Draft for comment

WETLAND IMPACT ASSESSMENT REPORT FOR:

The proposed upgrade of sewage infrastructure located within the northern area of Kwadukuza, eThekwini Metropolitan Municipality, KwaZulu-Natal

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DECLARATION OF INDEPENDENCE

Independent Specialist Consultant

This is to certify that the following report has been prepared by KSEMS Environmental Consulting Pty Ltd. who:

- Act as independent specialist consultants, in this application, in the field of wetland and aquatic ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the 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 EIA Regulations, 2014 as amended; and
- Will provide the competent authority with access to all the information at our disposal regarding the application for the water use license, whether such information is favourable to the applicant or not.

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The KSEMS' team members involved in the compilation of this report and whom are in agreeance with the Declaration of Independence.

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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on KSEMS Consulting's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and the abovementioned authors reserve the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research or further work in this field or pertaining to this investigation.

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KSEMS Environmental Consulting, 2020. *Watercourse Delineation and Functional Assessment for the proposed upgrade of sewage infrastructure located within Kwadukuza North, eThekwini Metropolitan Municipality, KwaZulu-Natal. P*repared for eThekwini Municipality Water and Sanitation, August 2020.

EXECUTIVE SUMMARY

KSEMS Environmental Consulting Pty Ltd. (KSEMS) were appointed by eThekwini Municipality Water and Sanitation to conduct a Watercourse Delineation and Functional Assessment for sewage upgrades, associated with housing developments located on various pockets within Ntuzuma B ward 38, 41, and 45, located in the Northern operational area of KwaMashu, within the eThekwini Metropolitan Municipality of KwaZulu-Natal. The pipeline has a diameter of 160 mm and is approximately 13 kilometres (km) in length. The pipeline traverses various sections of watercourses which triggers the need for an environmental impact assessment and water use license application process.

Site Characteristics

The site fell within the North Eastern Coastal Belt and the watercourses within the study area were observed to fall within the DWS quaternary catchment area U20M which falls under the Mgeni sub water Management Area (WMA) and within the greater Mvoti to Umzimkulu WMA. This quaternary catchment was recorded to exhibit a Mean Annual Precipitation (MAP) and Mean Annual Runoff (MAR) rate of 921 and 152 mm, respectively (DWAF, 2005). Subsequent to an analysis of the NFEPA watercourse datasets, at a desktop level and during a field assessment, it was concluded that no NFEPA watercourses were identified within the study area, only the uMngeni River was identified south-west of the site and no risk was posed on this system. With reference to the eThekwini Municipality's Durban Metropolitan Open Space System (D'MOSS), a large portion fell outside of the study area with the site only traversing woodland north of the site which fell within the riparian areas and thicket north-east of the site.

Utilising the Mucina and Rutherford literature (2006) and dataset (2018), the study area was recorded to extend over a single vegetation unit, namely the KwaZulu-Natal Coastal Belt Grassland (Mucina & Rutherford, 2018). This vegetation unit falls within the Indian Ocean Coastal Belt biome and has been classified with a conservation category of endangered (SANBI, 2011). This vegetation unit was not observed during the field assessment as a majority of the site was hard surfaced with vegetation modified and predominantly comprising of invasive and alien plant species as a result of disturbance.

Subsequent to consulting the conservation datasets, the northern area fell within a Terrestrial Systematic Conservation Plan (TSCP) CBA1 area indicating features of high irreplaceability, whilst south of the study area, the site was transformed (EKZNW, 2010). The Freshwater Systematic Conservation Plan (FSCP) for the province indicated that the majority of the study area fell within a conservation planning unit which was available, inferring that the area contains untransformed biodiversity (EKZNW, 2007). However, the field assessment confirmed that the site was highly transformed through anthropogenic activities and little vegetation was conserved to provide a suitable habitat for biodiversity. The watercourses were heavily invaded by invasive and alien plant species (IAPS) with human settlements located along the riparian zones. Vegetation clearing had taken place with little habitat remaining that is suitable for biodiversity. The systems had also been disconnected

through roads which limits flora and fauna from migration. Therefore, the classification of untransformed is not applicable to the study area and a habitat for biota is limited.

Watercourse Assessment

Watercourses that fell within the GN509 regulated area of a watercourse (100 metres from edge of watercourse) were assessed utilising various tools and datasets.

Utilising the Kleynhans et al. (2008) Index for Habitat Integrity (IHI) tool, the ecological category of the river systems could be determined and the assessor may predict a trajectory of change as a result of the proposed sewage upgrade activities. For the riverine systems Rip01-Rip08 and Rip13, both the instream and riparian habitat were largely modified (category D). This is attributed to the locality of these systems in relation to the settlements. The riparian vegetation was mostly cleared for growing crops and for housing and formal and informal roads. Invasive and alien plant species dominated and will continue to proliferate as areas are cleared for placement of the sewage pipelines and future disturbances occur. The channels were incised as a result of increased hardened surfaces and were confined to smaller areas as settlements increase and occupy more land. No flows were observed in these systems, apart from Rip02, Rip05 and Rip07. Most culverts were blocked by debris and litter with inadequate stormwater drainage able to supply water inputs in a controlled manner into these systems (Table ES1). For the riverine systems Rip09- Rip11, the instream habitat was moderately modified (category C) and the riparian habitat was largely modified (category D). The streams have undergone channelling and diversion of water for culverts. Interfering with the perennial flows caused incision which had modified the beds and banks of the streams, and this was worsened from increased volumes and velocities of surface runoff from surrounding hard surfaces. The riparian habitat within these systems remains as woodland, however, riparian vegetation has been cleared for roads and housing which has reduced surface roughness and increased sediment and water loads into the riverine systems. Disturbance has caused the proliferation of invasive and alien plant species which outcompetes indigenous vegetation and interferes with sub surface and base flows (Table ES1).

Table ES1: Instream and riparian habitat integrity for the at risk riverine systems.

RIVERINE SYSTEMS	INSTREAM IHI	RIPARIAN IHI
Rip01/Rip02/Rip03/Rip04/Rip05/Rip06/Rip07/Rip08 & Rip13	54.9 (D)	44,3 (D)
Rip09/Rip10 and Rip11	61,9 (C/D)	55,4 (D)

The riverine systems, Rip01-Rip04, Rip06, Rip08 and Rip13 did not occur within a natural or sensitive area in terms of conservation and as a result, no species of conservation concern or unique species were identified during the field assessment. The riparian areas were not suitable for refugia as most of the vegetation was cleared and development and hard surfacing had replaced the vegetation. It appears these riverine systems

have received sewage and other toxicants and pollutants and therefore are no longer sensitive as they have been modified through anthropogenic activities. Rip05, Rip07, Rip09, Rip10 and Rip11 were well vegetated and contained woodland which provided a suitable habitat for fauna. These systems contained flowing water which provides a suitable habitat for maintaining connectivity in the landscape and allowing for migration. A protected lily was observed within the woodland areas and therefore in spring, it is likely that more threatened and/or protected species may arise.

Table ES2: Ecological Importance and Sensitivity (EIS) of the at risk riverine systems.

DETERMINANTS	RIP01-RIP04,RIP06,RIP08 AND RIP13 SCORES	RIP05, RIP07, RIP09, RIP10 AND RIP11 SCORES
BIOTA (RIPARIAN & INSTREAM)	**(0-4)**	**(0-4)**
Rare & endangered (	1.0	1.5
Unique	1.0	1.0
Intolerant	1.0	2.0
Species/taxon richness	0.5	1.5
RIPARIAN & INSTREAM HABITATS	**(0-4)**	**(0-4)**
Diversity of types	1.0	1.5
Refugia	1.0	2.0
Sensitivity to flow changes	1.0	2.0
Sensitivity to flow related water quality changes	1.5	2.5
Migration route/corridor	0.5	2.0
Importance of conservation & natural areas	1	3.0
MEDIAN OF DETERMINANTS	1.00	2.00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)	**LOW, EC=D**	**MODERATE, EC=C**

Utilising the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) rating for the at risk riverine systems, the management objectives could be determined. The recommended ecological category for the riverine systems were to maintain their ecological category at seriously modified (Table ES3).

Table ES3: Phase 2 summary of results obtained for the at risk watercourses

WATER RESOURCE	RISK CATEGORY	PES SCORE	EIS SCORE	MANAGEMENT OBJECTIVE
Rip05, Rip07, Rip09, Rip10 and Rip11	High	E	Moderate	E Maintain
Rip01- Rip04, Rip06, Rip08 and Rip13	High	E	Low	E Maintain

Risk Assessment Matrix (RAM)

Although the upgrade will improve existing sanitation and improve water quality for the riverine systems by avoiding direct discharge of sewage into the rivers, sewage is still an aspect that will occur above or within the watercourses. During the construction phase, the greatest risk posed on these watercourses is the placement of the sewer pipeline. This activity accompanies various aspects that will result in a moderate impacts on the river

systems. Aspects that were assessed to have a moderate risk included the utilisation of machinery and vehicles within or in close proximity to the watercourses, and the excavation of the trench along/within watercourses. During the operation phase, the utilisation and operation of sewerlines posed the greatest risk and the aspect that would result in moderate impacts were the lack of regular inspections and maintenance resulting in collapse or failure of infrastructure as well as leakage and contamination into the river systems. The operational activities (lack of regular inspections and maintenance) was an activity that could not be mitigated to low risk as sewage entering the watercourses could have a detrimental effect on the functionality and the quality of water. Although the systems may potentially be receiving sewage via informal ablution facilities, the impacts will be compounded and contaminants may bioaccumulate and cause die off of more species and further affect human health, especially if water is abstracted from these systems for domestic purposes.

Specialist Recommendations

It is the specialist's opinion that the project may proceed. The impact of sewage on the watercourse could not be mitigated to low and therefore it is the specialist's opinion that the proposed activities fall within the ambit of a full water use license in accordance with the NWA, 1998 (No. 36 of 1998). The buffer zone tool generated a 50 metre buffer zone around the at risk riverine systems may not be feasible but must apply to the laydown areas and must be implemented where practical and possible. Where applicable, the eThekwini Municipal bylaws pertaining to sewage and stormwater as well as the Durban Metro guidelines relating to sewage must be implemented and adhered to. A protected species was observed, a botanist must be consulted prior to clearing activities, particularly in the D'MOSS area, to ensure no threatened and/or protected species, species of conservation concern or unique species are cleared accidentally. Only water uses under Section 21 (c) and (i) of the NWA, 1998 (No. 36 of 1998) have been assessed in this report. Therefore, no other activities may take place i.e. abstraction and discharge of sewage via conduit into watercourses.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ACRONYM	EXPANSION
AEV	ACUTE EFFECT VALUE
ASCP	AQUATIC SYSTEMATIC CONSERVATION PLAN
BA	BIODIVERSITY AREA
CBA	CRITICAL BIODIVERSITY AREA
CEV	CHRONIC EFFECT VALUE
DAFF	DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES
DEA	DEPARTMENT OF ENVIRONMENTAL AFFAIRS
DEFF	DEPARTMENT OF ENVIRONMENT, FORESTRY AND FISHERIES
DWAF	DEPARTMENT OF WATER AFFAIRS AND FORESTRY
DWS	DEPARTMENT OF WATER AND SANITATION
EC	ECOLOGICAL CATEGORY
EAP	ENVIRONMENTAL ASSESSMENT PRACTITIONER
EIA	ENVIRONMENTAL IMPACT ASSESSMENT
EIS	ECOLOGICAL IMPORTANCE AND SENSITIVITY
EN	ENDANGERED
EMPr	ENVIRONMENTAL MANAGEMENT PROGRAMME
ESS	ECOSYSTEM SERVICES
FEPA	FRESHWATER ECOSYSTEM PRIORITY AREA
FHIA	FRESHWATER HABITAT IMPACT ASSESSMENT
GA	GENERAL AUTHORISATION
GIS	GLOBAL INFORMATION SYSTEMS
GPS	GLOBAL POSITIONING SYSEM
HGM	HYDROGEOMORPHIC
IAPS	INVASIVE AND ALIEN PLANT SPECIES
IHI	INDEX OF HABITAT INTEGRITY
KSEMS	KSEMS ENVIRONMENTAL CONSULTING
MAP	MEAN ANNUAL PRECIPITATION
NEMA	NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO. 107 OF 1998)
NEM:BA	NATIONAL ENVIRONMENTAL MANAGEMENT BIODIVERSITY ACT
NEMPAA	NATIONAL ENVIRONMENTAL MANAGEMENT PROTECTED AREAS ACT
NFEPA	NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA
NWA	NATIONAL WATER ACT (ACT NO. 36 OF 1998)
PES	PRESENT ECOLOGICAL STATE
SANBI	SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE
TSCP	TERRESTRIAL SYSTEMATIC CONSERVATION PLAN
TWQR	TARGET WATER QUAITY RANGE
WMA	WATER MANAGEMENT AREA
WULA	WATER USE LICENSE APPLICATION

GLOSSARY

TERM	DEFINITION[1]
Acute Effect Value (AEV)	A criterion used to identify those cases requiring urgent management attention due to the aquatic environment under threat. The AEV may be used to identify cases in urgent need of mitigation.
Alluvium	Sedimentary materials deposited by flowing water as velocity decreases.
Anthropogenic	Induced, caused or with reference to man, society or humans.
Artificial	Produced by human beings as opposed to naturally occurring.
Biodiversity	The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are a part, and also includes diversity within species, between species, and of ecosystems.
Biophysical	The biological and physical components of the environment.
Buffer zone	A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.
Canalization	The creation of artificial drains or the incision caused by erosion gullies where no visible confined flow path existed previously.
Catchment	An area from which rainfall will collect and drain into a common outlet i.e. a watercourse.
Channel	The part of a river-bed containing its main current, naturally shaped by the force of water flowing down its gradient.
Chroma	The relative purity of the spectral colour which decreases with increasing greyness.
Chronic Effect Value (CEV)	A criterion used in certain special cases where the target water quality range is exceeded. The setting of water quality requirements or objectives at the CEV protects aquatic ecosystems from acute toxicity.
Construction	Any works undertaken to initiate or establish impeding or diverting or modifying resource quality, for the first time, including vegetation removal, site preparation and ground levelling.
Critical Biodiversity Area	Terrestrial (land) and aquatic (water) areas that are required to have their natural or near-natural state (function and structure) safeguarded to conserve biodiversity and maintain ecosystem functioning. The maps are spatial plans that stipulate biodiversity priority areas that are important for the long-term ecological functioning of ecosystems.
Cumulative	Refers to the impact on the environment which results from the incremental or combined effects of one or more developmental activities in a specified area over a particular time period, which may occur simultaneously, sequentially, or in an interactive manner.
Degradation	Lowering the quality of the environment and integrity of ecosystems.
Delineation	The technique utilised to establish the boundary of a water course using soil, vegetation and hydrology indicators/components.
Ecoregion	Geographic regions that are homogenous and delineated in a top-down manner on the basis of physical/abiotic factors including: physiography, climate, geology, soils and vegetation.

[1]As defined within: NWA (Act no. 36 of 1998); Macfarlane et al., (2007) and the DWS Notice 509, Gazette no. 40229 of 2016.

Ecosystem	A complex, interconnected system of interacting biotic (flora and fauna) and abiotic (soil, water etc.) components.
Ecosystem goods and services	The benefits people obtain from the natural processes in ecosystems which can be provisioning, regulating, cultural and supporting. The benefits derived from ecosystems are in accordance with the structure and functionality of that ecosystem. Aquatic ecosystems are renowned to provide water supply, flood attenuation and habitat for a range of aquatic biota.
Environmental Control Officer	An individual appointed to ensure the implementation of the EMPr and ensure environmental management practices are implemented and carried out on site for the duration and following the project.
Environmental Management Programme	Provides an overall environmental framework and guidelines upon which a contractor must carry out their operations throughout the project, from pre-construction through to post construction phases. This includes the activities, potential impacts, responsibilities and mitigation measures.
Ephemeral	Streams that only flow during and immediately after periods of precipitation. These systems mostly have inputs from surface runoff and may not have a distinct well defined channel. The drainage basin is either impervious or the groundwater table is below the bed of the stream.
Erosion	The process by which soil and rock are removed from the earth's surface by natural processes such as wind or water and then transported to and deposited in other locations.
General Authorisation	An authorisation to use water without a licence, provided that the water use is within the limits and conditions set out in the General Authorisation. It may only apply to new water uses and cannot be back dated. Schedule 1 water uses are not included under the General Authorisations, as they are already permissible in terms of the Act and do not require further authorisation.
General waste	Waste that does not pose an immediate hazard or threat to health or to the environment, and includes— (a) domestic waste; (b) building and demolition waste; (c) business waste; (d) inert waste; or (e) any waste classified as non-hazardous waste in terms of the regulations made under Section 69 of the NWA, and includes non-hazardous substances, materials or objects within business, domestic, inert, building and demolition wastes.
Ground water	Subsurface water in the saturated zone below the water table.
Habitat	The natural environment in which biota live. Biota are commonly adapted to the physical environment in which they live and changes in the environmental conditions can change the composition of biota (richness and diversity).
Hazardous waste	Substances or a mixture of substances, products or materials that are harmful to people and the environment as stipulated under Section 2(1) of the Hazardous Substance Act No. 15, 1973. Any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles.
Hue (of colour)	The dominant spectral colour.

Hydric Soils	Soils that are either seasonally or permanently saturated and are therefore under anoxic conditions. Redoximorphic features i.e. mottles are usually an indicator of seasonally saturated soils.
Hydrogeomorphic unit:	An aquatic ecosystem distinguished primarily on the basis of: (i) landform (the shape and localised setting of the ecosystem); (ii) hydrological characteristics (the nature of water movement into, through and out of the ecosystem); and (iii) hydrodynamics (the direction and strength of flow through the ecosystem). The Classification System recognises seven primary hydrogeomorphic (HGM) Units.
Hydrological regime	Fluctuations in the volume and rates of flow in water courses that is closely related to seasonal changes in climate i.e. rainfall.
Hydrophytic vegetation	Plant species that are adapted to living in soils that are either periodically or permanently saturated/ inundated and hence are adapted to anoxic conditions.
Indicator species	A species whose presence in an ecosystem if indicative of particular conditions (e.g. degraded, saline conditions, particular zones of wetness).
Indigenous	A species that occurs, or has historically occurred, naturally in a free state of nature within a specific ecosystem but excludes a species that has been introduced into the ecosystem as a result of human activity.
Intermittent stream	Intermittent streams tend to flow during the wet seasons and are dry during the dry seasons. These systems are therefore predominantly fed by surface runoff but during the wet season, receive base flow contribution from groundwater.
Invasive Alien Plant Species	Plant species that establish and disperse outside of their natural habitat range and are therefore tolerant of conditions (i.e. droughts) and threaten the naturally occurring species and other habitats in the area.
Mitigation	A practical means of minimising or reducing the impacts of a particular activity on biota and the environment.
Monitoring	Surveys, inspections and examinations to determine the trends and status of changes or to assess the outcome of an implemented activity.
Monitoring Programme	A programme for taking regular measurements of the quantity and quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge.
Mottles	A redoximorphic feature indicated by spots of colour in the soil that contrast with the background (matrix). They are associated with periodic wetting and occur when minerals in the soil re-oxidise when aerobic conditions occur.
Perennial	The stream is continually flowing, with the groundwater table above the bed of the river and therefore maintaining a continuous base flow.
Pollution	The direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it– (a) less fit for any beneficial purpose for which it may reasonably be expected to be used; or

	(b) harmful or potentially harmful.
Precautionary principle	Avoiding risk through a cautious approach in that negative impacts on the environment and society are anticipated and prevented, and when they cannot be altogether prevented, are minimised and remedied.
Protection	In relation to a water resource, refers to– (a) maintenance of the quality of the water resource to the extent that the water resource may be used in an ecologically sustainable way; (b) prevention of the degradation of the water resource; and (c) the rehabilitation of the water resource.
Rehabilitation	Refers to the methods and measures of restoring the integrity, functionality and natural characteristics of degraded ecosystems that have mostly been disturbed by anthropogenic activities.
Re-vegetation	The process of reinstating natural vegetation in areas that were disturbed or degraded throughout various phases of the project. It mostly entails planting indigenous plant species.
Riparian habitat	The area of land directly adjacent to the active channel of a river, which is influenced by river-induced or river-related processes. The soils are inundated at a frequency that supports a particular unit of vegetation with a composition and physical structure distinct from those of adjacent land areas.
River/Riverine Habitat	A large natural stream with a clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit.
Terrestrial	Pertains to dry land and is outside the boundaries of aquatic ecosystems.
Waste	Any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 [NEMWA; 2014]
Watercourse	(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.
Water resource	– a river or a spring; – a natural channel in which water flows regularly or intermittently; – a wetland, lake or dam into which, or from which, water flows; – any collection of water which the Minister may declare to be a watercourse; and – surface water, estuaries and aquifers (underground water). – All water bodies in the hydrological cycle, including underground water, are regarded as water resources.
Water table	The upper surface of groundwater or that level below which the soil is completely saturated

	with water. The water levels vary according to climate (precipitation and evapotranspiration).
Wastewater	Water containing waste, or water that has been in contact with waste material.
Wetland	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 as referred in Section 1 (1) (xxix) of the NWA No. 36 of 1998.

1. INTRODUCTION

1.1 Background to Wetland Impact Assessments

As per the National Water Act (NWA), 1998 (No. 107 of 1998), a wetland is defined as land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil. Wetlands therefore form at the interface between terrestrial and aquatic environments, and this interface allows for wetland systems to constitute an interconnected web within the landscape and catchments, maintaining *inter alia* an adequate supply of surface and underground water; hydrological stability; erosion control and providing a habitat to flora and fauna. The importance and functionality of wetland systems has caused them to become exploited, with 35 and 60 % of wetlands already degraded or lost due to various anthropogenic activities in the form of mining, urban development and agricultural and timber plantations (Dada et al., 2007).

Wetlands must therefore be safeguarded in the long term in an approach to balance the need for economic growth and the use of land with the need to protect the environment and ecology. The Department of Water and Sanitation (DWS) in terms of the NWA, 1998 (No. 36 of 1998), is the custodian and mandated to regulate water use, and activities affecting wetlands.

This report will classify and provide detailed infield delineations of the wetlands, along with an assessment of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and Ecosystem Service (ESS) delivery/potential of the wetland systems that may potentially be impacted on by the proposed activities. The results of this assessment will subsequently be utilised to guide the manner in which the prospective activities are carried out and determine the best mitigation and/or rehabilitation measures to be implemented to sustain the Recommended Ecological Category (REC) of the wetlands identified to be at risk (DWAF, 2007).

1.2 Background to Project

According to the draft National Sanitation Policy (DWS, 2016), South Africa is at present, experiencing an increase in human settlements and thus there is strain on existing small sanitation systems and an increase in informal sanitation systems. The country is expected to undergo increased urbanisation and as a result, this will place further pressure and challenges on sanitation systems and water resources. Significant consideration must therefore be placed on maintaining and upgrading the provision of sanitation services, whilst planning and designing human settlements in an integrated holistic approach with freshwater resources. As the water and sanitation department within the eThekwini Municipality, the department is the custodian responsible for maintaining water and sewage servitudes within the eThekwini Metropolitan area. The proposed upgrade activities will improve domestic waste and sewage disposal systems for the residents of KwaMashu and further improve the water quality of watercourses in the area that are currently receiving sewage discharges via informal ablution facilities.

The proposed upgrade activities will fall in line with the eThekwini Municipality's Integrated Development Plan, the municipal bylaws on sewage, Durban Metro guidelines on sanitation and national policies such as the White Paper on Water Supply and Sanitation (1994); the White Paper on a National Water Policy of South Africa (1997) and the White Paper on Basic Household Sanitation (2001). The proposed infrastructure will be located on various pockets within Ntuzuma B ward 38, 41, and 45, as highlighted in purple in Figure 1 below. These pockets are located in the northern operational area of KwaMashu, within the eThekwini Metropolitan Municipality of KwaZulu-Natal (Figure 1). The sewage pipeline has a diameter of 160 mm and is approximately 13 kilometres (km) in length.

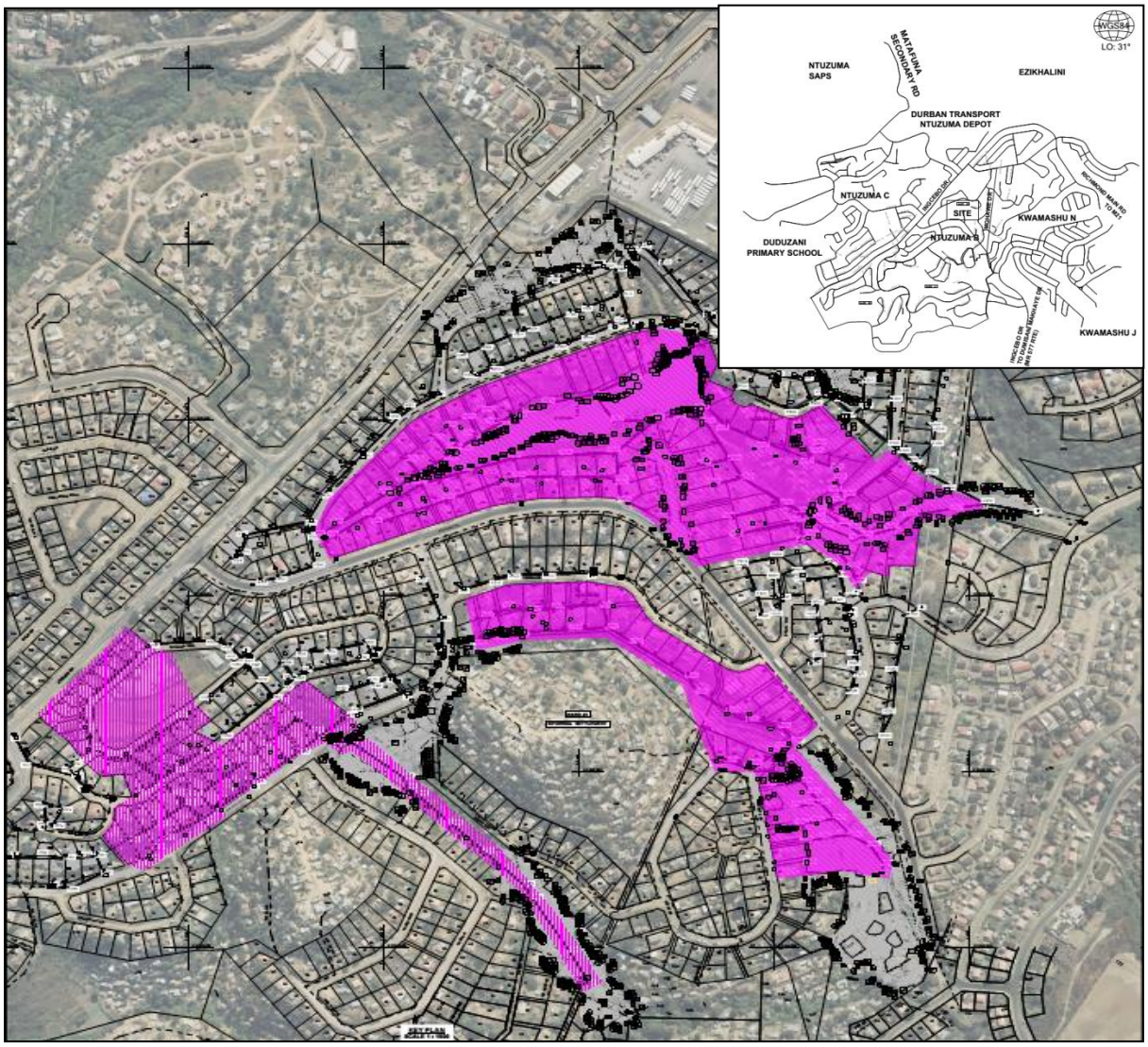


Figure 1: Master layout plan of the upgrade activities proposed for Kwamashu North (Ncumatha Trading and Projects, 2019).

