according to their land type units namely the Bb70 land type to the south (lower lying footslopes and valley bottom regions) and Fa 802 to the north (mainly the midslope, crest and plateau areas). The Bb70 land type, as mentioned, covers the bulk of the study area (Land Type Survey Staff, 1987) (refer to Figure 7). Only a small section of the study area's northern boundary falls within Fa 802.

» The **Bb group** of land types are mainly characterised by Yellow apedal (structureless) soils which may be moderately (mesotrophic) to highly (dystrophic) leached and is characterised by a wide textural range, mostly sandy loam to sandy clay loam. Soils contain a greyish subsoil layer (plinthic) where iron and manganese accumulate in the form of mottles, due to a seasonally fluctuating water table. With time these mottles may harden (or even cement) to form concretions. These plinthic layers will case restricted water infiltration and root penetration. In drier areas, however, they may help to hold water in the soil that plants can use (Land Type Survey Staff, 1987).

» The **Fa group** of land type are generally characterised by Plinthic Catenas (upland duplex and margalitic soils) containing shallow soils consisting of a topsoil directly underlain by weathered rock (Glenrosa form) or hard rock (Mispah form), sometimes with surface rock and steep slopes. These land types are usually associated with moister areas or areas with acidic parent materials, where little lime exists.

A summary of the dominant soil forms found within the different terrain types are as follows:

» **Midslope**: Avalon, Westleigh, Glenrosa and Mispah
» **Footslope**: Avalon, Valsrivier, Glencoe, Glenrosa, Dundee, Bainsvlei
» **Valley Bottom**: Valsrivier, Dundee

Hydrology and Geohydrology

The study area is located within the Sundays River Catchment where it forms the upper reaches of the V60C Quaternary Catchment Area (refer to Figure 8). The Sundays River Catchment forms part of the Thukela Water Management Area. The Sundays River flows in a south-easterly direction from the Eastern Escarpment to its confluence with the Thukela River near the Bushmans River confluence. Commercial dryland agriculture dominates the area and there are also fairly large tracts of trial / communal land in the lower reaches of the catchment. Other than the Slangdraai Dam, which has a full supply capacity of 10.3 million m^3, there is no significant storage in this catchment area. Irrigation within the catchment is supplied from farm dams or from run-of-river flows. Coal mining abounds in the upper areas of the catchment which contributes both to water quality problems and is a source of return flows. According to the Present Ecological State (DWS PES, 1999) the condition of the Sundays River is classified as Class A, which indicates that the river is mostly in an unmodified and natural state.

An unnamed non-perennial watercourse drains most of the upper reaches of the V60C Quaternary Catchment Area. A portion of this watercourse traverse the focus area of the study and the wetland types associated with this watercourse, located south of the proposed aggregate quarry, forms the main focus of this study. This non-perennial water course originates as numerous smaller tributaries within the vicinity of the Matiwane informal settlement and tribal/communal land. After the union of these smaller tributaries the non-perennial watercourse flows mostly in an easterly direction for the next 4km (passing just south of the proposed aggregate quarry). Smaller tributaries originate along the higher lying ridges and hills to the north, running mostly parallel with the watercourse. Just after the N11 road crossing the non-perennial watercourse changes direction and flows in a south-easterly direction for approximately 6.13km, after which the watercourse converge with another non-perennial watercourse (just south of the crossing of the R602 road). The converged non-perennial watercourses flow in an easterly direction for approximately 3.9km to finally terminate into the Sundays River. These non-perennial watercourses are highly seasonal and will contain surface water, for mostly short periods of time, during the rainy season with small isolated pools remaining for some time. Water flow, feeding in from the catchment area as well as within the non-perennial watercourse, is mainly in the form of natural-surface flow with subsoil water flow contributing much less to the waterbudget. Transformations and other disturbances within the catchment area (especially within the higher lying areas around Matiwane including the smaller tributaries found in this area) have caused alterations in flow volumes, velocity and patterns resulting in a higher volume of water flowing at higher velocities for short periods of time. This in turn has resulted in the alteration of the morphology of this non-perennial watercourse creating for example; localised, deep erosion channels and areas with transformed vegetation structures, subsequently rendering this non-perennial watercourse incapable to slow down and retain some water for longer (more natural) periods of time. Only one small farm (gravel) dam is located within the non-perennial watercourse itself with four farm dams located within the catchment area especially within smaller tributaries and drainage lines located towards the eastern half of the watercourse. These relative small farm dams rarely exceed 300 thousand m^3. Such a small farm dam is located just west of the focus area for this study. Natural channels within this watercourse are normally moderate to shallow in depth and narrow in width and are locally accompanied by overspill or flooding sections adjacent to these channels comprising out of typical wetland vegetation adapted to seasonal and temporary periods of soil saturation.

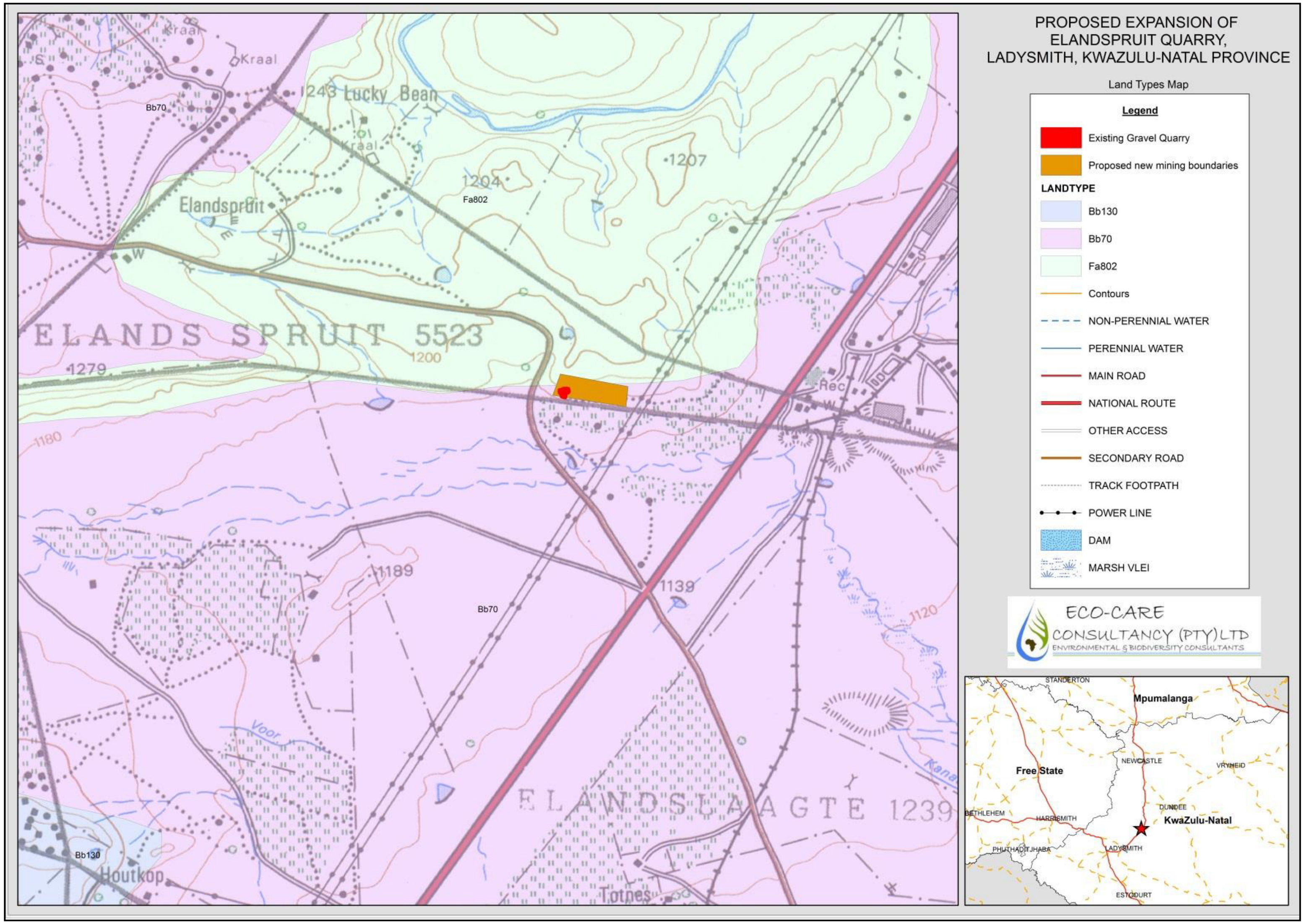

Figure 7: Land types found within the study area as well as the surrounding environment.

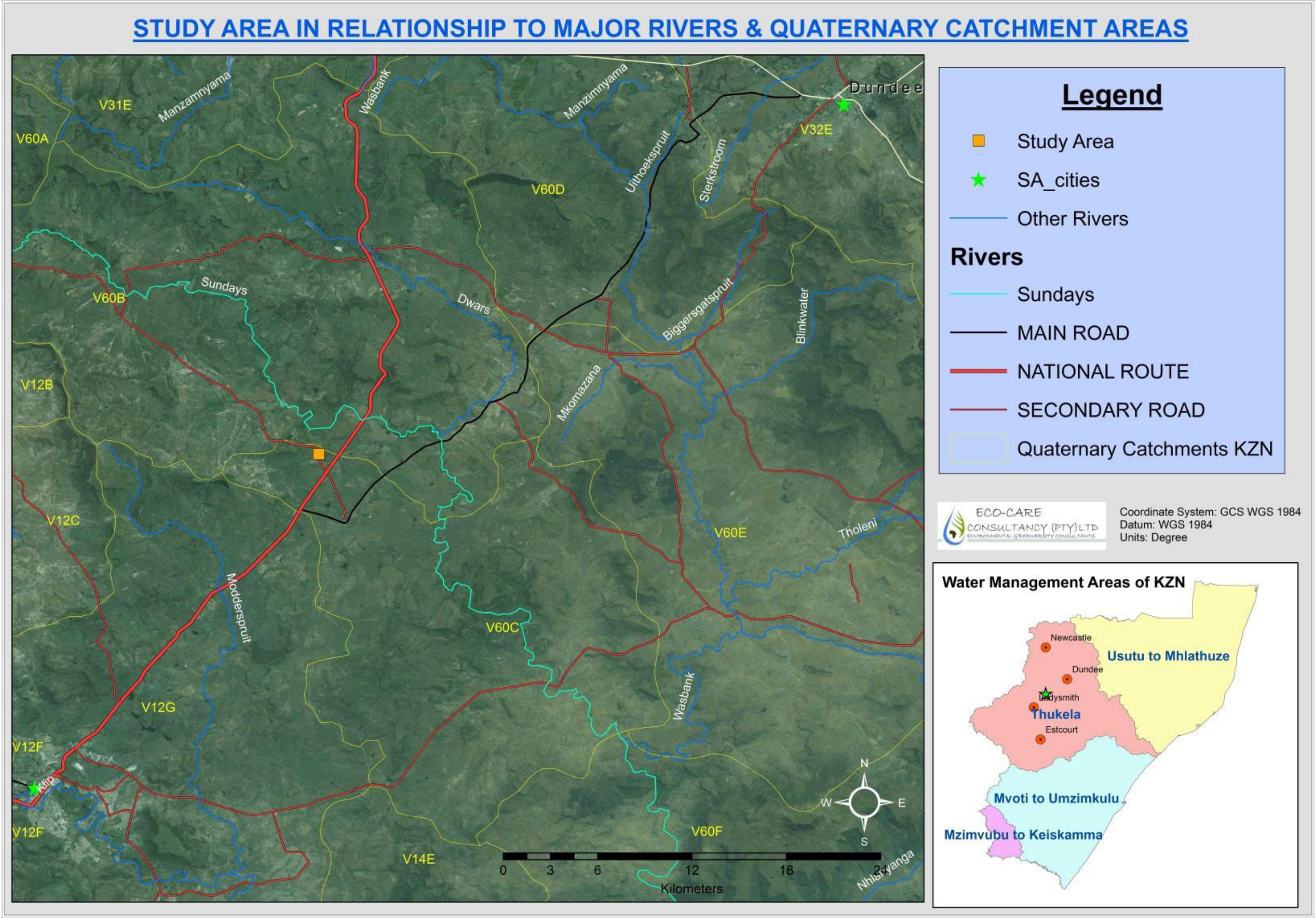

Figure 8: Map showing the location of the proposed development with regards to the Quaternary Catchments as well as the Water Management Areas of KZN.

4.4 Broad-Scale Vegetation Patterns

The study area is situated in the Grassland biome and Sub-Escarpment Grassland (Mucina & Rutherford, 2012). The vegetation in and around the study area is mostly Northern KwaZulu-Natal Moist Grassland (Gs 4) with patches of Northern KwaZulu-Natal Shrubland found to the north (refer to Figure 9). Within the KwaZulu-Natal vegetation coverage (EKZNW, 2012) one azonal vegetation type have been identified (Figure 9) namely Freshwater Wetlands (Eastern Temperate Wetlands) within the surrounding landscape. Most of the Freshwater Wetlands identified within the vicinity is associated with the non-perennial watercourse (downstream from the focus area). A brief description of the structure, extent, conservation and key species are provided below:

4.4.1 *Zonal (Terrestrial) Vegetation Units*

Northern KwaZulu-Natal Moist Grassland

The distribution of the vegetation type is restricted to northern and north-western regions of KwaZulu-Natal Province where it forms a discontinuous rim around the upper Thukela Basin and is situated almost entirely within the catchment of the Thukela River. Extensive areas of KwaZulu-Natal Moist Grassland is found around Winterton, Bergville, Fort Mistake, Dannhauser, Dundee, north of Ladysmith and west of Newcastle. At lower altitudes to the east this unit is surrounded and/or broken by KwaZulu-Natal Highland Thornveld and Thukela Thornveld. This vegetation type occurs within hilly and rolling landscapes, supporting tall tussock grassland usually dominated by *Themeda triandra*, and *Hyparrhenia hirta*. Open *Acacia sieberiana* var. *woodii* savannoid woodlands encroach up the valleys, usually on disturbed (strongly eroded) sites.

This vegetation type is regarded as Vulnerable with only about 2% statutorily conserved. More than a quarter have already been transformed either for cultivation, plantations and urban sprawl or building dams. Alien tree species such as *Acacia dealbata, Rubus, Eucalyptus* ad *Populus* have invaded extensive areas. Bush encroachment is also very common. Erosion is mostly low (53%) with localised area having moderate levels (20%).

Northern KwaZulu-Natal Shrubland

This is a widely scattered (throughout KwaZulu-Natal Province) group of patches embedded within Sub-Escarpment Grassland units where they are found mostly on small dolerite koppies and steeper slopes of ridges. This vegetation type contains a sparse grass cover and typical occurrence of scattered shrubland pockets (and locally also thickets). A*cacia caffra, A. natalitia, Clerodendrum glabrum, Diospyros lycioides, Searsia pyroides, S. pentheri, Scutia murtina* etc. are the most prominent shrubs and trees.

The vegetation unit is regarded as least threatened with about 3% transformed by cultivation. Less than 1% is statutorily conserved. Erosion very low (35%), moderate (29%), low (22%) and high (10%)

4.4.2 Inland Azonal Vegetation Units

Eastern Temperate Freshwater Wetlands

Freshwater wetlands form a system of archipelagos of small and highly fragmented patches, embedded within all mainland biomes. The floristic composition in the freshwater habitats underwent a serious of ecological and evolutionary filters linking the azonal vegetation with this background zonal vegetation. The typical freshwater wetlands are vleis, which form in the catchment areas of Highveld streams (spruits), where a sufficiently shallow gradient permits the soils to remain wet without being eroded by flowing water. The perimeter around stagnant water bodies (lakes, banks of dams) as well as the "Floodplain Vleis" is here classified as part of Freshwater Wetlands as well. Many pans, especially on the precipitation-rich eastern and north-eastern highveld are also considered freshwater wetland habitats.

Eastern Temperate Freshwater Wetlands are widely distributed throughout southern African and can be found in all Provinces of South Africa, with the exception of Western-Cape Province, as well as neighbouring countries such as Lesotho and Swaziland. These wetland types are embedded within the Grassland Biome where they occur around water bodies with stagnant water (lakes, pans, periodically flooded vleis, and edges of calmly flowing rivers). Typically the landscape within which these wetlands occur can be described as flat or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herblands. The soils of these systems may be peaty (Champagne soil form) to vertic (Rensburg soil form). These vleis/wetlands form where flow of water is impeded by impermeable soils and/or by erosion resistant features, such as dolerite intrusions. Many vleis and pans of this type of freshwater wetlands are inundated and/or saturated only during the summer rainfall season, and for some months after this into the middle of the dry winter season, but they may remain saturated all year round. Surface water inundation may be present at any point while the wetland is saturated and some plant species will be present only under inundated conditions, or under permanently saturated conditions.

Only 5% of this azonal vegetation type is statutorily conserved with some 15% being transformed to cultivated land, urban areas or plantations. In places intensive grazing and use of lakes and freshwater pans as drinking pools for cattle or sheep cause major damage to the wetland vegetation. The following alien plants may become invasive within such wetlands; *Bidens bidentata, Cirsium vulgare, Conyza bonariensis, Oenothera rosea, Physalis viscosa, Plantago lanceolata, Rumex crispus, Sesbania punicea,* *Schkuhria pinnata, Stenotaphrum secundatum, Trifolium pratense, Verbenea bonariensis, V. brasiliensis, Xanthium strumaria*, etc.

Key species:

- **Within Marshes**:
  Megagraminoid: *Cyperus congestus*
  Graminoids: *Agrostis lachnantha, Carex acutiformis, Eleocharis palustris, Eragrostis plana, E. planiculmis, Fuirena pubescens, Helictotrichon turgidulum, Hemarthria altissima, Imperata cylindrica, Leersia hexandra, Paspalum dilatatum, P. urvillei, Pennisetum thunbergii, Schoenoplectus decipeins, Scleria dieterlenii, Setaria sphacelata, Andropogon appendiculatus, A. eucomus, Aristida aequiglumis, Ascolepis capensis, Carex austro-africana, C. schlechteri, Cyperus cyperoides, C. distans, C. longus, C. marginatus, Echinochloa holubii, Eragrostis micrantha, Ficinia acuminate, Fimbristylis complanata, F. ferruginea, Hyparrhenia dregeana, H. quarrei, Ischaemum fasciculatum, Kyllinga erecta, Panicum schinzii, Pennisetum sphacelatum, Pycreus macranthus, P. nitidus, Setaria pallide-fusca, Xyris gerrardii.*
  Herbs: *Centella asiatica, Ranunculus mutifidus, Berkheya radula, B. speciosa, Berula erecta subsp. thunbergii, Centella coriacea, Chironia palustris, Equisetum ramosissimum, Falckia oblonga, Haplocarpha lyrata, Helichrysum difficile, H. dregeanum, H. mundtii, Hydrocotyle sibthornpioides, H. verticillata, Lindernia conferta, Lobelia angolensis, L. flaciida, Mentha aquatic, Monopsis decipiens, Puicaria scabra, Pycnostachys reticulate, Rorippa fluviatilis* var. *fluviatilis, Rumex lanceolatus, Senecio inornatus S. microglossus, Sium repandum, Thelypteris confluens, Wahlenbergia banksiana*
  Geophytic Herbs: *Cordylogyne globosa, Crinum bulbispermum, Gladiolis papilio, Kniphofia ensifolia, K. fluviatilis, K. linearifolia, Neobolusia tysonii, Satyrium hallackii subsp. hallackii*
- **Reed & sedge beds**:
  Megagraminoid: *Phragmites australis, Schoenoplectus corymbosus, Typha capensis, Cyperus immensus*.
  Graminoids: *Carex cernua*
- **Water bodies**:
  Aquatic Herbs: *Aponogeton junceus, Ceratophyllum demersum, Lagarosiphon major, L. muscoides, Marsilea capensis, Myriophyllum spicatum, Nymphaea lotus, N. nouchali var. caerulea, Nymphoides thunbergiana, Potamogeton thunbergii*.
  Carnivorous Herb: *Utricularia inflexa*
  Herb: *Marsilea farinose* subsp. *farinosa*.

