REVISED FRESHWATER ECOLOGICAL IMPACT ASSESSMENT

PROPOSED SWELLENDAM HOUSING AND BULK SEWER PIPELINE CONSTRUCTION

Prepared for: Swelledam Municipality

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COMPLINACE WITH THE APPENDIX 6 OF THE AMENDED 2014 EIA REGULATIONS

REQUIREMENTS OF APPENDIX 6 – GN 326	**ADRESSED IN SPECIALIST REPORT**
1. (1) A specialist report prepared in terms of these Regulations must contain - a) details of: i) the specialist who prepared the report; and ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Chapter 1 and Appendix A
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Original attached to formal application to DEA&DP. Included in beginning of report
c) an indication of the scope of, and the purpose for which, the report was prepared;	Chapter 1
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Chapter 3.12
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Chapter 3.
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Chapter 5
g) an identification of any areas to be avoided, including buffers;	Chapter 6
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figures 2 and 3
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Chapter 3.12
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Chapter 7
k) any mitigation measures for inclusion in the EMPr;	Chapter 7
l) any conditions for inclusion in the environmental authorisation;	Chapter 7
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Chapter 7

n) a reasoned opinion - i) as to whether the proposed activity or portions thereof should be authorised; and ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Chapter 7
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	BAR Comments and Response Report
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	BAR Comments and Response Report
q) any other information requested by the competent authority.	N/A

1. INTRODUCTION AND BACKGROUND

Eco Impact Legal Consulting (Pty) Ltd (Eco Impact) is appointed by the Swellendam Municipality to assess the impacts of the proposed housing infrastructure, bulk sewerage and water pipeline upgrades and attenuation dams upgrade construction on the Freshwater Ecology.

The Swellendam Municipality proposes to establish a mixed use housing development on the Remaining Extent of Erf 1 at Swellendam.

The Swellendam Municipality proposes a subsidised housing project on a Remainder of Erf 1 at Swellendam, comprising of 950 residential erven. As well as 4 erven for community facilities, 2 erven for business, 3 for mixed use and 10 erven for public open space. Associated internal roads and associated services infrastructure.

Upgrades to attenuation dams 4 and 5 as the proposed development's runoff will have a direct influence on the capacity. These attenuation dams are situated in a degraded non-perennial drainage line which runs to the west of the proposed site.

Dam 5 –

- Clear and grub of wall embankments.
- Clear and grub for basin extensions (10,000m^2)
- Cut to spoil for basin enlargements (7,100m^3)
- Cut to fill wall embankment from selected excavated/imported material (1,000m^3)
- Cut to fill berm from selected excavated/imported material (144m^3)
- Construction of gabion lined spillway
- Concrete outlet structure (25m^3)

Dam 4 –

- Upgrading of the outlet works

Bulk water distribution will need to be upgraded. The following is currently proposed:

- SSW4.1: 94 m x 160 mm Ø parallel reinforcement of main pipe
- SSW4.6: 282 m x 160 mm Ø parallel reinforcement of main pipe
- SSW4.10: 77 m x 160 mm Ø inter-connection pipe
- SSW4.11: 352 m x 160 mm Ø parallel reinforcement of main pipe
- SSW4.17: 300 m x 160 mm Ø parallel reinforcement of main pipe
- SSW4.18: 263 m x 110 mm Ø new supply pipe & connections

- SSW5.2: 140 m x 160 mm Ø new supply pipe & connections
- SSW5.3: 107 m x 110 mm Ø new supply pipe & connections
- SSW4.7a: New 110 mm Ø zone valve
- SSW4.7b: New 75 mm Ø zone valve
- SSW5.1: New 15 ℓ/s @ 20 m booster pump station

Sewer reticulation will need to be upgraded to accommodate the proposed development. The following is currently proposed:

- SSS1.2: 250 mm Ø New flow diversion
- SSS1.3: 84 m x 250 mm Ø New outfall sewer
- SSS1.6: 315 mm Ø New flow diversion
- SSS1.7: 100 m x 315 mm Ø New outfall sewer
- SSS1.8: 229 m x 315 mm Ø Re-align existing bulk sewer
- SSS1.9: 304 m x 315 mm Ø Re-align existing bulk sewer

Swellendam Housing.
FIA. DWS regulated

Scale: 1:36 112
Date created: December 11, 2018

Western Cape Government
Agriculture

Figure 1: The water uses falling within the regulated zones that require authorization in terms of the National Water Act.

2. LEGISLATIVE REQUIREMENTS

National Water Act, 1998 (Act No. 36 of 1998)

The National Water Act guides the management of water in South Africa. The Act aims to regulate the use of water and activities that may impact on water resources through the categorisation of "listed water uses" encompassing water extraction and flow attenuation within catchments as well as the potential contamination of water resources, where the Department of Water and Sanitation (DWS) is the administering body in this regard. In terms of the proposed development and its nature, a specialist assessment is needed to provide Breede Gouritz Catchment Management Agency (BGCMA) as DWS administrator with the necessary information related to the proposed projects water uses and the potential impacts on the water resources of the area. It is the client's intention to register and license all water uses related to this project.

The National Environmental Management Act, 1998 (Act 107 Of 1998)

The activities in accordance with the requirements of the National Environmental Management Act, 1998 (Act 107 of 1998) for which Environmental Authorization is required applicable to this Freshwater Ecology Impact assessment is:

Activity 12 of Listing Notice 1 (GN 327) of the NEMA EIA regulations, 2014 (as amended) states that: The development of: **The development of- (x) buildings exceeding 100 square metres in size and** (**xii) infrastructure or structures with a physical footprint of 100 square metres or more; within 32 metres of a watercourse, measured from the edge of a watercourse; -**

Activity 19 of Listing Notice 1 (GN 327) of the NEMA EIA regulations, 2014 (as amended) states **The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from- (i) a watercourse;**

The road crossing at Theunissen Street and the upgrading of dams 4 and 5 stormwater dams trigger the above listed activities for which Environmental Authorization is required.

3. METHOD OF ASSESSMENT, ASSUMPTIONS AND LIMITATIONS OF THE STUDY

Input into the overall project was driven by the following Terms of Reference, which required the specialist to:

- Identify and describe freshwater ecosystems in the study area based on existing data and an onsite survey;
- Place freshwater ecosystems in a regional context and describe freshwater ecosystem-dependent fauna and flora species present;
- Classify, describe and map freshwater ecosystems in terms of their ecological sensitivity and functional value;
- Comment on and map freshwater ecosystem sensitivity in terms of ecologically important habitats, ecological corridors and linkages with other ecological systems;
- Undertake a site walk-down with other specialists,
- Identify potential impacts of the proposed project on freshwater ecosystems;
- Conduct a specialist assessment in line with National Environmental Management Act (NEMA) (Act no. 107 of 1998) minimum specialist report requirements, which are presented within Appendix 6 of the NEMA: EIA Regulations (2014, as amended);
- Assess the direct, indirect and cumulative impacts (pre and post-mitigation) of the final location of infrastructure (and alternatives, if applicable) on freshwater ecosystems in the study area using the prescribed impact assessment methodology;
- Recommend practicable mitigation measures to avoid and/or minimise/reduce impacts and enhance benefits;
- Investigate an area of 500m from the proposed development area to determine if any

wetlands occur within this area which would potentially trigger GN509 as promulgated in 2016;

3.1. Freshwater Ecological Assessment sites and site selection

The sites were visually assessed. Several methods (refer to below) was used to assess the risks to the freshwater ecology at the impact area.

The outer boundary of all natural freshwater resources temporary zones were ground-truthed and delineated according to the guidelines advocated by DWAF (2008) taking into consideration wetland soil characteristics as defined by Job (2009) (where applicable given the infilling activities). The freshwater delineations as presented in this report are regarded as a best estimate of the above mentioned freshwater feature boundaries based on the site conditions present at the time of the assessment.

During the field verification, the following indicators were used in order to determine the boundary of the freshwater resources within the study area:

- **Topography/Elevations** were used to determine in which parts of the landscape the freshwater resources were most likely to occur;
- **Obligate and facultative wetland/riparian species** such as *Typha capensis, Phragmites australis* and *Pennisetum macrourum* were used in conjunction with terrain units as well as the point where a distinct change in the vegetation composition was observed in order to determine the riparian zone boundary. Obligate species are almost always found in a freshwater feature (>99% of occurrences) while facultative species are usually found in a freshwater feature (76%-99% of occurrences) but are also occasionally found in areas not associated with wetlands or rivers and often in areas of disturbance;
- **Surface water** was noted and used to determine the permanent zone and was also considered when defining the outer boundary of the wetland; and
- **Soil form indicators** were used to determine the presence of soils that are associated with prolonged and frequent saturation with key indicators including gleying, mottling, organic streaking and increased clay content.

3.2. Visual Assessment of Aquatic Assessment Points

Each site was selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the systems identified, was identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual records of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Upstream and downstream significance of each point, where applicable;
- Significance of the point in relation to the study area;
- stream morphology;
- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;
- depth flow and substrate characteristics;
- signs of physical disturbance of the area; and
- other life forms reliant on aquatic ecosystems.

3.3. Intermediate Habitat Integrity Assessment (IHIA)

It is important to assess the habitat of riverine systems in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the sites was assessed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper; 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), was used using the site specific application protocols. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site was scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones were analysed separately, and the final assessment was then made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone is, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data was carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the sites. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 1: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

Ecological Category	**Description**	**Score (% of total)**
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.	0-19

3.4. Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: "riparian habitat" includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans et al, 2007). Results are defensible because their generation can be traced

through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 2: Descriptions of the A-F ecological categories

Ecological Category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
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The level of aquatic assessment undertaken was considered to be adequate for this study.

3.5. Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of riparian areas is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on a local scale to a more broader scale; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).

Table 3: List of the EIS categories used in the assessment tool (Kleynhans & Louw, 2007)

EISC	General description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/marginal	Quaternaries/delineations which are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

Table 4: Rating scheme used for the assessment of riparian EIS (Kleynhans & Louw, 2007)

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

3.6. National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWS, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of the proposed development.

3.7. Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2014)

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourses traversed by the proposed developments.