The pipelines traverse various sections of watercourses which triggers the need for an environmental impact assessment and water use license application process. KSEMS Environmental Consulting Pty Ltd. (KSEMS) were appointed by the eThekwini Municipality Water and Sanitation to conduct a Wetland Impact Assessment

report for wetlands that may be at potential risk of impact as a result of sewage upgrades, associated with housing developments. Figure 2 below illustrates KSEMS' role in the environmental survey process.

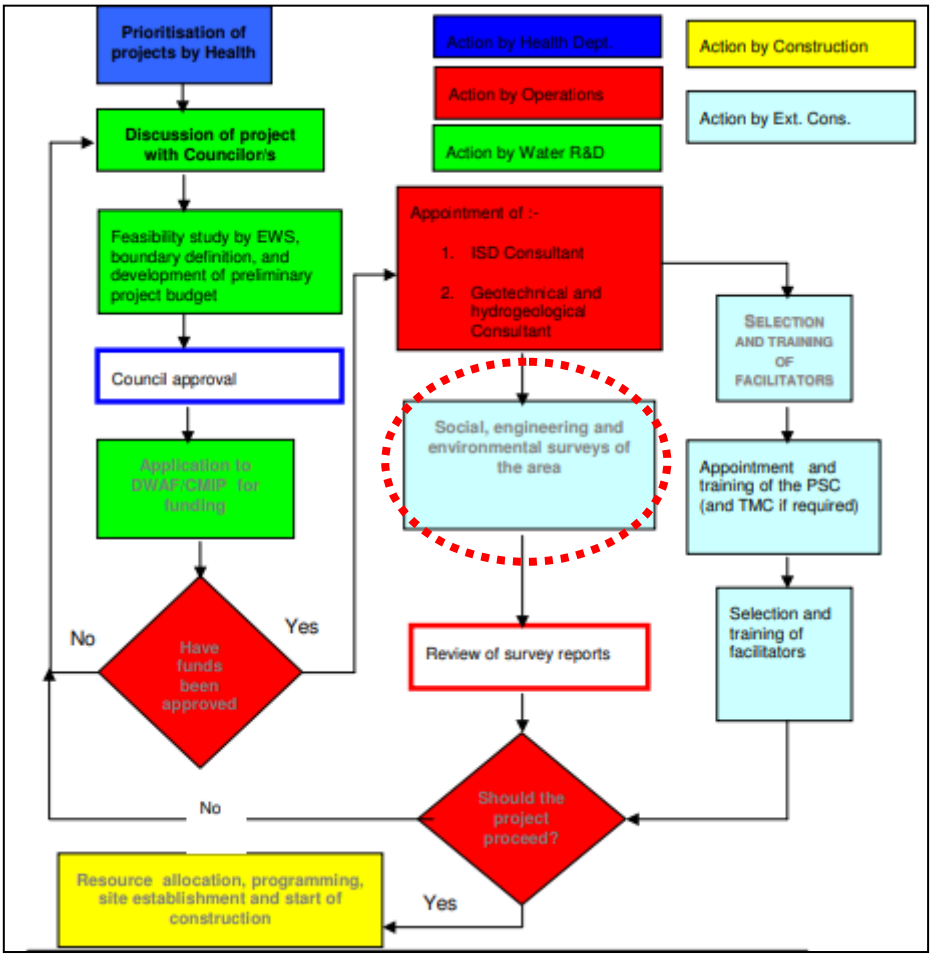


Figure 2: Implementation plan for the delivery of basic water and sanitation services in the eThekwini Municipal area (eThekwini Municipality, 2003).

2 SCOPE OF WORKS

KSEMS were appointed to fulfil the requirements of the National Environmental Management Act, 1998 (No. 107 of 1998) Environmental Impact Assessment Regulations (General Notice (GN) 326 of Government Gazette No. 40772, dated 7 April 2017) in addition to the National Water Act, 1998 (No. 36 of 1998) Regulations Regarding the Procedural Requirements for Water Use Licence Applications and appeals (General Notice (GN) 267 of Government Gazette No. 40713, dated 24 March 2017). In order to fulfil these requirements, the following scope was undertaken.

Conduct a wetland impact assessment report that comprises of:

- Identification of site-specific biophysical characteristics; hydrology, vegetation, geomorphological features on a local scale and broach catchment scale.
- Conducting a qualitative assessment comprising of assessing the direct, indirect and cumulative impacts to the watercourses within the study area, summarised into a Risk Assessment Matrix (RAM).

- Conducting a phase 2 assessment, comprising of assessing the Present Ecological State (PES), provision of Ecosystem Services (ESS) and the Ecological Importance and Sensitivity (EIS) of all the wetland systems which were deemed to be at risk of being impacted on by the proposed upgrade activities.
- Providing Recommended Ecological Categories (REC) for the assessed watercourses.
- Mapping the development, superimposing associated activities and infrastructure in relation to sensitive environments and "no-go" areas.
- Devising and recommending management and mitigation measures to manage and mitigate potential negative impacts whilst enhancing the positive impacts.

3 SITE CHARACTERISTICS

3.1 Locality

The site is located within the northern rural area of Kwamashu, adjacent to the town of Ntuzuma. The central geographic point of the school is 29^0 44' 32.61" S and 30^{0}57' 27.08 "E. Figure 3 provides the locality of the housing and associated infrastructure in relation to surrounding features and towns.

Figure 3: Locality map of the northern Kwamashu area, adjacent to the town of Ntuzuma (Google Earth, 2020).

3.2 Land Use & Cover

The land uses within the study area comprised mainly of rural developments in the form of housing and roads (informal and formal). Natural features observed in the area were watercourses draining in a south easterly direction and riparian vegetation limited to the drainage areas.

3.3 Hydrological Setting

The watercourses within the study area were observed to fall within the DWS quaternary catchment area U20M which falls under the Mgeni sub water Management Area (WMA) and within the greater Mvoti to Umzimkulu WMA (Figure 4). The WMA is drained by several parallel rivers which flow in a south-easterly direction and discharges into the Indian ocean. The main river within this WMA is the Mgeni River with several tributaries feeding into the system (DWA, 2003). Quaternary catchment U20M was recorded to exhibit a Mean Annual Precipitation (MAP) and Mean Annual Runoff (MAR) rate of 925 and 131 mm, respectively (DWAF, 2005).

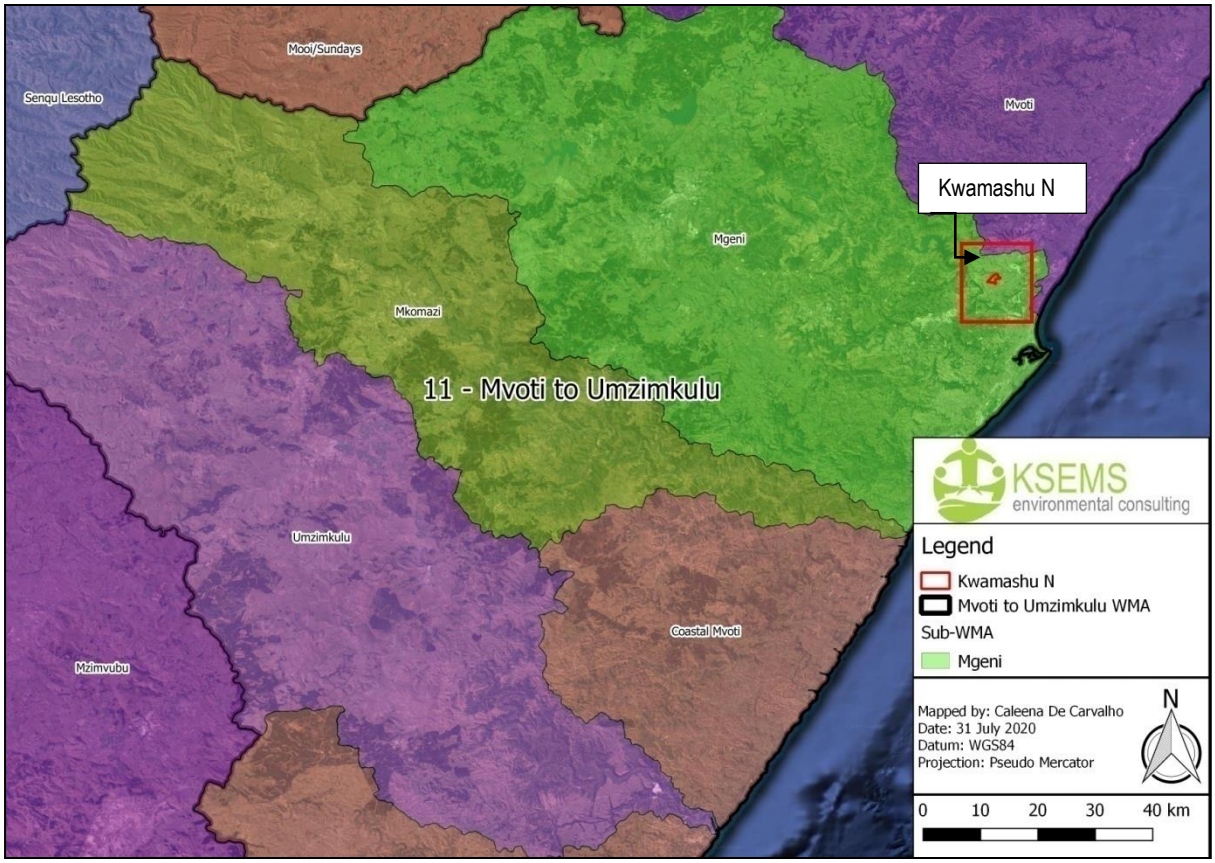


Figure 4: Map of the Mvoti to Umzimkulu WMA and Mgeni sub- relevant to the Kwamashu North study area (KSEMS, 2020).

3.4 Conservation Priorities

Land-cover change and habitat loss are widely recognised as the major drivers of biodiversity loss in the world. With a diverse range of ecosystems distributed over South Africa, measures, guided by policies and frameworks are required to conserve these habitats. The following will provide an overview of the various national and provincial conservation tools in place, which are relevant to the study area.

3.4.1 National Freshwater Ecosystem Priority Areas (NFEPAs)

The NFEPA data provides strategic spatial priorities for conserving South Africa's freshwater ecosystems whilst supporting their sustainable use. NFEPAs were identified based on a range of criteria for the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries such as (Driver et al., 2011):

- Threatened and near threatened fish species and migration corridors;
- Identification of connected ecosystems;
- Maintenance of water supply with high water yields;
- Ecosystem types and conservation concern;
- Ecosystems identified in the National Biodiversity Assessment of 2011; and
- Protected areas and focus areas.

Subsequent to an analysis of the NFEPA watercourse datasets, at a desktop level and during a field assessment, it was concluded that no NFEPA watercourses were identified within the study area, only the uMngeni River was identified south-west of the site a distance away (Figure 5).

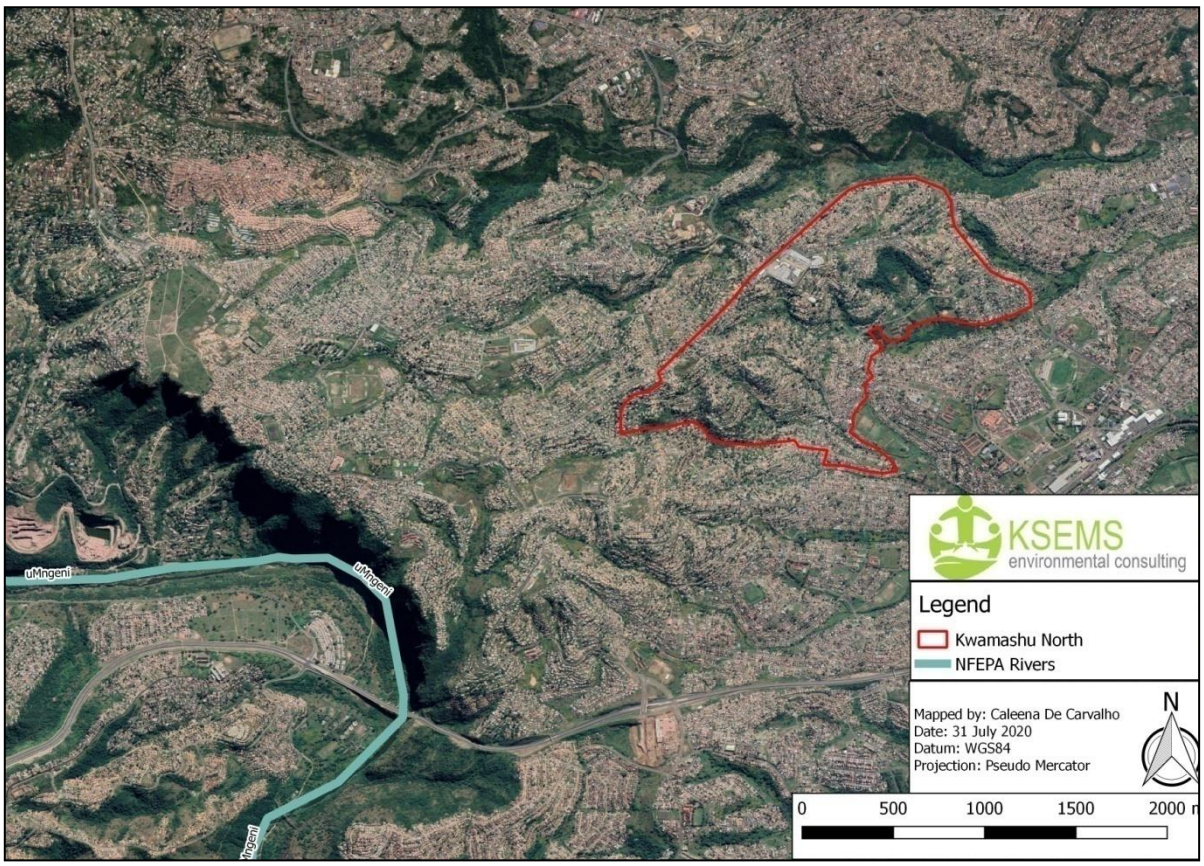


Figure 5: Map of the NFEPA river located south-west of the site (KSEMS, 2020).

3.4.2 Durban Metropolitan Open Space System (D'MOSS)

D'MOSS forms an integral component of the eThekwini Municipality's planning schemes such that it enables them to integrate open spaces with infrastructural developments. Open space areas are areas that have been assessed to contain biodiversity and ecosystems that are of ecological importance for future generations. They are public, private and traditional authority owned land that seeks protection. From Figure 5 below, it is evident that the proposed activities will traverse woodland north of the site and thicket north-east of the site. A large portion of D'MOSS falls outside of the study area.

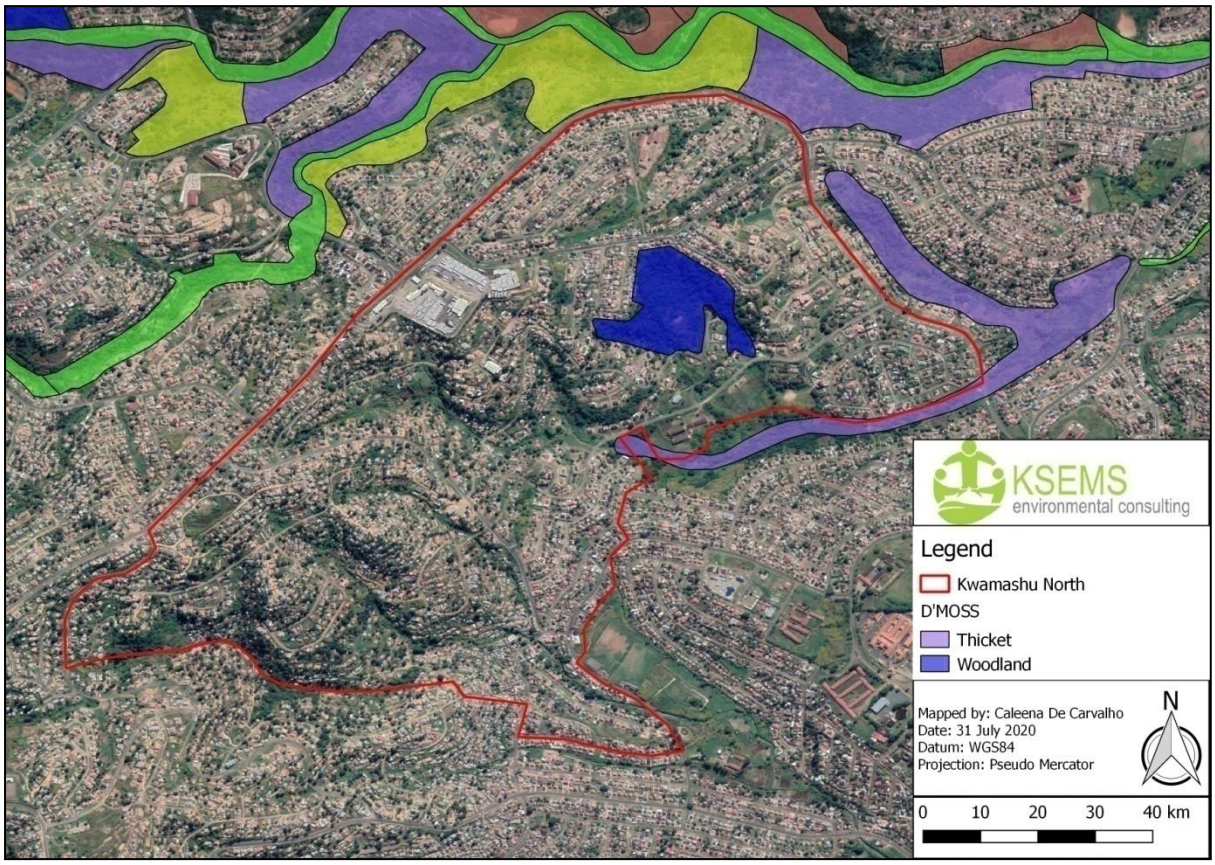


Figure 6: D'MOSS located within and surrounding the study area (KSEMS, 2020).

3.4.3 KwaZulu-Natal Systematic Conservation Plans

Critical Biodiversity Areas (CBAs) are terrestrial (land) and aquatic (water) areas that are required to have their natural or near-natural state (function and structure) safeguarded to conserve biodiversity and maintain ecosystem functioning and the provision of ecosystem services (ESS) (Nel et al., 2011). An area is selected as a CBA if it contains the following:

i. Irreplaceable sites or features;
ii. Near-irreplaceable sites or features;
iii. Nationally-listed critical ecosystems;
iv. NFEPAs; and/or
v. Flagship free-flowing rivers.

Terrestrial Biodiversity Areas were categorised according to Table 1 below.

Table 1: Explanation of Terrestrial Biodiversity Area categories according to EKZNW (2010).

LEGEND	BIODIVERSITY AREAS	BIODIVERSITY AREA CATEGORY EXPLANATION
R2	CBA 1 (Mandatory)	Indicates that the Planning Unit (PU) contains one or more features with a very high irreplaceability score. There are no other localities which have the potential to meet the conservation target for this feature.

R1	CBA 2 (Mandatory)	PUs that contain one or more features within a very high irreplaceability score. This infers that alternate sites have been identified within which the targets can be met, but there are few.
R0	CBA 3 (Optimal)	PUs that contain one or more features within a low irreplaceability score.
0Co	Biodiversity Area (BA)	PUs which have the potential to be substituted for CBA2 and CBA3 that become developed, thus ensuring the protection of biodiversity, environmental sustainability and human well-being.
Res	Existing Protected Areas	PUs that have already been incorporated into the KZN Protected Areas Network.
Ign	100% Transformed (2005 LC)	PUs that have been 100 % transformed by anthropogenic pressures and are of least concern.

According to the Terrestrial Systematic Conservation Plan (TSCP), the northern area fell within a CBA1 area such that there are features of high irreplaceability, south of the study area, the site was transformed (EKZNW, 2010) (Figure 7). However, the field assessment confirmed that the site was highly transformed and little vegetation was conserved to provide a suitable habitat for biodiversity.

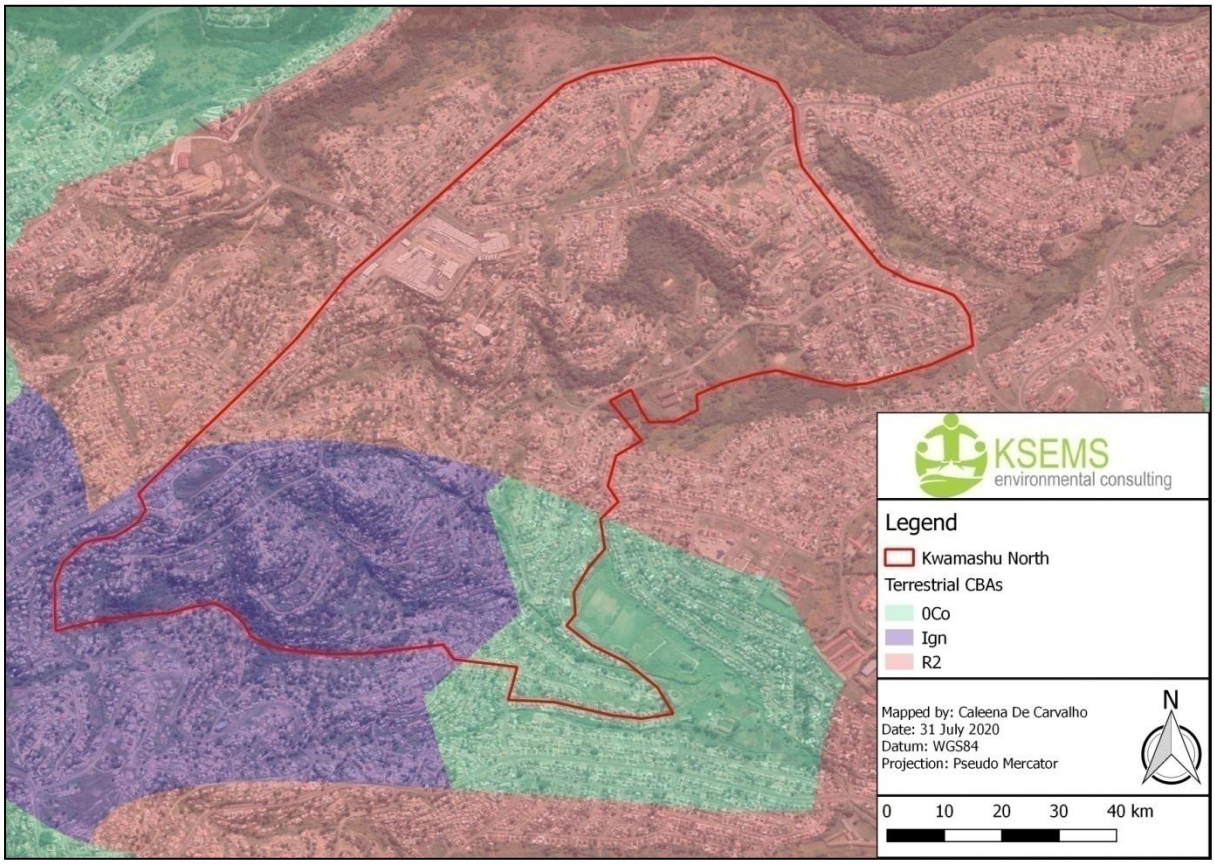


Figure 7: Map of the KZN TSCP units that were recorded within the study area (EKZNW, 2010).

Planning Units were categorised according to Table 2 below.

Table 2: Status descriptions for freshwater planning units (EKZNW, 2007).

LEGEND/STATUS	DESCRIPTION OF STATUS
Available	Untransformed biodiversity areas
Conserved	Formal Protected Areas
Earmarked	Optimal biodiversity areas required to meet biodiversity targets
Excluded	Biodiversity transformed areas

According to the Freshwater Systematic Conservation Plan (FSCP) for KZN, the majority of the study area traverses through one (1) conservation planning unit which was available, inferring that the area contains untransformed biodiversity (EKZNW, 2007) (Figure 8). However, from conducting the field assessment, the site was highly transformed and the watercourses were heavily invaded by invasive and alien plant species (IAPS) with human settlements located along the riparian zones. Vegetation clearing had taken place with little habitat remaining that is suitable for biodiversity. The systems had also been disconnected through roads which limits flora and fauna from migration. Therefore, the classification of untransformed is not applicable to the study area and a habitat for biota is limited.

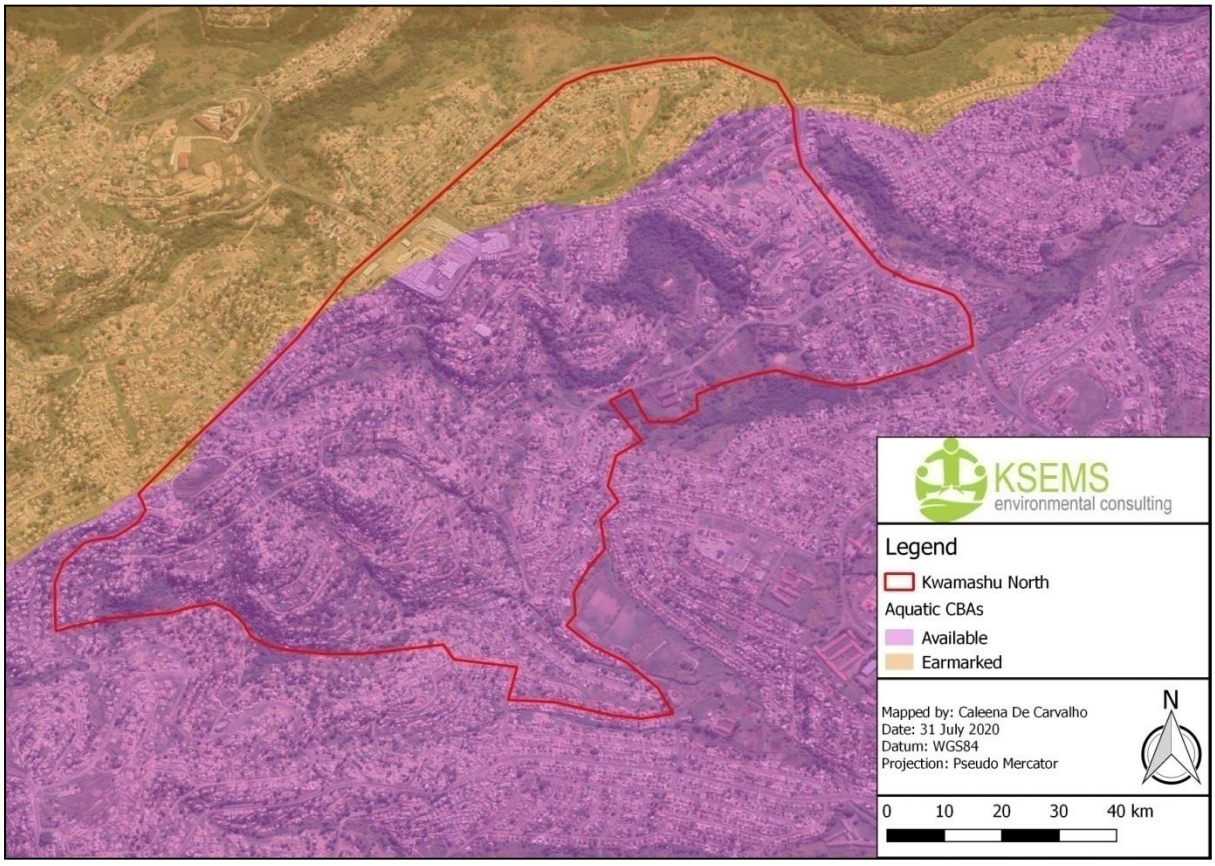


Figure 8: Map of the KZN FSCP planning units that were recorded within the study area (EKZNW, 2007).

