WATERCOURSE ASSESSMENT

FOR THE PROPOSED EXPANSION OF WOODBURN SHOPPING CENTRE IN PIETERMARITZBURG, MSUNDUZI LOCAL MUNICIPALITY, UMGUNGUNDLOVU DISTRICT, KWA-ZULU NATAL

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DRAFT REPORT

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GLOSSARY

Bar: accumulations of sediment associated with the channel margins or bars forming in meandering rivers where erosion is occurring on the opposite bank to the bar.

Biodiversity: the number and variety of living organisms on earth, the millions of plants, animals, and micro-organisms, the genes they contain, the evolutionary history and potential they encompass, and the ecosystems, ecological processes, and landscapes of which they are integral parts.

Catchment: the area contributing to runoff at a particular point in a river system.

Channel section: a length of river bounded by the banks and the bed.

Delineation (of a wetland or riparian zone): to determine the boundary of a water resource (wetland or riparian area) based on soil and vegetation (wetland) or geomorphological and vegetation (riparian zone) indicators.

Ecosystem Goods and Services: The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota.

Erosion: is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations. While erosion is a natural process, human activities have dramatically increased the rate at which erosion is occurring globally. Erosion gullies are erosive channels formed by the action of concentrated surface runoff.

General Authorisation: is an authorization to use water without a license, provided that the water use is within the limits and conditions set out in the General Authorisation.

Gleying: a soil process resulting from prolonged soil saturation, which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.

Groundwater: subsurface water in the saturated zone below the water table. Habitat: the natural home of species of plants or animals.

High terrace: relict floodplains which have been raised above the level regularly inundated by flooding due to lowering of the river channel (rarely inundated).

Hue (of colour): the dominant spectral colour (e.g. red).

Hydromorphic soil: a soil that, in its undrained condition, is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).

Hydrology: the study of the occurrence, distribution and movement of water over, on and under the land surface.

Hydrophyte: any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.

Invasive alien species: Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.

Mottles: soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.

Munsell colour chart: a standardized colour chart, which can be used to describe hue (i.e. its relation to red, yellow, green, blue and purple), value (i.e. its lightness) and chroma (i.e. its 10 10 purity).Munsell colour charts are available which show that portion commonly associated with soils, which is about one fifth of the entire range.

NEMA: National Environmental Management Act, Act 107 of 1998.

Obligate species: species almost always found in wetlands (> 99% of occurrences).

Redoximorphic soil features: physic-chemical changes in the soil due to (1) in the case of gleying, a change from an oxidizing (aerated) to reducing (saturated, anaerobic) environment; or (2) in the case of mottling, due to switching between reducing and oxidizing conditions (especially in seasonally waterlogged wetland soils).

Riparian habitat (as defined by the National Water Act): includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils (deposited by the current river system), and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Saturation zone: the zone in which the soils and rock structure are saturated with water.

Scree Pan: a collection of rocks and coarse debris that accumulates at the foot of a steep slope.

Seasonal zone of wetness: the zone of a wetland that lies between the Temporary and Permanent zones and is characterized by saturation for three to ten months of the year, within 50cm of the surface.

Sedges: grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.

Soil horizons: layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bounded by air, hard rock or other horizons (i.e. soil material that has different characteristics).

Soil profile: the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons.

Temporary zone of wetness: the outer zone of a wetland characterized by saturation within 50cm of the soil surface for less than three months of the year.

Terrace: area raised above the level regularly inundated by flooding (infrequently inundated).

Acronyms

CVB	Channeled Valley Bottom
DWS	Department of Water & Sanitation
DWAF	Department of Water Affairs & Forestry
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIS	Ecological Importance & Sensitivity
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographical Information Systems
HGM	Hydro-Geomorphic
IAPs	Invasive Alien Plants
PES	Present Ecological State
NFEPA	National Freshwater Ecosystem Priority Areas

Table of Contents

Tables

Figures

Annexures

ANNEXURE A	Classification Structure for Inland Systems up to Level 4
ANNEXURE B	Wetland and Soil Classification Field Datasheet Example
ANNEXURE C	Steps for Riparian Delineation
ANNEXURE D	Wetland Vegetation Mix

Specialist Details & Declaration

This report has been prepared in accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 327 Environmental Impact Assessment Regulations and the National Environmental Management Act (NEMA, No. 107 of 1998 as amended 2017). It has been prepared independently of influence or prejudice by any parties. A full declaration of independence has been provided in Annexure F. The details of Specialists are as follows –

Table 1 Details of Specialist

Specialist	Task	Qualification and accreditation	Client	Signature
Bruce Scott-Shaw NatureStamp	Fieldwork, Assessments & report	PhD, Hydrology	Joleen Wilson	Date: 25/08/2022
Nick Davis Isikhungusethu Environmental Services	Design, GIS & Review	BSc, BSc Hon, MSc Hydrology	Joleen Wilson	Date: 29/08/2022

Details of Authors:
Bruce is a hydrologist, whose focus is broadly on hydrological perspectives of land use management and climate change. He completed his MSc under Prof. Roland Schulze in the School of Bioresources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, South Africa. Throughout his university career he mastered numerous models and tools relating to hydrology, soil science and GIS. Some of these include ACRU, SWAT, ArcMap, Idrisi, HEC-RAS, WRSM, SEBAL, MatLab and Loggernet. He has some basic programming skills on the Java and CR Basic platforms. Bruce completed his PhD at the Center for Water Resources Research (UKZN), which focused on rehabilitation of alien invaded riparian zones and catchments using indigenous trees. Bruce is currently affiliated to the University of KwaZulu-Natal where he is a post-doctoral student where he runs and calibrates hydrological and soil erosion models. Bruce has presented his research around the world, including the European Science Foundation (Amsterdam, 2010), COP17 (Durban, 2011), World Water Forum (Marseille, 2012), MatLab advanced modelling (Luxembourg, 2013), World Water Week (Singapore, 2014), Forests & Water, British Colombia, (Canada, 2015), World Forestry Congress (Durban, 2015), Society for Ecological Restoration (Brazil, 2017). Conservation Symposium (Howick, South Africa, 2018) and SWAT modelling in Siem Reap (Cambodia, 2019). As a consultant, Bruce is the director and principal hydrologist of NatureStamp (PTY) Ltd. In this capacity he undertakes flood studies, calculates hydrological flows, performs general hydrological modelling, stormwater design, dam designs, wetland assessments, water quality assessments, groundwater studies and soil surveys.

Details of Reviewer:Nicholas Davis is a hydrologist whose focus is broadly on hydrological perspectives of land use management, climate change, estuarine and wetland systems. Throughout his studies and subsequent work at UKZN he has mastered several models and programs such as ACRU, HEC-RAS, ArcMap, QGIS, Indicators of Hydrologic Alteration software (IHA) and Idrisi. He has moderate VBA programming skills, basic UNIX and python programming skills.

1. INTRODUCTION

1.1 Project Background and Description of the Activity

NatureStamp has been contracted to conduct a watercourse delineation and impact assessment for the extension of the existing Woodburn Shopping Centre.

A development has been proposed on Sub 0 and Sub 5 of Erf 4346 of Pietermaritzburg. Given the proximity of the site to a stream/canal, a watercourse/wetland assessment is required. The proposed development is located on the following erven sites:

Sub Div	Farm No.	Town Name	Latitude	Longitude	Area (m^2)	SG Code	Deed
5	4346	Pietermaritzburg	30.3908	-29.6162	17 824	N0FT02580000434600005	N/A
0	4346	Pietermaritzburg	30.3911	-29.6106	64 573	N0FT02580000434600000	N/A

Uninformed and poorly planned infrastructural developments in the vicinity of water resources, such as sensitive surface and groundwater, can rapidly degrade these resources. Thus, pre-development (or in some cases post development) assessments are required to gain an understanding of the natural environment and guide the developmental process in order that site-specific mitigation measures can be put in place.

