WETLAND ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR AN AREA EARMARKED FOR THE DEVELOPMENT OF A STORMWATER ATTENUATION FACILITY NEAR PHILLIPI, WESTERN CAPE PROVINCE

Prepared for

Bergstan South Africa

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Declaration

This report has been prepared according to the requirements of Section 32 (3b) of the Environmental Impact Assessments (EIA) Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a wetland assessment as part of the environmental assessment and authorisation process for the proposed development of a storm water attenuation facility, hereafter referred to as the "subject property". The subject property is located directly to the south of Vangaurd Drive and to the east of Papkuilsvleiweg road within the suburb of Philippi, Western Cape Province. A field assessment was undertaken in November 2013 to determine the extent of wetland habitat within the subject property and the possible impact the proposed attenuation facility could have on the Ecological Importance and Sensitivity (EIS) of the feature.

It became evident during the field assessment that the wetland feature within the subject property can be defined as a unchannelled valley bottom feature[1] and not an isolated wetland depression as indicated by the National Freshwater Ecosystem Priority Areas database (NFEPA; 2011) and Prioritisation of City Wetlands Map. It is however considered possible that historically the feature did form part of an extensive floodplain wetland. The valley bottom is canalised upstream of the subject property and ponding was noted on both sides of Vanguard Drive and Old Lansdowne Road.

Wetland resources within the subject property has been significantly transformed due to alien and weedy grass encroachment as well as earth moving activities resulting in change in the natural hydrological regime. The results obtained by the Wet-Health[2] as well as wetland function and service provision[3] assessment were indicative of the degree to which transformation has occurred.

Various soil samples were taken across the subject property in order to identify the outer boundary of the wetland feature. Attention was also afforded to additional characteristics as defined by DWA (2005) and Job (2009) for the Western Cape Province. After taking all findings into consideration it was concluded that the earth canals and impoundment can be considered permanent wetland and the remainder of the subject property seasonal wetland due to the presence of facultative floral species as well as gleyed soil. The entire area earmarked for the development of the attenuation facility can therefore be considered wetland. It was therefore not possible to delineate the extent of the outer boundary of the wetland associated with the subject property and allocation of a buffer zone was not deemed to be necessary.

If correctly designed and rehabilitated, the attenuation facility can be created to sustain wetland habitat that will provide seasonal as well as permanent zones for various indigenous floral and faunal species. By so doing indigenous wetland habitat can be created within a region where a significant amount of wetlands are lost due to urban sprawl.

The table below serves as a summary of the key findings made during the impact assessment process.

Table A: A summary of impact significance before and after mitigation and rehabilitation as part of the attenuation facility development.

Impact	Phase	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Construction	Medium High (-ve)	Medium Low (-ve)
	Operation	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Construction	Medium Low (-ve)	Low (-ve)
	Operation	Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Construction	Medium High (-ve)	Medium Low (-ve)
	Operation	Medium Low	Very Low

[1] *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems* (Ollis *et al*., 2013)
[2] Macfarlane *et al.,* (2009)
[3] Kotze *et al* (2008)

Impact	Phase	Unmanaged	Managed
		(-ve)	(-ve)

From the results of the impact assessment it was observed that 3 major impacts are likely to impact the feature on the subject property. All the impacts are likely to have an effect on the receiving environment if unmanaged. However, the majority of the impacts can be effectively mitigated by proper planning, management and implementation of an effective rehabilitation plan and would most likely result in a positive impact after rehabilitation.

After conclusion of the wetland assessment, it is the opinion of the wetland ecologists that the proposed attenuation facility development be considered favourably, provided that the recommendations as provided in the impact assessment are adhered to.

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Acronyms

BGIS - Biodiversity Geographic Information Systems

DWA – Department of Water Affairs

DWAF – Department of Water Affairs and Forestry

EAP – Environmental Assessment Practitioner

EIA- -Environmental Impact Assessment

EIS - Ecological Importance and Sensitivity

FEPA - Freshwater Ecosystem Priority Areas

GA – General Authorisation

GIS – Geographic Information System

HGM – Hydrogeomorphic Units

NFEPA – National Freshwater Ecosystem Priority Areas

NWA – National Water Act

NWCS - National Wetland Classification Systems

PES – Present Ecological State

REC - Recommended Ecological Category

SANBI – South African National Biodiversity Institute

SAS – Scientific Aquatic Services

subWMA – sub Water Management Area

WMA – Water Management Area

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a wetland assessment as part of the environmental assessment and authorisation process for the proposed development of a storm water attenuation facility, hereafter referred to as the “subject property”. The subject property is located directly to the south of Vangaurd Drive and to the east of Papkuilsvleiweg road within the suburb of Philippi, Western Cape Province. A field assessment was undertaken in November 2013 to determine the extent of wetland habitat within the subject property and the possible impact the proposed attenuation facility could have on the Ecological Importance and Sensitivity (EIS) of the feature.

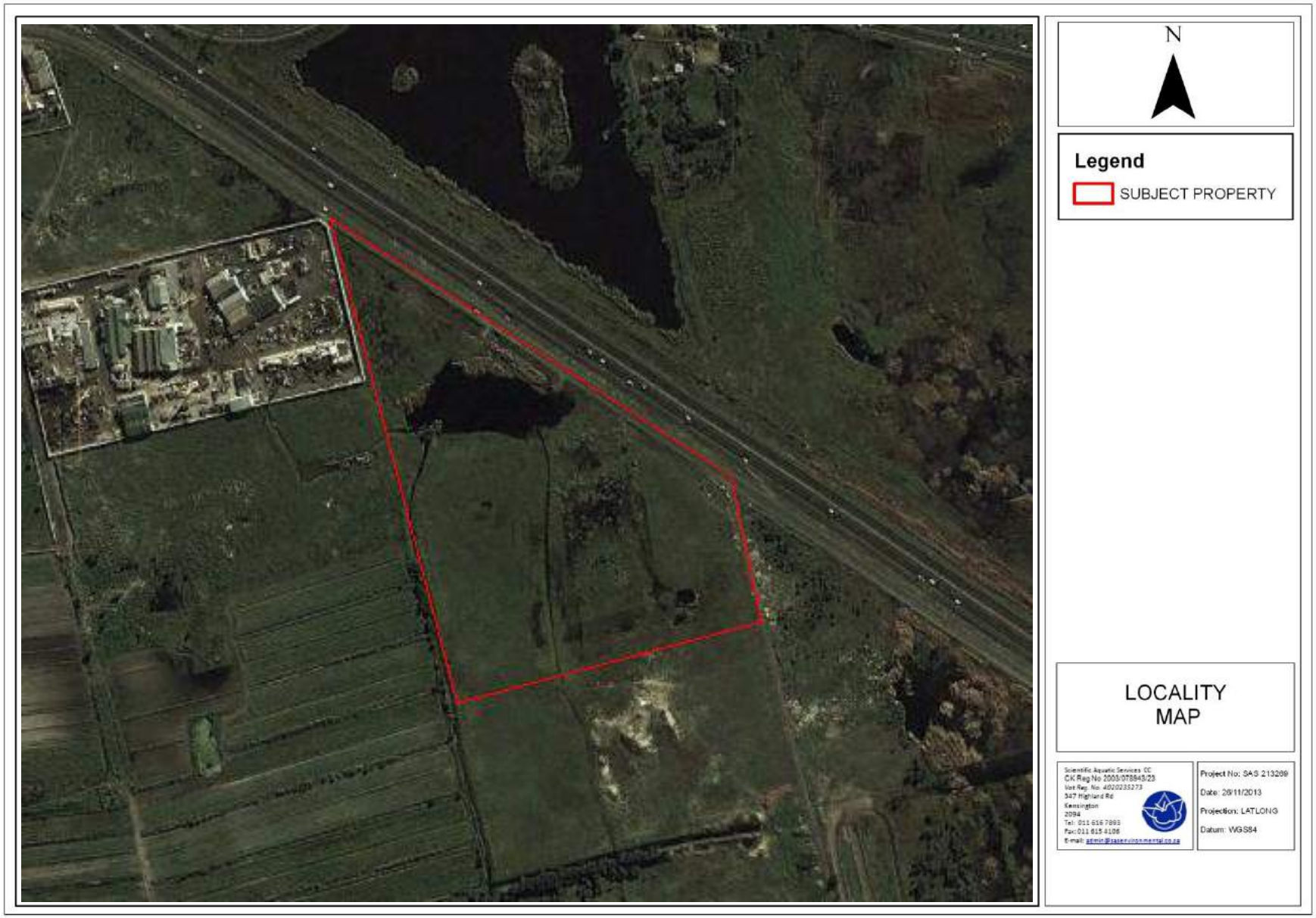

Figure 1: Digital satellite image depicting the location of the subject property in relation to surrounding areas.