It must be noted that the aforementioned biodiversity priority areas were modelled at a desktop level on a provincial scale, and thus may not be accurate representations of the current on-site status of the relevant planning units. Therefore, ground truthing of all the relevant at-risk biodiversity areas was conducted during the

field assessment to ascertain the current state, and thus the biodiversity value. Subsequently, the study area was observed to have undergone high degradation and large modification that can predominantly be attributed to rural development.

3.5 Vegetation

Mucina and Rutherford delineated vegetation units throughout southern Africa. The purpose of this exercise was to map the extent of various vegetation types across the country and to identify their conservation status. Utilising the Mucina and Rutherford literature (2006) and dataset (2018), the study area was recorded to extend over a single vegetation unit, namely the KwaZulu-Natal Coastal Belt Grassland (Figure 9) (Mucina & Rutherford, 2018). This vegetation unit falls within the Indian Ocean Coastal Belt biome and has been classified with a conservation category of endangered (SANBI, 2011). This vegetation unit was not observed during the field assessment as a majority of the site was hard surfaced with vegetation modified and predominantly comprising of invasive and alien plant species as a result of disturbance. Vegetation was limited to the riparian areas and comprised mainly of vegetation used in livelihoods such as Amaranth species and Musa acuminate. Invasive and alien plant species observed were commonly *Bidens Pilosa, Ricinus communis, Solanum mauritianum, Tithonia rotundifolia, Ageratum conyzoides, Ipomoea purpurea, Chromolaena odorata, Tagetes minuta, Canna indica* and *Cardiospermum grandiflorum.*

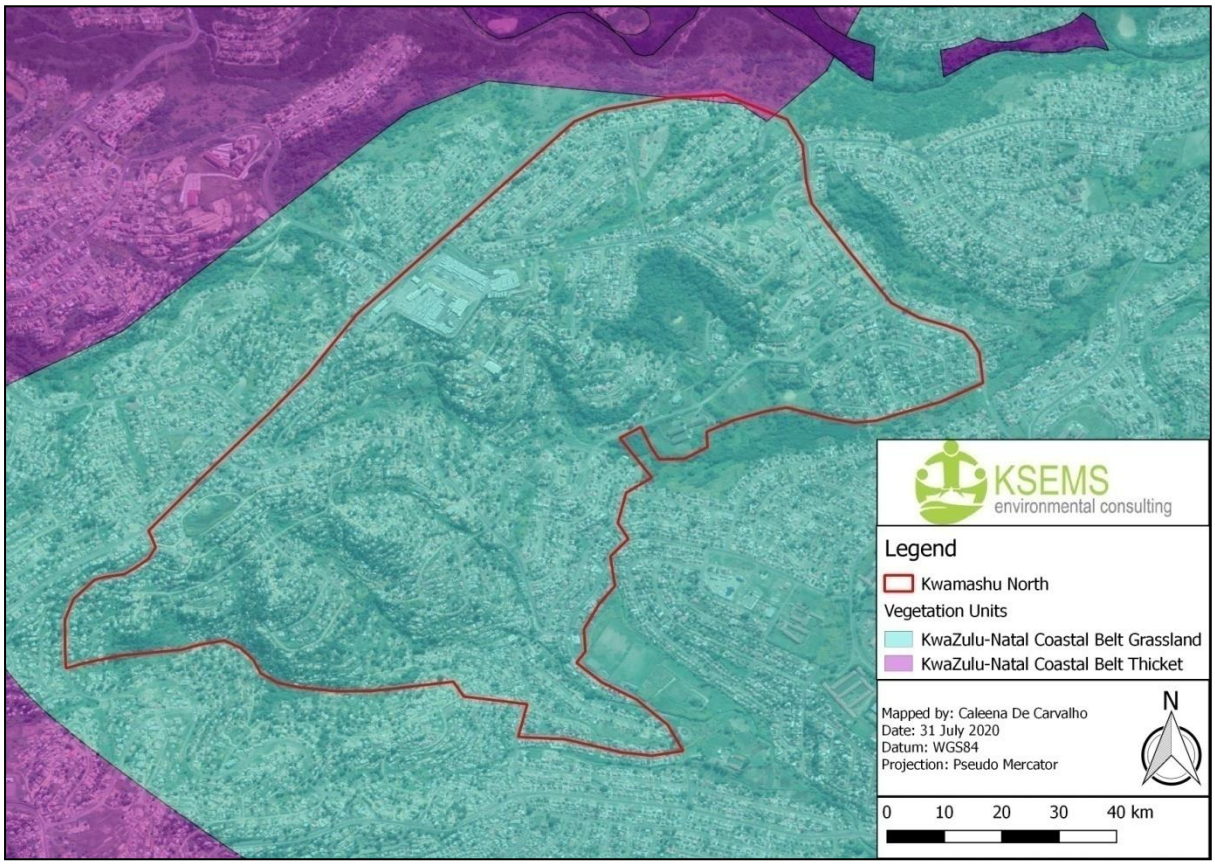


Figure 9: Map of the vegetation units relevant to the study area (Mucina & Rutherford, 2018; KSEMS, 2020).

3.6 Geology

The study area dataset illustrated that the study area comprised of two geological units, namely Natal Sandstone and Dywka tillite (Figure 10). The sandstone is generally reddish, feldspathic and micaceous sandstone with subordinate quartz arenite, mudrock, granulestone and conglomerate whilst tillite is a dark grey softish sedimentary rock. Sedimentary units comprise of shales and sandstones which are fine to coarse grained sediments that are known to erode and fracture easily resulting in groundwater seepage into the soil and sediment deposits along drainage lines.

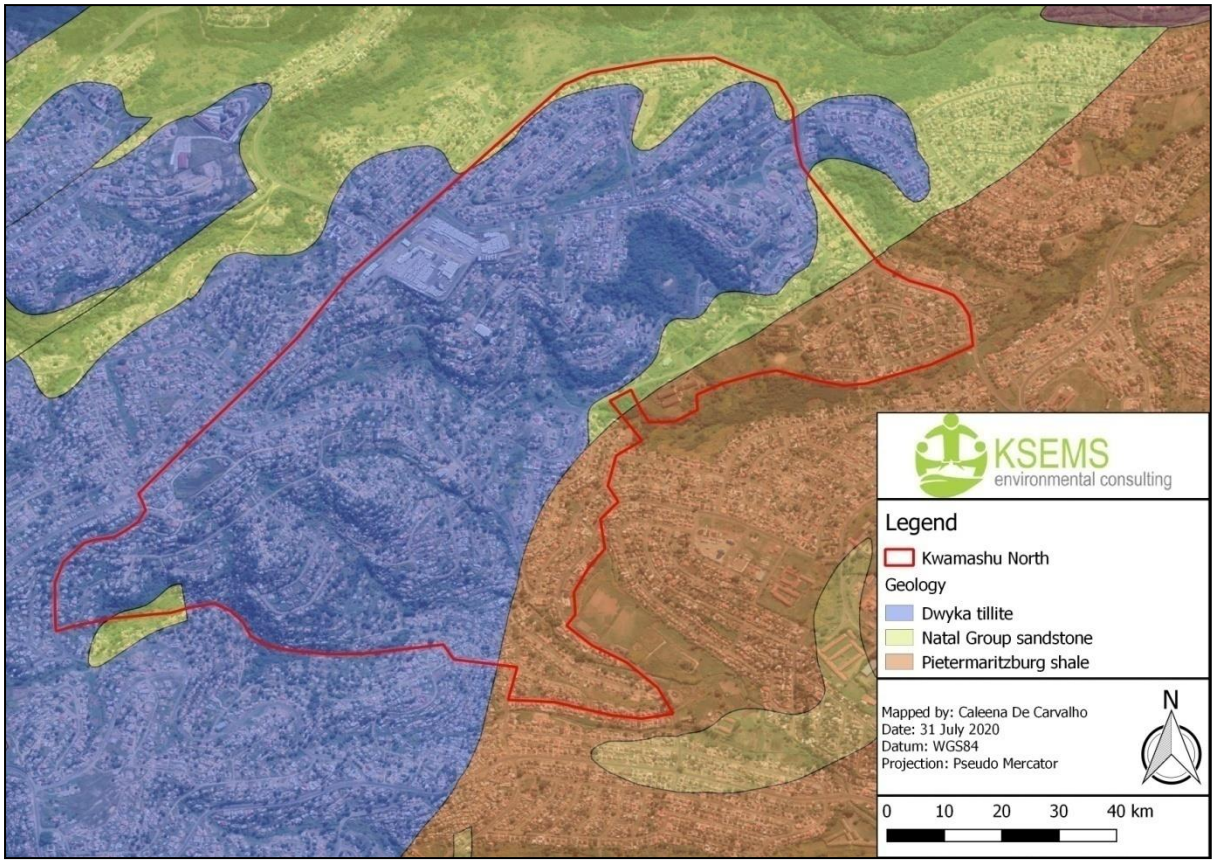


Figure 10: Map of the geology relevant to the study area (KSEMS, 2020).

3.7 Biophysical Characteristics

Table 3 below provides the climatic conditions of the study area.

Table 3:Biophysical characteristics of the Mgeni sub-WMA, quaternary catchment U20M.

BIOPHYSICAL CATEGORIES	BIOPHYSICAL CHARACTERISTICS	SOURCE
Elevation (A.S.L.)	Minimum –293.00m Maximum-812.00 m	Google Earth 2020 ™& Surveyor General
Mean Annual Precipitation (MAP)	925 mm	DWAF, 2003
Rainfall Seasonality	Early Summer – late summer	DWAF, 2003
Mean Annual Temperature (MAT)	16º C	DWAF, 2003

Mean Annual Runoff (MAR)	674.00 (million m^3/annum)	DWAF, 2003
Mean Annual Potential Evaporation (MAPE)	1,214 mm	DWAF, 2003
Quaternary Catchment	U20M	DWA, 2010
DWA Ecoregion (Level 1)	North Eastern Coastal Belt	DWA, 2010
Vegetation Type (Provincial level)	KwaZulu-Natal Coastal Belt Grassland (Endangered)	Mucina & Rutherford, 2018

Key: A.S.L – Above Sea Level

4 APPLICABLE LEGISLATION & POLICIES

This study was drafted and the relevant data gathered in accordance with the objectives, methods/techniques/guidelines and requirements stipulated within the following legislation (Table 4).

Table 4: Legislation, policies and frameworks applicable to the nature of this project.

NATIONAL LEGISLATION	APPLICABILITY
Constitution of the Republic of South Africa (No. 108 of 1996)	Section 24 of the Constitution provides that: "Everyone has the right – to an environment which is not harmful to their health or well-being; to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that: prevent pollution and ecological degradation; promote conservation; secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.
National Water Act, 1998 (No. 36 of 1998)	Ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which consider amongst other factors: – meeting the basic human needs of present and future generations; – promoting the efficient, sustainable and beneficial use of water in the public interest; – facilitating social and economic development; – protecting aquatic and associated ecosystems and their biological diversity; and – reducing and preventing pollution and degradation of water resources. <u>*Section 19: Prevention and remedying effects of pollution*</u>: An owner of land, a person in control of land or a person who occupies or used the land on which – (a)any activity or process is or was performed or undertaken, or (b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. The measures referred to may include to: a) cease, modify or control any act or process causing the pollution; b) comply with any prescribed waste standard or management practice; c) contain or prevent the movement of pollutants; d) eliminate any source of the pollution;

	e) remedy the effects of the pollution; and f) remedy the effects of any disturbance to the bed and banks of a watercourse. *Section 20: Control of emergency incidents:* A responsible person must – (a) take all reasonable measures to contain and minimize the effects of the incident; (b) undertake clean-up procedures; (c) remedy the effects of the incident; and (d) take such measures as the catchment management agency may either verbally or in writing direct within the time specified by such institution. *DWS Regulation No. R. 267 (Government Gazette No. 40713 of 2017)* The purpose of these regulations is to prescribe the procedure and requirements for WULAs as contemplated in Section 41, as well as an appeal in terms of Section 41(6) of the NWA. Within Section 6 of Regulations No. R. 267 the content required within a Wetland Delineation Report (including watercourses) are stipulated, and thus were considered by the author when drafting this report. Additionally, the standardized and DWS accepted methods that must be used for determining the various aspects of assessments during the WULA process related to wetlands are presented and their sources referenced. Notice No. 509, National Water Act (36/1998) » General Authorisation for water uses as defined in section 21(c) or section 21(1) of the Act stipulates activities and conditions that allow for an Applicant to apply for a GA instead of a full WULA and provides mitigation measures to be implemented that will reduce impacts on the watercourses at risk by the proposed development activities.
White Paper on Conservation and Sustainable Use of South Africa's Biological Diversity	The main aim of this white paper is the protection and the use of ecosystem services in a sustainable manner as to ensure the survival of these important aspects of our environments and surroundings.
National Water Resource Strategy of 2013	Given constraints and demands on water resources, South Africa cannot afford practices which reduce supply, such as pollution, inefficient water management practices, lack of infrastructure maintenance, unaccounted for water, and poor governance. This Strategy provides for the necessary capacity to manage our water resources sustainably and equitably whilst protecting the water resources.
DWAF Position Paper on Wetland Management (Draft Legislation)	Legislation that has been proposed and submitted to ensure the protection of wetlands and to ensure they are successfully monitored and protected as they are categorised as sensitive environments and biodiversity hotspots in our ecosystems and environments.

National Veld and Forest Fire Act, 1998 (No. 101 of 1998)	The main objective is the protection of soil, water and plant life through the prevention and combatting of veld, forest, and mountain fires.
National Environmental Management Act, 1998 (No. 107 of 1998)	Section 28 of the Act instils the duty of care to every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, insofar as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimize and rectify such pollution or degradation of the environment. It is an offence for any person to unlawfully and intentionally or negligently commit any act or omission which: (a) causes, or is likely to cause, significant pollution or degradation of the environment, or (b) detrimentally affects, or is likely to affect, the environment in a significant manner.If convicted of an offence, the responsible person is liable to a fine of up to R5 million or imprisonment for up to one year, or to both. *EIA Regulations (2014, as amended in 2017)* The primary purpose of this assessment is to provide specialist input into the environmental management process, including the water use license application, associated with the proposed development. The author has drafted this specialist report in accordance with the requirements listed under Appendix 6 of the NEMA: EIA Regulations (2014, as amended).
National Environmental Management: Biodiversity Act, 2004 (No. 10 of 2004)	This Act seeks to provide for the management and conservation of biodiversity and the sustainable use of natural resources. This Act was established under the framework of NEMA and refers to biomonitoring, threatened and protected ecosystems and floral and faunal species and deals with biodiversity planning and monitoring, relocation and permits and the control of invasive and alien plant species. *NEM:BA (No. 10 of 2004) Alien and Invasive Species List (2016)* The legislation presented under this regulation relates to Category 1a, 1b, 2 and 3 listed invasive species. Specifically, what activities are restricted in terms of Section 74A (1), exempted in terms of Section 71(3) and which activities require permits from the relevant competent authority in terms of Section 71(1). All IAPS that are listed within this report must be cross-referenced with this regulation and the legislated requirements followed accordingly.
Environmental Conservation Act, 1989 (No. 73 of 1989)	This Act ensures that all environmental components which have a major role to play in our environments and ecosystems are protected to ensure their survival and the ecosystem services they provide.
National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003)	This Act supports the conservation of soil, water and biodiversity especially in areas known as biodiversity hot spots. This Act creates a framework and management system for all protected areas in South Africa.

	The system of protected areas in South Africa consists of: – Special nature reserves, national parks, nature reserves and protected environments; – World Heritage Sites; – Marine protected areas in terms of the Marine Living Resources Act; – Specially protected forest areas, forest nature reserves and forest wilderness areas; and – Sensitive environments which includes biodiversity species which are endangered.
National Forests Act, 1998 (No. 84 of 1998)	The purpose of this Act is to: – Promote the sustainable management and development of forests for the benefit of all surrounding communities and environments; – Create the conditions necessary to restructure forestry and sustainably use these forest areas; – Provide special measures or boundaries for the protection of certain forests; – Promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes; – Enhance community forestry; and – Promote greater participation from all elements of society relating to aspects of forestry and the forest products industry by any person disadvantaged by unfair discrimination.
National Environmental Management: Waste Management Act (No. 59 of 2008)	This Act provides laws regulating waste management in order to protect the health of the environment by implementing reasonable measures for the prevention of pollution and ecological degradation and for ensuring sustainable development. It aims to establish national standards for the regulation of waste by all levels of government, and to provide for control of all waste management activities and implement remediation measures and compliance enforcement for land which has been impacted by waste.
PROVINCIAL	**APPLICABILITY**
KwaZulu-Natal Biodiversity Conservation Plan (Updated 2007)	The provincial spatial biodiversity plan has two main goals (SANBI website): – To guide conservation agencies by identifying priority areas for expansion and consolidation of protected areas; and – To guide land-use planners and decision-makers in other sectors by identifying critical biodiversity areas (CBAs) critical for conserving representative samples of biodiversity and maintaining ecosystem functioning.
KwaZulu-Natal Nature Conservation Management Act, 1997 (No. 9 of 1997)	The main aim is to provide institutional structures such as policies for nature conservation and protection in Kwa-Zulu Natal and to establish, control and monitor bodies and mechanisms.
Nature Conservation Ordinance,	Provides a list of threatened and/or protected floral and faunal species within the

1974 (No. 15 of 1974)	province and the implementation of laws for their removal and protection.
Provincial Spatial Development Framework 2005.	The Provincial SDF is a document that promotes a pragmatic approach to future planning and developmental opportunities as well as challenges in any province. The primary objectives of this document is to: – Provide spatial goals and supporting policies to achieve positive changes and outcomes in the spatial organisation of Municipal areas to better ensure a sustainable development future; – Promote the sound planning principles according to the relevant legislation; as to ensure a sustainable initiative; and – Promote the general well-being of its in habitants, thereby ensuring that the most effective and orderly planning is achieved for an area whereby changes, are needed and growth in the area can be managed to utterly benefit its inhabitants.
LOCAL	**APPLICABILITY**
eThekwini Municipality Sewage Disposal Bylaw (2015)	The purpose of this guideline is to provide for the management and regulation of sewage and to provide efficient access to sanitation and sewage services which applies to the Municipality's proposed housing and sewage upgrade project.
POLICIES & GUIDELINES	**APPLICABILITY**
Biodiversity Impacts Assessment Handbook for KwaZulu-Natal (still in draft format), 2010	The main aim is to provide guidance and mentorship for decision-makers on a range of biodiversity principles, elements and issues which confronts decision-makers daily as they evaluate impact assessments.
National Spatial Biodiversity Assessment 2005	The policy includes a clear and quantitative goal for the conservation of aquatic ecosystems at a national level. Some of the objectives include: – Developing methods and data layers for the spatial representation of both biodiversity patterns and ecosystem processes, with conservation being incorporated from beginning to end. This needs to be done at scales that are appropriate to national and sub-national level biodiversity planning; – Develop and test a planning framework for generating spatial options to satisfying explicit and quantitative conservation targets; and – Develop conservation plans and implementation strategies to assist the mainstreaming of the protection of river ecosystems at sub-national levels (Water Management Areas) across South Africa.
Integrated Development Plans	These plans are implemented within each Municipality who are responsible for promoting socio-economic development through providing a framework on infrastructural developments required and planned, the utilisation of land for future use, goods and service delivery and provision and the protection and sustainable use of the environment.
Guidelines for development activities that may affect wetlands released by the KZN	This guideline is built on the Department of Water Affairs (DWA) operational policy to regulate development and activities affecting watercourses (DWA, 2012) where the regulation is based on scientific decision-making taking cognizance of the legal

Dept. agriculture	environment. The interaction between groundwater (water resource) and surface water (watercourse) is recognised. When water, which is a key driver to wetland well-being, is impacted either in its quality or quantity and hence the wetland is impacted, the consequences are transferred to society immediately in forms like poverty, disasters, inflation, etc.
The National Biodiversity Strategy Action Plan 2005	The main objectives of this plan is to: – Protect, manage and sustainably use biodiversity to ensure equitable benefits to the people of South Africa, now and in the future. – Manage biodiversity assets and acknowledging their contribution to the economy, rural development, job creation and social wellbeing is enhanced. – Provide investments in ecological infrastructure to enhance resilience and ensure benefits to society. – Ensure biodiversity considerations are incorporated into policies, strategies and practices of a range of sectors. – Ensure people are educated to adopt practices that sustain the long-term benefits of biodiversity. – Conservation and management of biodiversity is to be greatly improved through the development of an equitable and suitably skilled and educated workforce. – Ensure effective knowledge foundations, including indigenous knowledge and citizen science, to support the management, conservation and sustainable use of biodiversity to a large extent.
National Wetland Monitoring Programme (NWMP)	The aim of the NWMP is to assess and monitor the extent of wetlands, the threats posed on wetlands and the change in the Present Ecological State (PES) and Ecosystem Services (ESS) provided by wetlands in South Africa. It is a "state-of-wetland" reporting programme, designed to demonstrate trends in the state or integrity (biological, physical and chemical components of its ecosystem and their interactions) of wetlands over time. Monitoring is necessary to collect sufficient and accurate data to inform decision making, and reduce and manage risks. Therefore, the ultimate goal is to provide information needed for planning, decision making and operational water management and related infrastructure at local, national and regional levels.
National Freshwater Ecosystem Priority Areas (NFEPA)	The aims of the National Freshwater Ecosystem Priority Areas (NFEPA) project is the provision of A strategic policy orientated initiative for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. NFEPAs are identified based on: – Representation of ecosystem types and flagship free-flowing rivers – Maintenance of water supply areas in areas with a high-water yield; – Identification of connected ecosystems; and

	– Representation of threatened and near-threatened fish species and associated migration corridors.
River Health Program (RHP) or the National Aquatic Ecosystem Health Monitoring	River Eco-status Monitoring Programme (REMP) evolved from the River Health Programme (RHP)
Ramsar Convention (1971)	The conservation and wise use of wetlands by national action and international co-operation as a means to achieving sustainable development throughout the world. The following objectives apply: – Designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance; – Formulate and implement its planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetland in their territory; and – Promote the conservation of wetlands by establishing nature reserves on wetlands, whether they are included in the List or not, and provide adequately for their wardening.
Earth Summit (1992)	Agenda 21 requires countries to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature. Targets including: – Protection and conservation of water resources on a sustainable basis; – Water pollution prevention and control; – Establishment of biological, health, physical and chemical quality criteria for all water resources; and – Adoption of an integrated approach to environmentally sustainable management of water resources, including the protection of aquatic ecosystems and freshwater living resources.
Convention of Biological Diversity 1992	South Africa is required (DEA, 2009a) to: – Establish a system of protected areas to conserve biodiversity; – Develop guidelines for the selection, establishment and management of protected areas; and – Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species. The goal of the CBD is to conserve and manage terrestrial and aquatic biodiversity to ensure sustainable and equitable benefits to the people of South Africa now and in the future.

Policy and Strategy for Groundwater Quality Management in SA , 2000	The value and vulnerability of groundwater represent astrategic component of the water resources of SouthAfrica and therefore the Policy will serve as a decisive input to theformulation of South Africa's National Water ResourceStrategy as required in terms of Section 5 of the NWA.

5 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant to this report:

- KSEMS were only appointed to conduct a wetland delineation and functional assessment for the wetland systems identified to be at risk by the proposed upgrade activities. Therefore, no aquatic studies were undertaken.
- Baseline information regarding the riverine system identified to be at risk has been provided.
- Due to the steep sloping terrain and private housing developments, the entirety of the riverine systems could not be confirmed during the field assessment. The riverine systems that were inaccessible were therefore delineated on a desktop level.
- Only the sewer pipelines formed part of this assessment. No treatment works were assessed.
- The Department of Water and Sanitation require a master layout to form part of the water use license application. As no datafiles were received for the existing and proposed new infrastructure, the layout could not be provided and only a general layout of the northern area was mapped.
- A once-off field assessment was conducted on the 6th of August 2020 and therefore only a dry season assessment was carried out. The report therefore does not cover seasonal variations in watercourse characteristics.
- Apart from the two streams identified within the floodline assessment data (Rip05 & Rip07), the remaining riverine systems were identified as non-perennial. Aquatic studies are recommended for the perennial rivers that fall within the study area.
- No water quality tests formed part of the quotation. This would form part of the aquatic studies which has been recommended to be carried out on the perennial riverine systems located within the study area.
- Due to the once off field assessment, cumulative impacts could not be assessed and were only referred to in terms of undertaking projects of a similar nature. Should an assessment of the cumulative impacts be required, an assessment over a longer period of time would need to be carried out.
- KSEMS have recommended the water uses to be applied for based on the information and proposed activities provided by the client. Should further activities be proposed and KSEMS are not consulted, KSEMS will not take responsibility on the required water uses in terms of Section 21 of the NWA.
- Wetland and/or riparian boundaries are essentially based on GPS co-ordinate waypoints. The variations experienced in GPS precision will ultimately affect the accuracy of the GPS waypoints and consequently will affect the accuracy of the recorded watercourse boundaries. All sampling waypoints were recorded using a Garmin Oregon 600 GPS and captured, analysed and geo-processed utilising a GIS tool (QGIS).

- No formal vegetation plot surveys were conducted under this study and therefore all information pertaining to vegetation is based on observation.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific conditions identified during the infield assessment and based on the assessor's working knowledge and experience with similar projects.
- No construction method statements were provided by the client to feed into the risk assessment. These were based on the specialist's expertise with similar projects and the impacts associated with the various activities.

6 METHODOLOGY

6.1 Desktop Study

Data from various sources was required to accurately assess the study area at a desktop level before conducting the infield assessment (Table 5). The relevant data was utilised to determine what features or ecosystems of potential importance may be impacted on by the proposed development and its associated infrastructure and activities.