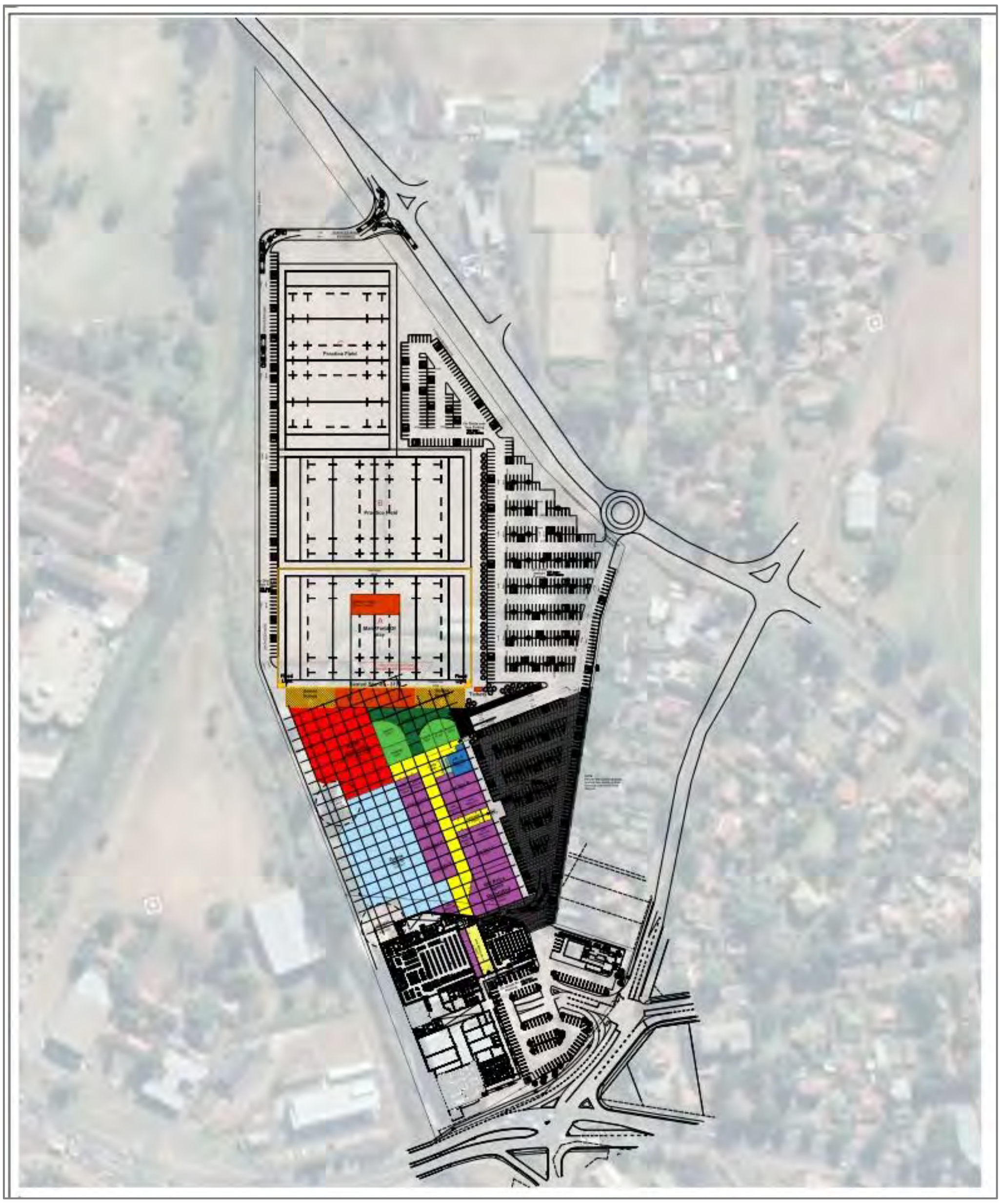

Figure 1 Layout of the proposed shopping centre expansion

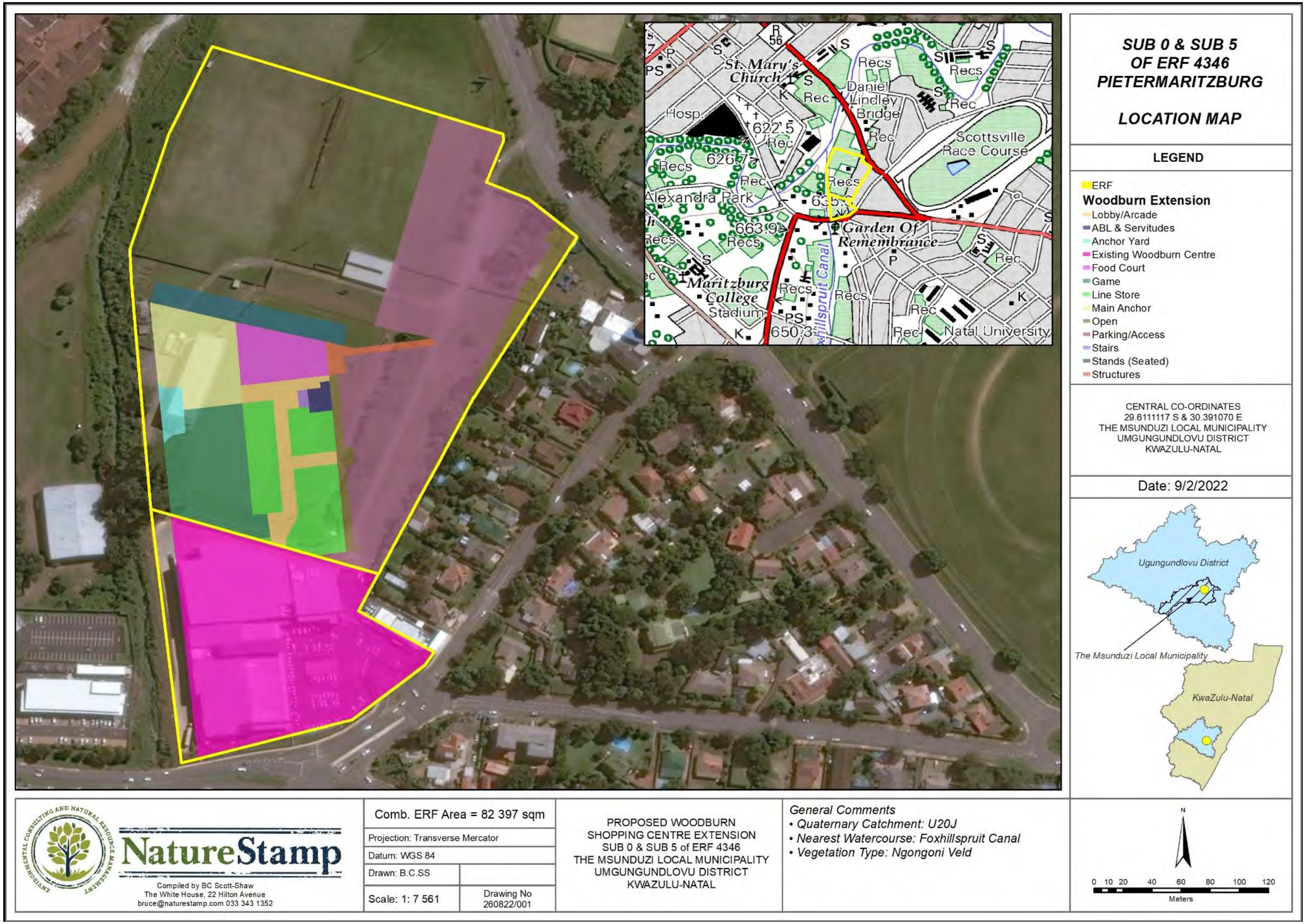

Figure 2 Location of the proposed expansion

1.2 Terms of reference

i. Watercourse/Aquatic Assessment

The condition/Present Ecological State (PES) of the delineated riverine and wetland areas present within 500 m of the proposed site; as well as the functional importance of any wetlands present within and near the development footprint would be assessed. This will involve:

a. an assessment of the delineated riverine areas by:
    i. determining the condition/PES of the riverine system using the rapid/qualitative Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) for rivers (in-stream and riparian habitats assessed separately); and
    ii. determining the health/ecological importance & sensitivity (EIS) using the DWAF riverine EIS tool (Kleynhans, 1999).
b. an assessment of the delineated wetland areas by:
    i. determining the condition/ PES of the delineated wetlands using the Level 1 WET-Health tool (Macfarlane et al, 2009); and
    ii. determining the ecological importance & sensitivity (EIS) of the delineated wetlands using the Department of Water Affairs and Forestry (DWAF) wetland EIS tool (Duthie, 1999).
c. an impact assessment to investigate, evaluate and assess the impacts of the abovementioned activities on the environment.
d. Compilation of buffers to reduce minimise the identified impacts.

1.3 Classification System for Wetlands and Other Aquatic Systems

Differences in terminology can lead to confusion in the scientific and consulting fields. As such, terminology used in the context of this report needs to be defined. The National Water Act (No. 36 of 1998) defines a watercourse, wetland and riparian habitat as follows:

- A watercourse means - (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.
- A wetland means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.
- A riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

Any features meeting these criteria within the development site were delineated and classified using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems hereafter referred to as the "Classification System" (Ollis *et. al.*, 2013). A summary of Levels 1 to 4 of the classification system are discussed further below.

Inland wetland systems (non-coastal) are ecosystems that have no existing connection to the ocean which are inundated or saturated with water, either permanently or periodically (Ollis *et. al.*, 2013). Inland wetland systems were divided into four levels by the Freshwater Consulting Group in 2009 and revised in 2013. Level 1 describes the connectivity of the system to the ocean, level 2 the regional setting (eco-region), level 3 the landscape setting, level 4A the hydro-geomorphic (HGM) type and level 4B the longitudinal zonation. Further information has been provided in Annexure B.
The level 3 classification has been divided into four landscape units. These are:

a) Slope – located on the side of a mountain, hill or valley that is steeper than lowland or upland floodplain zones.
b) Valley Floor – gently sloping lowest surface of a valley, excluding mountain headwater zones.

c) Plain – extensive area of low relief. Different from valley floors in that they do not lie between two side slopes, characteristic of lowland or upland floodplains.
d) Bench (hilltop/saddle/shelf) - an area of mostly level or nearly level high ground, including hilltops/crests, saddles and shelves/terraces/ledges.

Level 4 HGM types (which is commonly used to describe a specific wetland type) have been divided into 8 units. These are described as follows:

- Channel (river, including the banks) - an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow.
- Channelled valley-bottom wetland - a mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see channel). Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow).
- Un-channelled valley-bottom wetland - a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events.
- Floodplain wetland - the mostly flat or gently sloping wetland area adjacent to and formed by a Lowland or Upland Floodplain river, and subject to periodic inundation by overtopping of the channel bank.
- Depression - a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow.
- Flat - a near-level wetland area (i.e. with little or no relief) with little or no gradient, situated on a plain or a bench in terms of landscape setting. The primary source of water is precipitation.
- Hillslope seep - a wetland area located on (gentle to steep) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope.
- Valley head seep - a gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line, with water inputs mainly from subsurface flow.

2. ALLOWABLE ABSTRACTIONS AND LEGISLATION

Quaternary Catchment (QC) site: U20J (uMgeni/uMsunduzi). According to GN 538 (2016), the General Authorization (GA) limits for this QC are as follows–

- Abstraction of surface water: 2 000 m^3 / year @ 1 l/s from throughout the year
- Storage of water: 2 000 m^3
- Groundwater abstraction: 275 m^3/ha/year (allowed under GA).

These limits show that this catchment area is water limited and restricted water use applies.

3. STUDY SITE

3.1 General Description

The site is located within Quaternary Catchment U20J; falling under the uMvoti to Mzimkulu Management Area (WMA) and the uMgeni waterboard (uMgeni Water). The proposed area sits on a modified tributary of the uMsunduze river, known as the Foxhillspruit canal.