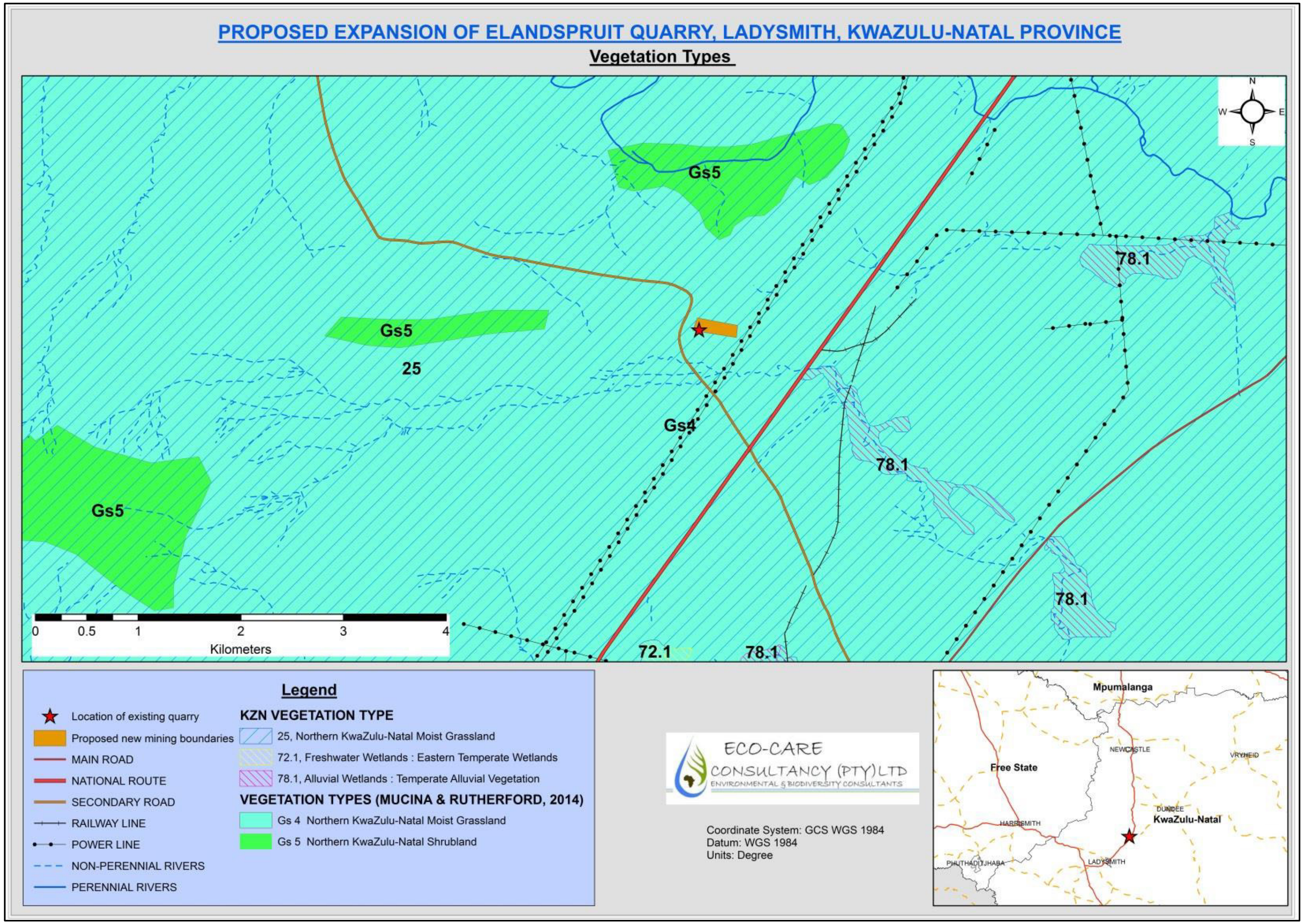

Figure 9: Map showing the vegetation types found within the study area as well as within the larger surrounding landscape (Mucina & Rutherford, 2012 & EKZN, 2012).

4.5 Existing Land Use

Most of the data for the larger area and the catchment area was obtained through the analysis of available spatial (GIS) data sources whilst the land use data for the Focus Area consisted out of both available spatial data as well as site observations.

Within the larger area

Land use within the greater landscape is predominantly for agricultural purposes with the bulk of the land (almost 70%) being natural to semi-natural rangelands (grasslands) grazed mostly by cattle. The higher lying areas to the north-west (around the headwaters of the non-perennial watercourse and smaller tributaries) falls mostly within tribal/communal land (12%) and is severely transformed and degraded through a number of disturbances including; the low to medium density village (Matiwane), associated small patches of cultivated lands (subsistence purposes), areas devoid of vegetation or covered by a low basal vegetative covering, and severely grazed and trampled areas. Cultivation for commercial purposes comprises only small portion of land use within this landscape (<4%) whilst cultivation for subsistence purposes (outside of the Matiwane boundaries) encompass a slightly larger percentage (~6%). Only 1 coal mine is located within the area covering less than 1% of the total land cover. As mentioned earlier a few small farm dams are present (<1%) within the area and is mostly associated with small tributaries and drainage lines associated with the non-perennial watercourse. Outside of the boundaries of the tribal lands located to the north-west, which is characterised by large bare areas, bare patches are mostly associated with eroded areas around the non-perennial watercourse (6%). Plantations and woodlots are sparse with small patches found around some homesteads (<1%).

Within the catchment area

Within the catchment area of the delineated wetland, slightly less than 60% of the land is used for agricultural purposes (~56% as rangelands; ~3% for subsistence cultivation and <1% for commercial cultivation). This excludes the small patches of cultivated lands associated with most of the homesteads located in and around Matiwane. The western portion of the catchment area (around the headwaters/source of the non-perennial watercourse) is, as mentioned above, severely transformed and degraded through various activities associated with Matiwane settlement/village (~30% of the catchment). Large portions of land within the boundaries of the Matiwane settlement have been left bare and are exposed to severe erosion, especially around the tributaries. Erosion throughout the catchment (including those around the headwaters of the non-perennial watercourse) comprises 7 – 8% of the total area and is mostly centred around the watercourse itself. Plantations and woodlots is largely absent from the catchment area, restricted to very small and isolated patches around farmsteads. Alien tree species appear to be sparsely distributed throughout the catchment area and likely occurs as singular species scattered here and there (refer to Figure 10).

Within the focus area

Within the focus area/study area (~89h), the delineated wetland covers approximately 39.22h (44.06%) of the total area. The primary land use is for agricultural purposes (refer to Figure 11 as well as Table 10). The bulk of the area (predominantly grasslands with a small portion of open woodland located along the hill) is used as grazing for cattle (36%). Most of the cultivated lands (21.3%) haven't been ploughed for a few years (old fallow lands are covered by transformed vegetation covering). The historical open aggregate quarry covers only 0.3% of the total area. Most of the delineated wetland area is used for grazing (~69%). Approximately 23.66% of the wetland has been severely altered, mainly due to the effects of erosion, trampling and overgrazing. This has resulted in the modification of the wetland morphology and the hydrological character of channels as well as associated wetland. Further alterations in the morphology, resulting in an alteration in the hydrological functions provided by the wetland, include channel obstructions (artificial crossing points and ineffective culverts) and artificial damming (roads and culverts).

Table 10: List of impacts present within the Focus Area as well as within the Delineated Wetland.

			Area (ha)	**Length (m)**	**% of Focus Area**	**% of Wetland**
Focus Area			89			
Focus Area – Excluding wetland area			49.78			
Wetland			39.22		44.06	
Length of Non-Perennial Watercourse within Focus Area				2539		
	Land Use / Disturbance					
Within Catchment Area	Rangeland (cattle grazing) – Entire focus area including wetland		32		**36**	
	Cultivated Land (Total)		**18.95**		**21.3**	
		Historically[1]	15.97		17.9	
		Old	2.98		3.3	
	Informal Homesteads		0.73		0.8	
	Highly Trampled & Overgrazed Areas		2.5		2.8	
	Aggregate Quarry		0.31		0.3	
	Roads (Total)			**1154**		

[1] * *Historical cultivated land refers to areas which haven't been ploughed within the past 10 years whereas old cultivated lands refer to areas which have been ploughed within the past 10 years but have been left fallow for the past two years.*

		Collings road		710		
		N11 National road		444		
	Power Lines (Total)			**1733**		
		1		691		
		2		1042		
Within Wetland Area	Grazing (Cattle) – Only wetland area		27			**68.84**
	Channel Obstructions (Combined)		**0.1015**			**0.26**
		Road Culverts (3 culverts)	0.0672			0.17
		Crossing Points (5 crossing points)	0.0343			0.08
	Erosion (Combined)		**8.38**			**21.3**
		Rill & Sheet Erosion	7			17.8
		Sheet Erosion	0.57			1.45
		Deep Channel & Bank Erosion	0.81	864.6		2.1
	Artificial damming caused by inappropriate culverts		0.015			0.04
	Shallow scars/trenches (drainages)		0.0393			0.1
	Artificial depression		0.07			0.18
	Highly Trampled & Overgrazed Areas		0.81			2.1
	Power Line Crossing			290		
	Roads (Total)					
		N11 National Road		57.8		
		Collings road		319		

4.6 Contamination risk

Wetlands often have a large capacity to attenuate pollution. In the case of mine water, wetlands are often cited as a means of pollution control. It should, however be noted that the removal of pollutants from water result in the build-up of contamination in the solid material of the wetlands. The primary processes of pollution attenuation are the absorption of pollutant ions onto reactive surfaces within the wetland. Many of these reactions are most efficient under reducing conditions, with sulphate-reducing bacteria playing an important role. These bacteria are generally abundant in natural wetland systems, producing sulphides, including pyrite and hydrogen sulphide, which gives wetlands their characteristic sulphurous smell. In assessing the wetlands risk to contamination by the proposed quarry and its vulnerability to contamination one has to look at the activities associated with the quarry and the capability of the wetland itself to handle and react to such contamination.

The proposed aggregate quarry does not pose a great contamination threat to the wetland and water course system located approximately 170m to the south. This is due to the scale of mining operations, which can be regarded as small, and the activities and infrastructure associated with such a small scale mining operation. Most contaminants will likely be generated in small quantities due to localized spillage and leakages of hydrocarbons from mining equipment, machinery and vehicles. These contaminants can potentially be carried along the slope into the wetland system through surface water flow. This can mostly be effectively avoided by maintaining good practices such as for example;

» Using good quality equipment, machinery etc. and regular monitoring and servicing thereof;
» Correct storage and removal of used hydrocarbon fuels and liquids (e.g. within sealed containers stored on concrete slabs and removed from site by a reputable company);
» Effective and prompt execution of mitigation measures in the case of an accidental spillage.

The wetland's potential to attenuate pollutants and protect downstream habitats can be regarded as low due to transformations the wetland has experienced such as changes in the hydrological / geohydrological character of the wetland as well as within the vegetation structure and composition. Due to changes in the upper parts of the catchment, flow volumes and patterns have been greatly altered resulting in the wetland being saturated for shorter periods of time (the potential to attenuate pollution is reliant on the reducing conditions and the extent thereof). These alterations along with onsite disturbances (overgrazing, and local erosion) have also greatly modified the wetland vegetation resulting in sparser vegetation covering with isolated bare patches and unnatural channel formation and erosion. Some portions of the wetland have become completely desiccated and haven't experienced saturated conditions for a very long time (also resulting in a transformation in vegetation). Subsequently the potential of the wetland to accumulate and store nutrients, organic components and potential pollutants have been greatly reduced allowing such materials to be transported downstream.

4.7 Erosion Risk

Erodibility and the impediment presented by the B horizon to water and plant roots are the most notable concerns relating to duplex soils (characterising most soils of the region). The main cause of erosion is clay dispersion, which give rise to surface crusting, which in turn reduces the infiltration of rainwater and intensifies surface runoff. Gully erosion can become especially severe in the cumulic forms (also lithic[2]) derived from pedisediments on concave footslopes once the main solum is breached and highly unstable subsoil clay is exposed. Slaking and spalling of the subsoil leads to undercutting and eventual collapse of the topsoil. Duplex soils on level typography such as that of river and coastal plain terraces do not carry the same erosion risk. A wetness hazard is also associated with the eluvic forms and with the achromic forms (bleached orthic A) families.

2 Lithic and cumulic soils are complementary. Where cumulic soils characterise gentler, concave footslopes and valley basins where deposition keeps pace with soil formation, lithic soils characterise convex crests and steep slopes where natural erosion keeps pace with weathering. In the lithic soil group rock or its weathered but intact derivative, saprolite, dominate the solum. Natural erosion commonly occurs more rapidly than weathering and results in exposing these lithic soils throughout large parts of the land.

Erosion is probably the most significant threat to the non-perennial watercourse as well as its associated wetland systems. The occurrence of erosion throughout the catchment area is very prominent, especially around the Matiwane settlement where numerous disturbances have removed the vegetation covering exposing the soils to soil capping and erosion. Deep erosion gullies remain as scars which is visible from satellite images. Almost 90% of the non-perennial headwater areas and smaller tributaries are exposed to severe levels of erosion. Downstream (lower gradient areas) channel and bank erosion as well as sheet and rill erosion has greatly modified the channel morphology of the non-perennial watercourse. Within the focus area erosion is clearly evident in localised areas of the wetland as well as surrounding terrestrial environment. The steeper slopes are exposed to low to moderate levels of sheet erosion (including portions of the Hillslope Seep area). Most of these areas have now been stabilised by a vegetation covering (indicative of a historical disturbance which now longer occur). Around most of the Valley Bottom Wetland area low to moderate levels of sheet erosion is present with the exception of the portion of wetland to the west, wedged between the two channels. Here relative high levels of sheet and rill erosion has occurred removing a high percentage of natural vegetation and forming shallow rills and scars within the landscape. Large sections of the channels have been subjected to deep channel bank and bed erosion (fluvial erosion), widening and deepening these channels.

Due to the steep slope and soil types (lithic soils such Glenrosa and Mispah) found within the proposed quarry area, erosion is likely to be significant impact within the development area itself. Significant potential impact within the wetland will likely be due to a change in surface water flow (surface hydrology) from development area into the wetland. By removing topsoil, vegetation and by altering the local morphology within the proposed quarry area, the direction, amount, velocity and frequency of surface water flow will be subsequently altered, this in turn my result in erosion within the wetland area (where water flow velocity is increased and concentrated. By planning the layout and position of infrastructure and with a sufficient erosion and rehabilitation plan in place the potential for erosion to occur can be maintained to an absolute minimum and localised, avoiding such impact occurring within the wetland area.

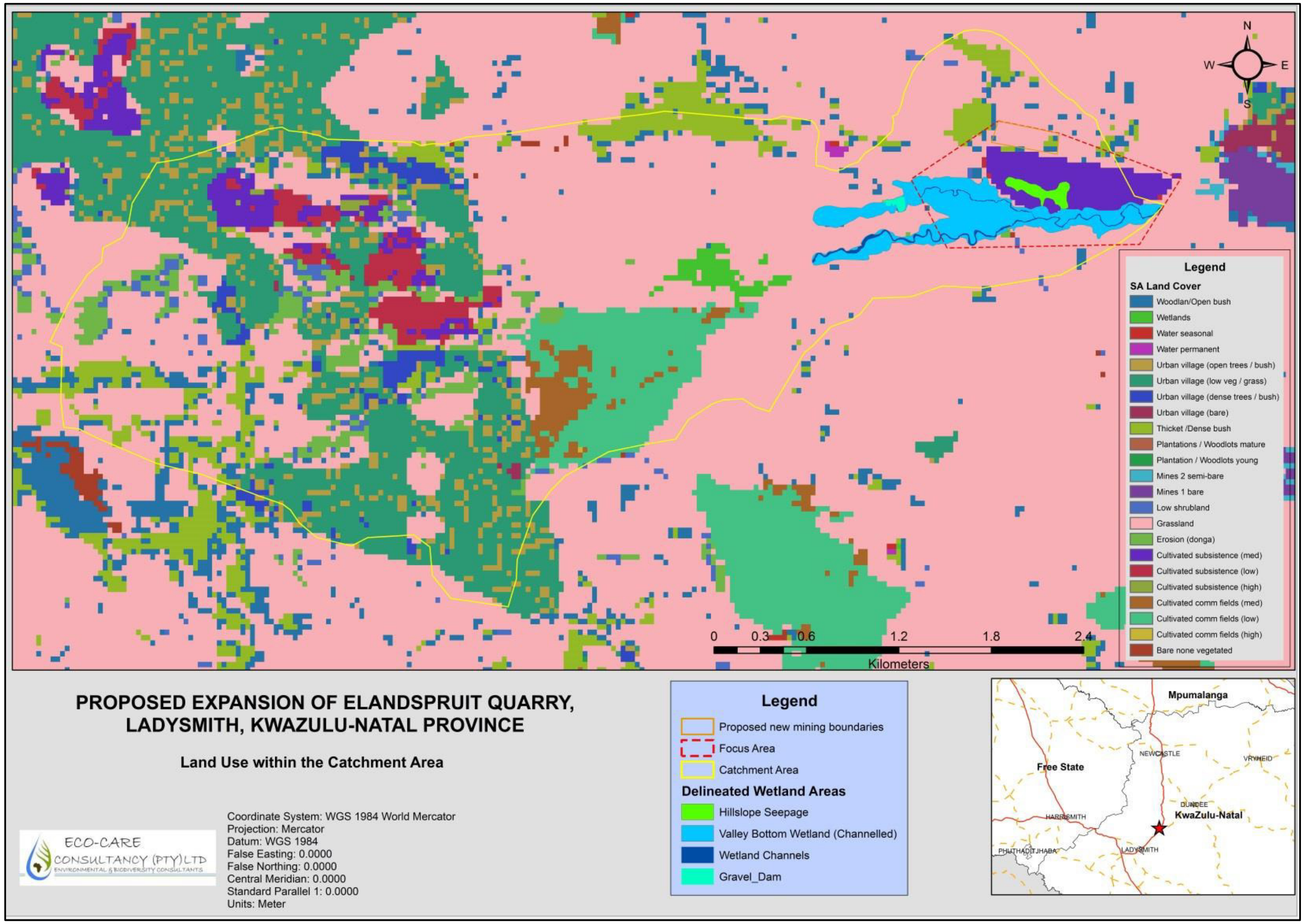

Figure 10: Map showing the primary land uses occurring in the wetland catchment (National land cover, 2014).