3.8. Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

All wetland or riparian features encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis et. al., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table 5: Classification System for Inland Systems, up to Level 3

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL ONE: SYSTEM	**LEVEL TWO: REGIONAL SETTING**	**LEVEL THREE: LANDSCAPE UNIT**
Inland	DWA Levels 1 Ecoregions Or NFEPA WetVeg Groups Or Other special frameworks	Valley floor Slope Plain Bench (Hilltop / Saddle / Shelf)

Table 6: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNITS		
LEVEL FOUR: HYDROGEOMORPHIC (HGM) UNITS		
HGM TYPE	**Longitudinal zonation/ Landform / Outflow drainage**	**Landform / Inflow drainage**
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)

Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level One: Inland systems
From the classification system, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level Two: Ecoregions & NFEPA Wetland Vegetation Groups
For Inland Systems, the regional spatial framework that has been included in Level two of the classification system is that of the DWA's Level One Ecoregions for aquatic ecosystems (Kleynhans et. al., 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups' vegetation types across the country, according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel et al., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level Three: Landscape Setting
At Level three of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table 5) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis et. al., 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor**: The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf)**: an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat

[1] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level Four: Hydrogeomorphic Units
Seven primary HGM Types are recognised for Inland Systems at Level Four (A) of the classification system (Table 6), on the basis of hydrology and geomorphology (Ollis et. al., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane et. al., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze et. al., 2009).

3.9. Wet-Ecoservices (2009)

“The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class” (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze et al. (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;

- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 7: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3 High	High

3.10. Index of Habitat Integrity (IHI)

To assess the PES of the riparian / wetland feature, the Index of Habitat Integrity (IHI) for South African floodplain and channelled valley bottom wetland types (DWAF Resource Quality Services, 2007) was used. The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below) and provide a score of the PES of the habitat integrity of the riparian system being examined.

Table 8: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.	0-19

3.11. WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

Level of Evaluation
Two levels of assessment are provided by WET-Health:

- **Level One:** Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- **Level Two:** On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment
A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment
Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

Quantification of Present State of a wetland
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. This takes the form of assessing the spatial extent of the impact of individual activities and then separately assessing the intensity of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores, and Present State categories are provided in the table below.

Table 9: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0 – 0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2 – 3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6 – 7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8 - 10	F

Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (table below).

Table 10: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years 1	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

3.11. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purpose of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWS used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, et, al, 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- **Ecological Importance and Sensitivity**, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- **Hydro-functional importance**, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- **Importance in terms of socio-cultural benefits**, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table 11) of the wetland system being assessed.

Table 11: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

3.12. Assumptions and Limitations

The ground-truthing and delineation of the freshwater resource boundaries and the assessment thereof are confined to a single site visit undertaken in September 2018 which considered the freshwater resources associated with the development, as identified within the EIA application. All freshwater resources identified within the investigation area were delineated in fulfilment of Regulation GN509 of the National Water Act, 1998 (Act 36 of 1998) using various desktop methods including the use of topographic maps, historical and current digital satellite imagery and aerial photographs. These resources were ground-truthed.

All areas surrounding the development have undergone significant anthropogenic changes (such as infilling, constructed stormwater dams, disposal of rubble, road crossings and channelization at places) which have altered the geomorphic characteristics, hydrological regime and vegetation composition. The freshwater resource delineations as presented in this report are regarded as the best estimate of the boundaries based on the site conditions present, as observed during the site assessment. The results obtained are, however, considered sufficiently accurate to allow planning and decision making to take place. Global Positioning System (GPS) technology is inherently somewhat inaccurate, and some inaccuracies due to the use of handheld GPS instrumentation may occur, however, the delineations as provided in this report are deemed appropriately accurate to fulfil the authorisation requirements.

Freshwater resources and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater resource boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results. With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, the delineations as provided in this report are deemed appropriately accurate to guide any future development plans

4. RESULTS OF THE LITERATURE REVIEW

The site is located in the Breede River catchment (Department of Water and Sanitation (DWS) Primary Drainage Region H), within the Breede-Gouritz Water Management Area (WMA). This WMA falls under the administration of the BGCMA. The proposed water uses would pass through sections of the H70B quaternary catchment. H70B is drained primarily by the Breede, Sonderend, Sout, Bot and Palmiet rivers. The natural vegetation on site used to be Swellendam Silcrete Fynbos, (Vulnerable conservation status). The impacted and surrounding area is however mostly transformed and disturbed as a result of previous agricultural and residential activities.

Two biodiversity conservation mapping initiatives are of relevance to the freshwater ecosystems within the study area; the Western Cape Biodiversity Spatial Plan mapping initiatives that were undertaken on a regional basis and the National Freshwater Ecosystem Priority Areas (NFEPA) mapping initiative. The Koornlands River was identified as a NFEPA wetland area (Natural valley floor floodplain wetland and an artificial NFEPA wetland was identified in the western non-perennial stream where the sewer pipeline will cross the river.

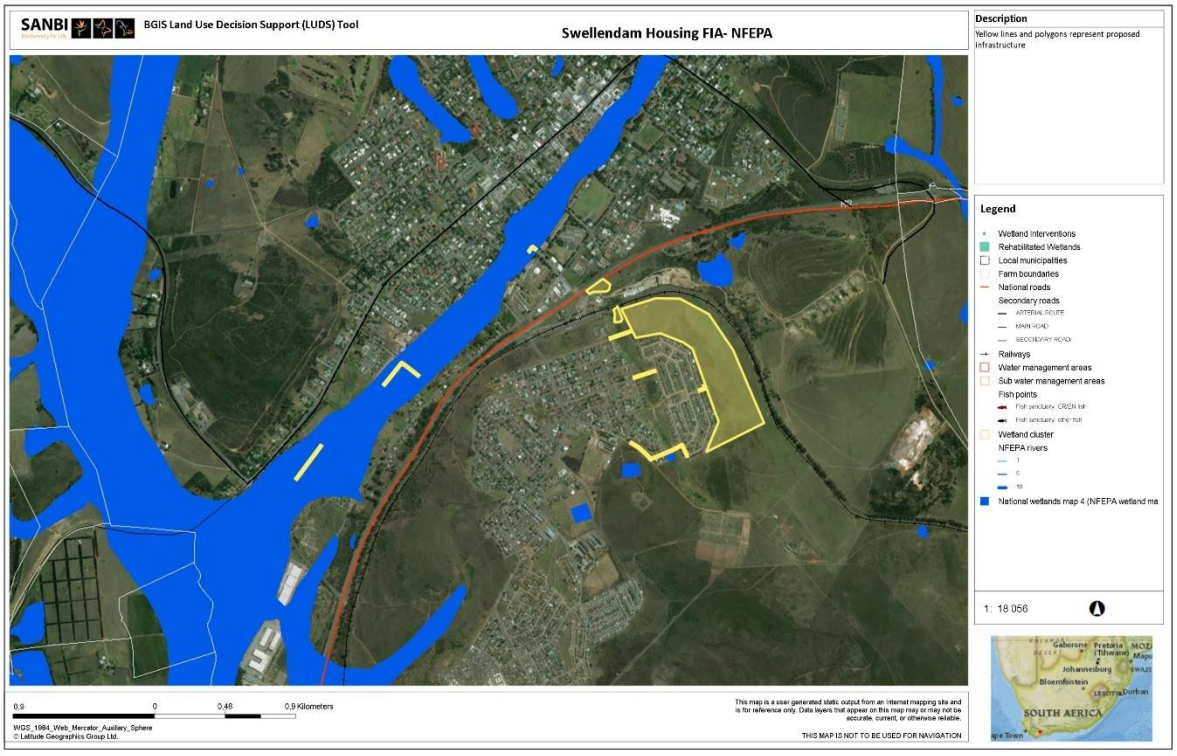

Figure 2: The National Freshwater Ecosystem Priority Areas (NFEPA) mapping initiative.

The Koornlands perennial river and non-perennial river that will be impacted was identified as Ecological Support Areas (ESAs) in the latest Western Cape Biodiversity Spatial Plan (2017). ESA's are supporting zones required to prevent the degradation of Critical Biodiversity Areas and Protected Areas.

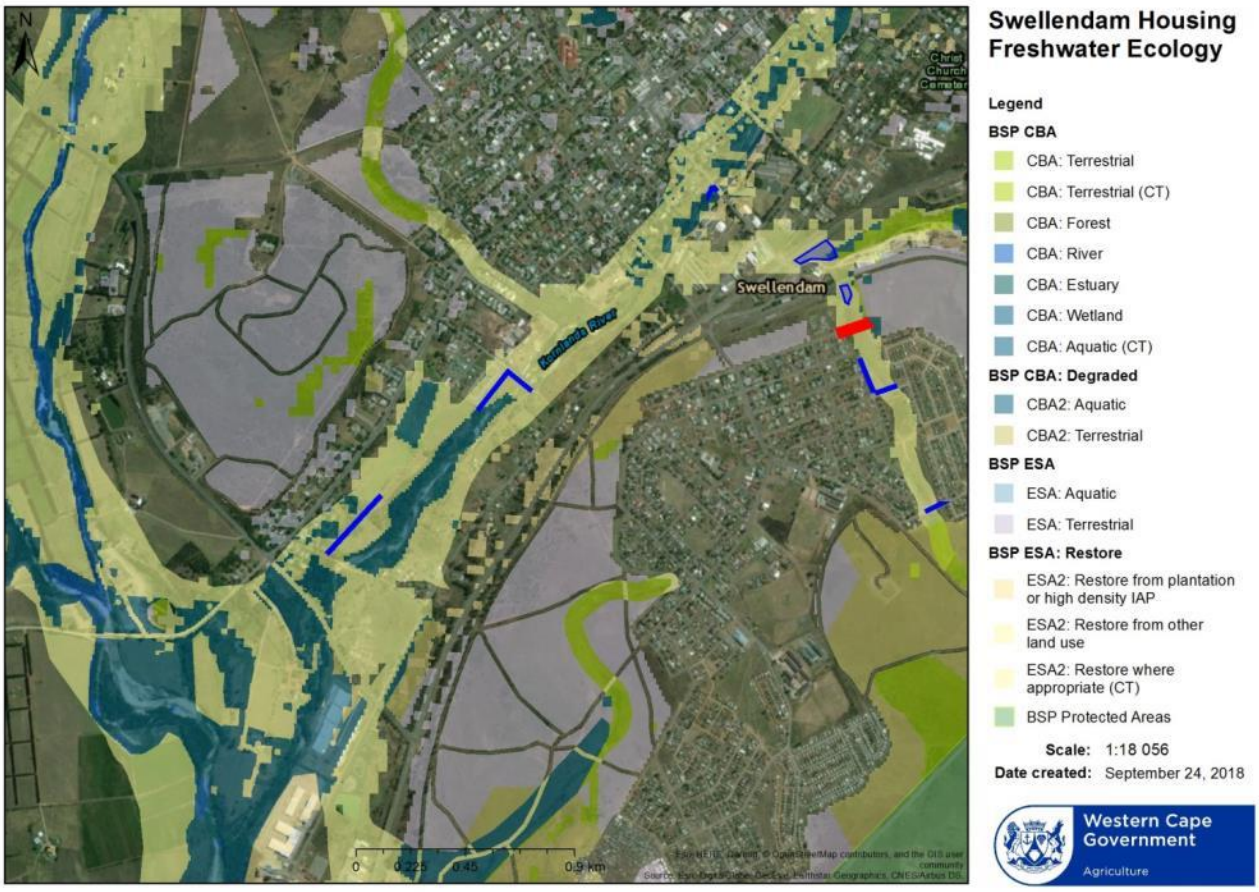

Figure 3: Western Cape Biodiversity Spatial Plan mapping initiative.