The Foxhillspruit and the Msunduzi are highly degraded due to the presence of settlements, rubbish dumps and factories that have encroached along the edge and impacted upon of this watercourse. Given the vulnerable state of these watercourse systems, and their associated high population, all catchments areas contributing to this system should be given extra attention and precaution regarding development proposals.

Rainfall in the region occurs in the summer months (mostly December to February), with a mean annual precipitation of 859 mm (observed from rainfall station 0239756 W). The reference potential evaporation (ET_o) is approximately 1667 mm (A-pan equivalent, after Schulze, 2011) and the mean annual evaporation is between 1300 – 1400 mm, which exceeds the annual rainfall. This suggests a high evaporative demand and a water limited system. Summers are warm to hot and winters are cool. The mean annual temperature is approximately 21.5 ºC in summer and 13.8 ºC in the winter months (Table 2). The underlying geology of the site is sedimentary Ecca Shale and the soils overlain are sandy-clay-loam ranging from Mispah, Glenrosa to Oakleaf form in this particular area. Much of the soils identified on site were transported material and highly modified.

Table 2 Mean monthly rainfall and temperature observed at Pietermaritzburg (derived from historical data)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean Rainfall (mm)	119	110	98	42	17	7	6	19	37	81	97	108	756
Mean Temperature (ºC)	21.5	21.6	21.0	18.5	16.0	13.7	13.8	15.3	17.3	18.0	19.2	20.8	18.1

Figure 3 The site around Woodburn Shopping Centre

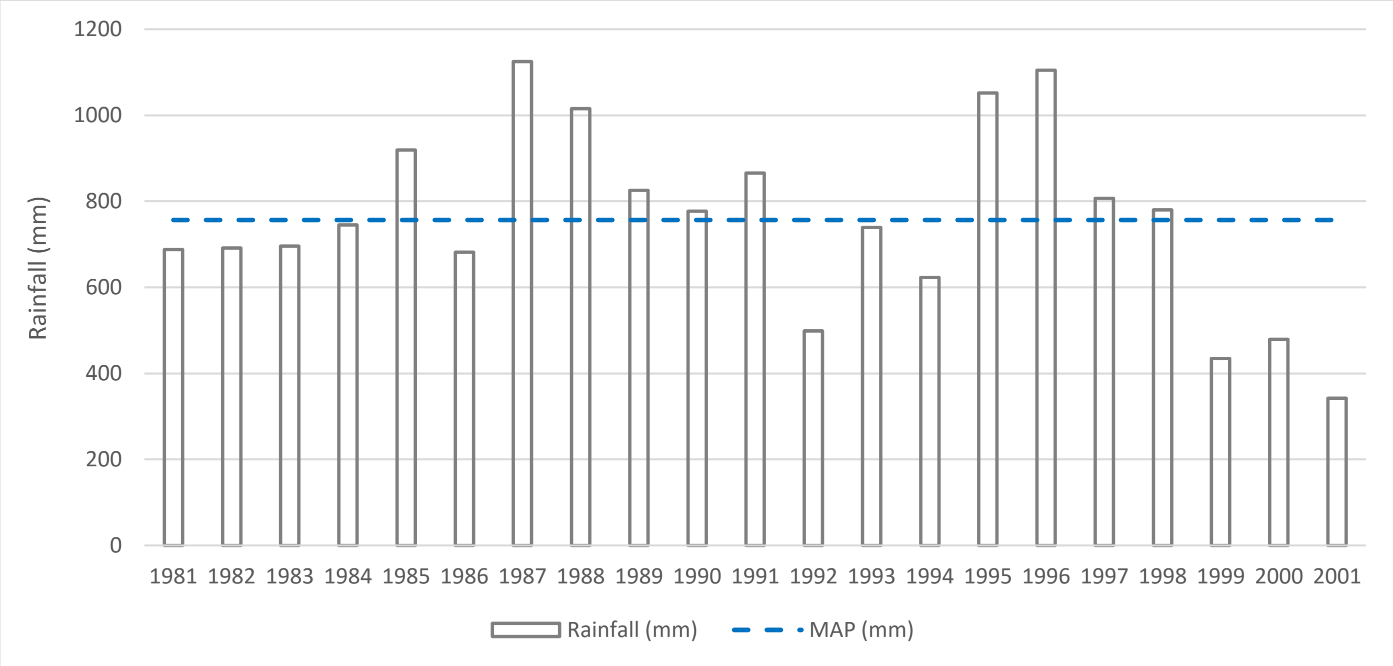

Figure 4 Long-term rainfall near the site

4. METHODOLOGY

A detailed description of the methods has been provided. The regional context and desktop analysis were used as the point of departure. Subsequently, a site visit was undertaken to delineate any wetlands and riparian areas. These systems were then assessed to determine the potential impacts that have been caused. The assessment of these systems considered the following tools where relevant:

Table 3 Assessment approach and the recommended tools for rivers and wetlands

Aquatic Component	Method/Technique	Tool Utilized
Rivers	Delineation	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).*
	Classification	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).*
	River condition/Present Ecological State (PES)	DWAF IHI (Index of Habitat Integrity) tool (Kleynhans, 1996) for rivers (riparian habitat only)
	River Ecological Importance & Sensitivity (EIS)	DWAF riverine EIS tool (Kleynhans, 1999)
Wetlands	Delineation	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).*
	Classification	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2014).*
	Wetland condition/Present Ecological State (PES)	Level 1 WET-Health tool (Macfarlane *et al*., 2009)
	Wetland Functional/Ecosystem Services Assessment	Level 2 WET-EcoServices assessment tool (Kotze *et al*., 2009)
	Wetland Ecological Importance & Sensitivity (EIS)	DWAF wetland EIS tool (Duthie, 1999)

Table 4 Data type and source for the assessment

Data Type	Year	Source/Reference
Aerial Imagery	2016	Surveyor General
1:50 000 Topographical	2011	Surveyor General
5m Contour	2010	Surveyor General
River Shapefile	2011	EKZNW
Land Cover	2014	EKZNW
Water Registration	2013	WARMS - DWS

*Data will be provided on request

4.1 Regional Context

4.1.1 National Freshwater Ecosystem Priority Areas (NFEPA) Project / Assessment

The 'National Freshwater Ecosystem Priority Areas' (NFEPA) project is a systematic biodiversity planning tool developed by the CSIR (2011) to identify freshwater areas considered the most important for biodiversity conservation. The key objectives of the NFEPA project are to ensure that all ecosystems and species are represented and that key ecological processes remain intact – achieving biodiversity targets within the smallest, most efficient area possible, with attention to connectivity over large areas (CSIR, 2011).

The conservation importance of the Woodburn Shopping Centre site was determined by consulting the relevant NFEPA layers (NFEPA WMA map, NFEPA wetlands and NFEPA rivers) in a geographical information system.

NFEPA was a three-year partnership project between South African National Biodiversity Institute (SANBI), CSIR, Water Research Commission (WRC), Department of Environmental Affairs (DEA), Department of Water Affairs (DWA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs.

FEPAs were determined through a process of systematic biodiversity planning and were identified using a range of criteria for conserving ecosystems and associated biodiversity of rivers, wetlands and estuaries. FEPAs are often tributaries and wetlands that support hard-working large rivers, and are an essential part of an equitable and sustainable water resource strategy. FEPAs need to stay in a good condition to manage and conserve freshwater ecosystems, and to protect water resources for human use. The current and recommended condition for all river FEPAs is A or B ecological category. Wetland FEPAs that are currently in a condition lower than A or B should be rehabilitated to the best attainable ecological condition.

4.1.2 Terrain, Soils, Geology & Vegetation

Contour lines (2 meter) were used to calculate the slope of each of the banks. The soils and geology were obtained from GIS layers obtained from the Soil Science department at the University of KwaZulu-Natal (UKZN). Various vegetation databases were used to determine the likely or expected vegetation types (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). A number of recognized databases were utilized in achieving a comprehensive review, and allowing any regional or provincial conservation and biodiversity concerns to be highlighted. The Guideline for Biodiversity Impact Assessment (EKZNW, 2013) was followed where applicable. The following databases were interrogated:

- *Ezemvelo KZN wildlife (C-Plan & SEA Database)*

The C-Plan is a systematic conservation-planning package that consists of metadata within a shapefile, used by ArcGIS (or similar tool), which analyses biodiversity features and landscape units. C-Plan is used to identify a national reserve system that will satisfy specified conservation targets for biodiversity features (Lombard *et al*, 2003). These units or measurements are ideal for areas which have not been sampled. The C-Plan is an effective conservation tool when determining priority areas at a regional level and is being used throughout South Africa to identify areas of conservation value. Some of this information extends into the Eastern Cape.

The Strategic Environmental Assessment (SEA, 2000) Plan is a database of the modelled distribution of a selection of red data and endemic species that could, or are likely, to occur in an area.

- *Mucina and Rutherford's Vegetation Assessment*

The South African National Biodiversity Institute (SANBI) developed a database of vegetation types. This database provides information on groups of vegetation at a course scale. It is useful in determining the expected species, conservation status and management practices of an area. However, this database does not provide information on species of conservation concern. This database is used as a step towards grouping vegetation types identified on site.

4.2 Extent, Classification and Habitat Characteristics

The boundary of wetlands and riparian areas occurring on the site 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*' (Department of Water Affairs, 2005). Land cover data, contour data and the latest aerial imagery were examined in a thorough desktop analysis of the site. This provided important background information to the specialists' understanding of the broader context of the landscape (e.g. baseline vegetation, geology and climate). An on-site delineation was undertaken as described below.