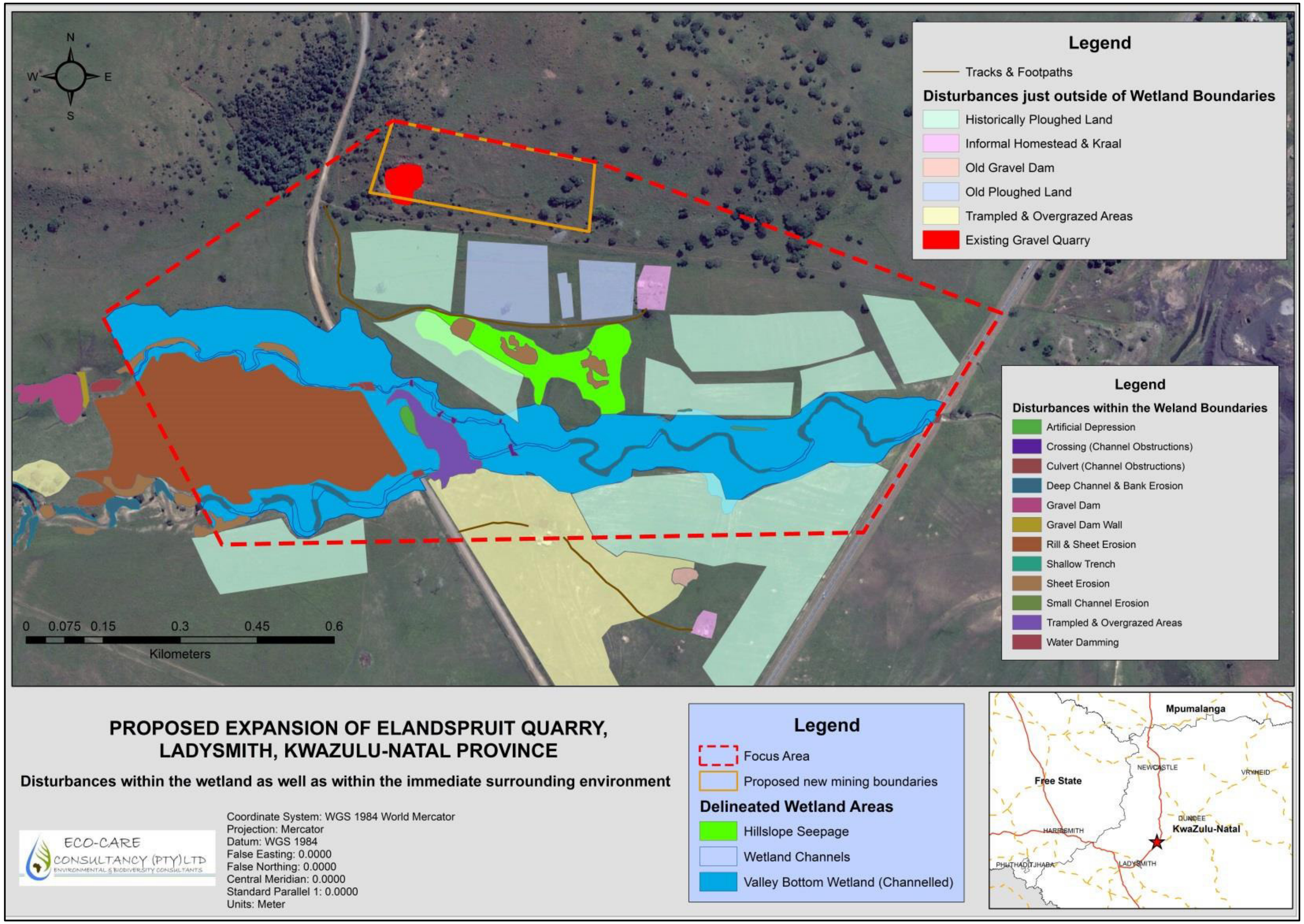

Figure 11: Current land use and disturbances present within the focus area.

4.8 Conservation context of water resources

Understanding the conservation context and importance of the site is important to inform decision making regarding the future use of the area. In this regard, both national and provincial level conservation planning information is available and was used to obtain an overview of the site.

The importance of water resources in meeting national freshwater conservation targets is illustrated in Figure 12 & 13. This shows that neither the non-perennial watercourse, nor the delineated wetland falls within any important FEPA's (Freshwater Ecosystem Priority Areas). Numerous FEPA wetlands have been identified within the surrounding environment including a wetland (Channelled Valley Bottom Wetland) associated with the non-perennial watercourse, downstream from the focus area (Figure 13). As indicated within Figure 12, the wetland catchments (Quaternary Catchment) is regarded as important Upstream FEPA (Upstream Water Management Area), according to the NFEPA coverage (CSIR, 2011). In such areas human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas, This, this non-perennial watercourse form a tributary of the Sundays River which is regarded as an important NFEPA river system and which terminates into the Thukela River (also an important NFEPA river system).

In terms of the Freshwater Systematic Conservation Plan (CPLAN) for the Province (EKZN, 2007) the focus area is not regarded as priority aquatic conservation areas (Figure 14).

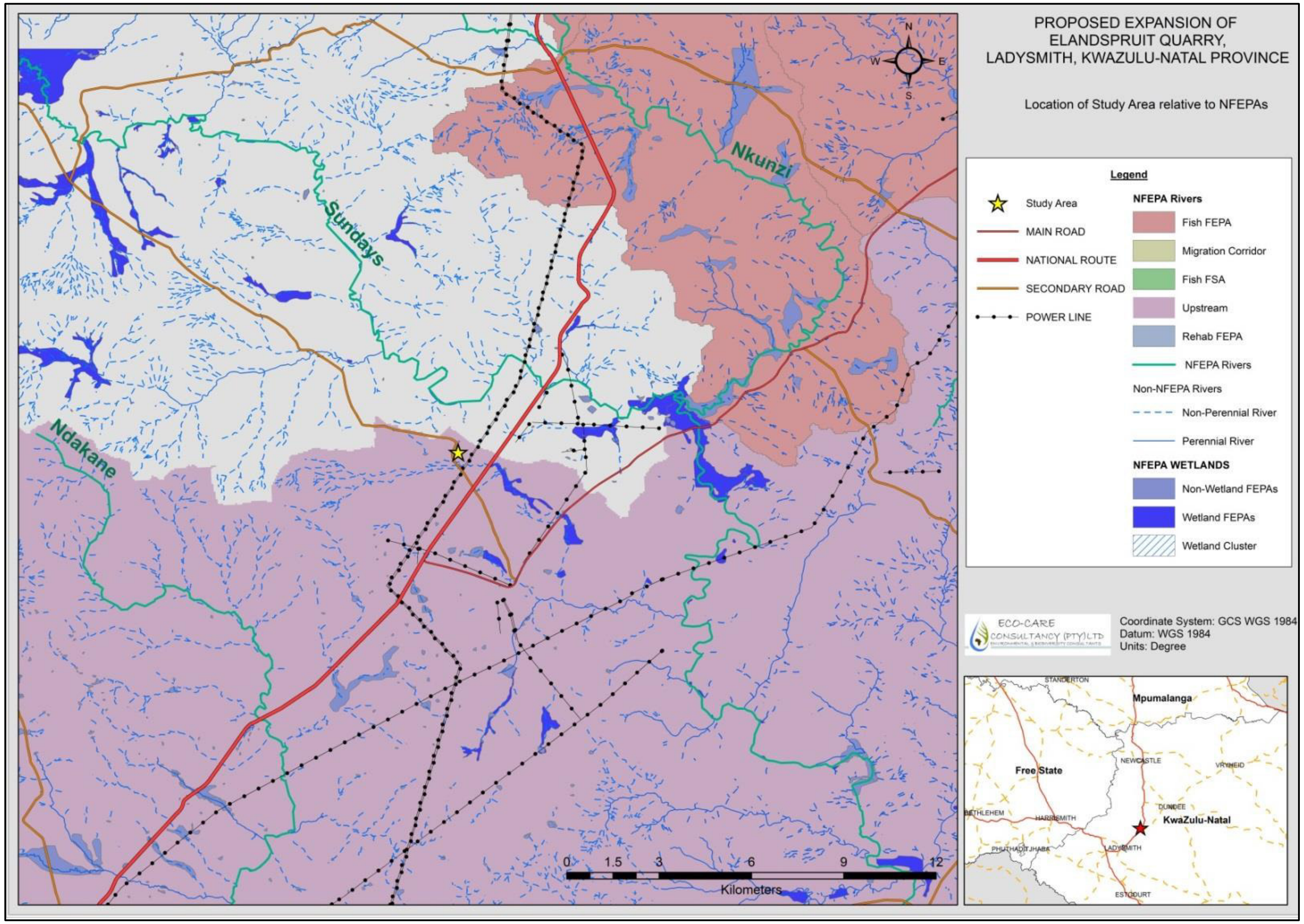

Figure 12: Map showing the location of the wetland system and catchment area relative to recently identified National Freshwater Ecosystem Priority Areas or NFEPA (CSIR, 2011).

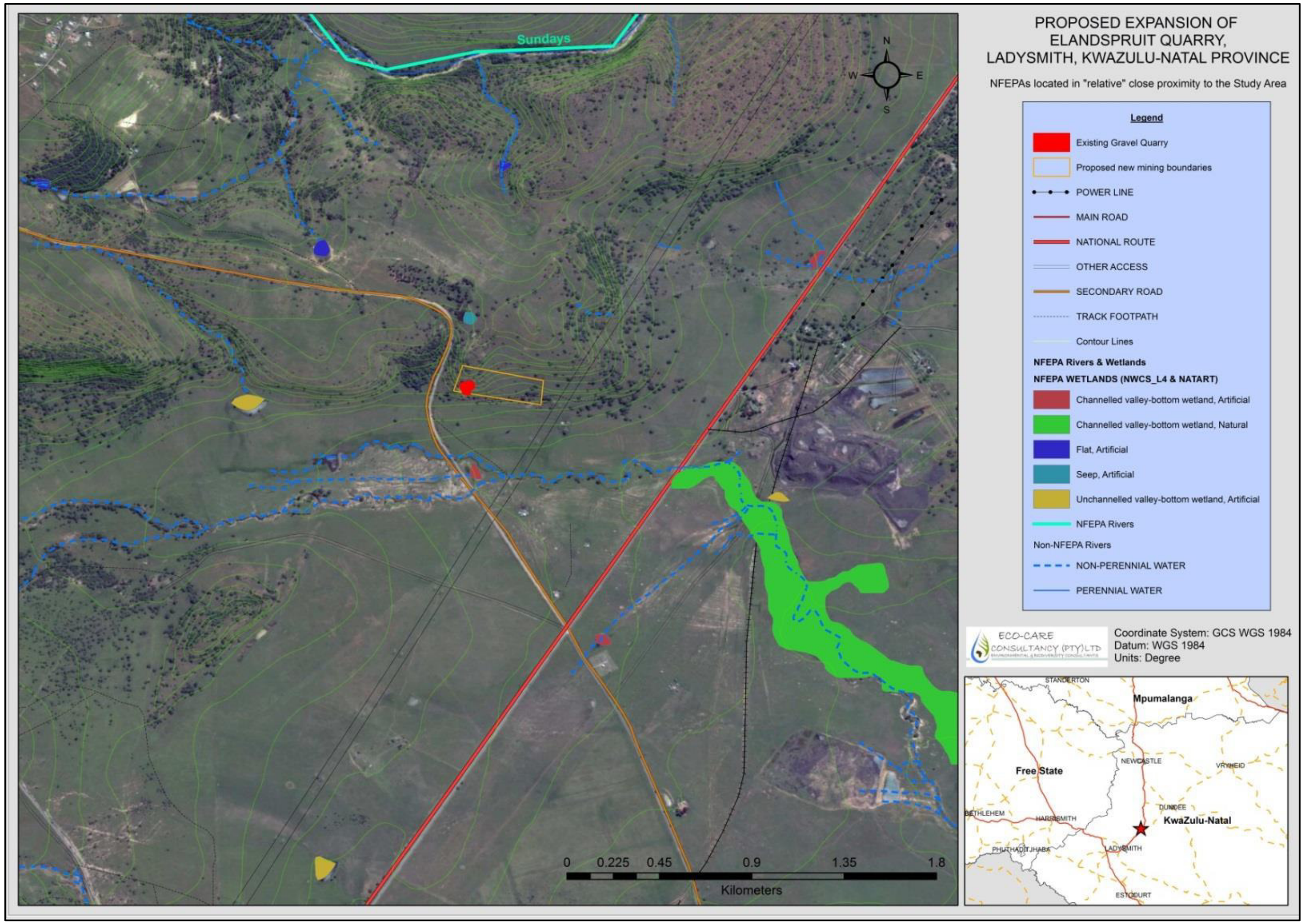

Figure 13: Map showing the location of NFEPA wetland areas located in relative close proximity to the focus area.

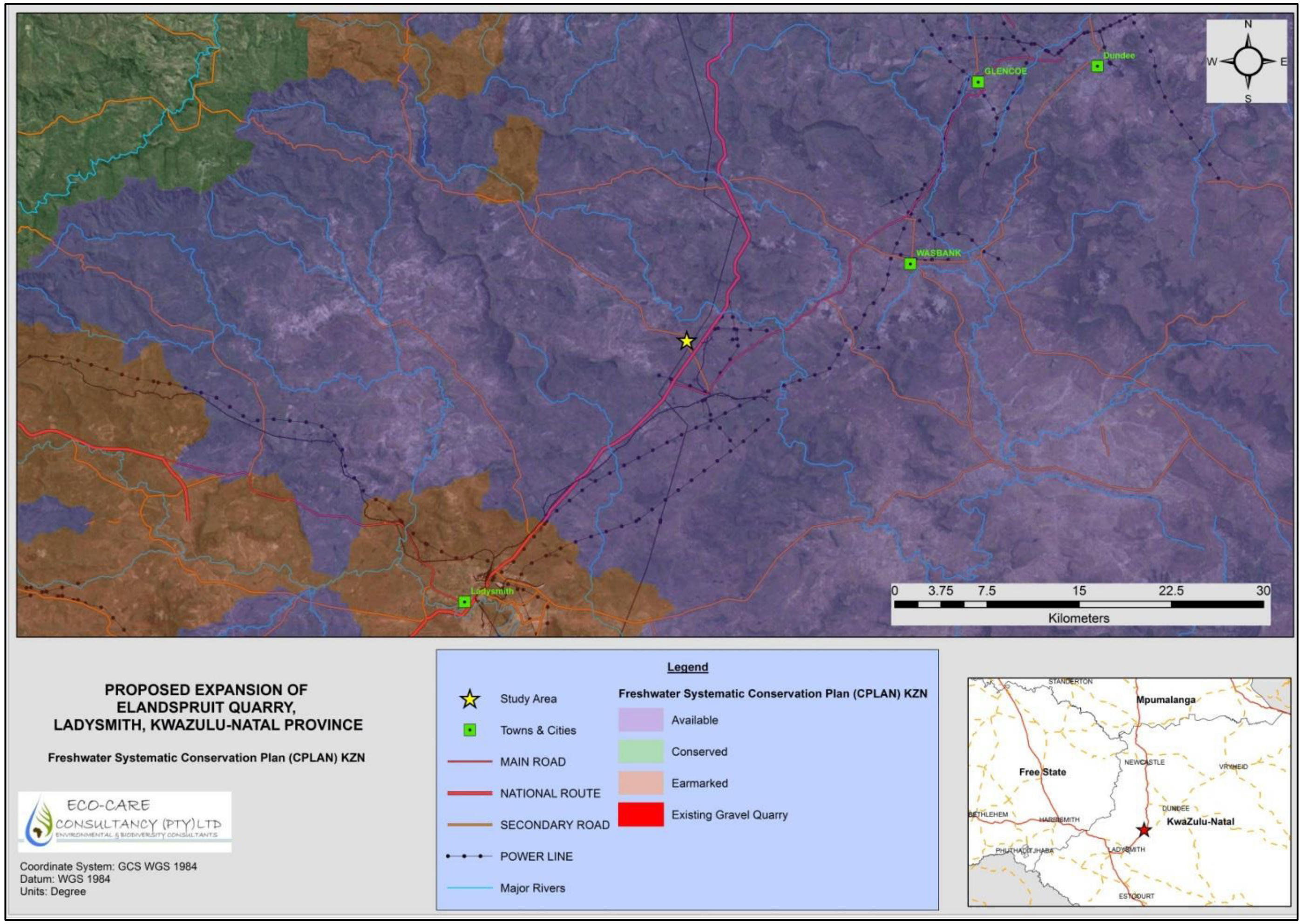

Figure 14: Map highlighting Provincial freshwater conservation priorities for the study area based on the Freshwater Conservation Plant for KZN (EKZN, 2007).

5 RESULTS

5.1 Wetland classification, delineation and description

The wetland area delineated (Figure 21) covered an area of approximately 367.72ha and consisted out of two HGM (Hydrogeopmorphic) units (Figure 15 & 18); Channelled Valley Bottom Wetland (~365ha) and a Hillslope Seepage (~2.72ha). The wetland area comprise approximately 27% of the catchment area (~1329 ha). The catchment area is characterised by average slope of 5.478%, generally in a north to south direction (N to S average slope: 6.75%). The upper parts (western portion) of the catchment area tend to be steeper and more rugged with an average slope (mostly in a west to east direction) of 7.175% whilst to latter part, including the wetland area is much more gradual with gentle wet to east slope of ~1.775%. A description of the HGM units' area provided below:

5.1.1 Wetland 1 (HGM 1)

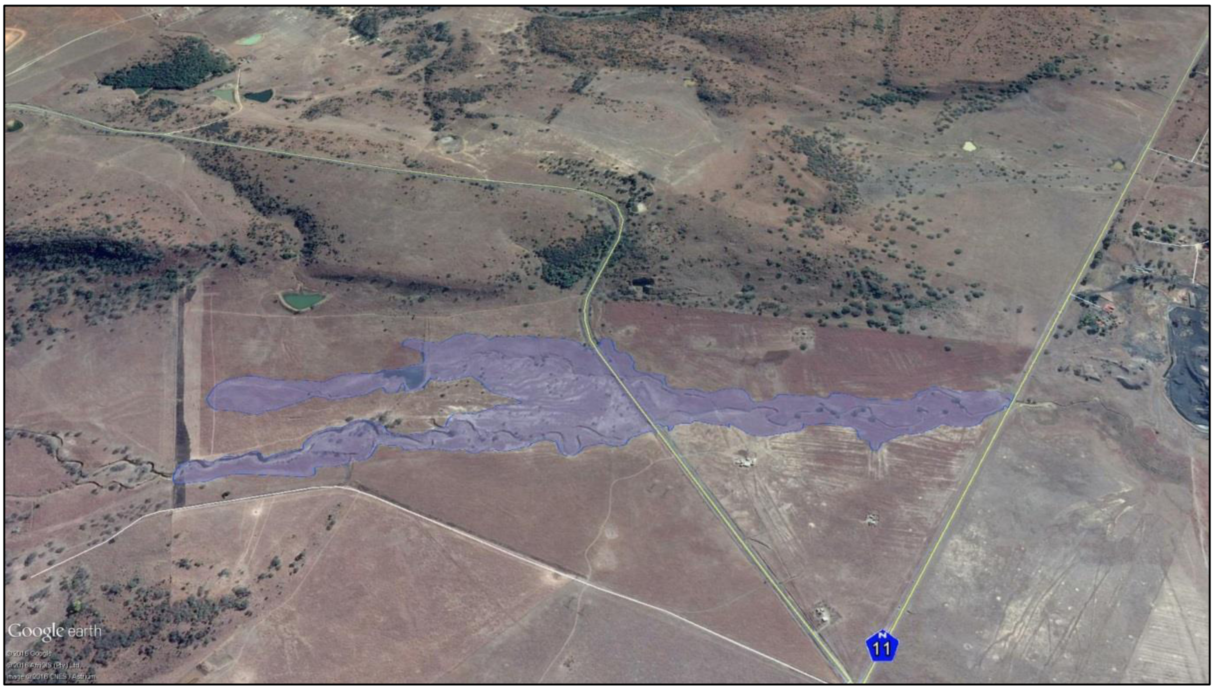

Figure 15: Google map indication the boundaries and wetland area of HGM 1 (Channelled Valley Bottom Wetland)

Based on the classification system for HGM units (Ollis *et al*. 2013) the aquatic ecosystem found to the north of the site can be classified as a Channelled Valley Bottom Wetland with small isolated areas which may be Intermittently Inundated with the largest portion of the wetland seldom to almost never being exposed to inundation. The bulk of the wetland indicates signs of Intermittently / Temporary Saturation with some areas fringing the channel indicating signs of Seasonal Saturation.