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the project area. The information from this database is based on information at a sub-quaternary catchment reach (SQR) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. No data was available for the non-perennial river or the Koornlands Perennial river which is a tributary of the Bree River.

The non-perennial river on the western side of the proposed housing development in which two sewer pipeline crossings, a road and the upgrade of two attenuation dams is planned and proposed starts south of the site on a cemetery and flows in a northern direction.

The State of Rivers Report: Rivers of the Breede Water Management Area (Belcher 2011) reported that the Koornlands River had a fair to poor Index of habitat integrity, fair geomorphology index, fair riparian vegetation index, fair SASS index and good fish index.

Photo 1: Start of the Non-perennial River and gravel access tod to cemetery.

It crosses the access gravel road to the cemetery before it flows in between two residential areas with two road crossings and a railway line before it meets up with a non-perennial river that runs east of the development also in a south west direction.

Photo 2: Non-perennial river on western side of housing development

The non-perennial river on the eastern edge of the housing development flows in a northern direction and then parallel with the N2 in a western direction until it meets up with the proposed upgrade area of the western stream attenuation dam. This non-perennial river starts at an area where small scale livestock is kept.

Photo 3: Upper catchment and start of the eastern Non-perennial River

A non-perennial river which flow from east to west meet up with this non-perennial river before it is crossed by the gravel road. A clay brick quarry is situated on the edge of the stream that flows from east to west.

Photo 4: Stream that meets up with the eastern non-perennial river.

A gravel road that give access to the small scale farming activities and clay brick quarry area crosses the eastern non-perennial river where after the non-perennial river flows into an instream dam.

Photo 5: Upstream view from the gravel access road crosses the eastern non-perennial river.

Photo 6: Downstream view from the gravel access road crosses the eastern non-perennial river.

Photo 7: Instream dam the eastern non-perennial river.

The non-perennial river flow in between industrial activities, stockpiling of mining aggregate and the N2 downstream of the instream dam.

Photo 8: Stockpile of mining aggregate on edge of non-perennial river with storm water runoff from these areas into the river.

Photo 9 a: Remnants of freshwater ecological features in **s**ections of the non-perennial river downstream of the industrial activities. These areas are however limited.

Photo 9 b: Remnants of freshwater ecological features in **s**ections of the non-perennial river downstream of the industrial activities. These areas are however limited.

All of these activities have a significant impact on the freshwater ecology of the non-perennial river.

From the proposed attenuation dam where the western and eastern non-perennial rivers meet up the non-perennial river is channelled in a concrete channel underneath the N2 and through the town until it meets up with the Koornlands perennial river.

Photo 10: Concrete channel **s**ection of the non-perennial river

The Koornlands river follows in an western direction through the town of Swellendam before it meets up with the Klippe river which is a tributary of the Bree River.

Photo 11: Downstream view of the Koornlands River where the sewer pipe will be upgrade on the eastern bank of the river.

5. FRESHWATER ECOLOGICAL ASSESSMENT RESULTS

A photographic record of each site was made in order to provide a visual record of the condition of each assessment site as observed during the field assessment. The photographs taken are presented, followed by a table summarising the observations for the various criteria made during the visual assessment undertaken at each point.

5.1(A) Activities Impacting on the Western Non-Perennial River

5.1.1. Water pipeline crossing at western non-perennial river.

Photo 12: Propose upgrade of existing water pipeline inside road crossing.

Photo 13: Artificial wetland upstream of water pipeline crossing.

Photo 14: Artificial wetland downstream of water pipeline crossing.

Table 12: Descriptions of the location of water pipe in relation to mapped non-perennial river

Characteristics	Water pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.

Surrounding anthropogenic activities	The site is situated at the point where the pipeline will cross the non-perennial river.	The site is situated upstream where the pipeline will cross the non-perennial river.	The site is situated downstream where the pipeline will cross the non-perennial river.
Riparian zone characteristics	The riparian zone at this point consists of a road.	Limited riparian at this point and it is characterised by constructed attenuation dam dominated by *Pennisetum clandestinum* and *Typha capensis.*	Limited riparian at this point and it is dominated by *Pennisetum clandestinum* with patches of *Typha capensis.*
Depth characteristics	No water was flowing during time of site visit. Constructed road surface	No water was flowing during time of site visit. The river at this point is characterised by a constructed attenuation dam.	No water was flowing during time of site visit. The river however has a deep natural channel.
Flow conditions	No water was flowing during time of site visit. Constructed road surface	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Water clarity	No water was flowing during time of site visit. Constructed road surface	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Stones habitat characteristics	Constructed road surface	Consisted of a silted river bed with no stones or diverse habitat	Consisted of a silted river bed with no stones or diverse habitat
Vegetation habitat characteristics	None. Road surface	Limited and dominated by *Pennisetum clandestinum.*	Limited and dominated by *Pennisetum clandestinum.*
Other habitat characteristics	None as result of infrastructure.	None as result of constructed attenuation dam. The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	None as result of upstream constructed attenuation dam and road crossing. The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.
Erosion potential	None as result of infrastructure.	Banks at this point are relatively stable and there	Banks at this point are relatively stable and there is little

		is little potential for erosion.	potential for erosion.

5.1.2. Non-perennial river where water pipeline will cross as well as expansion of the water pipeline on the bank of the non-perennial river next to the edge of existing erven.

Photo 15: Water pipeline crossing upgrade.

Photo 16: Water pipeline crossing upgrade.

Photo 17: Water pipeline upgrade.

Photo 18: Water pipeline crossing upstream of upgrade.

Photo 19: Water pipeline crossing downstream of upgrade.

Table 13: Descriptions of the location of water pipe in relation to mapped non-perennial river

Characteristics	Water pipeline site	Upstream area	Downstream area

Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the pipeline will cross the non-perennial river and be upgraded outside the river and floodplain.	The site is situated upstream where the pipeline will cross the non-perennial river.	The site is situated downstream where the pipeline will cross the non-perennial river.
Riparian zone characteristics	The riparian zone at this point consists of a road as well as disturbed non indigenous vegetated areas.	Limited riparian at this point and it is characterised by constructed attenuation dam dominated by *Pennisetum clandestinum* with patches of *Typha capensis.*	Limited riparian at this point and it is dominated by *Pennisetum clandestinum* with patches of *Typha capensis.*
Depth characteristics	Constructed road surface and flat area on bank of river outside flood plain.	No water was flowing during time of site visit. The river at this point is characterised by a constructed attenuation dam.	No water was flowing during time of site visit. The river however has a deep natural channel.
Flow conditions	Constructed road surface	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Water clarity	No water was flowing during time of site visit. Constructed road surface	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Stones habitat characteristics	Constructed road surface	Consisted of a silted river bed with no stones or diverse habitat	Consisted of a silted river bed with no stones or diverse habitat
Vegetation habitat characteristics	None. Road surface and degraded areas	Limited and dominated by *Pennisetum clandestinum.*	Limited and dominated by *Pennisetum clandestinum.*
Other habitat characteristics	None as result of infrastructure.	None as result of constructed attenuation dam. The surrounding land uses, cemetery in the catchment, road crossings and attenuation	None as result of upstream constructed attenuation dam and road crossing. The surrounding

		dam all contributed to the poor ecological state that the non-perennial river is in.	land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.
Erosion potential	None as result of infrastructure.	Banks at this point are relatively stable and there is little potential for erosion.	Banks at this point are relatively stable and there is little potential for erosion.

5.1.3. Proposed new access road over non-perennial river.

Photo 20: Proposed road crossing site in non-perennial river.

Photo 21: Upstream view of proposed road crossing. Wetland indicator species present.

Photo 22: Downstream view of proposed road crossing.

Table 14: Descriptions of the location of new road crossing in relation to mapped non-perennial river

Characteristics	Water pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site.	This point is to be used as a reference point for the site. Any degradation	This point is to be used as a reference point for the site.

	Any degradation from this point would serve as an indication of impacts on the surrounding area.	from this point would serve as an indication of impacts on the surrounding area.	Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the road will cross the non-perennial river.	The site is situated upstream where the road will cross the non-perennial river.	The site is situated downstream where the road will cross the non-perennial river.
Riparian zone characteristics	The riparian zone at this point is totally degraded and dominated by *Pennisetum clandestinum*.	Limited riparian at this point and it is dominated by *Pennisetum clandestinum* with patches of *Typha capensis, Zantesdeschia aethiopica, Cyperus sp, Searsia laevigata, Pennisetum macrourum and Cotula sp.*	Limited riparian at this point and it is dominated by *Pennisetum clandestinum.*
Depth characteristics	The river however has a deep natural channel.	The river however has a deep natural channel.	The river however has a deep natural channel.
Flow conditions	No water was flowing during time of site visit.	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Water clarity	No water was flowing during time of site visit.	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Stones habitat characteristics	Consisted of a silted river bed with no stones or diverse habitat	Consisted of a silted river bed with no stones or diverse habitat	Consisted of a silted river bed with no stones or diverse habitat
Vegetation habitat characteristics	The vegetation at this point is totally degraded and dominated by *Pennisetum clandestinum*.	The vegetation at this point is totally degraded and dominated by *Pennisetum clandestinum*.	The vegetation at this point is totally degraded and dominated by *Pennisetum clandestinum*.
Other habitat characteristics	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.
Erosion potential	Low. Banks at this point are relatively stable and there is	Low. Banks at this point are relatively stable and there is little potential for erosion.	Low. Banks at this point are relatively stable and there is

	little potential for erosion.		little potential for erosion.

5.1.4. Attenuation dam upgrade upstream of the rail way line in non-perennial river.

Photo 23: Existing attenuation dam to be upgraded. Wetland indicator species present as result of damming of river.

