FRESHWATER RESOURCE VERIFICATION AND OFFSET REQUIREMENTS CALCULATION FOR THE PROPOSED EXTENSION OF ERICA DRIVE FROM BELHAR TO OAKDENE AND DUALLING OF ERICA DRIVE / BELHAR MAIN ROAD, EAST OF REUTER STREET, OVER THE KUILS RIVER, WESTERN CAPE

Prepared for

Eco Impact Legal Consulting (Pty) Ltd

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Shallow interflow	The lateral movement of water, usually derived from precipitation that occurs in the upper part of the unsaturated zone between the ground surface and the water table. This water generally enters directly into a wetland or other aquatic ecosystem, without having occurred first as surface runoff, or it returns to the surface at some point down-slope from its point of infiltration.
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.
Watercourse:	In terms of the definition contained within the National Water Act, 1998 (Act 36 of 1998) a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks.
Wetland:	"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

1. INTRODUCTION

In August 2018 Scientific Aquatic Services (SAS) was requested to undertake a peer review of the specialist freshwater assessment and DWS Risk Assessment Matrix undertaken by Eco Impact Legal Consulting (Pty) Ltd in 2017 for the proposed extension of Erica Drive, from Belhar to Oakdene, over the Kuils River, Western Cape[1]. According to the Freshwater Assessment Report undertaken by Mr. N Hanekom (2017), it was recommended that a wetland offset be undertaken to compensate for the loss of the identified wetlands as a result of the proposed extension. During the public participation process, CapeNature agreed that a wetland offset would be acceptable.

SAS was therefore appointed to verify and delineate the natural wetlands as identified within the Freshwater Assessment Report (Hanekom, 2017) and determine the eco-services, Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of these wetlands, in order to ultimately determine the wetland offset requirements.

The proposed Erica Drive / Belhar Main Road extension is approximately 3.24km in length. Erica Drive will link the R300 roadway with an interchange which gives access to the north only. The first section of Erica Drive between Belhar Drive and New Nooiensfontein Road will be known as Erica Drive, and the section between New Nooiensfontein Road and Highbury Road will be known as Belhar Main Road. The planned road is a dual carriageway with a median that varies in width between 2m and 5m. The planned cross-section comprises two 3.4m lanes; a 2.4m surfaced shoulder and a 0.3m channel on both the shoulder side and median side per direction of travel. Thus a 9.8m kerb to kerb width per direction is required. The construction footprint for the entire project is approximately 12.5ha. The proposed extension of Erica Drive and dualling of Erica Drive will hereafter collectively be referred to as the "linear development" (Figure 1 and 2).

In order to identify all potential freshwater resources that may potentially be impacted by the proposed linear development, a 500m "zone of investigation" around the linear development, in accordance with Regulation 509 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998) (NWA), was used as a guide in which to assess possible sensitivities of the receiving environment. This area – i.e. the 500m zone of investigation around linear development - will henceforth be referred to as the "investigation area".

1.2 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 linear development, as identified within the Freshwater Assessment Report (Hanekom, 2017). The Kuils River was not assessed as part of this investigation;
- 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 not ground-truthed, however, the general surroundings were considered during the desktop assessment;
- Most areas surrounding the linear development have undergone significant anthropogenic changes (such as infilling, disposal of rubble and road crossings) 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

[1] Freshwater Ecological Impact Assessment. Proposed extension of Erica Drive, Belhar to Oakdene over the Kuils River. Eco Impact Legal Consulting (Pty) Ltd (2017).

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; and
- 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.

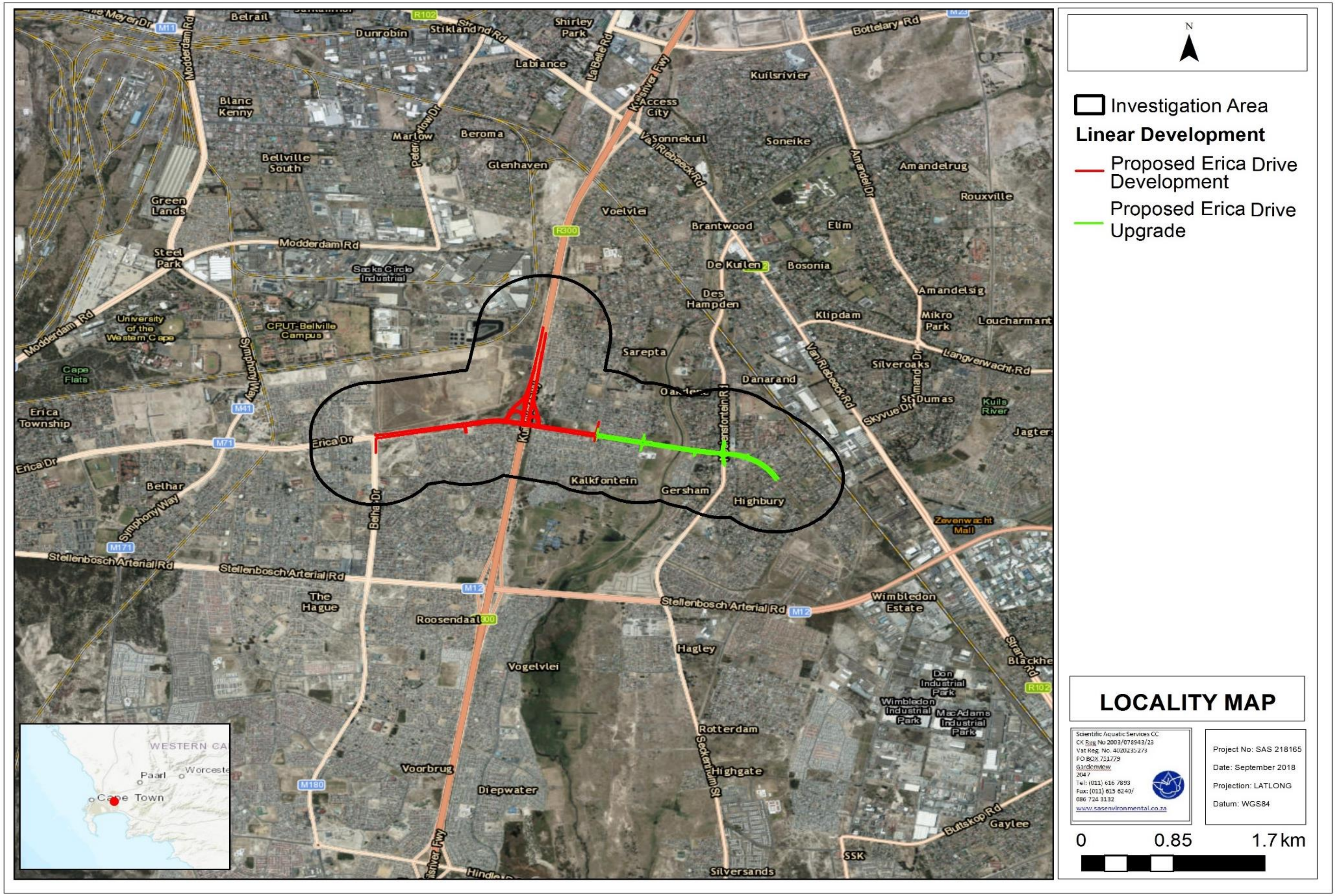


Figure 1: Digital satellite image depicting the linear development in relation to the surrounding areas.

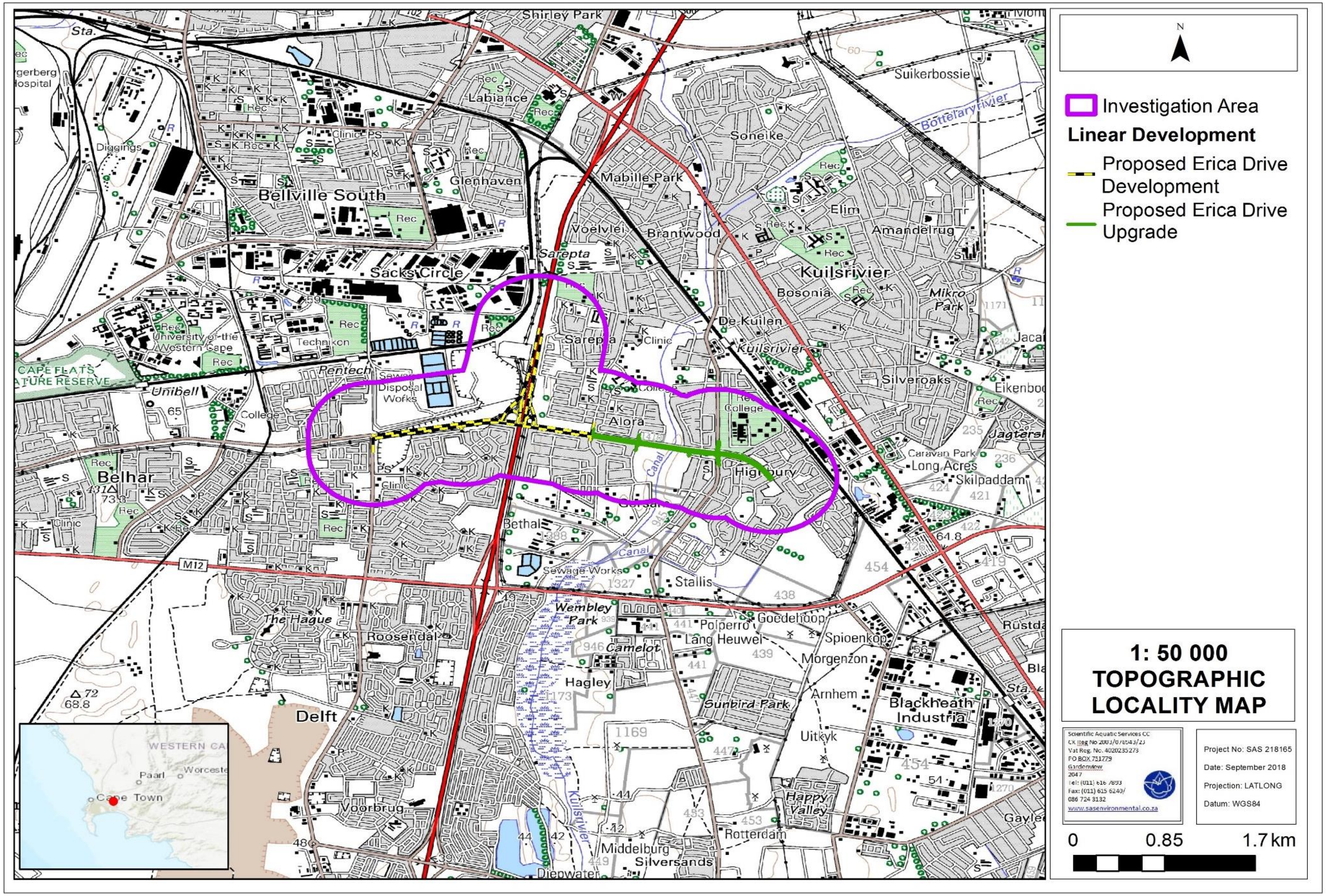


Figure 2: Location of the linear development depicted on a 1:50 000 topographical map, in relation to surrounding areas.

2. RESULTS OF THE DESKTOP ANALYSIS

2.1. Analyses of Relevant Databases

Use was made of aerial photography, digital satellite imagery, and available provincial and national wetland databases to identify points of interest prior to the field survey. Freshwater resources often display a diversity of digital signatures that can be used to assist the field verification.

The following table contains data accessed as part of the desktop assessment and presented as a "dashboard-style" report below (Table 1). It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the subject property's actual site characteristics at the scale required to inform the environmental authorisation and/or water use authorisation processes, however, this information is considered to be useful as background information to the study. This data was therefore used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance during the site-specific field verification survey.

Table 1: Desktop data relating to the characteristics of the wetlands associated with the linear development.

Aquatic ecoregion and sub-regions in which the linear development is located	
Ecoregion	South Western Coastal Belt
Catchment	Berg
Quaternary Catchment	The western portion of the linear development is situated within G22C while the eastern portion is situated within G22E (Figure 4)
WMA	Berg
subWMA	Greater Cape Town

Dominant characteristics of the South Western Coastal Belt Ecoregion Level II (24.03) (Kleynhans *et al.,* 2007)	
Dominant primary terrain morphology	Moderately undulating plains
Dominant primary vegetation types	Dune Thicket, West Coast Renosterveld, Strandveld Succulent Karoo
Altitude (m a.m.s.l)	0 – 100
MAP (mm)	100 – 400
The coefficient of Variation (% of MAP)	30 – 40
Rainfall concentration index	50 – 60
Rainfall seasonality	Winter
Mean annual temp. (°C)	16 – 18
Winter temperature (July)	6 – 20
Summer temperature (Feb)	14 – 30
Median annual simulated runoff (mm)	<5 – 60

Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	G22E – 09207 (Kuils River)
Proximity to linear development	Traversed by linear development
Assessed by an expert?	Yes
PES Category Median	E (Seriously Modified)
Mean EI Class	Moderate
Mean ES Class	High
Stream Order	2
Default Ecological Class (based on median PES and highest EI or ES mean)	B (High)

Detail of the linear development in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The linear development is located within a sub-quaternary catchment currently not considered important for fish or freshwater resource conservation.
NFEPA Wetlands	According to the NFEPA Database, the linear development is not associated with any wetland features. An artificial flat wetland is situated approximately 175m north of the linear development (Figure 4)
Wetland Vegetation Type	The western portion of the linear development is situated within the Western Strandveld (Endangered), while the eastern portion is situated within the Southwest Sand Fynbos (Least Threatened). The threat statuses are provided by Mbona *et al.* (2014) (Figure 5)
NFEPA Rivers	The proposed Erica Drive Upgrade portion of the linear development traverses the Kuils River. According to the NFEPA Database, the Kuils River is considered largely modified (Class D) (Figure 4).

Importance of the linear upgrade according to the City of Cape Town Wetlands (2017)
According to the City of Cape Town Wetlands Database, the linear development traverses several natural or semi-natural seep wetlands and a natural or semi-natural depression wetland, and there are numerous seep wetlands within the investigation area. All of the wetlands traversed by the linear development and situated within the investigation area were categorised as a Critical Ecological Support Areas (CESA). CESAs are high ranking artificial wetlands or middle ranking natural or semi-natural wetlands and are wetlands that are considered important for connectivity or as support areas for CBA wetlands. CESA wetlands should be managed as close to natural or near natural states as possible (Figure 6 – 8).

CBA = Critical Biodiversity Areas; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Meters Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; WMA = Water Management Area

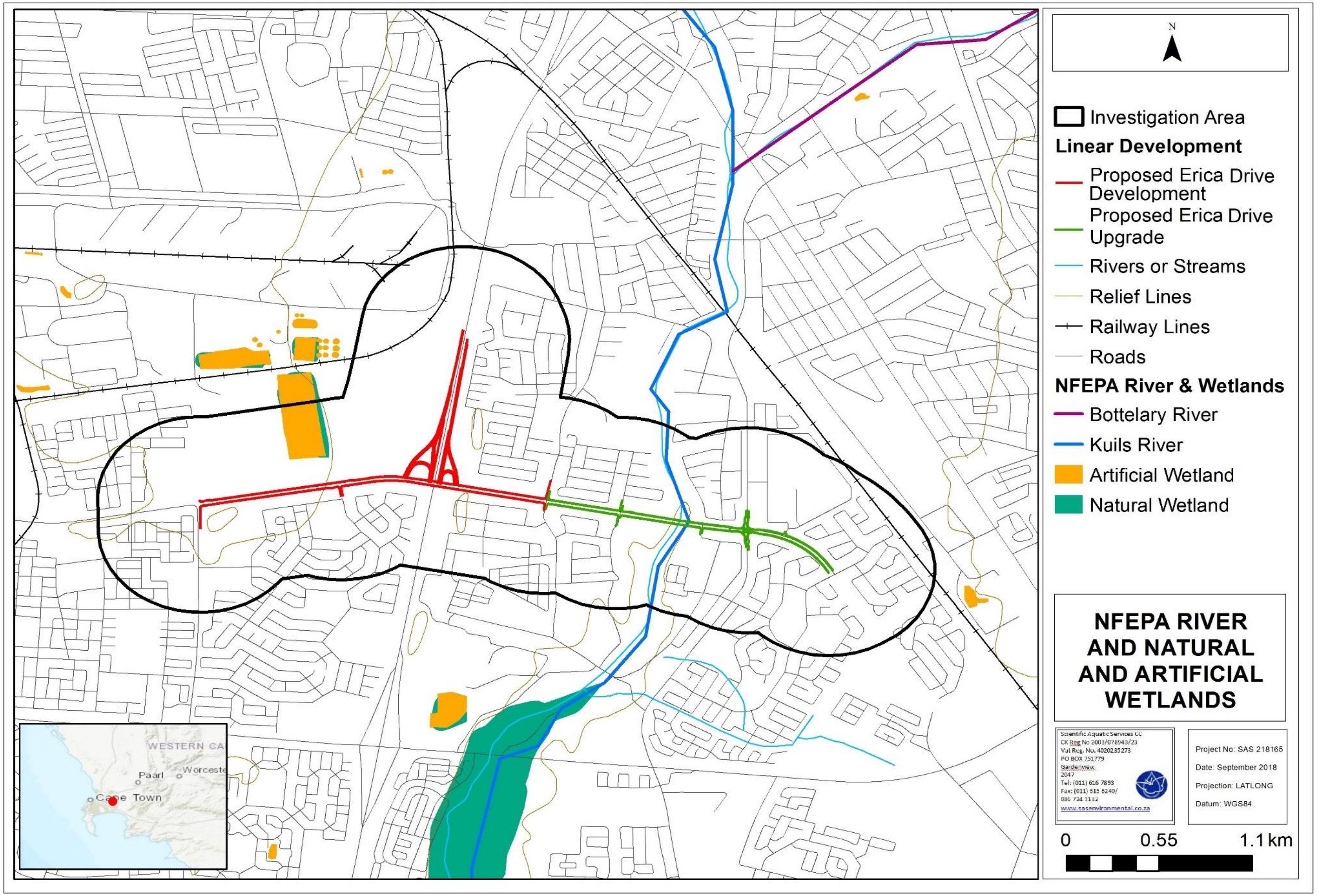


Figure 3: Rivers and natural and artificial wetlands associated with the linear development according to the NFEPA database (2011).

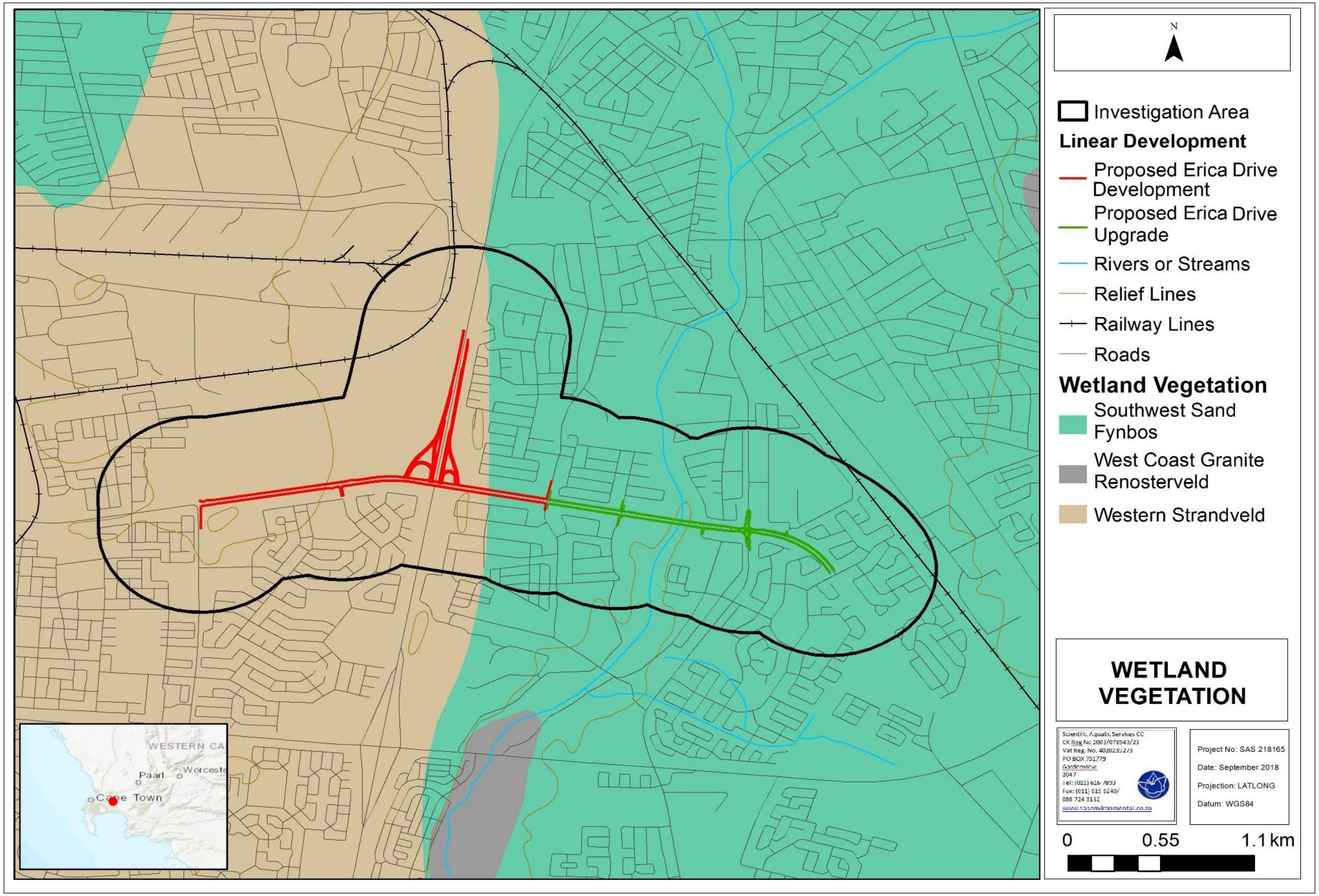


Figure 4: Wetland Vegetation Types associated with the linear development according to the NFEPA database (2011).

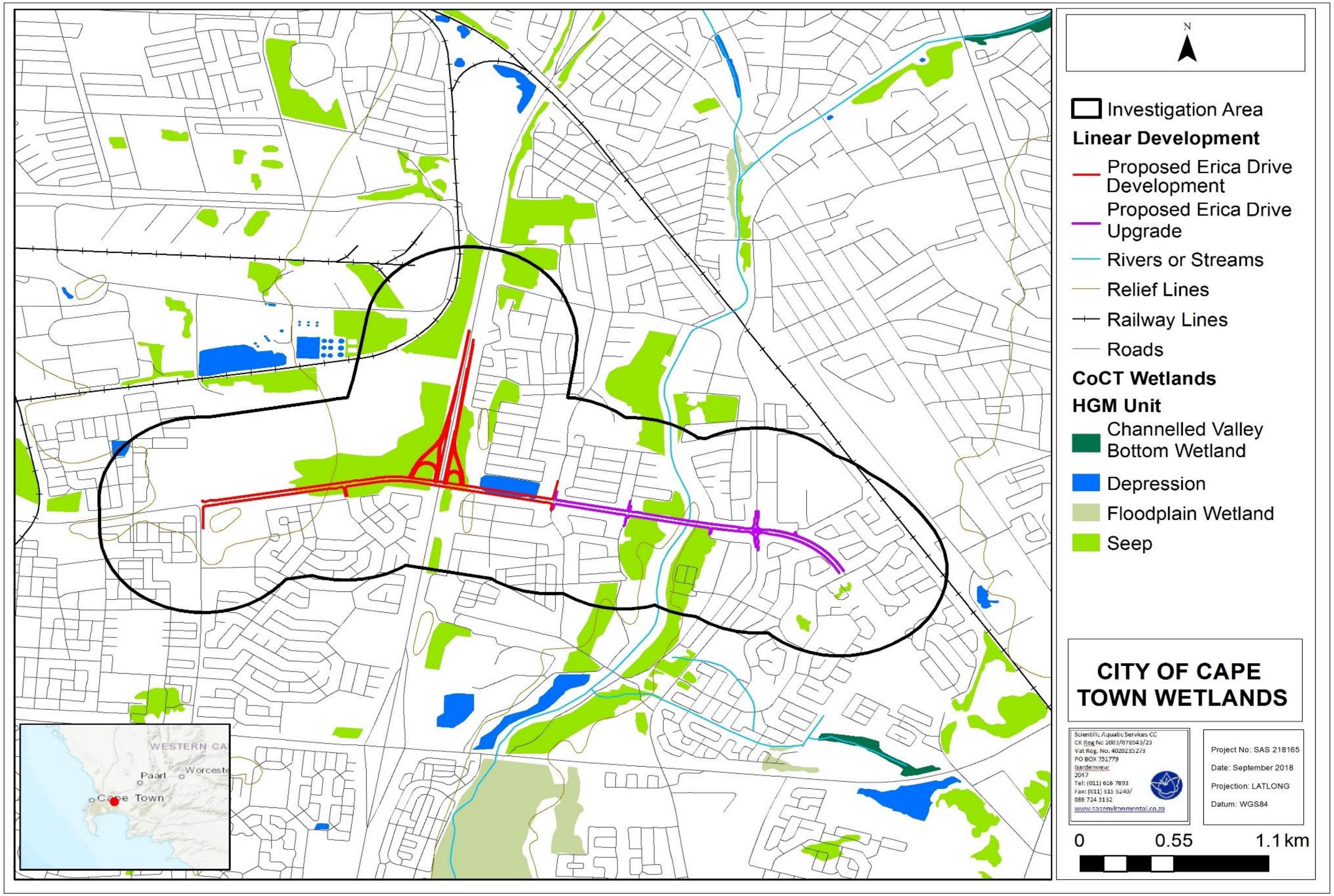


Figure 5: Different hydrogeomorphic (HGM) units associated with the linear development according to the City of Cape Town Wetlands (2017).

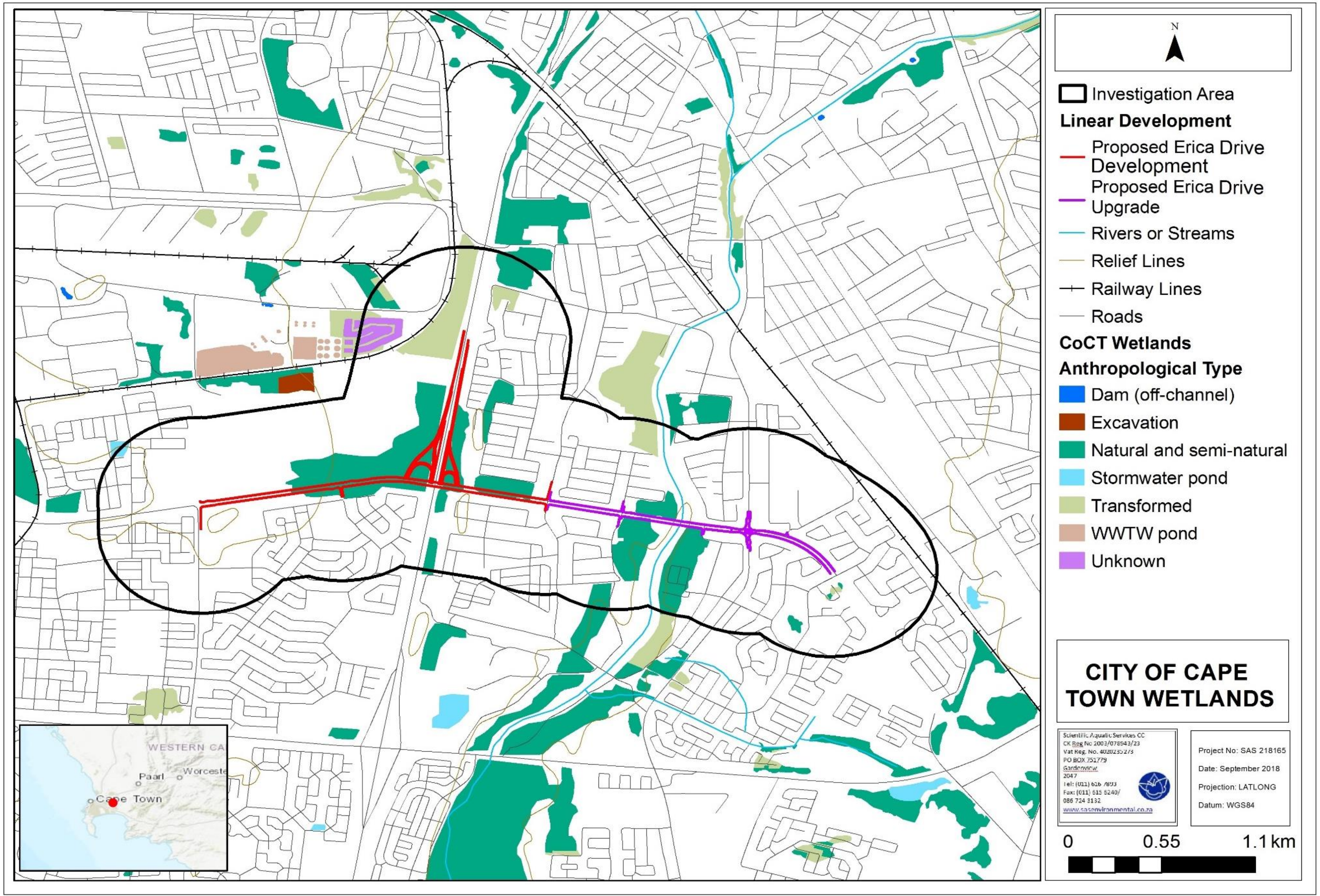


Figure 6: Natural and transformed wetland features associated with the linear development according to the CoCT Wetlands database (2017).

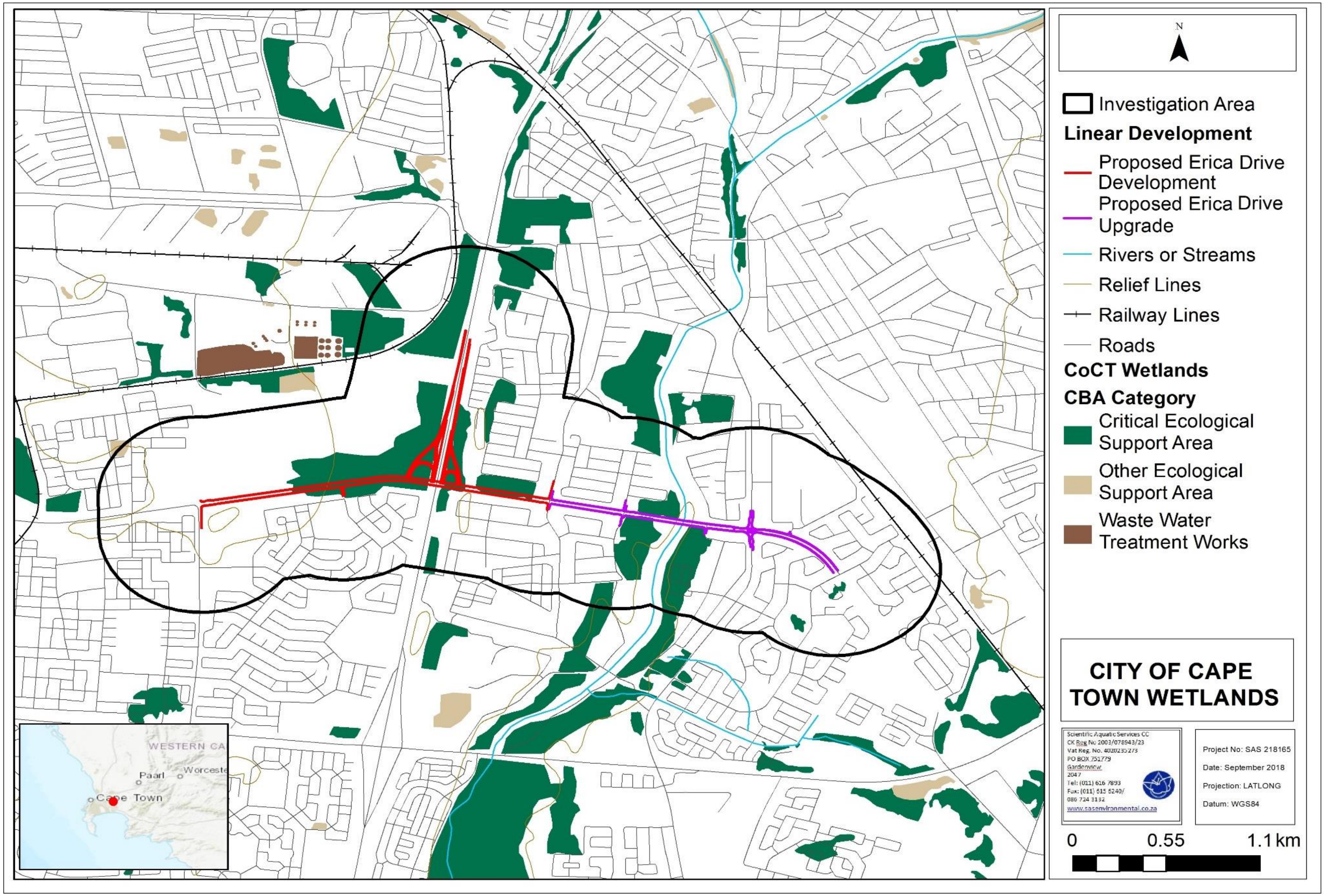


Figure 7: CBAs and ESAs associated with the linear development according to the CoCT Wetlands database (2017).

2.2. Ecological Status of Sub-Quaternary Catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database]

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.

Key information on background conditions associated with the study area, as contained in this database and pertaining to the PES and EIS for the SQR G22E – 09207 (Kuils River) is tabulated in Table 2 and indicated in Figure 8 below.

The Ecological Importance (EI) data for SQR G22E – 09207 (Kuils River) indicates that *Galaxias zebratus* is likely to be present at this site.

The Ecological Importance (EI) data for SQR the Kuils River (G22E – 09207) indicates that the following macro-invertebrate taxa are expected to occur at this site:

Aeshnidae	Gerridae	Notonectidae
Baetidae 1 Sp	Gomphidae	Oligochaeta
Baetidae 2 Sp	Hirudinea	Physidae
Belostomatidae	Hydracarina	Planorbinae
Ceratopogonidae	Hydrophilidae	Pleidae
Chironomidae	Hydropsychidae 1 Sp	Simuliidae
Coenagrionidae	Libellulidae	Thiaridae
Corixidae	Lymnaeidae	Turbellaria
Culicidae	Muscidae	Veliidae/Mesoveliidae
Dytiscidae	Naucoridae	

Table 2: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR G22E – 09207 (Kuils River) based on the DWS RQS PES/EIS database

	G22E – 09207 (Kuils River)
Synopsis	
PES Category Median	Serious Modification (Class E)
Mean EI class	Moderate
Mean ES class	High
Length	21.88
Stream order	2
Default EC[4]	B (High)
PES Details	
Instream habitat continuity MOD	Large
RIP/wetland zone continuity MOD	Large
Potential instream habitat MOD activities	Serious
Riparian/wetland zone MOD	Serious
Potential flow MOD activities	Critical
Potential physico-chemical MOD activities	Critical
EI Details	
Fish spp/SQ	1.00
Fish average confidence	1.00
Fish representativity per secondary class	Very Low
Fish rarity per secondary class	False
Invertebrate taxa/SQ	29.00
Invertebrate average confidence	4.38
Invertebrate representivity per secondary class	Moderate
Invertebrate rarity per secondary class	Very High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	Very High
Habitat diversity class	Low
Habitat size (length) class	High
Instream migration link class	Moderate
Riparian-wetland zone migration link	Moderate
Riparian-wetland zone habitat integrity class	Low
Instream habitat integrity class	Low
Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m	High
Riparian-wetland natural vegetation rating based on expert rating	Very High
ES Details	
Fish physical-chemical sensitivity description	Moderate
Fish no-flow sensitivity	Moderate
Invertebrates physical-chemical sensitivity description	Moderate
Invertebrates velocity sensitivity	Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Very High
Stream size sensitivity to modified flow/water level changes description	Low
Riparian-wetland vegetation intolerance to water level changes description	High

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

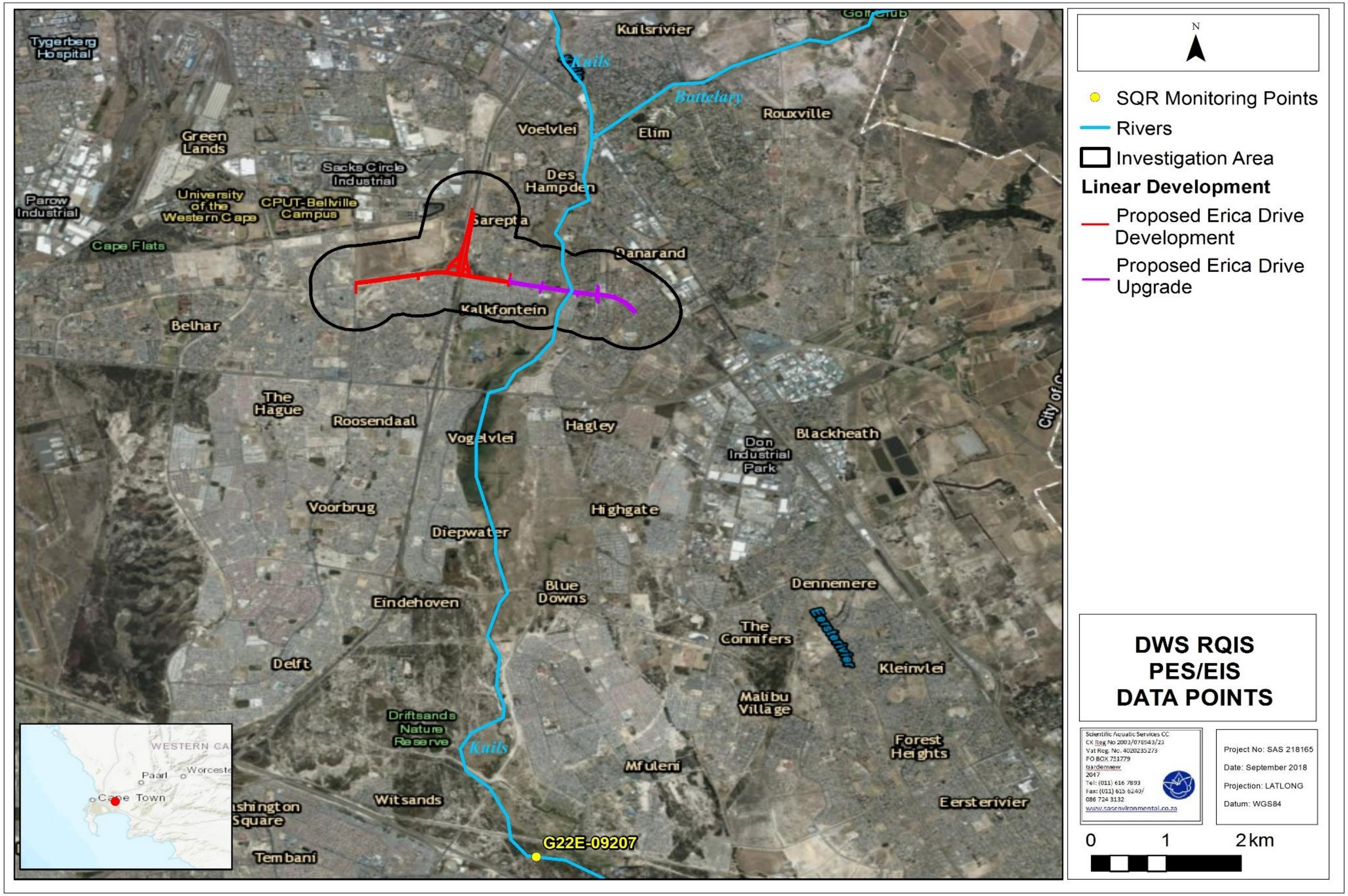


Figure 8: Relevant Sub-Quaternary Catchment Reach (SQR) in the vicinity of the linear development

3. SITE VERIFICATION RESULTS

A site visit was undertaken on the 18^{th} of September 2018, during which the presence of any areas representing wetland characteristics, as defined by the Department of Water and Forestry (DWAF) (2008) as defined by the National Water Act, 1998 (Act 36 of 1998), were identified. The field assessment also included the verification of the identified and delineated wetland areas as indicated within the Freshwater Assessment Report (Hanekom, 2017) (Figure 10).

During the field assessment, the following indicators were used to delineate the boundaries of the freshwater resources:

- Terrain units are used to determine in which parts of the landscape a freshwater resource (including wetlands) was most likely to occur;
- Obligate and facultative wetland species such as *Typha capensis, Pennisetum macrourum* or *Phragmites australis* could be used in conjunction with terrain units as well as the point where a distinct change in the vegetation composition was observed to determine the various freshwater resource boundaries. Obligate species are almost always found in a freshwater resource (>99% of occurrences), while facultative species are usually found in a freshwater resource (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 and/or saturated soils can be used to determine if there is a permanent zone and to define the outer boundaries (temporary zone) of the freshwater resource; and
- Soil form indicators are used to determine the presence of soils that are associated with prolonged and frequent saturation and a fluctuating water table within 50 cm of the land surface.

It should be noted that for an area to be identified as a freshwater resource, at least two (2) of the above indicators should be present (*Pers Comm Prof. F. Ellery*).

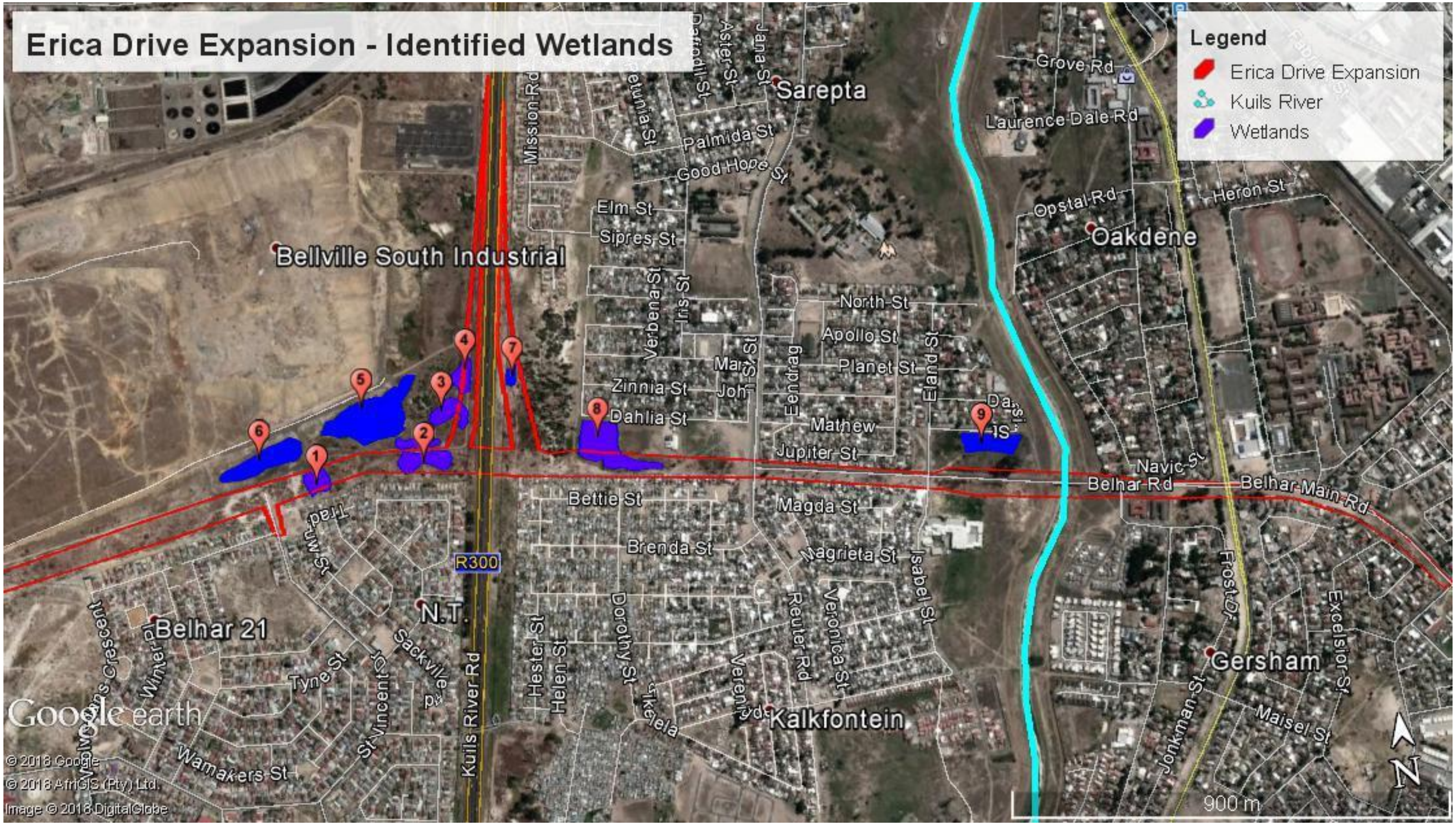


Figure 9: Wetlands identified within the Freshwater Assessment Report by Hanekom (2017).

3.1. Key Observations

1. The area surrounding the proposed new portion of Erica Drive, which is to be developed (western portion of the linear development), is considered to be significantly disturbed by anthropogenic activities. Such activities include the development of the Bellville South Industrial waste disposal site (north of the proposed Erica Drive portion), the excavation and shaping of informal roads within the surrounding area and the infilling and the disposal of household refuse.
2. According to the Freshwater Assessment Report (Hanekom, 2017), the western portion of the linear development has eight wetland features (As per Figure 10, numbered 1 – 8). During the field assessment, undertaken in September 2018, only one of the previously identified wetlands in the western portion of the proposed development route (approximating 0,48ha in extent) was considered to be natural and can be classified as a wetland flat (as per Figure 10, wetland number 2).
3. Wetland number 9 (as per Figure 10) located within the eastern portion of the linear development was also identified to be a natural system during the recent field verification (approximating 0,38ha in extent) and was also classified as a wetland flat.
4. The remaining areas previously identified as wetlands (Hanekom, 2017) were confirmed during the recent field verification to be artificially impounded areas or highly disturbed areas, where opportunistic invasive reed species (such as *Arundo donax*) have established due to water ponding within these excavated areas (Figure 11).

Figure 10: (Left) Wetland 6, as identified within the Freshwater Assessment Report, identified as an artificially dammed area. A waste disposal site is located north of this feature. (Right) Wetland 7, as identified within the Freshwater Assessment Report, is considered artificial. This is a zone of artificial ponding in which runoff water from the R300 collects, as a result of the altered topography in the vicinity of the road.

Figure 12 provides a visual representation of the locality of the two natural wetlands identified along the proposed linear development. Table 3 and 4 below summarises the findings of the field verification and that of the Freshwater Assessment Report (Hanekom, 2017) regarding relevant aspects (hydrology, geomorphology and vegetation components) for these two wetlands. Due to the significant disturbance to both of these wetlands and their close proximity to the surrounding high-density urbanisation , it is not expected that any Species of Conservation Concern (SCC) would be found within these wetlands. On review of the proposed linear development alignment in relation to the natural wetlands identified (Figure 12), it was determined that only the western wetland flat will be impacted upon and require an offset (Section 4 and 5). The remaining eastern wetland flat, although within close proximity will remain intact, provided suitable mitigation measures are implemented.

The details pertaining to the methodology used to assess the various assessments are available in **Appendix A** of this report.

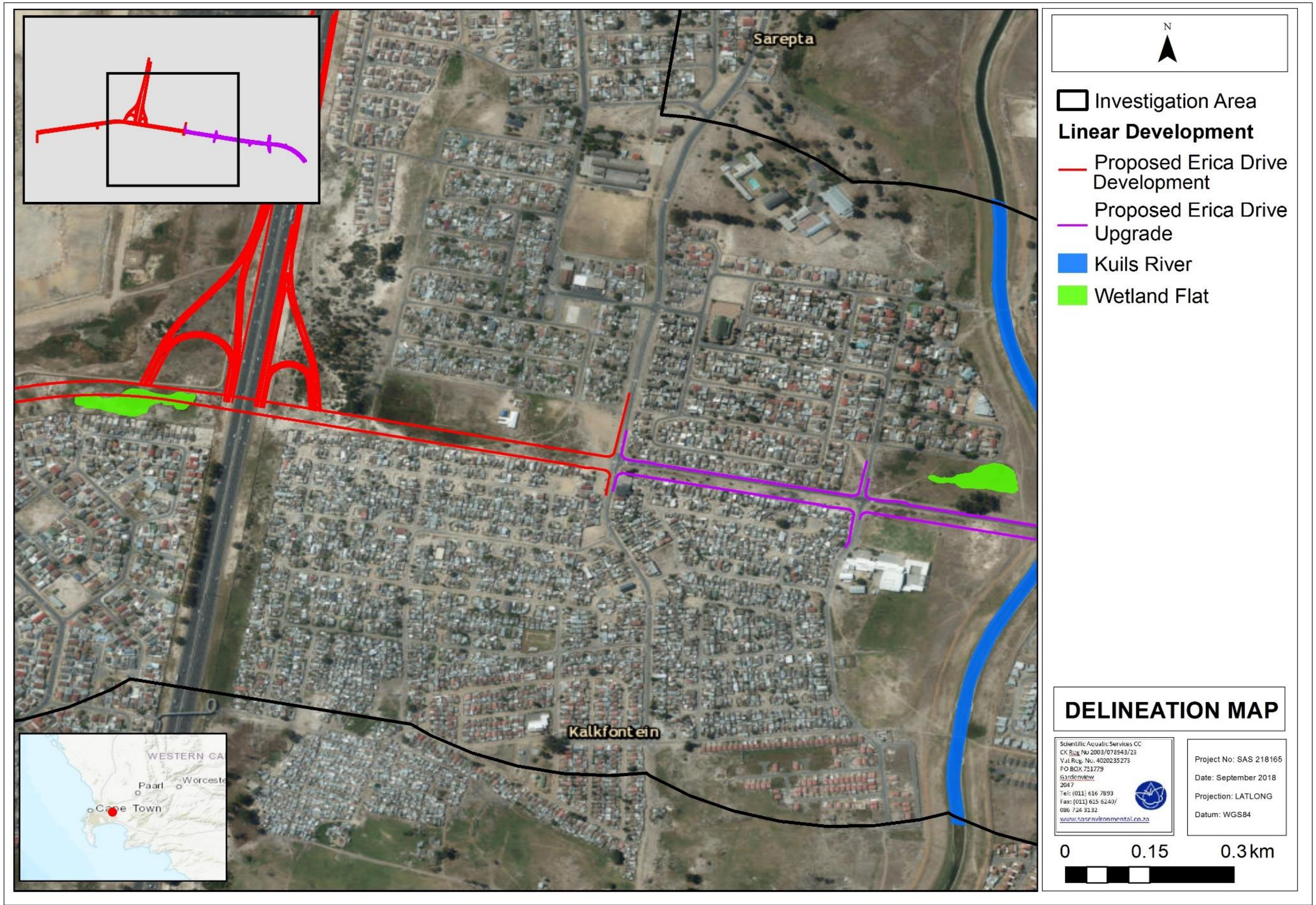
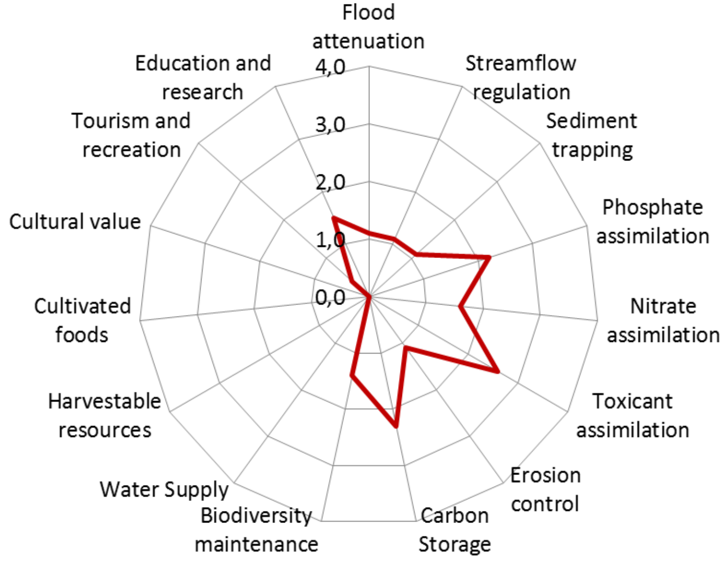


Figure 11: The locality of the identified wetlands in relation to the proposed linear development.

Table 3: Summary of the assessment of the wetland flat, located along the western portion of the proposed linear development.

Ecological & socio-cultural service provision graph:



Photograph notes	This wetland is highly disturbed, with infilling visible within the true extent of the wetland. No remnants of the Strandveld Wetland Vegetation Type were evident, as this wetland mainly comprises of the *Ficinia* sedge species, *Zantedeschia aethiopica*, and common weed species such as *Oxalis purpurea* and *Cotula tubinata.* Alien and invasive tree species *Acacia saligna* were also present within the wetland and the surrounding terrestrial area.

HGM Unit Description	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 (Ollis *et al.,* 2013).
PES discussion	**PES Category: D (Largely Modified)** As per the Freshwater Assessment Report (Hanekom, 2017), this wetland is considered to be largely modified, mainly due to the

Watercourse characteristics:

a) Hydraulic regime

Due to the severe transformation of the topography of the surrounding landscape, the hydrological regime of this wetland has also been impacted. It is assumed that the primary source of hydrology for this wetland is shallow interflow, of which a shallow confiding layer perches the shallow interflow, to which a wetland response has formed. Infilled areas allow for surface runoff to enter this wetland, changing the flow patterns and the inundation period of this wetland.

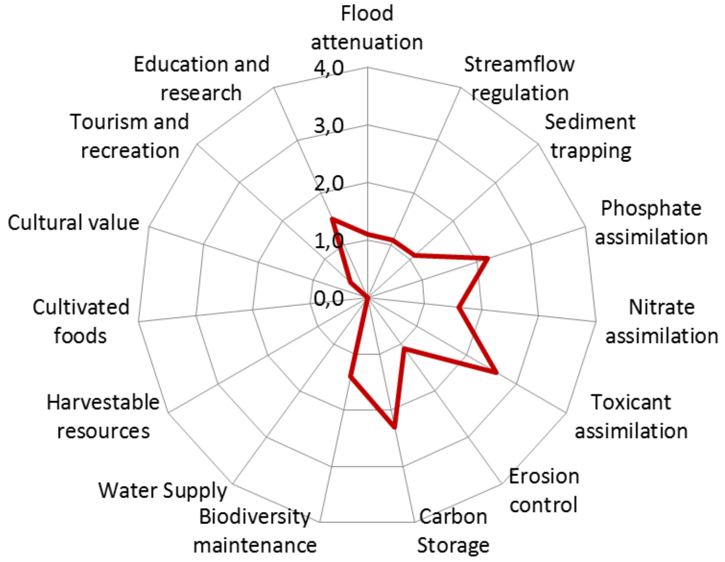
<table>
<tr><td></td><td>surrounding anthropogenic impacts which have degraded the overall habitat integrity and hydrological regime of the wetland.</td><td rowspan="3">b) Water quality
Due to runoff from the adjacent waste disposal site entering this wetland, the water quality can be considered to be of poor quality.

c) Geomorphology and sediment balance
Changes to the geomorphological processes of this wetland and its surrounding area has impacted on not only the hydrological regime of this wetland but also on the extent and inundation zones thereof. The mostly bare landfill located north of this wetland contributes sediment to this wetland.

d) Habitat and biota
The vegetation composition has been critically modified through the removal of indigenous wetland species, mainly due to the construction of informal roads, residential areas and powerline infrastructure within close proximity to the wetland. The proliferation of alien and invasive plant species such as Acacia saligna and Pennisetum clandestinum as well as a large variety of other weed and grass species, indicative of disturbed areas, were also evident. No endangered species were identified during the site visit, but the system may provide suitable breeding habitat for various common avifaunal and amphibian species.</td></tr>
<tr><td>Ecoservice provision</td><td>Ecoservice: Moderate
The wetland provides moderate services in terms of trapping and removing of phosphates, nitrates and toxicants. It also offers moderate services in terms of controlling erosion and attenuating floods (mainly due to the high surface roughness provided by the vegetation).</td></tr>
<tr><td>EIS discussion</td><td>EIS Category: Moderate
This wetland is considered to be of moderate ecological importance and sensitivity, primarily due to its status as a Critical Ecological Support Area (identified on the Western Cape Biodiversity Spatial Plan (2017) database in Figure 8) as well as its location within the Endangered Western Strandveld Wetland Vegetation Type (although no remnants of this vegetation type were observed during the field assessment).</td></tr>
<tr><td>Business Case and Wetland Offset Outcome</td><td colspan="2">As the proposed linear development does traverse this wetland, 0,28 ha will be lost.
It is therefore required that an offset investigation be undertaken to ascertain the functional habitat hectare equivalents that must be conserved by the proponent to account for the above-mentioned residual wetland loss.
From the offset requirement calculations, it was determined that 0,2 functional hectare equivalents and 0,7 habitat hectare equivalents of wetland area need to be conserved to offset the loss of the 0,28 hectares of wetland eco-services and ecosystem conservation value in the catchment.
It is therefore proposed that an assessment be undertaken to identify and assess feasible receiving wetlands to offset the hectare equivalents lost. Due to the lack of feasible wetlands within close proximity to this wetland, offsite offsetting is deemed necessary.</td></tr>
</table>

Table 4: Summary of the assessment of the wetland flat, located along the eastern portion of the proposed linear development, west of the Kuils River.

Ecological & socio-cultural service provision graph:



Photograph notes	This wetland is located west of the Kuils River (blue line – left photograph). Historical infilling, potentially from the construction of the surrounding roads (Dassie Street north of the wetland; Isabel Street west of the wetland), have significantly altered the topography thereof. (Right) Disturbance to the vegetation was also evident, however, patches of the indigenous sedge species *Cyperus longus* were present.

HGM Unit Description	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 (Ollis *et al.,* 2013).
PES discussion	**PES Category: D (Largely Modified)** This wetland is also considered to be largely modified (as reported in the Freshwater Assessment Report (Hanekom, 2017). Impacts on this wetland are related to the construction of the surrounding road infrastructure and the associated surface runoff entering the wetland. Informal paths and trampling by residents through the wetland, have also impacted on the vegetation component of this wetland.

Watercourse characteristics:

a) Hydraulic regime

The hydrological regime of this wetland has been impacted on by the transformed topography of both the wetland and surrounding terrestrial area. The natural drainage pattern is interrupted by heaps of infilled material, while additional surface water runoff from the road enters the wetland. This has altered the saturation zones of the wetland.

b) Water quality

The water quality of this wetland has been impacted upon to some degree, mainly due to road runoff (containing hydrocarbons and oil) entering the wetland.

<table>
<tr>
<td>Ecoservice provision</td>
<td>Ecoservice: Moderate
The wetland provides moderate services in terms of trapping and removing phosphates, nitrates and toxicants. It provides moderate services in terms of carbon storage (as evidenced by the soil organic matter during soil sampling), promoting the storage of organic carbon. However, due to the frequent human activity within the wetland and surrounding area, it is not considered to provide habitat to a variety of faunal and floral species.</td>
<td rowspan="2">c) Geomorphology and sediment balance
Since the physical landscape characteristics of this wetland have been altered, the overall change to the geomorphological features has therefore impacted on the hydrological regime and drainage patterns of the wetland. Due to the sandy nature of the surrounding terrestrial area (some of these areas are bare), a higher sediment load in this wetland is expected.

d) Habitat and biota
Large areas of natural vegetation have been replaced with Kikuyu grass (Pennisetum clandestinum), but patches of the indigenous sedge species Cyperus longus was present. Due to the lack of diversity of habitat types within this wetland, very few faunal species were noticed during the site assessment, This can also be attributed to the constant human activity within the surrounding area of the wetland.</td>
</tr>
<tr>
<td>EIS discussion</td>
<td>EIS Category: Moderate
This wetland is considered to be of moderate ecological importance and sensitivity, mainly due to its status as a Critical Ecological Support Area (identified on the Western Cape Biodiversity Spatial Plan (2017) database in Figure 8).</td>
</tr>
<tr>
<td>Business Case and mitigation measures.</td>
<td colspan="2">As this wetland would not be traversed by the proposed linear development activities, care should be taken to limit any edge effects to impact on the wetland.
The footprint of the proposed activities should be limited and no indiscriminate movement of vehicles within this wetland may be permitted.
Management of stormwater should be implemented during the construction phase of the proposed activities to prevent any additional and/or contaminated runoff from entering this wetland.

This wetland is not considered feasible to use as an offset receiving wetland due to its small size and the area in which it is located (urbanised area), which would prove challenging for the rehabilitation and management procedures to be implemented and sustained.</td>
</tr>
</table>

4. OFFSET INVESTIGATION

4.1. Mitigation Hierarchy

Offsets are applied within a mitigation hierarchy and are only aimed at mitigating or compensating for residual impacts of project development on the environment (often called "compensatory mitigation") after all appropriate and feasible steps have first been taken to avoid/prevent, minimize/reduce and remediate/rehabilitate impacts (Macfarlane D. *et al.* 2014).

- First, the proposed development should try to **avoid or prevent** negative impacts on biodiversity and ecosystem services by seeking alternative types of development, or alternative locations, different scales of development, different layouts and siting of development components, etc.;
- Secondly, if the above-mentioned alternatives have been exhausted, every effort should be made to **minimize negative impacts** and to rehabilitate or remediate affected areas; and
- 'Residual impacts' are what will remain after **minimizing impacts and rehabilitation**. These residual impacts would then need to be compensated for, and this may involve the specific application of an offset.

4.2. General Offset Guidelines

The South African National Biodiversity Institute (SANBI, 2004) defines biodiversity offsets as "*measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken*."[2]

Regarding the Provincial Guideline on Biodiversity Offsets (Western Cape; 2007), the significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss of irreplaceable biodiversity, the residual impacts should be considered to be of *very high significance* and when residual impacts are considered to be of *very high significance*, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have *medium to high significance*, an offset initiative may be investigated. If the residual biodiversity impacts are considered of *low significance,* no biodiversity offset is required.[3]

During 2005 the Department of Environmental Affairs and Development Planning (DEA&DP) started a process to develop a guideline on biodiversity offsets. Currently, in South Africa, only the Western Cape and KwaZulu Natal have provincial guidelines on biodiversity offsets. No guidelines or regulations relating to biodiversity offsets are formally written for the remainder of the South African provinces.

Nonetheless, biodiversity offset strategies are starting to increase in number within South Africa and although thought of as a "last resort" to counteract the cumulative impacts on biodiversity, do have the potential to increase the future value of biodiversity within a region. The increase in attempts to offset residual impact, ultimately led to the release of a *Provincial Guideline on Biodiversity Offsets* in October 2007 for the Western Cape. Recently the *Draft Best Practice Guideline for South Africa* specifically focused on wetland offsets was released by Department of Water and Sanitation (DWS) in collaboration with SANBI (Macfarlane D. *et al* 2014).

The significance of a residual negative impact on biodiversity is heavily influenced by the characteristics of the receiving environment, for example, if an area is identified in a bioregional plan or fine scale biodiversity plan as a Critical Biodiversity Area (CBA), a priority site, a listed protected area, a threatened ecosystem or habitat containing threatened species or special habitat (Macfarlane D. *et al.* 2014).

Biodiversity offsets generally target features or areas with similar biodiversity ("like for like" concept) as that residually impacted by development but may target features or areas with biodiversity of higher

[2] Business and Biodiversity Offsets Programme (BBOP). 2009. *Biodiversity Offset Design Handbook*. BBOP, Washington, D.C.
[3] Provincial Guideline on Biodiversity Offsets, Western Cape, 2007.

conservation significance. According to "*Towards a best-practice guideline for wetland offsets in South Africa*" (Macfarlane D. *et al.* 2014) the goals of wetland offsets in South Africa are as follows:

- Provide appropriate and adequate compensation for residual impacts on key water ecosystem services and contribute to achieving water resource objectives (including both Water Resource Management and Water Resource Quality Objectives) by:
  - Ensuring "no net loss" in the overall wetland functional area by providing gains in wetland area and/or conditions equal to or greater than the losses due to residual impacts;
  - Directing offset activities that will improve key regulating and supporting services towards those wetlands where these specific services can best be enhanced, and where these offset activities will contribute best to achieving water resource objectives including both Water Resource Management and Quality Objectives; and
  - Providing 'in kind' services through offset activities, or substitute services acceptable to affected communities, for residual impacts on direct (provisioning or cultural) services, to ensure that these communities are at least as well off as before the development taking place.
- Secure formal protection of wetland systems in good condition to contribute to meeting national biodiversity and protection targets for the representation and persistence of different wetland types, thereby ensuring that cumulative impacts of increased water use, development authorisation and land use change do not jeopardise the ability to meet the country's targets; and
- Adequately compensate for residual impacts on threatened or otherwise important (e.g. wetland-dependent) species through appropriate offset activities that support and improve the survival and persistence of these species.

4.3. Wetland Specific Offset Guidelines

The offset ratios as defined by DEA&DP (2011) were refined in the draft wetland offset calculator specifically pertaining to wetland offsets (Macfarlane D. *et al.* 2014). The wetland offset calculator was designed to guide the criteria and importance of wetland habitat regarding water resource and ecosystem value, ecosystem conservation and presence of species of conservation concern, at the end providing hectare equivalents representative of the wetland that requires an offset. The wetland offset calculator was used during the determination of this development offset.

Hectare Equivalents: To enable the quantification of an appropriate offset, it is important to establish a unit or measurement that will allow for losses (due to the proposed impacts) and gains (due to the proposed offset) in wetland / biodiversity values to be assessed. This is central to the concept of offsets, and the goal of achieving no net loss. In the past, the area of wetland affected (as measured in hectares, for example) was a commonly used 'currency' and is still used in many instances. However, the approach taken in these guidelines which is based international best practice, shows that a more refined "currency" that better incorporates a measure of ecological function, quality, and/or integrity. The basic "hectare equivalents" used in these guidelines are a combination of area impacted and the change in condition or functionality. These basic values are modified based on the significance of the feature being impacted (in the case of the calculation of the required offset) or the quality of the offset achieved (in the case of the offset receiving calculation). This currency ('hectare equivalents') is used as a surrogate for residual loss and has been adopted as the primary currency for evaluating impacts to wetlands as a result of the proposed development.

Where a wetland offset is deemed appropriate, various actions may be used to deliver the required outcomes. These actions can be broadly grouped into the different categories listed below as provided by Macfarlane D. *et al.* 2014.

- **Protection**: This refers to the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under the National Environmental Management: Protected Areas Act, 2014 (Act 21 of 2014), a legally binding conservation servitude, or a long-term Biodiversity Agreement under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) and putting in place appropriate management structures and actions. This may include setting appropriate water reserve determinations and specifying protection measures within DWS planning instruments. Furthermore, the inclusion of offset sites into appropriate land use zones and land use plans, including provincial and local conservation plans, ensure that conservation outcomes are secured and maintained in the long-term. In light of the high regional rate of loss of wetlands and associated biodiversity, protection is necessary for any wetland offset, irrespective of the means used to deliver the “no net loss” outcome (i.e. rehabilitation, or other activities that compensate for wetland degradation or loss). It is important to recognise that increased protection (especially at a catchment level) greatly improves the chance of long-term persistence of wetland function and biodiversity, and therefore contributes to “no net loss” objectives. As protection increases the current "value" of a wetland system, it is important that the offset mechanism fully recognises the benefits associated with increased protection in reducing the potential for long-term loss and adding to the overall conservation estate, in line with national conservation goals and targets;

- **Averted loss*:*** This refers to physical activities which prevent the loss or degradation of an existing wetland system, its ecosystem services and its biodiversity, where there is a demonstrated threat of decline in the system’s condition, ability to provide ecosystem services or support overall Water Resource Objectives (both quality and quantity). This would apply in situations where a wetland head-cut[4] is stabilised to prevent an erosion gully from propagating further into the wetland, where excessive sediment inputs are prevented from entering a wetland through the stabilization of erosion dongas alongside the wetland or by creating structures to trap such sediment before reaching the wetland, or where there is significantly improved management of a wetland (e.g. reduced grazing pressure or control of invasive aliens impacting on wetland ecosystem functioning). These actions can, therefore, count as ‘gains’ which contribute to achieving a “no net loss” outcome for key wetland services. Although, it can be argued that protection mechanisms measured against the regional background rate of wetland/biodiversity loss are part of ‘averted loss’;
- **Rehabilitation**: Rehabilitation results in an improvement in wetland condition, function, and associated biodiversity. Rehabilitation involves the manipulation of the physical, chemical, or biological characteristics of a degraded wetland system to repair or improve wetland integrity and associated ecosystem services. This could involve actions such as removing obstructions to flow or assisting the regeneration of the natural vegetation. By increasing the condition of a wetland system and its biodiversity, a positive contribution is made towards the goal of “no net loss”;
- **Establishment**: This involves the development (i.e. creation) of a new wetland system where none existed before by manipulating the physical, chemical, or biological characteristics of a specific site. The successful establishment would result in ‘gains’ in the wetland area, functions and biodiversity values. It is important to note, however, that while selected ecosystem services may quite readily be created through the establishment, many ecological values – let alone whole intact systems - are very difficult if not impossible to create. In general, establishment as a mechanism for delivering an offset should, therefore, be avoided, or only used in exceptional circumstances, where it is known (based on research and demonstrated experience) that a particular system or service that has been lost can be reliably created elsewhere. Sites would also need to be located such that they do not impact on important terrestrial resources (e.g. intact natural grasslands);
- **Direct compensation**: Direct compensation involves directly compensating affected parties for the ecosystem services lost as a result of development activities. This is ideally done by providing an equivalent substitute form of offset or in some cases may take the form of monetary compensation. This form of offset action is generally most relevant to direct services (e.g. loss of grazing land) but may occasionally be applied to compensate for losses of regulating and supporting services (e.g. through the direct treatment of polluted water).

5. OFFSET REQUIREMENTS

Taking the above into consideration and on reflection of the findings as presented in Table 3 of this report, offset requirements were defined for the proposed linear development and an additional 10m buffer (of potential edge effects) which would encroach on 0.28 ha of the wetland flat located along the western portion of the proposed linear development (Figure 13).

[4] Erosion occurring upstream of a specific point.

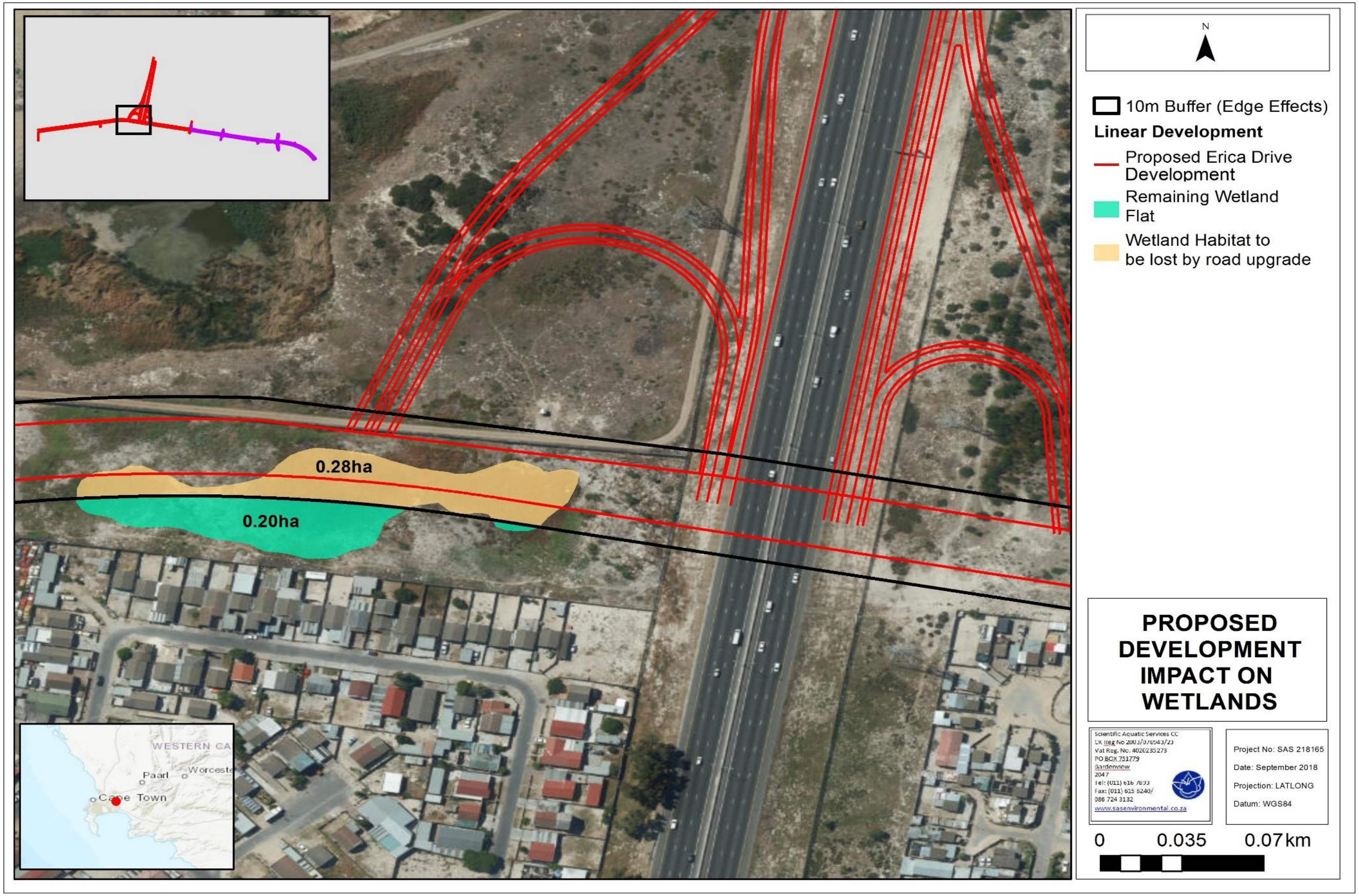


Figure 12: Map indicating the development footprint. A 10m buffer is included as edge effects and the anticipated loss of the wetland habitat, and the wetland habitat of the western wetland flat which will still remain.

The identification of required wetland offsets is divided into three key themes, namely **water resources and ecosystem services, ecosystem conservation, and species of conservation concern**. As per the key observations listed in Section 3 of this report, it was noted that no Species of Conservation Concern were identified and therefore this theme was excluded from the offset requirements.

The remaining two themes must be evaluated in the specific context of the impacted wetland to ensure that the residual impacts associated with the wetland is included when assessing proposed impacts and deciding on adequate mitigation measures, including offsets (Macfarlane D. *et al.* 2014). All results as obtained in Section 2 and 3 of this report were used to address the two key themes and determine the residual impact that will result due to the proposed linear development. The sections below provide a summary of the characteristics and findings considered for each of the themes.

5.1. Wetland Functional Services

The wetland flat proposed to be traversed by the proposed linear development, was determined to be of moderate importance in terms of wetland function and service provision (refer to Table 3 and 4) for which the highest scores were calculated for nitrate, phosphate and toxicant assimilation. This was considered to be mainly as a result of the locality of this wetland in a quaternary catchment in which urban development is dominant and the fact that this wetland is classified as a wetland flat, whereby the system is considered to act as a carbon sink. The remainder of the function and services assessed scored either a low score or 0.

5.2. Ecosystem Conservation

Ecosystem conservation ratios are calculated based on a suite of wetland characteristics that are regarded as important in determining conservation value. These include (i) ecosystem status; (ii) regional and national conservation context and (iii) local site attributes.

In the absence of more appropriate measures, the vegetation module of WET-Health can be used as a surrogate measure for habitat intactness pre- and post-development. This is regarded as a more appropriate measure than the integrated PES score as the suitability of a wetland to support biodiversity is most strongly linked to vegetation attributes. The Wet-Health vegetation module for the wetland calculated scores falling within Category D (Vegetation composition has been largely altered and introduced; alien and/or increased weed species occur in a greater abundance to the characteristic indigenous wetland species). However, in a regional conservation, this wetland is located within an indicated Critical Ecological Support Area (Figure 8 in Section 2.1 above). This wetland is also located in the Western Strandveld wetland vegetation group according to the National Freshwater Ecosystem Priority Areas (NFEPA) WetVeg database and is listed as endangered. Local site attributes considered included the transformed nature of the buffer presently around the wetland, and the wetland itself, due to surrounding urbanisation and anthropogenic activities.