According to Ollis et al., 2013 the dominating zones found within this wetland can be described as follows:

» Period of inundation
  - Intermittently inundate zone: Holding surface water for irregular periods of less than one season, at intervals varying from less than a year to several years. Only a few isolated areas within the wetland comprises of this zone. Mainly the vegetation areas within the channel, just above and below channel obstructions such as culverts and crossing points created by the residents of the property. A few patches adjacent the channel my experience temporary periods of inundation during periods of very high rainfall.
  - Never / rarely inundate zone: Covered by water for less than a few days at a time (up to one week at most), if ever. The bulk of the wetland comprises of this zone.

» Period of Saturation
  - Seasonally saturated zone: With all the spaces between the soil particles filled with water for extended periods (generally between 3 – 9 months duration), usually during the wet seasons, but dry for the rest of the year. This corresponds to the 'seasonal zone' of a wetland, according to the terminology used in the DWAF (2005) wetland delineation manual. A narrow linear band fringing the channel beds comprise this zone. This band is not continual but broken in some areas by the intermittently saturated zone
  - Intermittently saturated zone: With all the spaces between the soil particles filled with water for irregular period of less than one season. This corresponds to the 'temporary (outer) zone' of a wetland, according to the terminology used in the DWAF (2005) wetland delineation manual. The bulk of the study area comprises the zone.

The stream/watercourse flowing through the wetland is regarded as <u>Non-Perennial</u> as it does not flow continuously throughout the year, although pools may persist. The non-perennial stream can be furthermore described as <u>Intermittent</u> as water flows for a relatively short time of less than one season's duration (i.e. less than approximately 3 months), at intervals varying from less than a year to several years

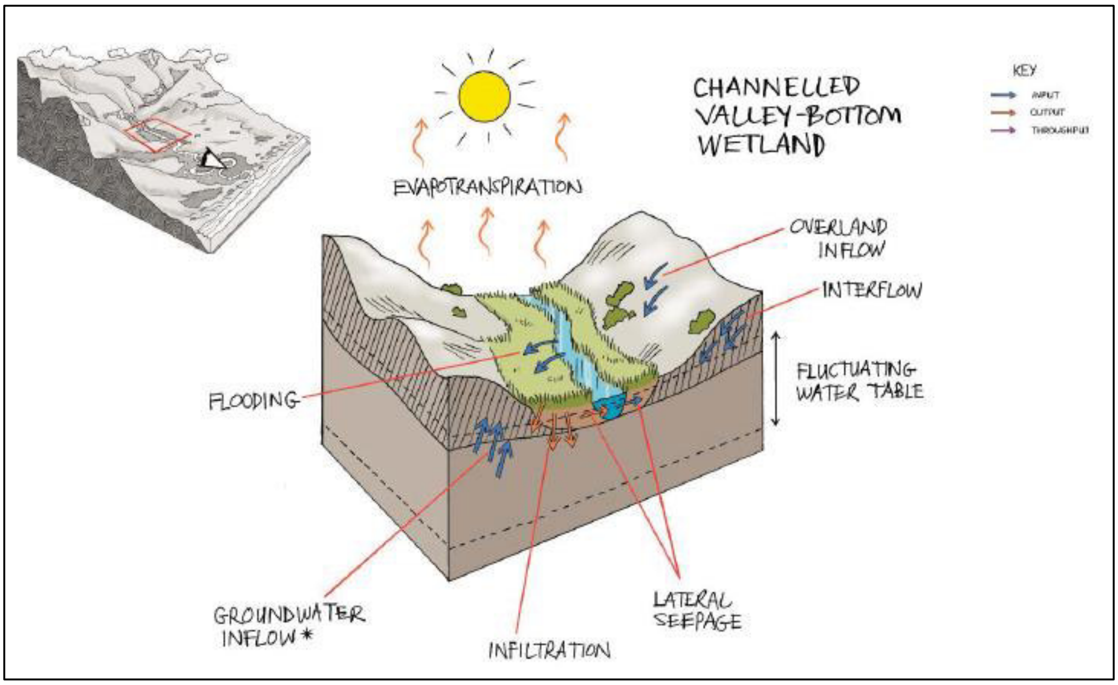

Figure 16: Conceptual illustration of a channelled valley bottom wetland, showing typical landscape setting (Copied from Ollis et al. 2013).

Channelled valley bottom wetlands are characterised by their location on valley floors (Figure 16), the absence of characteristic floodplain features and the presence of a river channel flowing through the wetland (in this case a non-perennial stream). The dominant water inputs (Figure 16 & 17) to this wetland is mostly surface flow resulting from flooding as well as from runoff from the surrounding valley slopes (especially to the north), including from the Hillslope Seepage. Sub-surface flow contributes to a lesser extent to the total water input and output of the wetland. Input is dominated by over-bank flow and lateral flow, supplemented by precipitation and surface runoff with, as mentioned, input from groundwater discharge very limited. Output mainly through drainage and to a lesser extent through surface outflow and evaporation. The inflows and outflows are controlled largely by water level in the non-perennial stream/watercourse.

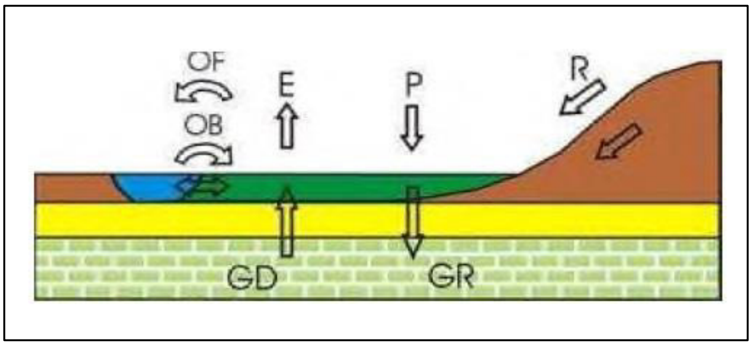

Figure 17: Conceptual illustration of a channelled valley bottom wetland and the dominant inputs and outputs of water (P - precipitation; E - evapotranspiration; R - runoff, L - lateral inflow; D - drainage; OB - over-bank flow; OF - out flow; GD - groundwater discharge; GR – groundwater recharge) (Copied from Collins, 2005).

As described in Sections 4.5, 4.6 & 4.7 numerous alterations and disturbances within the catchment area as well as the wetland itself have resulted in a transformation in the geomorphology, vegetation composition and subsequently in the hydrology characterising the area. This in turn as largely altered the ecological functions provided by this HGM. Through residential development, severe overgrazing, ineffective cultivation techniques etc. within the upper parts of the catchment area, most of these areas have been transformed resulting in an increase surface water flow and velocities (especially during high rainfall events and extreme weather events). This has resulted in sever gully and channel erosion within the headwater reaches of the non-perennial watercourse. Further downstream alterations (mainly overgrazing, uncontrolled burning and some cultivation) accompanied with this increase in surface water flow (during rainfall events) and velocity of flow upstream, has caused deep bank and bed erosion of the channel leaving these channels and their fringing habitats (wetland habitats) incapable of retaining, spreading and slowing down some of this water with a decrease in overbank flow as well as groundwater discharge and recharge. These effects have resulted in a transformation of the Channelled Valley Bottom wetland through bank & bed erosion of the 'natural' channel, the formation of new 'artificial channels (north-western portion), rill erosion, a change in the hydrological regime (small farm dam located in the north-western portion and channel obstruction such as culverts and crossing points has also contributed to this) and within the vegetation composition.

5.1.2 Wetland 2 (HGM 2):

Figure 18: Google map indication the boundaries and wetland area of HGM 2 (Channelled Valley Bottom Wetland)

Based on the classification system for HGM units (Ollis *et al*. 2013) the aquatic ecosystem found to the north of the site can be classified as a Hillslope Seepage

Wetland. This HGM is not an isolated system be is connected to the Channelled Valley Bottom wetland, however outflow is not contained within a channel (Without Channelled Outflow) but occur as diffuse surface flow. The entire HGM is Never / Rarely Inundated with surface water. The bulk of the HGM is Intermittently / Temporarily Inundated with only a small portion being Seasonally Inundated.

According to Ollis et al., 2013 the dominating zones found within this wetland can be described as follows:

» Period of inundation
  - Never / rarely inundate zone: Covered by water for less than a few days at a time (up to one week at most), if ever. This is applicable for the entire HGM.

» Period of Saturation
  - Seasonally saturated zone: With all the spaces between the soil particles filled with water for extended periods (generally between 3 – 9 months duration), usually during the wet seasons, but dry for the rest of the year. This corresponds to the 'seasonal zone' of a wetland, according to the terminology used in the DWAF (2005) wetland delineation manual. A small patch, not more than 0.31ha, located in the top right corner is seasonally saturated.
  - Intermittently saturated zone: With all the spaces between the soil particles filled with water for irregular period of less than one season. This corresponds to the 'temporary (outer) zone' of a wetland, according to the terminology used in the DWAF (2005) wetland delineation manual. The bulk of the study area comprises the zone.

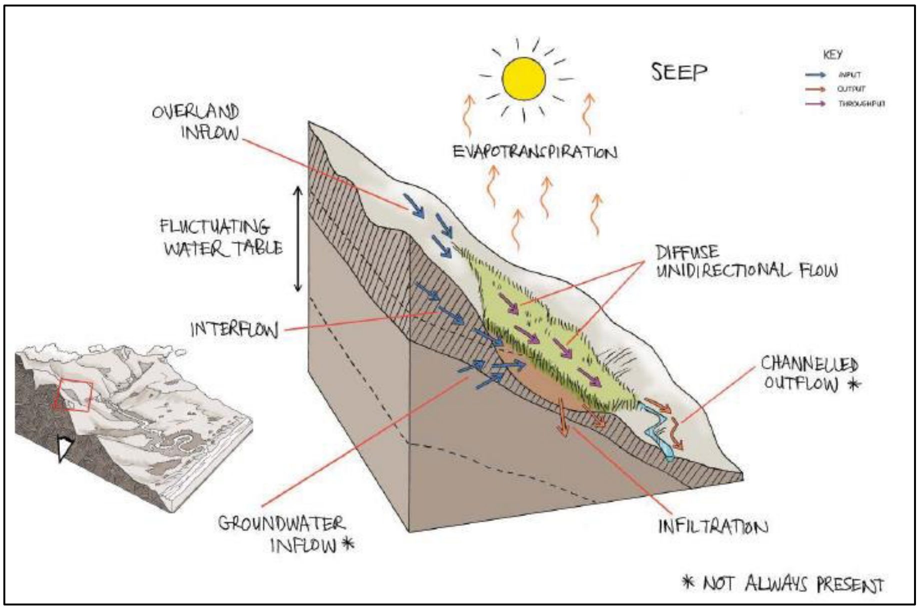

Figure 19: Conceptual illustration of a Hillslope seepage wetland, showing typical landscape setting (Copied from Ollis et al. 2013).

Seeps are wetland types found on gently to steeply sloping land and dominated by colluvial, unidirectional movement of water and material down-slope (Figure 19). Seeps are often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor. Seeps are characterised by their association with geological formations (lithologies) and topographic position that either cause groundwater to discharge to the land surface or rain-derived water and surface runoff to seep down-slope as subsurface interflow (Figure 20). In the case of this Hillslope Seepage, it is associated with both these two factors (underlying geology – lower permeability layer; typographical position – slight indent in sloping typography collecting surface runoff and rain water) and as a result interflow is due to groundwater discharge and subsurface interflow, although subsurface interflow is likely to be the prominent source of water. Outflow into the valley bottom wetland is not contained within a channel but rather occurs as unchannelled outflow by means of a combination of diffuse surface flow, interflow and infiltration.

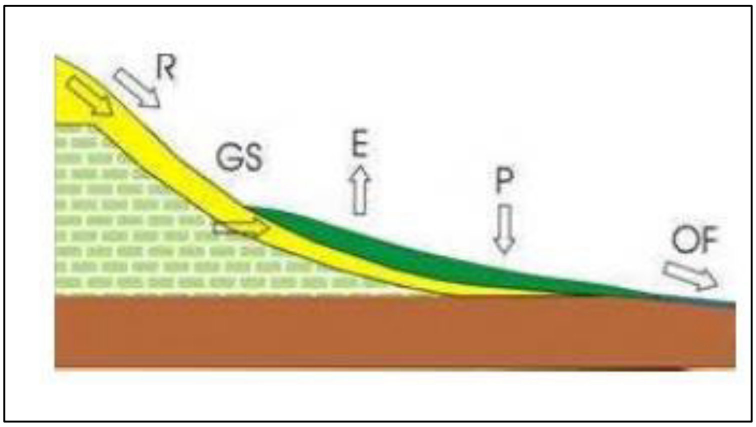

Figure 20: Conceptual illustration of a Hillslope Seepage wetland and the dominant inputs and outputs of water (P - precipitation; E - evapotranspiration; R – runoff; OF - out flow; GS – groundwater seepage) (Copied from Collins, 2005).

This hillslope seepage is not as much affected by the greater catchment area of the delineated wetland, but rather by the more immediate surroundings especially the dolerite koppie's south facing midslope and crest as well as in situ impacts. Hydrological inputs have been slightly affected by the presence of the quarry (probably resulted in a slight/unnoticeable decrease). Furthermore, a slight change in the hydrological character of the hill slope seepage is a result of a decrease in roughage (change in vegetation due to overgrazing and trampling) and low to moderate levels of sheet erosion (have been stabilised by vegetation). A small and very shallow gully (still in initiating phase) have been noted just below the seasonal saturated zone and is probably also the result of roughage removal due to overgrazing. Two power lines also traverse the wetland in close proximity to this eroded area and the disturbance around these pylon areas may also be responsible for the formation of this feature. These alterations have most likely caused the wetland to retain moister for shorter periods of time releasing more water at vaster rates into the valley bottom wetland.

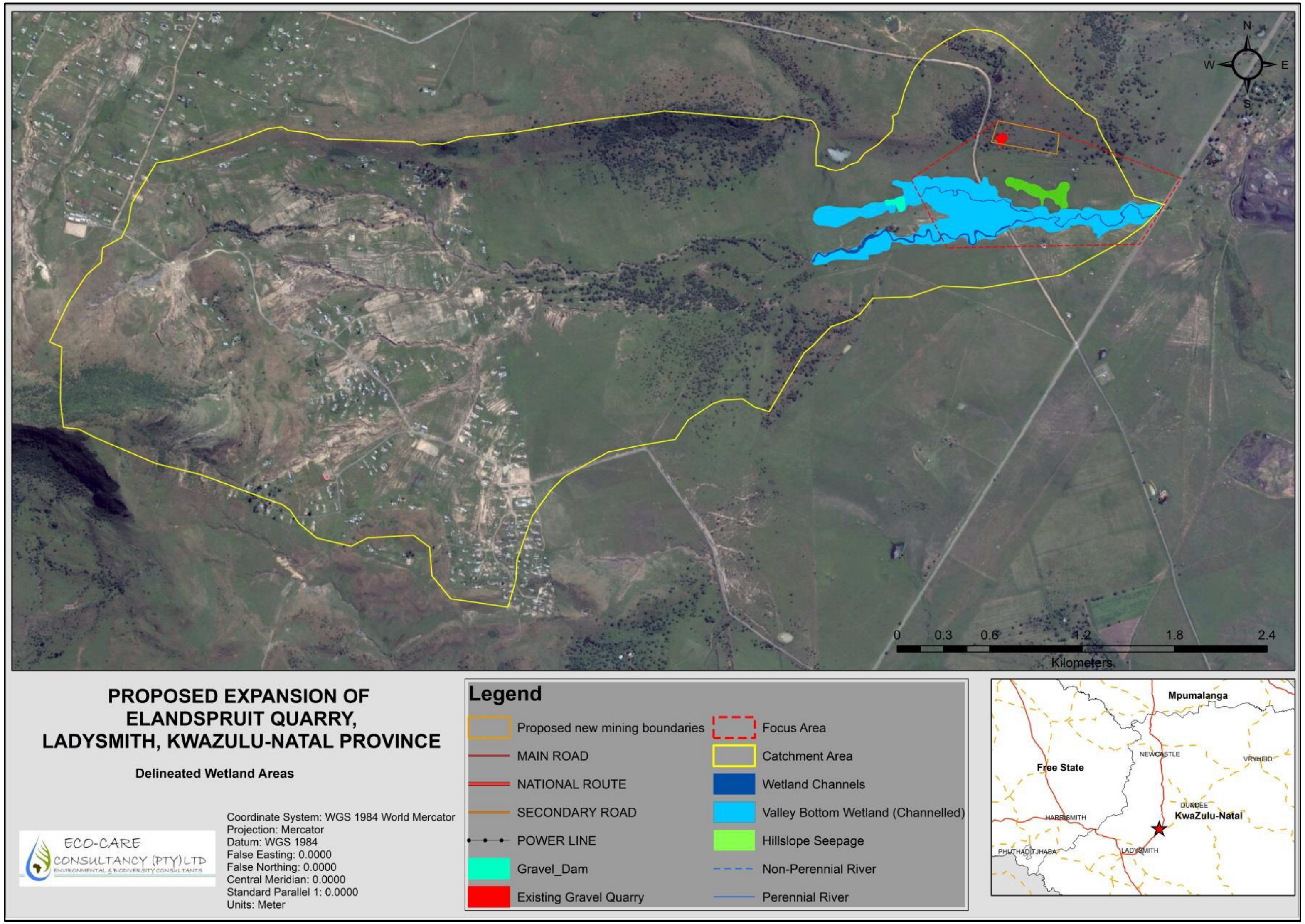

Figure 21: Map showing the delineated wetland relative to the catchment area.

5.1.3 Site Photos: HGM 1 (Valley Bottom Wetland)

Photo 1: View from the north of valley bottom wetland (VB). The darker patch of vegetation indicates the seasonal saturated zone. Also note the power lines traversing the wetland area.

Photo 2: Low roughage of VB's temporary saturated zone due to overgrazing.

Photo 3: Portion of channel containing surface water (pool) due to obstruction caused by artificial crossing.

Photo 4: Portion of channel containing pool of water (following a rainfall event) and wetland vegetation.

Photo 5: Culvert obstruction the natural flow of water

Photo 6: Artificial depression within VB created downstream of the culvert (seasonally saturated)

Photo 7: Artificial obstruction of channel resulting in temporary pools forming after sufficient rainfall events.

Photo 8: Portion of channel exposed to bank erosion

Photo 9: Channel exposed to bed erosion (channels stabilised by relative good covering of graminoids (Tree species: *Acacia sieberiana var. woodii*)

5.1.4 Site Photos: HGM 2 (Hillslope seepage)

Photo 10: Dark green patch in the background (footslope of koppie) indicates the seasonally saturated zone of the Hillslope Seepage (HS). Imperata cylindrical in the foreground indicates a portion of the seasonally saturated zone of the VB wetland.

Photo 11: Seasonally saturated zone of HS.

Photo 12: Power line traversing the HS (Pylon placed within the seasonally saturated zone).

Photo 13 Transition area between the seasonally saturated zone (top left corner of wetland area) and temporary zone (rest of wetland area). Note the power lines traversing the HS.

5.2 Wetland Soils

The dominating geology of the wetland is predominantly fine-grained sandstone with some siltstone and shale (Vryheid Formation) to the north the geology change to dolerite (Jurassic dolerite intrusion).

The wetland soil encountered during the survey has signs of wetness within 50cm of the surface, and both seasonal and temporary wet zones have been identified. The soil type of the seasonal wet zone is consistent with the soil forms Katspruit (seasonally wet zones fringing the channel) and Pindene (depression area within valley bottom wetland as well as seasonal saturated zone of hillslope seep), whereas the temporary wet zone is consistent with Westleigh (most of the temporary saturated zones for both valley bottom and hillslope seepage wetlands), with Glenrosa soil form with signs of wetness in the B1 horizon. All of these soil types are associated with wetland habitats. All of the soil types displayed mottling due to localisation of iron oxides, with Katspruit containing a low chrome coloration (grey) indicative of extended periods of saturation (redoximorphic features). Mottling by magnesium was also observed, especially within the seasonal wet zone. The soils outside the wetland area are typical terrestrial soils that have a uniform red colour indicating well-aerated soils.