Photo 24: Upstream view of the non-perennial river where the proposed attenuation dam upgrade is proposed.

Photo 25: Existing attenuation dam to be upgraded. Wetland indicator species present as result of damming of river.

Table 15: Descriptions of the location of attenuation dam in relation to mapped non-perennial river

Characteristics	Water pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.

Surrounding anthropogenic activities	The site is situated at the point where the existing attenuation dam will be upgraded in the non-perennial river.	The site is situated upstream where the existing attenuation dam will be upgraded in the non-perennial river.	The site is situated downstream where the existing attenuation dam will be upgraded in the non-perennial river.
Riparian zone characteristics	The riparian zone at this point is altered as a result of the existing attenuation dam and downstream flow modification as result of the construction of the railway line. The vegetation at this point is dominated by *Typha capensis with patches of Zantesdeschia aethiopica, Searsia laevigata, etc.*	Limited riparian at this point and it is characterised by constructed attenuation dam dominated by *Pennisetum clandestinum* with patches of *Typha capensis.*	Limited riparian at this point as a result of the constructed railway line.
Depth characteristics	The river at this point is characterised by a constructed attenuation dam.	No water was flowing during time of site visit. The river at this point is characterised by a constructed attenuation dam.	No water was flowing during time of site visit. River channel destroyed as a result of the constructed railway line.
Flow conditions	No water was flowing during time of site visit.	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Water clarity	No water was flowing during time of site visit.	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Stones habitat characteristics	The river at this point is characterised by a constructed attenuation dam.	Consisted of a silted river bed with no stones or diverse habitat	None as a result of the constructed railway line.
Vegetation habitat characteristics	Limited and dominated by *Pennisetum clandestinum.*	Limited and dominated by *Pennisetum clandestinum.*	None as a result of the constructed railway line.
Other habitat characteristics	Artificial wetland as a result of the constructed attenuation dam and railway line that block the river flow.	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.

Erosion potential	Low. Banks at this point are relatively stable and there is little potential for erosion.	Low. Banks at this point are relatively stable and there is little potential for erosion.	Low. Banks at this point are relatively stable and there is little potential for erosion.

5.1.5. Attenuation dam upgrade in non-perennial river between railway line and N2.

Photo 26 Proposed attenuation dam.

Photo 27: Downstream view of channelled non-perennial river.

Table 16: Descriptions of the location of attenuation dam in relation to mapped non-perennial river

Characteristics	Water pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the attenuation dam will be constructed in the non-perennial river.	The site is situated upstream where the attenuation dam will be constructed in the non-perennial river.	The site is situated downstream where a attenuation dam will be constructed in the non-perennial river.
Riparian zone characteristics	The riparian zone at this point is altered as a result of the existing upstream modifications and impacts on the non-perennial river. Consist mostly of pioneer plants with no freshwater ecology functioning left.	None at this point as a result of the constructed railway line.	None at this point. River is channelled in concrete channel.

Depth characteristics	Flat area	Flat area	None. Water is channelled underneath the N2 and into a concrete channel.
Flow conditions	No water was flowing during time of site visit. The river channel at this point consists of a small eroded channel as a result of the concentrate stream release underneath the railway line.	No water was flowing during time of site visit. The river channel at this point consists of a small eroded channel as a result of the concentrate stream release underneath the railway line.	None. Water is channelled underneath the N2 and into a concrete channel.
Water clarity	No water was flowing during time of site visit.	No water was flowing during time of site visit.	No water was flowing during time of site visit.
Stones habitat characteristics	Consisted of eroded river channel with sand and stone river bed.	Consisted of eroded river channel with sand and stone river bed.	None. Water is channelled underneath the N2 and into a concrete channel.
Vegetation habitat characteristics	Degraded and dominated by pioneer plants.	Degraded and dominated by pioneer plants.	None. Water is channelled underneath the N2 and into a concrete channel.
Other habitat characteristics	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	The surrounding land uses, cemetery in the catchment, road crossings and attenuation dam all contributed to the poor ecological state that the non-perennial river is in.	None. Water is channelled underneath the N2 and into a concrete channel.
Erosion potential	Low. Banks at this point are relatively stable and there is little potential for erosion.	Low. Banks at this point are relatively stable and there is little potential for erosion.	None. Water is channelled underneath the N2 and into a concrete channel.

5.1(B) Habitat Assessment Of The Whole Non-Perennial River

Instream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
Impacted Site	0	25	25	25	22	25	22	22	9	21.56	E: The loss of natural habitat, biota and basic ecosystem functions is extensive.

None	Small	Moderate	Large	Serious	Critical

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
Impacted Site	25	25	3	0	25	25	22	25	25.76	E: The loss of natural habitat, biota and basic ecosystem functions is extensive.

None	Small	Moderate	Large	Serious	Critical

From the results of the application of the IHIA to the impacted site, it is evident that the rivers reach is modified and that the loss of natural habitat, biota and basic ecosystem functions is extensive. Instream impacts included a large impact from flow modifications, inundation as well as bed and channel modifications. Overall, the site achieved a 21.56 % score for instream integrity.

Riparian impacts included a large impact from flow modifications, inundation, alien vegetation encroachment as well as bed and channel modifications. Overall, the site achieved an 25.76

% score for instream integrity.

The site obtained an overall IHIA rating of 23.66%, which indicates the loss of natural habitat, biota and basic ecosystem functions is extensive. (Class E conditions).

5.1. (C) Riparian Vegetation Response Assessment Index (VEGRAI)

Table 17: The overall VEGRAI score of the impacted area

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	10,0	3,8	2,7	2,0	60,0
NON MARGINAL	10,4	6,5	3,8	1,0	100,0
2.0					160,0
LEVEL 3 VEGRAI (%)				10,3	
VEGRAI EC				**F**	
AVERAGE CONFIDENCE				3,3	

The score attained for the VEGRAI indicated that the riparian system falls into the category F. This indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive. Modifications have reached a critical level and the system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.

5.1. (D) Ecological Importance and Sensitivity (EIS)

Table 18: Results of the EIS assessment for the affected watercourse

Component	Score	Confidence	Comments/description
Channel type	3	4	Channelled non-perennial river.
Conservation context	0	4	No Status
Vegetation and habitat Integrity	1	4	Largely modified
Connectivity	0	4	Not connected. Downstream connection is lost.
Threat Status of Vegetation Type	0	4	Vegetation has endangered conservation status
EIS Category	**0.80**		**Low/marginal**

EIS considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale. The median of the resultant score is calculated to derive the EIS category.

The non-perennial river is considered to be of low to marginal ecological importance.

The non-perennial river was classified according to the Classification System outlined in chapter 3 of this report as an Inland System, located within the Southern Coastal Belt Ecoregion. Table 12 below presents the classification from level 3 to 4 of the Wetland Classification System.

Table 19: Characteristics of the freshwater resources associated with the water pipeline

upgrades, housing development and new road and bridge crossing.

Watercourse	Level Three: Landscape unit	Level Four: Hydrogeomorphic (HGM) Type
Channelled Valley Bottom Wetland	Valley floor: The typically gently sloping, lowest surface of a valley.	Channelled valley-bottom wetland: A valley bottom wetland with a river channel running through it.

Wetlands as defined by the National Water Act (Act 36 of 1998) "*are a portion of land that 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." Wetland delineation relates to the determination and marking of the boundary of a wetland to the outer edge of the temporary zone of wetness.

The wetland assessment consisted of the following wetland assessment components: Wetland delineation; Wetland classification; Wetland integrity; Wetland ecological importance and sensitivity; and Ecosystem services supplied by the wetland.

The wetland delineation process uses four wetland indicators to provide an estimate of the extent of a wetland. They are: landscape position (must be flat or depressed), vegetation (must be hydrophilic), soil form (must compliment an existing wetland type) and soil wetness (water table must be within 50 cm of profile).

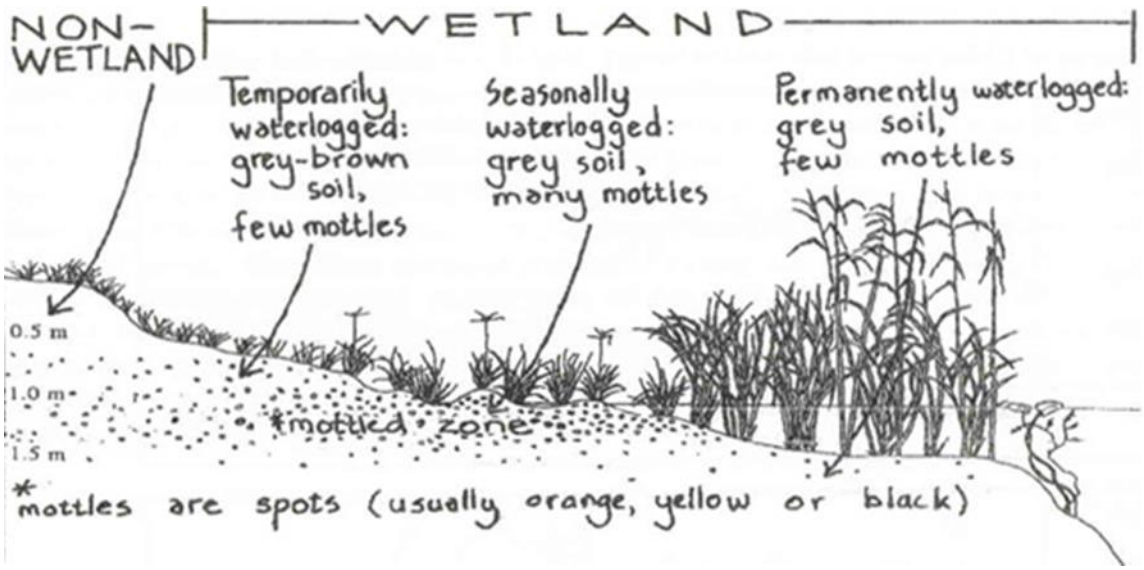

Figure 4: Wetland illustration

The WET-Health method was also then used to determine the Present Ecological Status (PES) scores for the hydrology, geomorphology, water quality and vegetation of the wetland and generate an overall PES and ecological category for the wetland.

PES Category: F (Critical Modified)
Modifications have reached a critical level and the ecosystem has been modified completely with an almost complete loss of natural habitat and biota. The hydrological regime of the system has been altered by ponding of water upstream, road crossings and surrounding

residential activities as well as stormwater ponds, railway line and N2 road crossings and alterations downstream. The geomorphological characteristics and vegetation composition have been modified as a result of anthropogenic activities, surrounding residential activities and livestock grazing, thereby reducing vegetation species composition and abundance.