Table 5: Utilised data relevant to the scope of works and nature of the project.

DATA	DATA TYPE	SOURCE	APPLICABILITY TO PROJECT
Ecological regions	Global Information System (GIS) coverage	DWS (2005)	Provides delineated ecoregions based on attributes such as physiography, climate, rainfall, geology and potential natural vegetation.
A level Iand II river ecoregional classification system for South Africa, Lesotho and Swaziland	Literature	Kleynhans et. al (2005)	Provides ecological regions that are grouped together, forming a mosaic of ecosystems and ecosystem components (biotic and abiotic, aquatic and terrestrial) within a hierarchy.
Google Earth Pro™ Imagery	GIS coverage	Google Earth Pro™ (2020)	Provides up-to-date satellite imagery of the proposed development, the extent of the proposed development and desktop catchment and hydro-geomorphic (HGM) unit impacts.
Interactive catchment CD	GIS coverage and literature	Frank Sokolic of GISolutions in the WET-Health package by Macfarlane et al. (2009)	Determine primary, secondary, tertiary and quaternary catchments applicable to the study area and their climatic variables.
National Biodiversity Assessment (NBA) National list of threatened ecosystems	GIS coverage	South African National Biodiversity Institution (SANBI) (2011)	Provides a list of ecosystems that are threatened in South Africa.
National Biodiversity	GIS coverage	Council for Scientific and	Provides the condition, Ecosystem Threat

Assessment (NBA) River ecosystem threat status and protection		Industrial Research (CSIR) (2018)	Status (ETS) and Ecosystem Protection Level (EPL) information for rivers.
National Biodiversity Assessment (NBA) Terrestrial ecosystem threat status and protection level	GIS coverage	Council for Scientific and Industrial Research (CSIR) (2018)	Provides the condition, Ecosystem Threat Status (ETS) and Ecosystem Protection Level (EPL) information for terrestrial ecosystems.
National Wetland Map version 5 (NWM5)	GIS coverage	Council for Scientific and Industrial Research (CSIR) (2018)	Illustrates the distribution of inland wetland ecosystem types across the region, in addition to a limited number of rivers and estuaries.
National Freshwater Ecosystem Priority Areas (NFEPA) river, fish sanctuaries and wetland inventories	GIS coverage	Council for Scientific and Industrial Research (CSIR) (2011)	Identify potentially important river and wetland systems at a local and regional scale. Fish species with an IUCN status of Critically Endangered or Endangered are identified in this layer.
Critical Biodiversity Areas and Ecological Support Areas	GIS coverage	SANBI (2010)	Map Critical Biodiversity Areas which is required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan for the various regions.
Vegetation Map of South Africa, Lesotho and Swaziland	GIS Coverage	Mucina & Rutherford (2018)	Provides the vegetation types located within the study area.
Vegetation Map of South Africa, Lesotho and Swaziland	Literature	Mucina & Rutherford (2006)	Provides a description of the climatic conditions in which the vegetation units are found, alongside their threat status, conservation targets and activities/pressures that are modifying the natural vegetation communities.
South African Geological Map	GIS coverage	Geological Survey (1988)	Determine the regional and study area geology and soil types.
Resource Quality Information System Present Ecological State/ Ecological Importance and Sensitivity Data (RQGIS PES/EIS)	GIS coverage	DWS (2014)	For riverine systems under assessment that could not account for seasonal and temporal variations, this data assists in determining the ecological state of the riverine systems within the study area.

6.2 Assessment Methodologies/Tools

Table 6 below provides the methodologies/tools utilised for the assessment of the watercourses, both on a desktop level and within the field.

Table 6: Methodologies used in assessing the impacts of the proposed upgrade activities and the condition of the watercourses identified to be at risk.

METHOD/TOOL*	SOURCE	REFERENCE
Classification of wetlands and/ or other aquatic ecosystems	National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa	Ollis et al., 2013; Kotze et al., 2009
River PES assessment	River Health Programme: Site Characterisation Field-Manual and Field-Data Sheets	Dallas, 2005
River PES assessment	Rapid Index of Habitat Integrity (IHI) tool	Kleynhans et al., 2009
River PES/EIS data	River Health Programme	DWS, 2013
Risk Assessment Matrix (RAM)	DWS Aquatic Risk Assessment	DWS, 2016
Buffer Zone Determination/ WRC Buffer Tool	Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries in South Africa	Macfarlane et al., 2014
Delineation of wetland and/or riverine systems	A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas	DWAF, 2005

6.3 Field Assessment

A once off field assessment was carried out with the objectives to:

1) Confirm the biophysical attributes of the study area;
2) Verify and accurately delineate the watercourses that were deemed to be at risk of being impacted on by the proposed upgrade activities and infrastructure;
3) Assess the current ecological integrity of the surrounding catchment areas by identifying disturbances and areas of degradation in relation to the reference, or natural state, noting land use changes; and
4) Conduct an in-depth analysis of the PES of the at-risk watercourses and determine the potential of, and level to which, the systems supply valuable ESS to the surrounding natural and anthropogenic environments and therefore the Ecological Importance and Sensitivity (EIS) of these systems in the landscape.

The duration, date and season of the field assessment was as follows: 06 August 2020 (1-day period) (dry winter season).

6.3.1 Infield delineation of watercourses

All watercourses identified within the study area were delineated on a desktop level using QGIS 2.18 and Google™ Earth Pro 2020. The in-field assessment confirmed the existence of these watercourses through the use of '*Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*' (Rountree et al.,

2008) and the wetness zones and boundaries were delineated using a GPS. The permanent, seasonal and temporary zones of wetness were determined by various indicators, namely:

- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological signatures or redoximorphic features that form in the soil's profile as a result of prolonged, permanent and/or frequent saturation. In practice, this indicator is used as the primary indicator of the presence of hydric soils and thus in the identification of watercourse (DWAF, 2008) (Figure 9). Hydric soils may be defined as soils that undergo repeated and prolonged periods of saturation and must exhibit signs of wetness within the top 50 centimetres (cm) of the soil profile to be classified as hydric soil (DWAF, 2008). Signatures or features of hydric soil include, but are not limited to, the presence of mottling (i.e. brightly coloured streaky, or specks of iron compounds), a gleyed soil matrix (i.e. grey coloured soil) and iron or manganese concretions (Table 7).
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils (Table 8).
- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (Figure 12).

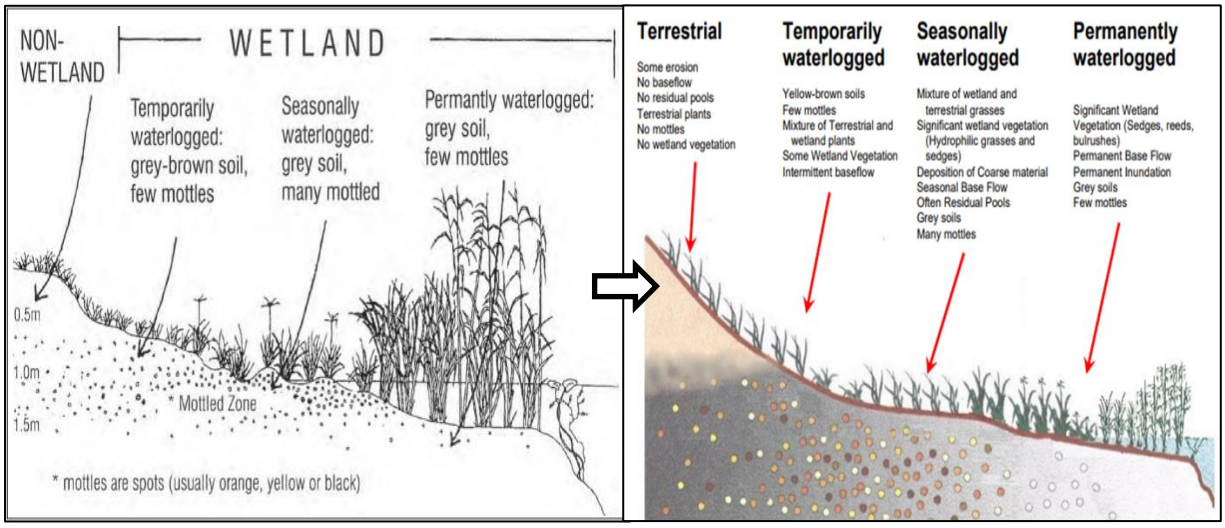


Figure 11: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of increasing wetness, from left to right (Kotze,2009; Kotze et al., 1994).

Table 7: Examples of soil wetness indicators in the various wetland zones.

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (< 10 %)	Grey matrix (< 10 %)	Prominent grey matrix
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year around (possible sulphuric odour)
Soil Depth (0 – 10 cm): Matrix chroma: 1-3; few/no mottles; low/intermediate	Soil Depth (0 – 10 cm) Matrix chroma: 1-2; many mottles; intermediate OM	Soil Depth (0 – 10 cm) Matrix chroma: 1-1; few/no mottles; high OM and non-

OM and non-sulphuric	and seldom-sulphuric	sulphuric
Soil Depth (40 – 50 cm) Matrix chroma: 0-2; few/ many mottles	Soil Depth (40 – 50 cm) Matrix chroma: 0-2; many mottles	Soil Depth (40 – 50 cm) Matrix chroma: 0-1; few/no mottles

Table 8 below describes the various types of hydrophytic vegetation species that were utilised as a guide to the delineation of the wetness zones within each watercourse that was identified within the study area.

Table 8: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands (Kotze et al., 2009).

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (*Typha capensis*), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).

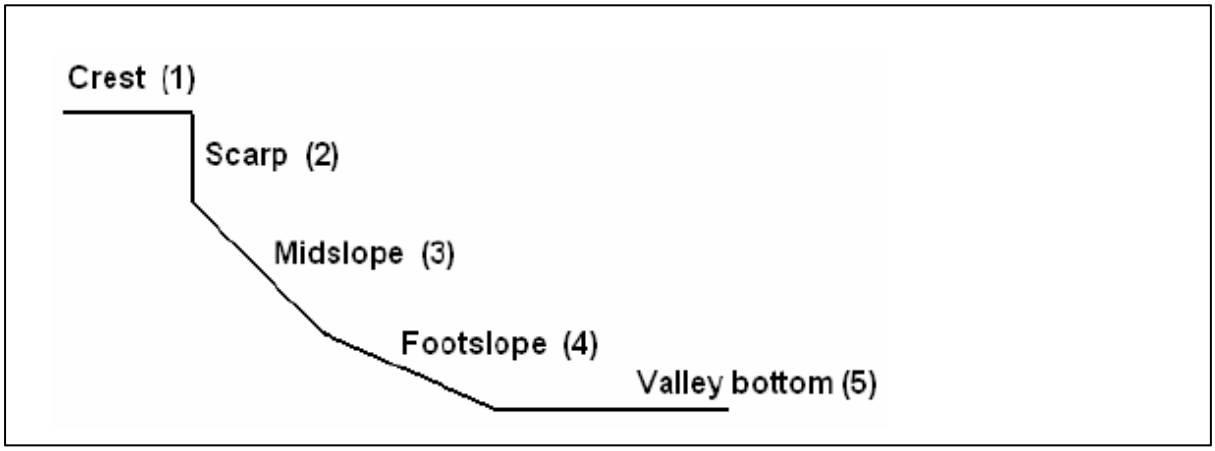


Figure 12: Longitudinal profile of the landscape and potential locality of watercourses (Macfarlane, 2007).

6.3.2 Regulated Area to be Assessed

Table 9 below provides the legislative requirements pertaining to the mining, water and environmental sectors in terms of the locality of activities in relation to watercourses. For the purpose of this project, the NWA, 1998 (No. 36 of 1998) legislative requirements apply.

Table 9: Legislative requirements for assessing the area of watercourses (riverine and wetland systems).

LEGISLATION	LEGISLATIVE REQUIREMENTS
NWA, 1998 (No. 36 of 1998) pertaining to water	– 1: 100 year floodline, – Outer edge of riparian zone, – 100 m from edge of watercourse, or – 500 m from edge of wetland.
NEMA, 1998 (No. 107 of 1998) pertaining to the environment	– 32 m from the edge of a watercourse or provincial/local setback
GN 704 of the NWA, 1998 (No. 36 of 1998) pertaining to mining	– 1: 50 year floodline, or – 100 m from edge of watercourse.

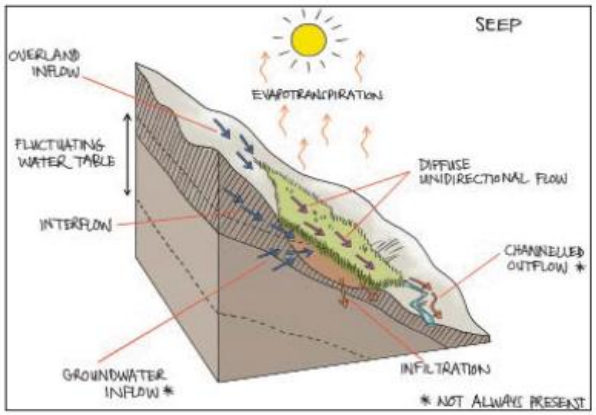
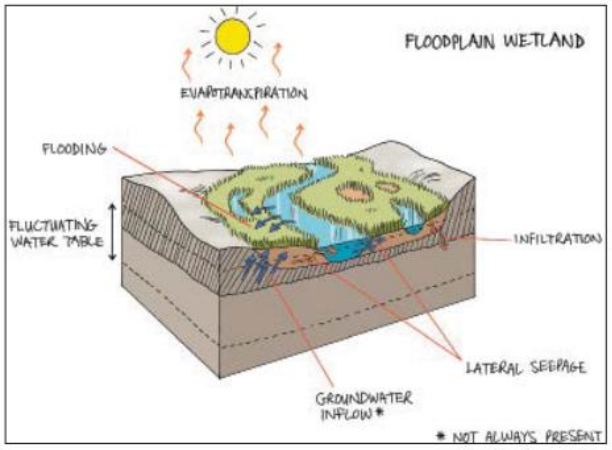
6.3.3 Equipment Utilised

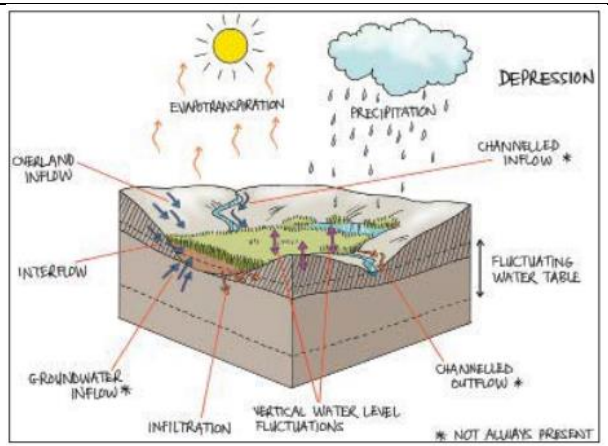
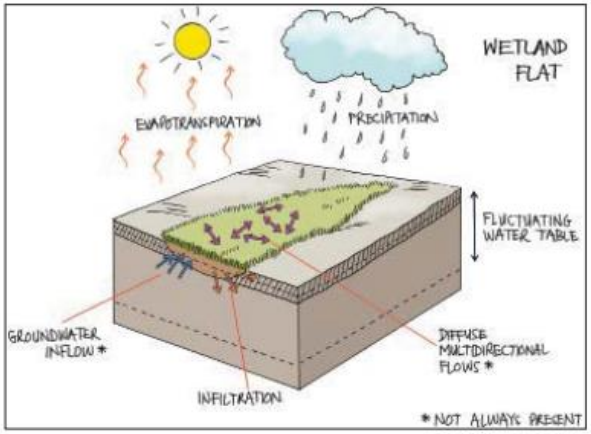
- Dutch soil auger: Collection of soil samples
- Camera: Photographic evidence of the site conditions.
- Munsell Soil Colour Chart: Used in soil indicator in determination of soil matrix and chroma.
- Global Positioning System: Provide co-ordinates of monitoring points, sample collection, infrastructural localities and watercourse delineations.
- Soil Sheet: Determine soil and vegetation characteristics used in the delineation of wetlands and the determination of wetland zonation (after Kotze et al. 1994).
- Assessment field sheets

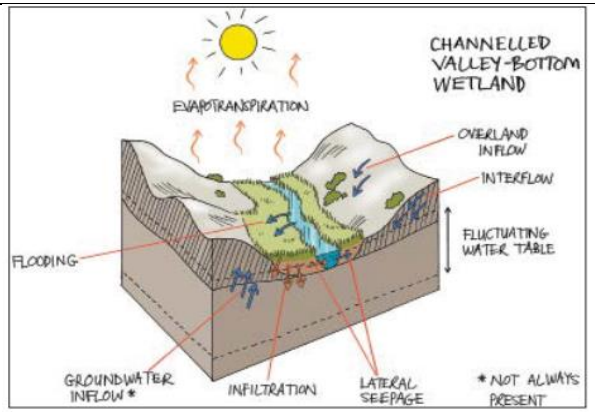
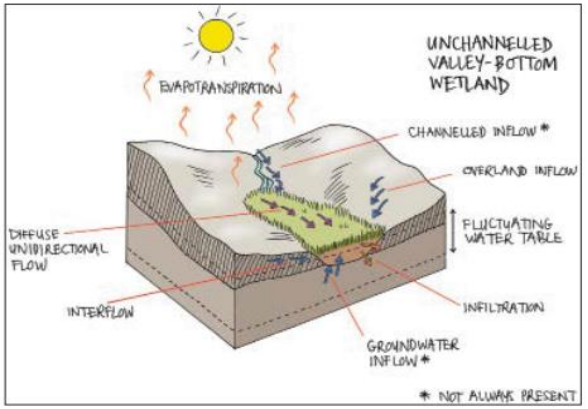
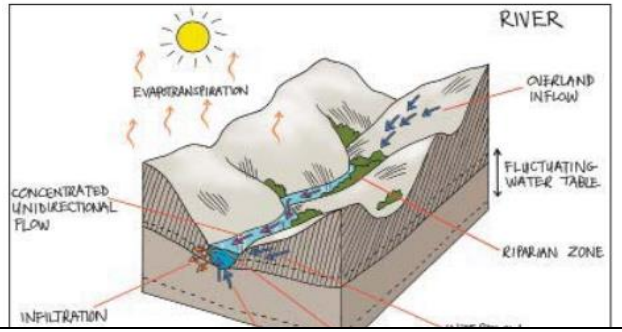
6.3.4 Classification of Watercourses

To allow for in-depth system-specific analysis to occur within this study, the various watercourses that were delineated within the study area were classified in accordance with the '*Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis et al., 2013). It must be noted that this study entailed the assessment of inland systems and therefore no estuarine or marine studies were undertaken (Table 10).

Table 10: Classification of watercourses to level 4 (Ollis et al., 2013)

LEVEL 1: BROADEST SPATIAL SCALE SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT	LEVEL 4: HYDRO-GEOMORPHIC (HGM) UNIT	DIAGRAM OF INPUT, THROUGHPUT AND OUTPUT OF FLOWS THROUGH HGM UNITS	LEVEL 4: HYDRO-GEOMORPHIC UNIT (LONGITUDINAL ZONATION/ LANDFORM / OUTFLOW DRAINAGE)
Inland Systems	DWA Level 1 Ecoregions/ NFEPA WetVeg Groups/ Other special frameworks	Slope	Hillslope seepage wetland		Isolated Connected to a channel
		Plain	Floodplain		Floodplain depression Floodplain flat

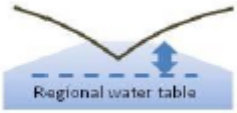
			Depression		Exorheic Endorheic Dammed
			Wetland Flat		Not Applicable

<table>
<tr><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4">Valley Floor</td><td rowspan="2">Valley-bottom wetland</td><td> 
</td><td>Channelled valley-bottom</td></tr>
<tr><td> 
</td><td>Unchanneled valley-bottom</td></tr>
<tr><td rowspan="5">Riverine System</td><td rowspan="5"> 
</td><td>Mountain headwater stream</td></tr>
<tr><td>Mountain stream</td></tr>
<tr><td>Transitional stream</td></tr>
<tr><td>Upper foothill rivers</td></tr>
<tr><td>Lower foothill rivers</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Lowland river</td></tr>
</table>

					Rejuvenated bedrock fall Rejuvenated foothill rivers Upland floodplain rivers
Estuarine Systems					
Marine Systems					

The differentiation of riverine systems as outlined in (DWAF, 2005) is according to their position relative to the zone of saturation in the riparian area. The zone of saturation must be in contact with the channel network for base flow to take place at any point in the channel and the classification separates the channel sections that do not have base flow (A Sections) from those that irregularly have base flow (B Sections) and those that continually have base flow (C Sections) (Table 11). A sections are regarded at the least sensitive as they usually only carry water following storm events.

Table 11: Criteria used in determining the sensitivity and classification of riverine systems (Ollis et al., 2013).

PERENNIALITY OF RIVER FLOWS	DESCRIPTION/ CRITERION	CROSS SECTION
Intermittent (A Section)	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.	
Seasonal (B Section)	Water flows for extended periods during the wet season (generally between 3 to 9 months duration) but not during the rest of the year.	
Permanent (C Section)	Flows continuously throughout the year	

6.4 Delineation of Watercourses

All the at-risk watercourses within the study area were delineated on-site utilising the delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2008). The following sections provide descriptions of the wetness indictors that were recorded during the field assessment.

6.4.1 Terrain Unit Indicator (Landscape Position & Topography)

The topography of the study area was characterised as rolling hills. Drainage lines have cut through and incised in the landscape and thus, the majority of the watercourses were identified as riverine systems. There has been cut and fill processes which has altered the natural topography and caused some areas to be relatively flat and other areas relatively steep due to erosion and scour occurring over time.

6.4.2 Soil Wetness Indicator

No wetland systems were observed during the field assessment and therefore no soil observations were carried out.

6.4.3 Vegetation Indicator

Although Cyperaceae species were observed, these were found along drainage lines from outdoor taps and were indicative of wet conditions from anthropogenic activities and not natural wetland processes. The most common riparian vegetation was *Arundo donax* which was observed along most of the riverine systems (Figure 13).

Figure 13: Photographic evidence of vegetation commonly observed along the riparian zones (KSEMS, 2020).

6.4.4 Watercourse Delineation Maps

The watercourses within the study area were identified on a desktop level, classified and delineated in-field and subsequently mapped utilising GIS (QGIS 2.14 and Google™ Earth Pro). Figure 13 illustrates the delineated watercourses identified within the study area during the infield assessment.

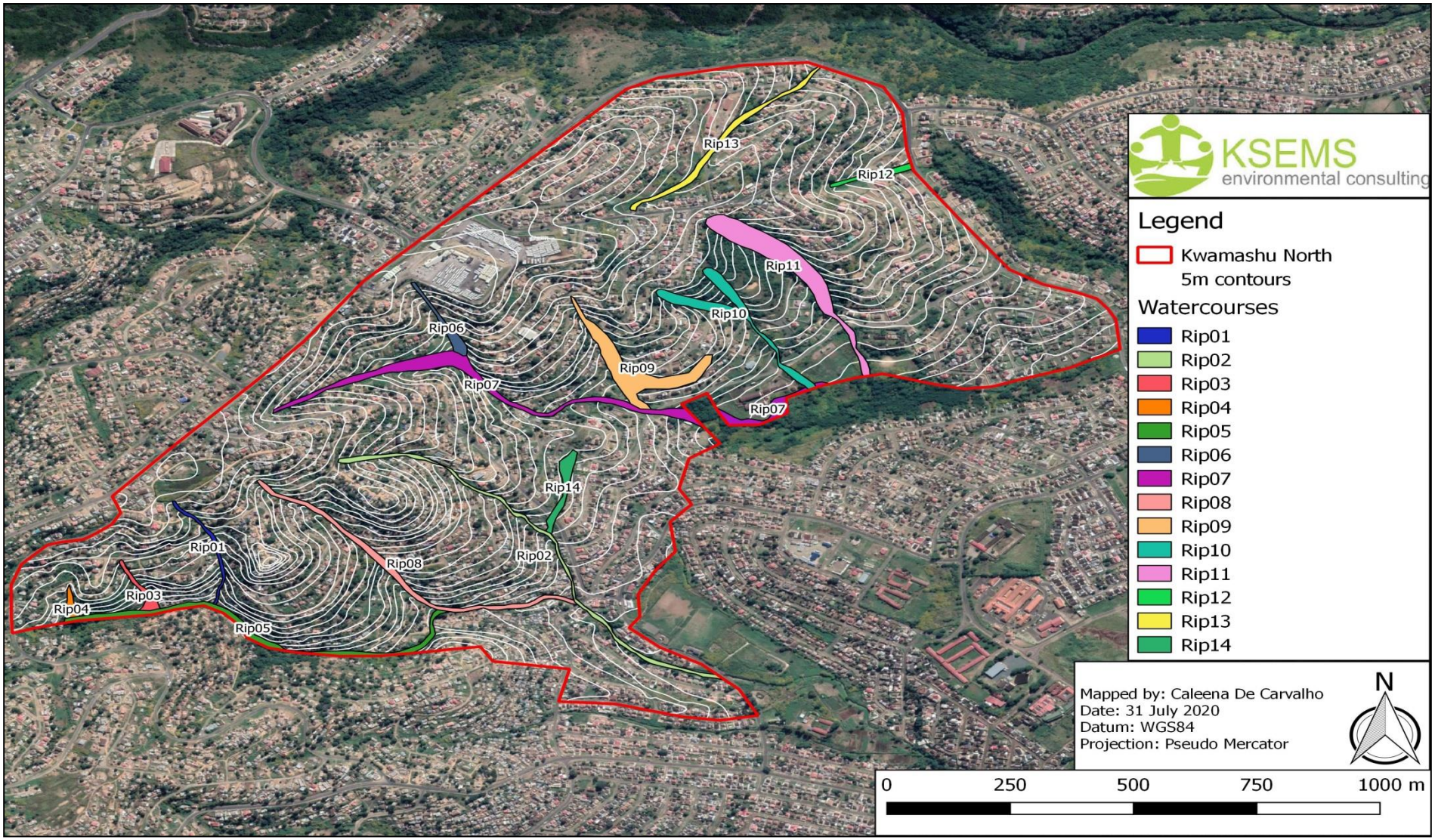


Figure 14: Map of watercourses delineated within the study area of KwaMashu North (KSEMS, 2020).