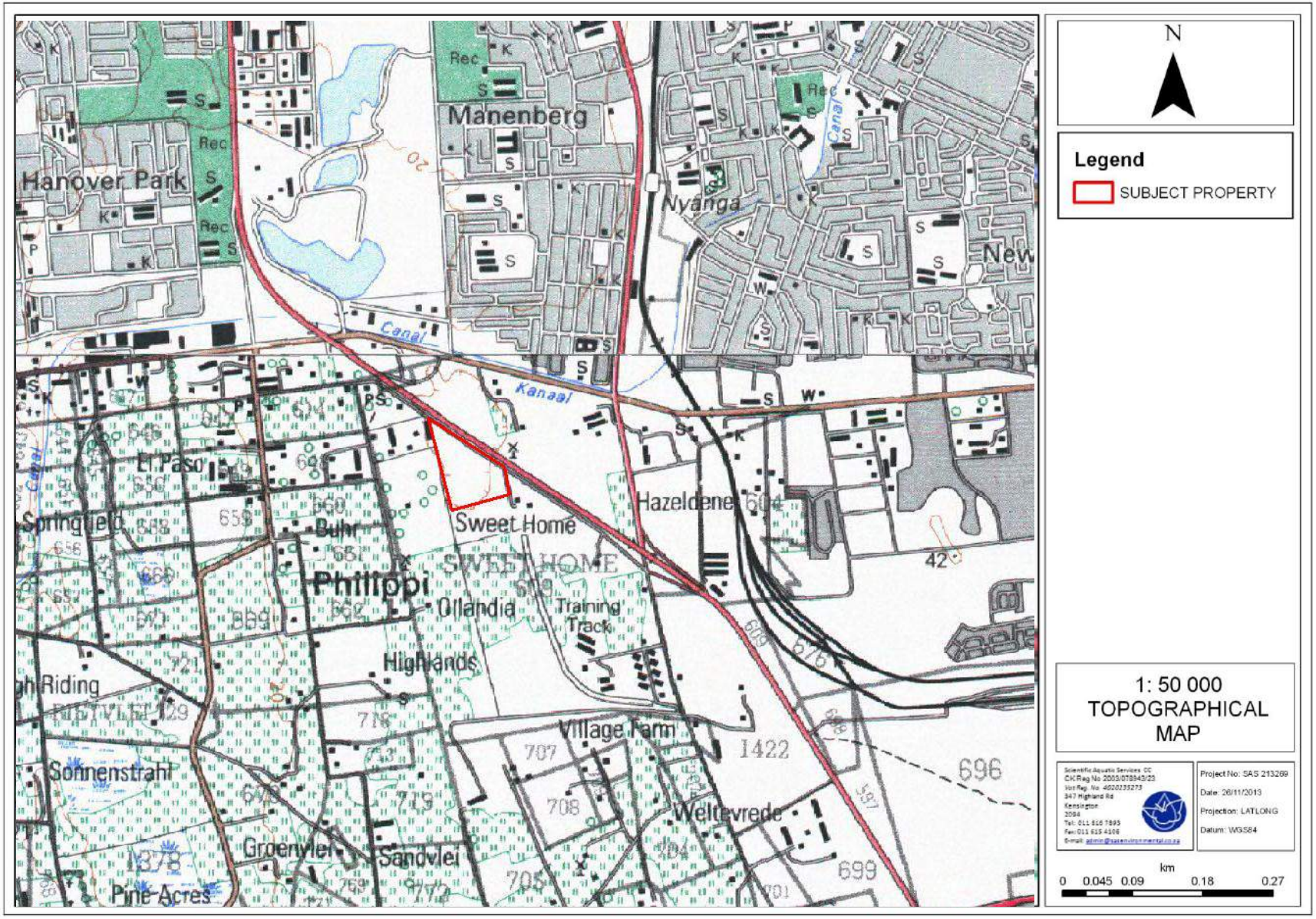

Figure 2: Location of the subject property depicted on a 1:50 000 topographical map in relation to surrounding areas.

1.1 Scope

Specific outcomes in terms of this report are as follows:

- Classification of wetland features according the Classification System for Wetlands and other Aquatic Ecosystems in South Africa as defined by Ollis *et al*., 2013;
- Define the wetland services provided by the resources on the subject property according to the Method of Kotze *et al* (2008) both prior to the development of the attenuation facility as well as after;
- Assess the wetland Health according to the resource directed measures guideline as defined by Macfarlane *et al*., (2009);
- Water sample analysis;
- Delineate the wetland temporary zone according to "DWA (Department of Water Affairs), 2005: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones";
- Determination of the EIS;
- Advocate a Recommended Ecological Category (REC) for the wetland feature based on the findings of the EIS assessment;
- Determine the environmental impacts of the proposed attenuation facility on the wetland area within the subject property;
- Define mitigatory measures to minimise impacts should the proposed activities proceed; and
- Identify wetland features located further from the proposed footprint that will still fall within the 500 m boundary of applicability of General Notice no. 1199 as it relates to the National Water Act.

1.2 Assumptions and limitations

The following assumptions and limitations are applicable to this report:

- The wetland assessment is confined to the subject property as per Figure 1 and 2 and does not include the neighbouring and adjacent properties, these were however considered as part of the desktop assessment;
- The subject property is located within a larger wetland system therefore, the entire extent of the subject property showed signs of hydromorphy with special mention of gleying observed within all soil samples taken and the presence of scattered facultative species. As a result it was not necessary to delineate the extent of the temporary wetland zone;
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked; and

- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative and obligate wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however if the DWA 2005 method is followed, all assessors should get largely similar results.

1.3 Indemnity and Terms of Use of this Report

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

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1.4 Legislative requirements

National Environmental Management Act, 1998

- The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended in June 2010, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

National Water Act (NWA, Act 36 of 1998)

- The NWA (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved.
- No activity may therefore take place within a watercourse unless it is authorised by DWA.
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWA in terms of Section 21.

General Notice 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA (Act 36 of 1998)

Wetlands are extremely sensitive environments and as such, the Section 21 (c) and (i) water use General Authorisation does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland or estuary.

2 METHOD OF ASSESSMENT

Refer to Appendix A for the methods of assessment applied in this study.

3 RESULTS

3.1 General importance of the subject property

3.1.1 The National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

National Freshwater Ecosystem Priority Areas (NFEPA; 2011), database was consulted to define the aquatic ecology of the wetland or river systems close to or within the subject property that may be of ecological importance. Aspects applicable to the subject property and surroundings are discussed below:

- The subject property falls within the Berg Water Management Area (WMA). Each WMA is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The SubWMA indicated for the subject property is the Greater Cape Town subWMA;
- The subWMA is not regarded important in terms of fish sanctuaries, translocation, relocation, rehabilitation or corridors;
- No river systems are located within 500m of the subject property, however an artificial canal is located approximately 425m to the north of the subject property;

- The Wetland Vegetation Type for the region where the subject property is located is the Southwest Sand Fynbos wetland vegetation. Southwest Sand Fynbos wetlands are listed as critically endangered wetland vegetation; and
- A large, artificial, flat wetland is indicated within the subject property boundary by the NFEPA database and an additional artificial, flat wetland is indicated directly to the north of the subject property. Both wetlands are indicated to have less than 25% natural vegetation remaining and are not indicated to be of any importance in terms of wetland conservation in the region.

3.1.2 Prioritisation of City Wetlands

According to the Prioritisation of City Wetlands Map the subject property includes a Sand Fynbos isolated wetland depression. This feature is listed as an isolated stormwater pond. However, upon investigation of the subject property it was determined that the feature forms a part of an unchannelled valley bottom system.

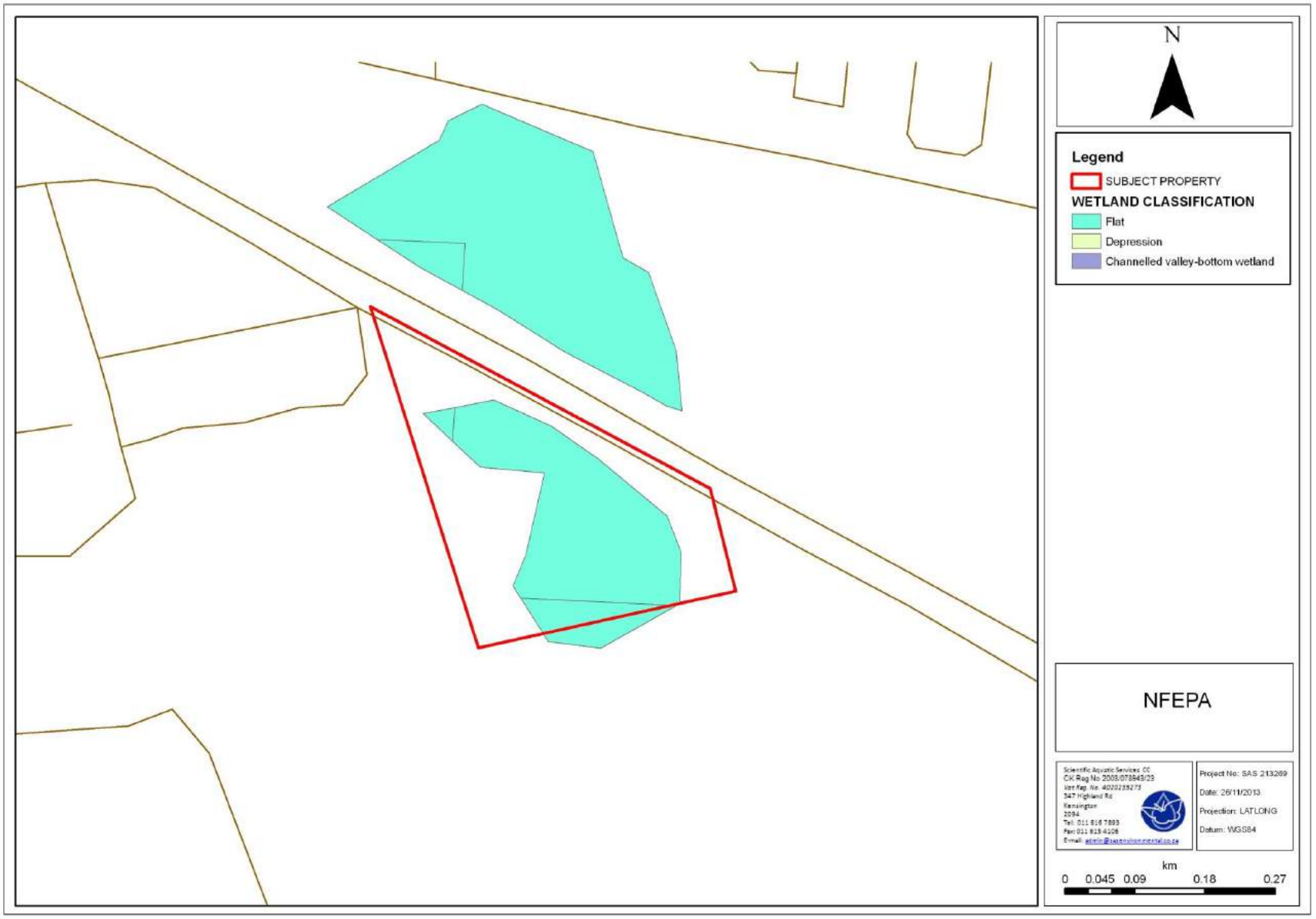

Figure 3: Wetland features indicated by NFEPA database.

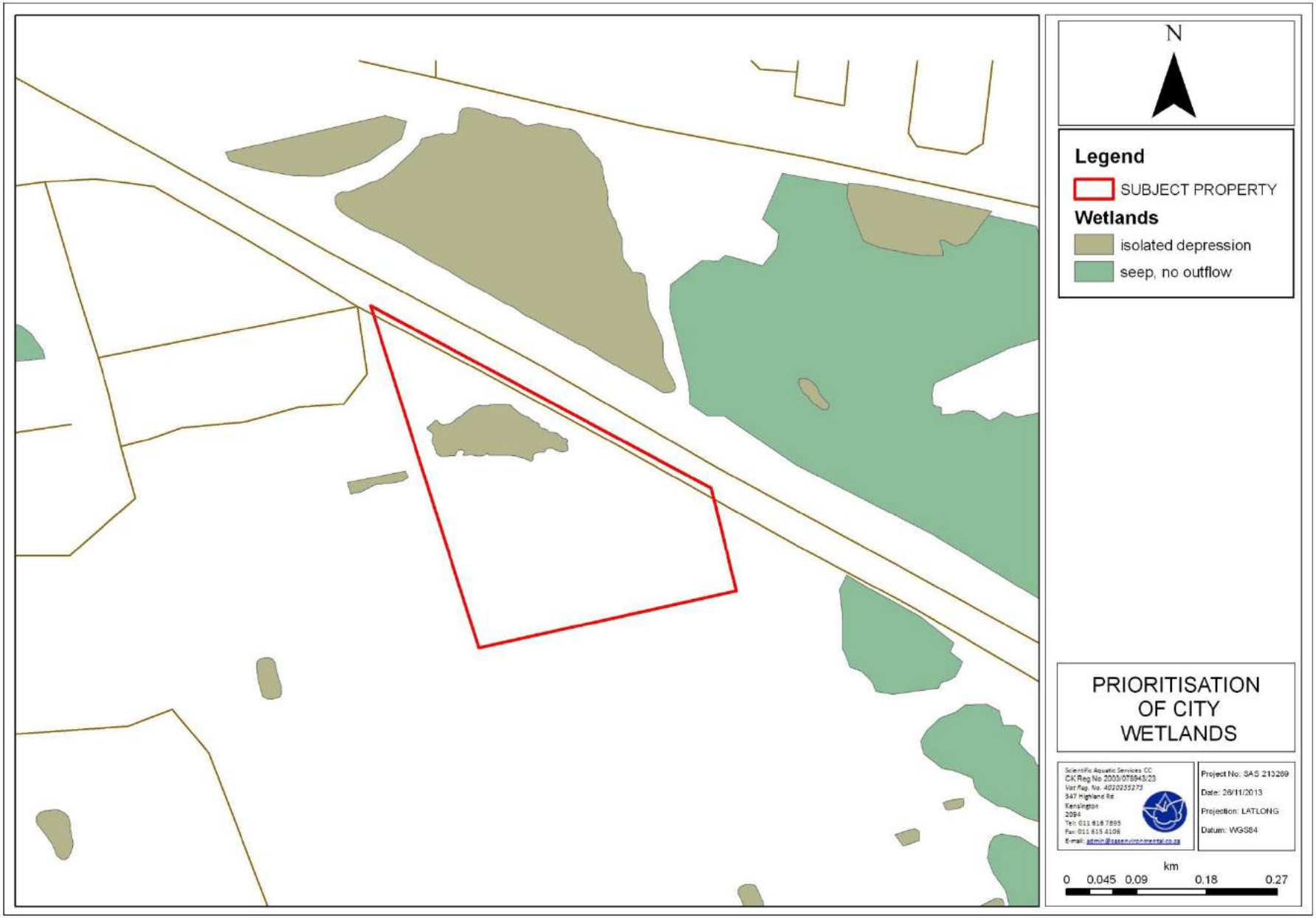

Figure 4: Wetland features indicated by the Prioritisation of City Wetlands Map.

3.2 Characterisation of Wetland Features

The wetland within the subject property was categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al,* 2013). It is considered likely that the wetland feature could historically have been considered part of a floodplain, however after groundtruthing was considered more representative of an unchannelled valley bottom wetland within its present state. Furthermore, background information as discussed in section 3.1 indicated the feature to be isolated, however, the Hydrogeomorphic Unit (HGM) does form part of a larger system extending past the subject property boundaries both in a south and northern direction.

Table 1: SANBI 2013.

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The subject property falls within the South Western Coastal Belt Ecoregion and the South-western Sand Fynbos wetland vegetation group (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Unchannelled valley bottom wetland: a valley-bottom wetland without a river channel running through it	Not applicable

3.3 General Wetland Assessment Results

Phillipi forms part of the Cape Flats which is documented as a ‘special case’ within the Western Cape due to the presence of a sandy soils coastal aquifer (Job, 2009). Therefore, a large part of water augmenting wetlands will be from the shallow water table. The shallow water table will also result in the relatively easy formation of permanent wetland zones within depressions caused by earth moving activity that in turn, could sustain obligate wetland species. It is therefore considered possible that, if correctly designed and rehabilitated, the attenuation dams can be created to sustain wetland habitat that will provide seasonal as well as permanent zones for various indigenous floral and faunal species. By so doing indigenous wetland habitat can be created within a region where a significant amount of wetlands are lost due to urban sprawl. It will however be necessary to ensure the correct design and operating procedure of the system in order to ensure that the wetland function and biodiversity support is not lost.

Historically the wetland feature associated with the subject property most likely formed part of a larger seasonal floodplain wetland. However, excavation activities associated with the road development, impoundment and canalization of flow has resulted in areas within the

subject property that can presently be considered permanent wetland zones with the remainder of the subject property being seasonally saturated. As a result, the feature in its present state can more accurately be defined as an unchannelled valley bottom and was therefore assessed as such in the sections that follow.

Figure 5: Artificial impoundment (left) and earth canal traversing the north western portion of the subject property (right).

3.4 Wetland Function Assessment

Wetland function and service provision were assessed for the wetland feature within the subject property. The assessment was undertaken twice, for the wetland feature within its Present Ecological State (PES) and again should an attenuation facility be created. During the assessment of the attenuation facility it was assumed that mitigation measures listed as part of the impact assessment will be strictly adhered to and that natural wetland habitat will be re-instated during rehabilitation.

Table 2: Wetland functions and service provision.

Ecosystem service	PES	Attenuation facility
Flood attenuation	1.9	2
Streamflow regulation	2.2	2.2
Sediment trapping	2.2	2.2
Phosphate assimilation	2.6	2.8
Nitrate assimilation	3.3	3.3
Toxicant assimilation	2.8	3
Erosion control	2.2	2.3
Biodiversity maintenance	1.5	1.8
Carbon Storage	2	2
Water Supply	0.8	0.8
Harvestable resources	0	0
Cultural value	0	0
Cultivated foods	0	0

Tourism and recreation	0	0.2
Education and research	1.7	1.7
SUM	**23.2**	**24.3**
Average score	**1.5**	**1.6**

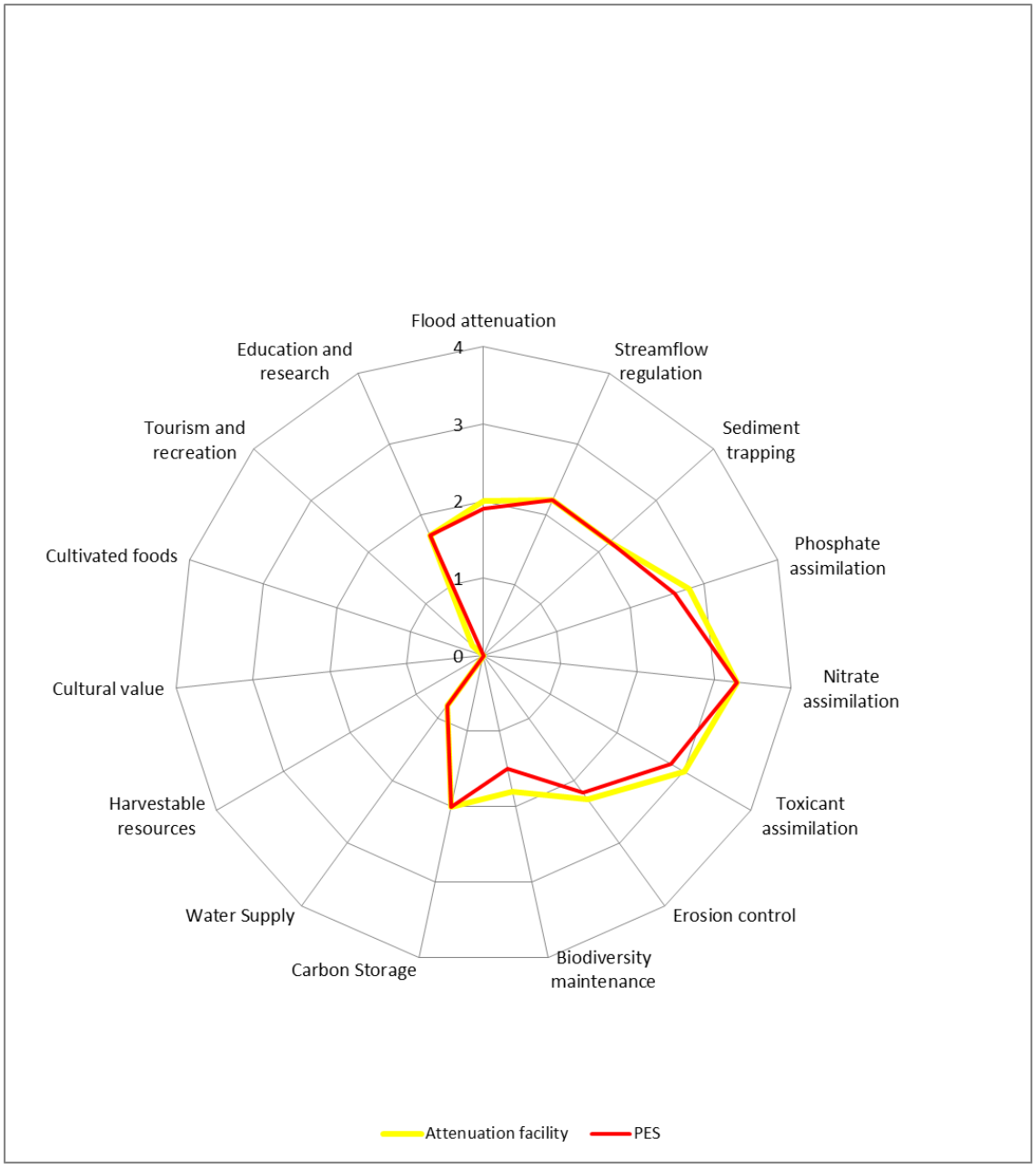

Figure 6: Radar plot of wetland services provided by the wetland within its PES and should an attenuation facility be built.

The wetland scored an intermediate level of ecological function and service provision (average score of 1.5 – Table 4), within its PES and the mean score calculated for ecological function and service provision remained within an intermediate category (average score 1.6 – Table 4) if an attenuation facility is to be created. However, the feature did show a slight

increase in importance in terms of flood attenuation, chemical assimilation, erosion control and biodiversity maintenance.

All the above mentioned functions and services that are likely to increase are directly related to the abundance and diversity of indigenous wetland floral species that will be used as part of the landscape design and rehabilitation.

The wetland feature is located within a catchment in which agricultural and industrial activities dominate. This increases the importance of the wetland in terms of the assimilation of phosphates, nitrates and toxicants which enter into the wetland within surface flow from surrounding roads, industrial and agricultural areas.

Areas within the immediate vicinity of the wetland feature have been cultivated and it is deemed likely that water from this feature may presently be used for irrigation, however no evidence of such activities were encountered during the field survey. No crops are planted directly into the wetland and no evidence was encountered during the field visit that the wetland is used by the local community as a source of harvestable resources or that the wetland is of any cultural significance. Therefore, the feature cannot be considered to be of significant importance in terms of harvestable resources, cultivated foods or cultural value.

Although the unchannelled valley bottom is considered of importance in terms of the provision of a number of services, it is in a degraded state. The entire subject property is dominated by weedy grass species such as *Avena fatua* and *Ehrharta calycina* and past disturbance within the feature has resulted in the proliferation of alien species such as *Ehrharta calycina* and *Pennisetum clandestinum*. However, it is deemed possible to create wetland habitat relatively representative of the Southwest Sand Fynbos wetland vegetation type, presently considered to be critically endangered, with the implementation of mitigation measures in combination with successful rehabilitation.

3.5 WET-Health

A level 2 assessment was undertaken in order to determine the PES of the wetland feature. Presented in Table 6 below.

Table 3: Summary of the Hydrological, Geomorphological and Vegetation PES of the wetland feature based on impact score and change score.

Feature type	Hydrology		Geomorphology		Vegetation	
	Impact Score	Trajectory of change	Impact Score	Trajectory of change	Impact Score	Trajectory of change
Un-channelled valley bottom	C	↓↓	E	↓	E	↓↓

The present hydrological state of the wetland calculated a score which falls within Category C (moderately modified). Therefore, impact on hydrology is clearly identifiable but limited. The present geomorphological as well as vegetation calculated scores which fall within Category E. Category E is defined as a change in geomorphic processes that can be considered great but some features are still recognisable and vegetation composition has been substantially altered but some characteristic species remain, although the vegetation consists mainly of introduced, alien and/or ruderal species.

The main activities that resulted in change in the natural hydrological regime of the feature are increased runoff volumes from surrounding hard surfaces as well as agricultural lands devoid of vegetation and earth works associated with earth canal construction, canalising a portion of the water that would have been transported subsurface through seasonal and temporary zones. In addition the construction of Old Lansdown Road and Vanguard Drive obstructed sufficient amounts of water over an extended period of time to create a permanently inundated impoundment, presently, impeding flow that would have augmented downstream wetland habitat.

The low scores calculated for both geomorphology as well as vegetation are as a result of earth moving activities, possible historic tilling in portions of the subject property, and subsequent vegetation transformation and significant loss of indigenous floral species diversity.

The overall score for the wetland which aggregates the scores for the three modules, namely hydrology, geomorphology and vegetation, was calculated using the formula [4] as provided by the Wet-Health methodology. The overall score calculated was 5.7, falling within the PES Category D (largely modified, a large change in ecosystem processes and loss of natural habitat and biota has occurred). Therefore, the proposed attenuation facility is not considered a significant threat to wetland areas within the subject property and could have the potential to increase PES with correct design and rehabilitation.

[4] ((Hydrology score) x 3 + (geomorphology score) x2 + (vegetation score) x 2))/ 7 = PES

3.6 Wetland Vegetation

Upon the assessment of the subject property, the various wetland vegetation components were assessed. Dominant species were characterised as either wetland or terrestrial species. The wetland species were then further categorised as seasonal and permanent zone species due to the lack of temporary and terrestrial zones. It should however be noted that the subject property was dominated by alien and invasive species, with very few indigenous floral species identified. It is therefore considered important that invasive species be removed and replaced with indigenous wetland species in order to re-establish the wetland vegetation assemblage within the subject property.

Table 4: Dominant floral species identified during the assessment of the wetland feature.

Seasonal species	Permanent species
Sarcocornia sp.	*Typha capensis*
Cynodon dactylon	*Carex* sp.
Pennisetum clandestinum	*Bolboschoenus maritimus*
Polypogon monspeliensis	*Lemna gibba*
Stenotaphrum secundatum	*Cyperus* sp.
Zantedeschia aethiopica	
Echium plantagineum	
Avena fatua	
Ehrharta calycina	
Senecio burchellii	
Trifolium sp.	

Figure 7: Seasonal zone dominated by weedy grasses (right) and algal growth noted within surface water (left) indicative of possible eutrophication.

3.7 Hydrological Function

Wetland hydrology generally refers to the inflow and outflow of water through a wetland therefore land is characterised as having wetland hydrology when, under normal circumstances, the land surface is either inundated or the upper portion of the soil is saturated at a sufficient frequency and duration to create anaerobic conditions[5].

Phillipi forms part of the Cape Flats which is documented as a 'special case' within the Western Cape due to the presence of a sandy soils coastal aquifer (Job, 2009). Therefore, a large part of water augmenting wetlands will be from the shallow water table. However, surface runoff from concrete surfaces, roads and agricultural areas within the catchment, will also contribute significantly to the amount of water reaching the wetland portion within the subject property.

Surface water presently flows in a northerly direction and damp soil within seasonal zones also indicated subsurface water movement at least for part of the year. Furthermore, the wetland is part of a longitudinal system extending past the subject property boundary. Therefore, water flow within the subject property is therefore considered important in terms of water provision for downstream areas. It is therefore important that the attenuation facility allows for movement of sufficient water volumes through the pond to downstream areas while effectively attenuating flood peaks.

The subject property is located within a valley, therefore the flow of water, presently, is towards the artificial impoundment. The attenuation facility will also be developed within the lowest portion of the topographical sequence and therefore no change of the hydrological regime is expected should the attenuation facility be created.

3.8 Aquatic and Wetland Fauna

The aquatic biota of the existing aquatic ecosystem was briefly assessed. From the results of the assessment it was identified that an aquatic macro-invertebrate community of fair diversity but limited sensitivity was present. Specific taxa noted include:

- Notonectidae
- Gerridae
- Corrixidae
- Velidae
- Potamonautidae
- Coenagrionidae

[5] www.*forestandrange.org/new_wetlands*

In addition to the aquatic macro-invertebrate community observed one fish species was observed namely *Gambusia affinis*. This species is known to have a sporadic distribution through the Western Cape.

No adult frogs were observed during the short site visit however two species of tadpole were observed. One species could not be identified while the other species was identified as *Xenopus laevis.*

Avifaunal species noted during the site visit included *Alopochen aegyptiaca, Vanellus armatus, Fulica cristata, Threskiornis aethiopicus.*

3.9 EIS Determination

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS Category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS Category as listed in Table 5 below.

Table 5: EIS determination

Determinant	PES	
	Score	Confidence
PRIMARY DETERMINANTS		
1.Rare & Endangered Species	0	3
2.Populations of Unique Species	1	4
3.Species/taxon Richness	0	4
4.Diversity of Habitat Types or Features	1	4
5.Migration route/breeding and feeding site for wetland species	1	3
6.PES as determined by WET-Health assessment	1	4
7.Importance in terms of function and service provision	2	3
MODIFYING DETERMINANTS		
8.Protected Status according to NFEPA Wetveg	3	4
9.Ecological Integrity	0	4
TOTAL	9	
MEDIAN	1	
OVERALL EIS Category	**D**	

Based on the findings of the EIS assessment it is evident that the wetland has, in its PES, an EIS falling within Category D (Low marginal), considered representative of the degree of transformation noted during the site assessment.

3.10 Recommended Ecological Category

Should the development of the attenuation facility prove feasible an appropriate and achievable REC is deemed to be Category D. Due to the significance of impacts already present within areas up and downstream of the subject property, resulting in a decrease in wetland habitat integrity of the larger system, it is doubtful that the PES can be increased to a higher Category.

3.11 Wetland Delineation

Various soil samples were taken across the subject property in order to identify the outer boundary of the wetland feature. Attention was also afforded to additional characteristics as defined by DWA (2005) and Job (2009) for the Western Cape Province (refer to Appendix B for field assessment results). After taking all findings into consideration it was concluded that the earth canals and impoundment can be considered permanent wetland and the remainder of the subject property was considered seasonal wetland due to the presence of facultative floral species as well as gleyed soil. The entire area earmarked for the development of the attenuation facility can therefore be considered wetland. It was therefore not deemed necessary to delineate the extent of the outer boundary of the wetland associated with the subject property.

Figure 8: Gleyed soils noted within all soil samples taken.

3.12 Buffer Allocation

Due to the entire subject property being considered wetland habitat as well as the nature of the proposed activities, the designation of a buffer zone to the wetland feature is not deemed necessary.

4 ATTENUATION POND ECOLOGICAL DESIGN CRITERIA

In order for the attenuation pond to minimise the loss of wetland habitat the attenuation facility should have several key characteristics. The points below serve to highlight the key design criteria which should be implemented in the design of the attenuation facility in order to support the ongoing function of the wetland and minimise the loss of the current wetland structure and function:

- The dam should be managed in such a way as to remain inundated beyond the current area of inundation for as short a period as possible;
- The bank slope of the attenuation pond should be as gradual as possible in order to create as large a littoral zone as possible with as much micro-habitat as possible due to the altered hydrology of the system;
- Bank material should primarily be sandy soil in order to allow effective rooting of wetland vegetation;
- Ensure that inundation is limited and that water flow is managed. The depth of the dam must not exceed 1000mm for a period exceeding 14 days beyond the area where open water currently exists in the system;
- During dry periods (summer) the wetlands upstream of the dam wall must be allowed to dry as much as possible with as little surface water as possible in order to ensure that the flooded area does not become devoid of vegetation but ensures that vegetation is re-established after the winter high rainfall period;
- Larger natural rocks found on the subject property could be used to create a micro habitat within the wetland areas by the creation of rock piles in strategic areas on the banks of the pond and in the wetland area;
- A small island should be created within the attenuation facility to support safe roosting and breeding of avifauna;
- The discharge points of all stormwater outlets are to be developed with soft engineering techniques as far as possible;
- At the point of discharge of the stormwater system, energy dissipation structures must be constructed to ensure that downstream erosion does not occur. Specific mention is made of the potential need for reno mattresses and short sections of gabions along with energy breaking structures; and
- The stormwater outlet structures should have shallow gradients, which must be vegetated upon completion of construction, to increase the surface area of the system in which vegetation species with an affinity for waterlogged soils can establish.

5 IMPACT ASSESSMENT

The tables below serve to summarise the significance of perceived impacts on the wetland biodiversity of the subject property based on the proposed construction of the attenuation facility within the subject property. The assessment was undertaken twice, in order to determine impact significance prior to mitigation and if mitigation and rehabilitation guidelines are adhered to.

5.1 Impact 1: Loss of wetland habitat and ecological structure

Activities leading to impact

Design	Construction	Rehabilitation	Operation
Poor design leading to extensive permanent open water	Earth works associated with the construction of the attenuation facility	Lack of wetland zonation variation within the created ponds	Maintenance activities
Inadequate design leading to prolonged inundation and loss of wetland vegetation	Site clearing and the removal of vegetation cover	Lack of indigenous floral diversity	Indiscriminate movement of vehicles during maintenance activities
Design not catering for an extensive littoral zone	Movement of construction vehicles through the subject property	Inadequate erosion control measures	Inadequate management of edge effects such as alien vegetation proliferation and erosion within disturbed areas
	Indiscriminate movement of vehicles within adjacent properties	Indiscriminate movement of vehicles	Blocked culverts after heavy rainfall events
	Inadequate outlet structure resulting in desiccation of downstream wetland habitat		
	Compacting of soil where construction activities have taken place		
	Dumping of building material or waste within the subject property		
	Inadequate management of edge effects such as alien vegetation proliferation and erosion during construction		
	Contamination of wetland soils and surface water		
	Contamination of wetland soils through diesel spillage or by cement mixing within the wetland feature		
	Indiscriminate fire		

Aspects of wetland habitat and ecology affected

Construction	Rehabilitation	Operational
Loss or transformation of wetland habitat	Loss or transformation of wetland habitat	Loss or transformation of wetland habitat in the vicinity of maintenance activities
Loss of wetland biodiversity	Loss of wetland biodiversity	Loss of wetland biodiversity

Impact on wetland habitat and ecology

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**5**	**3**	**4**	**2**	**4**	**8**	**10**	**80 (Medium High) Negative**
Operation	**4**	**3**	**3**	**1**	**4**	**7**	**8**	**56 (Medium Low) Negative**

Essential mitigation measures:

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise environmental damage;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas;
- All vehicles should remain on designated roads with no indiscriminate driving through the subject property or adjacent properties;
- All spills should be immediately cleaned up and treated accordingly;
- Regularly inspect all construction vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent hydrocarbons reaching surface/subsurface water that could potentially flow to the wetland feature;
- The relevant approvals must be obtained from DWA for any activities within the wetland area and associated buffer. In this regard special mention is made of water use licences in terms of section 21 c and i of the National Water Act as well as any authorisation that may apply as part of General Notice 1199 as published in the Government Gazette 32805 of 2009 as it relates to the National Water Act, 1998 (Act 36 of 1998);
- Design and implement a Rehabilitation and Management Plan with input from a qualified landscaping architect;
- As part of the ecologically sensitive landscaping plan and rehabilitation attention should be afforded to the following:
  - Rip and profile areas within the wetland zone that have been compacted due to construction activities;
  - All alien vegetation should be removed during all phases of the development;
  - As far as possible alien vegetation should be removed manually, should machinery or vehicles be required the impacted areas should be ripped and profiled;
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - All alien or weed species removed should be disposed of at a registered waste disposal site;
  - After profiling, the feature should be lightly compacted and reseeded with indigenous vegetation species or species recommended by the landscape architect that will provide cover and bind soil;
  - Vegetation requirements:
    - It is not considered to be of very high importance to plant significant numbers of plants in the areas to be rehabilitated, rather a higher diversity of floral species (dependent on availability). Each year seed can be harvested to increase the density of the vegetation within rehabilitated areas;
    - If possible, species such as *Cyperus* species and *Zantedeschia aethiopica* (Arum lily) should be removed prior to construction and replanted during rehabilitation;
    - Give priority to perennial species that establish rapidly;
    - Select species adaptable to the broadest ranges of depth, frequency and duration of inundation (hydroperiod); and
    - Give priority to species that have already been used successfully in constructed stormwater wetlands and that are commercially available.
  - The landscaping plan should address rehabilitation to ensure ongoing wetland function if the preferred layout is selected;
  - Re-assessment and monitoring are considered very important to determine success of the rehabilitation and any follow-up measures required; and
  - Monitor the system, visually, for erosion and incision after heavy rainfall events;
- Sanitation facilities must be provided for the duration of the proposed development and all waste removed to an appropriate facility. These facilities must be located outside of the wetland feature and must be regularly serviced;

- Prevent run-off from dirty water areas entering the wetland habitat;
- The rehabilitation area is located next to large roads and as a result it is expected that litter could be blown from surroundings, it is therefore considered important to regularly inspect the site for litter;
- No dumping of development waste material should be allowed within the subject property;
- No temporary storage of building material should be allowed within permanently saturated areas; and
- All waste, with special mention of waste rock and spoils and remaining building material should be removed from the site on completion of the construction or maintenance.

Recommended mitigation measures

- Restrict activities to winter months in order to limit impact on aquatic species utilising wetlands as foraging and breeding habitat.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**5**	**3**	**3**	**1**	**3**	**8**	**7**	**56 (Medium Low) Negative**
Operation	**2**	**3**	**1**	**1**	**2**	**5**	**4**	**20 (Very Low) Negative**

Probable latent impacts

- The wetland feature within the subject property may be permanently altered or lost if inadequate rehabilitation takes place; and
- Wetland structure will be locally altered due to altered hydrology of the system and increased inundation.

The probability of impact as a result of construction related activities cannot be avoided and therefore will therefore remain definite even though mitigation measures are implemented. However, severity and duration during the construction phase can be reduced. The impact significance was therefore determined to be medium high (negative) prior to mitigation and medium low (negative) after mitigation.

It is considered highly likely that impact could occur as a result of maintenance activities during the operation phase. The impact significance was determined to be medium low (negative) prior to mitigation and very low (negative) after mitigation.

5.2 Impact 2: Changes to wetland ecological and socio-cultural service provision

Activities leading to impact

Design	Construction	Rehabilitation	Operation
Poor design leading to extensive permanent open water	Earth works associated with the construction of the attenuation facility	Lack of wetland zonation variation within the created ponds	Inadequate management of edge effects such as alien vegetation proliferation and erosion within disturbed areas
Inadequate design leading to prolonged inundation and loss of wetland vegetation	Site clearing and the removal of vegetation cover	Lack of indigenous floral diversity	
Design not catering for an extensive littoral	Inadequate culvert size resulting in desiccation of		

Design	Construction	Rehabilitation	Operation
zone	downstream wetland habitat		
	Inadequate management of edge effects such as alien vegetation proliferation and erosion during construction		

Aspects of wetland ecological and socio-cultural services affected

Construction	Rehabilitation	Operational
Inability to support wetland biodiversity due to disturbance of the wetland feature during the construction phase	Inability to support wetland biodiversity due to ineffective rehabilitation	Loss of wetland biodiversity in the vicinity of maintenance activities
Loss of phosphate, nitrate and toxicant removal abilities due to disturbance of the wetland feature and removal of wetland vegetation during construction activities	Loss of phosphate, nitrate and toxicant removal abilities due to unsuccessful re-establishment of the wetland floral community	Loss of phosphate, nitrate and toxicant removal abilities due to disturbance of the wetland feature and removal of wetland vegetation during maintenance activities
Loss of sediment trapping and stream flow regulation abilities	Loss of sediment trapping and stream flow regulation abilities	Loss of sediment trapping and stream flow regulation abilities

Impact on ecological and socio-cultural services affected

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**4**	**3**	**3**	**1**	**5**	**7**	**9**	**63 (Medium Low) Negative**
Operation	**3**	**3**	**2**	**1**	**4**	**6**	**7**	**42 (Low) Negative**

Essential mitigation measures:

- The footprint of construction related activities should be kept to a minimum;
- Incorporate adequate erosion management measures in order to prevent erosion and the associated sedimentation of the wetland feature. Management measures may include berms, silt fences, hessian curtains and stormwater diversion away from areas susceptible to erosion. Care should however be taken so as to avoid additional disturbance during the implementation of these measures;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas; and
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas.

Recommended mitigation measures

- Restrict activities to winter months in order to limit impact on aquatic species utilising wetlands as foraging and breeding habitat.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**4**	**3**	**2**	**2**	**3**	**7**	**7**	**49 (Low) Negative**
Operation	**1**	**3**	**1**	**1**	**2**	**4**	**4**	**16 (Very Low) Negative**

Probable latent impacts

- Overall wetland function and service provision may be reduced permanently, should mitigation measures not be strictly adhered to.

The loss of wetland function and service provision are considered likely during both phases, should mitigation measures not be adhered to. However, as with the loss of wetland habitat impact assessment, it is deemed possible to reduce negative impact significance with mitigation and successful rehabilitation to the extent that impact significance can be positive during the rehabilitation phase.

5.3 Impact 3: Impacts on wetland hydrological function and sediment balance

Activities leading to impact

Design	Construction	Rehabilitation	Operational
Poor design leading to extensive permanent open water	Earthworks in the vicinity of wetland areas	Ineffective rehabilitation	Maintenance activities
Inadequate design leading to prolonged inundation and loss of wetland vegetation	Inadequate outlet structure resulting in desiccation of downstream wetland habitat	Inadequate erosion control measures	
Design not catering for an extensive littoral zone	Inadequate erosion control measures		

Aspects of wetland hydrology and sediment balance affected

Construction	Rehabilitation	Operational
Incision of wetland areas and erosion of wetland habitat	Incision of wetland areas and erosion of wetland habitat	Incision of wetland areas and erosion of wetland habitat
Sediment deposition	Sediment deposition	Sediment deposition
Altered runoff patterns	Altered runoff patterns	Altered runoff patterns
Increased erosion potential		Increased erosion potential

Impact on wetland hydrology and sediment balance

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**5**	**3**	**4**	**2**	**5**	**8**	**10**	**80 (Medium High) Negative**
Operation	**4**	**3**	**3**	**1**	**4**	**7**	**8**	**56 (Medium Low) Negative**

Essential mitigation measures:

- Incorporate adequate erosion management measures in order to prevent erosion and the associated sedimentation of the wetland feature. Management measures may include berms, silt fences, hessian curtains and stormwater diversion away from areas susceptible to erosion. Care should however be taken so as to avoid additional disturbance during the implementation of these measures;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas,
- Any discharge of runoff into the wetland system must be done in such a way as to prevent erosion. In this regard special mention is made of the use of energy dissipating structures in storm water discharge
- After profiling, the disturbed areas should be lightly compacted and reseeded with indigenous vegetation species that will provide cover and bind

soil; and
- Ecological design criteria must be implemented into the design of the attenuation pond.

Recommended mitigation measures
- Desilt the attenuation pond as necessary.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction	**5**	**3**	**3**	**2**	**3**	**8**	**8**	**64 (Medium Low) Negative**
Operation	**2**	**3**	**1**	**1**	**2**	**5**	**4**	**20 (Very Low) Negative**

Probable latent impacts
- N/A

Earthworks in the vicinity of the wetland feature that could result in erosion, sedimentation and altered runoff patterns are considered to be likely during both phases of the proposed attenuation facility development. However, with effective erosion control in combination with the re-establishment of indigenous vegetation it is deemed possible that the impact significance can be reduced.

5.4 Impact Assessment Conclusion

If mitigation and management measures are implemented as outlined in this document, the likelihood of impacts occurring and the consequence of all potential impacts may be significantly reduced. The table below serves as a summary of the key findings made during the impact assessment process.

Table 6: A summary of impact significance before and after mitigation as part of the attenuation facility development.

Impact	Phase	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Construction	Medium High (-ve)	Medium Low (-ve)
	Operation	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Construction	Medium Low (-ve)	Low (-ve)
	Operation	Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Construction	Medium High (-ve)	Medium Low (-ve_
	Operation	Medium Low (-ve)	Very Low (-ve)

From the results of the impact assessment it was observed that 3 major impacts are likely to impact the feature on the subject property. All the impacts are likely to have an effect on the receiving environment if unmanaged. However, the majority of the impacts can be effectively mitigated by proper planning, management and implementation of an effective rehabilitation

plan. If the project is well executed the project could have a positive impact on wetland ecological service provision and on the hydrological functioning of the system as well as sediment control in the system.

5.5 Cumulative Impacts

Wetlands within the region are under continued threat due to ongoing industrial and informal development in the area. The continued sprawl of developments within the area has resulted in the loss of a large number of wetland features. The disturbance of the wetland feature within the study area may add to the cumulative effect on the loss of wetlands. However, it is also deemed highly likely that with rehabilitation and implementation of ecologically sensitive landscaping the EIS of the feature can increase and in future could provide habitat for both faunal and floral species under severe threat due to cumulative loss of wetland in the region. Furthermore, will also result in positive impact due to increased attenuation and reduced downstream flooding.

6 LAB ANALYSIS – WATER TEST RESULTS

To be provided as soon as it is received.

7 CONCLUSION

SAS was appointed to conduct a wetland assessment as part of the environmental assessment and authorisation process for the proposed development of storm water attenuation facility, hereafter referred to as the "subject property". The subject property is located directly to the south of Vangaurd Drive and to the east of Papkuilsvleiweg road within the suburb of Philippi, Western Cape Province. A field assessment was undertaken in November 2013 to determine the extent of wetland habitat within the subject property and the possible impact the proposed attenuation facility could have on the EIS of the feature.

It became evident during the field assessment that the wetland feature within the subject property can be defined as an unchannelled valley bottom feature[6] and not an isolated wetland depression as indicated by the NFEPA (2011) and Prioritisation of City Wetlands Map. It is however considered possible that historically the feature did form part of an extensive floodplain wetland. The valley bottom was canalised upstream of the subject property and ponding was noted on both sides of Vanguard Drive and Old Lansdowne Road.

[6] *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems* (Ollis *et al*., 2013)

Wetland resources within the subject property has been significantly transformed due to alien and weedy grass encroachment as well as earth moving activities resulting in change in the natural hydrological regime. The results obtained by the Wet-Health[7] as well as wetland function and service provision[8] assessment were indicative of the degree to which transformation has occurred.

Various soil samples were taken across the subject property in order to identify the outer boundary of the wetland feature. Attention was also afforded to additional characteristics as defined by DWA (2005) and Job (2009) for the Western Cape Province. After taking all findings into consideration it was concluded that the earth canals and impoundment can be considered permanent wetland and the remainder of the subject property seasonal wetland due to the presence of facultative floral species as well as gleyed soil. The entire area earmarked for the development of the attenuation facility can therefore be considered wetland. It was therefore not possible to delineate the extent of the outer boundary of the wetland associated with the subject property and allocation of a buffer zone will not be viable.

If correctly designed and rehabilitated, the attenuation facility can be created to sustain wetland habitat that will provide seasonal as well as permanent zones for various indigenous floral and faunal species. By so doing indigenous wetland habitat can be created within a region where a significant amount of wetlands are lost due to urban sprawl.

The table below serves as a summary of the key findings made during the impact assessment process.

Table 7: A summary of impact significance before and after mitigation and rehabilitation as part of the attenuation facility development.

Impact	Phase	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Construction	Medium High (-ve)	Medium Low (-ve)
	Operation	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Construction	Medium Low (-ve)	Low (-ve)
	Operation	Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Construction	Medium High (-ve)	Medium Low (-ve_
	Operation	Medium Low (-ve)	Very Low (-ve)

[7] Macfarlane *et al.*, (2009)
[8] Kotze *et al* (2008)

From the results of the impact assessment it was observed that 3 major impacts are likely to impact the feature on the subject property. All the impacts are likely to have an effect on the receiving environment if unmanaged. However, the majority of the impacts can be effectively mitigated by proper planning, management and implementation of an effective rehabilitation plan.

After conclusion of the wetland assessment, it is the opinion of the wetland ecologists that the proposed attenuation facility development be considered favourably, provided that the recommendations as provided in the impact assessment are adhered to.

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APPENDIX A

Method of Assessment

A – 1 Desktop Study

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the subject property included:

- National Freshwater Ecosystem Priority Areas (NFEPAs) (2011)
  - NFEPA water management area (WMA);
  - NFEPA wetlands/National wetlands map;
  - Wetland and estuary Fresh Water Ecosystem Priority Areas (FEPA);
  - FEPA (sub)WMA % area;
  - Sub water catchment area FEPAs;
  - Water management area FEPAs;
  - Fish sanctuaries;
  - Wetland ecosystem types;
- Prioritisation of City Wetlands

A – 2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland features encountered within the subject property were assessed using the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems* (Ollis *et al*., 2013).

A summary of Levels 1 to 4 of the proposed Classification System for Inland Systems are presented in Table 1 and 2, below.

Table 1: Proposed classification structure 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 2: 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

For the proposed Classification System, Inland Systems are defined as ***an aquatic ecosystem that have no existing connection to the ocean***[9] (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 an historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the proposed Classification System is that of Department of Water Affairs (DWA) Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). 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.

[9] 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.

Level 2: NFEPA Wet Veg Groups

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.

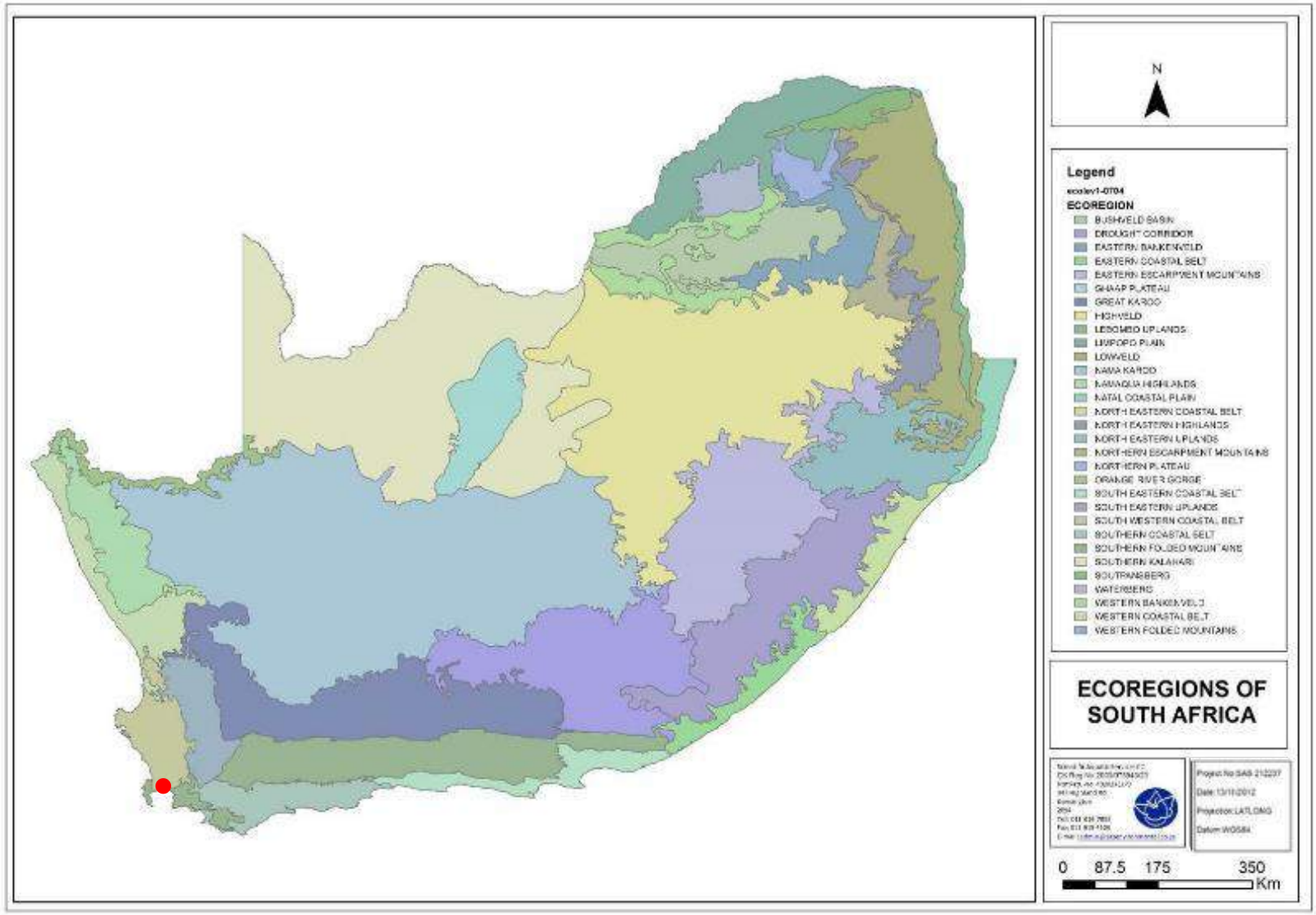

Figure 1: Map of Level 1 Ecoregions of South Africa, with the approximate position of the subject property indicated in red.

Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 3) 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.
- ***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 permendicular 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

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the proposed National Wetland Classification Systems (NWCS) (Table 13), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- ***River:*** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- ***Channelled valley-bottom wetland:*** a valley-bottom wetland with a river channel running through it.
- ***Unchannelled valley-bottom wetland:*** a valley-bottom wetland without a river channel running through it.
- ***Floodplain wetland:*** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- ***Depression:*** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- ***Wetland Flat:*** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- ***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.,* 2009) and WET-EcoServices (Kotze *et al.,* 2008).

A – 3 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[10] is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

Level of Evaluation

Two levels of assessment are provided by WET-Health:

[10] Kleynhans et al., 2007

- 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; and
- 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*.

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 impact of individual activities and then separately assessing the *intensity* of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in Table 3.

Table 3: 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 recognizable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	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 from 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 4).

Table 4: 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 provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM units and for the entire wetland.

A – 4 Wetland function assessment

"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".[11] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al* (2008). 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
- 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.

[11] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999*

Table 5: 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

A – 5 Defining Ecological Importance and Sensitivity

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category. A confidence score is also provided on a scale of 0 to 4, where 0 indicates low confidence and 4 high confidence.

Table 6: EIS Category definitions

EIS Category	Range of Median	Recommended Ecological Management Class[12]
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

A – 6 Recommended Ecological Category

"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." [13]

The REC was determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity of the resource (sections above).

[12] Ed's note: Author to confirm exact wording for version 1.1

[13] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

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 to enhance the PES of the wetland feature.

Table 7: Description of REC classes.

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

A – 7 Wetland Delineation

For the purposes of this investigation, a wetland habitat is defined in the National Water Act (NWA, 1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the Department of Water Affairs and Forestry (DWAF) in February 2005. Attention was also paid to wetland soil guidelines as defined by Job (2009) for the Western Cape. The foundation of the method is based on the fact that wetlands have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils; and
- Vegetation adapted to saturated soils.

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).

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 part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, 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.

A – 8 Ecological Impact Assessment

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, environmental impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[14]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and is used to determine whether mitigation is necessary[15].

The assessment of significance is undertaken twice. Initial significance is based only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[14] The definition has been aligned with that used in the ISO 14001 Standard.

[15] Some risks/impacts that have low significance will however still require mitigation

LIKELIHOOD DESCRIPTORS

Probability of impact	**RATING**
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 100m	2
Local area / within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	4
Entire habitat unit / Entire system / > 2000ha impacted / Linear features affected > 3000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 8: Significance Rating Matrix.

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
	3	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30**	**33**	**36**	**39**	**42**	**45**
	4	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**	**60**
	5	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**
	6	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**	**72**	**78**	**84**	**90**
	7	**14**	**21**	**28**	**35**	**42**	**49**	**56**	**63**	**70**	**77**	**84**	**91**	**98**	**105**
	8	**16**	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**88**	**96**	**104**	**112**	**120**
	9	**18**	**27**	**36**	**45**	**54**	**63**	**72**	**81**	**90**	**99**	**108**	**117**	**126**	**135**
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**

Table 9: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Improve current management	Maintain current management
High	101-125	Improve current management	Maintain current management
Medium-high	76-100	Improve current management	Maintain current management
Medium-low	51-75	Maintain current management	Improve current management
Low	26-50	Maintain current management	Improve current management
Very low	1-25	Maintain current management	Improve current management

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for all stages of the project cycle including:
  - Construction;
  - Operation; and
  - Rehabilitation.
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur post-closure.

Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed development:

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[16] are identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimization, mitigation or compensation.

Desired outcomes are defined, and have been developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, with estimates of the *resources* (including human resource and training requirements) *and responsibilities for implementation*.

[16] Mitigation measures should address both positive and negative impacts

APPENDIX B

Field Assessment Sheets

Site number : 1		
GPS position :	34°00'16.67"S 18°32'59.10"E	
Description of topographic position	Permanent zone within earth canal, bottom of the topographical sequence.	
Vegetation :	*Typha capensis*	
Soil morphology 0-10cm		
Mottling:	**Present :** No	**Contrast :**
	Colour :	**Abundance :**
Soil morphology 40-50cm		
Mottling :	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Zone indicated by the above : Permanent		
Comments : Soil was dark grey (gleyed), surface water was present.		

Site number : 2		
GPS position :	34°00'18.04"S 18°32'59.70"E	
Description of topographic position	Moving toward center of the subject property, where a definite change in floral species diversity was noted. Bottom of the topographical sequence.	
Vegetation :	*Cynodon dactylon* *Echium plantagineum* *Ehrharta calycina* *Avena fatua*	
Soil morphology 0-10cm		
Mottling:	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Soil morphology 40-50cm		
Mottling :	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Zone indicated by the above : Seasonal		
Comments : Damp, dark grey soils with a high number of weedy grass species present.		

Site number : 3		
GPS position :	34°00'19.05"S 18°33'00.45"E	
Description of topographic position	Centre of the subject property. Bottom of the topographical sequence.	
Vegetation :	*Cynodon dactylon* *Echium plantagineum* *Ehrharta calycina* *Avena fatua*	
Soil morphology 0-10cm		
Mottling :	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Soil morphology 40-50cm		
Mottling :	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Zone indicated by the above : Seasonal		
Comments : No change in soil colour when compared to sample 2 with very faint streaking, vegetation dominated by weedy grasses.		

Site number : 4	
GPS position :	34°00'32.41"S 18°33'01.58"E
Description of topographic position	Southern portion of subject property. Bottom of the topographical sequence.
Vegetation :	*Stenotaphrum secundatum*

	Echium plantagineum *Ehrharta calycina* *Avena fatua*	
Soil morphology 0-10cm		
Mottling :	**Present :**No	**Contrast :**
	Colour :	**Abundance :**
Soil morphology 40-50cm		
Mottling :	**Present :** No	**Contrast :**
	Colour :	**Abundance :**
Zone indicated by the above : Seasonal.		
Comments : Gleyed soil with weedy grasses dominating.		