4.2.1 Wetland Delineation

The following indicators stipulated in the national delineation guidelines were considered in the field. Not necessarily all of these indicators were used at each site. Mention was made in the results which of these indicators were used:

- Terrain Unit Indicator – this relates to the position within the landscape where a wetland may occur. A typical landscape can be divided into five main terrain units, namely the crest (hilltop), scarp (cliff), midslope (often a convex slope), footslope (often a concave slope), and valley bottom. As wetlands occur where there is a prolonged presence of water, the most common place one would expect to find wetlands is on the valley bottom (Rountree *et al,* 2008*).*

- Soil Form Indicator – this identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.

- Soil Wetness Indicator - Prolonged saturation of soil results in the development of anaerobic conditions, which has a characteristic effect on soil morphology, causing two important redoximorphic features: mottling and gleying. The hue, value and chroma of soil samples obtained at varying depths can be visually interpreted with the aid of the Munsell Colour Chart and the interface between wetland and non-wetland zones determined.

- Vegetation Indicator – Plant species have varying tolerances to different moisture regimes. The presence, composition and distribution of specific hydrophytic plants within a system can be used as an indication of wetness and allow for inference of wetland characteristics.

The area was extensively traversed, auger sample points were taken as required and the exact location of sample points logged using a Garmin GPSMAP 64. At each sampling point the soils were sampled at depths of 0-10 cm and 40-50 cm below surface. The soil value, hue and matrix chroma were recorded for each sample according to the Munsell Soil Colour Chart, and the degree of mottling and/or presence of concretions were recorded. Although the site was severely transformed, any vegetation of interest was noted for the assessments. If the author was not able to identify any potentially important species, a leaf and bark sample was taken for analysis using a key guide.

4.2.2 Riparian Delineation

Riparian area/zone delineation is similar to wetland delineation in that indicators are used to define the edge of the system. It considers indicators such as topography, vegetation, alluvial soils, and deposition of material to mark the outer edge of the macro-channel and its associated vegetation. The Figure 5 shows the typical morphology of a river channel.

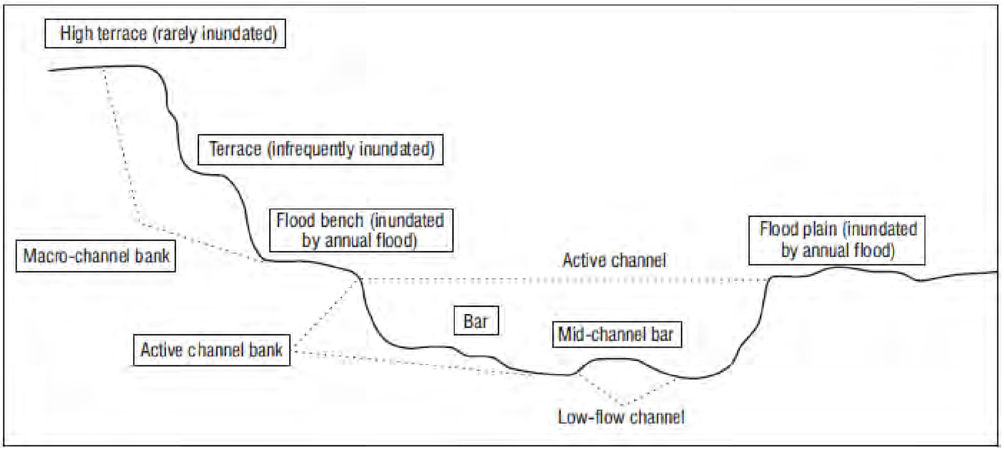

Figure 5 Typical cross-section of a river showing channel morphology **'A Practical Field Procedure for Identification and** Delineation of Wetland and Riparian Areas **– Edition 1' (Department of Water Affairs, 2005)**

A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas (DWAF, 2005) was used in the delineation of the riparian zone boundary. Delineated riparian zones were then classified using an HGM classification system based on the system proposed by Ollis *(*2013*).* According to Cowan *et* al. (2005), riparian ecosystems are separated from other wetland ecosystems on the following three major features:

1. They have linear form as a consequence of their proximity to rivers and form a boundary between the terrestrial and aquatic ecosystems.
2. Energy and materials from the surrounding landscape converge and pass through riparian ecosystems. This amount is greater in terms of unit area than with any other system.
3. Riparian ecosystems are connected hydrologically to both upstream and downstream ecosystems (intermittently).

An example of the soil sampling approach is provided in Figure 6.

Figure 6 Soil sampling undertaken at the site

4.3 Present Ecological State (PES) Assessment for Riparian Areas

4.3.1 Present Ecological State (adapted from WET-Health, Macfarlane *et al*., 2008)

A WET-Health (Macfarlane *et al*., 2009) Level 1 Rapid Appraisal was used to assess the eco-physical health of any wetlands in the study area. Focusing on geomorphology, hydrology and vegetation, the tool examines the impacts and indicators of change within the system and its catchment by determining the deviation (in terms of structure and function) from the natural reference condition. The outcomes of the appraisal place importance on issues that should be addressed through rehabilitation, mitigation and/or prevention measures. A standardized scoring system allows for consistencies between different systems and reduces user subjectivity.

Scores are allocated according to the magnitude and extent of impact. These scores are integrated to produce an overall score for Present Ecological State (PES) of the system – *namely, natural, largely natural, moderately modified, largely modified, extensively modified,* and *critically modified.*

4.3.2 Index of Habitat Integrity (IHI)

The ecological integrity of a river is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on a temporal and spatial scale that are comparable to the natural characteristics of ecosystems of the region (Kemper, 1999). The observed or deduced condition of these criteria as compared to what it could have been under unperturbed conditions is surmised to indicate a change in the habitat integrity. The methodology is based on the qualitative assessment of a number of pre-weighted criteria which indicate the integrity of the in-stream and riparian habitats available for use by riverine biota. Tables 5, 6 & 7 provide the list of criteria and their scores, the impact category and the final scores for the IHI assessment that were used in the calculations.

Table 5 Criteria used in the assessment of the habitat integrity

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 6 Impact classes and their associated scores

Impact category	Description	Score
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area is affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 7 Description of the IHI categories

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

4.4 Ecological Importance & Sensitivity (EIS) Assessment (Riparian)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on a local scale to a broader scale; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). In this study a qualitative assessment was applied and was partially informed by the present state assessment. This assessment followed the DWA river eco-classification criteria (Module A, Kleynhans & Louw, 2007). The classification provides insights into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition (Kleynhans & Louw, 2007). This further provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw, 2007).

Table 8 List of the EIS categories used in the assessment tool (Kleynhans & Louw, 2007)

Ecological Importance and Sensitivity Categories	General Description
Very high	Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.
High	Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use.
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.
Low/marginal	Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.

Table 9 Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

Score	Channel Type	Conservation Context			Vegetation and Habitat Integrity	Connectivity	Threat Status of Vegetation Type
0	Ephemeral Stream	Non-FEPA river	No status	None/Excluded	No natural remaining	None	No Status
1	Stream – non-perennial flow		Upstream management area	Available	Very poor	Very low	Least Threatened
2	Stream – perennial flow		Rehab FEPA		Poor	Low	Vulnerable
3	Minor river – non-perennial flow		Fish Corridor	Earmarked for conservation	Moderately modified	Moderate	Near Threatened
4	Minor river – perennial flow		Fish Support Area		Largely natural	High	Endangered
5	Major river – perennial flow	FEPA river	River FEPA	Protected	Unmodified/natural habitat	Very High	Critically Endangered

4.5 Impact Assessment

The aim of the impact assessment is to identify the impacts that the current activity, as well as the remaining construction and operational phase of the development will have on the receiving environment. If avoidance is not possible, mitigation is required in the form of practical actions (Ramsar Convention, 2008). Mitigation actions can be grouped into the following:

i. Pre-construction: This may take the form of changes in the scale of the development (e.g. reduce the size of the development), location of development (e.g. find an alternative area with less impact), and design (e.g. change the structural design to accommodate flows and continuity).
ii. Construction/Implementation: This may take the form of a process change (e.g. changes in construction methods), siting (e.g. locality to sensitive areas), sequencing and phasing (e.g. construction during seasonal periods).
iii. Operational: This may take the form of changes in post management (e.g. change management to match unpredicted impacts), monitoring (e.g. frequent checks by an ECO), rehabilitation (e.g. if mitigation actions are not effective).

An assessment of the potential impacts of the Woodburn Shopping Centre extension was guided by the EKZNW handbook for biodiversity impact assessments (2011). As it is an existing impact, a pre- and post-rehabilitation assessment was undertaken.

5. LIMITATIONS AND ASSUMPTIONS

In order to apply generalized and often rigid scientific methods or techniques to natural, dynamic environments, a number of assumptions are made. Furthermore, a number of limitations exist when assessing such complex ecological systems. The following constraints may have affected this assessment –

- A Garmin GPSMAP 64 was used in the mapping of waypoints on-site. The accuracy of the GPS is affected by the availability of corresponding satellites and accuracy ranges from 1 to 3 m after post-processing corrections have been applied.

- A Munsell Soil Colour Chart was used to assess soil morphology. This tool requires that a dry sample of soil be assessed. However, due to in-field time constraints, slightly wet soil samples were assessed. Wet samples would have consistently lower values than dry soils; and this is taken into consideration.

- Although the vegetation was taken into account, protected and threatened species that are seasonal, such as bulbs that have not emerged, may not have been identified.

- The soils were very uniform, as such it was difficult to determine the difference between temporary and dry-land wetland/riparian areas.

- The sampling was undertaken after a rainy period. Given these circumstances, extra caution was taken to ensure that watercourse features were not overlooked. Furthermore, the water quality sampling may differ from median year samples as parameters may be concentrated in such conditions (reduced flow).

- Much of the site is transformed which made access to some areas impossible.

6. RESULTS AND DISCUSSION

6.1 Regional Context

6.1.1 NFEPA assessment

In accordance with the NFEPA guidelines, the relevant reach of the Foxhillspruit Canal stream (and its associated riparian area) has been classified as a wetland FEPA, which indicates that these river systems are a national freshwater conservation priority. The uMnsunduzi River, which has numerous conservation organizations working on it (such as Duzi-Umgeni Conservation Trust, DUCT) has been classified at a Class D (Largely Modified) river.