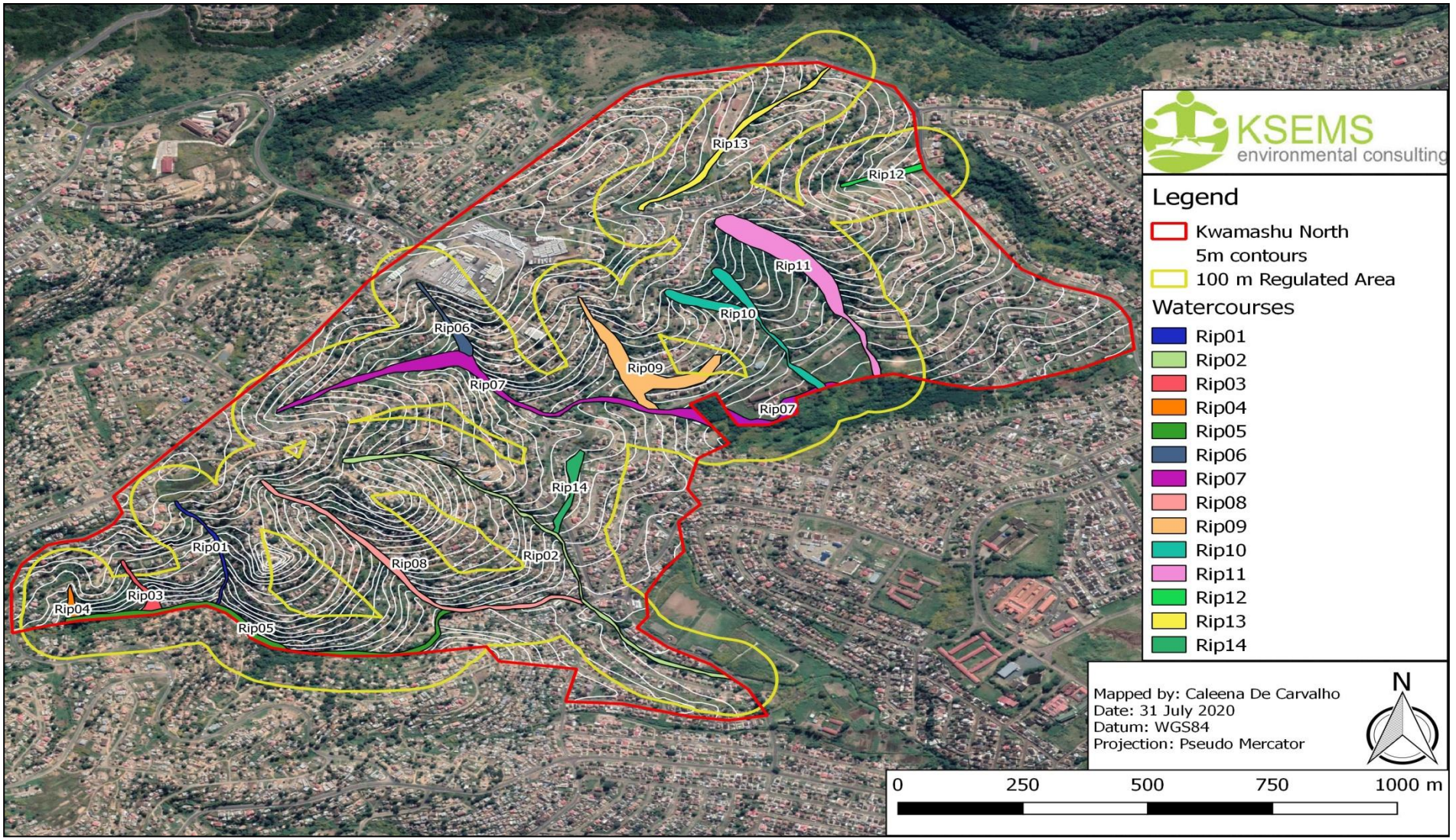


Figure 15: Map of watercourses delineated and the regulated area for watercourses within the study area of KwaMashu North (KSEMS, 2020).

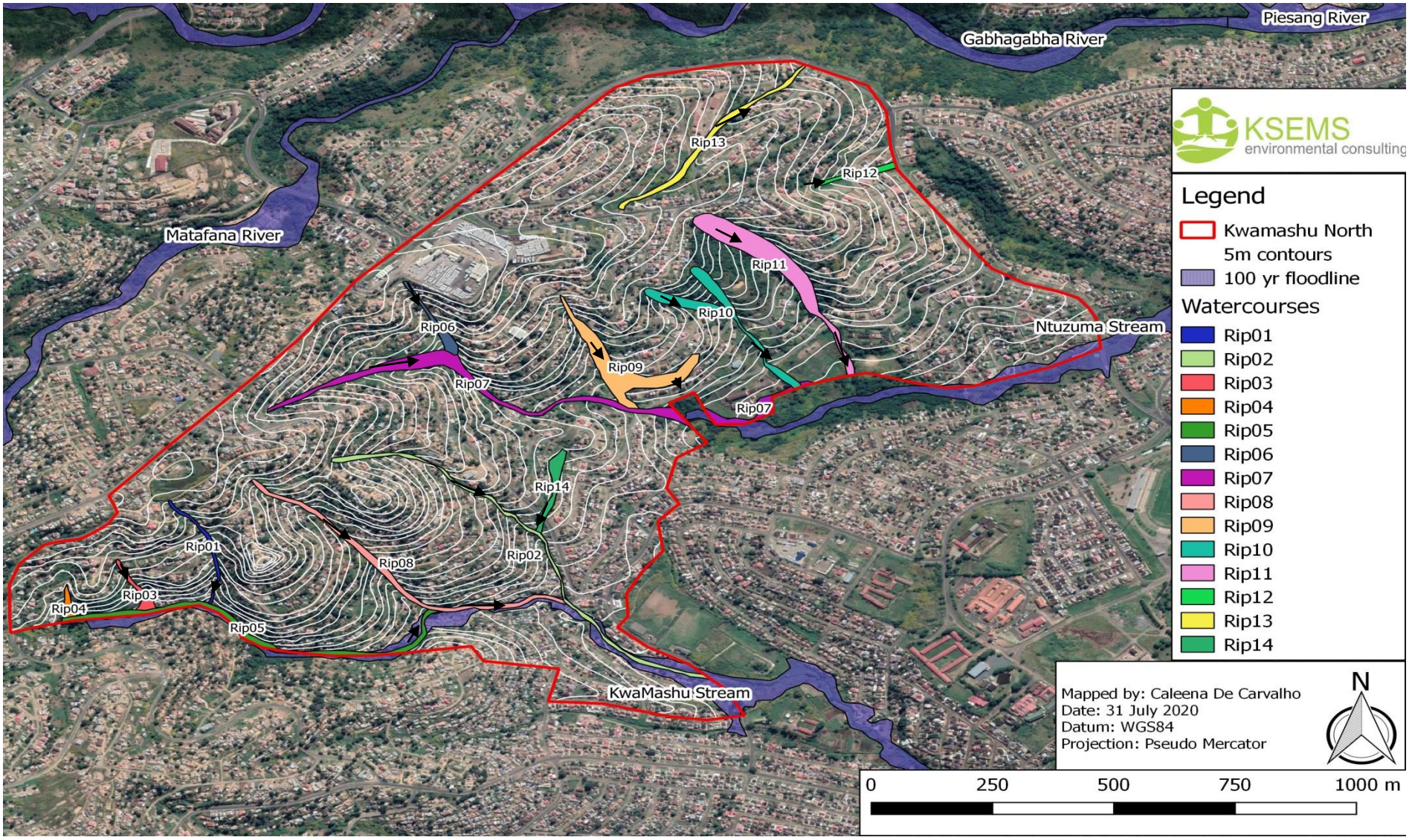


Figure 16: Map of watercourses delineated and the 1:100 year floodline superimposed with flow directions (KSEMS, 2020).

7 INITIAL RISK/SCREENING ASSESSMENT (PHASE 1)

The infield field assessment phase confirmed the location and extent of the watercourses and a subsequent screening provided an indication of which of the watercourses may potentially be impacted upon by the proposed upgrade activities. There are several factors which influence the level a watercourse will be impacted upon such as; the type of system (river or wetland (hillslope seepage, unchanneled valley bottom, depression)), position of the system in relation to the activities and position in which the system is located in the landscape (valley bottom or hillslope). As a result of no datafile being provided by the client, all of the watercourses located near the housing developments where proposed or existing sewer lines are located were delineated and identified to be at risk. From the field assessment, thirteen (13) watercourses in the form of riverine systems were identified to be at risk. The magnitude of risk (low to high) could not be determined, however due to the nature of the project entailing sewage, all of the at risk watercourses were believed to be at high risk of impact. Table 12 below presents the criteria used to rank the various watercourses in terms of risk.

Table 12: Criteria utilised to rank the delineated watercourses within the study area of KwaMashu North.

RISK RATING	CRITERIA/DESCRIPTION
High	The watercourse is situated directly within or in close proximity to, or within the same minor catchment area as, the proposed development footprint. Therefore, the habitat, biota, water quality and/or the hydrological regime through the watercourse are highly likely to be impacted on by aspects of the proposed upgrade.
Moderate	The watercourse is situated directly downstream of the proposed activities or within the same minor catchment area or a distance of less than 50 m away. This may result in the habitat, biota, water quality of and/or the hydrological regime through the watercourse being indirectly impacted on by aspects pertaining to the upgrade activities (e.g. sedimentation, alteration to hydrological characteristics of the system).
Low	The watercourse is situated a significant distance (>50 m) upstream or downstream of the proposed upgrade activities or within a landscape that prevents any direct impacts and with mitigation measures, the system is not likely to be impacted on.
None	The watercourse is situated a distance away, more than 100 m away, and/or within a completely different minor catchment area to the proposed activities, or is located within the landscape such that the proposed development is occurring downslope of the position of the watercourse and thus will not be affected by direct or indirect impacts that have been determined to originate from the proposed activities.

Table 13 below presents the watercourses that were identified within the study area. Only watercourses that were identified to be at risk by the proposed upgrade activities were assessed further in the Phase 2 functional assessment.

Table 13: Watercourses within the study area of KwaMashu North and their associated risk rating.

WATERCOURSE CODE AS PER FIGURE 14	WATERCOURSE CLASSIFICATION	CHARACTERISTIC POTENTIALLY IMPACTED (YES/NO=Y/N)				RISK RATING	NEED FOR FURTHER ASSESSMENT	RATIONALE
		HABITAT	BIOTA	WATER QUALITY	FLOW REGIME			
Rip01	Riverine System	Y	Y	Y	Y	High	Yes	This system is located along Impungushe Avenue, adjacent to the proposed new infrastructure and Umkhiwane Grove. This system required further assessment.
Rip02	Riverine System	Y	Y	Y	Y	High	Yes	Rip14 and Rip08 connects to this system and it is traversed by Impungushe Avenue, Mpala Avenue, Mthomboti Road and Mncaka Road. This system required further assessment.
Rip03	Riverine System	Y	Y	Y	Y	High	Yes	This system is located along Impungushe Avenue, adjacent to the proposed new infrastructure and Umkhiwane Grove. This system required further assessment.
Rip04	Riverine System	Y	Y	Y	Y	High	Yes	This system is located along Mphafa Crescent which links on to Impungushe Avenue. This system required further assessment.
Rip05	Riverine System	Y	Y	Y	Y	High	Yes	This system, referred to as KwaMashu Stream is the main channel on to which Rip01, Rip03 and Rip04 connect. This system required further assessment.
Rip06	Riverine System	Y	Y	Y	Y	High	Yes	This system is located along Egugwini Street, adjacent to Imamba Road and the proposed new infrastructure. This system required further assessment.
Rip07	Riverine System	Y	Y	Y	Y	High	Yes	This system is located adjacent to Egugwini Street and Iqhawe Walk. This system required further assessment. It further traverses Mpala Avenue in a south easterly direction and links to Rip09. This system

WATERCOURSE CODE AS PER	WATERCOURSE CLASSIFICATION	CHARACTERISTIC POTENTIALLY IMPACTED (YES/NO=Y/N)				RISK RATING	NEED FOR FURTHER	RATIONALE
								required further assessment.
Rip08	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system is located along Impungushe Avenue, adjacent to the proposed new infrastructure and Msinsi Avenue. This system required further assessment.
Rip09	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system occurs between Mpala Avenue and Umathinta Drive and connects to Rip07 above Ibohlololo Road. This system required further assessment.
Rip10	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system is located south of Umfusamvu Close and adjacent to Umathinta Drive. It traverses Ibohlololo Road south of the site. This system required further assessment.
Rip11	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system is a perennial river that traverses Ibohlololo Road in a southerly direction. This system is adjacent to Utshanibezwe Grove. This system required further assessment.
Rip12	Riverine System	**N**	**N**	**N**	**N**	**None**	No	This system is located adjacent to Abaphaphi Close. This system occurred within the study area but no infrastructure is proposed close to this system and therefore this system was not assessed further.
Rip13	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system is traversed by Mbondwe Road and occurs below the proposed upgrade sewer line. This system required further assessment.
Rip14	Riverine System	**Y**	**Y**	**Y**	**Y**	**High**	Yes	This system occurs below Ibohlololo Road. This system required further assessment.

8 FUNCTIONAL ASSESSMENT (PHASE 2)

The following will present the results for the assessments conducted pertaining to the watercourses identified to be at potential risk by the associated upgrade activities and infrastructure. Figures 17 and 18 below provide photographic evidence of the on-site conditions.

8.1 Present Ecological State & Ecological Importance and Sensitivity of Riverine Systems

Hydrological condition of riverine systems – At a catchment scale, drainage lines throughout the landscape have resulted in cut and fill activities which has left the terrain steep in some areas which has caused the riverine systems to incise as there is an increase in sediment and surface water inputs. Diversions and impeding structures have further altered the natural hydrological regime and flows with hard surfaces disconnecting systems in the landscape. Although culverts are present to maintain connectivity, the infrastructure is overgrown with weed species and there are blockages due to illegal dumping. The quality of water has been impaired due to sewage discharge directly into the riverine systems and stormwater drains draining lubricants and oils from the road surfaces. The quantity of water has been reduced due to abstraction for agriculture and domestic water supply whilst in other areas quantity has increased due to informal and formal stormwater infrastructure leading directly into the riverine systems. On a local scale and in with reference to site specific impacts, the hydrological regime of the riverine systems was seriously modified as a result of ineffective stormwater drainage causing pooling on the road surface and the collection of oils and grease that are reaching the riverine systems from surface runoff. The blockage of culverts from debris and littering, as well as the informal and formal road networks, are causing fragmentation along the streams and disconnecting flow continuity. The water quality has deteriorated significantly as a result of informal ablution facilities located along the riparian zones which have altered the physico-chemical composition of the stream. Vegetation has been cleared which has increased sediment inputs and turbidity which will further deteriorate water quality. The riverine systems that contain continual annual flows may be able to flush out more of the sewage and other contaminants, however macroinvertebrates are at risk and have more than likely died off as a result. Informal housing developments located along the banks of the riverine systems were also observed to contain running water taps outside and it is a possibility that water is being abstracted from the perennial rivers for domestic use and for agricultural purposes in terms of irrigating crops which is impacting on the quantity of water feeding the systems which may alter the hydrological regime.

Vegetation state within riparian and in stream channel of riverine systems – At a catchment scale, the vegetation did not resemble grassland as most of the areas were cleared for housing and road infrastructure. The area was rural with vegetation limited to the riparian areas and therefore grassland was not synonymous with vegetation found along zones of wetness and therefore was not present or indicative of the desktop vegetation unit. On a local scale, the vegetation within the stream channels and riparian areas had been seriously modified as a result of clearing activities for housing and road infrastructure. Disturbance was observed

through the encroachment and proliferation of invasive and alien plant species within the riparian zones and species comprised mainly of *Cardiospermum grandiflorum* (Ballon vine), *Canna indica* (Indian shot), *Lantana camara* (Lantana), *Nephrolepis exaltata* (Sword fern), *Ricinus communis* (Castor oil), *Schinus terebinthifolius* (Brazillian Pepper), *Senna didymobotrya* (Peanut butter cassia), *Solanum mauritianum* (Bugweed), *Ageratum conyzoides* (Billy goat weed), *Arundo donax* (Giant reed), *Bidens pilosa* (Black jack) and *Tithonia diversifolia* (Mexican sunflower). Only Cyperus species were observed along drainage lines and were indicative with anthropogenic conditions and not natural wet conditions. The most common species found along zones of wetness was the reed, *Arundo donax* and these were found to proliferate much of the stream areas. Vegetation was modified for subsistence crops such as *Musa acuminate* (wild banana), asparagus and lettuce.

Geomorphological state of riverine systems – On a catchment scale, erosional features in the form of rills and incision was present due to steep sloping terrain, particularly within the drainage lines. Increased surface water inputs from stormwater drains and hard surfaces have increased the velocity and volumes of water entering the watercourses which has increased erosion and caused sedimentation of the watercourses. On a local scale, the road and housing infrastructure has increased the hardened surfaces and the clearing of vegetation has reduced surface roughness. These activities have resulted in increased surface runoff which has increased erosion and sediment inputs into the riverine systems. Scouring has occurred along the banks of most of the riverine systems and the little vegetation that remains is assisting in stabilising the riparian areas. In areas of steep sloping terrain or where cut and fill activities have occurred, riverine systems have become incised and the banks are unstable with little to no vegetation present. The geomorphological component of the systems was therefore seriously modified.

Figure 17: Photographic evidence of conditions affecting the hydrological and geomorphological components of the riverine systems (KSEMS, 2020).

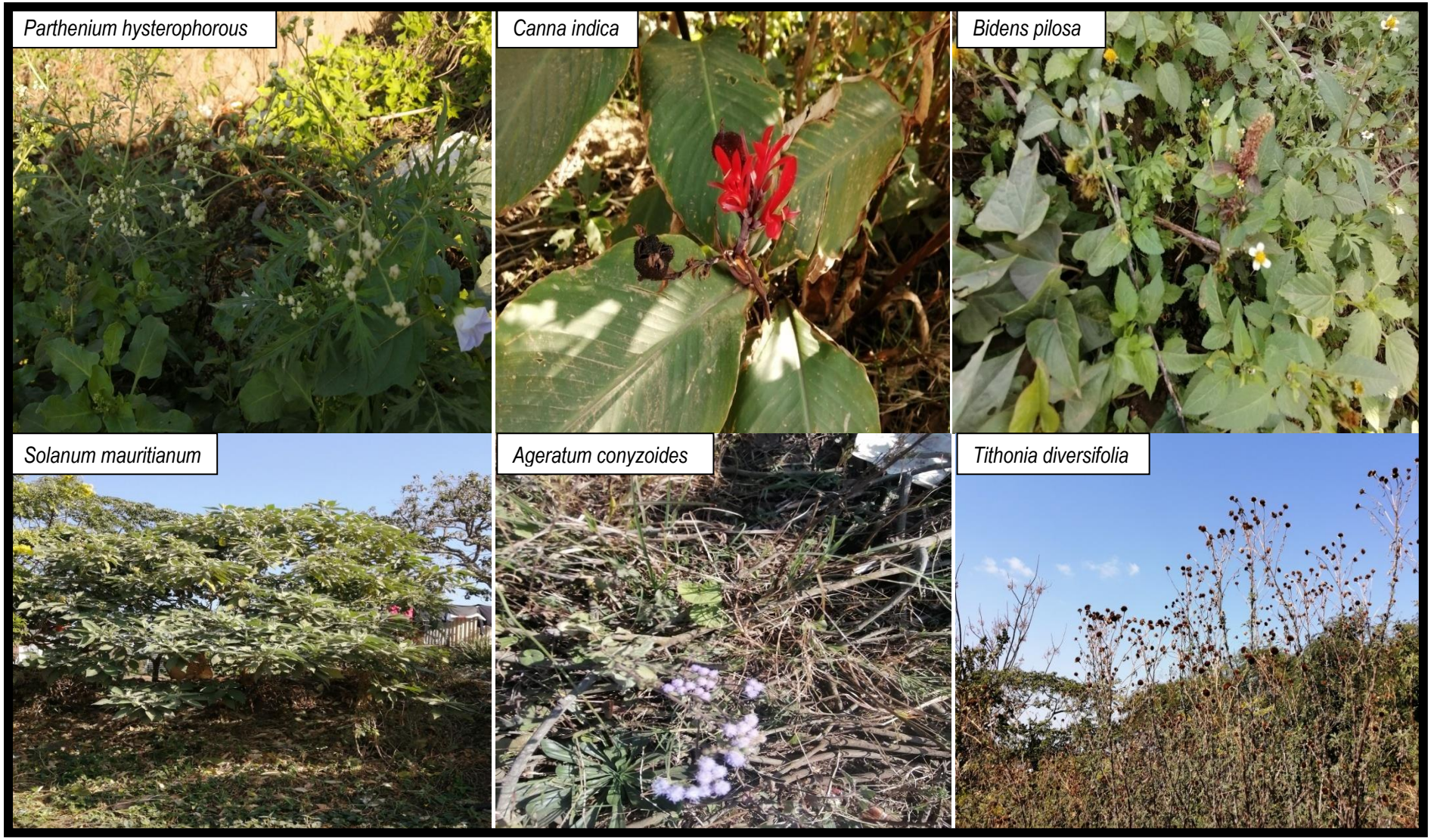


Figure 18: Photographic evidence of the conditions affecting the vegetation component of the riverine systems (KSEMS, 2020).

No data was identified for the riverine systems on site, however through the River Health Programme (DWAF, 2013) the EIS, PES and ES of the uMngeni River was summarised in Table 14 below and can be used as a baseline on catchment activities acting on the riverine systems within the sub quaternary reaches. The system contained a PES category E, high ecological importance and very high ecological sensitivity. For the ecological condition of the system to fall within category E, it infers that the system is seriously modified and the loss of natural habitat, biota and basic ecosystem functions are extensive.

Table 14: Present Ecological State, Ecological Importance and Sensitivity of uMngeni River located west of KwaMashu north.

PRESENT ECOLOGICAL STATE		ECOLOGICAL IMPORTANCE				ECOLOGICAL SENSITIVITY	
INSTREAM HABITAT CONTINUITY MOD	SERIOUS	**FISH SPP/SQ**	26.00	**INVERT TAXA/SQ**	83.00	**FISH PHYS-CHEM SENS DESCRIPTION**	VERY HIGH
RIP/WETLAND ZONE CONTINUITY MOD	LARGE	**FISH: AVERAGE CONFIDENCE**	4.08	**INVERT AVERAGE CONFIDENCE**	4.54	**FISH NO-FLOW SENSITIVITY DESCRIPTION**	VERY HIGH
POTENTIAL INSTREAM HABITAT MOD ACT.	SERIOUS	**FISH REPRESENTIVITY PER SECONDARY: CLASS**	VERY HIGH	**INVERT REPRESENTIVITY PER SECONDARY, CLASS**	VERY HIGH	**INVERT PHYS-CHEM SENS DESCRIPTION**	VERY HIGH
RIPARIAN-WETLAND ZONE MOD	SERIOUS	**FISH REPRESENTIVITY PER SECONDARY: CLASS**	VERY HIGH	**INVERT RARITY PER SECONDARY: CLASS**	MODERATE	**INVERTS VELOCITY SENSITIVITY**	VERY HIGH
POTENTIAL FLOW MOD ACT.	SERIOUS	**FISH RARITY PER SECONDARY: CLASS**	VERY HIGH	**ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING**	VERY HIGH	**RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) INTOLERANCE WATER LEVEL/FLOW CHANGES DESCRIPTION**	VERY HIGH
POTENTIAL PHYSICO-CHEMICAL MOD ACTIVITIES	LARGE	**ECOLOGICAL IMPORTANCE: RIPARIAN-WETLAND-INSTREAM VERTEBRATES (EX FISH) RATING**	VERY HIGH	**HABITAT DIVERSITY CLASS**	LOW	**STREAM SIZE SENSITIVITY TO MODIFIED FLOW/WATER LEVEL CHANGES DESCRIPTION**	HIGH
		RIPARIAN-WETLAND NATURAL VEG RATING BASED ON % NATURAL VEG IN 500m (100%=5)	MODERATE	**HABITAT SIZE (LENGTH) CLASS**	HIGH	**RIPARIAN-WETLAND VEG INTOLERANCE TO WATER LEVEL CHANGES DESCRIPTION**	**VERY HIGH**

RIPARIAN-WETLAND NATURAL VEG IMPORTANCE BASED ON EXPERT RATING	VERY HIGH	**INSTREAM MIGRATION LINK CLASS**	LOW
		RIPARIAN-WETLAND ZONE MIGRATION LINK	MODERATE
		RIPARIAN-WETLAND ZONE HABITAT INTEGRITY CLASS	LOW
		INSTREAM HABITAT INTEGRITY CLASS	LOW

8.2 Habitat Integrity of Riverine Systems

Utilising the Index of Habitat Integrity tool, devised by Kleynhans et al. (2008), the habitat condition of the riverine systems identified to be at risk, could be assessed. The tool will assist in determining the current habitat condition of the watercourses and how the condition may deteriorate as a result of the proposed activities. From the IHI tool, the riparian and instream habitat condition of the riverine systems Rip09, Rip10 and Rip11 were identified to be a category C and D respectively which refers to a moderately modified and largely modified habitat. The riparian and instream habitat condition for the remaining riverine systems was a category D which infers a largely modified habitat.

A moderately modified habitat infers the following metrics are affected (Kleynhans et al., 2009):

Physical drivers:

- Hydrology: The flow regime may have been significantly modified and direct manipulation by impoundments may be present.
- Geomorphic: sediment changes due to increased inputs or flow may have increased significantly. Physico-chemical changes: changes in nutrients, salts, oxygen concentration and temperature may deviate significantly from the reference. Low levels of toxics may sporadically be present.

Associated habitat conditions:

- Instream: Dimensions and frequency of some habitat types have changed significantly. Fragmentation of habitats may often be present
- Riparian: Changes in the structure of the zone may be common. Some fragmentation of the zone may often be present.

Whilst a largely modified infers the following metrics have been affected (Kleynhans et al., 2009):

Physical drivers:

- Hydrology: The flow regime has been extensively modified and manipulation by impoundments may be

present.

- Geomorphic: Drastic changes in sediment loads due to increased inputs or flow modification may have occurred. Physico-chemical changes: nutrients, salts, oxygen concentration and temperature may deviate considerably from the reference. Low levels of toxics may regularly be present.

Associated habitat conditions:

- Instream: Dimensions and frequency of some habitat types may differ drastically from the reference. Fragmentation of habitats may often and extensively be present.
- Riparian: Extensive changes of the zone may be present. Significant fragmentation of the zone may have occurred.

Rip09 – Rip11 (Table 15) - The instream habitat was less modified compared to the riparian zone as the only impacts that occurred instream were channeling and diversion of water for culverts. Interfering with the perennial flows has caused incision which has modified the beds and banks of the streams, this has been worsened from increased volumes and velocities of surface runoff from surrounding hard surfaces. The riparian habitat within these systems remains as woodland, however, riparian vegetation has been cleared for roads and housing which has reduced surface roughness and increased sediment and water loads into the riverine systems. Disturbance has caused the proliferation of invasive and alien plant species which outcompetes indigenous vegetation and interferes with sub surface and base flows.

Table 15: Instream and riparian habitat condition for riverine systems Rip09 - Rip11.