5.2.1 Site Photos: Some of the wetland soils found within the study area

Photo 14: Westleigh soil form with a soft plinthic B horizon with signs of wetness.

Photo 15: Pindene soil form with unspecified material with signs of wetness underlying a yellow-brown apedal B horizon**.**

Photo 16: Soft plinthic B horizon with of the Westleigh form.

Photo 17: Mottles (accumulation of iron and manganese oxides) within the soft plinthic B horizon. Grey colour is the result of gleying.

Photo 18: Unconsolidated material with signs of wetness from Pindene soil form.

Photo 19: Mottles within the unconsolidated material horizon. Combination of organic matter, clay, sand and coarse fragments.

Photo 20: Katspruit soil form with. Has not undergone marked removal of colloidal matter (silicate clay), but have rather accumulated such matter. The G horizon is dominated by grey, low Chroma colours (grey), often with a blue or green tint.

Photo 21: G horizon of Katspruit soil form with randomly patterned sesquioxide mottles (red brown).

5.3 Flora biodiversity of the depression wetland

Due to overgrazing and trampling the vegetation structure and coverage, especially within the temporary saturated zone have been greatly altered resulting in a short grassy cover (kept short through constant grazing) dominated by species such as *Paspalum notatum, P. dilatatum, P. urvillei, Cynodon dactylon, C. incompletes, Imperata cylindrical, Eragrostis plana, E. chloromelas* and *E. micrantha.* This altered vegetation form varies in terms of roughness (coverage) from relatively bare areas (to the west between the two channels) to moderately high coverage. Within the bare areas species such as *Aristida congesta* var. *barbicollis, A. junciformis*, *Tragus berteronianus* as well as *Trachypogon spicatus* may become prominent. This altered vegetation cover provide moderate protection against erosion especially in area where the vegetation has been severely grazed. Furthermore, this transformed vegetation cover has resulted in a reduced ability of the wetland to contain surface water flow and attenuate flooding.

The seasonal saturated zones are characterised by a mixtures of grasses and sedges with *Leersia hexandra, Paspalum urvillei, Imperata cylindrical, Eragrostis planiculmis, Panicum repens, Bulbostylis hispidula, Cyperus articulatis, Eleocharis acutangula, Schoenoplectus corymbosus, Pycreus macranthus* and *Kylinga erecta* being the most prominent species. The deep pools being inundated for relative extended periods of time after sufficient runoff events have occurred comprise mostly out of *Paspalum urvillei, Leersia hexandra, Schoenoplectus corymbosus* and *Cyperus articulatis*. The seasonal saturated zones, a bit further from the channel comprise mostly out of *Cyperus articulatis, Pycreus macranthus, Bulbostylis hispidula, Eleocharis acutangula, Kylinga erecta, Eragrostis planiculmis* and *Imperata cylindraca*. Within the ecotone between the Seasonal and Temporary saturated zones Imperata cylindrical may form dominant stands. The small seasonal saturated portion of the hillslope seep is dominated by an almost monotonous stand of *Imperata cylindrical* with *Paspalum urvillei, Eragrostis planiculmis, E. micrantha* and *Pycreus macranthus* interspersed between *I. cylindrical*. Most of the seasonal saturated zone along the channel have been lost due to bank erosion eating into this section resulting relative deep channels which may become relative broad (in the context of the non-perennial streams natural morphology), transitioning directly into the temporary zone which is seldom saturated due to confinement of flow within the deep eroded channels with little potential for lateral flow. This removal of vegetation has resulted in little protection for the channels against further erosion and the slowing down of flowing water. Relative broad areas of seasonal saturated zones with moderate-high to high density vegetation cover have formed immediately above and below the culverts as a result of water obstruction. This vegetation, especially below the culverts is vital for protection against the adverse effects of channelled water flowing through the culverts posing an erosion threat.

Herbaceous species were mostly found within the temporary zone although a few were also present within the saturated zone. These included mostly species belonging to Fabaceae, Asteraceae, Apocynaceae and Polygonaceae. Prominent Asteraceae species included; *Helichrysum rugulosum, H. aureonitens, H. pallidum, Senecio napifolius, S. paucicalyculatus, S. inornatus, S. hygrophylis, Berkheya onopardifolia, B. radula, Blumea mollis, Haplocarpa scaposa, Verbene brasiliensis*. The Fabaceae group was dominated by *Eriosema salignum, Zornia linearis*, *Indigofera* spp. and *Tephrosia* spp., whilst the Apocynaceae family was represented by *Acalypha glandulifolia, A. stellifera and Sisyranthus virgatus*. Other prominent herbs included; *Anthospermum herbaceum, Diclis reptans, Polygala virgata, P hottentotta, Polygala spp., Monopsis decipiens, Hypericum lalandii, Berula erecta, Kohouta virgata* and *Limum thunbergii.*

The only red data species noted was a small isolated population of *Crinum bulbispermum* which is classified as declining with the Red Data List.

Numerous exotic and alien invasive species were recorded within the focus area, especially within the temporary saturated zone and included the following:
Schkuhria pinnata, Xanthium spinosum (Category 1b), *Cirsium vulgare* (Category 1b), *Verbena bonarienses* (Category 1b), *Verbena aristigera, Gomphrena celosioides, Centella asiatica, Richardia brasiliensis, Solanum sisymbriifolium* (Category 1b), *Paspalum urvillei, Paspalum notatum, P. dilatatum* and *Cyperus esculentis*.

5.4 Ecological Importance and Sensitivity (EIS) of wetlands

Wetlands are known to provide a range of ecosystem goods and services to society, and it is largely on this basis that policies aimed at protecting wetlands have been founded. This section of the report provides a summary of the predicted level of importance of the wetlands in terms of their effectiveness in providing ecosystem goods and benefits. The predicted level of importance's of various potential goods and services have been summarised in Table 11 and are illustrated in Figures 22 & 23, below.

Generally speaking, from a functional point of view, channelled valley bottom wetlands tend to contribute less towards flood attenuation and sediment trapping, but still perform these functions to a certain extent. Some nitrate and toxicant removal potential can be expected, particularly from the water being delivered from the adjacent hillsides.

As for hillslope seepage wetlands feeding a stream, these systems are normally associated with groundwater discharges, although flows through them may be supplemented by surface water contribution (in the case of the delineated hillslope seep of this study area, surface water may contribute to a larger extent). They can be expected to contribute to some surface flow attenuation early in the season, until the soils are saturated, after which their contribution to flood attenuation is likely to be limited (McCartney, 2000 in Kotze *et a*l., 2005; McCartney et al., 1988 in Kotze et al., 2005). Evapotranspiration in the wetland may result in a considerable reduction in the total volume of water which would otherwise potentially reach the stream system. Nonetheless, the accumulation of organic matter and fine sediments in the wetland soils results in the wetland slowing down the sub-surface movement of water down the slope, This "plugging effect" increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the stream system during low flow periods, For some hillslope seepage wetlands this contribution may continue into the dry season, but for many others it is confined mainly to the wet season. Seepage wetlands are widely considered to perform a number of water quality enhancement functions, for example, removing excess nutrients and inorganic pollutants produced by agriculture; industry and domestic waste (Postel and Carpenter, 1997 in Kotze *et al.*, 2005). Hillslope seepages generally would be expected to have a relatively high nitrogen removal potential. Nitrogen and specifically nitrate removal could be expected as the groundwater emerges through low redox potential zones with the wetland soils, with the wetland plants contributing to the necessary supply of organic carbon. Particular effective removal of nitrates from diffuse sub-surface flow, as characterized hillslope seepages, has been recorded (Muscutt *et al.*, in Kotze *et al.*, 2005). Owing to their slope, hillslope seepages tend to perform limited sediment-trapping, provided that the vegetation remains intact.

Based on a rapid level assessment of wetland goods and services for the systems, both HGM systems provide indirect benefits such as flood attenuation, sediment trapping and nutrient (Phosphate and Nitrate)/toxicant removal to a moderate/low moderate level. This is mainly due to the effects of trampling, overgrazing and erosion which have altered some of the wetland geomorphology and vegetation cover, resulting in some loss of these services. Key direct human benefits provided by the wetland to a moderate degree include cultivated food, harvestable natural resources. Food for livestock can be regarded as moderate to low-moderate mainly due to overgrazing which as replaces some palatable species with less palatable species and the fact a large portion of the biomass is being kept to a minimum (grasses being grazed short and maintained in such a state) due to constant applied grazing pressure. Biodiversity maintenance is generally low to low-moderate due to constant disturbances and the level of habitat transformation. The wetland is also not considered suitable for tourism/recreation with a rather low education/research value due to the degraded state.

Table 11: Summary of the importance of the different HGM units in providing ecosystem goods & services

ECOSYSTEM SERVICE		Channelled Valley Bottom		Hillslope Seepage	
		WET-EcoServices Overall Score	Importance	WET-EcoServices Overall Score	Importance
INDIRECT BENEFITS	**Flood Attenuation**	2	Moderate	2.2	Moderate
	Stream Flow Regulation	2	Moderate	1.7	Low-Moderate
	Sediment Trapping	2.1	Moderate	1.5	Low-Moderate
	Phosphate Trapping	1.6	Low-Moderate	2	Moderate
	Nitrate Removal	1.9	Low-Moderate	2.4	Moderate
	Toxicant Removal	1.8	Low-Moderate	1.6	Low-Moderate
	Erosion Control	2	Moderate	2.3	Moderate
	Carbon Storage	1.3	Low	1.3	Low
ECOSYSTEM SERVICE		**Channelled Valley Bottom**		**Hillslope Seepage**	
		WET-EcoServices Overall Score	**Importance**	**WET-EcoServices Overall Score**	**Importance**
DIRECT BENEFITS	**Biodiversity Maintenance**	1.4	Low	1.6	Low-Moderate
	Water Supply	1.7	Low-Moderate	0.4	Low
	Harvestable Natural Resources	3	Moderate-High	2.2	Moderate
	Cultivated Foods	2.4	Moderate	1.6	Moderate

	Food for Livestock	2	Moderate	1.7	Low-Moderate
	Cultural Significance	1	Low	1	Low
	Tourism & Recreation	0.3	Low	0	Low
	Education & Research	1.3	Low	1	Low
THREATS		2	Moderate	3	Moderate-High
OPPORTUNITIES		1	Low	1	Low

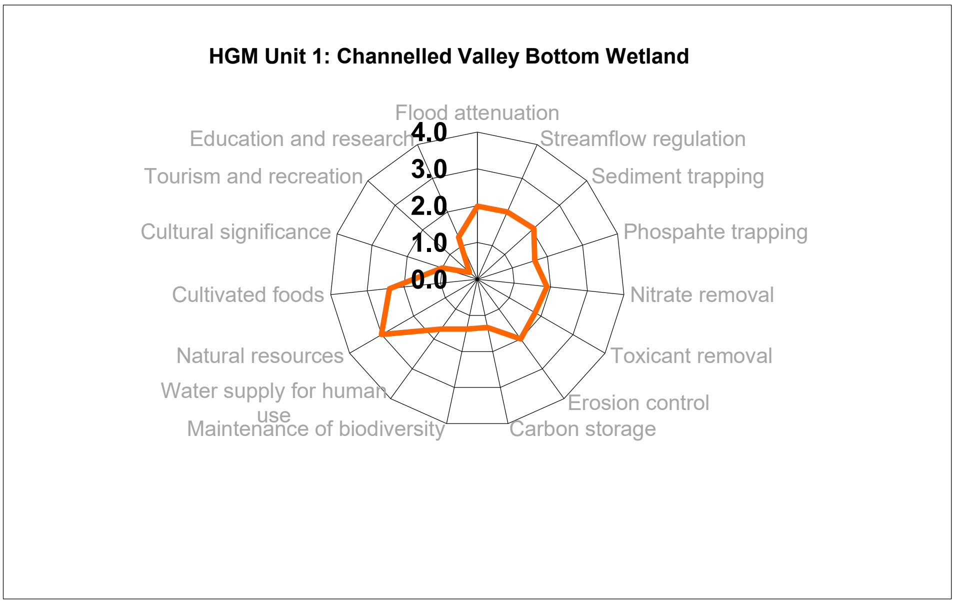

Figure 22: Spider diagram indicating the estimated levels for a range of ecosystem services for HGM unit 1: Channelled Valley Bottom Wetland.

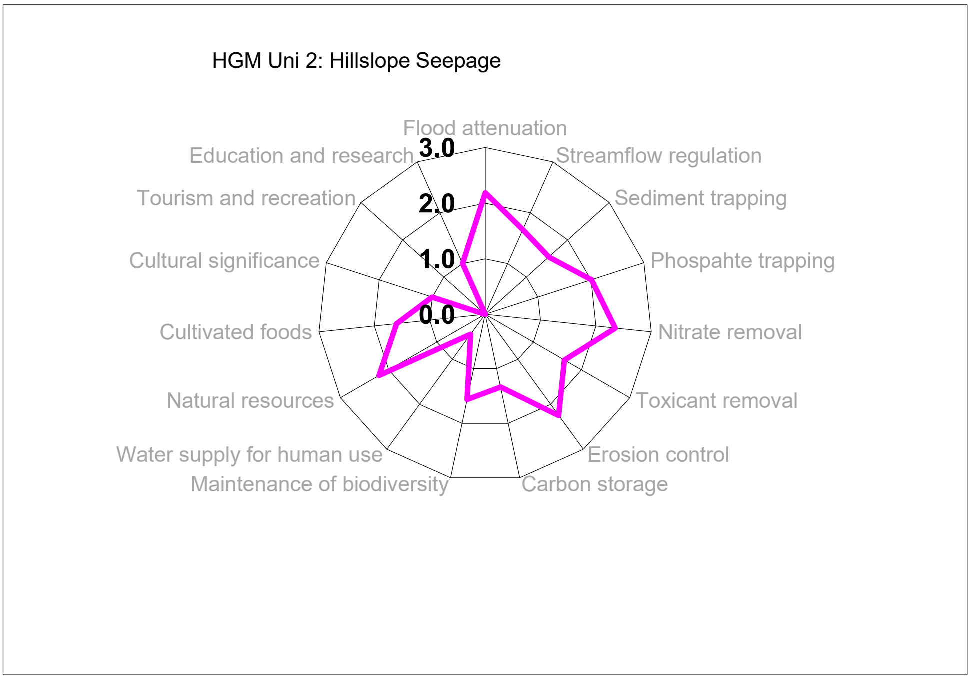

Figure 23: Spider diagram indicating the estimated levels for a range of ecosystem services for HGM unit 2: Hillslope Seepage Wetland.

Within the Wet-Health modelling the outputs can be split into three categories which are Hydrology, Geomorphology and Vegetation. According to the Wet-Health model the following comments can be derived regarding the condition of the HGM units (also refer to Table 12 for a summary of the entire wetland):

HGM unit 1: Channelled Valley Bottom Wetland

» Hydrology:
- According to the model the hydrological character can be described as largely modified but is expected to stay relative stable within the next 5 years.
- Due to catchment disturbances including: cultivation, culvert obstructions and channel modifications it is expected that a slight reduction in flow (water input has occurred), however due to vegetation removal, severe erosion, increase in bare areas and hard surfaces upstream (within the headwaters) it is expected that flood peaks have been increased moderately, often resulting in a noticeable reduction in sub-surface water inputs.
- Human activities within the wetland system have also greatly altered the hydrological character of the wetland system. These activities include server overgrazing and trampling, historical cultivation, dam construction (small farm dam located to the north-west of the wetland) and water obstructions (culverts and crossing points). These activities has resulted in impacts severely altering the hydrology of the wetland by reducing the ability to attenuate, hold and spread out rain water, runoff and flood water (especially within the channel). These impacts include:
- Erosion within the wetland area in the form of shallow gully, sheet and rill erosion
- Modifications to the existing channel through channel straightening (lesser extent), widening (bank erosion) and deepening (bed erosion). These modifications have a serious impact but some overtopping (overbank flow) may still occur, although much less frequently than was the case naturally.
- A reduction of roughage (vegetation)
- Impeding features upstream as well as downstream such culverts and areas filled up with gravel to create areas to cross the wetland (for humans as well as cattle). This has created areas immediately upstream which are inundated for longer periods of time (pools within the channel) as well as larger seasonal zones.

» Geomorphic:
- According to the model the Geomorphological character can be described as mostly natural with few modifications but is expected to decrease within the next 5 years.

- Upstream little modification has occurred due to the construction of dams, stream diversion/shortening and infilling.
- Most of the modifications within the wetland are due to an increased in flooding and runoff from the surrounding slopes, which is indirectly a result of a decrease in roughage and the presence of numerous erosion features, especially within the channel, which has been greatly altered.

» Vegetation:

- According to the model the vegetation character can be described as moderately modified but the situation is expected to decrease within the next 5 years.
- Most of the vegetation alteration within the wetland area is due to erosion and overgrazing and trampling.
- Overgrazing and trampling has systematically resulted in the transformation of the vegetation composition replacing most of the vegetation with more grazing resilient species and has resulted in a reduction in roughage especially within the temporary saturated zone with some bare patches, especially to the west of the wetland.

HGM unit 2: Hillslope Seepage Wetland

» Hydrology:

- According to the model the hydrological character can be described as mostly unmodified to near natural with very slight alterations. This situation is expected to stay relative stable within the next 5 years.
- Due to some disturbance within the catchment, which includes the quarry, a slight reduction in terms of flow (water input) has occurred. Furthermore, flood patterns have likely not been altered.
- Water retention, attenuation and dispersal within the wetland itself have however been altered. Overgrazing resulting in a decrease in roughage and relative low to moderate levels of erosion (small and shallow gully just below the seasonal saturated zone and stabilised sheet erosion to the south and north-west) are the main causes of these alterations resulting in surface water and runoff attenuated weakly with water retained for very short periods of time within the wetland.
- Most of the water is lost to the valley bottom wetland.
- Although as mentioned, erosion is present within the seep, most of the areas have been stabilised with vegetation and subsequently most of these eroded area do not pose a threat level to the extent of which the erosion in the valley bottom wetland pose.

» Geomorphic:

- According to the model the geomorphic character can be described as unmodified to near natural with very slight alterations. This situation is expected to stay relative stable within the next 5 years.
- The only geomorphic alterations within the wetland are, as mentioned, the eroded areas.
- Most of the eroded area have been stabilised by vegetation (sheet erosion), there is however a small gully, still in its initial stage, present just below the seasonal zone, which may develop over time.

» Vegetation:

- According to the model the vegetation character can be described as moderately modified but the situation is expected to decrease within the next 5 years.
- Most of the vegetation alteration within the wetland area is due to overgrazing.
- Overgrazing has systematically resulted in the transformation of the vegetation composition replacing most of the vegetation with more grazing resilient species and has resulted in a reduction in roughage especially within the temporary saturated zone.

Table 12: WET-Health scores for the two HGM units

HGM UNIT	HYDROLOGY		GEOMORPHOLOGY		VEGETATION	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Channelled Valley Bottom	6	0	1.2	-1	2.7	-1
Hillslope Seepage	0	0	0	-1	3.2	-1
Area weighted impact scores	**5.6**	**0.0**	**1.2**	**-1.0**	**2.8**	**-1.0**
PES Category	**D**	→	B	↓	C	↓

Based on the PES and importance of the wetland in terms of wetland goods and services, the EIS of the wetland was rated using the tool by Rountree (in prep). Both HGM units have obtained an estimated Low to Moderate EIS rating as per Table 13, below. The HGM units are considered to be of Low Medium ecological importance and are Low-Medium importance from a hydrological/functional perspective (as reflected in the WET-Ecoservices assessment). From a direct-use perspective the wetland are not considered important, with the only direct use observed being livestock grazing which also take place across the terrestrial environment.