The NFEPA project highlights the associated sub-quaternary catchments and Upstream Management Areas as a Freshwater Ecosystem Priority Areas (FEPAs) and Fish Support Area. As there is much focus on the Msunduzi River, the same considerations should be applied to its tributaries which cumulatively impact on this system. NFEPA wetlands were identified north of the Foxhillspruit Canal bordering on the edge of the project footprint.

6.1.2 Vegetation

Small patches of alien invaders were noted on the opposite banks. Dumping was observed along the riparian banks. This site is dominated by Ngongoni veld (SVs 4, Mucina and Rutherford, 2006). This occurs within the sub-escarpment savanna biome. The desktop analysis revealed that the area is a vulnerable area, with the potential for some flagged fauna and flora (e.g. red data species and endangered wildlife) being found from the C-plan, SEA and MINSET databases. However, this does not necessarily mean that rare or endangered species will occur in the area of interest. The following information was collected for the vegetation unit SVs 4 (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011). The surrounding vegetation (outside of the hub area) consists of Hinterland Thornveld and Midlands Mistbelt Grassland (Scott-Shaw & Escott, 2011). The characteristics of this grassland are described as:

- Undulating plains and hilly landscape mainly associated with drier coast hinterland valleys in the rain-shadow of the rain-bearing frontal weather systems from the east coast.
- Sour sparse wiry grassland dominated by unpalatable Ngongoni grass (*Aristida junciformis*) with this mono-dominance associated with low species diversity.
- In good condition dominated by *Themeda triandra* and *Tristachya leucothrix*.
- Wooded areas are found in valleys at lower altitudes, where this vegetation unit grades into KwaZulu-Natal Hinterland Thornveld and Bisho Thornveld.
- Termitaria support bush clumps with *Acacia* species, *Cussonia spicata*, *Ehretia rigida, Grewia occidentalis* and *Coddia rudis*.

6.1.3 Terrain/Catchment Analysis

The site (Figure 8) is situated on a gentle to moderate slope, rising towards Pelham. In this setting, it is 101 meters at the closest point to the uMsunduzi river. The majority of runoff from the site would flow directly towards the Foxhillspruit canal.

The geology of the site is characterised by Pietermaritzburg Ecca shale. The terrain, as identified through a desktop analysis had a gradient of 0.03 m/m and a slope of 1.5° between the upper lands and the river. The terrain was slightly uneven due to numerous buildings and roads. Some soil profiles were identified throughout the site. All of the non-wetland soils consisted of an Orthic A-horizon underlain by either a yellow a-pedal B-horizon (unconsolidated), lithocutanic material or ecca shale directly. Clovelly soils were the most commonly identified soils. Many of these points had transported material.

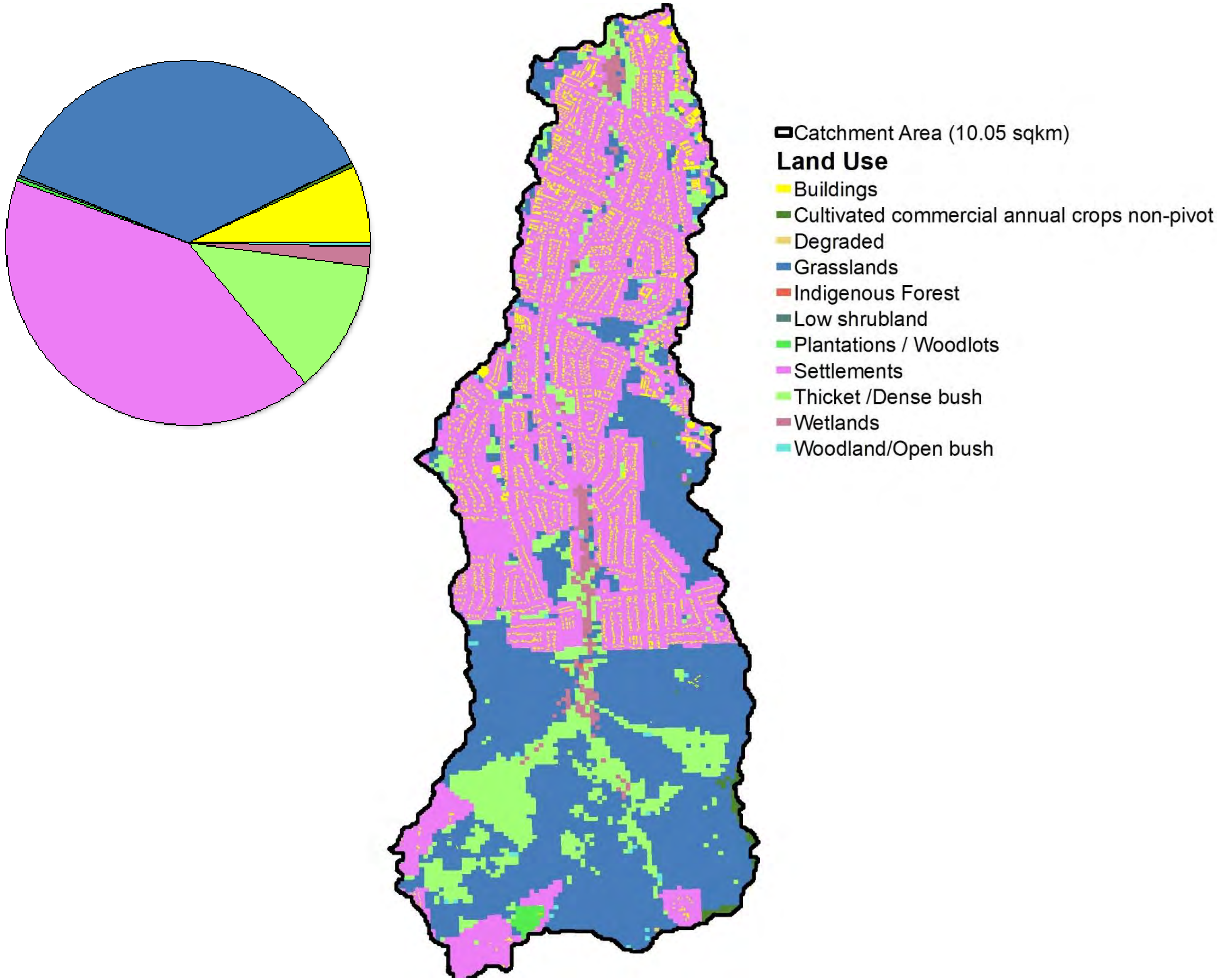

Figure 7 Existing land use for the catchment area of Woodburn Shopping Centre

Figure 8 Exaggerated (x3) Digital Elevation Model (DEM) of the catchment surrounding Woodburn Shopping Centre

6.2 Extent, Classification and Habitat Characteristics

The current land cover was obtained from various databases and the site visit. The site is surrounded by the urban areas, settlements and roads. Some grassland areas exist around the site although are not natural. Significant patches of alien invaders were noted.

The dominant species around the site were mostly *Lantana camara, Melia azedarach, Acacia mearnsii* and *Solanum mauritianum*. The area is not at high risk of erosion due the terrain and vegetated cover. The hydrological regime has been significantly historically modified due to large changes in these systems.

The site consists of areas of hydrological interest and these areas have been tabulated (Table 10) and described in detail. The HGM units are further illustrated in Figure 10. There are no natural wetlands within the development footprint. Any wetlands that the proposed expansion will not impact were not assessed for wetland health or functionality as they would not be disturbed by the development. These areas were considered when checking the connectivity of the systems and potential impacts from the roads and spoil sites; as well as to show 'No-Go' areas. Watercourse systems that would be affected by the development were assessed.

The delineation of the wetland and riparian areas identified the following:

- One riverine system (Msunduzi river linked to the Foxhillspruit Canal stream);
- Riparian habitat associated with the linear system;

The wetland/drainage system surrounding the Woodburn Shopping Centre site have been significantly historically modified.

Figure 9 Typical vegetation around the site

Table 10 Description of HGM units

Feature	Wetland/Riparian/Artificial	Description & Vegetation (after Kotze, 1999)	Soil Characteristics	On-site images
RH	Riparian Habitat	Banks of the Msunduzi river. Dominated by tree and sedge species (mostly alien invasives). Veld is present on the flood plain side of the bank.	N/A	
W	Watercourse (Msunduzi River)	A highly modified yet highly important river system that flows through Pietermaritzburg. Many households are dependent on this system.	No mottles Gley-5YR Value – 3 Chroma – 1 Dark Gray Depth sampled: 0-0.5m High Organic matter content in the upper layer	
W	Watercourse (Foxhillspruit canal)	A highly modified canal system that flows through Pelham suburb. Many households grey water is discharged into this system.	No mottles Gley-5YR Value – 3 Chroma – 1 Dark Gray Depth sampled: 0-0.5m High Organic matter content in the upper layer	
FL	Historical Floodplain	This is not a floodplain wetland but is within the 1:100 year floodline (which is different to a floodplain wetland). The site has been historically transformed and terraced for the rugby field. The field itself floods but does not show floodplain wetland characteristics such as alluvial soils.	Transported material (Rugby Field)	

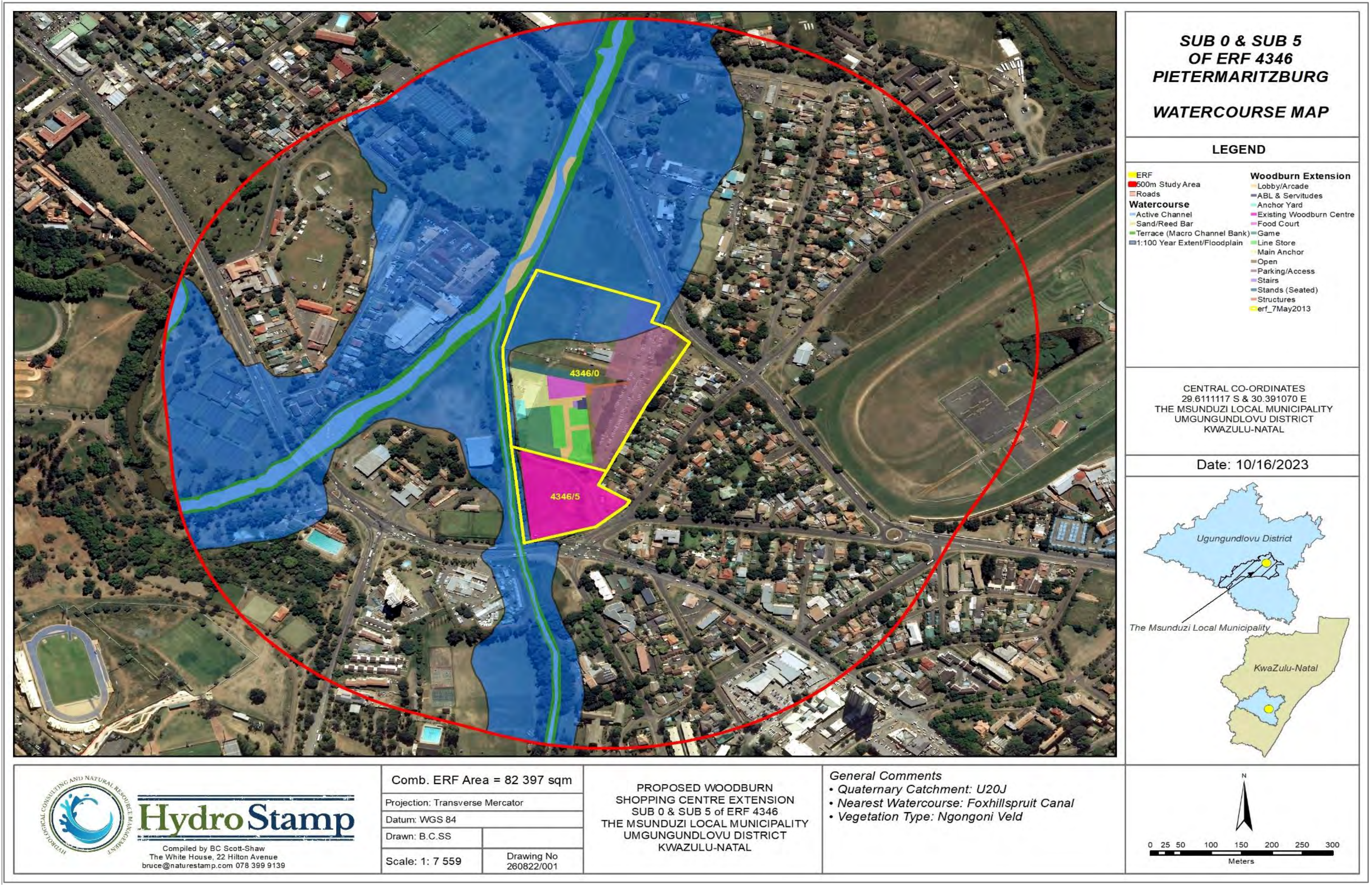

Figure 10 HGM units identified within 500m of the proposed expansion

6.3 Present Ecological State (PES)

4.1.1 Index of Habitat Integrity for riparian areas

The Index of Habitat Integrity tool (Kleynhans, 1996) was used to determine the integrity of the riparian zone only (relevant reach of the Msunduzi). The results have been provided in Tables 11. The results for the system show a PES category of D (44, Table 14): "*Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred*." The key change is the removal of indigenous vegetation due to industry and settlement encroachment, the conversion of riparian edges to dump sites and housing areas. As a result, the channel and flow has been altered and drains have been diverting flow away from infrastructure for many years.

Table 11 PES score using the Index of Habitat Integrity tool (Kleynhans, 1999) for the Woodburn Shopping Centre riparian area

Riparian Zone					
Criterion	Score	Weighting	Actual	Potential	
Indigenous vegetation removal	19	13	247	325	
Exotic vegetation encroachment	15	12	180	300	
Bank Erosion	5	14	70	350	
Channel modification	16	12	192	300	
Water abstraction	12	13	156	325	
Inundation	4	11	44	275	
Flow modification	17	12	204	300	
Water quality	22	13	286	325	
Totals			1379	2500	55.16
Category					44.84

The Index of Habitat Integrity tool (Kleynhans, 1996) was used to determine the integrity of the riparian zone associated with the Foxhillspruit. The results have been provided in Tables 12. The pre-dumping state was determined by previous assessments and assessments of the immediate surrounding areas. The results for the show a PES category of E (39.68, Table 12): "*The loss of natural habitat, biota and basic ecosystem functions are extensive.*" The riparian areas are heavily invaded by alien plant species and the water quality has been compromised. The surrounding areas are largely transformed with numerous road crossings, footpaths, dump sites and industrial encroachment.

Table 12 PES score using the Index of Habitat Integrity tool (Kleynhans, 1999) for the Foxhillspruit canal

Riparian Zone					
Criterion	Score	Weighting	Actual	Potential	
Indigenous vegetation removal	22	13	286	325	
Exotic vegetation encroachment	24	12	288	300	
Bank Erosion	5	14	70	350	
Channel modification	16	12	192	300	
Water abstraction	10	13	130	325	
Inundation	8	11	88	275	
Flow modification	14	12	168	300	
Water quality	22	13	286	325	
Totals			1508	2500	60.32
Category					39.68

4.1.2 WET-Health (Macfarlane *et al.*, 2008) of wetlands

A WET-Health assessment was undertaken for the wetland systems found within 500m of the proposed operation. The Foxhillspruit was assessed as a valley bottom system.

- *Hydrology*

The present hydrological state of the and the CVB (channelled valley bottom wetland associated with the Foxhillspruit) were given a score of D (Largely Modified). The MAP: PET ratio indicates that the wetland is not dependant on direct precipitation falling onto the wetland, depending on flow from upstream to a greater extent, making them more vulnerable to reduced flows.

The key factors influencing hydrological impacts on the wetlands are the encroachment by humans in the wetland catchment. The largest change from the past is the addition of numerous drains to channel water out of the wetlands away from urban areas. This would have been done in the past to create more arable land. However, it has been intensified in recent years to reduce the flood risk (although is likely to results in the opposite) and create space for development. These are streamflow reduction activities, decreasing water flow into the system. Natural water distribution and retention patterns are altered as a result of impeding structures across the wetland, that is the dirt paths that have resulted in hardened surfaces and therefore greater runoff as the surface roughness is altered.

Table 13 The hydrology module for the nearby wetlands

Hydrology module	Channelled Valley Bottom
Extent of the wetland (ha)	2.6
MAP:PET	0.4 – 0.49
Vulnerability factor	0,9
Combined score for increased and decreased flows	7.3
Intensity of impact of factors potentially altering flow patterns	2 – small
Magnitude of impact of canalisation and stream modification	0.07
Magnitude of impact of impeding features	0
Magnitude of impact of altered surface roughness	0,1
Impact of direct water losses	1,60
Magnitude of impact of recent deposition, infilling or excavation	0
Combined magnitude of impact of on-site activities	5.8 – Large
Combined magnitude score as a result of impacts on hydrological functioning	7
Overall hydrological health	The impact of the modifications is clearly detrimental to the hydrological integrity. Approximately 50% of the hydrological integrity has been lost.
Present hydrological state of the HGM unit	D
Trajectory of change of wetland hydrology	(→)

- *Vegetation*

The present state of wetland vegetation of the flat wetland has been given a class of F as the vegetation composition has been heavily transformed. Since the formation of this wetland it has likely never had indigenous wetland species present.

Table 14 Vegetation module for the nearby wetlands

Vegetation module	Channelled Valley Bottom
Extent of the HGM unit (ha)	2.6
Identify and estimate the extent of each disturbance class	High
Magnitude of impact score	6.4
Present vegetation state	F
Trajectory of change to wetland vegetation	(→)
Overall vegetation health	Seriously Modified
Alien vegetation present (%)	50

- *Geomorphology*

The overall geomorphological health of the wetlands were classified as D, which is largely modified: *a large change in geomorphic processes has occurred and the system is appreciably altered*. This was due to the unit having numerous drainage channels, large changes in upstream runoff characteristics and significant infilling from roads, farmlands and houses. The trajectory of change if the impacts progress is likely to remain stable (→). The key concerns lie in the hydrology and geomorphology components.

Note that, although the system scores badly, it is visually in good condition and is in an extremely high pressure system due to significant impacts and alterations.

Table 15 Geomorphology module for the wetlands near Woodburn Shopping Centre

Geomorphology module	Channelled Valley Bottom
Extent of the HGM unit (ha)	2.6
Impacts of channel straightening	0.2
Extent of impact of infilling	0.8
Impacts of changes in runoff characteristics	3.0
Impacts of erosion	0.1
Impacts of deposition	0.2
Present geomorphic state	D
Trajectory of change of geomorphic state	(→)
Overall geomorphological health	Largely Modified

- *Overall Health*

The overall health based on the combined impact score is D (largely modified). A large loss of natural habitat, biota and basic ecosystem functions have occurred.

6.4 Ecological Importance & Sensitivity Assessment

An EIS category was determined for the Foxhillspruit system. The category of this system (Table 16) was calculated to be Low: ‘Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use. There was no change due to the activities on site.

Table 16 EIS category scoring summary for the Foxhillspruit Canal

Component	Score (0-5)	Comments/description
Channel Type	2	Stream – perennial flow
Conservation Context	0	No context
Vegetation and Habitat Integrity	1	Very Poor
Connectivity	3	Moderate
Threat Status of Vegetation Type	2	Vulnerable
EIS Rating	1.6	Low

Considering the PES and EIS scores, the recommended management objective for the Woodburn Shopping Centre Expansion site would be to maintain the present integrity and ecosystem functioning of the system but offset the geomorphological and vegetation changes which could improve the immediate small area.

7. POTENTIAL IMPACT PREDICTIONS AND DESCRIPTIONS

The site is in a visibly modified condition. The primary surrounding impacts are primarily from the urban encroachment and the subsequent discharge of waste. The wetlands immediately surrounding the proposed development is artificially formed. The geomorphology is in a modified state due historical and recent terracing and levelling.

7.1 Present Impacts

Within the Woodburn Shopping Centre development footprint, the existing impacts on the watercourses and respective catchment areas include -

- The presence of water demanding alien species that have replaced veld;
- The clearance of natural habitat for developments and pathways;
- Concentrated flow paths from drain outlets/dongas along the roads
- Historical modification of watercourse systems for settlements;
- Erosion and sedimentation from construction activities; and
- A high volume of litter around the site.

In the broader WMA, similar impacts are present as noted for the proposed site. Additional existing impacts on the watercourses and respective catchment areas include -

- Infrastructure development within wetland systems (wetland encroachment) or river banks – leading to a direct loss of wetland systems and decrease in provision of ecosystem services;
- Cattle grazing in wetlands and the riparian edge – potential for a change in vegetation species composition to occur, soil erosion (cattle path erosion is prevalent in the area) and water pollution;
- Canalisation of streams and rivers – leading to change in the hydrological regime;
- Informal and formal watercourse crossings – leading to the change in hydrological regime;
- Litter and solid waste disposal – direct water pollution; and
- Poor or absent sanitation – direct water pollution.

In addition to these impacts, there is a high risk of flood damage (infrastructure, cattle, crops and livelihood) to the community living within the flood line. There is also a likelihood that soil sediment levels would increase resulting in a loss of yield.

7.2 Potential Impacts During Implementation

Some impacts are likely during construction. These include -

Table 17 Impact Drivers and Description – Implementation Phase

ACTIVITY / DRIVER OF IMPACT	IMPACT	DESCRIPTION OF HOW IMPACT OCCURS
Construction activities for the expansion/developments	Enhanced erosion potential	As a result of subsequent changes in the hydrological partitions and slight modifications to the slope and soil characteristics (changes to vegetation cover, root content and infiltration rates). This is further described – The potential increase in slope and bank construction will enhance erosion potential (greater energy for sediment wash). The reduction in vegetation cover will open bare soil therefore reducing the surface roughness and increasing the erosive potential to the elements (wind and rain). Sheet wash, rill and gully erosion is likely and may lead to the collapse or slumping of wetland/stream bank areas that would bury marginal wetland habitat. An increase in compaction of the soils along the edge of the plot where heavy machinery traverses would lead to an increase in the runoff.
	Decrease in water quality	As a result of contaminants from heavy machinery (oil, fuel) infiltrating / washed into the system.
	Spread of alien invasives	As these plants colonise stockpiles and spoil sites / spoil sites given their easily dispersed seed.
High activity of heavy machinery and construction staff	Air pollution affecting wetland fauna	As a result of excessive air emissions from heavy machinery and generators.
	Noise and disturbance affecting wetland fauna	As a result of excessive air emissions from heavy machinery and generators.
	Decrease in water quality (impact to aquatic flora and fauna; and water supply)	As a result of potential leaks of fuel, grease and oil from the heavy machinery. Wash related to the above-mentioned changes during rainfall events will lead to the movement of these substances into the soil and the watercourse systems. As a result of improper storage and handling of hazardous chemicals such as fuel and oil as well as chemicals relating to staff ablution facilities. As a result of any spills, such as concrete, during construction.

7.3 Potential Impacts During Operation

1. Change in the land cover and roughness characteristics: by the presence of new buildings, roads and parking. This is particularly relevant due to close proximity to the watercourse buffer:
   - o The fairly steep slopes associated with the levelling of the edge of the development as well as the new access routes may encourage bank erosion and sedimentation.
   - o A greater impervious area due to the new surfaces, which may increase peak flow events (due to a decreased lag time), and further scour out downstream aquatic systems while changing the sediment yield.

- An increase of flow from storm water outlet points which may increase the risk of floods downstream of the development.

2. Pollution (water, air and noise): an increase in pollution resulting from:

    - Wash from the building and road surfaces including petro-chemicals and human rubbish. The presence of vehicles accessing and parking on the property may lead to a risk of oil spills adjacent to the watercourse.
    - Infiltration of oil leaks through the parking areas towards the watercourse.
    - The input of chemicals and non-biodegradable rubbish into the river, either through surface runoff from the impervious surfaces, along drains or transported by the wind, will result in the deterioration of the local river water quality in vicinity of point source discharge points. Long term loss in aquatic and terrestrial biodiversity will be the major impact.
    - Air and noise pollution may be slightly increased with the increase in human movements.

3. Increase in presence/abundance of invasive alien species: Disturbed areas are commonly invaded by alien invasive plant species during operation as:

    - The operation of this Eureka development may encourage additional invasive species due to human presence and vehicles aiding seed dispersal (via being caught in tyres and grills).
    - As the property is already invaded by alien plants, there is potential for the development to clear these plants and promote indigenous species.

7.4 Impacts associated with Climate Change Projections

The following potential impacts may arise as a result of climatic changes in the future, which would possibly effect the watercourses and surrounding environment (Msunduzi Municipality, 2016):

- Increase in extreme weather events such as powerful rain/thunderstorms, strong winds, intense heat waves, severe coldness and increased lightning strikes.
- This would likely cause flooding within the watercourses, as well as fallen trees which would damage the surrounding environment and municipal infrastructure.
- The risk of contamination of watercourses would increase due to significantly greater volumes of runoff, which may lead to disease outbreaks and human health problems.
- The changing environmental conditions could potentially increase the invasion of alien plants species within and surrounding watercourses due to newly suitable temperature and weather conditions.
- Alien vegetation uses more water than indigenous vegetation, therefore reducing natural water supplies / choking natural watercourses. Alien plants have the ability to overpower indigenous vegetation and becoming overgrown within rivers and streams.

8. PROPOSED INTERVENTION MEASURES & SURFACE WATER MONITORING PROGRAMME

8.1 Construction Phase

1. Site Establishment and Planning:

    - The freshwater ecosystem buffer zone should be clearly demarcated prior to the commencement of any activities on the site;
    - Vehicle access to the site should be via a clearly demarcated route that is outside the wetland habitat and its buffer zone;
    - The construction area should be clearly identified including access roads, stockpile or excavation areas, storage facilities and parking areas;
    - "No Go" areas should be clearly identified for the entirety of the construction phase;
    - Demarcated areas should be marked using easily visible fencing and should be properly maintained during construction;
    - Signs to indicate hazardous areas or indication signs need to be placed where required;
    - All demarcated areas need to be agreed upon with an ECO before construction begins;
    - Work conducted in the river/wetland channel needs to be overseen by an ECO so that sediment loads are controlled (by appropriate control techniques); and
    - Storm water management (SWM) structures, in line with the SWMP should be included in the design and construction of all infrastructure.

2. Soil Management: (erosion and sedimentation control):

    - To prevent erosion and sedimentation, construction activities should be undertaken during the dry periods when flows will be substantially reduced;
    - Erosion structures (such as silt traps) need to be placed around all stockpiles to prevent sediment wash;
    - Topsoil stripped from the construction footprint must not be spoiled but stockpiled and preserved for use in rehabilitation. Top-soil and sub-soil stockpiles to be placed on opposite sides of the road as this is where they will cause the least impact;
    - Vehicles should be parked out of the floodline or recommended buffers when not in use in order to prevent compaction of the soil profile;
    - Topsoil should be replaced in the correct order it was extracted and erosion prevention measures be put in place on areas with a steep gradient (such as geo-textiles);
    - Any excess subsoil must be removed from the development area once back filling is completed, and spoiled at an agreed spoil site; and
    - Stockpiles must be clearly demarcated and be kept free of weeds and compaction.

3. Loss of natural/indigenous vegetation and alien invasion:

    - Bank areas need to be stabilized before re-vegetation occurs. Bare areas need to be controlled by geo-textiles in order to give the vegetation a chance to establish;
    - All growth forms of Category 1 weeds and invader plants shall actively be removed from all works areas, at all times;
    - Areas for re-vegetation/alien clearing should be demarcated in order to prevent further disturbance. Furthermore, access roads for machinery should avoid any of the vegetation focus areas and areas with existing natural vegetation;
    - All Category 2 and 3 weeds and invader plants shall be actively removed all prior to flowering;
    - All riparian and wetland areas disturbed during the construction phase must be rehabilitated and re-vegetated and overseen by an ECO and qualified wetland specialist; and
    - Follow up assessments should be undertaken to prevent alien re-growth in alignment with time frames identified by a re-vegetation plan/vegetation specialist.

4. Pollution (water, air and noise):

    - A Spill Contingency Plan for both construction and operational phases should form part of the Environmental Management Programme (EMPr). The Spill Contingency Plan should address measures to prevent and mitigate the spillage of hazardous materials, which include oil, grease and petrochemicals as well as herbicides which may be used as part of the alien clearing operation;
    - All chemicals should be appropriately stored and handled. Storerooms must be outside of watercourse zones and buffers and have appropriate concrete flooring and bunding;
    - No washing of construction equipment and vehicles must be done on site;
    - Any remnant rubbish, spoil, machinery and contaminants need to be removed from the development area. This includes all spoil, broken equipment, tools and other waste;
    - Vehicles or machinery must not be serviced or re-fuelled on site;
    - If pumping from the river occurs, it needs to be done from a controlled point in the river to prevent the disruption to aquatic species. Furthermore, the pump needs to be placed above a drip tray;
    - Appropriate ablution facilities need to be put in place with no effluent released into the soil or the river;
    - Rubbish bins need to be placed on site so that no litter or food waste is left around the development;
    - A baseline water quality assessment should be undertaken prior to any development. This could be either in the form of water quality sampling or an aquatic SASS assessment; and
    - Sufficient storm water outlet points should be installed in alignment with the SWMP.