INSTREAM IHI	MRU
Base Flows	-1,0
Zero Flows	-1,0
Floods	1,0
HYDROLOGY RATING	1,0
pH	2,0
Salts	2,0
Nutrients	4,0
Water Temperature	2,5
Water clarity	3,0
Oxygen	2,5
Toxics	3,5
PC RATING	
Sediment	4,0
Benthic Growth	3,0
BED RATING	4,0
Marginal	2,0
Non-marginal	2,0

BANK RATING	2,0
Longitudinal Connectivity	4,0
Lateral Connectivity	4,0
CONNECTIVITY RATING	4,0
INSTREAM IHI %	61,9
INSTREAM IHI EC	C/D
INSTREAM CONFIDENCE	3,5
RIPARIAN IHI	**MRU**
Base Flows	-1,0
Zero Flows	-1,0
Moderate Floods	0,5
Large Floods	1,5
HYDROLOGY RATING	1,0
Substrate Exposure (marginal)	3,0
Substrate Exposure (non-marginal)	3,0
Invasive Alien Vegetation (marginal)	4,0
Invasive Alien Vegetation (non-marginal)	2,5
Erosion (marginal)	4,0
Erosion (non-marginal)	3,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	
Marginal	4,0
Non-marginal	3,0
BANK STRUCTURE RATING	3,5
Longitudinal Connectivity	1,0
Lateral Connectivity	2,0
CONNECTIVITY RATING	1,5
RIPARIAN IHI %	55,4
RIPARIAN IHI EC	D
RIPARIAN CONFIDENCE	**2,3**

Rip01 – Rip08 & Rip13 (Table 16) – Both the instream and riparian habitat were largely modified. This is attributed to the locality of these systems in relation to the settlements. The riparian vegetation was mostly cleared for growing crops and for housing and formal and informal roads. Invasive and alien plant species dominated and will continue to proliferate as areas are cleared for placement of the sewage pipelines and future disturbances occur. The channels were incised as a result of increased hardened surfaces and were confined to smaller areas as settlements increase and occupy more land. No flows were observed in these systems, apart

from Rip02, Rip05 and Rip07. Most culverts were blocked by debris and litter with inadequate stormwater drainage able to supply water inputs in a controlled manner into these systems.

Table 16: Instream and riparian habitat condition for riverine systems Rip01 – Rip08 and Rip13.

INSTREAM IHI	MRU
Base Flows	-1,0
Zero Flows	-3,0
Floods	-1,0
HYDROLOGY RATING	1,9
pH	3,0
Salts	2,5
Nutrients	4,5
Water Temperature	3,0
Water clarity	3,5
Oxygen	2,5
Toxics	4,0
PC RATING	
Sediment	4,0
Benthic Growth	3,0
BED RATING	4,0
Marginal	2,5
Non-marginal	3,5
BANK RATING	2,9
Longitudinal Connectivity	4,0
Lateral Connectivity	4,0
CONNECTIVITY RATING	4,0
INSTREAM IHI %	54,9
INSTREAM IHI EC	D
INSTREAM CONFIDENCE	-1,0
RIPARIAN IHI	**MRU**
Base Flows	-2,0
Zero Flows	-3,0
Moderate Floods	-2,5
Large Floods	-2,5
HYDROLOGY RATING	2,5
Substrate Exposure (marginal)	3,0
Substrate Exposure (non-marginal)	3,0
Invasive Alien Vegetation (marginal)	4,0
Invasive Alien Vegetation (non-marginal)	2,5

Erosion (marginal)	4,0
Erosion (non-marginal)	3,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	
Marginal	4,0
Non-marginal	3,0
BANK STRUCTURE RATING	3,5
Longitudinal Connectivity	1,5
Lateral Connectivity	2,0
CONNECTIVITY RATING	1,8
RIPARIAN IHI %	44,3
RIPARIAN IHI EC	D
RIPARIAN CONFIDENCE	2,3

8.3 Functional Importance of Riverine Systems

The riparian zone has specific important biotic and abiotic characteristics which are important for the continued functioning of the riparian system and ensuring the provision of goods and services (supporting, provisioning, regulating and cultural). According to Rogers (1995), the riparian zone must be considered and managed not in isolation, but with full awareness of its roles and functions in the landscape as a whole. There are numerous functions associated with riparian zones including (but not limited to):

- Riparian plant roots bind to the soil and reduce erosion and the scouring of the stream bed and banks during flooding and elevated flows which further reduce sedimentation and the water quality through increased turbidity;
- Provision of potable drinking water;
- Riparian vegetation provides resources such as food, medicines, firewood and grasses for thatching or weaving;
- Provision of renewable power such as hydropower.
- Provision of water for irrigation. Industry and agriculture;
- Provision of recreational activities such as fishing, river rafting or the use of dams;
- Control flows and therefore reduce risk of floods;
- Riparian vegetation acts as a buffer to flood control and wind erosion as well as raindrop erosion on groundcover;
- Woody species along the riparian zone also reduce carbon emissions and are important in carbon stocks;
- Vegetation within the riparian zone and channel also increases the deposition of both organic and inorganic suspended materials which in turn results in a decrease in flood energy;

- The riparian zones provides a habitat for fauna and flora and provides a corridor for biodiversity by enabling movement and dispersal;
- Riverine systems remove any pollutants from watercourse through dilution;
- Perennial rivers enable spawning, breeding and migratory patterns to take place; and
- The riparian zone provides aesthetics to the overall landscape.

8.4 Ecological importance and Sensitivity of Riverine Systems

The ecological importance of freshwater habitats is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on a local and wider 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). Both abiotic and biotic components of the system are taken into consideration in the assessment of EIS. Tables 17 and 18 below provide the EIS which has been calculated for the at risk riverine systems. According to Kleynhans and Louw (2007), streams with a very high EIS usually consist of many aspects in the biota and habitat which may be sensitive to flow modifications and often have a substantial capacity for use. Systems with a moderate EIS are observed to have a number of aspects which can be influenced by alterations to the hydrological regime, or changes to water quality, however, they are usually not sensitive to such changes. Alternatively, the low EIS systems may have one or a few aspects which may be sensitive to changes in water quality and the hydrological regime, however, generally, they are not very sensitive (Kleynhans & Louw, 2007).

The riverine systems, Rip01-Rip04, Rip06, Rip08 and Rip13 did not occur within a natural or sensitive area in terms of conservation and as a result, no species of conservation concern or unique species were identified during the field assessment. These systems were not flowing over the dry period and therefore will serve little importance to biota in terms of a suitable habitat. The riparian areas were not suitable for refugia as most of the vegetation was cleared and development and hard surfacing had replaced the vegetation. It appears these riverine systems have received sewage and other toxicants and pollutants and therefore are no longer sensitive as they have been modified through anthropogenic activities. If any aquatic species were present previously it is likely they have died off as a result of poor water quality and the inability to migrate due to blocked drains, hindering connectivity. As a result of the above, the EIS of the riverine systems was low, with an ecological category of D, inferring that the rivers do not contain aspects that will be sensitive to changes in water quality and quantity.

Table 17: Ecological Sensitivity and Importance (EIS) of the riverine systems Rip01-Rip04, Rip06, Rip08 and Rip13.

Determinants	Score
BIOTA (RIPARIAN & INSTREAM)	**(0-4)**
Rare & endangered (range: 4=very high - 0 = none)	1.0
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	1.0
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	1.0

Species/taxon richness (range: 4=very high - 1=low/marginal)	0.5
RIPARIAN & INSTREAM HABITATS	**(0-4)**
Diversity of types (4=Very high - 1=marginal/low)	1.0
Refugia (4=Very high - 1=marginal/low)	1.0
Sensitivity to flow changes (4=Very high - 1=marginal/low)	1.0
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1.5
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	0.5
Importance of conservation & natural areas (range, 4=very high - 0=very low)	1
MEDIAN OF DETERMINANTS	1.00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)	**LOW, EC=D**

Rip05, Rip07, Rip09, Rip10 and Rip11 were perennial rivers and therefore offer more of a suitable habitat by maintaining connectivity in the landscape and allowing for migration. The riparian areas were well vegetated to provide a suitable habitat for refuge by species. Rip10 also fell within the woodland D'MOSS area and contained species synonymous with this vegetation unit and this increases its potential to contain rare and endangered species. A protected lily was observed within the woodland areas and therefore in spring, it is likely that more threatened and/or protected species may arise.

Table 18: Ecological Sensitivity and Importance (EIS) of the riverine systems Rip05, Rip07, Rip09, Rip10 and Rip11.

Determinants	Score
BIOTA (RIPARIAN & INSTREAM)	**(0-4)**
Rare & endangered (range: 4=very high - 0 = none)	1.5
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	1.0
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2.0
Species/taxon richness (range: 4=very high - 1=low/marginal)	1.5
RIPARIAN & INSTREAM HABITATS	**(0-4)**
Diversity of types (4=Very high - 1=marginal/low)	1.5
Refugia (4=Very high - 1=marginal/low)	2.0
Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.0
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.5
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	2.0
Importance of conservation & natural areas (range, 4=very high - 0=very low)	3.0
MEDIAN OF DETERMINANTS	2.00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)	**MODERATE, EC=C**

9 MANAGEMENT OF THE FRESHWATER SYSTEMS

The Recommended Ecological Category (REC) devised by DWAF (2007) provides a realistic and practically attainable ecological category using the EIS and PES of the assessed watercourse (Table 19). The REC forms the management objective that is used to guide the mitigation measures and the need for rehabilitation. Subsequent to an analysis of the current state/condition (PES score) and importance (EIS score) of each system, the specific management objective for each resource was determined. The management objectives,

PES and EIS score of the river systems is presented in Table 20. The recommendations and mitigation measures provided in this report will at the least, ensure that the system does not deteriorate further, but rather maintain their current ecological condition. The management objective of maintaining the current state of the ecosystem is further supported by the Ezemvelo KZN Wildlife guideline document: Guidelines for Biodiversity Impact Assessment (EKZN, 2013) and the National Environmental Management Act, 1998 (No. 107 of 1998), in which the biodiversity conservation and sustainable development principle is that of no net loss of biodiversity and ecosystem processes must occur.

Table 19: Recommended management objectives for watercourses based on PES & EIS scores (DWAF, 2007).

			ECOLOGICAL IMPORTANCE AND SENSITIVITY (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

Table 20: Recommended management objective for the at risk riverine systems.

WATER RESOURCE	RISK CATEGORY	PES SCORE	EIS SCORE	MANAGEMENT OBJECTIVE
Rip05, Rip07, Rip09, Rip10 and Rip11	High	E	Moderate	E Maintain
Rip01- Rip04, Rip06, Rip08 and Rip13	High	E	Low	E Maintain

10 BUFFER ZONES

Buffer zones are defined as a strip of land with a use, function or zoning specifically designed to protect one area of land against the impacts from another (DWA, 2005). Due to the increasing stress from anthropogenic pressures impacting on the ecological condition of watercourses throughout South Africa, it is vital that measures to prevent further degradation be implemented. Thus, buffer zones can play a meaningful role in reducing impacts to aquatic resources and, in doing so, protect the ESS provision to communities and ecosystems which surround them. The following services summarise the essential importance of the implementation of relevant buffer zones, these include;

- Maintaining basic ecosystem services and aquatic processes;
- Reducing impacts on water resources from adjacent land-use practices and upstream activities;
- Providing habitats for fauna and flora, including rare and endangered, species;
- Meeting life need requirements for aquatic and semi-aquatic species; and

- Providing several ancillary societal benefits.

Buffer zones are proposed as a mitigation measure to reduce the impacts of proposed activities on water resources. The buffer tool calculated a 50 m buffer zone around the riverine systems for the construction phase. This may however not be practical given that it is assumed the sewer lines will be gravity fed which infers that it will traverse rivers or be located in close proximity to them. It is therefore recommended that where possible, the buffer be applied and that any laydown areas occur outside of the buffer zone. The pipeline must avoid riverine systems were practical and possible to do so. Figure 19 illustrates the 50 metre buffer applied to the riverine systems.

Table 21: Buffer zones calculated for the construction and operation phases associated with the upgrade activities.

PHASE	BUFFER DISTANCE (M)
Construction Phase	50
Operational Phase	55

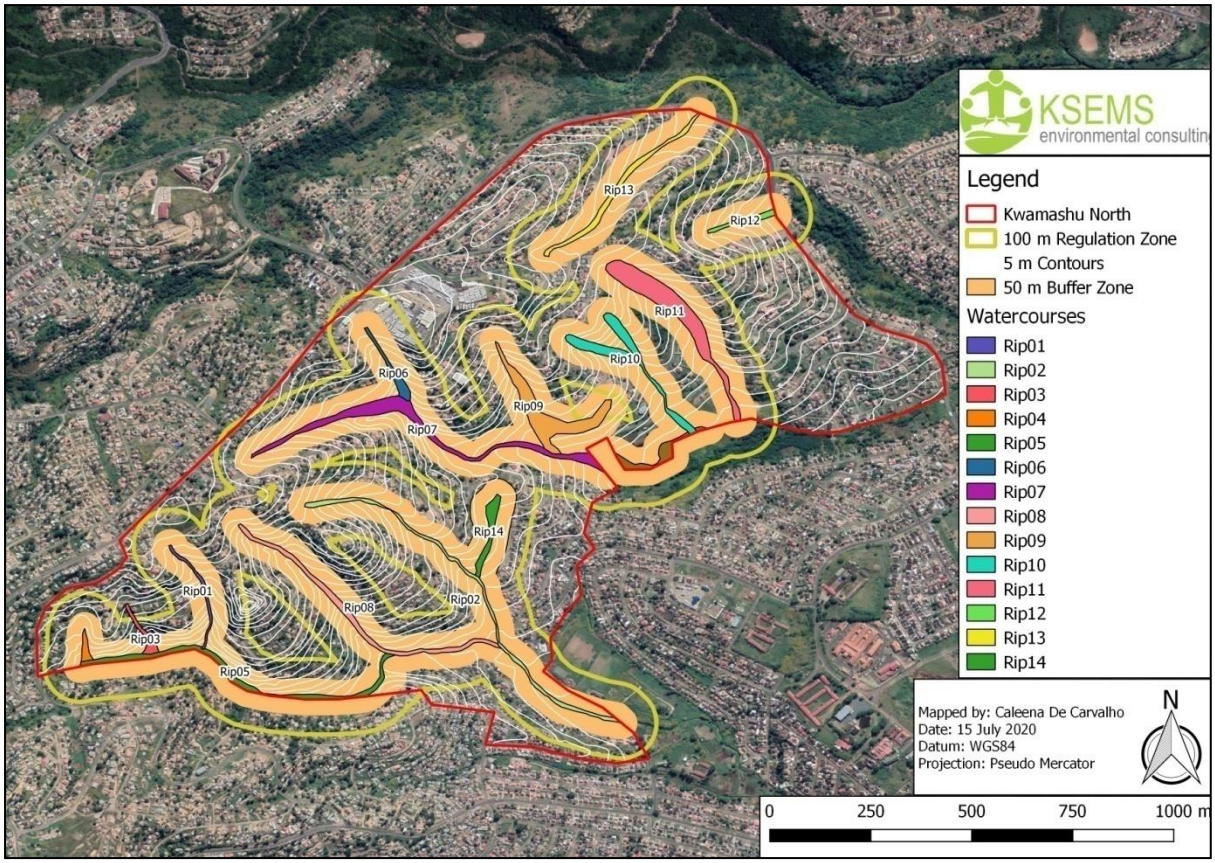


Figure 19: Buffer zones calculated for the watercourses within the study area (KSEMS, 2020).

11 IMPACT AND RISK ASSESSMENT

11.1 Impact Assessment

An understanding of the relationship between the landscape and the dynamic characteristics of watercourses is vital for the accurate assessment of the freshwater functions and values. Watercourses are adjusting to

disturbance occurring within them and within the greater landscape, on a continuous basis. The recognition to what extent these various disturbances have on watercourse and their associated PES and EIS is vital when assessing disturbance and impact and when considering mitigative measures.

The types of impacts on watercourses can be categorised into three (3) broad categories, namely; direct, indirect and cumulative impacts.

1. Direct impacts: Activities that result in disturbance occurring within the watercourse such as canalisation, channelling, impeding features, diversions, infilling, removal of indigenous vegetation and infrastructural development such as roads, pipelines and bridges.
2. Indirect impacts: Disturbances that occur outside of the watercourse, such as increased surface water and sediment runoff, loss of recharge area, nutrient enrichment and changes in drainage patterns.
3. Cumulative impacts: Disturbances that arise from combined direct and/or indirect impacts to the system over time. However, as this study was conducted over a one-day period, the cumulative impacts could not be documented with confidence within this report. A more in-depth assessment over several seasons would need to be conducted to accurately determine the relevant cumulative, and/or downstream impacts.

Figure 20 provides photographic evidence of the conditions on site and impacts within the catchment and watercourses.


Rip01
Rip08
Rip02
Rip07
Rip11
Rip14

Figure 20: Photographic evidence of the site conditions and features within the study area and watercourses (KSEMS, 2020).

11.2 Risk Assessment Matrix (RAM)

The Department of Water and Sanitation (DWS) is the custodian of South Africa's water resources and NWA, 1998 (No. 36 of 1998) provides a legal framework in which the competent authority regulate the use of water whilst conserving the water resource at use, such that pollution or changes in the water resource are prevented that could render the water resource harmful (to humans or the environment) or unfit for use. Therefore, in terms of Section 22 of the National Water Act, a person may only use water without a license if the water use is permissible under Schedule 1 (permissible water use of low volume and impact that is largely consistent with domestic activities and general stock watering); if it is a continuation of an existing lawful use; or if it is permissible in terms of a General Authorisation (GA) issued under Section 39 (activities that occur within the regulated area of a watercourse that's impacts can be reduced to low risk with the implementation of mitigation measures).

Under Section 39 of the NWA, 1998 (No. 36 of 1998), it replaces the need for a water user to apply for a license in terms of the Act, provided that the water use is within the limits and conditions of the GA and where the Risk Class as determined by the RAM (DWS, 2016) is low or can be reduced from moderate to low risk following the implementation of additional mitigation and avoidance measures. The associated risk category of the various activities was assessed utilising the DWS RAM (DWS, 2016). A summary of the RAM specific to this project is summarised in Table 22 below. The full RAM is available on request. Each category of the RAM has an explanation which can be found in Appendix 18.4.

The strength of the revised DWS RAM is that the critical components of each impact, namely: duration, extent, magnitude, probability and significance, are carefully considered. Within the table below, each aspect pertaining to a specific activity has been analysed in a pre-mitigation phase. If an aspect is calculated to be of a moderate risk level pre-mitigation and it has the ability to be mitigated down to a low risk class, with the use of the mitigation measures specified within this report, then the water use may fall within the ambit of a GA. However, if an aspect calculated a moderate risk class (above 80) pre-mitigation and does not have the ability to be mitigated to a low risk class, the aspect will remain a moderate risk post-mitigation, and thus trigger the need for the water uses to fall within the ambit of a full WULA as per Section 21 of the NWA (No. 36 of 1998).

Although the upgrade will improve existing sanitation and improve water quality for the riverine systems by avoiding direct discharge of sewage into the rivers, sewage is still an aspect that will occur above or within the watercourses. During the construction phase, the greatest risk posed on these watercourses is the placement of the sewer pipeline. This activity accompanies various aspects that will result in a moderate impacts on the river systems. Aspects that were assessed to have a moderate risk included the utilisation of machinery and vehicles within or in close proximity to the watercourses, and the excavation of the trench along/within watercourses. During the operation phase, the utilisation and operation of sewerlines posed the greatest risk and the aspect that would result in moderate impacts were the lack of regular inspections and maintenance resulting in collapse

or failure of infrastructure as well as leakage and contamination into the river systems. The operational activities (lack of regular inspections and maintenance) was an activity that could not be mitigated to low risk as sewage entering the watercourses could have a detrimental effect on the functionality and the quality of water. Although the systems may potentially be receiving sewage via informal ablution facilities, the impacts will be compounded and contaminants may bioaccumulate and cause die off of more species and further affect human health, especially if water is abstracted from these systems for domestic purposes.

As a result of the potential to contaminate the watercourses, is it the specialist's opinion that the project proceed in accordance with a full water use license application process.

Table 22: Summary of potential risks tabulated in a risk assessment matrix for sewage upgrade activities associated with KwaMashu north housing.

Nr.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Control Measures	Risk, Post Mitigation	PES/EIS of watercourses
1	Pre-C, C & O	Establishment of a construction site/laydown areas and site camp	Increase in hardened surfaces	Construction site above Rip01 may result in increased volumes of surface water entering this system. This may result in scour and erosion	1.50	3.50	9,00	31.50	Low	Areas must remain vegetated where possible. Only clean surface water may be drained into Rip01, this must be done in a controlled manner. Adequate stormwater infrastructure must be in place. Access to site is via existing road servitudes and no additional hard surfacing is required. Use areas already cleared for the laydown of construction materials. Adequate runoff conveyance measures must be implemented. Ensure all the riverine systems are demarcated and the access roads and laydown areas are not located within the watercourses and the buffer zones.		Rip01: PES -E, EIS- low
	Pre-C & C		Clearing of vegetation and grubbing of soil	Encroachment of IAPS into cleared areas. Removal of indigenous vegetation and reduced surface roughness. Loss of biodiversity. Scour and erosion	1.50	3.50	10,00	35,00	Low	Only clear areas within the development footprint and in a phased approach, guided by the ECO. Areas must be landscaped and vegetation maintained where possible. Shade cloth must be erected around the camp site fence to prevent sediment from reaching the riverine systems. Access roads are existing and therefore clearing will be limited to the construction and camp sites. Any additional routes and turning areas required by the contractor must be approved by the ECO. Stabilise banks using sods.		
2	Pre-C, C & O	Establishment and utilisation of stockpile sites	Inappropriate use and demarcation of stockpile areas	Stockpiles stored at inappropriate heights will result in erosion and sedimentation. Stormwater drainage may	1.25	3.25	10,00	32.50	Low	The construction site is not located near any watercourses and must remain outside of the 1:100 year floodline and 50 metres away from any riverine systems. The stockpiles may not exceed 2 m in		

				become blocked. Topsoils and sub-soils may become mixed and reduce the soil quality and fertility. Contaminants may reach the soil. Winds may create dust storms.						height. Stockpiles that remain longer than 6 months must be revegetated to prevent erosion and a netting must be used to confine sediment from water and wind erosion. Stockpiles must only be placed in allocated areas. Topsoil must be stored separately from subsoil.		
3	Pre-C, C & O	Placement of sewer pipeline	Utilisation of machinery and vehicles	TLBS and excavators may be used and enter into the riverine systems, causing soil compaction and erosion. Ad hoc access roads may occur to access the riverine systems and cause tyre erosion and rill formation. Tyre tracks may divert flows. Accidental spillage of hydrocarbons may seep into soil profile and enter into watercourses, reducing water quality and altering physico-chemical composition of water, affecting macroinvertebrates.	3,00	6,00	12,00	72,00	Moderate	Drip trays must be placed under all machinery, servicing of vehicles must be avoided on site unless absolutely necessary and then this must take place in a bunded area. Spill kits must be kept on site and any accidental spillages reported immediately to the ECO. No vehicles may be washed within 50 m of the watercourses and if this is required it must be within a designated area agreed upon by the ECO. Refueling and servicing of vehicles must take place off site if possible	Moderate risk, reduced to low post mitigation	Rip01-Rip04/ Rip06/Rip08/Rip13: PES - E EIS – low Rip05/Rip07/ Rip09/ Rip10 & Rip11: PES – E; EIS - Moderate
	Pre-C, C & O		Excavation of trench along/within watercourses	Destruction of vegetation along riparian zone and within channel. Loss of fertile topsoils. Increased sediment inputs via erosion causing reduced water quality and increased turbidity. Sediment may suffocate benthic communities located within perennial rivers. Diversion of flows if excavation occurs within watercourse. Cut and fill activities will cause	3,00	6,00	12,00	72,00	Moderate	Diversion dikes and berms must be implemented to control runoff and erosion into riverine systems. Design must account for the 1:100 year floodline data and avoid watercourses where possible. It is assumed gravity fed pipelines will be used over rising mains and pump stations. Pump stations will increase the risk of contamination of the riverine systems and should be avoided where feasible and practical. Excavation in watercourses should be avoided where possible. Excavation must be undertaken in a phased approach and activities monitored by an ECO. Where necessary, diversion	Moderate risk, reduced to low post mitigation	

				uneven topography and increase in steepness and potential for scour and erosion of banks. Habitat fragmentation. Impact on stream flow dynamics resulting in potential flooding or impounding. Preferably construct when water levels are at their lowest for the perennial rivers to avoid destruction and floodling. Unstable banks causing collapse of sediment into riverine systems, affecting turbidity and water quality.						ditches will be created to intercept and slow the speed of runoff. Other potential measures to reduce surface water runoff and sediment erosion include geotextiles, riprap,soil nails and french drains. Grade and shape the land to avoid erosion. Sufficient stabilisation of the banks must occur to accommodate the 1:100 year flood levels and change in the topography due to cut and fill activities. Clear IAPS as part of construction process to assist in improving ecological status.		
4	O	Utilisation and operation of sewerlines	Operation of sewerlines	Positive impact: Increase in efficiency of sewage conveyance. Improved water quality and river health. Improved sanitation services	1,00	5,00	11,00	55,00	Low			
			Lack of regular inspections and maintenance	Contamination of soil profile. Damages and leakages in sewerlines. Discharge of sewage and contaminants into riverine systems, deteriorating water quality and river health. Seepage of soil affecting flora and fauna.	3.25	7.25	15,00	108.75	Moderate	Design must accommodate sewage volumes. Pipelines must contain impermeable casings. Water quality testing must take place above and below areas the pipeline traverses a watercourse and this must meet the South African Target Water Quality Range for aquatic ecosystems. Manholes must feature to allow for monitoring and maintenance. Design must account for flow dynamics and must not contribute to flooding or impounding. Regular inspections must take place and record keeping. Water quality tests must take place immediately following a leakage or collapse of infrastructure. This must be reported to the ECO and relevant government departments.		Rip01-Rip04/ Rip06/Rip08/Rip13: PES - E EIS – low Rip05/Rip07/ Rip09/ Rip10 & Rip11: PES – E; EIS - Moderate

5	Po-C	De-establishment of the site camp, spoil sites, waste dumps etc.	Removal of waste	If not disposed of correctly, waste/contaminants may seep into the soil and cause die off of vegetation.	1,00	3,00	8,00	24,00	Low	Ablution facilities must be removed safely. Safety disposal certificates must be obtained for waste disposal. No rubble must be left on site that may deposit in drains.		
6	R	Rehabilitation of site	Infill soil, re-vegetate cleared areas with indigenous vegetation	**Positive impacts**: increase surface roughness and reduce the velocity of the surface runoff; Decrease erosion potential; Increase biodiversity; Remove all potential contaminants; Reinstate natural topography.	1,00	7,00	10,00	70,00	Moderate	Tillage of areas of bare-soil and revegetation using a mixture of indigenous grass species. Reshape areas to natural topography where possible and if necessary. If fertile topsoil not deemed suitable for use, it is the Contractors responsibility to replace soil. Soil used must be free from IAPS seeds. Soil water quality tests must be undertaken prior to backfill/infill.	Moderate risk, reduced to low post mitigation	Rip01-Rip04/ Rip06/Rip08/Rip13: PES - E EIS – low Rip05/Rip07/ Rip09/ Rip10 & Rip11: PES – E; EIS - Moderate
			Incorrect placement of removed soils, no monitoring of IAPS	**Negative impacts**: Planting IAPS, destabilisations of soils, loss of fertile topsoil, mixture of sub soil and top soil	2,00	8,00	9,00	72,00	Moderate	Adequate budget must be kept to cover all maintenance and future replacement costs to failed infrastructure	Low	

12 MITIGATIVE MANAGEMENT MEASURES

The proposed upgrade activities should be planned, designed and operated in a sustainable manner ensuring further disturbance is avoided or, where it cannot be altogether avoided, appropriate mitigative measures be applied in the form of reactive practical actions that minimise or reduce in-situ impacts. This is to ensure no unnecessary degradation of sensitive, vulnerable, highly dynamic or stressed ecosystems occurs during the development lifecycle.