The habitat integrity of all the wetlands are considered to be largely modified. The most significant impacts on the wetland areas are the direct habitat loss due to surrounding land uses and flow modifications of the non-perennial river.

The wetland areas offer moderate services in terms of trapping and or removing phosphate, nitrate and toxicants. It also offers moderate services in terms of controlling erosion and attenuating floods. There are no critically important aquatic ecosystems downstream of the site.

Table 20: Goods and services assessment results for the wetland in the study site (high=4; low=0)

Goods and services	**Wetlands within 500m from the impacted zone of the proposed developments and upgrades.**	**Goods and services**	**Wetlands within 500m from the impacted zone of the proposed developments and upgrades.**
Flood attenuation	2	Maintenance of biodiversity	0
Stream flow regulation	2	Water supply for human use	0
Sediment trapping	3	Natural resources	0
Phosphate trapping	2.2	Cultivated foods	0
Nitrate removal	2	Cultural significance	0
Toxicant removal	2.6	Tourism and recreation	0
Erosion control	2	Education and research	0
Carbon storage	1.4		

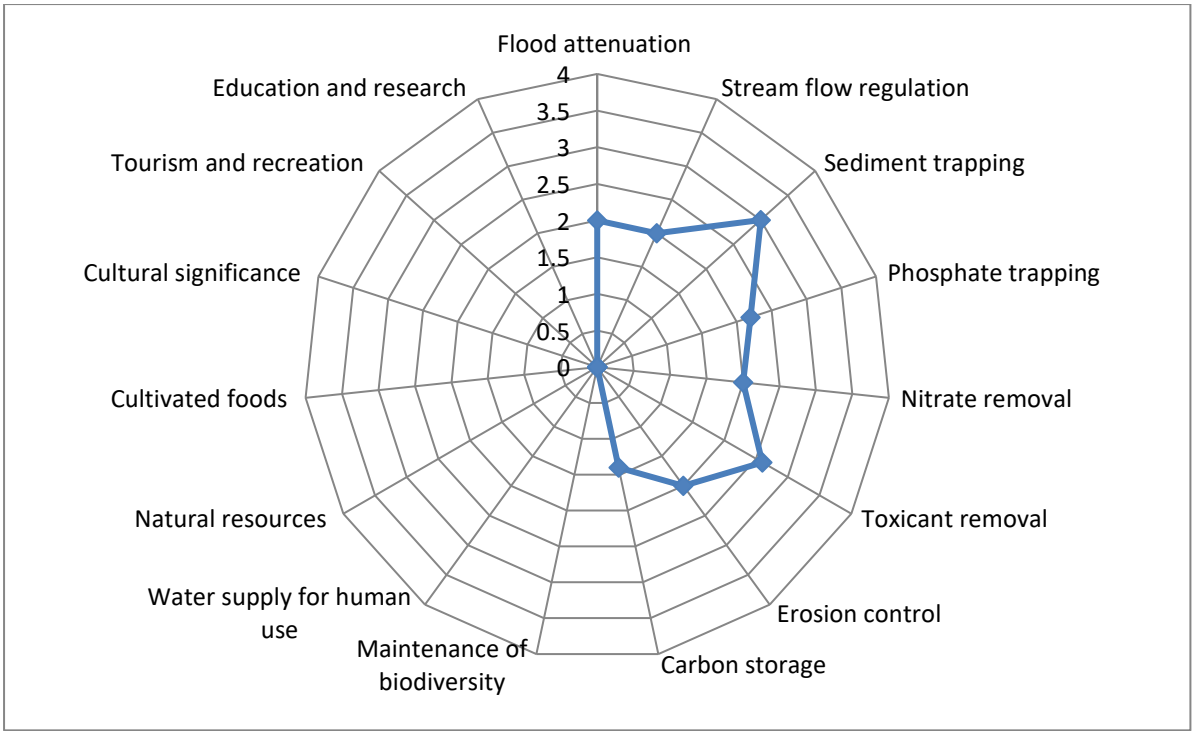

Figure 5: Ecosystem services provided by the wetland area

The wetlands Ecoservice has a value of 1.075 (**Low/marginal).** Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. From an ecological perspective, the wetland areas are of a low to marginal ecological sensitivity and importance. They provide a refuge for some indigenous species and water attenuation functions. Furthermore, as they are the interface between the terrestrial and aquatic environments, they have higher species diversity than the surrounding terrestrial, which has been extensively altered.

This confirm the assessment results of the NFEPA study that concluded that these non-perennial rivers do not have any wetlands other than an artificial wetland that formed as a result of a stormwater pond upstream of the one road crossing. The changes in the natural flow regime and ponding as a result of the railway bridge crossing and N2 road with the stream alterations downstream resulted in wetland vegetation characteristics establishing in some parts of the non-perennial water courses.

5.2 (A) Activities Impacting on the Koornlands Perennial River

5.2.1. Sewer pipeline upgrade on southern bank of Koornlands River.

Photo 27: Propose upgrade of existing sewer pipeline.

Photo 28: Upstream view of Koornlands river where the sewer pipeline upgrade is proposed.

Photo 29: Upstream view of Koornlands river where the sewer pipeline upgrade is proposed.

Table 21: Descriptions of the location of sewer pipe upgrade in relation to mapped perennial river

Characteristics	Sewer pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the pipeline will be upgraded next to the perennial river.	The site is situated upstream where the pipeline will run next to the perennial river.	The site is situated downstream where the pipeline will run next to the perennial river.
Riparian zone characteristics	The riparian zone at this point is impacted by urban activities.	Limited riparian vegetation at this point.	Limited riparian vegetation at this point.

Depth characteristics	Water was flowing during time of site visit in the Koornlands River next to the site.	Water was flowing during time of site visit. The river has a deep natural channel.	Water was flowing during time of site visit. The river has a deep natural channel.
Flow conditions	Water was flowing during time of site visit in the Koornlands River next to the site.	Water was flowing during time of site visit. The river has a deep natural channel.	Water was flowing during time of site visit. The river has a deep natural channel.
Water clarity	Site outside the river.	The water observed in the Koornlands River at the time of the survey was clear.	The water observed in the Koornlands River at the time of the survey was clear.
Stones habitat characteristics	Site outside the river.	The river channel is characterised by alluvial river rock channel.	The river channel is characterised by alluvial river rock channel.
Vegetation habitat characteristics	The riparian zone at this point is impacted by urban activities.	Limited riparian at this point and it is characterised by *Pennisetum macrourum. Acacia mearnsii* was recently cleared and the area is dominated by pioneer grasses.	Limited riparian at this point and it is characterised by *Pennisetum macrourum. Acacia mearnsii* was recently cleared and the area is dominated by pioneer grasses.
Other habitat characteristics	None. Situated outside river.	The river channel is characterised by alluvial river rock channel.	The river channel is characterised by alluvial river rock channel.
Erosion potential	None. Outside river and its banks.	Banks at this point are relatively stable and there is little potential for erosion.	Banks at this point are relatively stable and there is little potential for erosion.

5.2.2. Non-perennial river where water pipeline will cross as well as expansion of the water pipeline on the bank of the non-perennial river next to the edge of existing erven.

Photo 30: Upgrade of existing sewer pipeline hanged downstream on the bridge.	**Photo 31:** Upgrade of existing sewer pipeline outside the river and its banks.
 **Photo 32:** Upstream of Koornlands River of existing sewer pipeline crossing.	 **Photo 33:** Upstream of Koornlands River of existing sewer pipeline crossing.

Table 22: Descriptions of the location of sewer pipe in relation to mapped perennial river

Characteristics	Sewer pipeline site	Upstream area	Downstream area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the pipeline will be upgraded next to and over the perennial river.	The site is situated upstream where the pipeline will run next to and over the perennial river.	The site is situated downstream where the pipeline will run next to and over the perennial river.
Riparian zone characteristics	The riparian zone at this point where the existing pipeline will be upgraded consists of a bridge and road crossing.	Limited riparian vegetation at this point due to rocking river bed.	Limited riparian vegetation at this point due to rocking river bed.
Depth characteristics	Water was flowing during time of site visit in the Koornlands River. Channel is moderate at this point in the Koornlands River.	Water was flowing during time of site visit. The river has a moderate natural channel.	Water was flowing during time of site visit. The river has a moderate natural channel.
Flow conditions	Water was flowing during time of site visit in the	Water was flowing during time of site visit. The river has a moderate natural channel.	Water was flowing during time of site visit. The river has

	Koornlands River next to the site.		a moderate natural channel.
Water clarity	Water at this site in the Koornlands River is clear.	Water at this site in the Koornlands River is clear.	Water at this site in the Koornlands River is clear.
Stones habitat characteristics	The river channel is characterised by alluvial river rock channel.	The river channel is characterised by alluvial river rock channel.	The river channel is characterised by alluvial river rock channel.
Vegetation habitat characteristics	The riparian zone at this point where the existing sewer pipeline will be upgraded consists of a bridge and road crossing.	Riparian at this point is characterised by *Pennisetum macrourum, Acacia mearnsii, Phragmites australis* and in a fairly good condition despite the presence of alien vegetation.	Riparian at this point is characterised by *Pennisetum macrourum, Acacia mearnsii, Phragmites australis* and in a fairly good condition despite the presence of alien vegetation.
Other habitat characteristics	None. Existing infrastructure	The river channel is characterised by alluvial river rock channel.	The river channel is characterised by alluvial river rock channel.
Erosion potential	None. Outside river and its banks and existing infrastructure.	Banks at this point are relatively stable and there is little potential for erosion.	Banks at this point are relatively stable and there is little potential for erosion.

5.1.3. Proposed upgrade of sewer pipeline next to the perennial river outside the flood lines.

Photo 34: Proposed sewer pipeline upgrade next to river.

Photo 35: Condition of the riparian vegetation of the Koornlands River next to the proposed sewer pipeline upgrade.

Table 23: Descriptions of the location of upgrade to the existing sewer pipeline in comparison to the mapped perennial river

Characteristics	Sewer pipeline site	Next to sewer pipeline upgrade area
Significance of the point	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.	This point is to be used as a reference point for the site. Any degradation from this point would serve as an indication of impacts on the surrounding area.
Surrounding anthropogenic activities	The site is situated at the point where the pipeline will be upgraded next to the perennial river.	The site is situated upstream where the pipeline will run next to and over the perennial river.
Riparian zone characteristics	The riparian zone at this point is impacted by urban and agricultural activities.	Riparian vegetation in good condition at this point. *Acacia mearnsii* has an impact on species diversity.
Depth characteristics	None. Outside the river and its floodplain.	Water was flowing during time of site visit. The river has a moderate natural channel.
Flow conditions	None. Outside the river and its floodplain.	Water was flowing during time of site visit. The river has a moderate natural channel.
Water clarity	None. Outside the river and its floodplain.	Water at this site in the Koornlands River is clear.
Stones habitat characteristics	None. Outside the river and its floodplain.	The river channel is characterised by alluvial river rock channel.
Vegetation habitat characteristics	None. Outside the river and its floodplain.	Riparian at this point is characterised by *Pennisetum macrourum, Acacia mearnsii, Phragmites australis* and in a fairly good condition despite the presence of alien vegetation.
Other habitat characteristics	None. Existing infrastructure	The river channel is characterised by alluvial river rock channel.
Erosion potential	None. Outside river and its banks and existing infrastructure.	Banks at this point are relatively stable and there is little potential for erosion.

5.2 Habitat Assessment Of The Whole Koornlands Perennial River

Instream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
Impacted Site	12	12	12	12	3	2	2	2	5	69.52	C: Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.

None	Small	Moderate	Large	Serious	Critical

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
Impacted Site	12	15	6	12	12	12	2	2	63.92	C: Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.

None	Small	Moderate	Large	Serious	Critical

From the results of the application of the IHIA to the impacted site, it is evident that the rivers reach is modified and a loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. Instream impacts included a large impact from flow modifications, inundation as well as bed and channel modifications. Overall, the site achieved a 69.52 % score for instream integrity.

Riparian impacts included a large impact from flow modifications, inundation, alien vegetation encroachment as well as bed and channel modifications. Overall, the site achieved an 63.92 % score for instream integrity.

The site obtained an overall IHIA rating of 66.72%, which indicates that the river is largely natural with few modifications. (Class C conditions).

5.2.1. Riparian Vegetation Response Assessment Index (VEGRAI)

Table 24: The overall VEGRAI score of the impacted area

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	50,0	18,8	3,3	2,0	60,0
NON MARGINAL	70,0	43,8	3,5	1,0	100,0
2.0					160,0
LEVEL 3 VEGRAI (%)				62,5	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				3,4	

The score attained for the VEGRAI indicated that the riparian system falls into the category C. Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.

5.2.2. Ecological Importance and Sensitivity (EIS)

Table 25: Results of the EIS assessment for the affected watercourse

Component	Score	Confidence	Comments/description
Channel type	4	4	Channelled perennial river.
Conservation context	5	4	NFEPA
Vegetation and habitat Integrity	3	4	Moderately modified
Connectivity	4	4	Connected to Bree River
Threat Status of Vegetation Type	4	4	Vegetation has endangered conservation status
EIS Category	**4**		**Very High**

EIS considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale. The median of the resultant score is calculated to derive the EIS category.

The perennial river is considered to be of very high ecological importance.

The Koornlands perennial river was classified according to the Classification System outlined in chapter 3 of this report as an Inland System, located within the Southern Coastal Belt Ecoregion. Table 20 below presents the classification from level 3 to 4 of the Wetland Classification System.

Table 26: Characteristics of the freshwater resources associated with the sewer pipeline upgrades.

Watercourse	Level Three: Landscape unit	Level Four: Hydrogeomorphic (HGM)

		Type
Channelled Valley Bottom Wetland	Valley floor: The typically gently sloping, lowest surface of a valley.	Channelled valley-bottom wetland: A valley bottom wetland with a river channel running through it.

Wetlands as defined by the National Water Act (Act 36 of 1998) "*are a portion of land that 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." Wetland delineation relates to the determination and marking of the boundary of a wetland to the outer edge of the temporary zone of wetness.

The wetland assessment consisted of the following wetland assessment components: Wetland delineation; Wetland classification; Wetland integrity; Wetland ecological importance and sensitivity; and Ecosystem services supplied by the wetland.

The wetland delineation process uses four wetland indicators to provide an estimate of the extent of a wetland. They are: landscape position (must be flat or depressed), vegetation (must be hydrophilic), soil form (must compliment an existing wetland type) and soil wetness (water table must be within 50 cm of profile).

The WET-Health method was also then used to determine the Present Ecological Status (PES) scores for the hydrology, geomorphology, water quality and vegetation of the wetland and generate an overall PES and ecological category for the wetland.

PES Category: C (Moderately Modified)
A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact. The hydrological regime of the system has been altered by surrounding residential activities and road crossings. The geomorphological characteristics and vegetation composition have been modified as a result of anthropogenic activities and surrounding residential activities, thereby reducing vegetation species composition and abundance.

The habitat integrity of all the wetlands are considered to be moderately modified. The most significant impacts on the wetland areas are the direct habitat loss due to surrounding land uses and flow modifications of the non-perennial river.

The wetland areas offer moderate services in terms of trapping and or removing phosphate, nitrate and toxicants. It also offers moderate services in terms of controlling erosion and attenuating floods. There are no critically important aquatic ecosystems downstream of the site.

Table 27: Goods and services assessment results for the wetland in the study site (high=4; low=0)

Goods and services	**Wetlands within 500m from the**	**Goods and services**	**Wetlands within 500m from the**

	impacted zone of the proposed developments and upgrades.		**impacted zone of the proposed developments and upgrades.**
Flood attenuation	3	Maintenance of biodiversity	2
Stream flow regulation	3	Water supply for human use	0
Sediment trapping	3	Natural resources	2
Phosphate trapping	2.2	Cultivated foods	0
Nitrate removal	2	Cultural significance	2
Toxicant removal	2.6	Tourism and recreation	0
Erosion control	3	Education and research	2
Carbon storage	1.4		

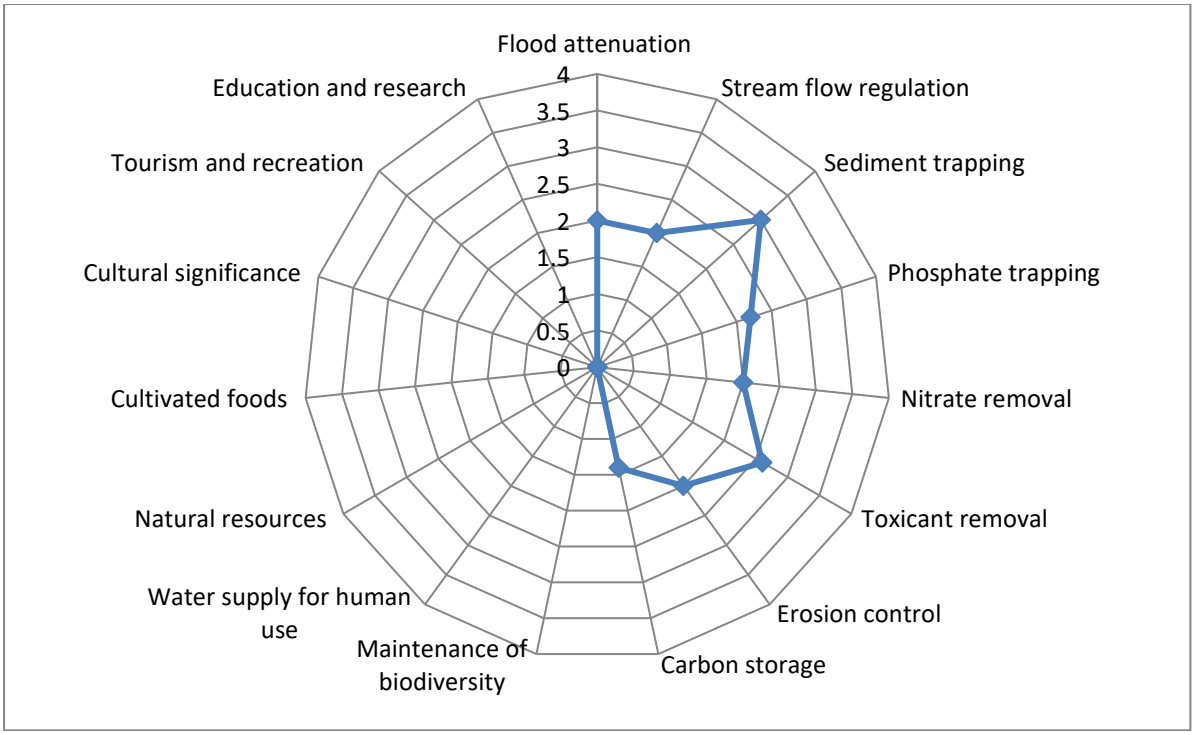

Figure 6: Ecosystem services provided by the wetland area

The wetlands Ecoservice has a value of 3 (**Moderate).** Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. From an ecological perspective, the wetland areas are of a moderate ecological sensitivity and importance. They provide a refuge for some indigenous species and water attenuation functions. Furthermore, as they are the interface between the terrestrial and aquatic environments, they have higher species diversity than the surrounding terrestrial, which has been extensively altered.

This confirm the assessment results of the NFEPA study and State of the River report findings.

6. IMPACT ASSESSMENT OF THE ACTIVITIES

Nature of impact: Loss of freshwater ecology habitat
Discussion:

Habitat destruction is the alteration of a natural habitat to the point that it is rendered unfit to support the species dependent upon it as their home territory. Many organisms previously using the area are displaced or destroyed, reducing biodiversity. Modification of habitats for agriculture as well as surface mining and urban development are the main causes of habitat destruction in this case. Additional causes of habitat destruction include water pollution, introduction of alien species and overgrazing. The non-perennial riverine systems have very low flows as part of their annual hydrological cycles and are particularly susceptible to changes in habitat condition. The proposed development project has the potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the study area. It is however important to note that the freshwater ecology, and especially aquatic habitats of most of the systems has been seriously to critically impaired or impacted already as a result of existing infrastructure and as such the risk to the receiving environment as a result of the proposed project is reduced to some degree.

Cumulative impacts:

Riparian zone

Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns.
Construction of the pipelines and attenuation dams altering stream flow patterns and water velocities.
Alien invasive vegetation encroachment.
Erosion and incision of riparian zone.

Instream zone

Loss of aquatic refugia.
Altered substrate conditions due to the deposition of silt
Altered depth and flow regimes in the major drainage systems
Alien vegetation proliferation

Mitigation:

Essential mitigation measures:

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. The non-impacted areas of the water courses and wetlands, its riparian zones and 32m buffer areas is regarded as no go and no impact areas.
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by a suitably qualified assessor.
- Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the water courses and wetlands.
- Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation;
- Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream;

Recommended mitigation measures

- Permit only essential construction personnel within 32m of all riparian systems;
- Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time revegetation should take place allowing for a full summer growing season to become established.

Criteria	Without Mitigation	With Mitigation	No-Go Alternative Without Mitigation	With Mitigation

Extent	2	1	Not Applicable (No construction activities to take place during the No-Go Alternative)
Duration	5	5	
Magnitude	2	2	
Probability	4	2	
Significance	36-Medium	16-Low	
Status	Medium significance if not mitigated	No significance if mitigated	
Reversibility	0%		
Irreplaceable loss of resources	2- Partly Replaceable		
Can impacts be mitigated?	2-Partly, but impact on subsurface geological layers during excavations is inevitable.		

Nature of impact:
Degradation / loss of naturally occurring / indigenous flora and habitats.

Discussion:
Special precaution is to be taken during the construction of the infrastructure that falls within the regulated area as determined in the NWA. Construction activities must be controlled to ensure that the river and its buffer areas are not negatively impacted.

Cumulative impacts:
Loss of significantly impacted upon vegetation and habitat.

Mitigation:

- Undertake construction activities only in identified and specifically demarcated areas.
- Invasive vegetation to be removed during construction to be disposed of at landfill site in such a manner that seeds must not be able to spread from the disposal site or during transportation.
- In order to access the river with the required construction equipment and activities, and upgrading of the attenuation dams, vegetation will need to be cleared. All vegetation removed must be disposed of at a suitable disposal facility.
- At no point may construction equipment stand unauthorised within or near the river.
- All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase.
- It is recommended that the upgraded attenuation dams be designed to be as natural as possible (earthed and unlined) and vegetated to function as a constructed wetland for water quality filtration.
- One culvert crossings are proposed over the river to gain access. Care must be taken when constructing the culverts to ensure that the design accommodates a 1 in 100 year flood event and that the base levels are maintained so that no erosion or ponding of water occurs surrounding the crossing.
- Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.
- All soils within the river surrounding the culvert must be loosened on completion of works to allow for revegatation.

Criteria			**No-Go Alternative**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**

Extent	3	2	Not Applicable (No construction activities to take place during the No-Go Alternative)
Duration	2	1	
Magnitude	4	2	
Probability	4	2	
Significance	36 - Medium Significance	10 - Low Significance	
Status	Medium significance if not mitigated	No significance if mitigated	
Reversibility	30%	70%	
Irreplaceable loss of resources	2 - Resource may be partly destroyed		
Can impacts be mitigated?	2 - Partly mitigable		

Nature of impact:
Damage to existing infrastructure.

Discussion:
Construction activities will impact upon existing sewer pipelines that may occur along the pipeline route as well as when connected to the existing sewer line. Damage to private property of adjacent landowners may potentially occur.

Cumulative impacts:
Damage or loss of existing infrastructure. Damage and loss of private property adjacent to the proposed activity. Spillage of sewerage into the natural environment.

Mitigation:

- Care should be taken when conducting construction activities in close proximity to infrastructure and private property;
- Should any damage occur to existing infrastructure or private property as a result of construction activities; the relevant service provider / landowner must be contacted and the repair/replacement must be commissioned to the satisfaction of the service provider / landowner. Should spillage occur, the BGCMA and DEA&DP: Pollution and chemical management directorate must be informed immediately.

Criteria	**Without Mitigation**	**With Mitigation**	**No-Go Alternative**	
			Without Mitigation	**With Mitigation**
Extent	3	2	Not Applicable (No construction activities to take place during the No-Go Alternative)	
Duration	1	1		
Magnitude	2	0		
Probability	4	3		
Significance	24 - Low Significance	9 - Low Significance		
Status	Low Significance if not mitigated	No significance if mitigated		
Reversibility	90%			
Irreplaceable loss of resources	1 - Resource will not be lost			
Can impacts be mitigated?	1 - Completely mitigable			

Nature of impact:
Waste management.

Discussion:

General construction waste will be generated during the construction phase. Poor waste management practices on site may lead to dumping and windblown litter creating a negative visual impact and nuisance for adjacent landowners / users as well as impacting the natural environment.

Cumulative impacts:

- Dumping;
- Windblown litter causing nuisance;
- Pollution / degradation of the natural environment.

Mitigation:

- All waste generated on site shall be collected and disposed of at a registered landfill facility;
- All safe disposal certificates and waste manifests from service providers to be kept and maintained;
- All staff to receive training on correct waste management practices.

Criteria	Without Mitigation	With Mitigation	No-Go Alternative	
			Without Mitigation	With Mitigation
Extent	2	1	Not Applicable (No construction activities to take place during the No-Go Alternative)	
Duration	2	1		
Magnitude	2	2		
Probability	3	2		
Significance	18 - Low Significance	8 - Low Significance		
Status	Low Significance if not mitigated	No significance if mitigated		
Reversibility	90%			
Irreplaceable loss of resources	1 - Resource will not be lost			
Can impacts be mitigated?	1 - Completely mitigable			

Nature of impact:
Infrastructure failure.

Discussion:
Infrastructure failure will result in the spillage of raw sewerage into the receiving environment.

Cumulative impacts:
Pollution of the receiving environment as well as offensive odours from the spillage causing a nuisance to adjacent landowners / users.

Mitigation:

- Regular inspection and maintenance of the sewer pipeline.
- Infrastructure failure reported or identified to be fixed as a priority.
- Spillage of raw sewerage to be mitigated and remediated where required.
- Should any damage occur to existing infrastructure or private property as a result of construction activities; the relevant service provider / landowner must be contacted and the repair/replacement must be commissioned to the satisfaction of the service provider / landowner. Should spillage occur, the BGCMA and DEA&DP: Pollution and chemical management directorate must be informed immediately.

Criteria	No-Go Alternative

	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Extent	3	2	Not Applicable (No construction activities to take place during the No-Go Alternative)	
Duration	2	1		
Magnitude	4	4		
Probability	2	2		
Significance	18 - Low Significance	14 - Low Significance		
Status	Low Significance	Low Significance		
Reversibility	60%			
Irreplaceable loss of resources	2 - Resources may be partly destroyed			
Can impacts be mitigated?	2 - Partially			

Nature of impact: Stormwater from the 950 unit housing development released into the surrounding environment.
Discussion: Stormwater Management for the proposed housing development site. Potential impacts to the preferential surface flow pathway within the study area and the non-perennial river into which the housing development stormwater will be discharged.
Cumulative impacts: Changes to hydrological function and sediment balance.
Mitigation: The preferential flow pathway of the stormwater outlets to the non-perennial river should be rehabilitated into an earth stormwater swale and re-vegetated with indigenous wetland species. All stormwater swales proposed for the study area as well as the two proposed attenuation ponds should be constructed with a slope of not steeper than a 1:3 ratio and a degree of sinuosity should be re-established. The swale should be lined with rock and/or cobbles to create additional ecological habitat.

Criteria	Without Mitigation	With Mitigation	No-Go Alternative Without Mitigation	With Mitigation
Extent	3	2	Not Applicable (No construction activities to take place during the No-Go Alternative)	
Duration	2	1		
Magnitude	4	4		
Probability	2	2		
Significance	18 - Low Significance	14 - Low Significance		
Status	Low Significance	Low Significance		
Reversibility	60%			
Irreplaceable loss of resources	2 - Resources may be partly destroyed			
Can impacts be mitigated?	2 - Partially			

Cumulatively, if adequately mitigated the potential impacts of the proposed activities to be undertaken will be of low negative significance and will in the short term just require some rehabilitation of the disturbed areas and longer term monitoring and control of the growth of alien invasive plants, erosion and waste accumulation.

7. CONCLUSION

Eco Impact Legal Consulting (Pty) Ltd were appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the freshwater and riparian resources as part of the Water Use Authorization application.

The proposed project form part of service delivery to the proposed housing project and the upgrade of water and sewerage pipelines, attenuation dams and new road crossing is require.

Based on the impact assessment it is evident that there are seven possible impacts on the freshwater ecology of the area observed. In considering the impacts and mitigation, it is assumed that a high level of mitigation will take place without high prohibitive costs. From the table it is evident that prior to mitigation, the impacts on the loss of freshwater ecology habitat, disturbance to subsurface geological layers, degradation / loss of naturally occurring / indigenous flora and habitats are medium level impacts, which can be mitigated and will be reduced to low level impacts. The other four impacts identified all has low impacts that is reduce to very low with the proposed mitigation measures.

NON-PERENNIAL RIVER WITH THE PROPOSED WATER PIPELINE UPGRADES, ATTENUATION DAMS UPGRADE AND NEW ROAD CROSSING ACTIVITIES.

Habitat Assessment

From the results of the application of the IHIA to the impacted site, it is evident that the rivers reach is modified and that the loss of natural habitat, biota and basic ecosystem functions is extensive. Instream impacts included a large impact from flow modifications, inundation as well as bed and channel modifications. Overall, the site achieved a 21.56 % score for instream integrity.

Riparian impacts included a large impact from flow modifications, inundation, alien vegetation encroachment as well as bed and channel modifications. Overall, the site achieved an 25.76 % score for instream integrity.

The site obtained an overall IHIA rating of 23.63%, which indicates the loss of natural habitat, biota and basic ecosystem functions is extensive. (Class E conditions).

Riparian Vegetation Response Assessment Index (VEGRAI)

The score attained for the VEGRAI indicated that the riparian system falls into the category F. This indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive. Modifications have reached a critical level and the system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.

Ecological Importance and Sensitivity (EIS)

EIS considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale. The median of the resultant score is calculated to derive the EIS category.

The non-perennial river is considered to be of moderate ecological importance.

From an ecological perspective, the wetland areas are of a low to marginal ecological sensitivity and importance. They provide a refuge for some indigenous species and water attenuation functions. Furthermore, as they are the interface between the terrestrial and aquatic environments, they have higher species diversity than the surrounding terrestrial, which has been extensively altered.

This confirm the assessment results of the NFEPA study that concluded that these non-perennial rivers do not have any wetlands other than an artificial wetland that formed as a result of a stormwater pond upstream of the one road crossing. The changes in the natural flow regime and ponding as a result of the railway bridge crossing and N2 road with the stream alterations downstream resulted in wetland vegetation characteristics establishing in some parts of the non-perennial water courses.

PERENNIAL KOORNLANDS RIVER WITH THE PROPOSED SEWER PIPELINE UPGRADES

Habitat Assessment

From the results of the application of the IHIA to the impacted site, it is evident that the rivers reach is modified and that the loss of natural habitat, biota and basic ecosystem functions is extensive. Instream impacts included a large impact from flow modifications, inundation as well as bed and channel modifications. Overall, the site achieved a 69.52 % score for instream integrity.

Riparian impacts included a large impact from flow modifications, inundation, alien vegetation encroachment as well as bed and channel modifications. Overall, the site achieved an 63.92 % score for instream integrity.

The site obtained an overall IHIA rating of 66.72%, which indicates the loss of natural habitat, biota and basic ecosystem functions is extensive. (Class E conditions).

Riparian Vegetation Response Assessment Index (VEGRAI)

The score attained for the VEGRAI indicated that the riparian system falls into the category F. This indicates that the loss of natural habitat, biota and basic ecosystem functions is extensive. Modifications have reached a critical level and the system has been modified completely with almost complete loss of natural habitat and biota. In worst instances basic ecosystem functions have been destroyed and changes are irreversible.

Based on the findings of this study it is the opinion of the freshwater ecologists that the proposed construction activities be considered favourably, from a freshwater ecological point of view, provided that the mitigatory measures presented in this report are strictly adhered to.

Ecological Importance and Sensitivity (EIS)

EIS considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale. The median of the resultant score is calculated to derive the EIS category.

The perennial river is considered to be of high ecological importance.

Based on the findings of the freshwater resource assessment and the results of the impact assessment, it is the opinion of the ecologist that the proposed developments and upgrades does not pose any significant risks, however, the sewer pipeline will traverse the Koornlands Perennial River which will pose a Moderate risk to the integrity of the freshwater resource

provided that adherence to cogent, well-conceived and ecologically sensitive site development and management plans and the mitigation measures provided in this report as well as general good construction practice are adhered. Authorisation by means of an Environmental Authorisation in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) and a Water Use Licence in terms of the National Water Act, 1998 (Act 36 of 1998) must be obtained from the relevant authorities prior to commencement of any works.

From an ecological perspective, the floodplain wetland areas are of a moderate ecological sensitivity and importance. They provide a refuge for some indigenous species and water attenuation functions. Furthermore, as they are the interface between the terrestrial and aquatic environments, they have higher species diversity than the surrounding terrestrial, which has been extensively altered.

This is in line with the assessment results of the NFEPA study as well as the State of the River report. The proposed development and upgrades will not lead to the degradation in ecological status of the Koornlands River, non-perennial river and associated wetlands.

Mitigation measures for inclusion in the EMPr

Essential mitigation measures:

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area.
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. The non-impacted areas of the water courses and wetlands, its riparian zones and 32m buffer areas is regarded as no go and no impact areas.
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by a suitably qualified assessor.
- Contractor laydown areas and stockpiles to be established outside of the 100m Zone of Regulation implemented around the water courses and wetlands.
- Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of all relevant zones of regulation;
- Care must be taken to ensure that all concrete mixing is done on batter boards or within suitably bunded areas and no cement laden run-off may enter into the preferential surface flow pathway or the downstream ephemeral stream;
- Permit only essential construction personnel within 32m of all riparian systems;
- Restrict construction activities to the drier summer months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time revegetation should take place allowing for a full summer growing season to become established.
- Invasive vegetation to be removed during construction to be disposed of at landfill site in such a manner that seeds must not be able to spread from the disposal site or during transportation.
- In order to access the river with the required construction equipment and activities, and upgrading of the attenuation dams, vegetation will need to be cleared. All vegetation removed must be disposed of at a suitable disposal facility.
- At no point may construction equipment stand unauthorised within or near the river.

- All excess sediment removed from the watercourses must be utilised as part of the building activities or be removed from site. At no point may this material be dumped on site or within any of the other freshwater features identified within the surrounding area. Topsoil will have a high density of alien invasive seeds which will need to be controlled into the operational phase.
- It is recommended that the upgraded attenuation dams be designed to be as natural as possible (earthed and unlined) and vegetated to function as a constructed wetland for water quality filtration.
- One culvert crossings are proposed over the river to gain access. Care must be taken when constructing the culverts to ensure that the design accommodates a 1 in 100 year flood event and that the base levels are maintained so that no erosion or ponding of water occurs surrounding the crossing.
- Soil surrounding the wingwalls must be suitably backfilled and sloped (minimum of a 1:3 ratio) and concrete aprons as well as gabion mattresses should be installed both up and downstream for energy dissipation and sediment trapping.
- All soils within the river surrounding the culvert must be loosened on completion of works to allow for revegatation.
- Should any damage occur to existing infrastructure or private property as a result of construction activities; the relevant service provider / landowner must be contacted and the repair/replacement must be commissioned to the satisfaction of the service provider / landowner. Should spillage occur, the BGCMA and DEA&DP: Pollution and chemical management directorate must be informed immediately.
- All waste generated on site shall be collected and disposed of at a registered landfill facility;
- All safe disposal certificates and waste manifests from service providers to be kept and maintained;
- All staff to receive training on correct waste management practices.
- The preferential flow pathway of the stormwater outlets to the non-perennial river should be rehabilitated into an earth stormwater swale and re-vegetated with indigenous wetland species. All stormwater swales proposed for the study area as well as the two proposed attenuation ponds should be constructed with a slope of not steeper than a 1:3 ratio and a degree of sinuosity should be re-established. The swale should be lined with rock and/or cobbles to create additional ecological habitat.

Operational Phase

- Regular inspection and maintenance of the sewer pipeline.
- Infrastructure failure reported or identified to be fixed as a priority.
- Spillage of raw sewerage to be mitigated and remediated where required.
- Should any damage occur to existing infrastructure or private property as a result of construction activities; the relevant service provider / landowner must be contacted and the repair/replacement must be commissioned to the satisfaction of the service provider / landowner. Should spillage occur, the BGCMA and DEA&DP: Pollution and chemical management directorate must be informed immediately.

Conditions for inclusion in the environmental authorisation

- Appointment of Environmental Control Officer during construction phase
- Should any damage occur to existing infrastructure or private property as a result of construction activities; the relevant service provider / landowner must be contacted and the repair/replacement must be commissioned to the satisfaction of the service provider / landowner. Should spillage occur, the BGCMA and DEA&DP: Pollution and chemical management directorate must be informed immediately.

Monitoring requirements for inclusion in the EMPr or environmental authorisation

- On-going aquatic ecological monitoring must take place on a 6 monthly basis by a suitably qualified assessor.

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APPENDIX A: ABBREVIATED CURRICULUM VITAE AND DECLARATION OF INDEPENDENCE OF FRESHWATER SPECIALIST

Name:	Nicolaas Willem Hanekom (Pri.Sci.Nat)
Profession:	Ecological Scientist
Nationality:	South African
Years experience	26 Years
Academic Qualifications	• National Diploma, Nature Conservation (Cape Technikon) • B. Tech Degree in Nature Conservation (Cape Technikon) • M.Tech in Nature Conservation (Cape Peninsula University of Technology) • Completed various Environmental Management Courses • Qualified Environmental Management System ISO 14001: 2004 Audit: Internal Auditor Course Based on ISO 19011:2002 (Centre for Environmental Management North West University)
Areas of specialisation:	• Ecosystem (terrestrial and aquatic) monitoring and assessments • Design of monitoring programmes for ecosystems (terrestrial and aquatic) • Environmental Impact Assessments • River classification and environmental water requirements • Wetlands Delineation • River and Wetlands management • Water Use Authorization Applications • Water quality management • River Health Assessments
Countries of Work Experience:	South Africa (Northern Cape, Western Cape, Free State, Mpumalanga, Gauteng)
Employment Record	• Student at Bontebok National Park (1992) • Assistant Reserve Manager at Gariep Dam Nature Reserve, Free State (1993 - 1998)

	• Reserve Manager, Conservation Services Manager for Western Cape Nature Conservation Board (1998 - 2006) • External Lecturer at Cape Peninsula University of Technology (2003 - 2005) • Director: Environmental Management at Cape Lowlands Environmental Services (2006 – 2010) • Director, Environmental Management and lead Environmental Impact Assessment Practitioner at Eco Impact (Pty) Ltd (2010 – to date)
Professional membership, accreditations and courses	• South African Council for Natural Scientists Professions Pri.Sci.Nat (Ecological Science) • Riparian vegetation identification and health assessment. Internal Western Cape Nature Conservation short course presented by Dr C Boucher (Stellenbosch University) in 2000. • SASS5 Aquatic Biomonitoring Training Course. 2 to 5 September 2013. Ground Truth Water and Environmental Engineering consultancy in partnership with the Department of Water Affairs. • Workshop on "Section 21(c) and (i) Water Use Training: Understanding Watercourses and Managing Impacts to their Characteristics". 10 May 2017. Presented by Dr Wietsche Roets of the Department of Water and Sanitation (Sub-Directorate: Instream Water Use).
Summary of experience	1992: South African National Parks. Student at Bontebok National Park with management and monitoring actions related to the Breede River. 1993 -1998: Free State Nature Conservation. Ecological management and monitoring actions related to the Gariep Dam, Orange and Caledon Rivers. 1998 -2006: CapeNature. Ecological management and monitoring actions related to the Berg River Estuary, Verlorenvlei, Lamberts bay's Jackalsvlei, Wadrift Soutpanne, Oliphant's River mouth, Rocherpan Nature Reserve, etc. Review and assessment of EIA applications, inclusive of Freshwater ecology. Did some site visits with Department of Water Affairs and Forestry (Hester Lyons) to confirm the presence of aquatic ecological features during EIA water use registration applications. 2006 to date: Cape Lowland Environmental Services and Eco Impact Legal Consultant. Ecological (Freshwater and aquatic) Specialist input, assessment, monitoring and reports.
Publications and assessment reports	Just to name a few. Was involved in many Ecological Assessments, monitoring and inputs in EIA applications. • Elandskloof Farm 475 Citrusdal Biodiversity Baseline Survey. August 2010. This Biodiversity Assessment Covering Terrestrial and Aquatic Aspects to Inform Decisions Regarding The Proposed Elandskloof Weir Flood Damage Project On Farm 475, In The Citrusdal Area. • Cape Solar Energy Electricity Generation Facility. Farm 187/3 & 187/13 Kenhardt. Biodiversity And Ecological Baseline Survey. January 2011. (Included Terrestrial and aquatic ecological assessments and water use authorization applications) • Prieska Photvoltaic Power Generation Project. Prieska Commonage Northern Cape. Biodiversity And Ecological Baseline Survey. July 2011. (Included Terrestrial and aquatic ecological assessments and water use authorization applications)

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