8.2 Operational Phase

1. Pollution (water, air and noise):

    - Storm water drains associated with the development must be in alignment with the SWMP. This will reduce the risk of petrochemicals entering the watercourse. These structures should be regularly checked for blockages or damage.

2. Increase in invasive alien species:

    - Follow up assessments by the Environmental Control Officer (ECO), for six months post construction, should be undertaken to determine the success of the re-vegetation process;
    - The success of the re-vegetation process needs to be checked by the ECO; and
    - The ECO must determine if further follow-up assessments are needed.

3. Bank erosion:

    - The condition of the banks around the development need to be checked by the ECO during operation and signed off if in a controlled state where no erosion has been observed for 1 year during operation.

4.2 Soil Management

To ensure rehabilitation is effective, it is vital that the working area is managed correctly during the construction phase. An important part of this management will be that careful preservation and management of soil stockpiles should be implemented on the Woodburn developments site. The following points have been provided for use with the rehabilitation actions:

- Consider stone packs/walls and alternative barriers.
- Green concrete structures need to be strong enough to hold the soil, be inundated during peak events and allow infiltration. This should be in alignment with the SWMP.
- Top- and subsoil stockpiles (used for road levelling and bank lifting) must not be stockpiled within the buffers/demarcated ‘no go’ areas or within the 1:100 year floodplain of a water course.
- Naturally occurring vegetation removed by site clearance operations may be grubbed in with the topsoil for stockpiling.
- The topsoil shall not be rendered in any other way inappropriate for rehabilitation use.

- Topsoil stripping (in widening and realignment areas) shall not occur in wet weather and during stripping and stockpiling, the topsoil shall not be subject to a compaction force greater than 1 500kg/m² and shall not be pushed for more than 50m.
- Topsoil shall also only be handled twice, once to strip and stockpile, and secondly to replace, level, shape and scarify if necessary.
- Top soil stockpiles must be protected against erosion and a record kept of all top soil quantities and should there be shortfalls of topsoil required for rehabilitation, adequate replacement material from commercial sources should be obtained as approved by the Engineer (preferably from areas identified with sourced excess topsoil).
- Equally, excess topsoil shall be landscaped and stabilized in accordance to the requirements of the Engineer and in consultation with the Contractor's Land Rehabilitation Specialist.
- Topsoil stockpiles should not be stockpiled for longer than 6 months. If this can't be avoided, the stockpiles will need to be enriched or upgraded prior to rehabilitation. The Contractor shall consult with the Engineer with regards to matching preconstruction conditions or existing adjacent conditions.
- All stockpiles left for extended periods of time shall be stabilized using approved vegetation cover or other erosion control measures.
- Any excess subsoil must be removed from the road fringe once back filling is completed, and spoiled at an agreed spoil site (spoil sites to be agreed between landowner, ECO and Engineer).

9. CONCLUSION

The developers of the proposed Woodburn Shopping Centre Expansion must note that watercourses are protected by nine Acts and two Ordinances in KwaZulu-Natal[1], which verifies that both national and provincial authorities recognise these systems as highly valuable multiple-use resources and are committed to their conservation. The work undertaken for this report indicates that no watercourse systems/wetlands were identified within the property boundary, as detailed in Section 5.2. However, two systems were identified within 500 meters of the development site. These are the Foxhillspruit Canal and the Msunduzi river These systems are heavily modified. The floodplain associated with the Foxhillspruit and the Msunduzi river is within 500m of the site but the proposed development is outside of this extent. Furthermore, the floodplain is partly present due to the modified flat rugby fields which cannot be assessed. No wetland area is lost due to the proposed development. As such, there is no offset required.

The authors have undertaken soil sampling, terrain analysis and vegetation analysis. The wetland system is classified as FEPA system and should be given protection to minimize the impacts identified. The developments proposed for the site will have some impact on these surrounding watercourses although these will be low.

The key impacts from the development are stormwater discharge and potential contamination from activities on site (construction and operation). As such, there is a need for strict adherence to the rehabilitation plan should the development continue.

1 The Lake Areas Development Act, Act No. 39 of 1975; The National Water Act, Act No. 36 of 1998; The Mountain Catchment Areas Act, Act No. 63 of 1976; The Environmental Conservation Act, Act No. 73 of 1976; The National Environmental Management Act, Act No. 107 of 1998; The Conservation of Agricultural Resources Act, Act No. 43 of 1983; The Town Planning Ordinance 27 of 1949; The Physical Planning Act, Act No. 88 of 1967; The Forest Act, Act No. 84 of 1998; The Natal Nature Conservation Ordinance No. 15 of 1974; The KwaZulu Nature Conservation Act, Act No. 8 of 1975

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ANNEXURE A Classification structure for inland systems up to Level 4

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	**LEVEL 2: REGIONAL SETTING**	**LEVEL 3: LANDSCAPE UNIT**
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

FUNCTIONAL UNIT LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River (Channel)	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional stream	Active channel
		Riparian zone
	Upper foothill rivers	Active channel
		Riparian zone
	Lower foothill rivers	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothill rivers	Active channel
		Riparian zone
	Upland floodplain rivers	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Note: 2[nd] row of Table provides the criterion for distinguishing between wetland units in each column

ANNEXURE B Wetland and soil classification field datasheet example

Sampling Sheet Summary	
Wetland	Msunduzi
Area (ha)	<5
Indicator	Soil and vegetation
Connectivity (level 1)	Inland
Eco region (level 2)	South Eastern Uplands
Landscape setting (level 3)	Riparian system
HGM Type (level 4A)	Endhoreic
Longitudinal zonation (level 4B)	With channel
Hydrological regime	Frequent Inundation
Soil characteristics	Hue – Gley 2 to 5YR Value – 4 Chroma – 2 (Dark Reddish Gray) Depth sampled: 0-0.5m
Comment	No change in soil characteristics

ANNEXURE C Steps for Riparian Delineation

Steps for Riparian Delineation in the field

To delineate riparian areas, use the terrain unit indicator, vegetation indicator species, soil wetness indicator, combined with

- Geomorphology of the banks; and
- Extent of riparian vegetation.

Evidence of alluvial deposits can also be used.

STEPS to delineating the riparian zone:

I. Is the site relatively undisturbed (banks have not been extensively engineered, and the site is predominantly indigenous, naturally occurring vegetation)? If yes, proceed to step II. If no, proceed to step V.

II. Starting at the edge of the channel, use the regional riparian vegetation indicator list, identify the edge of the zone of (obligate) riparian plants.

III. At this point, check:

a. If there are any hydric indicators in the soil (refer to Wetland Delineation component).
b. If you are still in a zone of unconsolidated recent alluvial sediment.

If yes for either **a** or **b**, proceed outwards from the channel to identify the edge of these zones.

Once the answer to **a** and **b** are no, follow the same steps (II and III) using preferential and/or facultative riparian plant species *(Refer to the steps 1 to 12 from the vegetation assessment section below for further detail).*

Following completion of the above, proceed to step IV.

IV. Examine the geomorphology (shape) of the channel and banks. After moving away from the channel during steps II and III, you should be at or close to the edge of the top of the "macro-channel" bank (in the case of erosive rivers) or the edge of the active floodplain or flood zone (in the case of alluvial depositional rivers). At, or close to, this point you should see an inflection point (change in slope) between the riparian area and the upland (terrestrial) slopes. This can be taken as the edge of the riparian zone.

Using Reference Sites:

V. For sites which have been heavily disturbed (i.e. where there is almost no indigenous vegetation remaining, and/or where the banks have been heavily engineered such that it is no longer possible to identify the original morphology of the banks), then a REFERENCE site will need to be located. The Reference site will need to be close by on the same or a similar sized river system, in an area of similar topography. The Reference Site can be used to provide an indication of the likely riparian extent prior to disturbance. Once the reference site is located, proceed with step II.

Where problems may be encountered:

On floodplains, it is important to check whether the floodplain is active (i.e. regularly flooded under the current climatic regime) or a relict floodplain (meaning that the floodplain depositional area formed due to a wetter historical climate and now is no longer regularly flooded). The type of vegetation on the floodplain surface, presence of soil wetness indicators and the presence of ox-bows and other riparian and wetland features would provide the indications of the current levels of flooding/inundation/saturation.

grass seed mix

WETLAND

Contents:

1. ORGANIC FERTILIZER
It provides nutrients to the soil
It improves soil structure
It retains moisture

2. ZEOLITE
Zeolite is a soil conditioner
It retains nutrients in sandy soil
It retains moisture
It reduces nutrient loss
It removes heavy metals from soil

3. ORGANIC MATERIAL

4. GRASS SPECIES
Contents may vary

Andropogon eucomus
Aristida junciformis
Chloris gayana
Cynodon dactylon
Diandrochloa namaquensis
Digitaria eriantha
Eragrostis capensis
Eragrostis gummiflua
Imperata cylindrica
Ischaemum fasciculatum
Panicum coloratum
Schizachyrium sanguineum
Setaria incrassata
Sporobolus africanus
Sporobolus fimbriatus

SOWING INSTRUCTIONS

- Scarify to loosen soil by raking.
- Sow half of the seed with first application. Sow the rest as a second application to ensure proper coverage.
- Cover seed lightly by raking.
- Water gently or alternatively utilize as dryland seed mix.

Application

100g / 25 m2 (5m x 5m) ☐

500g / 125 m2 (11m x 11m) ☐

1kg / 250 m2 (16m x 16 m) ☐

5 kg / 1250 m2 (35m x 35m) ☐

WARNING
Selected seed treated.
Do not use seed for:
food, feed or consumption.

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