According to Chapter 1 Principle 2(4) of the NEMA, 1998 (No. 107 of 1998) regarding sustainable development and management of sensitive ecosystems:

(a) Sustainable development requires the consideration of all relevant factors including the following:

(i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;

(ii) that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;

(iii) that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;

(iv) that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and

(v) That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied."

(r) Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

The mitigation of negative impacts on biodiversity and ESS provision is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation requires proactive planning that is enabled through a mitigation hierarchy (Figure 18). Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA, 2013).The mitigative measures detailed within this report must be taken into consideration during financial planning to ensure that sufficient funds are available to implement all the measures required to maintain the integrity of the watercourses. The proof of this financial capacity must be made available on request from the DWS.

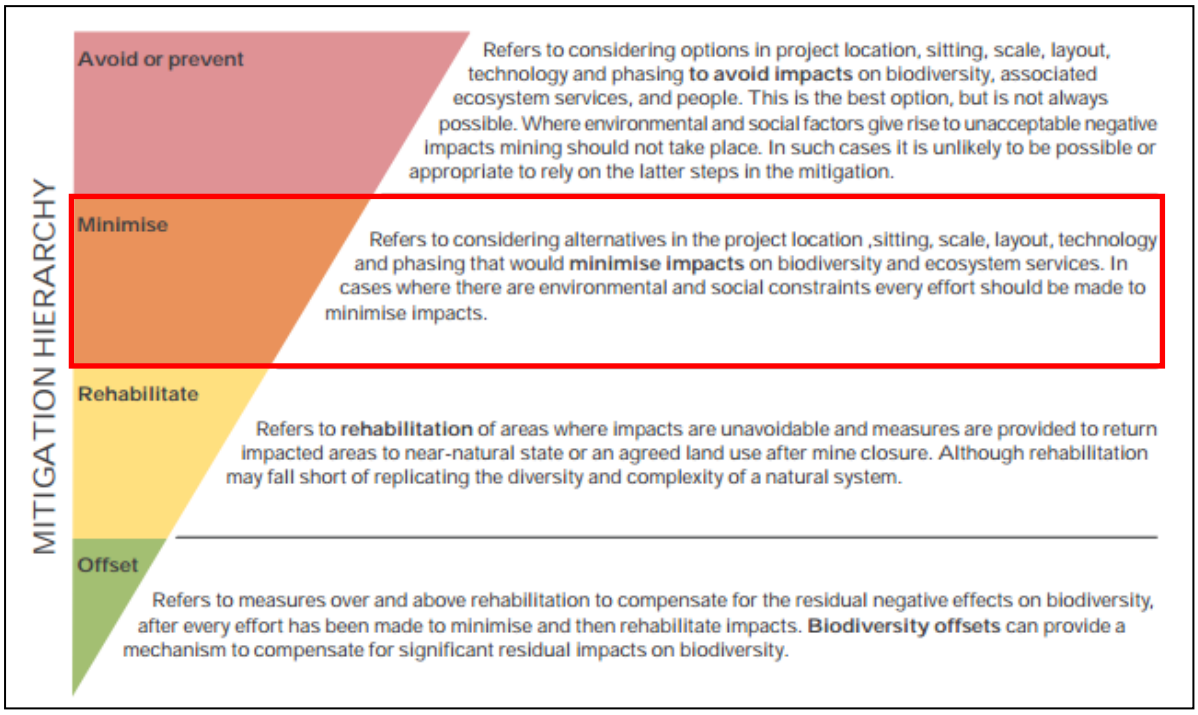


Figure 21: The mitigation hierarchy (DEA, 2013).

Under the NEM:WA, 2008 (No. 59 of 2008)

General duty in respect of waste management

16. (1) A holder of waste must, within the holder's power, take all reasonable measures to—

a) avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;

b) reduce, re-use, recycle and recover waste;

c) where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;

d) manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour or visual impacts;

e) prevent any employee or any person under his or her supervision from contravening this Act; and

f) prevent the waste from being used for an unauthorised purpose.

Consequences of listing waste management activities

20. No person may commence, undertake or conduct a waste management activity, except in accordance with -

a) the requirements or standards determined in terms of Section 19(3) for that activity; or

b) a waste management licence issued in respect of that activity, if a licence is required.

Prohibition of unauthorised disposal

26.(1) No person may—

a) dispose of waste, or knowingly or negligently cause or permit waste to be disposed of, in or on any land, waterbody or at any facility unless the disposal of that waste is authorised by law or

b) dispose of waste in a manner that is likely to cause pollution of the environment or harm to health and well-being.

Under the NWA, 1998 (No. 36 of 1998, as amended in 2014)

19. Prevention and remedying effects of pollution

1. An owner of land, a person in control of land or a person who occupies or used the land which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring
2. The measures referred to in subsection (1) may include measures to –
    a) cease, modify or control any act or process causing the pollution;
    b) comply with any prescribed waste standard or management practice;
    c) contain or prevent the movement of pollutants;
    d) eliminate any source of the pollution;
    e) remedy the effects of the pollution; and
    f) remedy the effects of any disturbance to the bed and banks of a watercourse.

Although mitigation measures were provided in the RAM, below are mitigation measures per aspect that must be taken into consideration throughout the various phases of the upgrade.

Table 23: Mitigation measures applicable to the sewage upgrades for KwaMashu north housing.

GENERAL	MITIGATION MEASURE
	– Conduct all activities in a sustainable, least risk manner – Observe delineation of all onsite riverine systems and prescribed buffers and ensure that no encroachment within these areas occur without appropriate authorisations and licenses. – The precautionary approach is applicable. Thus, worst-case conservative assumptions must be made in instances where there is a lack of information or level of knowledge. – All staff are to be trained on their environmental responsibilities before commencing work. All new staff are to be trained before they start work on site. – The Applicant must comply with the provisions of GN704 of the NWA, and includes making available the necessary financial and human resources, training and education, management structures contact with expertise for necessary investigations, etc. – Copies of all designs, method statements, risk assessments, and any other reports required must be made available to the responsible authority when requested to do so. – The emergency protocol as per Appendix C of Notice 509 of 2016 must be implemented in the case of emergency situations and incidents. – Prior to the carrying out of any works, the water user must ensure that all persons entering on -site, including contractors and casual labourers, are made fully aware of the conditions and related management measures specified in the water use licenses. – All disturbed areas must be: • cleared of construction debris and other blockages;

	• cleared of IAPS; • reshaped to free -draining and non -erosive contours, and • re- vegetated with indigenous vegetation suitable to the area and ecosystem.
BIODIVERSITY IMPACTS	**MITIGATION MEASURES**
– Loss of biodiversity through die off of sensitive and conservative species/organisms. – Smothering of instream habitats with sediments from the scour of banks from increased flows. – Small fragments of habitat can support only small populations and small populations are more vulnerable to extinction. – Macro-invertebrates are sensitive to disturbance and changes in water quality will cause die off. – Loss of rare/unique/endangered species. – Burying of benthic communities as a result of deposition of sediment.	– Hunting is prohibited and monitoring for snare traps must be conducted. – The riverine systems that are not traversed by the sewer line must be demarcated as "no go areas" – Although the system is already seriously modified, the water user must maintain the current ecological state by ensuring that measures are implemented to: • prevent detrimental changes to the breeding, nesting or feeding patterns of aquatic biota, including migratory species; • allow for the free up and downstream movement of aquatic biota, including migratory species; and • prevent a decline in the composition and diversity of the indigenous and endemic aquatic biota.
SEDIMENT	**MITIGATION MEASURES**
– The creation of informal or ad-hoc roads will compact vegetation and soils. – Slope instability through excavation activities. – Increase in hard surfaces increasing surface flows and channelling water into the watercourses downslope. – Concentrated flows from surface flows on hard surfacing may increase the risk of erosion in areas of reduced surface roughness.	– The area must remain well vegetated to prevent erosion – Only set walkways and access roads may be used. – No ad-hoc routes may be created. – Sediment traps and diversion berms must be erected to control runoff and mitigate erosion. – Adequate stormwater drainage infrastructure must be implemented and a stormwater management plan, particularly within the camp site and cleared vegetation areas.
HYDROLOGY	**MITIGATION MEASURES**
– Alteration to the hydrological regime through increased volumes and velocities of water at discharge point.	– Adhere to the eThekwini Stormwater Management Bylaws. – No abstraction of water is permitted unless a Section 21 (a) water use is applied for and has been granted by the Department of Water and Sanitation. If required, the quantities of water must be strictly controlled, recorded and monitored by the appropriate personnel. – Natural water resources may not be used for personal washing, the washing of clothes or the washing of machinery as per the Best Practice Guideline G1 Storm Water Management (DWAF, 2006). – Ensure that all storm water structures can accommodate a defined precipitation event and no obstruction within the pipeline route interferes with the floodline events. – Ensure that the maximum volume of clean water runoff is diverted directly to watercourses. – Hard surfaces must have associated stormwater to control the velocity of water entering nearby watercourses.

	– The water user must ensure that measures are taken to prevent increased turbidity, sedimentation and detrimental chemical changes to the composition of the riverine systems as a result of carrying out the works, including emergency remedial works or the rectification of reportable incidents. – Losses of water and consumptive use of water must be minimised. – Any water system must be kept free of obstructions to ensure continued efficiency thereof. – The water user must ensure that all works, including emergency alterations or the rectification of incidents, start upstream and proceed in a downstream direction, to ensure minimal impact on the riverine systems. – The water user must ensure that the works: • are structurally stable; • do not induce sedimentation, erosion or flooding; • do not cause a detrimental change in the quantity, velocity, pattern, timing, water level and assurance of flow; • do not cause a detrimental change in the quality of water; and • do not cause a detrimental change in the stability or geomorphological structure of the rivers.
VEGETATION	**MITIGATION MEASURES**
– Die off of sensitive vegetation from contamination. – Removal of threatened and/or protected plant species and species of conservation concern. – Invasive and alien plant species encroachment will cause indigenous vegetation to become outcompeted.	– Hydrophytes and any threatened, protected or conservative species that arise must be removed to avoid die off in the event of a spillage. – Any invasive and alien plant species that germinate throughout the lifespan of the project must be cleared using the appropriate methodology depending on the severity of infestation, the type of plant species and their locality (i.e. in sensitive environments – terrestrial or aquatic). Under the National Environmental Management Biodiversity Act, landowners are under legal obligation to control invasive and alien plant species – Relocation activities must take place to a nearby nursery for continuous nurturing and protection for later replanting post operation.
WASTE & POLLUTION IMPACTS	**MITIGATION MEASURES**
– Deposition of litter in watercourses can hinder the flow of water, altering the hydrological regime. – Deposition of litter in stormwater drainage can inhibit the flow of water that reaches the watercourses and cause flooding on the surface. – The constituents of wastewater may include a varying range of potential contaminants such as silt; sand; biodegradable organic wastes; detergents; fats; oil; greases; solvents; phenols; nutrients (nitrogen, phosphates, ammonia); metals (Hg, Pb, Cd, Cr, Cu, Ni) and microorganisms (pathogenic bacteria and viruses). – Contamination of groundwater through	– Tanks, pipelines, valves and seals should be adapted to the waste characteristics. The components should be corrosion resistant. – Utilise the relevant Waste Management Plan and emergency spill instructions to mitigate the potential impacts of the constituents entering the rivers. – Implement integrated waste management through waste prevention (avoidance of the production of wastes) and waste minimisation (reduction of the volume of waste). – Areas demarcated for waste must be bunded, or on concrete underlined with impervious material as to prevent seepage of contaminants into the soil and groundwater. – The bund wall must be high enough to contain at least 110% of any stored volume. – If a spill occurs, this should be immediately reported to the construction manager and the area should be cleaned up immediately to ensure no hydrocarbons or foreign material is washed into downstream watercourses.

leakages and spillages. – The input of potentially harmful pathogens into watercourses may occur. These pollutants alter several water quality parameters such as turbidity (increased suspended solids), nutrient levels, chemical oxygen demand and pH. Consequently, these impacts on the aquatic species composition of the system, specifically species that are sensitive to minor changes in these parameters.	– In the event of a spillage, the contractor shall be liable to contract professional service providers to clear the affected area/s. – Management of incidents will require a register of events, reporting requirements, clean up requirements, disposal, monitoring and close-out following successful rehabilitation – Sand saturated with contaminates is required to be disposed of at a registered hazardous landfill facility and Safe Disposal Records kept on file. – Any solid waste produced must be disposed of at a landfill licensed in terms of Section 20 (b) of NEM:WA (No. 59 of 2008). – The spill must be reported to the ECO. The ECO must ensure that all site personnel are aware of the spill response procedures during training and toolbox talks. If the spill results in contamination or if the spill falls within the definition of an emergency incident, the ECO must report the incident to the relevant authorities. – Machinery should be checked for oil and fuel leaks, or possible soil and water contamination. – Drip trays must be provided for all emergency repairs that may be required on site. Drip trays are to be watertight, and must be emptied regularly and before rain events. The contents of drip trays are to be treated as hazardous waste. – Material Safety Data Sheets (MSDSs) must be readily available on site for all chemicals and hazardous substances to be used on site. Where possible and available, MSDSs must additionally include information on ecological impacts and measures to minimise negative environmental impacts during accidental releases or leakages. – The soil quality must be assessed and any soil deemed to be contaminated must be removed. – Sufficient bins must be placed on site as to avoid littering and dumping in drainage lines. – Should potential leakages be detected by groundwater and soil monitoring records, a professionally registered engineer should be consulted immediately to determine potential causes. – An equipment/machinery operating manual should be developed as part of the design and construction phase. – Prevent water containing waste or any substances which causes or is likely to cause pollution from entering water resources, either by natural flow or seepage. Retain and collect such substance or water containing waste for use, re-use, evaporation or for purification or disposal. – Should any spillage take place during the transport, off-loading and handling activities, the following actions should apply (as per the EPRP): • Minor spillage - clean up with use of a spill kit (to be included in the EPRP; and • Major spillage - Remediation measures to be investigated and a NEMA Section 30 incident report to be submitted to the national Department. – The DWAF (2007) Best Practice Guideline for the Pollution Prevention and Minimisation of Impacts should be applied where necessary.

	– The Contractor shall ensure all personnel are aware of the incident procedures and know how to use equipment provided to contain spills and other incidents.

13 MONITORING REQUIREMENTS

The Department of Water Affairs as the custodian of South Africa`s water resources, has initiated various monitoring programs and promulgated a series of laws that regulate all water matters to ensure efficient; effective and sustainable utilisation thereof. Monitoring is defined as surveys, inspections and examinations to determine the trends and status of changes or to assess the outcome of an implemented activity whilst a monitoring programme refers to programme for taking regular measurements of the quantity and quality of a water resource, waste or wastewater discharge at specified intervals and at specific locations to determine the chemical, physical and biological nature of the water resource, waste or wastewater discharge. An impact on water quality refers to any alteration of the physical, chemical or biological properties of water.

Record keeping:

- Written record of the wastewater disposal and related activities including the location of the wastewater disposal site and details of failures and malfunctions of any wastewater disposal system that the registered user is responsible for, and such information must be made available upon written request to the responsible authority.

Incident reporting:

- A relevant DWS regional office must be notified about the emergency incident or situation by means of an email and or 24 hour hotline of DWS. The document emailed must as a minimum contain the following information:
  a) Date of occurrence of the emergency;
  b) Date at which any person became aware of the emergency;
  c) Nature of emergency;
  d) A motivation and definition of the emergency;
  e) Description, location and receiving environment sensitivity of the emergency;
  f) Description of short, medium and long term actions, environmental management and rehabilitation, and emergency plan required to be taken to respond to the emergency;
  g) Date(s) when the actions will be taken (or have taken place); and
  h) Contract details of responsible persons.
- Materials that absorb fuel and oil, such as spill kits or earth should be placed over the spill. This contaminated material must be uplifted, placed within an impermeable container and disposed of at a recognised disposal site.

- In the event of a spillage that cannot be contained, and which poses a serious threat to the environment, the following Departments must be informed of the incident in accordance with Section 30 of NEMA, 1998 (No. 107 of 1998), within forty-eight (48) hours:
  - The Local Authority;
  - DWS;
  - The Department of Environment, Forestry and Fisheries;
  - The Local Fire Department when relevant; and
  - Any other affected departments.
- An incident record must be kept on site for all spills that do occur onsite. Minor incidents will include small spills of less than 5 litres that do not enter a watercourse, stormwater drains, housekeeping issues and general small non-compliances with the requirements of this report, method statements, EA and/or EMPr whereas major incidents must be reported to the authorities, which include spills larger than 5 L and all incidents involving contamination of water resources, stormwater or other reportable incidents. The ECO must be notified and advise on remediation measures and to follow up on actions taken to address the incidents.

Under Section 30 of NEMA, 1998 (No. 107 of 1998), the following procedures must be followed:

1. Initial reporting of the incident to the authorities
2. Containing and minimising the effects of the incident to the environment, health, safety and property of persons.
3. Undertaking clean up procedures.
4. Remedying the effects of the incident.
5. Assessing the immediate and long-term effects of the incident on the environment and public health.
6. Initial evaluation reporting within 14 days of the incident.
7. The issuing of a directive by a relevant authority for actions 2-6 above.
8. Confirmation of a verbal directive in writing.
9. Undertaking of actions 2-4 by the relevant authority where the responsible person fails to act.
10. Claiming reimbursement of all reasonable costs from every responsible person.
11. Comprehensive reporting by a relevant authority which has exercised actions 7-9 above.

14 POTENTIAL LICENSING AND PERMIT REQUIREMENTS

Water uses are defined within Section 21 of the NWA, 1998 (No. 36 of 1998). These generally relate to the utilisation/abstraction of water (surface and ground), alterations and/or diversions of watercourses and, discharging/disposing of waste into a watercourse. It must be noted that upon receiving an authorisation, the Minister may make regulations –

a) limiting or restricting the purpose, manner or extent of water use;

b) requiring that the use of water from a water resource be monitored, measured and recorded;
c) requiring that any water use be registered with the responsible authority;
d) prescribing the outcome of effect which must be achieved by the installation and operation of any waterwork;
e) regulating the design, construction, installation, operation and maintenance of any waterwork, where it is necessary or desirable to monitor any water use or to protect a water resource;
f) requiring qualifications for the registration of persons authorised to design, construct, install, operate and maintain any waterwork, in order to protect the public and to safeguard human life and property;
g) regulating or prohibiting any activity in order to protect a water resource or instream or riparian habitat;
h) prescribing waste standards which specify the quantity, quality and temperature of waste which may be discharged or deposited into or allowed to enter a water resource;
i) prescribing the outcome or effect which must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource;
j) requiring that waste discharged or deposited into or allowed to enter a water resource be monitored and analysed, and prescribing methods for such monitoring and analysis; and
k) prescribing procedural requirements for licence applications.

Table 24: Section 21 Water Uses applicable to the proposed upgrade activities.

SECTION 21 OF THE NWA	DEFINITION (NWA, 2014)	APPLICABILITY
(c): Impeding or diverting the flow of water in a watercourse	Causing an obstruction to the flow of water in a watercourse or diverting some or all of the flow in or from a watercourse .Impeding or diverting flow does not normally cause any loss of water, but influences the flow regime in a watercourse. Impeding or diverting structures can fully or partially extend into a river, forcing the natural flow direction to be re-directed by the structure. Any activity that occurs within the regulated area of a watercourse.	The sewage upgrade activities may occur directly within the riverine systems or fall within the regulated area. If the sewer lines traverse the rivers, a Section 21 (c) will apply to each crossing point. If the sewer lines only occur within 100 metres of a watercourse, the Section 21 (c) will apply.
(i): Altering the bed, banks, course or characteristics of a watercourse	Alteration of the course (including the beds, banks or characteristics) of a watercourse. Alteration of the course refers to any changes affecting: the energy of the watercourse; the morphology of the watercourse; the physical characteristics; the chemical characteristics; flood dynamics; and biotic components of a watercourse.	The sewage upgrade activities may occur directly within the riverine systems or fall within the regulated area. If the sewer lines traverse the rivers, a Section 21 (i) will apply to each crossing point. If the sewer lines only occur within 100 metres of a watercourse, the Section 21 (i) will

	Any activity that occurs within the regulated area of a watercourse.	apply.

It must be noted that all water uses as stipulated in Table 24 above may only commence upon receipt of a registration certificate from the Department of Water and Sanitation. Although a full water use license applies, as per the Department of Water and Sanitation (DWS) General Notice (GN 509 of 2016), General Authorisation in Terms of Section 39 of the NWA, 1998 (No. 36 of 1998) for Water Uses as defined in Section 21(c) or Section 21(i) of the NWA, 1998 (No. 36 of 1998), the following applies to the maintenance and monitoring of the water quality along the at risk watercourses (Table 25).

It must be noted that in order for accurate results to be obtained in terms of detecting leakages, water quality testing should be done above and below the pipeline areas. There are other upstream activities polluting the watercourses and therefore the water testing points must be selected carefully to be representative of the sewer pipeline impacts on water quality and no other activities/impacts.

Table 25: Summary of the sections within the amended GA (DWS, 2016) that are relevant to the maintenance and monitoring of the water quality.

GA SECTION 21 (C) AND (I)	DEFINITION
Paragraph 9 (3)(m)	The water user must ensure that in-stream water quality is measured, including for emergency alterations or the rectification of reportable incidents, which measurement must be by taking samples, and by analysing the samples for pH, EC/TDS, TSS/Turbidity, and /or Dissolved Oxygen (DO) both upstream and downstream from the activities.
Paragraph 9 (3)(n)	The water user must ensure that in-stream flow, both upstream and downstream from the activities, is measured on an ongoing basis by means of instruments and devices certified by the South African Bureau of Standards (SABS), including for emergency alterations or the rectification of reportable incidents.

Key: EC - Electrical Conductivity; TDS - Total Dissolved Solids; TSS - Total Suspended Solids; DO - Dissolved Oxygen.

15 CONDITIONS FOR AUTHORISATIONS

- The buffer zones may not be feasible but must apply to the laydown areas and must be implemented where practical and possible.
- The buffer zones provided must be considered in the planning/ pre-construction and construction phases of the upgrade activities.
- Where applicable, the eThekwini Municipal bylaws pertaining to sewage and stormwater must be implemented and adhered to.
- A protected lily was observed. A botanist must be consulted prior to clearing activities, particularly in the D'MOSS area, to ensure no threatened and/or protected species, species of conservation concern or unique species are cleared accidentally.
- Where applicable, the Durban Metro guidelines on sewage in terms of disposal, the design and construction of pipelines and construction of ablution facilities must be implemented and adhered to.
- Watercourses should be avoided where deemed practical and possible.
- Disturbance must be limited to the sewer pipeline servitude. Watercourses outside of the demarcated working area should be classified as no go areas.
- Prior to excavation for the trench, the informal roads must be stabilised to avoid collapse of the banks and the potential for pipeline failure in terms of collapse. This will also reduce sediment loads and improve the ecological condition of the watercourses.
- Re-vegetate all disturbed and cleared areas throughout the construction and operational phases.
- The proliferation and encroachment of IAPS must be eradicated, monitored and managed/controlled within the instream and riparian zones throughout the construction and operational phases.
- A site-specific waste management and stormwater management plan must be compiled and implemented throughout the various phases of the proposed development.
- Vehicle activities must be controlled such as speed, location and parking.
- All disturbed areas post construction must be rehabilitated.
- All soils that have become compacted as a result of vehicle and human activities should be ripped and profiled according to the natural topography.
- Water quality testing should be undertaken at a frequency of at least once a month, at fixed monitoring points for parameters such as pH, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS), dissolved oxygen (DO) and Electrical Conductivity (EC), in accordance with GN509 of the NWA, 1998 (No. 36 of 1998).
- Only water uses under Section 21 (c) and (i) have been assessed in this report. Therefore, no other activities may take place i.e. abstraction and discharge of sewage via conduit into watercourses.

16 CONCLUSION

Following the field assessment, it was determined that twelve (12) watercourses, in the form of riverine systems, were identified to be at risk as a result of proposed sewage upgrade activities associated with the KwaMashu north housing. The proposed infrastructure fell within the regulated area of a watercourse and therefore a wetland study was required. An assessment of the habitat integrity of the onsite river systems was undertaken and it was determined that the overall ecological category was largely modified. These modifications were attributed to the informal settlements located along the riparian zone and cut and fill activities that occurred in stream for the construction of roads and associated stormwater infrastructure. The existing infrastructure entailed the clearing of vegetation which has transformed the historic natural vegetation as the remaining indigenous communities have been largely outcompeted by invasive and alien plant species. Anthropogenic activities in close proximity to and within the river systems have caused a significant amount of pollution and contaminants entering the systems, particularly sewage from informal ablution facilities. The proposed upgrade activities will improve sanitation services, infrastructure and human and environmental health, however, the sewage infrastructure may occur within or in close proximity to the watercourses and as a result of the risk associated with contamination and reduced water quality, the operation of the sewer lines could not be mitigated to low risk following the implementation of the mitigation measures and specialist's recommendations. Therefore, it is the specialist's opinion that the project proceed and the activities associated with the sewage upgrades should fall within the ambit of a full water use license application.

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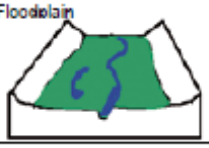
18 APPENDICES

18.1 Wetland Classification

The following figure provides the various hydrogeomorphic units and the components of classification which are namely:

- Geomorphic setting (e.g. hillslope or valley-bottom);
- Drainage is open or closed;
- Water source(surface water dominated or sub-surfacewater dominated); and
- Pattern of waterflow through the wetland unit

These HGM units are described in detail within the WET-Health (Macfarlane *et al*., 2008) and Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013).