Table 13: Summary of the EIS assessment

Component Assessed	Valley Bottom Wetland	Hillslope Seepage Wetland
Ecological Importance & sensitivity	1.68 (Low-Medium)	1.8 (Low-Medium)
Hydrological / Functional Importance	1.72 (Low-Medium)	1.84 (Low-Medium)
Importance of Direct Human Benefits	1.14 (Low)	1.4 (Low)
Overall Importance Score	1.51	1.68
EIS Class	**Low-Medium**	**Low-Medium**

5.5 Determination of Buffer Zones

Wetland buffers are areas that surround a wetland and reduce adverse impacts to wetland functions and values from adjacent developments. Buffers reduce wetland impacts by moderating the effects of storm water runoff including stabilising soil to prevent erosion, filtering suspended solid, nutrients, and harmful or toxic substances, and moderating water level fluctuations. Buffers also provide essential habitat for wetland-associated species for use in feeding, roosting, breeding and rearing of young, and cover for safety, mobility, and thermal protection. Finally, buffers reduce the adverse impacts of human disturbance on wetland habitats including blocking noise and glare; reducing sedimentation and nutrient input; reducing direct human disturbance from dumped debris, cut vegetation, and trampling; and providing visual separation. Wetland buffers are essential for wetlands protection.

The 'Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries' (Macfarlane et al., 2014) was considered for the determine the buffer zones for the HGM units found within the project boundary. This tool was used as a guideline for the buffer widths recommended in this report. The results from this tool suggest that, a **50m** buffer may be used on the wetland system. It is however recommended that this buffer area is increased to **70m** (refer to Figure 24) as this tool does not take into consideration the condition of the terrestrial vegetation comprising the buffer area. In this case the vegetation is in a relative transformed state due to overgrazing and as a result the roughage has been lowered. Thus an increase of 20m is deemed sufficient to accommodate for the on-site condition.

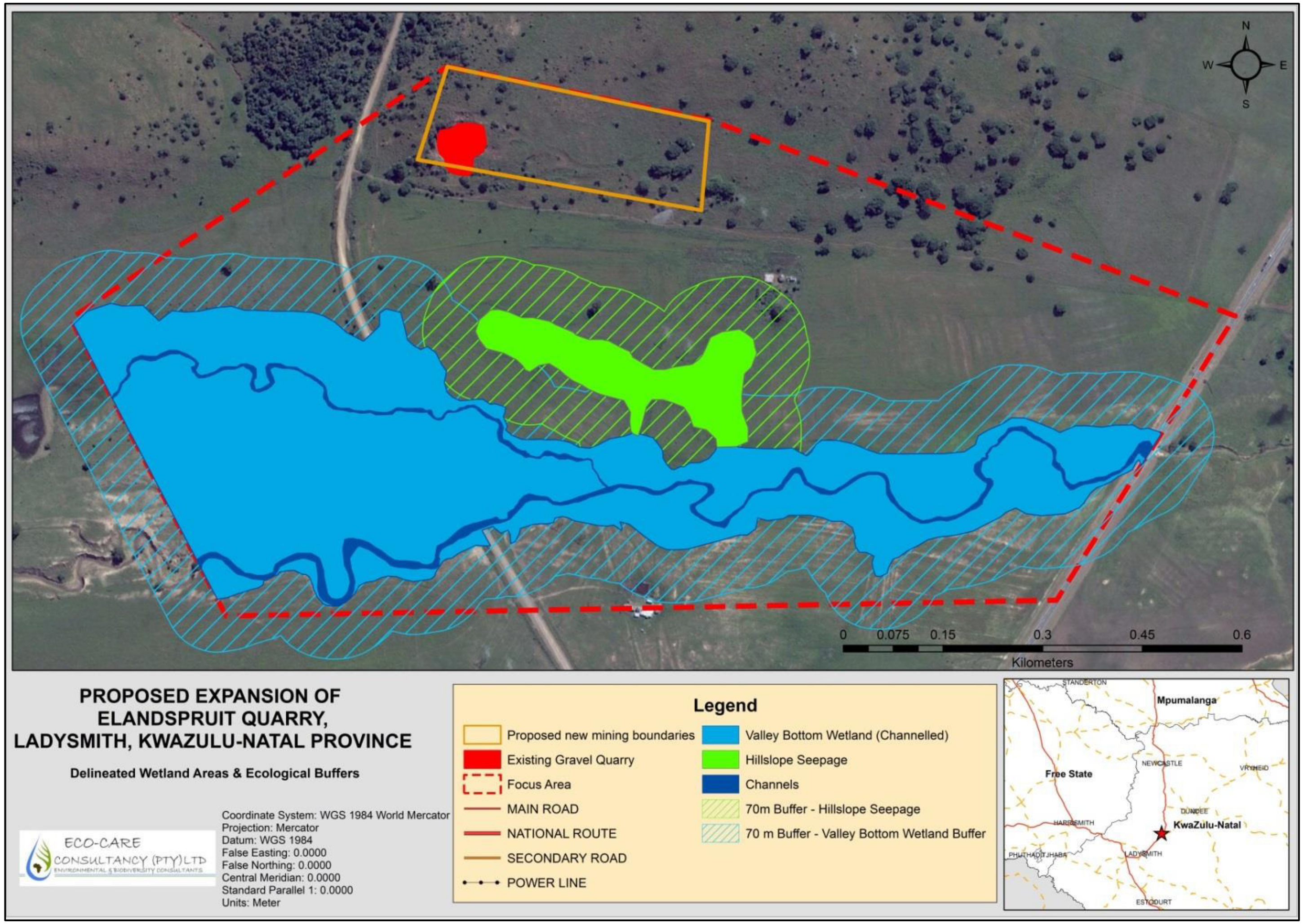

Figure 24: Map showing the applied 70m ecological buffers around both HGM units.

6 ASSESSMENT OF ECOLOGICAL IMPACTS (RISK ASSESSMENT)

6.1 Identification of Potential Impacts and Associated Activities

Construction and operation may lead to potential indirect loss of / or damage to the identified wetland area. This may potentially lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

» increased loss of soil;
» loss of/or disturbance to indigenous wetland vegetation;
» loss of sensitive wetland habitats;
» loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
» fragmentation of sensitive habitats;
» impairment of wetland function;
» change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
» reduction in water quality in wetlands downstream.

IDENTIFICATION OF POTENTIAL IMPACTS TO BE ASSESSED

The major risk factors (to the identified wetland) and contributing activities associated with the development are identified below before the impacts are assessed. These are not necessarily a reflection of the impacts that would occur, but rather a discussion on overall potential impacts and/or extent of these potential impacts that would occur if mitigation measures are not considered and/ or sensitive areas not avoided. The assessment of these impacts is outlined in Section 6.2.

» ***IMPACT 1***: *LOSS OF WETLAND VEGETATION AND WATER COURSES*
» ***IMPACT 2***: *IMPACT ON WETLAND & WATERCOURSE SYSTEMS THROUGH THE POSSIBLE INCREASE IN SURFACE WATER RUNOFF (VOLUME & VELOCITY)*
» ***IMPACT 3***: *INCREASE SEDIMENTATION AND EROSION*
» ***IMPACT 4***: *POTENTIAL IMPACT ON LOCALISED SURFACE WATER QUALITY*
» ***IMPACTS 5:*** *RECTION IN THE ABILITY TO ATTENUATED FLOODING.*
» ***IMPACT 6:*** *LOSS OF BUFFERING ABILITY TO PROTECT DOWNSTREAM HABITATS FROM THE ADVERSE EFFECTS CAUSED DURING EXTREME WEATHER EVENTS (EG. INCREASED FLOODING, SEVERE EROSION OR SEDIMENTATION)*

6.2 RISK ASSESSMENT

The impacts identified above are assessed according to the activities and aspects that may cause them. This is done for the construction and operation phase of the development.

<table>
<tr><td colspan="7"><u>Activities</u>: Site establishment and clearing of vegetation within proposed development footprint area.</td></tr>
<tr><td colspan="7"><u>Phase</u>: During the construction phase.</td></tr>
<tr><td colspan="7"><u>Environmental Aspect</u>: Removal of vegetation, compaction and disturbance of soils, creation of runoff zone, redistribution and concentration of runoff, stockpiling of construction material and topsoil storage, reduced buffering capacities of the landscapes during extreme weather events</td></tr>
<tr><td colspan="7"><u>Environmental impact</u> WITHIN DEVELOPMENT FOOTPRINT AREA: Loss of vegetation, loss of and alteration of microhabitats altered vegetation cover, possible invasion and settling of alien plant species, site specific altered distribution of rainfall and resultant runoff patterns, general increase in runoff from bare areas and associated accelerated erosion, reduction of habitat and resource availability for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. increased flooding, severe erosion or dust due to lower buffering capacity of sparser vegetation. <u>WITHIN WETLAND</u>: Increase in volume and velocity of surface water flow into wetlands, potential acceleration in erosion, loss of wetland vegetation & habitat, altered vegetation cover, increase in sediment load into wetland, reduced ability to attenuate flooding, possible contamination of surface as well as ground water with pollutants, loss of buffering ability to protect downstream habitats from the adverse effects caused during extreme weather events (eg. increased flooding, sever erosion or sedimentation)</td></tr>
<tr><th rowspan="2">Aspect</th><th colspan="4">Impact</th><th rowspan="2">Risk Rating</th><th rowspan="2">Borderline LOW MODERATE rating classes</th></tr>
<tr><th>Severity</th><th>Consequence</th><th>Likelihood</th><th>Significance</th></tr>
</table>

Removal or excessive damage to vegetation	1.25	6.25	8	50	**L**	N/A
Compaction of topsoil	1.5	5.5	6	33	**L**	N/A
Redistribution and concentration of runoff from hard/impenetrable surfaces	1.5	4.5	6	27	**L**	N/A
Redistribution and concentration of runoff from hard/impenetrable surfaces	1.5	3.5	6	21	**L**	N/A
Stockpiling of construction material and topsoil storage	1	3	7	21	**L**	N/A

Sight Specific Mitigation:

» No activities may be allowed outside of the development area, and especially within the identified wetland areas. These areas are regarded as no-go areas.
» Keep the clearing of natural and semi-natural grasslands to a minimum
» Aim to maintain vegetation where it will not interfere with the construction or operation of the development, rehabilitate an acceptable vegetation layer where possible (use only species that were part of the original indigenous species composition)
» Ensure that the buffer area around the wetland is maintained in suitable condition with a well-developed vegetation covering (roughage), regular monitoring of the buffer area should be done.
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» When topsoil is being stored, the topsoil heaps need to be continuously protected against loss of soil due to wind and water erosion,

- Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated (storm water and erosion management plan required)
- Ensure adequate drainage
- Monitor the area around the cleared areas regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation or soil erosion control efforts accordingly
- Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind
- Monitor the establishment of all invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Activities: Upgrading of existing access road, construction of smaller internal roads, maintenance of roads
Phase: During the construction and operation phase.
Environmental Aspect: Removal of vegetation, compaction and disturbance of topsoils, creation of runoff zone, redistribution and concentration of runoff, stockpiling of construction material and topsoil storage, alteration of soil surface properties
Environmental impact WITHIN DEVELOPMENT FOOTPRINT AREA: Loss of vegetation, compaction and disturbance of soils, increase in runoff and erosion, possible distribution of alien invasive plants, possible change of natural runoff and drainage patterns. **WITHIN WETLAND AREA:** Localised channeling and increase in velocity of surface water flow, potential acceleration of erosion, loss of wetland vegetation, increase in sediment & nutrient load into wetland, reduced ability to attenuate localised flooding, possible contamination of surface as well as ground water with pollutants, loss of buffering ability to protect downstream habitats from the adverse effects caused during extreme weather events (e.g. increased flooding, severe erosion or sedimentation)

Aspect	Impact				Risk Rating	Borderline LOW MODERATE rating classes
	Severity	Consequence	Likelihood	Significance		
Removal and/or disturbance to vegetation	1.25	3.25	5	16.25	L	N/A
Compaction of topsoil	1.5	3.5	5	17.5	L	N/A
Creation of runoff zones	1.5	3.5	5	21	L	
Redistribution and concentration of runoff from hard/impenetrable surfaces	1.5	3.5	5	21	L	N/A
Stockpiling of construction material and topsoil storage	1.25	3.25	7	16.25	L	N/A
Alteration of soil surface properties	1	3	11	15	L	

Sight Specific Mitigation:

- During construction: create designated turning areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
- Keep the clearing of natural and semi-natural grasslands to a minimum
- Where practical, phased development and vegetation clearing should be applied so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.
- If filling material is to be used, this should be sourced from areas free of invasive species
- Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil,

- When topsoil is being stored, the topsoil heaps need to be continuously protected against loss of soil due to wind and water erosion,
- Stored topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
- Topsoil heaps to be stored longer than a period of 6 months needs to be vegetated with and indigenous grass seed mix.
- Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas
- Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated
- Ensure adequate drainage
- Ensure that the buffer area around the wetland is maintained in suitable condition with a well-developed vegetation covering (roughage), regular monitoring of the buffer area should be done.
- Prevent leakage of oil or other chemicals or any other form of pollution
- Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
- Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
- All bare areas, as a result of the development, should be revegetated, where possible, with locally occurring species, to bind the soil and limit erosion potential.
- Roads should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring to assess the success of the remediation.
- Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
- Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary.
- Reduced activity at the site after large rainfall events when the soils are wet. No driving off of designated hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
- After decommissioning, if access road or portion thereof will not be of further use to the landowner, remove all foreign material and rip area to facilitate the establishment of vegetation, followed by a suitable revegetation program.

Activities: Establishment of infrastructure and the occupancy and operation thereof

Phase: During the construction and operation phase.

Environmental Aspect: Removal of vegetation, compaction and alteration of topsoils, creation of runoff zone, redistribution and concentration of runoff, sewage (ablution facilities), Storage and dispersing of fuels, hazardous chemicals and the storage and removal of hazardous wastes.

Environmental impact WITHIN DEVELOPMENT FOOTPRINT AREA: Loss of vegetation, compaction and disturbance of soils, increase in runoff and erosion, possible distribution of alien invasive plants, possible change of natural runoff and drainage patterns. **WITHIN WETLAND AREA:** Localised channeling and increase in velocity of surface water flow, potential acceleration of erosion, loss of wetland vegetation, increase in sediment & nutrient load into wetland, reduced ability to attenuate localised flooding, possible contamination of surface as well as ground water with pollutants, loss of buffering ability to protect downstream habitats from the adverse effects caused during extreme weather events (e.g. increased flooding, severe erosion or sedimentation)

Aspect	Impact				Risk Rating	Borderline LOW MODERATE rating classes
	Severity	Consequence	Likelihood	Significance		
Removal and/or disturbance to vegetation	1.5	3.5	5	17.5	L	N/A
Compaction of topsoil	1.5	3.5	5	17.5	L	N/A
Creation of runoff zones	1.5	3.5	5	17.5	L	N/A
Redistribution and concentration of runoff from hard/impenetrable surfaces	1.5	3.5	5	17.5	L	N/A

Sewage (Ablution facilitiies)	1.25	3.25	7	22.75	**L**	N/A
Storage of fuel, hazardous chemicals and hazardous waste products	1.25	3.25	11	35.75	**L**	N/A

Sight Specific Mitigation:

- Keep the clearing of natural and semi-natural grasslands to a minimum
- If filling material is to be used, this should be sourced from areas free of invasive species
- Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil,
- Stored topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
- Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated
- Use runoff controls such as berms, bunds, toe paddocks, drains, etc.) around residue facilities
- All solid waste must be adequately stored and disposed of.
- Prevent leakage of oil or other chemicals or any other form of pollution,
- Appropriate facilities must be provided for maintenance of toxic waste (e.g. used oils etc.) which must be taken off-site and disposed of in an appropriate manner
- Secondary containment where chemicals (hydrocarbons, fuels etc.) are stored;
- No dumping of waste is toe allowed on site.
- No ablution facilities may be placed within 200m from the wetland boundary,
- Avoid releasing untreated effluent.
- No servicing of vehicles must be permitted on site, unless for emergency purposes or a designated service bay has been approved (may not be placed within 200m from the wetland boundary),
- Ensure that wash areas are placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater are not polluted
- A Method of Statement is required for all wash areas where hydrocarbon, hazardous materials and pollutants are expected to be used. This includes, but is not limited to, vehicles washing, workshop wash bays, paint wash and cleaning

- Runoff from fuel depots/workshops/truck washing areas and concrete swills must be directed into a conservancy tank and disposed of at a site approved by the CM.
- The contaminated water, contaminated runoff, or effluent may also require analysis prior to disposal.
- Location of storage area must take into account prevailing winds, distance to water bodies and general on-site topography,
- Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
- All bare areas, as a result of the development, should be revegetated, where possible, with locally occurring species, to bind the soil and limit erosion potential.
- Ensure that structures like berms or silttraps are built to prevent soil from entering wetlands as this can result in sedimentation,
- Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary.

Activities: Mining (quarrying) for aggregate (including all activities associated with quarrying namely; Blasting, Excavation, Transporting of aggregate
Phase: During the operation phase.
Environmental Aspect: Alteration in catchment morphology, resulting in an alteration in surface / ground water flow, removal of or damage to vegetation, compaction and alteration of topsoils, presence of hydrocarbons and other hazardous chemicals, reduced buffering capacity of the landscape during extreme weather events.
Environmental impact WITHIN DEVELOPMENT FOOTPRINT: Loss of vegetation, loss of and alteration of microhabitats, site-specific altered distribution of rainfall and resultant runoff patterns, increase in concentrated runoff from specific localities, higher accelerated erosion, invasion with alien plants, reduction in habitat and resources available for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events (e.g. increased flooding, severe erosion or dust dust) due to lower buffering capacity of landscape. **WITHIN WETLAND**: Alteration in surface water flow into wetlands (flow pattern, frequency, amount & velocity) and subsequently also into channels and downstream, Alteration in groundwater flow, alteration in water quality (increase in sediment load, heavy metal contaminants & organic contaminants), suspended solids, loss of wetland vegetation, accelerated effects of erosion (locally and downstream), alien plant invasion, reduce ability of the wetland to buffer downstream habitats from the adverse effects extreme weather conditions

Aspect	Impact				Risk Rating	Borderline LOW MODERATE rating classes
	Severity	Consequence	Likelihood	Significance		
Alteration in catchment morphology, resulting in an alteration in surface / ground water flow, altered distribution of rainfall	1.75	5.75	13	74.75	**M**	L (downgrade to 55)
Removal of or damage to vegetation	1	6	7	42	**L**	N/A
Compaction of soils	1.5	3.5	7	24.5	**L**	N/A
Presence of hydrocarbons & other hazardous chemicals	1	3	7	21	**L**	N/A
Reduced buffering capacity of the landscape during extreme weather events	**1**	**7**	**7**	**49**	**L**	N/A

Sight Specific Mitigation:

- Create designated turning areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
- Keep the clearing of natural and semi-natural grasslands to a minimum
- If filling material is to be used, this should be sourced from areas free of invasive species
- Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil,
- When topsoil is being stored, the topsoil heaps need to be continuously protected against loss of soil due to wind and water erosion,
- Topsoil heaps to be stored longer than a period of 6 months needs to be vegetated with and indigenous grass seed mix.
- Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of

the track and surrounding areas

- Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated
- Ensure adequate drainage
- Where it is necessary to remove surface water from the quarry site; water must be pumped to a site where it will not negatively influence the natural environment through erosion of permanent flooding, possibly the non-perennial stream.
- To prevent a decrease in groundwater infiltration storm water (an road-surface run-off) should be redirected towards remaining wetland features to increase groundwater infiltration, thereby providing sufficient soil moisture to support wetland species (ensure that this water is slowed down, not channelized and spread out across the surface in order to prevent this water flow from causing erosion – where erosion signs are present prompt actions and measures should be taken to rehabilitate these areas and prevent erosion from occurring in these areas in the future),
- To prevent an increase in surface water flow velocity,
  - Ensure that an approved stormwater plant is compiled and implemented;
  - The diameters of stormwater pipes should be sufficiently large so as to not result in overly high flow velocities during rainfall events
  - The flow of stormwater onto the buffer and wetland features should be moderated.
- To prevent the contamination of the aquatic environment
  - The contractor must notify the CM and ECO immediately of any pollution incidents on site
  - Wash areas must be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater are not polluted
  - A Method of Statement is required for all wash areas where hydrocarbon, hazardous materials and pollutants are expected to be used. This includes, but is not limited to, vehichle washing, workshop wash bays, paint wash and cleaning
  - The contractor must prevent discharge of any pollutants, such as cement, concrete, lime chemicals and fuels into any water source
  - Runoff from fuel depots/workshops/truck washing areas and concrete swills must be directed into a conservancy tank and disposed of at a site approved by the CM.
  - The contaminated water, contaminated runoff, or effluent may also require analysis prior to disposal.

To prevent an increase in solid waste:

- All solid waste must be adequately stored and disposed of
- Ensure that structures like berms are built to prevent soil from entering wetlands as this can result in sedimentation,

- No dumping of waste is toe allowed on site.
- Littering and any dumping of waste must be discourage, especially within any wetland areas.

» Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

» Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.

» Ensure that structures like berms or silttraps are built to prevent soil from entering wetlands as this can result in sedimentation,

» Where practical, phased development and vegetation clearing should be applied so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.

» Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary.

Activities: Crushing and Stockpiling

Phase: During the operation phase.

Environmental Aspect: Stockpiling of aggregate, stockpiling of topsoil, compaction of soil, creation of runoff zone, redistribution and concentration of runoff

Environmental impact WITHIN DEVELOPMENT FOOTPRINT AREA: Site specific altered distribution of rainfall and resultant runoff patterns, increase in runoff from bare areas and associated accelerated erosion, establishment of alien invasive plants. **WITHIN WETLAND**: Increase sediment input, alteration in flow pattern, erosion

Aspect	Impact				Risk Rating	Borderline LOW MODERATE rating classes
	Severity	Consequence	Likelihood	Significance		
Stockpiling of aggregate	1.25	5.25	7	36.75	L	N/A

Stockpiling of topsoil	1.5	5.5	7	38.5	**L**	N/A
Compaction of soil	1.25	3.25	4	13	**L**	N/A
Creation of runoff zone	1.5	5.5	5	27.5	**L**	N/A
Redistribution and concentration of runoff	**1.5**	**5.5**	**5**	**27.5**	**L**	N/A

Sight Specific Mitigation:

- Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil,
- When topsoil is being stored, the topsoil heaps need to be continuously protected against loss of soil due to wind and water erosion,
- Topsoil heaps to be stored longer than a period of 6 months needs to be vegetated with and indigenous grass seed mix.
- Place topsoil stockpiles on a leveled area
- Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated
- Divert storm water around the topsoil heaps, stockpile areas and stockpiled aggregate
- Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
- Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
- Ensure that structures like berms or silttraps are built to prevent soil from entering wetlands as this can result in sedimentation,
- Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary.

7 DISCUSSION AND CONCLUSION

The wetland delineated covered and area of approximately 367.72ha and based on its hydro-geomorphic setting 2 HGM units occurred within the wetland system namely; Channelled Valley Bottom Wetland (~365ha) and Hillslope Seepage (~2.72ha). The wetland are comprise approximately 27% of the catchment area (~1329 ha). The stream/watercourse flowing through the wetland system is regarded as non-perennial (intermittent) as water flows for relative short periods of time of less than one season's duration, at intervals varying from less than a year to several years.

» **HGM unit 1:** This Channelled Valley Bottom Wetland is never/rarely inundated with the exception of isolated areas within the channel where pools of water are artificially retained for relative short periods of time. The bulk of the wetland is temporary saturated with some area, mostly fringing the channel, indicating signs of permanent saturation. Water inputs are mainly from surface flow resulting from flooding (over bank flow and lateral flow) as well as runoff from the surrounding valley slopes (including from the Hillslope Seep). Sub-surface flow contributes to a lesser extent to the total water input and output of the wetland. Water output is mainly through drainage, especially along the main channel.
» **HGM unit 2:** The Hillslope Seepage is never/rarely inundated with surface water. The largest portion of this wetland is temporary saturated with only a small portion being seasonally saturated. This HGM unit is connected to the channelled valley bottom wetland, however outflow is not contained within a channel but rather occur as diffuse surface flow. Due to this HGM unit's association with specific geological formations and due to its topographical position this unit is fed by rain-derived water, surface runoff seeping down-slope (as subsurface flows) as well as, although to a small extent, groundwater discharge.

The wetland soils encountered during the survey has signs of wetness within 50cm of the surface and both semi-permanent and seasonal wet soils have been identified. Signs of wetness include yellow and red high chroma mottles (iron oxide) and manganese concretions (black spots) situated within a depleted or reduced matrix (grey soil).

» The seasonally saturated zone associated with the fringes of the channel is characterised by the soil form **Katspruit**. This soil form has not undergone marked removal of colloidal mater (silicate clay), but has rather accumulated such matter. The G horizon is dominated by grey, low chroma colours (grey) and randomly patterned sesquioxide mottles.
» The seasonal saturated zone outside of the channel fringes and within the hillslope seepage is characterised by the soil form **Pindene**, which is

characterised by unconsolidated material with signs of wetness (mottles) underlying a yellow-brown apedal B horizon.

» The temporary saturated zone comprises of **Westleigh** soil form which contain a soft plinthic B horizon with indication of wetness (mottles).

Due to overgrazing and trampling the vegetation structure and coverage, especially within the temporary saturated zone have been greatly altered resulting in a short grassy cover (kept short through constant grazing) dominated by species such as *Paspalum notatum, P. dilatatum, P. urvillei, Cynodon dactylon, C. incompletes, Imperata cylindrical, Eragrostis plana, E. chloromelas* and *E. micrantha.* This altered vegetation form varies in terms of roughness (coverage) from relatively bare areas (to the west between the two channels) to moderately high coverage. Within the bare areas species such as *Aristida congesta* var. *barbicollis, A. junciformis*, *Tragus berteronianus* as well as *Trachypogon spicatus* may become prominent. This altered vegetation cover provide moderate protection against erosion especially in area where the vegetation has been severely grazed. Furthermore, this transformed vegetation cover has resulted in a reduced ability of the wetland to contain surface water flow and attenuate flooding. Numerous exotic and alien invasive plants were recorded within the focus area, especially within the temporary saturated zone and included the following:

Schkuhria pinnata, Xanthium spinosum (Category 1b), *Cirsium vulgare* (Category 1b), *Verbena bonarienses* (Category 1b), *Verbena aristigera, Gomphrena celosioides, Centella asiatica, Richardia brasiliensis, Solanum sisymbriifolium* (Category 1b), *Paspalum urvillei, Paspalum notatum, P. dilatatum* and *Cyperus esculentis*.

The only red data species noted was a small isolated population of ***Crinum bulbispermum*** which is classified as declining with the Red Data List.

Based on the results obtained during the assessment of the wetlands' ecological importance and sensitivity the following conclusion can be drawn:

» **Ecosystem goods and services provided by the wetland:**

Based on a rapid level assessment of wetland goods and services for the HGM units, both HGM systems provide indirect benefits such as flood attenuation, sediment trapping and nutrient (Phosphate and Nitrate)/toxicant removal to a moderate/low moderate level. This is mainly due to the effects of trampling, overgrazing and erosion which have altered some of the wetland geomorphology and vegetation cover, resulting in some loss of these services. Key direct human benefits provided by the wetland to a moderate degree include cultivated food, harvestable natural resources. Food for livestock can be regarded as moderate to low-moderate mainly due to overgrazing which as replaces some palatable species with less palatable species and the fact a large portion of the biomass is being kept to a minimum (grasses being grazed short and maintained in such a state) due to constant applied grazing pressure. Biodiversity maintenance is generally low to low-moderate due to constant disturbances and the level of habitat transformation. The wetland is also not considered suitable for tourism/recreation with a rather low education/research value due to the degraded state.

» **Ecosystem heath and present ecological status:**

According to the Wet-Health model the following comments can be derived regarding the condition of the HGM units:

- HGM unit 1: Channelled Valley Bottom Wetland

  Hydrology:
  - According to the model the hydrological character can be described as largely modified but is expected to stay relative stable within the next 5 years.
  - Due to catchment disturbances including: cultivation, culvert obstructions and channel modifications it is expected that a slight reduction in flow (water input has occurred), however due to vegetation removal, severe erosion, increase in bare areas and hard surfaces upstream (within the headwaters) it is expected that flood peaks have been increased moderately, often resulting in a noticeable reduction in sub-surface water inputs.
  - Human activities within the wetland system have also greatly altered the hydrological character of the wetland system. These activities include server overgrazing and trampling, historical cultivation, dam construction (small farm dam located to the north-west of the wetland) and water obstructions (culverts and crossing points). These activities has resulted in impacts severely altering the hydrology of the wetland by reducing the ability to attenuate, hold and spread out rain water, runoff and flood water (especially within the channel). These impacts include:
  - Erosion within the wetland area in the form of shallow gully, sheet and rill erosion
  - Modifications to the existing channel through channel straightening (lesser extent), widening (bank erosion) and deepening (bed erosion). These modifications have a serious impact but some overtopping (overbank flow) may still occur, although much less frequently than was the case naturally.
  - A reduction of roughage (vegetation)

- Impeding features upstream as well as downstream such culverts and areas filled up with gravel to create areas to cross the wetland (for humans as well as cattle). This has created areas immediately upstream which are inundated for longer periods of time (pools within the channel) as well as larger seasonal zones.

Geomorphic:

- According to the model the Geomorphological character can be described as mostly natural with few modifications but is expected to decrease within the next 5 years.
- Upstream little modification has occurred due to the construction of dams, stream diversion/shortening and infilling.
- Most of the modifications within the wetland are due to an increased in flooding and runoff from the surrounding slopes, which is indirectly a result of a decrease in roughage and the presence of numerous erosion features, especially within the channel, which has been greatly altered.

Vegetation:

- According to the model the vegetation character can be described as moderately modified but the situation is expected to decrease within the next 5 years.
- Most of the vegetation alteration within the wetland area is due to erosion and overgrazing and trampling.
- Overgrazing and trampling has systematically resulted in the transformation of the vegetation composition replacing most of the vegetation with more grazing resilient species and has resulted in a reduction in roughage especially within the temporary saturated zone with some bare patches, especially to the west of the wetland.

- HGM unit 2: Hillslope Seepage Wetland

Hydrology:

- According to the model the hydrological character can be described as mostly unmodified to near natural with very slight alterations. This situation is expected to stay relative stable within the next 5 years.
- Due to some disturbance within the catchment, which includes the quarry, a slight reduction in terms of flow (water input) has occurred. Furthermore, flood patterns have likely not been altered.
- Water retention, attenuation and dispersal within the wetland itself have however been altered. Overgrazing resulting in a decrease in roughage and relative low to moderate levels of erosion (small and

shallow gully just below the seasonal saturated zone and stabilised sheet erosion to the south and north-west) are the main causes of these alterations resulting in surface water and runoff attenuated weakly with water retained for very short periods of time within the wetland.

- Most of the water is lost to the valley bottom wetland.
- Although as mentioned, erosion is present within the seep, most of the areas have been stabilised with vegetation and subsequently most of these eroded area do not pose a threat level to the extent of which the erosion in the valley bottom wetland pose.

Geomorphic:

- According to the model the geomorphic character can be described as unmodified to near natural with very slight alterations. This situation is expected to stay relative stable within the next 5 years.
- The only geomorphic alterations within the wetland are, as mentioned, the eroded areas.
- Most of the eroded area have been stabilised by vegetation (sheet erosion), there is however a small gully, still in its initial stage, present just below the seasonal zone, which may develop over time.

Vegetation:

- According to the model the vegetation character can be described as moderately modified but the situation is expected to decrease within the next 5 years.
- Most of the vegetation alteration within the wetland area is due to overgrazing.
- Overgrazing has systematically resulted in the transformation of the vegetation composition replacing most of the vegetation with more grazing resilient species and has resulted in a reduction in roughage especially within the temporary saturated zone.

» **Ecological Importance and Sensitivity (EIS):**

Based on the PES and importance of the wetland in terms of wetland goods and services, the EIS of the wetland was rated using the tool by Rountree (in prep). Both HGM units have obtained an estimated **Low to Moderate** EIS rating. The HGM units are considered to be of **Low-Medium** ecological importance and are Low-Medium importance from a hydrological/functional perspective (as reflected in the WET-Ecoservices assessment). From a direct-use perspective the wetland are not considered important, with the only direct use observed being livestock grazing which also take place across the terrestrial environment.

The 'Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries' (Macfarlane et al., 2014) was considered for the determine the buffer zones for the HGM units found within the project boundary. This tool was used as a guideline for the buffer widths recommended in this report. The results from this tool suggest that, a **50m** buffer may be used on the wetland system. It is however recommended that this buffer area is increased to **70m** (refer to Figure 24) as this tool does not take into consideration the condition of the terrestrial vegetation comprising the buffer area.

Based on the results obtained during the assessment potential impacts and the potential risk they pose to the wetland (Risk Assessment) the following conclusions can be drawn:

Construction and operation may lead to potential indirect loss of / or damage to the identified wetland area. This may potentially lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

- increased loss of soil;
- loss of/or disturbance to indigenous wetland vegetation;
- loss of sensitive wetland habitats;
- loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- fragmentation of sensitive habitats;
- impairment of wetland function;
- change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- reduction in water quality in wetlands downstream.

The potential impacts that have been identified include:

- **Impact 1:** Loss of wetland and watercourse vegetation
- **Impact 2:** Impact on wetland and watercourse systems through the possible increase in surface water runoff (volume and velocity)
- **Impact 3:** Potential impact on localised surface water quality
- **Impact 4:** Increase in sedimentation and erosion
- **Impact 5:** Reduction in the ability to attenuated flooding

» **Impact 6:** Loss of buffering ability to protect downstream habitats from the adverse effects caused during extreme weather events (e.g. increase flooding, severe erosion or sedimentation)

» The proposed footprint area for the quarry is located almost more than 170m from the outer boundary of the Hillslope Seepage. Due to the distance from the wetland and the nature of the development (small scale operation) most of the impacts are unlikely and with effective and diligent mitigation measures in place the likelihood in significance of these impact can be lowered even more.
» Probably the most significant impact would be a slight change in the wetlands water input due to a change in the catchment area. This is mostly applicable for the hillslope seepage as most of its water inputs are from rain-derived water and surface runoff from the higher lying areas. The channelled valley bottom wetland will likely be very slightly affected by this impact as some water is obtained as outflow from the hillslope seepage. Flooding pattern may decrease or most likely increase locally due to changes in this higher lying area (development footprint area) such as; increase in runoff from compacted or sealed surfaces, removal of roughage (vegetation), compaction and alteration of topsoils, accumulation and channelisation of storm water.
» As erosion is already present within the wetland areas this is also a potential risk and may increase in severity or new areas may become prone to erosion due to the increase in surface water flow (velocity) and the channeling of storm water runoff from the mining area. This impact can also be effectively avoided and managed by maintaining a well-developed and near-natural vegetation layer downslope of the mining area and especially within the buffer areas allocated for the wetland. Furthermore, a sufficient and effective storm water management plan should be put in place.
» An increase in sediment load is also a possible impact as bare areas and stockpiled area (within the mining boundary) may be prone to erosion which may lead to suspended soil particles carried down-slope into the wetland areas during rainfall events. This impact can also be effectively mitigated.

The impacts identified above were assessed according to the Risk Assessment Matrix and the results can be summarised as follow:

Activity	Phase	Environmental Aspect:	Risk Rating	Borderline LOW MODERATE rating classes

Site establishment and clearing of vegetation within proposed development footprint area.	During the construction phase.	Removal or excessive damage to vegetation	**L**	N/A
		Compaction of topsoil	**L**	N/A
		Redistribution and concentration of runoff from hard/impenetrable surfaces	**L**	N/A
		Redistribution and concentration of runoff from hard/impenetrable surfaces	**L**	N/A
		Stockpiling of construction material and topsoil storage	**L**	N/A
Upgrading of existing access road, construction of smaller internal roads, maintenance of roads	During the construction and operation phase.	Removal and/or disturbance to vegetation	**L**	N/A
		Compaction of topsoil	**L**	N/A
		Creation of runoff zones	**L**	N/A
		Redistribution and concentration of runoff from hard/impenetrable surfaces	**L**	N/A
		Stockpiling of construction material and topsoil storage	**L**	N/A
		Alteration of soil surface properties	**L**	N/A
Establishment of infrastructure and the occupancy and operation thereof	During the construction and operation phase.	Removal and/or disturbance to vegetation	**L**	N/A
		Compaction of topsoil	**L**	N/A
		Creation of runoff zones	**L**	N/A
		Redistribution and concentration of runoff from hard/impenetrable surfaces	**L**	N/A
		Sewage (Ablution facilitiies)	**L**	N/A
		Storage of fuel, hazardous chemicals and hazardous waste products	**L**	N/A
Mining (quarrying) for	During the operation	Alteration in catchment morphology, resulting in an	**M**	L (downgrade to 55)

aggregate (including all activities associated with quarrying namely; Blasting, Excavation, Transporting of aggregate	phase.	alteration in surface / ground water flow, altered distribution of rainfall		
		Removal of or damage to vegetation	**L**	N/A
		Compaction of soils	**L**	N/A
		Presence of hydrocarbons & other hazardous chemicals	**L**	N/A
		Reduced buffering capacity of the landscape during extreme weather events	**L**	N/A
Crushing and Stockpiling	During the operation phase	Stockpiling of aggregate	**L**	N/A
		Stockpiling of topsoil	**L**	N/A
		Compaction of soil	**L**	N/A
		Creation of runoff zone	**L**	N/A
		Redistribution and concentration of runoff	**L**	N/A

As mentioned, probably the most significant impact as an alteration in water inputs into the wetland (Alteration in surface water flow into wetlands due to a change in flow pattern, frequency, amount & velocity) due to a modification of the catchment area. The risk for this impact was listed as moderate (total of 74.75) but have been downgraded to a Risk Total of 55 (Low Risk) due to the fact that this impact can be sufficiently mitigated and subsequently avoiding any adverse effects such as erosion, sedimentation etc. within the wetland area. Such additional mitigation measures include:

» Keep the clearing of natural and semi-natural grasslands to a minimum
» When topsoil is being stored, the topsoil heaps need to be continuously protected against loss of soil due to wind and water erosion,
» Topsoil heaps to be stored longer than a period of 6 months needs to be vegetated with and indigenous grass seed mix.
» Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas
» Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated

» Ensure adequate drainage
» Where it is necessary to remove surface water from the quarry site; water must be pumped to a site where it will not negatively influence the natural environment through erosion of permanent flooding, possibly the non-perennial stream.
» To prevent a decrease in groundwater infiltration storm water (an road-surface run-off) should be redirected towards remaining wetland features to increase groundwater infiltration, thereby providing sufficient soil moisture to support wetland species (ensure that this water is slowed down, not channelized and spread out across the surface in order to prevent this water flow from causing erosion – where erosion signs are present prompt actions and measures should be taken to rehabilitate these areas and prevent erosion from occurring in these areas in the future),
» To prevent an increase in surface water flow velocity,
  - Ensure that an approved stormwater plant is compiled and implemented;
  - The diameters of stormwater pipes should be sufficiently large so as to not result in overly high flow velocities during rainfall events
  - The flow of stormwater onto the buffer and wetland features should be moderated.
» Ensure that the vegetation cover (roughage) located outside of the mining area (down-slope) is maintained in a good condition, especially within the allocated wetland buffers.
» To prevent the contamination of the aquatic environment
  - The contractor must notify the CM and ECO immediately of any pollution incidents on site
  - Wash areas must be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater are not polluted
  - A Method of Statement is required for all wash areas where hydrocarbon, hazardous materials and pollutants are expected to be used. This includes, but is not limited to, vehichle washing, workshop wash bays, paint wash and cleaning
  - The contractor must prevent discharge of any pollutants, such as cement, concrete, lime chemicals and fuels into any water source
  - Runoff from fuel depots/workshops/truck washing areas and concrete swills must be directed into a conservancy tank and disposed of at a site approved by the CM.
  - The contaminated water, contaminated runoff, or effluent may also require analysis prior to disposal.

To prevent an increase in solid waste:
  - All solid waste must be adequately stored and disposed of
  - Ensure that structures like berms are built to prevent soil from entering wetlands as this can result in sedimentation.

From the Specialist Wetland Assessment no objections or motives for the project not to be allowed, could be determined, and thus may occur within the proposed development boundaries.

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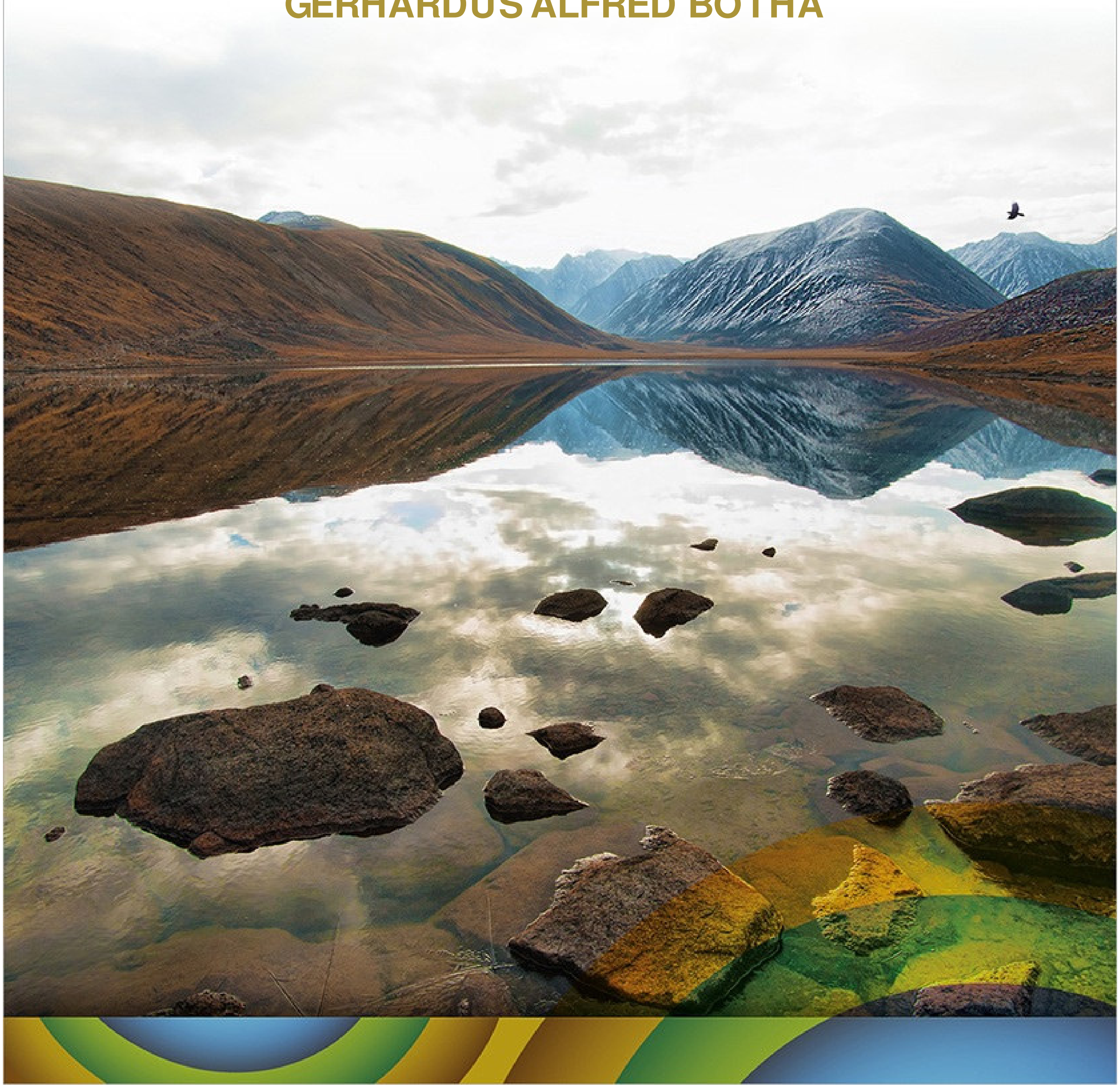
International Importance. Ramsar handbooks for the wise use of wetlands. 3rd Edition. Volume 14. Ramsar Convention Secretariat, Gland, Switzerland.

Nkurenkuru
ECOLOGY & BIODIVERSITY
SACNASP REG: 400502/14

CURRICULUM VITAE

GERHARDUS ALFRED BOTHA



CURRICULUM VITAE:

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
Postal Address	:	PO Box 12500 Brandhof 9324
Residential Address	:	3 Jock Meiring Street Park West Bloemfontein 9301
Cell Phone Number	:	084 207 3454
Email Address	:	gabotha11@gmail.com
Profession/Specialisation	:	Ecological and Biodiversity Consultant
Nationality:	:	South African
Years Experience:	:	8
Bilingualism	:	Very good – English and Afrikaans

Professional Profile:

Gerhard is a Managing Director of Nkurenkuru Ecology and Biodiversity (Pty) Ltd. He has a BSc Honours degree in Botany from the University of the Free State Province and is currently completing a MSc Degree in Botany. He began working as an environmental specialist in 2010 and has since gained extensive experience in conducting ecological and biodiversity assessments in various development field, especially in the fields of conventional as well as renewable energy generation, mining and infrastructure development. Gerhard is a registered Professional Natural Scientist (Pr. Sci. Nat.)

Key Responsibilities:

Specific responsibilities as an Ecological and Biodiversity Specialist include, inter alia, professional execution of specialist consulting services (including flora, wetland and fauna studies, where required), impact assessment reporting, walk through surveys/ground-truthing to inform final design, compilation of management plans, compliance monitoring and audit reporting, in-house ecological awareness training to on-site personnel, and the development of project proposals for procuring new work/projects.

Skills Base and Core Competencies

- Research Project Management
- Botanical researcher in projects involving the description of terrestrial and coastal ecosystems.
- Broad expertise in the ecology and conservation of grasslands, savannahs, karroid wetland and aquatic ecosystems.
- Ecological and Biodiversity assessments for developmental purposes (BAR, EIA), with extensive knowledge and experience in the renewable energy field (Refer to Work Experiences and References)
- Over 3 years of avifaunal monitoring and assessment experience.
- Mapping and Infield delineation of wetlands, riparian zones and aquatic habitats (according to methods stipulated by DWA, 2008) within various South African provinces of KwaZulu-Natal, Mpumalanga, Free State, Gauteng and Northern Cape Province for inventory and management purposes.
- Wetland and aquatic buffer allocations according to industry best practice guidelines.
- Working knowledge of environmental planning policies, regulatory frameworks and legislation
- Identification and assessment of potential environmental impacts and benefits.
- Assessment of various wetland ecosystems to highlight potential impacts, within current and proposed landscape settings, and recommend appropriate mitigation and offsets based on assessing wetland ecosystem service delivery (functions) and ecological health/integrity.
- Development of practical and achievable mitigation measures and

management plans and evaluation of risk to execution

- Qualitative and Quantitative Research
- Experienced in field research and monitoring
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa and include a number of projects located in sensitive and ecological unique regions.

Education and Professional Status

Degrees:

- *2015:* Currently completing a M.Sc. degree in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2009:* B.Sc. Hons in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2008:* B.Sc. in Zoology and Botany, University of the Free State, University of the Free State, Bloemfontein, RSA.

Courses:

- *2013*: Wetland Management (ecology, hydrology, biodiversity and delineation) – University of the Free State accredited course.
- *2014*: Introduction to GIS and GPS (Code: GISA 1500S) – University of the Free State accredited course.

Professional Society Affiliations:

- The South African Council of Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400502/14 (Botany and Ecology).

Employment History

- December 2017 – Current: Nkurenkuru Ecology and Biodiversity (Pty) Ltd
- 2016 – November 2017: ECO-CARE Consultancy
- *2015 - 2016*: Ecologist, Savannah Environmental (Pty) Ltd
- *2013 – 2014*: Working as ecologist on a freelance basis, involved in part-time and contractual positions for the following companies
  - Enviroworks (Pty) Ltd
  - GreenMined (Pty) Ltd
  - Eco-Care Consultancy (Pty) Ltd

- Enviro-Niche Consulting (Pty) Ltd
- Savannah Environmental (Pty) Ltd
- Esicongweni Environmental Services (EES) cc

- *2010 - 2012*: Enviroworks (Pty) Ltd

Publications

Publications:

- Botha, G.A. & Du Preez, P.J. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. S. *Afr. J. Bot*., **98**: 172-173 .

Congress papers/posters/presentations:

- Botha, G.A. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. 41st Annual Congress of South African Association of Botanists (SAAB). Tshipise, 11-15 Jan. 2015.
- Botha, G.A. 2014. A description of the vegetation of the Nxamasere floodplain, Okavango Delta, Botswana. 10st Annual University of Johannesburg (UJ) Postgraduate Botany Symposium. Johannesburg, 28 Oct. 2014.

Other

- Guest speaker at IAIAsa Free State Branch Event (29 March 2017)
- Guest speaker at the University of the Free State Province: Department of Plant Sciences (3 March 2017):

References:

- Christine Fouché
  Manager: GreenMined (Pty) LTD
  Cell: 084 663 2399
- Professor J du Preez
  Senior lecturer: Department of Plant Sciences
  University of the Free State
  Cell: 082 376 4404

WORK EXPERIENCES

&

References

Gerhard Botha

ECOLOGICAL RELATED STUDIES AND SURVEYS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Ecological Assessment (Basic Assessment)	Moeding Solar
2019	Expansion of the Raumix Aliwal North Quarry, Eastern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	GreenMined
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Faunal and Flora Rescue and Protection Plan	Zevobuzz
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Zevobuzz
2018	Proposed Kruisvallei Hydroelectric Power Generation Scheme in the Ash River, Free State Province	Ecological Assessment (Basic Assessment)	Zevobuzz
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Ecological Assessment (Basic Assessment)	Eskom
2018	Clayville Thermal Plant within the Clayville Industrial Area, Gauteng Province	Ecological Comments Letter	Savannah Environmental

2018	Iziduli Emoyeni Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Emoyeni Wid Farm Renewable Energy
2018	Msenge Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Amakhala Emoyeni Renewable Energy
2017	H2 Energy Power Station near Kwamhlanga, Mpumalanga Province	Ecological Assessment (Scoping and EIA phase assessments)	Eskom
2017	Karusa Wind Farm (Phase 1 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	Soetwater Wind Farm (Phase 2 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Ecological Assessment	Savannah Environmental
2016 - 2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Ecological Assessment (Scoping and EIA phase assessments)	Cresco
2016	Buffels Solar 2 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	Buffels Solar 1 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	132kV Power Line and On-Site Substation for the Authorised Golden Valley II Wind Energy Facility near Bedford, Eastern Cape Province	Ecological Assessment (Basic Assessment)	Terra Wind Energy
2016	Kalahari CSP Facility: 132kV Ferrum–Kalahari–UNTU & 132kV Kathu IPP–Kathu 1 Overhead Power Lines, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Kalahari CSP Facility: Access Roads, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Karoshoek Solar Valley Development – Additional CSP Facility including tower infrastructure associated with authorised CSP Site 2 near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 7 and 8 Facilities near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 9 Facility near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Lehae Training Academy and Fire Station, Gauteng Province	Ecological Assessment	Savannah Environmental
2016	Metal Industrial Cluster and Associated Infrastructure near Kuruman, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Northern Cape Department of Economic Development and Tourism
2016	Semonkong Wind Energy Facility near Semonkong, Maseru District, Lesotho	Ecological Pre-Feasibility Study	Savannah Environmental

2015 - 2016	Orkney Solar PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015 - 2016	Woodhouse 1 and Woodhouse 2 PV Facilities near Vryburg, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Expansion of the existing Komsberg Main Transmission Substation near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Proposed Karusa Facility Substation and Ancillaries near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Eskom Karusa Switching Station and 132kV Double Circuit Overhead Power Line near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Karusa Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Facility Substation, 132kV Overhead Power Line and Ancillaries, near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley

2015	Soetwater Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Expansion of the existing Scottburgh quarry near Amandawe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2015	Expansion of the existing AFRIMAT quarry near Hluhluwe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2014	Tshepong 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Transalloys circulating fluidised bed power station near Emalahleni, Mpumalanga Province	Ecological Assessment (for EIA)	Trans-Alloys
2014	Umbani circulating fluidised bed power station near Kriel, Mpumalanga Province	Ecological Assessment (Scoping and EIA)	Eskom
2014	Gihon 75MW Solar Farm: Bela-Bela, Limpopo Province	Ecological Assessment (for EIA)	NETWORX Renewables
2014	Steelpoort Integration Project & Steelpoort to Wolwekraal 400kV Power Line	Fauna and Flora Pre-Construction Walk-Through Assessment	Eskom
2014	Audit of protected *Acacia erioloba* trees within the Assmang Wrenchville housing development footprint area	Botanical Audit	Eco-Care Consultancy
2014	Rehabilitation of the N1 National Road between Sydenham and Glen Lyon	Peer review of ecological report	EKO Environmental
2014	Rehabilitation of the N6 National Road between Onze Rust and Bloemfontein	Peer review of ecological report	EKO Environmental
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfotnein	Vegetation Rehabilitation Plan	EnviroWorks
2011	Rocks Farm chicken broiler houses	Botanical Assessment (for EIA)	EnviroWorks
2011	Botshabelo 132 kV line	Ecological Assessment (for EIA)	CENTLEC
2011	De Aar Freight Transport Hub	Ecological Scoping and Feasibility Study	EnviroWorks
2011	Proposed establishment of the Tugela Ridge Eco Estate on the farm Kruisfontein, Bergville	Ecological Assessment (for EIA)	EnviroWorks
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Vegetation Rehabilitation Plan for illegally cleared areas	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Invasive Plant Management Plan	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Protected and Endangered Species Walk-Through Survey	NEOTEL
2011	Optic Fibre Infrastructure Network, Swartland Municipality	Botanical Assessment (for EIA) - Assisted Dr Dave McDonald	Dark Fibre Africa
2011	Optic Fibre Infrastructure Network, City of Cape Town Municipality	Botanical Assessment (for EIA) - Assisted Dr Dave McDonald	Dark Fibre Africa
2010	Construction of an icon at the southernmost tip of Africa, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	New boardwalk from Suiderstrand Gravel Road to Rasperpunt, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS

2010	Farm development for academic purposes (Maluti FET College) on the Farm Rosedale 107, Harrismith	Ecological Assessment (Screening and Feasibility Study)	Agri Development Solutions
2010	Basic Assessment: Barcelona 88/11kV substation and 88kV loop-in lines	Botanical Assessment (for EIA)	Eskom Distribution
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfotnein	Vegetation Rehabilitation Plan	EnviroWorks

WETLAND DELINEATION AND HYDROLOGICAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
In progress	Steynsrus PV 1 & 2 Solar Energy Facilities near Steynsrus, Free State Province	Wetland Assessment	Cronimet Mining Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Wetland Assessment (Basic Assessment)	Moeding Solar
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Wetland Assessment (Basic Assessment	Zevobuzz
2017	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Surface Hydrological Assessment (Basic Assessment)	Eskom
2017	Expansion of the Elandspruit Quarry near Ladysmith, KwaZulu-Natal Province	Wetland Assessment	Raumix
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Aquatic Assessment & Flood Plain Delineation	Savannah Environmental
2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Surface Hydrological Assessment (EIA phase)	Cresco
2016	Wolmaransstad Municipality 75MW PV Solar Energy Facility in the North West Province	Wetland Assessment (Basic Assessment)	BlueWave Capital
2016	BlueWave 75MW PV Plant near Welkom Free State Province	Wetland Delineation	BlueWave Capital
2016	Harmony Solar Energy Facilities: Amendment of Pipeline and Overhead Power Line Route	Wetland Assessment (Basic Assessment)	BBEnergy

AVIFAUNAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Avifauna Assessment (Basic Assessment)	Moeding Solar
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Avifauna Assessment (Basic Assessment)	Eskom
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Avifauna Assessment (Basic Assessment)	Eskom
2016	TEWA Solar 1 Facility, east of Upington, Northern Cape Province	Wetland Assessment (Basic Assessment	Tewa Isitha Solar 1
2016	TEWA Solar 2 Facility, east of Upington, Northern Cape Province	Wetland Assessment	Tewa Isitha Solar 2

ENVIRONMENTAL IMPACT ASSESSMENT

- Barcelona 88/11kV substation and 88kV loop-in lines – BA (for Eskom).
- Thabong Bulk 132kV sub-transmission inter-connector line – EIA (for Eskom).
- Groenwater 45 000 unit chicken broiler farm – BA (for Areemeng Mmogo Cooperative).
- Optic Fibre Infrastructure Network, City of Cape Town Municipality – BA (for Dark Fibre Africa (Pty) Ltd).
- Optic Fibre Infrastructure Network, Swartland Municipality – BA (for Dark Fibre Africa).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – EMP (for Eskom).
- Lower Kruisvallei Hydroelectric Power Scheme (Ash river) – EIA (for Kruisvallei Hydro (Pty) Ltd).
- Construction of egg hatchery and associated infrastructure – BA (For Supreme Poultry).
- Construction of the Klipplaatdrif flow gauging (Vaal river) – EMP (DWAF).

ENVIRONMENTAL COMPLIANCE AUDITING AND ECO

- National long haul optic fibre infrastructure network project, Bloemfontein to

Laingsburg – ECO (for Enviroworks (Pty) Ltd.).

- National long haul optic fibre infrastructure network project, Wolmaransstad to Klerksdorp – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the Vredefort/Nooitgedacht 11kV power line – ECO (for Enviroworks (Pty) Ltd.).
- Mining of Dolerite (Stone Aggregate) by Raumix (Pty) Ltd. on a portion of Portion 0 of the farm Hillside 2830, Bloemfontein – ECO (for GreenMined Environmental (Pty) Ltd.).
- Construction of an Egg Production Facility by Bainsvlei Poultry (Pty) Ltd on Portions 9 & 10 of the farm, Mooivlakte, Bloemfontein – ECO (for Enviro-Niche Consulting (Pty) Ltd.).
- Environmental compliance audit and botanical account of Afrisam's premises in Bloemfontein – Environmental Compliance Auditing (for Enviroworks (Pty) Ltd.).

OTHER PROJECTS:

- Keeping and breeding of lions (*Panthera leo*) on the farm Maxico 135, Ficksburg – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of lions (*Panthera leo*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of wild dogs (*Lycaon pictus*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Existing underground and aboveground fuel storage tanks, TWK AGRI: Pongola – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Erf 171, TWK AGRI: Amsterdam – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 14 000 L of fuel (diesel) aboveground on Erf 32, TWK AGRI: Carolina – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 23 000 L of fuel (diesel) above ground on Portion 10 of the Farm Oude Bosch, Humansdorp – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 16 000 L of fuel (diesel) aboveground at Panbult Depot –

Environmental Management Plan (for TWK Agricultural Ltd).

- Existing underground fuel storage tanks, TWK AGRI: Mechanisation and Engineering, Piet Retief – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Portion 38 of the Farm Lothair, TWK AGRI: Lothair – Environmental Management Plan (for TWK Agricultural Ltd).