The need and desirability of a wetland offset were also considered. Taking into consideration the total loss of habitat associated with the western wetland flat wetland – **0,28 hectares** as indicated in Table 3 and Figure 13 above, which includes a 10 m edge effect buffer– with the development of the proposed linear development activities, an offset to compensate for loss of habitat may be insisted upon by the relevant regulating authorities.

6. WETLAND OFFSET CALCULATION

Macfarlane D. *et al* (2014) as part of the attempt to develop a national standard, developed a tool for the calculation of wetland offset requirements by making use of risks and threat statuses in conjunction with the consideration of extent of the wetland and the PES and the perceived state of the wetland before and after development to define the required wetland offset necessary to meet the offset targets.

The wetland offset calculator was used to calculate the functional hectare equivalents as well as the habitat hectare equivalents for the themes ecosystem services and ecosystem conservation, respectively. These results are presented in Tables 5 and 6 below. The wetland flat is not considered important in terms of species of conservation concern, therefore, the calculation was not included in the assessment.

From the below assessment it is evident that 0,2 functional hectare equivalents and 0,7 habitat hectare equivalents of wetland area need to be conserved to offset the loss of the 0,28 hectares of wetland eco-services and ecosystem conservation value in the catchment (Table 3).

It is therefore recommended that feasible wetland offset receiving areas be investigated in order to compensate for the 0,2 functional hectare equivalents and 0,7 habitat hectare equivalents of wetland area lost. These targeted wetland should ideally be of the same HGM wetland type and located within the same local catchment as the western wetland flat.

Since the eastern wetland flat (0.38 ha) is of to small size and not within the same local catchment as the western wetland flat, this wetland is considered to not be feasible to be considered for wetland offsetting, and an offsite alternative should be considered.

Table 5: Functional area equivalents calculated for the western wetland flat affected.

Wetland Functionality Targets			
Impact Assessment	Prior to development	Wetland size (ha)	0,28
		Functional v alue (%)	48
	Post development	Functional v alue (%)	0
		Change in functional v alue (%)	48
	Key Regulating and Supporting Services Identified		
	Development Impact (Functional hectare equivalents)		0,1
Offset calculation	Offset Ratios	Triggers for potential adjustment in exceptional circumstances	Wetlands providing critical flood attenuation, water quality enhancement or carbon sequestration functions
		Functional Importance Ratio	1,5
	Functional Offset Target (Functional hectare equivalents)		0,2

Table 6: Ecosystem Conservation Targets for the western wetland flat affected.

Ecosystem Conservation Targets				
Impact Assessment	Prior to development	Wetland size (ha)	0,28	
		Habitat intactness (%)	45	
	Post development	Habitat intactness (%)	0	
		Change in habitat intactness (%)	45	
	Development Impact (Habitat hectare equivalents)		0,126	
Determining offset ratios	Ecosystem Status	Wetland Vegetation Group (or type based on local clasification)	Western Strandveld	
		Threat status of wetland	Threat status	CR
			Threat status Score	15
		Protection level of wetland	Protection level	Moderately Protected
			Protection level Score	0,75
			Ecosystem Status Muliplier	11,25
	Regional and National Conservation context	Priority of wetland as defined in Regional and National Conservation Plans	Moderate Importance	0,75
			Regional & National Context Multiplier	0,8
	Local site attributes	Uniqueness and importance of biota present in the wetland	Moderate biodiversity value	0,75
		Buffer zone integrity (within 500m of wetland)	Buffer compatability score	0,5
		Local connectivity	Moderate connectivity	0,75
			Local Context Multiplier	0,7
	Ecosystem Conservation Ratio			5,91
Offset Calculation	Development Impact (Habitat hectare equivalents)		0,1	
	Ecosystem Conservation Ratio		5,9	
	Ecosystem Conservation Target (Habitat hectare equivalents)		0,7	

7. CONCLUSIONS AND WAY FORWARD

Based on the findings of the study, the following can be summarised:

1. Given the findings of this investigation, it was found that only two natural wetlands are located along the proposed linear development. All other wetlands as identified in the Freshwater Assessment Report (Hanekom, 2017), are considered to be artificial;
2. A wetland flat (0.48 ha) is proposed to be traversed by the western portion of the proposed linear development. With the inclusion of an additional 10m buffer from the edge of the linear development that can be assumed will be lost as a result of the linear development and edge effects associated with the construction activities, it was calculated that this would cause a loss of 0.28 ha of wetland area;
3. The wetland flat (0.38 ha) located along the eastern portion of the proposed linear development would be unimpacted by the proposed road upgrade, however, it must be made clear to any contractors that this area may not be utilised for a contractor's camp or any laydown areas;
4. An initial offset investigation was therefore undertaken to ascertain the functional hectare equivalents and the habitat hectare equivalents required to offset the anticipated 0,28 ha loss of the western wetland flat. It was determined that 0,2 functional hectare equivalents and 0,7 habitat hectare equivalents of wetland area need to be conserved to offset this loss;
5. It is, therefore, recommended that feasible wetland offset receiving areas be investigated in order to compensate for the hectare equivalents lost. These targeted wetland should ideally be of the same HGM wetland type and located within the same local catchment as the western wetland flat;
6. As part of the abovementioned assessment, a rehabilitation and implementation plan must be compiled indicating what actions must be undertaken, both during construction and for the operational phase to ensure that the hectare equivalents lost are fully compensated for, and the overall PES of the receiving wetland improved in order to meet the functional hectare equivalent requirements.

8. REFERENCES

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APPENDIX A: Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the freshwater resources and drainage line features present in close proximity of the proposed development are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 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), DWA, 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.

1.2 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 watercourse traversed by the proposed linear development.

2. 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 C1: Classification System for Inland Systems, up to Level 3.

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

Table C2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
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 1: Inland systems

From the classification system, Inland Systems are defined as **aquatic ecosystems that have no existing connection to the ocean**[5] (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 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the DWA's Level 1 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 3: Landscape Setting

At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table C1) 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 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 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table C2), 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;

[5] 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.

- **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. 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 C3: 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

4. 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 C4: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

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

5. 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 1: 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 2: 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 C5: 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 C6: 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	↑
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.

6. 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 DWA (now 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 DWA 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 C7) of the wetland system being assessed.

Table C7: 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

7. Recommended Ecological Category (REC)

“A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure” (DWA, 1999).

The REC (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above), and is followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.
A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Table C8: Description of REC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

8. Wetland Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as “land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”.
The wetland zone delineation took place according to the method presented in the DWAF (2005) document “A practical field procedure for identification and delineation of wetlands and riparian areas.

An updated draft version of this report is also available and was therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008).
Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant periods of wetness (at least three months of saturation per annum) and the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

APPENDIX B: Calculations from the Wetland Assessment

PRESENT ECOLOGICAL STATE (PES), ECOSERVICES AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table B1: Presentation of the results of the Socio-cultural and Ecoservice provision for the wetland flats assessed

Ecosystem service	Wetland Flat
Flood attenuation	1,1
Streamflow regulation	1,1
Sediment trapping	1,1
Phosphate assimilation	2,2
Nitrate assimilation	1,6
Toxicant assimilation	2,6
Erosion control	1,1
Carbon Storage	2,3
Biodiversity maintenance	1,4
Water Supply	0,0
Harvestable resources	0,0
Cultivated foods	0,0
Cultural value	0,0
Tourism and recreation	0,4
Education and research	1,5
SUM	**16,4**
Average score	**1,1**

Table B2: Presentation of the results of the PES assessment (WET-Health) for the wetland flats assessed

<table>
<tr><th rowspan="2">HGM Unit</th><th rowspan="2">Ha</th><th rowspan="2">Extent (%)</th><th colspan="2">Hydrology</th><th colspan="2">Geomorphology</th><th colspan="2">Vegetation</th><th rowspan="2">Overall Score</th></tr>
<tr><th>Impact Score</th><th>Change Score</th><th>Impact Score</th><th>Change Score</th><th>Impact Score</th><th>Change Score</th></tr>
<tr><td>1</td><td>1</td><td>100</td><td>5,0</td><td>-1</td><td>5,0</td><td>-1</td><td>4,5</td><td>-1</td><td rowspan="2">4,8</td></tr>
<tr><td colspan="3">Area weighted impact scores*</td><td>5,0</td><td>-1,0</td><td>5,0</td><td>-1,0</td><td>4,5</td><td>-1,0</td></tr>
<tr><td colspan="3">PES Category</td><td>D</td><td>↓</td><td>D</td><td>↓</td><td>D</td><td>↓</td><td>D</td></tr>
</table>

APPENDIX C: Details, Expertise and Curriculum Vitae of Specialists

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Christel du Preez	MSc (Environmental Sciences) (North West University)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Johannesburg, 2007		
Postal code:	1401	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

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SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP);
Accredited River Health practitioner by the South African River Health Program (RHP);
Member of the South African Soil Surveyors Association (SASSO);
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member pf the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leone
Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

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- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

Yours faithfully

STEPHEN VAN STADEN

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Wetland Ecologist
Date of Birth	22 March 1990
Nationality	South African
Languages	English, Afrikaans
Joined SAS	January 2016

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2017
BSc (Hons) Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

COUNTRIES OF WORK EXPERIENCE

South Africa – KwaZulu Natal, Northern Cape, Gauteng, Mpumalanga, Free State, Eastern Cape

SELECTED PROJECT EXAMPLES

Wetland Assessments

- Baseline freshwater assessment as part of the environmental assessment and authorisation process for the proposed National Route 3 (N3) Van Reenen Village Caltex Interchange, KwaZulu Natal.
- Basic assessment for the proposed construction of supporting electrical infrastructure for the Victoria West Wind Farm, Victoria West, Northern Cape Province.
- Freshwater Ecological Assessment in Support of the WULA Associated with the Rehabilitation of the Wetland Resources in Ecopark, Centurion, and Gauteng.
- Wetland Ecological Assessment for the Proposed Mixed Land Use Development (Kosmosdal Extension 92) on the remainder of Portion 2 of the farm Olievenhoutbosch 389 Jr, City of Tshwane Metropolitan Municipality, Gauteng Province.
- Freshwater Ecological Assessment for the Mokate Pig Production and Chicken Broiler Facility on the farm Rietvalei Portion 1 and 6 near Delmas, Mpumalanga.
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Relocation of a Dragline from the Kromdraai Section to Navigation Section of the Anglo American Landau Colliery in Mpumalanga.
- Freshwater Assessment as part of the Environmental Assessment and Authorisation Process for a proposed 132kv powerline and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces.
- Freshwater Ecological Assessment of the Freshwater Prospect Stream in the AEL Operational Area, Modderfontein, Gauteng.
- Specialist Freshwater Scoping and Environmental Impact Assessment for the Proposed Development of the Platberg and Teekloof Wind Energy Facility and Supporting Electrical Infrastructure near Victoria West, Northern Cape Province.
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Development of Wilgedraai, Vaaldam Settlement 1777, Free State Province.
- Freshwater Resource Delineation and Assessment as part of the consolidation of four Environmental Management Plans at the Graspan Colliery, in Middelburg, Mpumalanga Province.
- Freshwater Assessment as part of the Water Use Authorisation for the proposed Copperton Wind Energy Facility, Northern Cape.
- Freshwater Resource and Water Quality Ecological Assessment for the Lakefield Manor Residential project, Boksburg, Gauteng Province.