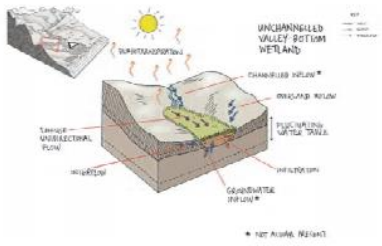
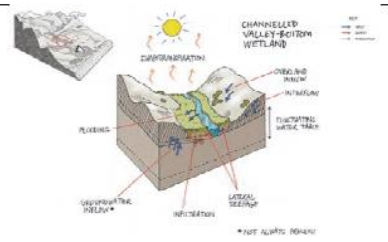
Hydrogeomorphic types	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Floodplain 	Valley-bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley-bottom. channelled 	Valley-bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley-bottom. unchannelled 	Valley-bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage linked to a stream 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hillslope seepage 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel	*	***
Depression (includes Pans) 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network	*/ ***	*/ ***

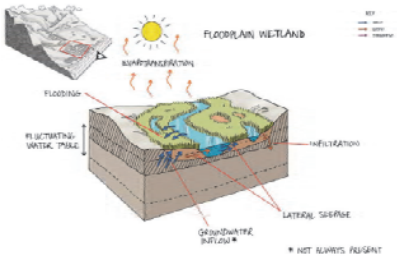
[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

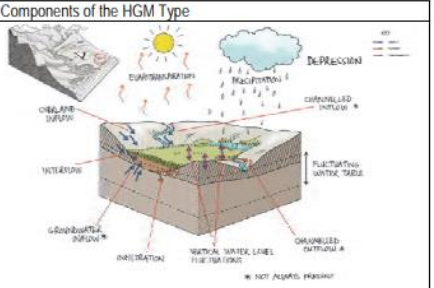
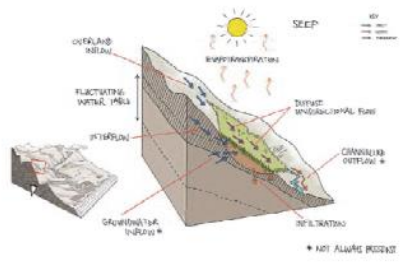
Water source: * Contribution usually small

*** Contribution usually large Wetland

*/ *** Contribution may be small or important depending on the local circumstances

Wetland HGM Type	Components of the HGM Type
Unchannelled valley-bottom wetland—a valley-bottom wetland without a river channel running through it. Unchannelled valley-bottom wetlands are characterised by (i) their location on valley floors, (ii) an absence of distinct channel banks, and the prevalence of diffuse flows. (iii) Water typically comes from an upstream channel that becomes dominated by diffuse (surface and subsurface) flow as it enters the wetland, with seepage from adjacent slopes. There may also be groundwater input into the wetland. (iv) Water characteristically moves through the wetland in the form of diffuse surface or subsurface flow, but the outflow may be in the form of either diffuse or concentrated surface flow. (v) Infiltration and evapotranspiration from unchannelled valley-bottom wetlands can be significant, but horizontal, unidirectional, diffuse surface flow tends to dominate these wetland systems.	
Channelled valley-bottom wetland—a valley-bottom wetland with a river channel running through it. Channelled valley-bottom wetlands must be considered as wetland ecosystems that are distinct from, but sometimes associated with, the adjacent river channel itself, which must be classified as a 'river' Channelled valley-bottom wetlands are characterised by: (i) their location on valley floors, (ii) the absence of characteristic floodplain features and (iii) the presence of a river channel flowing through the wetland.	

Wetland HGM Type	Components of the HGM Type
Floodplain wetland—a wetland area which can be found mostly on a flat or gently-sloping piece of land adjacent to and formed by an alluvial river channel under its present climate and sediment load. Floodplain wetlands contain several key features: (i) a depositional surface formed by an alluvial river[9], (ii) formed under the current climate and sediment load. (iii) flat surfaces may be present along the margins of a river from previous eras of differing climate and/or sediment load, and these surfaces are called terraces. Terraces are generally not currently being generated by river depositional processes. (iv) flooded (or inundated), during moderate peak flow events (such as a 1.5-year or 2-year flood).	

Wetland HGM Type	Components of the HGM Type
Depression—a wetland with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Although they may at times have a river flowing into or out of them, depressions are especially characterised by their closed (or at least near-closed) contour shape, which makes them relatively easy to identify on topographic maps. Depressions can be classified as: (i) 'exorheic' (i.e. outward-draining) (ii) 'endorheic' (i.e. inward-draining) (iii) artificially regulated outflow drainage = 'dammed'. In addition, the outflow drainage can be categorised as 'unknown'. The characterisation of the inflow characteristics of a depression is important in understanding the functioning of this type of aquatic ecosystem, and in their management. Depressions can be further subdivided on the basis of their inflows drainage characteristics, into: (i) 'with channelled inflow' (ii) 'without channelled inflow'. Concentrated overland flow is typically a major source of water for depressions with channelled inflow, whereas this is not the case for depressions without channelled inflow, which tend to be fed primarily by interflow and/or groundwater. Depressions may be flat-bottomed (in which case they are often referred to as pans) or round-bottomed and may have any combination of inlets and outlets or lack them completely.	
Seep—a wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps have the following characteristics: (i) often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor; (ii) water enters primarily via subsurface flows from an up-slope direction; (iii) water movement through the seep is mainly in the form of interflow, with diffuse overland flow (known as sheetwash) often being significant during and after rainfall events; (iv) associated with geological formations (lithologies) and topographic positions that cause either groundwater to discharge to the land surface or rain-derived water to 'seep' down-slope as subsurface interflow; (v) can also be categorised into those 'with channelled outflow' and those 'without channelled outflow' It is important to bear in mind that seeps can occur in relatively flat or very gently-sloping landscapes, as long as there is sufficient slope for there to be a unidirectional subsurface flow of water.	

18.2 Wetland Systems Methodology

18.2.1 Present Ecological State (PES)

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users

understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland. There are two levels of complexity: Level 1 is used for assessment at a broad catchment level and Level 2 provides detail and confidence for individual wetlands based on field assessment of indicators of degradation (e.g. presence of alien plants). A basic tertiary education in agriculture and/or environmental sciences is required to use it effectively. Level 2 was utilised for the assessment of the wetlands impacted upon by the activities.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules.

Hydrology is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.

Geomorphology is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A1).

Table A1: Guideline for interpreting the magnitude of impacts on wetland integrity (Macfarlane et al., 2009).

SCORE	IMPACT CATEGORY	DESCRIPTION

0 – 0.9	**None**	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.
1 – 1.9	**Small**	Although identifiable, the impact of this modification on this component of wetland integrity is small.
2 – 3.9	**Moderate**	The impact of this modification on this component of wetland integrity is clearly identifiable but limited.
4 – 5.9	**Large**	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.
6 – 7.9	**Serious**	The modification has a highly detrimental effect on this component of wetland integrity. Muchofthewetlandintegrityhasbeenlostbutremainingintegrityisstill clearly identifiable.
8 – 10	**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.

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" (Category F) as depicted in Table A2, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table A2: Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2009).

PES CATEGORY	RANGE	IMPACT CATEGORY	DESCRIPTION
A	0– 0.9	**None**	Unmodified, natural.
B	1– 1.9	**Small**	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.
C	2– 3.9	**Moderate**	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact
D	4– 5.9	**Large**	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.

E	6– 7.9	**Serious**	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.
F	8– 10	**Critical**	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.

An overall wetland health score was 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.

18.2.2 Wetland Functional Importance (Goods and Services)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A3) - that is, the benefits provided to people by the ecosystem.

Table A3:Ecosystem services assessed by WET-Ecoservices

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
			Streamflow regulation		Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance[2]**			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
			Education and research		Sites of value in the wetland for education or research

The steps involved in applying WET-EcoServices can be summarised as follows.

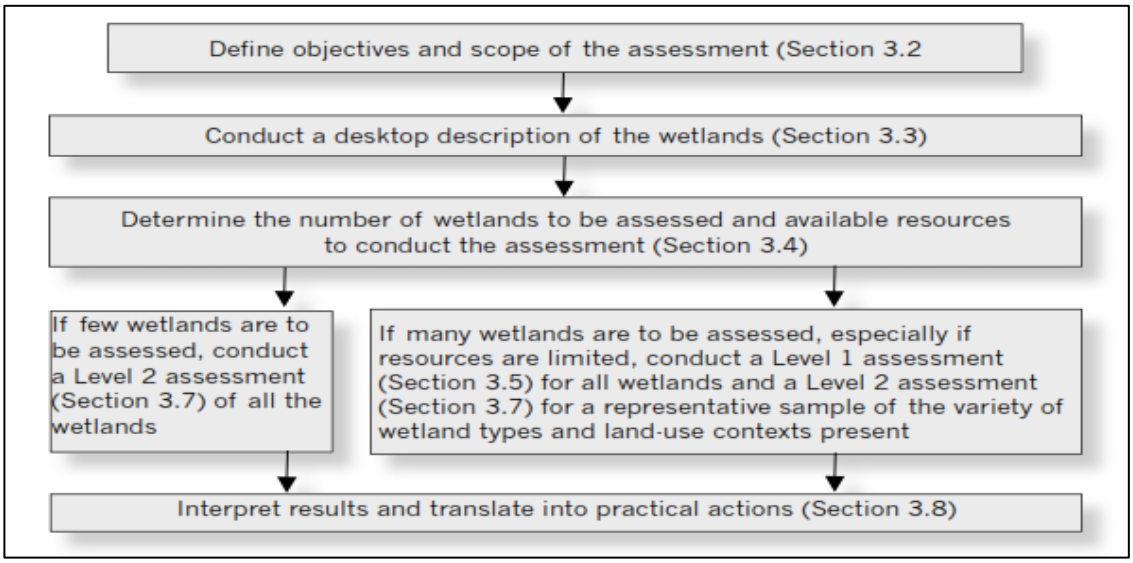


Figure A1: Steps required for Wet-EcoServices. The sections referred to within this figure relate back to the Wetland Management Series: Wet-Ecoservices. WRC Report TT 339/08

Table A4: The classes for determining the likely extent to which a benefit is being supplied based on the overall score for that benefit (Kotze, et. al., 2007).

Score Range (0-4)	< 0.5	0.5-1.2	1.3-2.0	2.1-2.8	> 2.8
Rating of the likely extent to which a	Low	Moderately	Intermediate	Moderately	High

benefit is being supplied		Low		High	

18.2.3 Ecological Importance & Sensitivity (EIS) - Wetlands

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2013). An example of the scoring sheet is attached as Table A5. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table A6.

Table A5: Example of scoring sheet for Ecological Importance and sensitivity.

ECOLOGICAL IMPORTANCE AND SENSITIVITY:			
Ecological Importance	**Score (0-4)**	***Confidence (1-5)***	**Motivation for site**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			
HYDROLOGICAL/FUNCTIONAL IMPORTANCE			
IMPORTANCE OF DIRECT HUMAN BENEFITS			
OVERALL IMPORTANCE			

Table A6: Category of score for the Ecological Importance and Sensitivity (Rountree, 2013).

Ecological Importance and Sensitivity categories	Range of EIS score
Very high: Wetlands that are considered ecologically important and sensitive on a **national or even international** level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

18.3 Riparian Systems Methodology

18.3.1 Delineation of Riparian Areas

Riparian zones are described as "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 areas" i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas. Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas. Landscape Position as discussed above, a typical landscape can be divided into 5 main units, namely the: - Crest (hilltop); - Scarp (cliff); - Mid-slope (often a convex slope); - Foot-slope (often a concave slope); and - Valley bottom. Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Quaternary alluvial soil deposits are often indicated on geological maps, and whilst the extent of these

quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised "macro-channels" which are typical of many of southern Africa's eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus, the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoximorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones: - **Vegetation Indicators**, and - **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of "restrictive floodplain" within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

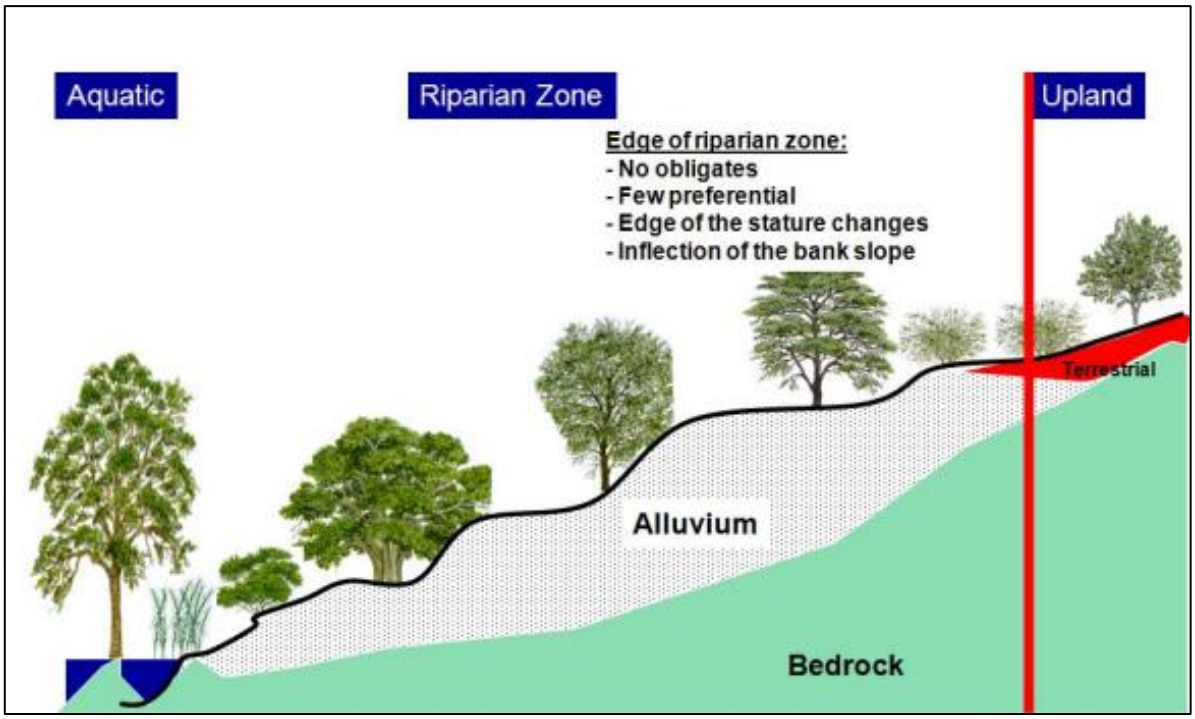


Figure A2: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF, 2008).

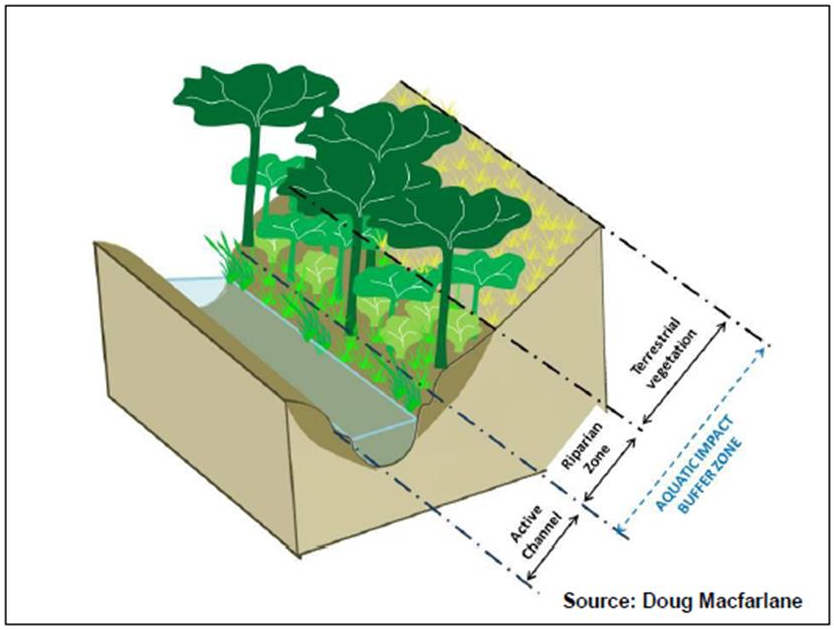


Figure A3: A schematic diagram illustrating the active channel, riparian zone and terrestrial zone within a riverine system.

18.3.2 Habitat Integrity

The following approach is followed to conduct habitat integrity assessment:

1. Instream and riparian perspectives: The instream and riparian zone aspects of the river are assessed separately. Both of these are formulated according to metric groups, each with a number of metrics that

enable the assessment of habitat integrity. The model functions in an integrated way, using the results from the assessment of metric groups, or metrics within a metric group, for the assessment of other metric groups where appropriate

2. Reference conditions: The basis of habitat integrity assessment is the deviation from the reference condition. Specification of the reference condition follows an impact based approach where the intensity and extent of anthropogenic changes are used to interpret the impact on the habitat integrity of the system.
3. Severity of impacts: Interpretation of the severity of impacts is based on the natural characteristics of the river. The premise is that the severity of impacts on the habitat integrity of a river will vary according to the natural characteristics of the river, i.e. particular river types will be more sensitive to certain impacts than other types.
4. River type context: Three natural attributes were considered in defining river types and determining the weights of metrics within metric groups for both the instream and riparian zone. A group of seven river ecologists participated in the weighting process. These weights were built into the model and are listed in Appendix A. In order of consideration the attributes are:
    - Perennial or non-perennial: Perennial rivers were considered to be those that usually flow all year round. Non-perennial rivers included all other rivers, seasonal and ephemeral. More detailed considerations on perenniality are important for assessment of hydrological impact (see the next section).
    - The longitudinal geomorphic zone (Rowntree and Wadeson, 1999): A simplified approach was followed by using only four zones: source, mountain stream (including mountain headwater stream), foothill (combining the upper, lowland and transitional zones) and lowland.
    - River size (width): Three width classes are distinguished, <5 m, 5-15 m and >15 m wide.

Below are the metric groups used to assess the riparian zone of the IHI.

	METRIC GROUPS			
	HYDROLOGICAL MODIFICATION	BANK STRUCTURE MODIFICATION		CONNECTIVITY MODIFICATION
METRICS	Base flow (low flow)	Marginal	Non-marginal	Longitudinal
	Zero flows	Bank structure modification indicators:		Lateral
	Moderate floods	Substrate exposure Invasive vegetation (native and alien) Physico-chemical Erosion Channel straightening		
	Large floods			

Below are the metric groups to assess the instream component of the IHI.

	METRIC GROUPS				
	HYDROLOGICAL MODIFICATION	PHYSICO-CHEMICAL MODIFICATION	BED MODIFICATION	BANK MODIFICATION	CONNECTIVITY MODIFICATION
METRICS	Baseflows	pH	Sediment	Marginal	Longitudinal
	Zero flows	Salts	Benthic growth	Non-marginal	Lateral
	Floods	Nutrients			
		Water Temperature			
		Water clarity			
		Oxygen			
		Toxics			

Table A7: IHI class, rating and description of the present ecological state of riverine systems.

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	**Unmodified, natural reference condition:** All physical drivers unmodified or virtually unmodified. If use of the resource is present, the impact of such use falls completely within the natural disturbance regimes both in terms of extent and severity.	90 - 100
B	**Largely natural with few modifications:** A small change in natural habitats may have taken place but the ecosystem functions are essentially unchanged. *Physical drivers:* – Hydrology: The flow regime has only slightly been modified – Geomorphic: limited to slight sediment changes – Physico-chemical changes: Water clarity may sporadically be slightly influenced. At worst, only sporadic traces of toxics present. Salts may sporadically be slightly increased. *Associated habitat conditions:* – Instream: Very little change in habitat types and their dimensions and frequency. Connectivity between habitats virtually unchanged. – Riparian: Riparian habitat close to natural in terms of biophysical characteristics. Very little modification and use of riparian zone. Virtually no fragmentation.	80 - 89
C	**Moderately modified:** Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. *Physical drivers:* – Hydrology: The flow regime may have been significantly modified and direct manipulation by impoundments may be present. – Geomorphic: sediment changes due to increased inputs or flow may have increased significantly.	60-79

	– Physico-chemical changes: changes in nutrients, salts, oxygen concentration and temperature may deviate significantly from the reference. Low levels of toxics may sporadically be present. *Associated habitat conditions:* – Instream: Dimensions and frequency of some habitat types have changed significantly. Fragmentation of habitats may often be present – Riparian: Changes in the structure of the zone may be common. Some fragmentation of the zone may often be present.	
D	**Largely modified.** A large loss and change of natural habitat, biota and basic ecosystem functions has occurred. *Physical drivers:* – Hydrology: The flow regime has been extensively modified and manipulation by impoundments may be present. – Geomorphic: Drastic changes in sediment loads due to increased inputs or flow modification may have occurred. – Physico-chemical changes: nutrients, salts, oxygen concentration and temperature may deviate considerably from the reference. Low levels of toxics may regularly be present. *Associated habitat conditions:* – Instream: Dimensions and frequency of some habitat types may differ drastically from the reference. Fragmentation of habitats may often and extensively be present. – Riparian: Extensive changes of the zone may be present. Significant fragmentation of the zone may have occurred.	40-59
E	**Seriously modified.** The loss of natural habitat, biota and basic ecosystem functions is extensive. *Physical drivers:* – Hydrology: The flow regime may have been extensively and severely modified and manipulation by impoundments is likely to be present. – Geomorphic: Extensive and severe changes in sediment loads due to increased inputs or flow modification may have occurred. – Physico-chemical changes: nutrients, salts, oxygen concentration and temperature may deviate severely and regularly from the reference. Significant levels of toxics may regularly be present. *Associated habitat conditions:* – Instream: Dimensions and frequency of some habitat types may differ extensively and severely from the reference. Fragmentation of habitats may regularly and extensively be present – Riparian: Severe and extensive changes of the zone may be present. Extensive fragmentation of the zone may have occurred.	20-39

F	**Critically / Extremely modified:** Modifications have reached a critical level and the 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. *Physical drivers:* – Hydrology: The flow regime may be extensively and extremely modified and manipulation by impoundments is often present. – Geomorphic: Extensive and extreme changes in sediment loads due to increased inputs or flow modification may have occurred. – Physico-chemical changes: Nutrients, salts, oxygen concentration and temperature may deviate extremely and very regularly from the reference. High levels of toxics may regularly be present. *Associated habitat conditions:* – Instream: Dimensions and frequency of some habitat types may differ extensively and extremely from the reference. Fragmentation of habitats may be severe. – Riparian: Extreme and extensive changes of the zone may be present. Fragmentation of the zone may be severe.	0-19

18.3.3 Present Ecological State (PES) – Riparian

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

The Index of Habitat Integrity, 1996, version 2 (Kleynhans, 2012) was used to obtain a habitat integrity class for the instream habitat and riparian zone. This tool compares the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state (in the absence of anthropogenic impacts). This involved the assessment and rating of a range of criteria for instream and riparian habitat scored individually (from 0-25) using Table A8 as a guide.

This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and land-uses / activities that could have a detrimental impact on river ecosystems.

Table A8: Category of score for the Present Ecological State (PES)

RATING SCORE	IMPACT SCORE	DESCRIPTION
0	A: Natural	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
1-5	B: Good	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
6-10	C: Fair	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
11-15	D: Poor	The modification is generally present with a clearly detrimental impact on habitat quality, diversity size and variability. Large areas are, however, not influenced.
16-20	E: Seriously Modified	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
21-25	F: Critically Modified	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.

18.3.4 Ecological Importance and Sensitivity – Riparian

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh, *et. a*l., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A9).

Table A9: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

ECOLOGICAL IMPORTANCE AND SENSITIVITY ASSESSMENT (RIVERS)		
DETERMINANTS		SCORE (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.0
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		**LOW, EC=D**

The scores assigned to the criteria in Table A9 were used to rate the overall EIS of each riverine system according to Table A10 below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane *et al*., 2008).

Table A10: The categories associated with the assessment of the EIA for riverine systems(Kleynhans & Louw, 2007).

EIS CATEGORY	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	Ecosystems that are not unique at any scale. These rivers (in terms of biotaand habitat) are generally not very sensitive to flow modifications and usually have asubstantial capacity for use. One or a few elements sensitive to changes in waterquality/hydrological regime
Moderate, Rating =2	Ecosystems that are considered to be unique on a provincial or local scaledue to biodiversity (habitat diversity, species diversity, unique species, rare andendangered species). These rivers (in terms of biota and habitat) are usually not verysensitive to flow modifications and often have a substantial capacity for use.
High, Rating =3	Ecosystems that are considered to be unique on a national scale due tobiodiversity (habitat diversity, species diversity, unique species, rare and endangeredspecies). These rivers comprise of elements that may be sensitive to flow modificationsbut in some cases, may have a substantial capacity for use.
Very high, Rating =4	Ecosystems that are considered to be unique on a national or eveninternational level based on unique biodiversity (habitat diversity, species diversity, uniquespecies, rare and endangered species). These rivers comprise of elements that are changes such as flow modifications or water quality alterations and therefore have no or only a small capacity for use.

Table A11: Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

Score	EIS Category	Channel type	Conservation Context	Vegetation & Habitat integrity	Connectivity	Threat status
0	None	ephemeral	Non-FEPA	No cover	None	No status
1	Low/marginal	Non perennial stream	Upstream management area (available)	Very poor	Very low	Least threatened
2	Moderate	Perennial stream	Rehab FEPA	Poor	Low	Vulnerable
3	High	No perennial minor river	Fish Corridor (Earmarked for conservation)	Moderately modified	Moderate	Near threatened
4	Very high	Perennial minor river	FEPA (Protected)	Largely natural/ unmodified	High/very high	Endangered/ critically endangered

18.4 Impacts and Risk Assessment Matrix (RAM) Methodology (DWS, 2016)

Table A12 – Risk Assessment Matrix Criteria

Severity *- How severe does the aspects impact on the environment and resource quality characteristics (flow regime, water quality, geomorphology, biota, habitat)?*

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5

Where "or wetland(s) are involved" it mean the activity is located within the boundary (the temporary, seasonal or permanent zone) of the watercourse	

Spatial scale - *How big is the area that the aspect is impacting on?*

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Duration - *How long does the aspect impact on the environment and resource quality?*

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	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	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5

Frequency of activity - *How often do you do the specific activity?*

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Frequency of incident/impact - *How often does the activity impact on the environment?*

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Legal issues - *How is the activity governed by legislation?*

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas (within the outer edge of the 1:100yr flood line, or delineated riparian area as measured from the middle of the watercourse measured on both banks, or within a 500m radius from the outer boundary of any wetland).	

Detection - *How quickly can the impacts/risks of the activity be observed on the environment (water resource quality characteristics), people and property?*

Immediately	1
Without much effort	2
Need some effort	3

Remote and difficult to observe	4
Covered	5

Table A13: Rating classes

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 costs 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.
A low risk class must be obtained for all activities to be considered for a GA (GN509, 2016)		

Table A14: Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection
Significance \Risk= Consequence X Likelihood

18.5 Specialist Declaration

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILSOF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	
NEAS Reference Number:	

Application for integrated environmental authorisation and waste management license in terms of the-

(1) NationalEnvironmentalManagementAct,1998 (No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

KSEMS Environmental Consulting, 2020. *Watercourse Delineation and Functional Assessment for the proposed upgrade of sewage infrastructure located within the northern area of Kwadukuza, eThekwini Metropolitan Municipality of KwaZulu-Natal. P*repared for eThekwini Municipality Water and Sanitation, August 2020.

Specialist:	KSEMS Environmental Consulting		
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Postal address:			
Postal code:		Cell:	
Telephone:	06 4650 9993	Fax:	
E-mail:	fundiswa.khumalo@durban.gov.za		

4.2 The specialist appointed in terms of the Regulations:

I, **Caleena De Carvalho**, declare that__

General declaration:

I act as the independent specialist in this application;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;

I will comply with the Act, Regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing-any decision to be taken with respect to the application by the competent authority; and- the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

All the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

KSEMS Environmental Consulting Pty Ltd.

Name of company (if applicable):

17 August 2020

Date: